Conference Program

July 30 - August 3 | Washington DC

American Society for Horticultural Science

General Information

Conference Facilities:

All Conference activities will take place at the Washington Hilton.

Registrations:

The ASHS conference registration desk is located at the Concourse Level Foyer.

Registration hours:

Monday, July 30	3:00 PM – 6:00 PM
Tuesday, July 31	7:30 AM – 6:00 PM
Wednesday, August 1	7:30 AM – 5:00 PM
Thursday, August 2	7:30 AM – 5:00 PM
Friday, August 3	7:30 AM – 3:00 PM

Posters:

Posters are located in the International Ballroom East/Center.

Poster Set Up:

Tuesday, July 31	2:00 PM – 5:00 PM

Viewing Hours:

Wednesday, August 1	8:00 AM – 5:00 PM
Thursday, August 2	8:00 AM – 5:00 PM
Friday, August 3	8:00 AM – 2:00 PM

Exhibits:

Exhibitors are located in the International Ballroom East/Center.

Exhibitor move-in: Tuesday, July 31....2:00 PM – 5:00 PM

Exhibitor move-out: Friday, August 3....2:30 PM – 5:00 PM

Exhibits Open to Attendees:

Wednesday, August 1	8:00 AM – 2:00 PM*
Thursday, August 2	8:00 AM – 2:00 PM*
Friday, August 3	8:00 AM – 2:30 PM

*Please note the hall will be open until 5:00 PM for poster viewing. However, exhibitors may choose to only staff their booths during the advertised hours.

Speaker Ready Room:

Oral, Workshop, Special Sessions, and Keynote speakers are requested to check in at the Speaker Ready Room located in Cabinet Room. Please note, even if you have uploaded in advance, you are still asked to check in at the Speaker Ready room at least 24 hours in advance of your presentation to confirm that your media and PowerPoint presentations were successfully uploaded and running properly. Updates and modifications can only be made up to 24 hours in advance of your presentation.

Poster Presenters and E-Posters:

ASHS is inviting/encouraging poster presenters to upload a PDF of their poster. You may also upload mp4 video or audio files to go along with the poster.

As part of enhancing the ASHS online conference proceedings, you have the option to make your poster into an interactive electronic version (E-Poster). If you would like to explore this option, a link will appear once you have uploaded your PDF file with instructions on how to create your E-Poster. Please note that E-Posters are not available for viewing until after the conference and that you must still present your poster at the scheduled time.

If you would like to create your E-Poster at the conference, a computer is available in the Speaker Ready Room.

All recordings will be housed on the ASHS website indefinitely. Your presentation will be accessible on the site with the rest of the ASHS technical program, giving the poster presenters the same opportunity to detail their work in an audio and/or video format.

Speaker Ready Room Hours:

Monday, July 30	10:00 AM – 6:00 PM
Tuesday, July 31	7:00 AM – 6:00 PM
Wednesday, August 1	7:00 AM – 6:00 PM
Thursday, August 2	7:00 AM – 6:00 PM
Friday, August 3	7:00 AM – 3:00 PM

Conference App:

Please note the most up-to-date information will be available on the conference app. The app can be located in either the Apple App Store or the Google Play Store.

American Society for Horticultural Science
1018 Duke Street Alexandria, VA 22314

July 2018

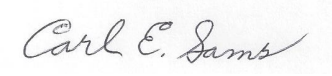
Dear ASHS 2018 Conference Attendees:

It is my distinct pleasure to welcome you to Washington, DC, for the 115th annual conference of the American Society for Horticultural Science. Our nation's capital has a rich history and culture. One can-not help but feel a sense of awe at the magnificent architecture and the record of the American experience that is present in the beautiful museums, monuments, and government buildings that symbolize our collective experience. Washington is a wonderful city with a wide array of entertainment and culinary options. During the day, the activity in the District, especially on the National Mall, is energizing. The view of the city and our national monuments at night is one not to be missed.

The Technical program for our conference is particularly exciting this year, and includes inspirational keynote presentations on topics ranging from the relevance of the Land Grant Universities in today's economy to the history and research programs of the National Arboretum and the scientific knowledge behind why we should be embracing the benefits of our microbes. The program also contains the largest and most diverse number of submitted oral and poster presentations that our annual conference has hosted in the past 24 years. There are Professional Interest Group workshops on a wide variety of topics, with the workshops emphasizing hands-on and interactive experiences for participants. Fitting to the location of the meeting in our nation's capital, the program contains several sessions sponsored by the National Issues Committee on advocating for specialty crops, including an informative session on how to prepare for your visit to Capitol Hill.

The program also provides opportunities for tours that have both historical and horticultural interest. There are tours to Jefferson's Monticello, The National Cathedral, and the Mount Vernon Estate and Gardens, to name a few. Professional tours range from urban farms and horticultural ecosystems in Washington, to an ornamental and turf tour of the Capitol, Smithsonian Museums, and the National Mall. There are also numerous opportunities for fun and socializing, including the traditional 5K fun run/walk, the opening reception, a closing event night of baseball at National's Park, several luncheons, and of course time in the poster sessions, the exhibits area, and hallways for renewing friendships, exchanging ideas, and team building.

Thanks to all of you for participating in the conference and joining all of your colleagues this week to exchange ideas and share your scholarship. You are ASHS, and on behalf of the Board of Directors of the American Society for Horticultural Science, best wishes for a productive, exciting, and energizing experience at the 115th ASHS Annual Conference.



Carl E. Sams

President of the American Society for Horticultural Science

Thank you to the following people for their efforts in making this a successful conference!

Annual Conference Technical Program
Dennis Ray, Co-Chair
Carl Sams, Co-Chair
Wm. Vance Baird
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Tracie Matsumoto
Dayton Wilde

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Paul Bosland
Michele Warmund
Zong-Ming Cheng
Gregory Reighard
Sandra Wilson
Paul Read
Bhimu Patil
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Carl Sams

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Amir Khoddamzadeh
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Manjul Dutt
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Michela Centinari
Rosanna Freyre
Gary Bachman
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Elizabeth Barton, National Arboretum
Dean Norton, Mount Vernon Estates

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John Dole
Carl Sams

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Kimberly Moore
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Katherine Warpea
David Kopsell
Kent Kobayashi
Martha Glenn
Dennis Ray

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Kim Hummer, Chair
Susan Miyasaka
Peter Hirst
Thomas Ranney

Outstanding International Horticulturist Award
Bruce Schaffer, Chair
Sastry Jayanty
Suping Zhou
Peng Jiang
Amir Khoddamzadeh
Alyssa Cho
Davie Kadyampakeni
Marisa Wall
Guochen Yang

Outstanding Researcher Award
Yi Li, Chair
Michael J. Havey
Richard Bell
Ajay Nair
Maria Jenderek
Lekha Paudel
Robert Trigiano
Cassondra Newman
Dilip Panthee

Outstanding Undergraduate Educator Award
Xin Zhao, Chair
Andrew Ristvey
John Ruter
Ami Erickson
Sam Wortman
Chad Miller
Alexander Niemiera
Charles Fontanier
Andrew Pulte

Outstanding Extension Educator Award
Eric Stafne, Chair
Chuck Ingels
Connie Landis Fisk
Clive Kaiser
Qingren Wang
Nicole Martini
E. Vanessa Campoverde
Roberto Lopez
Ursula Schuch

Outstanding Graduate Educator Award
Caula Beyl, Chair
Kent Kobayashi
Margaret Pooler
Floyd Woods
Ryan Contreras
Aliya Momotaz
Lauren Garner
Kimberly Shearer
Carolyn Robinson

Outstanding Industry Scientist Award
Allen Owings, Chair
Thomas Colquhoun
Heidi Kratsch
Steve Millett
Josh Weaver
Lisa Alexander
Terry Berke
Melanie Yelton
Steve McArtney

Screening Committees for Publications Awards

Cross-Commodity Publication Award
Jeffrey Brecht, Chair
Chengyan Yue
Stefano Musacchi
Hye-Ji Kim
Sastry Jayanty
Peter Dittmar
Clydette Alsup-Egbers
Aliya Momotaz

Education Publication Award
Harlene Hatterman-Valenti, Chair
Justin Moss
Rosa Raudales
Eric Stafne
Musa Mohamed
Tori Jackson
Cathie Lavis
Sven Svenson

Extension Publication Award
Mengmeng Gu, Chair
Lucy Bradley
David Graper
Bodie Pennisi
Ramon Arancibia
Guodong Liu
Louise Ferguson
Tim Coolong

Fruit Publication Award
Renae Moran, Chair
Diana Cochran
Rob Crassweller
Tripti Vashisth
Amaya Atucha
Glenn Wright
Tracie Matsumoto
Greg Lang

Ornamentals Publication Award
Yan Chen, Chair
Sven Svenson
Matthew Taylor
Margaret Hoffman
Rosa Raudales
Brent Pemberton
Lisa Alexander
Caula Beyl

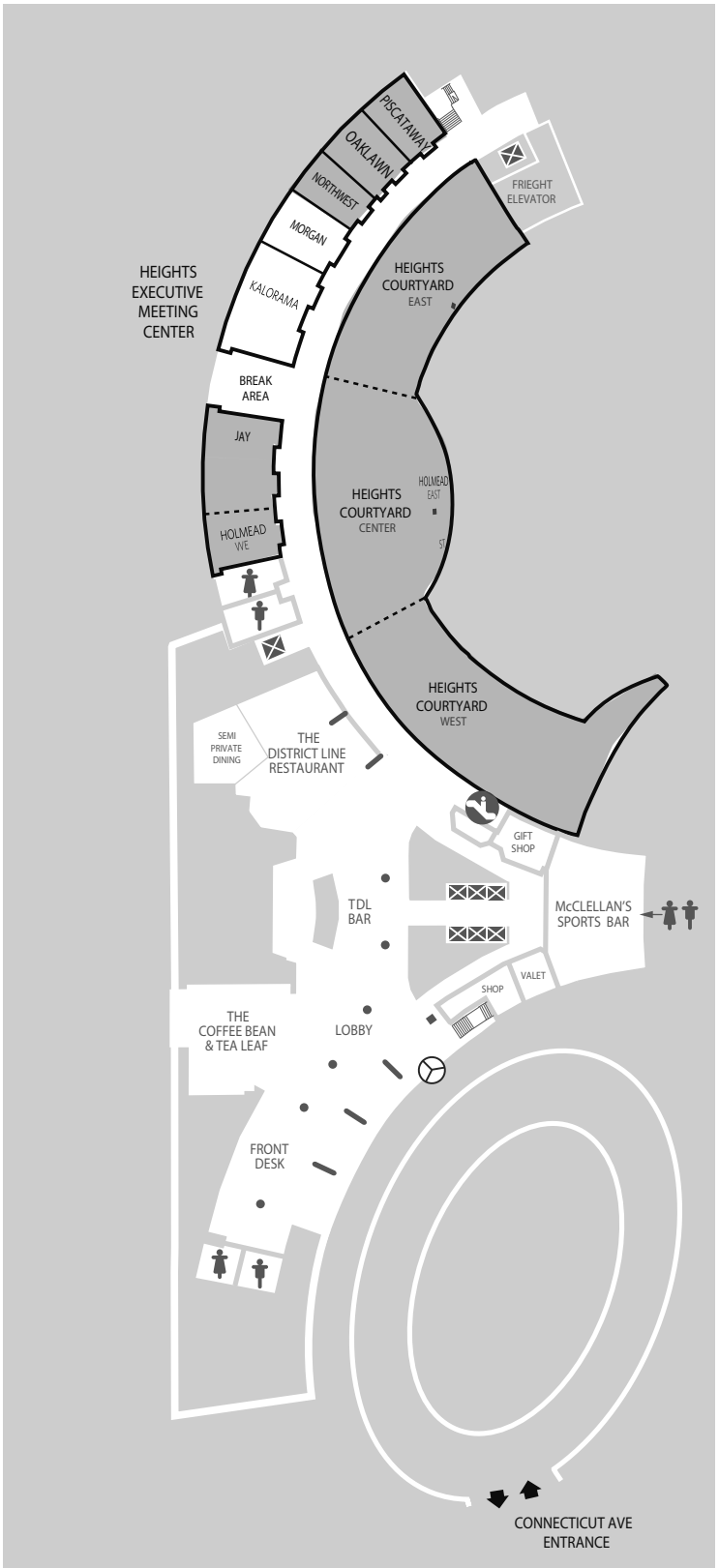
Vegetable Publication Award
Nancy Roe, Chair
Changbin Chen
Dilip Panthee
Jack Juvik
Wei Yang
Harlene Hatterman-Valenti
Chris Gunter
Guodong Liu

Thanks to our Sponsors:

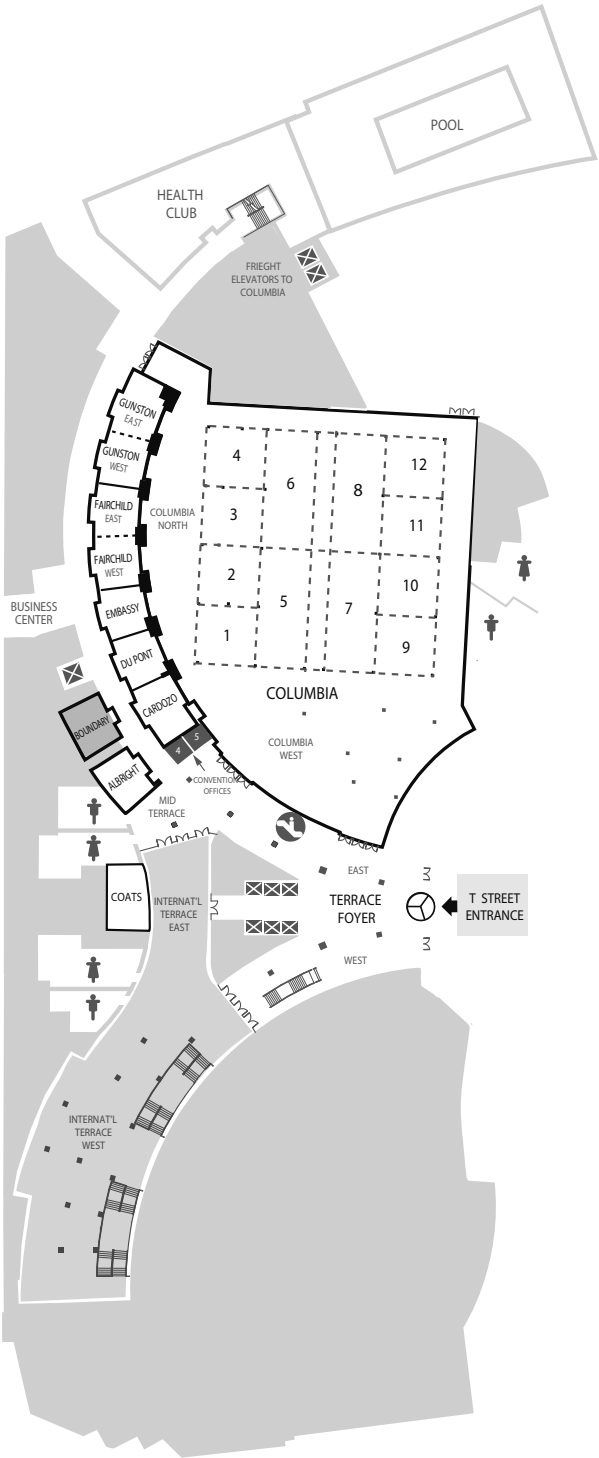
Ball Horticulture | E&J Gallo | Valent BioSciences
American Horticultural Therapy Association

Floor Plans

LOBBY LEVEL
WASHINGTON HILTON

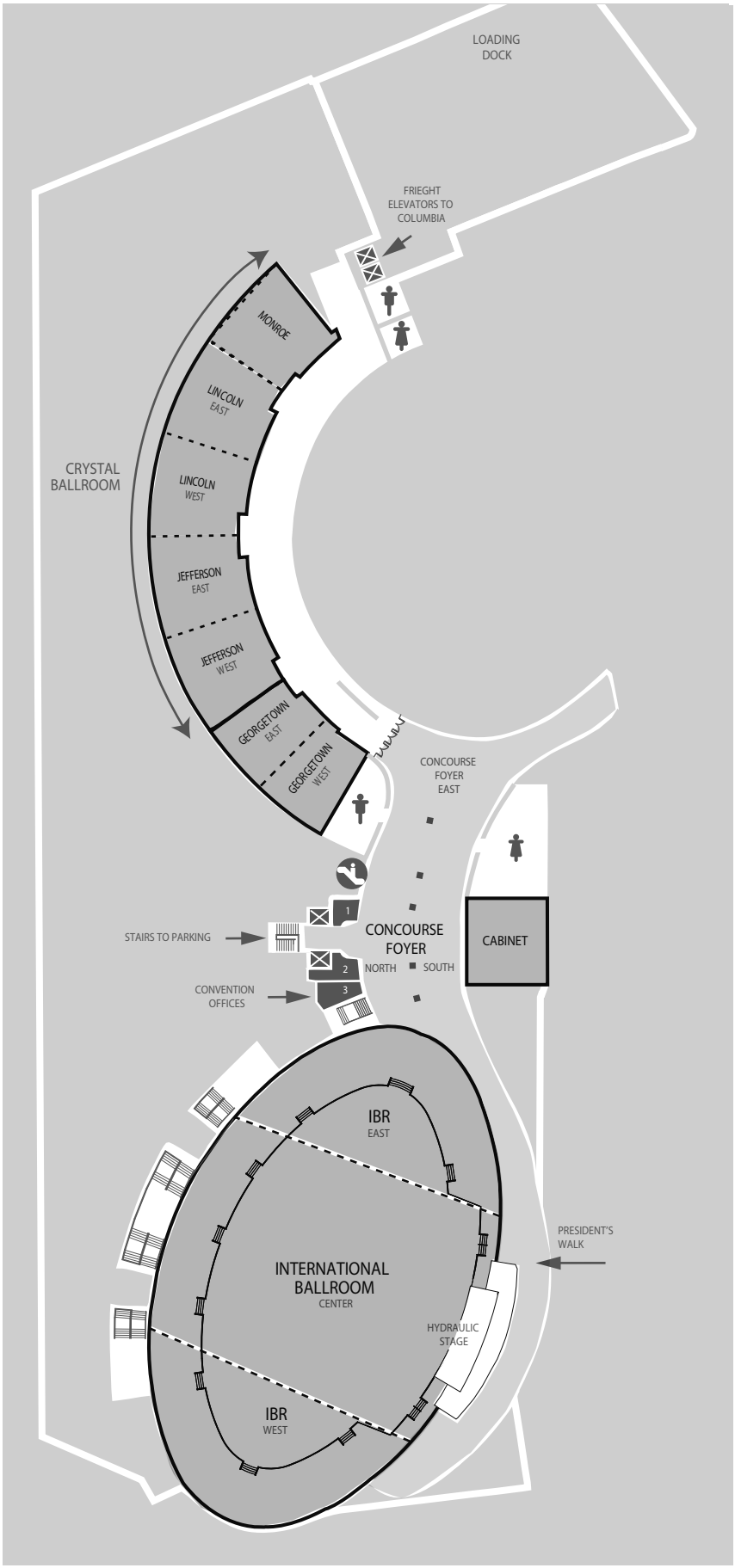


TERRACE LEVEL
WASHINGTON HILTON

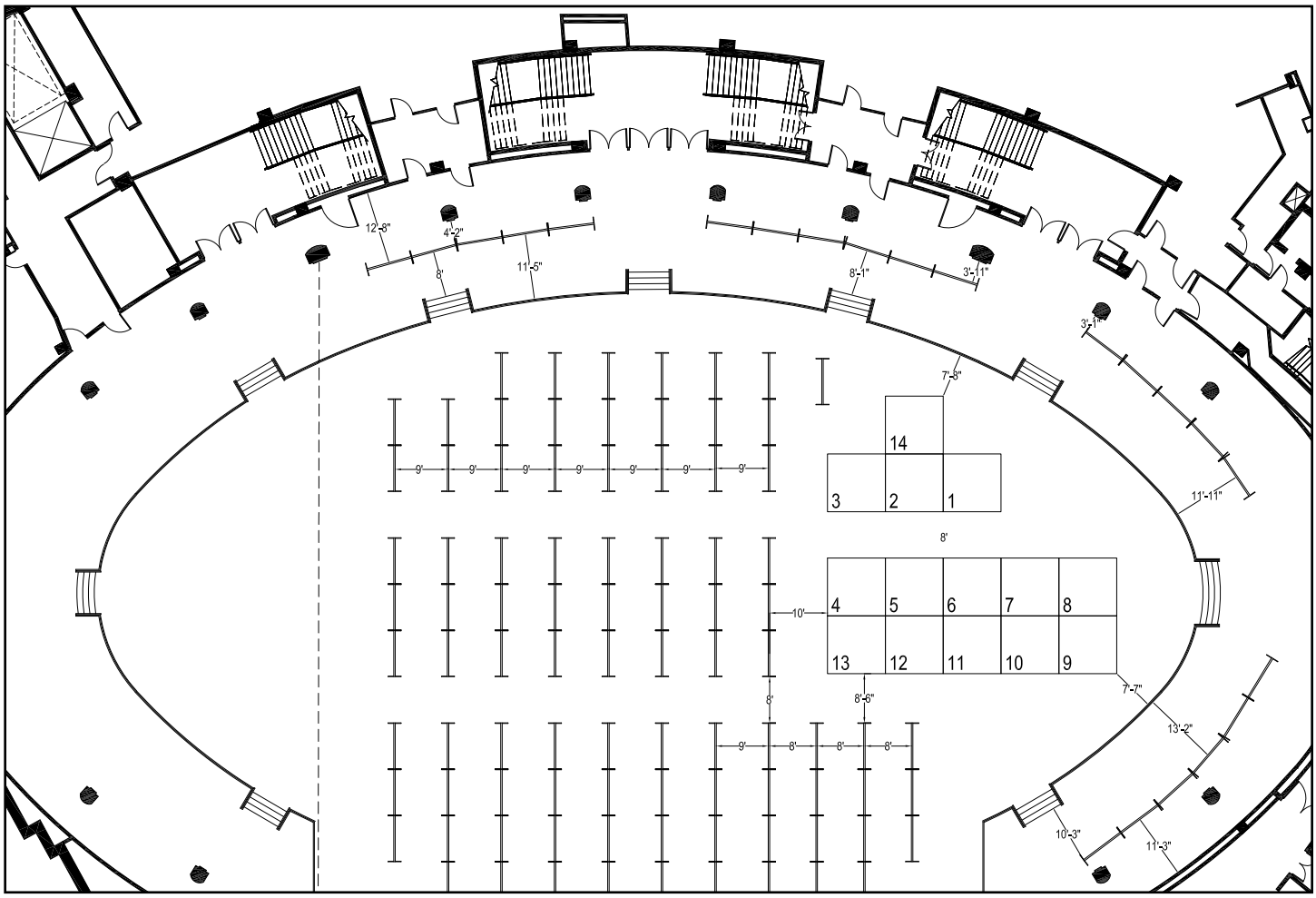


Floor Plans

CONCOURSE LEVEL
WASHINGTON HILTON



Exhibitor Floor Map



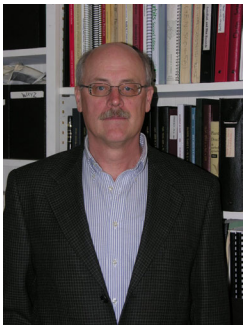
2018 ASHS AWARD WINNERS

ASHS Fellows: David Bryla

David Bryla
USDA-ARS Horticultural Crops Research Unit

David R. Bryla has devoted 30 years to the horticulture industry. He is recognized internationally for his expertise on mycorrhizal associations, root physiology, and water and nutrient management of tree fruit, vegetable, and especially small fruit crops. His findings have been adopted by the industry and are helping growers to reduce losses and improve productivity by millions of dollars each year. His contributions to ASHS include many outstanding publications, years of dedicated service as an Associate/Consulting Editor and member of the editorial board for HortScience, chairing sessions at the conferences, and organizing and participating in numerous workshops and colloquia.

ASHS Fellows: Michael Havey



Michael Havey
USDA ARS

Dr. Havey has worked for over 30 years to develop molecular technologies to more efficiently breed new vegetable cultivars with enhanced qualities, pest resistances, health-enhancing attributes. Dr. Havey has directed the USDA Onion Breeding and Genetics Program, the largest of public-sector onion breeding program in the USA. He has served as Chair of the graduate program in Plant Breeding and Plant Genetics (PBPG) at the University of Wisconsin for over 15 years, and has been actively involved with training of the next generation of horticultural scientists.

ASHS Fellows: Dean Kopsell

Dean Kopsell
University of Florida

Dean A. Kopsell is Professor and Chair of the Environmental Horticulture Department at the University of Florida. He has held faculty positions at the University of Tennessee and the University of New Hampshire. Kopsell has been a member of ASHS since 1995. Kopsell has also served as Research Division Vice President and as a member of the ASHS Board of Directors. He has served ASHS through membership on the Nominations and Elections Committee, the Annual Conference Technical Program Committee, and the National Issues Committee. Kopsell has been active in many ASHS working groups and participating in annual conference activities.

ASHS Fellows: Desmond Layne

Desmond Layne
Washington State University

Dr Desmond R. Layne has been actively engaged in Horticultural research, teaching, extension, and administration in positions at four Land-Grant Universities. As a career pomologist, he has focused on addressing relevant issues of the commercial tree-fruit industry through applied research and extension. He led Clemson statewide Extension's Horticulture Team during 2006-2013. He has taught four popular undergraduate courses at two universities was Director of an interdisciplinary program comprising 11 majors and is currently the currently head of the Department of Horticulture at Auburn University. He has won national awards for research and extension and has actively served ASHS as a member since 1986. He is currently Vice-President of the Extension Division.

ASHS Fellows: Mathieu Ngouajio

Mathieu Ngouajio
USDA-NIFA

Dr. Mathieu Ngouajio is an internationally acclaimed agricultural scientist, extension specialist, educator, and program leader specializing in vegetable cropping systems, sustainable agricultural practices, plasticulture, and crop microclimate modification. He is credited with implementing numerous innovative research projects in crop production systems on a global basis, with cooperative programs in the Americas, Africa, and Europe. Currently, he serves as National Program Leader, USDA National Institute of Food and Agriculture (NIFA). He has been an exceptionally active member of ASHS, assuming leadership roles in numerous groups, including publications (HortTechnology Consulting Editor for 12+ years) and the Board of Directors (International Division Vice President).

ASHS Fellows: Marc van Iersel

Marc van Iersel
University of Georgia

Marc van Iersel is the Vincent J. Dooley Professor of Horticulture in the Department of Horticulture at the University of Georgia, specializing in plant physiology. His research achievements are reflected in a prolific publication record. Dr. van Iersel combines his passions for plant science with a genuine desire to mentor students, having served as a major advisor to two dozen graduate students. His consistent and broad-reaching service to ASHS demonstrates his commitment to the mission of the Society. Dr. van Iersel has been recognized several times for his impactful research, as well as his influence on students.

ASHS Fellows: Hazel Wetzstein

Hazel Wetzstein
Purdue University

Dr. Hazel Wetzstein is a distinguished horticultural scientist and researcher, an exemplary teacher, and a successful administrator. She is a world authority in plant growth and development with emphasis on reproductive biology, pollination and fruit development. Her fundamental research addresses crop production needs for a wide spectrum of plant species of horticultural interest. She is the recipient of 5.6 million dollars in grants and published widely. She has guided 17 graduate students and served on 89 graduate committees.

ASHS Scholar: Melissa Eggleston

Melissa Eggleston

Horticultural sciences have been for me a path to expanding my knowledge as a scientist in a manner unique to other students. Growing up in an agricultural family, I discovered an affinity for biological sciences in junior high and high school yet did not understand the connection between these interests. Most of the science I had learned at that point was human-biology based and I was not aware of the excellent agricultural research which is foundational to the practices I witnessed in my daily life. Entering college, I realized my two passions were not contradictory but fundamentally connected! My horticultural classes have been my most relished as a way of understanding science that is not mainstream. As I look to my future, my desire is to teach others through the lens of horticultural sciences so they may enjoy the same benefits.

ASHS Scholar: Lucille Eggleston

Lucille Eggleston

Horticultural sciences have been for me a path to expanding my knowledge as a scientist in a manner unique to other students. Growing up in an agricultural family, I discovered an affinity for biological sciences in junior high and high school yet did not understand the connection between these interests. Most of the science I had learned at that point was human-biology based and I was not aware of the excellent agricultural research which is foundational to the practices I witnessed in my daily life. Entering college, I realized my two passions were not contradictory but fundamentally connected! My horticultural classes have been my most relished as a way of understanding science that is not mainstream. As I look to my future, my desire is to teach others through the lens of horticultural sciences so they may enjoy the same benefits.

Outstanding Extension Educator: Robert Crassweller

Robert Crassweller
Pennsylvania State University

For 30 years Dr. Crassweller has led Penn State's Horticulture extension program and he co-chairs the Tree Fruit & Grape extension team. He chairs the tree fruit program for the Mid-Atlantic Fruit & Vegetable Conference. He also coordinates educational programs for the National Peach Council and the tree fruit sessions, which involves inviting speakers for 25 presentations, including initiation of an educational session in Spanish for orchard workers. Rob coordinates the annual Mid-Atlantic Cider Competition with about 25 entries. In a typical year he makes 15 to 25 presentations at county, regional or county fruit meetings around the state. In the 1980s he developed an innovative computer-aided expert system for apple thinning. At the national level Dr. Crassweller has melded his applied research and extension activities by participating in several multi-state projects. He has participated in 16 international assignments on 3 continents to work with fruit growers and recommend production practices to improve their operations. Thanks to Dr. Crassweller's leadership, the PA fruit industry is successfully transitioning to intensive orchards with high-value cultivars and the industry supports Penn State extension.

Outstanding Graduate Educator: Sandra Wilson

Sandra Wilson
University of Florida

Dr. Wilson is an accomplished and outstanding graduate educator and mentor with a strong commitment to education. Dr. Wilson takes a hands-on approach to graduate student course scheduling, research advising, teaching involvement, publishing, grant writing, and career placement. She has formally advised 34 graduate students during her career. She takes pride in maintaining contact with all of her students well beyond their graduation and celebrates their personal and professional achievements. Her teaching and research programs have generated $1.76 million dollars in extramural grant funding and authorship of more than 140 refereed publications.

Dr. Wilson is an active ASHS member serving as the Education Division Vice President in addition to receiving the ASHS Outstanding Education Publication in 2012, ASHS Outstanding Undergraduate Educator in 2009, and inducted as an ASHS Fellow in 2015.

Outstanding Industry Scientist: Robert Mikkelsen

Robert Mikkelsen
International Plant Nutrition Inst

Robert Mikkelsen has devoted his efforts to improve plant nutrient management for his entire career. He started of his profession with a federal research fertilizer lab (TVA); he then moved to the North Carolina State University as a professor; in 2002, he joined the International Plant Nutrition Institute (IPNI). He initiated and hosts a bi-weekly IPNI webinar series on the science of nutrient management and is responsible for publication of quarterly magazines, biweekly newsletters, video production, and educational books on global nutrient issues. He has been responsible for directing research and educational efforts to improve nutrient management in western North America. Dr. Mikkelsen is in high demand as an invited speaker across the region to diverse horticultural groups, among them The Winegrape Commission, the Idaho Potato Conference, and the Almond Board. He has been a leader in the adoption of 4R Nutrient Stewardship practices for horticultural production (Right Source, Rate, Time, and Place). Dr. Mikkelsen frequently writes magazine articles for grower and industry organizations, IPNI newsletters and publications, and academic books and journals. He has served as ASHS Industry Vice President and as the organizer of the International Symposium on Soil & Plant Analysis.

Outstanding International Horticulturalist: John Griffis

John Griffis
Florida Gulf Coast University

For many decades, Dr. John Griffis has served as an excellent ASHS ambassador around the world. Through his outreach, teaching and research activities in the U.S. and around the globe, Dr. Griffis has developed a unique program with major impacts at the local and global level. He has received three Fulbright Scholar teaching appointments to Zimbabwe, Mauritius and Turkey. Dr. Griffis has served as an international volunteer expert for the USAID Farmer-to-Farmer program in 22 different countries, completing over 30 projects over the last 22 years. On those assignments, he adapts well to other cultures, and is truly exceptional at teaching horticultural concepts and techniques to clients ranging from university students to illiterate subsistence farmers in developing countries. As ASHS International Division Vice President (2007-2009), Dr. Griffis launched the International News and Opportunities column in the ASHS newsletter as his major signature program. His long-term engagement and impacts in international horticultural activities are impressive.

Outstanding Researcher Award: John Clark

John Clark
University of Arkansas

Dr. Clark developed or co-developed 63 fruit cultivars of blackberries, peaches, nectarines, grapes, and blueberries as a faculty member at the University of Arkansas. He also developed the world's first primocane (fall)-fruiting blackberries and the first dwarf blackberries. These innovations plus additional UA blackberry cultivars are used worldwide for fresh-market production, and account for 21.3 million plants sold with a wholesale value of $40 million, and a production area of 11,000 acres, with crop value of over $ 400 million. Of these cultivars, 51 US Patents were awarded or filed, the resulting royalty income totaled $5.7 million through 2017, and license agreements for propagation and use totaled 250 domestic and 359 International. These innovations expanded the annual intellectual property income of the breeding program to the University from $40,000 in 1997 to over $1,000,000 in 2017, and created cooperative breeding and testing agreements worldwide that resulted in the expansion of the utilization of Arkansas genetics in a range of environments and markets. Dr. Clark has also written, presented and produced over 1000 publications, presentations, and videos. He was inducted into the Arkansas Agriculture Hall of Fame in 2018.

Outstanding Undergraduate Educator: Bridget Behe

Bridget Behe
Michigan State University

Bridget has taught undergraduate students at both Auburn University (1989-1997) and Michigan State University (1997-present) with many of them excelling in management and marketing positions throughout the U.S. Dr. Behe has educated hundreds of horticulture undergraduates and helped them become better business managers and leaders through her Business Management and Marketing classes. Nearly a dozen undergraduate students have obtained financial backing as a result of completing a business plan in her class. She was co-advisor for the MSU Student Horticulture Association for 6 years. The group of approximately 30 members hosts an annual Spring Show where they transform and "landscape" the Conservatory and sell $30,000 to $45,000 of plant material, which they grow themselves, over one weekend. She is a recipient of the "Established Teacher" award for her dedication to educating undergraduates. Bridget chairs the Horticulture Scholarship committee and has done so for the past ten years. She also has served as a member of the Department Undergraduate Program Committee, past member and chairperson of the College of Agriculture and Natural Resources Curriculum Committee, and as a past member and chairperson of the University Committee on Academic Policy.

EXHIBITORS

Exhibitors are located in International Ballroom EastCenter.

Exhibits Open to attendees:

Wednesday, August 1, 8:00 am – 2:00 pm*
Thursday, August 2, 8:00 am – 2:00 pm*
Friday, August 3, 8:00 am – 2:30 pm
**Please note the hall will be open until 5:00 pm for poster viewing.*
However, exhibitors may choose to only staff their booths during the advertised hours.

Booth #6

Apogee Instruments

www.apogeeinstruments.com

Apogee Instruments develops and manufactures innovative environmental instrumentation for horticulture, meteorology, sustainable food production, and renewable research applications. The Logan, UT based company was founded in 1996 by Dr. Bruce Bugbee, a professor of crop physiology at Utah State University, with the focus of providing high-quality, cost-effective instrumentation for research and commercial applications. This year at ASHS, Apogee will be featuring our full-spectrum quantum sensor and durable field spectroradiometer for light measurements, chlorophyll concentration meter with linear output, and full line of infrared radiometers to measure plant canopy temperature.

Booth #3

Bio Chambers Inc.

www.biochambers.com

BioChambers is a leading manufacturer of reach-in and walk-in plant growth chambers that range from small bench top units providing 8ft^2 of growth area to large multi-tier walk-in rooms that provide a growth area exceeding 400ft^2. Each chamber is integrated with our easy to use control system that provides lighting level, photo-period, temperature and fan speed control as standard features, and humidity and CO_2 control as optional features. We invite you to visit us at our booth and see how we can help create ideal environments for your research needs.

Booth #7

CABI/CSIRO

www.styluspub.com

CABI is a not-for-profit international organization that improves people's lives by providing information and applying scientific expertise to solve problems in agriculture and the environment.

CSIRO PUBLISHING is an internationally recognized science and technology publisher, covering a wide range of disciplines, including agriculture, plant and animal sciences, and environmental management.

Booth #2

CID Bio-Science

www.cid-inc.com

CID Bio-Science designs, engineers, and manufactures instruments for plant scientists. From photosynthesis analysis and leaf area measurement, to leaf spectroscopy and root imaging, our portable, durable tools provide the data you need wherever you need it—from inside the lab to out in the field.

To learn more or make an appointment to meet with us, visit Booth #2, or contact us at *sales@cid-inc.com*.

Booth #12

Conviron

www.conviron.com

Established in 1964 and with a global sales, distribution, and service network – Conviron is the world leader in the design, manufacture and installation of controlled environment systems for plant science and agricultural biotechnology research.

Conviron's reach-in plant growth chambers, walk-in rooms and Argus Control Systems (a Conviron company) provide precise, uniform, and repeatable control of temperature, light, humidity, CO_2, and other environmental conditions. All environmental parameters can be remotely programmed, monitored and analyzed with unparalleled accuracy and convenience. With a staff that includes engineers, technicians and controls experts, Conviron is well equipped to supply both standard and custom applications for our clients around the world. Learn more at *www.conviron.com* or contact us at *info@conviron.com*.

Booth #5

CRC Press/Taylor & Francis Group

www.crcpress.com

CRC Press is a premier publisher of scientific and technical content, reaching around the globe to collect essential reference material and the latest advances in food quality and safety to make them available to researchers, academics, professionals, and students. CRC Press products include world-class references, handbooks, and textbooks as well as the award-winning netBASE eBook collections. CRC Press is a member of Taylor & Francis Group, an Informa business. For more information, visit *www.crcpress.com*

Booth #8

Driscoll's

www.driscolls.com

Driscoll's is the global market leader for fresh strawberries, blueberries, raspberries, and blackberries. With more than 100 years of farming heritage and hundreds of independent growers around the world, Driscoll's is passionate about growing fresh, beautiful, and delicious berries. Our values of humility, passion, and trustworthiness have guided our mission to delight consumers around the world.

Driscoll's exclusive patented berry varieties are developed through years of research using only natural breeding methods – meaning, no GMOs. From farm-to-table, we focus on delivering a high quality, premium berry experience with our many supply chain partners.

Driscoll's is the trusted brand for Only the Finest Berries ™.

Booth #11

Gylling Data Management

www.gdmdata.com

Gylling Data Management, providing research management software since 1982 including:

ARM Tablet Data Collector: enter and analyze assessments, take plot pictures, and record trial GPS locations.

ARM: establish, manage, analyze, and report information for crop experiments including field and greenhouse protocols and trials.

ARM ST: summarize and report a trial series across locations and/or years; links with ARM Trial Database to select trials based on information in any trial data entry field.

Booth #13

LI-COR Biosciences

www.licor.com/env

Visit LI-COR's booth and ask our Applications Scientists to demonstrate the latest instrumentation for environmental research, including the new LI-6800 Portable Photosynthesis System. The fast response of the LI-6800 Portable Photosynthesis System creates exciting new research opportunities. Technological advancements from Rapid Sensing™ Technology make the Rapid A-C_i Response, or RACiR™ Method, possible. The RACiR Method allows measurements under rapidly changing CO_2 concentrations, to quickly generate CO_2 response curves. For indoor horticultural studies, LI-COR will also feature the LI-1500 Light Sensor Logger, the LI-840A CO_2/H_2O Analyzer, and newly redesigned light sensors with an improved water-shedding design, detachable base, and multiple output options.

Booth #10

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Booth #4

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Booth #1

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ICT International designs and manufactures the Sap Flow Meter and Stem Psychrometer for ecophysiology and environmental research. These technologies offer solutions addressing; physiological and yield limitations of plants to water stress; ecosystem response to climate change and evaluate plant genetics. The scientists at ICT International also work alongside scientists to tailor specific monitoring solutions and then implement these solutions in the field.

Booth #14

Vegetable Grafting

Grafting is important for a number of reasons. First, grafting emphasizes the use of genetics in overcoming abiotic and biotic crop stress. Creating physical hybrids through grafting can allow important traits to be employed on farms more rapidly and flexibly than traditional single-variety, genetic hybrid development. Second, grafted plants can be used in vegetable operations of nearly all sizes and types. Further, in contrast to pesticides, grafted vegetable plants can be prepared and, possibly, sold by farmers. Finally, in many regions and systems, grafted vegetable plants routinely outperform their ungrafted counterparts in terms of vigor, stress tolerance and/or yield. Overall, grafted plants can be used by nearly all growers of tomato, melon and other crops. Also, these same growers can prepare grafted plants themselves, purchase them, or create a business based on grafted plant production.

That said, preparing and using grafted plants adds risk and cost and creates many questions. Therefore, grafting is seen as a technology that can be leveraged in addressing major stakeholder concerns, not the end-goal itself. The project team and its partners use a multi-faceted approach to assist stakeholders in obtaining the best from grafting. Expert on-farm and on-station research, aggressive technological innovation, and educational and outreach opportunities focus on complementing and adding value to stakeholder investments in grafting.

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, Specialty Crops Research Initiative under award Number 2016-51181-25404. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

Sunday, July 29, 2018

6:45 AM – 7:00 PM *T Street Entrance - Terrace Level*

Jefferson's Monticello: Gardens and their History

1:00 PM – 5:00 PM

NE1336 Multistate Meeting - Day 1
Piscataway (Lobby Level)

Coordinator: Randolph Beaudry, *Michigan State Univ*

2:00 PM – 5:00 PM *T Street Entrance - Terrace Level*

Architectural Beauty with Evensong Performance at the National Cathedral

8:00 AM – 1:00 PM *T Street Entrance - Terrace Level*

Urban Farms and Horticultural Ecosystems in Washington DC

8:00 AM – 4:00 PM *T Street Entrance - Terrace Level*

Tour of the Mount Vernon Estate and Gardens

8:00 AM – 5:00 PM

NE1336 Multistate Meeting - Day 2

Piscataway (Lobby Level)

Coordinator: Randolph Beaudry, *Michigan State Univ*

8:30 AM – 3:00 PM *Georgetown East*

ASHS Board of Directors Meeting

Chair: John M. Dole, *North Carolina State University*

8:30 AM – 5:00 PM

SCRI Project Director Meeting - Day 1

Georgetown West

Coordinator: Megan O'Reilly, *Institute of Food Production and Sustainability*

10:00 AM – 6:00 PM

Speaker Ready Room - Monday

Cabinet

12:45 PM – 5:00 PM

Creating YOUR Future: Strategic Career Planning Forum

International Ballroom East/Center

Coordinator: Curt Rom, *University of Arkansas*

Speakers: Craig Campbell, *Valent USA Corporation*; Richard Campbell, *Ciruli Brothers LLC*; Dean Kopsell, *University of Florida*; David Kopsell, *Illinois State University*; Logan McCollum, *Driscoll's*; Mercy Olmstead, *California Strawberry Commission*; Brian Pearson, *University of Florida, Mid-Florida Research and Education Center*; Dennis Ray, *University of Arizona*; Kate Santos, *Dümmen Orange* and Ed Stover, *USDA-ARS*

Objectives:

This forum is designed to inform students of horticulture a variety of career options as well as provide tips on how to go though the career search process. Information from academic, industry, and government careers will be discussed.

FORUM AGENDA:

Session 1 – Choosing the Right Career Path

1:00-1:45pm	What Path do I Take? What can you do with a BS, Master's degree or a PhD degree.
1:45-2:30pm	What is the Difference in Career Opportunities? How are academic, agency, government, or commercial career paths different.
2:30-3:15pm	What Tools do I Need? Tips on Resume Preparation, Interviewing, Publishing, Writing Grants, and Giving Presentations.
3:15-3:30pm	Break (Can also Network with Career Fair Representatives)

Session 2 – Making it Work for You

3:30-4:00pm	The Fishing Expedition: Strategies for Job Searches
4:00-4:30pm	Landing the "Big One": Tips on Job Resumes, Applications and Interviewing for Commercial or Academic Careers.
4:30-4:50pm	Hit the Ground Running! Getting a quick start in Your New Career Starting from Day One.
4:50-5:00pm	Wrap up and Certificate Presentations
5:00-6:30pm	Career and Graduate School Fair (beverages and snacks served)

1:00 PM – 5:00 PM

Expanding Fresh Culinary Herb Production SCRI Planning Meeting

Jay (Lobby Level)

Coordinator: Roberto G. Lopez, *Michigan State University*

3:00 PM – 4:00 PM

Moderator Training Session - Session Repeated on Tuesday

Oak Lawn (Lobby Level)

Speakers: Carl Sams, *The University of Tennessee* and Dennis Ray, *University of Arizona*

Objectives:

This session will give a general overview of how to use the equipment and processes for follow while moderating the conference oral sessions and workshops. Attendance is optional though recommended.

3:00 PM – 6:00 PM

Registration Open - Monday

Concourse Level Foyer

4:00 PM – 5:00 PM *Oak Lawn (Lobby Level)*

Professional Interest (Formerly Working Group) Chairs and Chairs-elect Meeting - Session Will Be Repeated on Tuesday

Presiding: Carl Sams, *The University of Tennessee*

Objectives:

Meeting of all officers of the ASHS Professional Interest (Formerly Called Working Groups). This session will be offered two times during the conference (Monday and Tuesday). The same material will be covered. Attendance at only one of the sessions is encouraged.

5:00 PM – 6:30 PM

Career and Graduate School Fair

International Ballroom East/Center

Objectives:

Visit exhibitor tables to learn more about available jobs, general company information, graduate school program information,

student internships or assistantships.

Exhibitors To Date:

- DowDupont Pioneer - Controlled Environments
- Driscoll's
- Syngenta Flowers
- Young Professional Council - American Floral Endowment
- Ball Horticulture
- The Ohio State University, Department of Horticulture and Crop Science
- University of Hawaii at Manoa,Tropical Plant & Soil Sciences Dept.
- University of Florida
- Cornell University
- Oklahoma State University

7:00 AM – 9:00 AM

5K Fun Run/Walk
T Street Entrance - Terrace Level

Objectives:
Participate in the kick-off event of the conference! This year's Fun Run will take place in the streets of Washington DC. See a bit of the city running or walking alongside your conference peers. All participants will receive a run t-shirt and breakfast food items. Meet at the Main Hotel Lobby at 7:00 AM.

7:00 AM – 6:00 PM

Speaker Ready Room - Tuesday
Cabinet

7:30 AM – 6:00 PM

Registration Open - Tuesday
Concourse Level Foyer

8:00 AM – 9:00 AM

Moderator Training Session (Repeat of Session offered on Monday)
Lincoln West

Speakers: Dennis Ray, *University of Arizona* and Carl Sams, *The University of Tennessee*
Objectives:
This session will give a general overview of how to use the equipment and processes for follow while moderating the conference oral sessions and workshops. Attendance is optional though recommended.

8:00 AM – 1:00 PM *T Street Entrance - Terrace Level*

Ornamental & Turf Management Tour at Capitol, Smithsonian Museum and National Mall

8:15 AM – 10:00 AM *Jefferson West*

Genetics and Germplasm 1

Moderator: Gayle M. Volk, *USDA-ARS National Laboratory for Genetic Resources Preservation*

8:15 AM **Outcomes of an International Workshop to Develop Training/Educational Programs for Plant Genetic Resources Management**
Gayle Volk*, *USDA-ARS National Laboratory for Genetic Resources Preservation*; Patrick Byrne, *Colorado State University* and Peter Bretting, *USDA ARS ONP GW Carver Ctr Mailstop 5139*

Abstract: There is an urgent need to develop foundational training for Plant Genetic Resources Management at a national level. A workshop was convened in April 2018 to identify the necessary scientific backgrounds, practical genebank management skills, and potential training/education formats to address this need. Workshop participants included representatives from the USDA-ARS National Plant Germplasm System (NPGS), USDA/NIFA, land-grant universities, industry, international genebanking programs, and a botanic garden. They represented NPGS curation and management teams as well as those who utilize genebank materials in their research and breeding programs. Together, these participants identified a combination of potential mechanisms for graduate students, genebank staff, as well as members of the international community, to be trained in core aspects of plant genebanking. The workshop identified a plan for developing and delivering a Plant Genetic Resource Management training/educational program in the near future. This presentation summarizes the outcomes of the workshop and seeks feedback from the horticulture community about the proposed training/educational program.
Specified Source(s) of Funding: NIFA

8:30 AM **The Challenges of Polyploid Crop Breeding: Survey Results**
David H. Byrne*, *Texas A&M University*

Abstract: A survey developed within the Tools for Polyploid SCRI planning grant collected information on the range of polyploid specialty crops to determine their characteristics and breeding needs. One-hundred and three responses including 36 root/tuber, 25 ornamental, 32 fruit and 10 turf breeding programs were received. The major crops represented were potato, sweetpotato, rose, blueberry, strawberry, kiwi, Rubus, bluegrass and ryegrass. The majority of the polyploid specialty crops were clonally propagated and highly heterozygous with genetic backgrounds that include either interspecific and interploidy hybridization. Although the type of ploidy is not always known, the crops ranged from auto to allopolyploids with many segmental allopolyploids, These crops showed disomic to tetrasomic to mixosomic segregation depending on the crop and genetic background within a crop. Although the most common ploidy level was tetraploid, there were significant numbers of crops that were triploid, hexaploid and octoploid. The programs ranged in size from less than 3,000 to more than 100,000 seedling per year and most commonly used backcrossing, recurrent selection and interspecific hybridization breeding approaches. The major impediments encountered when trying to incorporate genomic tools in their breeding were software tools to analyze polyploids, analytical expertise and more efficient phenotyping tools. On average, the polyploid breeders had medium to high confidence that they would be able to incorporate genomic tools to accelerate their breeding progress within 5 to 10 years.
Specified Source(s) of Funding: NIFA, SCRI grant "Tools for Polyploids", #2017-51181-26824

8:45 AM **Determining Chloroplast Haplotype Variation of Wild American Hazelnut**
Alex Mayberry*; Josh Honig; John Michael Capik; Jennifer Vaiciunas; Christine Kubik and Thomas J. Molnar, *Rutgers University*

Abstract: *Corylus americana,* the American hazelnut, is native to a wide area of land in eastern North America. It is resistant to the disease eastern filbert blight (EFB) caused by the fungus *Anisogramma anomala*, and is cross-compatible to the EFB-susceptible cultivated European hazelnut, *Corylus avellana.* Rutgers University has amassed a diverse collection of wild American hazelnuts, comprising 1900 seedlings from 126 individual seed lots spanning 23 states and one Canadian province. In this study, variation of chloroplast haplotypes in a large subset of the collection were determined in an effort to better understand population structure and associated evolutionary and post-glacial migration history of the native hazelnut. In total, 379 individuals from 23 states were included and compared to 20 reference accessions of European hazelnut that span a significant subset of known genetic diversity in *Corylus*. Sequences from eight different regions of the chloroplast were examined, consisting of: *atp*I-*rps*2, *ndh*K-*ndh*C, *psa*A-*trn*S, *rpo*B-*rpo*C1, *trn*C-*trn*D, *trn*H-*trn*K, *trn*L-*rpl*32, and *trn*V-*rbc*L. DNA was extracted using a Qiagen DNEasy Plant Kit protocol and quantified using a NanoDrop spectrophotometer. Sanger sequencing was performed at Rutgers University. The data will be used to create an unweighted pair group method using arithmetic averages dendrogram and STRUCTURE diagram to visualize results. A minimum spanning tree based on a parsimony model, and a maximum likelihood phylogeny based on a DNA evolution model will be used to interpret distinct lineages across the native range. Results including haplotype distributions, inferred post-glacial migration patterns, minimum spanning network, and phylogenetic analysis will be presented.

9:00 AM Expansins and Its Role in Cell Elongation during Blossom-End Rot Development in Bell Pepper

Andres Mayorga-Gomez*[1]; Savithri U. Nambeesan[1]; Juan Carlos Carlos Díaz-Pérez[1] and Timothy W. Coolong[2], *(1)University of Georgia, (2)The University of Georgia*

Abstract: Blossom-end rot (BER) is a common physiological disorder in peppers that occurs during early stages of rapid fruit growth. It is characterized by a dry, sunken, brown rot to the distal part of fruit resulting in huge economic losses. Occurrence of BER has been related to insufficient calcium uptake during the cell expansion phase of fruit growth leading to cell wall disintegration. Expansins (EXP) play an important role in facilitating cell expansion by loosening the cell wall in response to cell internal turgor. The main objectives of this study are to identify fruit-specific *EXP* during cell expansion phase and to determine cell elongation rates during fruit development and BER occurrence. Currently we have identified 29 *EXP* genes in bell pepper using database resources available from NCBI GenBank and the Sol genomics network. To determine the expression of *EXP*, bell pepper cultivar 'Aristotle' was grown under greenhouse conditions. Samples were harvested from seedlings, leaves, flowers and fruit at various days after anthesis (DAA; 7DAA, 14DAA, 21DAA, 28 DAA) including ripening. Gene expression is being performed using quantitative RT-PCR analysis. Fruit samples from the above stages are being analyzed for cell elongation rates using microscopy. In addition calcium accumulation during fruit growth phase will be determined. The expression of *EXP* and its role in cell expansion and calcium accumulation rates will be compared using BER resistant and susceptible bell pepper varieties. Collectively, this study will help to determine the importance of *EXP* in cell expansion and development of BER in peppers.

9:15 AM Genetic Diversity and Population Structure of a Sweetpotato (*Ipomoea batatas*) Germplasm Collection

Phillip A. Wadl*[1]; Bode A. Olukolu[2]; Sandra E. Branham[1]; Robert L. Jarret[3]; G Craig Yencho[2] and D. Michael Jackson[1], *(1)USDA-ARS, U.S. Vegetable Laboratory, (2)North Carolina State University, (3)ARS USDA*

Abstract: Sweetpotato, *Ipomoea batatas*, plays a critical role in food security and is the third most important root crop worldwide following potatoes and cassava. Sweetpotato is an important crop in the United States (US) and is valued at over $700 million dollars annually. The sweetpotato germplasm collection of the US is maintained by the USDA, ARS, Plant Genetic Resources Conservation Unit. There is currently a lack of knowledge of the genetic diversity within this collection that supports sweetpotato crop improvement. To date, no genome-wide assessment of genetic diversity of this collection has been reported. In our study, population structure and genetic diversity of 417 sweetpotato accessions originating from 8 broad geographical regions (Africa, Australia, Caribbean, Central America, Far East, North America, Pacific Islands, and South America) were genotyped with over 30,000 SNPs using a genotyping-by-sequencing (GBS) protocol optimized for sweetpotato. A neighbor joining cladogram and principal coordinates analysis based on the genetic relationships among the accessions indicated three major groups (North American, South American, and remaining regions). Pairwise F_{ST} values between broad geographical regions based on the origin of accessions ranged from 0.017 (Far East – Pacific Islands) to 0.110 (Australia – South America) and supported the clustering of accessions based on genetic distances. The markers developed for use with this collection of accessions provide an important genomic resource for the sweetpotato community, and contribute to our understanding of the genetic diversity present in the US sweetpotato genebank.

9:30 AM A Chromosome-Level Reference Genome of Wild Diploid Potato Species *Solanum Bulbocastanum*

Kelly Vining; Iovanna Pandelova and Vidyasagar Sathuvalli*, *Oregon State University*

Abstract: The wild, diploid (2n=2x=24) potato species *Solanum bulbocastanum* harbors disease and pest resistance genes that have been successfully introgressed into tetraploid potato breeding clones. We are developing genome resources for this species in order to study the genetic basis of resistance to Columbia Root Knot Nematode. We improved our Illumina-based draft genome assembly for *S. bulbocastanum* accession SB22 using long read sequencing. Sequencing libraries of 20 kb and 35 kb were run on a total of 44 SMRT cells on a Pacific Biosciences Sequel instrument. The resulting 39 Gb of sequence data were assembled into 1,301 contigs totaling 600 Mb. Chromosome confirmation capture performed by Dovetail Genomics was used to order the assembled genome contigs on twelve pseudochromosomes. A total of 32,943 protein-coding genes were predicted in the genome. This genome sequence is a resource for the study of disease resistance mechanisms in potato, and for development of molecular markers for marker-assisted selection in potato breeding programs.

Specified Source(s) of Funding: Northwest Potato Research Consortium

9:45 AM Genomic Resequencing of Bulked Heat-Tolerant and Heat-Susceptible Broccoli Segregants Identifies New QTLs Associated with Tolerance

Sandra E. Branham, *USDA-ARS, U.S. Vegetable Laboratory* and Mark W. Farnham*, *USDA-ARS U.S. Vegetable Laboratory*

Abstract: Broccoli is an economically important vegetable crop in the U.S. with an annual farm-gate value approaching a billion dollars. Nearly all commercial cultivars available to U.S. producers were developed for adaptation to relatively cool climates of California and other western states, where about 90% of broccoli production traditionally occurs. Head quality is negatively impacted by high temperatures (e.g., > 30 C) occurring during early stages of head development, and the resulting reduced quality can lead to significant marketable yield losses. There is renewed interest in breeding broccoli cultivars for East Coast production, but this effort is challenged by unpredictable high temperature spikes, higher nighttime temperatures during growing seasons, and limited knowledge of the genetic basis of heat tolerance. A doubled haploid broccoli population segregating for heat tolerance was evaluated in two summer field trials under conditions that readily cause head damage. The most and least tolerant broccoli lines were identified and then screened in two additional summer field trials. A subset of the most extreme tolerant and susceptible phenotypes were separately pooled for bulked segregant analysis using whole genome re-sequencing. Two novel QTL were identified that did not co-locate with previously characterized heat tolerance QTL.

Specified Source(s) of Funding: USDA-ARS and USDA-SCRI

***8:30 AM – 10:00 AM** Jefferson East*

Plant Nutrient Management 1

Moderator: Francesco Di Gioia, *University of Florida*

8:30 AM Distribution and Use Efficiency of Phosphorus in Tomato Grown on a Calcareous Soil

Qiang Zhu*; Monica P. Ozores-Hampton; Yuncong Li and Kelly T. Morgan, *University of Florida*

Abstract: Florida usually ranks first in the fresh-market tomato (*Solanum lycopersicum* L.) production in the United States. However, there are limited studies on phosphorus (P) accumulation and distribution in tomato as affected by P rates in calcareous soils. Thus, the objective of this study was to determine the effects of P rates on P uptake and partitioning, soil P budget, and P use efficiency in tomato production in a calcareous soil. A field trial was conducted during the winter season of 2015 in Homestead, FL. Treatments included six P rates: 0, 29, 49, 78, 98, and 118 kg ha^{-1}, and they were arranged in a randomized complete block design with four replications. Dry P fertilizers were used and banded in the bed prior to transplanting. The stems, leaves, roots, and fruits from one plant per plot were collected 95 days after transplanting (DAT) and measured plant dry biomass, P concentration, and P uptake. Soil samples were collected 82 DAT and analyzed for Mehlich-3 extractable P. Leachate were captured by gravitational lysimeters and analyzed for dissolved reactive P (DRP) concentration. Tomato fruits from ten plants per plot were harvested three times at 88, 102, and 116 DAT. Phosphorus apparent recovery efficiency (ARE) and partial factor productivity (PFP) were calculated. Results showed that total P uptakes (TPU) were not significantly affected by P rates and averaged 12 kg ha^{-1}. The proportions of stem, leaf, root, and fruit in the TPU ranged from 16 to 22%, 40 to 46%, 0.8 to 1.2%, and 32 to 43%, respectively. The ratio of stem/TPU decreased with increasing P rates and reached a plateau at 106 kg ha^{-1}, but the

proportions of leaf, root, and fruit were not significantly affected. Soil P and cumulative leachate DRP increased linearly with increasing P rates. The rate of 49 kg ha^{-1} resulted in a higher ARE than 29, 78, and 98 kg ha^{-1}. Tomato marketable yield at the first and second combined harvest was predicted by a linear-plateau model with a critical rate of 56 kg ha^{-1}. There were no significant differences in the total season (three harvests combined) marketable yields, thus, the PFP decreased with increasing P rates. Consequently, in the calcareous soils with 51 mg kg^{-1} of Mehlich-3 extractable P, 56 kg ha^{-1} was sufficient to meet tomato P requirement.

Specified Source(s) of Funding: Florida Department of Agriculture and Consumer Services

8:45 AM Tomato Response to Polyhalite As a K and Secondary Nutrient Source in Southeast Brazil

Simone da Costa Mello[1]; Fernando Ferraz Silveira[1]; Camila Gabriela de Souza[1] and Kiran Pavuluri[*2], *(1)University of Sao Paulo, (2)Sirius Minerals*

Abstract: Polyhalite (PH) is a naturally occurring multi-nutrient fertilizer containing 14% K_2O, 17% CaO, 6% MgO, and 19% sulfur. We recently reported the positive response of tomato (*Solanum lycopersicum* L.) to PH, in comparison to muriate of potash, sulfate of potash (SOP), and potassium magnesium sulfate (SOPM) from two rate response trials in Sao Paulo state, Brazil. However, PH as a sole K source exceeds crop S requirement and there is a need to determine its appropriate inclusion rates. The current study evaluated SOP, SOPM, SSP (single super phosphate) and PH as S sources, each supplying a 40 kg S ha^{-1} at three sites. Uniform K rate was ensured for the above treatments by varying MOP application rates. There were two control treatments, one did not contain K and S (KS control), and the other one contained K but not S (S control). All treatments received constant N and P rates. Yield, quality, foliar and fruit nutrient data was collected and analyzed by ANOVA in JMP software. Sources and rates were defined as fixed and random factors, respectively and the blocks were nested in site. Tukeys means separation procedure was used at 10% significant level. Pre-trial soil pH was 5.3, and soil K ranged from 61 to 83 mg kg^{-1}, soil Ca ranged from 250 to 266 mg kg^{-1}, and soil Mg ranged from 70 to 82 mg kg^{-1}. Only PH treatment increased total and marketable yields and fruit numbers compared to KS control which could be explained by the multi-nutrient composition of PH. In general, ascorbic acid, titratable acidity, and fruit pH were lower in the KS control compared to all other treatments. Fruits from all treatments were found to be similar for brix and firmness. Foliar K concentration was lower in KS control than all other treatments and foliar P concentration was lower in both KS and S controls than SSP, while both PH and SSP resulted in higher foliar S concentration than KS and S controls. Interestingly, KS control resulted in higher foliar Ca concentration than all other treatments except PH, possibly be due to lower competition between potassium and calcium in KS control and PH treatments. Consistently increased total and marketable yield for PH confirms its usage as a potential multi-nutrient source in Sao Paulo state of Brazil for tomato cultivation.

Specified Source(s) of Funding: Sirius Minerals

9:00 AM Seasonal Changes in Growth Dynamics, Nitrogen Nutrition, and Yield of Hydroponic Lettuce in Response to Nitrogen Fertilization

Daniel I Leskovar, *Texas A&M AgriLife Research & Extension Center, Texas A&M University* and Desire Djidonou[*], *Texas A&M AgriLife Reserach, Texas A&M University*

Abstract: Understanding the pattern of growth, nutrient uptake and utilization is a prerequisite to effectively managing fertilization programs in any cropping system including leafy vegetables in hydroponic production systems. An experiment was carried out in an unheated and naturally-lit hoop-house in Uvalde, TX to determine the effect of different concentrations of nitrogen (N) nutrient solution on growth dynamics, leaf N concentration and accumulation patterns, N nutrition index (NNI), yield, and N use efficiency (NUE) of lettuce grown over three consecutive seasons (fall, winter, and spring) in a recirculating hydroponic system. During each season, three lettuce varieties including Buttercrunch, Dragoon, and Sparx were grown in six N concentrations, i.e. 100, 150, 200, 250, 300, and 400 mg L^{-1} using a nutrient film technique (NFT). Leaf number, accumulated dry weight and N, and leaf area index (LAI) all followed a somewhat logistic trend over time characterized by a slow increase during the early growth period (14 to 21 days after transplanting, DAT) which was followed by a linear increase to a maximum level by the harvest. In contrast, total N concentrations in plants were highest at early stages and slightly decreased over time possibly due to a dilution effect. There was a more pronounced effect of season and variety on these growth traits than that of the N concentrations of the nutrient solution. Averaged over variety and N concentrations, accumulated biomass at harvest during the spring season was 73 and 34% greater than those of fall and winter, respectively, mostly due to the highest relative growth rates. At each sampling date, there were linear, quadratic, and cubic effects of N concentrations on each of these variables. Furthermore, the results revealed that Sparx is the most productive variety which exhibited 63 and 32 % higher fresh marketable yield than those of Buttercrunch and Dragoon, respectively during the fall season and 145 and 114 % in spring. Overall, increasing N concentrations from 100 to 400 mg L^{-1} increased the marketable fresh yield linearly or curvilinearly (quadratic or cubic) from 5.9 to 6.7 kg m^{-2} in fall, 8.1 to 10.7 kg m^{-2} in winter and 10.3 to 12.6 kg m^{-2} in spring. Additionally, NUE values were highest at the lowest N concentration (100 mg L^{-1}) and significantly decreased in response to increasing N concentrations in the nutrient solution. Similarly, NNI values during mid to late growth stages were near or above 1 even for the lowest N nutrient solution (100 mg L^{-1}). These results demonstrated that N concentrations of 100 to 150 mg L^{-1} can maximize growth and yield of hydroponic grown lettuce.

Specified Source(s) of Funding: Texas Department of Agriculture Specialty Crop Block Grant

9:15 AM Interactive Effects of Late-Season N Management and Foliar Disease on Nitrate Accumulation in Processing Carrots

Zachary D. Hayden[*]; Colin Phillippo; D. Corey Noyes; Mary K. Hausbeck and Daniel C. Brainard, *Michigan State University*

Abstract: Root nitrate concentration is an increasingly important quality concern for a large segment of the processing carrot industry, most notably where carrots are grown for baby food. N fertilizer topdress applications are often made late in the season in part to promote adequate and healthy carrot shoot growth, a key requirement for effective mechanical harvest; however, this may also increase risk of high nitrate content at harvest. Late-season foliar disease severity has the potential to further exacerbate nitrate challenges by reducing shoot N demand. The objective of this research was to investigate how late-season N management strategies and foliar disease influence dynamics of carrot root nitrate accumulation and production tradeoffs. Two on farm experiments were conducted in 2017 on sandy soils in Hart, Michigan. Carrots (*cv. Cupar*) were planted in mid-April and harvested in mid-October. Experiment 1 evaluated the effects of late-season (September) N fertilizer rate (0, 34, 67, or 101 kg N ha^{-1} as urea) and source (urea, slow-release, or foliar applied N) on carrot yield and quality, root nitrate content, and shoot growth. Carrot roots were subsampled every 2 wk leading up to harvest to evaluate temporal dynamics in root nitrate concentration. In Experiment 2, a subset of three treatments from a larger fungicide spray trial were selected to represent a gradient of foliar disease severity (low, medium, and high), and carrot subsamples were collected at harvest to evaluate impacts on root nitrate. Carrot yield was not affected by late-season N fertilizer rate or source treatments. Similarly, no significant differences in shoot biomass were observed, despite a modest trend toward greater biomass with higher N rates. All September N applications increased root nitrate content relative to the control. For N rates greater than 34 kg N ha^{-1}, nitrate concentrations increased linearly between fertilizer application and harvest. Slow release and foliar applied N both maintained lower root nitrate levels than urea over the course of the experiment. Foliar fungal disease severity was positively correlated with root nitrate at harvest, with concentrations over 7 times greater in high disease treatments (50-75% leaf area affected, Horsfall-Barratt scale) than in low disease treatments (3-6% leaf area affected). Our results suggest that late-season N applications in excess of recommended total season rates may have limited production benefits for carrots harvested in October, while also increasing risks of excessive nitrates, particularly if conditions are favorable for foliar disease.

Specified Source(s) of Funding: USDA/MDARD SCBG

9:30 AM Nutrient Distribution and Uptake Patterns in High Density Citrus Groves on Flatwoods Soils

Davie Kadyampakeni* and Kelly T. Morgan, *University of Florida*

Abstract: Citrus production in Florida occupies an estimated 176,848 ha, and had a crop value of $800 million in 2017. The total impact of citrus on Florida's economy is approximately $8.6 billion a year. The sandy soils, with more than 97% sand content, are prone to leaching of fertilizers and other agricultural chemicals when over-irrigation, heavy storms or hurricanes occur. Good understanding of nutrient movement and uptake in the root zone is critical for proper placement and timing of fertilizer applications. Experiments were conducted to determine nutrient and biomass accumulation patterns in in young citrus grown on Florida sandy soils. Results show improved nitrogen uptake by up to 45% using intensive microsprinkler and drip fertigation practices and reduced inorganic N, P and K leaching compared with conventional microsprinkler practices. Biomass, P and K accumulation among the fertilization practices was comparable over the years of study. The reduction in N leaching and improved uptake is important because it helps growers reduce N losses especially in summer months when leaching is exacerbated by rains.

Specified Source(s) of Funding: SWFWMD/FDACS

9:45 AM Production of Low Potassium Content Microgreens to Enhance the Diet of Patients Affected By Hyperkalemia

Francesco Di Gioia*[1]; Carlo Mininni[2]; Francesco Serio[2]; Giulia Conversa[3]; Antonio Elia[3] and Pietro Santamaria[4], *(1)University of Florida, (2)Institute of Sciences of Food Production, National Research Council,, (3)University of Foggia, (4)Universita' degli Studi di Bari*

Abstract: Defined as an excess of potassium (K) in the blood (≥ 5 mmol L^{-1}), hyperkalemia is a potentially life-threatening clinical condition affecting an increasing number of people worldwide. Commonly associated with chronic kidney disease (CKD) and other comorbidities (diabetes, cardiovascular disease, and hypertension), hyperkalemia derives from an impaired capacity to excrete K, or maintain its homeostasis between intra- and extra-cellular compartments. Patients affected by hyperkalemia must reduce the daily dietary intake of K limiting the consumption of high-K fruit and vegetables. Thereby, reducing also the intake of vitamins and bioactive compounds normally assured by the consumption of fruit and vegetables. Aiming to improve and enrich the diet of patients affected by hyperkalemia, a study was conducted to investigate the possibility to produce high quality low-K microgreens suitable for raw consumption. Broccoli (*Brassica oleracea* L. conv. *botrytis* (L.) Alef. var. *cymosa* Duch.), rapini (*Brassica rapa* L., Broccoletto group), and red cabbage (*Brassica oleracea* L. var. *capitata* f. *rubra* DC.) microgreens were grown in a soilless subirrigation system with nutrient solutions (NS) containing 3 (K_3), 0.75 ($K_{0.75}$), or 0 (K_0) mM of K. At harvest, 12 days after sowing, yield components, mineral content, total phenols (TP), and total antioxidant activity (TAA) were examined for all three species. The three species responded similarly to reduced K inputs. Potassium content of microgreens of the three species grown with K_3 NS ranged between 191 and 255 mg 100 g^{-1} of fresh product, which may provide between 9.5% and 17.0% of the daily recommended intake of K for people affected by hyperkalemia. Fertigation with $K_{0.75}$ or K_0 decreased microgreens K content by 49-59% and 79-82%, respectively, which may supply about 2.0% to 8.7% of the daily recommended intake of K. Fertigation with $K_{0.75}$ had no effects on yield and dry matter (DM) content compared to the standard NS; while fertigation with K_0 decreased microgreens yield by 28% and increased DM content by 21%. TP increased with decreasing the level of K in the NS. TAA was on average 35% higher in microgreens grown with reduced level of K compared to those grown at the standard level. In conclusion, reducing the level of K in the NS, it is possible to produce high-quality low-K microgreens suitable to satisfy the dietary needs of patients affected by hyperkalemia, with no or limited microgreens yield decrease.

Specified Source(s) of Funding: Project "Gusta il Biodiverso" Principi Attivi 2012 funded by Apulia Region, Italy

8:30 AM – 10:00 AM *Lincoln East*

Viticulture and Small Fruits 1

Moderator: Nahla V. Bassil, *USDA-ARS Corvallis*

8:30 AM Verifying Parentage and Confirming Identity in Blackberry with a Fingerprinting Set

Nahla V. Bassil*[1]; Jason Zurn[2]; Katherine A. Carter[3]; Melinda H. Yin[4]; Margaret Worthington[4]; John R. Clark[4]; Chad E. Finn[5] and Kim E Hummer[6], *(1)USDA-ARS Corvallis, (2)USDA-ARS, NCGR, (3)Oregon State University, (4)University of Arkansas, (5)USDA-ARS, (6)USDA ARS*

Abstract: Parentage and identity confirmation is an important aspect of clonally propagated crops outcrossing. Potential errors resulting misidentification include off-type pollination events, labeling errors, or sports of clones. DNA fingerprinting sets are an excellent solution to quickly identify off-type progeny or confirm clonal identity. A previously developed simple sequence repeat (SSR) fingerprinting set consisting of six primer pairs was used to verify parentage of seedling populations representing important blackberry (*Rubus* subg. *Rubus*) accessions from the University of Arkansas (UA) and the USDA-ARS Horticulture Crops Research Unit (HCRU) breeding programs. Six seedling populations from the UA and 12 seedling populations from the USDA-ARS breeding programs were genotyped. Incorrect parentage was detected where alleles that were absent in both parents occurred in seedlings. In the UA breeding program, 16 individuals were off-type while 11 individuals were off-type in the USDA-ARS HCRU program. In one of the USDA-ARS HCRU populations, ORUS 4647, all five individuals were off-type; the male parent was unknown. For parentage confirmation, the 6-SSR fingerprinting set was sufficient, however, 28 groups of individuals had identical DNA fingerprints. To achieve better resolution, 15 SSRs were examined. An improved 8-SSR fingerprinting set was developed by removing one marker from the 6-SSR set and adding three markers that differentiated undifferentiated individuals. The 8-SSR fingerprinting set reduced the number of indistinguishable samples to 10 groups consisting of two progeny per group. Interestingly, these groups consisted of adjacently planted individuals. Sampling errors may have occurred where the plants were inter-grown. The 8-SSR fingerprinting set was also used to evaluate a set of 71 *Rubus* clones from the USDA-ARS National Clonal Germplasm Repository (NCGR) to compare accessions that may be identical and to establish a library of genotypes for future identity comparison. The 8-SSR fingerprinting set was applied to 'Boysen' subclones, its presumed parents, and additional samples from private growers and commercial nurseries. Multiple subclones of this cultivar have been horticulturally recognized since the genotype was introduced in 1935. The results suggested which clone was most likely to be true-to-type, that 'Lucretia' was not a parent of 'Boysen', and grouped the 'Boysen' subclones into two general categories. Continuing work will focus on establishing pedigree or relational links for blackberry and hybrid berry cultivars.

Specified Source(s) of Funding: USDA-NIFA-SCRI project 'RosBREED: Combining Disease Resistance and Horticultural Quality in New Rosaceous Cultivars' (2014-51181-22378) and by the USDA-ARS CRIS project 2072-21000-044-00D.

8:45 AM Influence of Supplementary Foliar Nutrients on Crop Yield and Fruit Quality of Two New Primocane Bearing Blackberry Cultivars

Mikel Conway* and Jayesh Samtani, *Hampton Roads AREC, Virginia Tech*

Abstract: Supplemental foliar nutrient products are applied by some berry growers to improve sugar content, fruit quality and yield. However, there is not sufficient evidence that these applications improve fruit quality or increase crop yield. Virginia growers have limited information on two new thornless, primocane bearing blackberry cultivars- PrimeArk® Freedom and PrimeArk® Traveler. Both primocane cultivars are considered compatable for USDA hardiness zones 4-8. A study was conducted at the Hampton Roads Agricultural Research and Extension Center, Virginia Beach, VA (USDA zone 8A) with thirty-six PrimeArk® Freedom and Traveler plants each that were established on raised beds covered white woven polyethylene

and supported by T-post trellis. The objective of this study was to determine if supplemental foliar treatments showed increases in total soluble solids (TSS) content, yield and fruit size. Three sources of foliar nutrient treatments were applied using recommended label rates of: AgGrand (4-3-3); Sugar Express (40-10-40); K-Ace (0-0-25). An untreated control that received no supplementary nutrient was included in the study. Six foliar applications treatments were applied (April 17, May 5, May 27, June 11, June 25 and July 16 in 2017) at various growth stages from pre-bud to bloom through harvest. There were no significant differences between control and those that received foliar treatments, on crop yield, TSS content, or overall fruit size. The study will be repeated in the 2018 growing season.

Specified Source(s) of Funding: Virginia Department of Agriculture and Consumer Services, USDA Specialty Crop Block Grant

9:00 AM Phenology and Yield of Floricane-Fruiting Blackberry Cultivars Treated with Foliar Spray of Gibberellic Acid in Florida

Syuan-You Lin* and Shinsuke Agehara, *University of Florida*

Abstract: Most current blackberry (*Rubus* subgenus *Rubus* Watson) cultivars are adapted to temperate climates, requiring accumulation of 300 to 900 hours below 7.2°C to overcome the endodormancy of floricanes. To achieve high blackberry yields under subtropical climates in Florida, bud break must be artificially induced. Gibberellic acid (GA_3) is known to break dormancy and regulate flowering in many plant species, but its effectiveness in blackberry is unknown. Field experiments were conducted in the 2015-16 and 2016-17 seasons to evaluate the effects of foliar spray of GA_3 on phenology and yield of three floricane-fruiting blackberry cultivars, 'Natchez', 'Navaho' and 'Ouachita'. The experimental orchard was established in Balm, FL in 2013. Plants were sprayed with GA_3 at 0 or 49 g·ha^{-1} on 24 Dec. 2015 and 27 Jan. 2017. Cumulative chilling hours below 7.2 °C during the growing season were 130 and 165 hours for the 2016-17 and 2015-16 seasons, respectively. The onset of bud break was advanced by GA_3 by 70 to 80 days in the 2015-16 season, and by 14 to 34 days in the 2016-17 season. Fruit earliness was also improved remarkably in 'Navaho' (10 June vs. 23 May) and 'Ouachita' (11 June vs. 26 May) in the 2016-17 season. Significant yield increases by GA_3 were observed in both seasons, although some cultivars showed inconsistent responses. In the 2015-16 seasons, GA_3 increased yield of 'Ouachita' by 116%, but it had no significant effects on other two cultivars. In the 2016-17 season, the GA_3 x cultivar interaction was not significant, and yield increase by GA_3 averaging across three cultivars was 23%. These yield increases were due mostly to improved fruit set, as fruit yield showed a higher correlation with fruit number than with berry weight. By contrast, GA_3 reduced average berry weight by 13% in the 2015-16 season. In all cultivars, total soluble solid content was unaffected by GA_3 in both seasons. These results suggest that foliar spray of GA_3 is effective in promoting early blackberry bud break and fruit earliness, particularly for 'Navaho' and 'Ouachita' with relatively high chilling requirements, and that it can increase fruit set and yield with minimal negative impact on fruit quality. This strategy may improve the adaptability of existing blackberry cultivars with high chilling requirements to Florida's warm climate, and expand the blackberry production area.

Specified Source(s) of Funding: 2016 Florida Specialty Crop Block Grant # USDA-AMS-SCBGP-2016

9:15 AM Stomatal Functioning and Its Influence on Calcium Accumulation during Fruit Development in Northern Highbush Blueberry

Fan-Hsuan Yang[1]; Lisa Wasko DeVetter[2]; Bernadine C Strik[1] and David R. Bryla*[3], *(1)Oregon State University, (2)Washington State University, (3)USDA-ARS Horticultural Crops Research Unit*

Abstract: Accumulation of Ca in fruit is largely driven by transpiration and varies depending on the concentration of Ca in the xylem fluid. The objective of present study was to evaluate the relationship between fruit stomatal functioning and Ca accumulation during different stages of development in northern highbush blueberry (*Vaccinium corymbosum* L.). The information is needed to develop feasible practices for increasing Ca levels in the fruit. Stomata were scarce on the berries and were concentrated primarily on the distal end near the calyx. Density of the stomata was greatest at petal fall, averaging 5–108 stomata/mm^2 from the proximal (pedicel end) to the distal end of the berries. In comparison, mean density on the abaxial surface of the leaves averaged 496 stomata/mm^2. Stomata were wide open at the early green stage of berry development and only had a slight deposit of wax along the guard cells. As the berries expanded during the initial period of rapid growth (stage I), most of the stomata remained near the distal segment of the berries, and by the late green stage, almost none were found in the middle and proximal segments. The majority of these stomata were completely covered with wax once the berries began to change color and ripen. Stomatal conductance of the berries averaged 45 mmol·m^{-2}·s^{-1} at petal fall and rapidly declined as the fruit developed. By the fruit coloring stage, conductance was low and remained < 15 mmol·m^{-2}·s^{-1} throughout the ripening period. Leaf stomatal conductance measured at the green stage averaged ≈ 100 mmol·m^{-2}·s^{-1}. Dry matter accumulated in the berries in a typical double-sigmoid pattern, with an initial period of rapid growth (Stage I) from petal fall to fruit coloring, followed by a short lag period of growth (Stage II) during fruit coloring, and finally a second period of rapid growth (Stage III) during fruit ripening and prior to harvest. Calcium likewise accumulated rapidly during the initial stage of berry development, but in this case, accumulation slowed considerably between the late green and fruit coloring stages, and stopped completely during fruit ripening. In general, Ca accumulation appeared to end sooner in the early- and mid-season cultivars (Duke and Bluecrop) than in the late-season cultivars (Aurora and Elliott). Although stomatal conductance is low in developing blueberries, it appears to be an important mechanism by which Ca is delivered to the berries.

Specified Source(s) of Funding: Oregon Blueberry Commission

9:30 AM Effects of Amending Soil with Biochar on Plant Growth, Mycorrhizal Colonization, and Phytophthora Root Rot in Northern Highbush Blueberry

Bryan K. Sales*[1]; David R. Bryla[2]; Kristen M. Trippe[3]; Jerry E. Weiland[2] and Carolyn F. Scagel[2], *(1)Oregon State University Horticulture, (2)USDA-ARS Horticultural Crops Research Unit, (3)USDA-ARS Forage Seed and Cereal Research Unit*

Abstract: Biochar has been shown to improve soil conditions such as cation exchange capacity, porosity, pH, and beneficial microbial activity, and to suppress infection by soil-borne pathogens, but it has received relatively little attention in the horticulture industry. Two experiments were conducted in a greenhouse to determine the potential of using biochar as a soil amendment for northern highbush blueberry (*Vaccinium corymbosum* L. 'Legacy'). In Expt. 1, plants were fertilized once per week with a complete fertilizer solution (30–10–10) and irrigated twice per week. In Expt. 2, plants were fertilized once per month with 600 ppm of ammonium sulfate and irrigated three times per week. In both cases, the plants were grown in 4-L pots filled with soil (sandy clay) only or with soil amended with biochar or a biochar/bokashi blend at rates of 10% or 20% by volume. Half of the plants in each soil treatment were then inoculated with *Phytophthora cinnamomi*, which causes root rot. In the absence of *P. cinnamomi*, plants amended with 20% biochar or 10% or 20% biochar/bokashi blend had greater leaf area and 30% to 70% more total dry weight than those amended with 10% biochar or soil only. The biochar amendments also increased soil aggregation and root colonization by ericoid mycorrhizal fungi. The percentage of roots colonized by mycorrhizal fungi was ≤ 10% in soil only and ranged from 54% to 94% with the amendments. Plants inoculated with *P. cinnamomi* were stunted and showed typical symptoms of root rot. Root infection by the pathogen negated any growth benefits of biochar or biochar/bokashi and was greater in plants grown with the amendments than in those grown without them. Overall, amending soil with biochar appears to be a promising means of promoting plant growth and mycorrhizal colonization in northern highbush blueberry, but it may not suppress phytophthora root rot.

Specified Source(s) of Funding: Family Forests of Oregon

9:45 AM Evaluation of Mechanically Harvested Southern Highbush Blueberries (*Vaccinium corymbosum* L.) Advanced Selections for Fresh Market

Lauren Elizabeth Redpath*[1]; Terry W. Bland[2]; James R. Ballington[3]; Yu Jiang[4]; Changying Li[4]; Consuelo Arellano[1] and Hamid Ashrafi[1], *(1)North Carolina State University, (2)NCDA&CS, (3)North Carolina State University (emeritus), (4)University of Georgia*

Abstract: The predominant harvest method of blueberries, is hand harvesting. Production of southern highbush blueberries (SHB) by southern states (FL, GA and NC) makes up 26% of U.S. planted acreage and 20% of blueberry production. Hand harvesting blueberries increases production cost and risk of disease, lowering producer profit margins. In addition, hand picking is slower and more laborious than mechanical harvest (MH). These attributes in conjunction with competition among southern states for labor forces necessitates new strategies for blueberry production and harvest. Our objective was to evaluate advanced selections for MH by simulating blueberry growers' conditions using a mechanical harvester and sorting the fruit using color and soft sorter packing line. Thirteen five-year-old SHB advanced selections (NC4360, NC4385, NC4622, NC4638, NC4671, NC4676, NC4982, NC4984, NC4992, NC4994, NC4995, NC4996, and NC4998) and control SHB cv. 'Reveille' were used in a replicated trial from 2015-16. Fruit were harvested up to four times during the harvest season via Little Blue BEI harvester. Harvester efficiency was evaluated for fruit ground-waste, plant debris, and yield of acceptable fruit. Fruit quality was measured for berry weight, firmness, color, and appearance. Post-harvest storage amenability was evaluated after a week at 4 °C. Yield evaluations of consumer acceptable fruit after MH, showed that NC4360 had significantly higher yield than eleven other cultivars; NC4994 was not significantly different from the lowest yielding accession. NC4994 had the greatest average berry weight over the two years of study, followed by NC4360, both were significantly greater than nine other accessions. Further, NC4994 and NC4360 had the largest berry latitudinal diameter. The relation of berry weight and diameter to percentage of acceptable berries after MH is an important consideration for suitability of cultivar for MH. Interestingly, fresh fruit firmness was negatively correlated with fruit softness after storage; berries of accession NC4992 had significantly greater fresh fruit firmness and had significantly higher quality berries and least weight loss post-storage. In 2017, hyperspectral transmittance imaging showed NC4992 had the least bruising index compared with Reveille and 30 other described firm accessions. Harvester performance evaluation indicated that the average ratio of harvested consumer-quality-fruit to green or soft fruit was 3:1. NC4996 had significantly less soft and immature fruit to acceptable berries harvested at 1:7.5, all other accessions were less than 1:5. Accession evaluations show promise in cultivar adaptability to MH. Overall, accession 4992 has potential of being named as a new cultivar suitable to MH and storage.

Specified Source(s) of Funding: This research was funded by the North Carolina Blueberry Council, the North Carolina Department of Agriculture and Consumer Services, and the North Carolina State University Agriculture Foundation

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8:45 AM – 10:00 AM *Georgetown East*

Postharvest 1

Moderator: Zi Teng, *University of Maryland*

8:45 AM Investigation on the Major Sources of Organic Load and Chlorine Demand in Fresh-Cut Produce Wash Water

Zi Teng[*1]; Sam Van Haute[2]; Bin Zhou[2]; Cathleen J. Hapeman[2]; Patricia D. Millner[2]; Qin Wang[1] and Yaguang Luo[2], *(1)University of Maryland, (2)USDA-ARS*

Abstract: Large quantities of spent water heavily loaded with plant-derived organic compounds are generated during fresh-cut produce washing process. The significant chemical oxygen demand (COD) and chlorine demand (CLD) arising from those compounds complicate the safe reuse of the wash water. Thus, identification of the major chemicals contributing to COD/CLD will provide valuable information for improving the overall food quality and safety of fresh-cut produce. This study aims to characterize the chief sources of COD and CLD occurring during fresh-cut produce washing. Water samples, prepared by washing diced cabbages, were fractionated through centrifugation, ultrafiltration, and solid phase extraction. Sugars, organic acids, and phenolics were profiled by HPLC, and proteins and peptides were extracted directly from the wash water. Regression equations were established to predict the time-dependent CLD of each identified compound at their respective concentrations. Results revealed sugars as the major contributor to COD (81.6%), followed by proteins/peptides (5.3%), organic acids (3.6%), and phenolics (0.5%). In contrast, contributions to CLD ranked roughly as proteins/peptides > phenols ~ organic acids > sugars, although this ranking varied over time. Proteins/peptides accounted for approximately 50% of the total CLD during the cabbage washing process. Phenols reacted rapidly with chlorine, contributing to 21% of the total CLD at 5 min, but this percentage diminished over time as other compounds reacted continuously. Organic acids (citric, malic, oxalic, and ascorbic) and sugars (fructose and glucose) exhibited a gradual pattern of reaction, making up for 22% and 16%, respectively, of the total CLD at 2 hr. Collectively, the identified compounds explained for 94% of the total CLD in 2 hr. This is the first systematic report on the sources contributing to COD and CLD in produce wash water. It underscores distinctions between these two parameters, which will influence the development and selection of improved wash water treatment strategies to achieve improved fresh-cut produce safety.

9:00 AM Comparison of the Browning Potential of Fresh-Cut Romaine Lettuce during Cold Storage

Ellen R. Bornhorst[*1]; Eunhee Park[2]; Bin Zhou[2]; Ellen Turner[2]; Ivan Simko[2] and Yaguang Luo[2], *(1)ORISE, (2)USDA-ARS*

Abstract: Fresh-cut, ready-to-eat, packaged lettuce has become increasingly popular in the USA; however, this product is highly perishable and browns quickly with a relatively short shelf-life. The selection of cultivars with improved quality and less cut-edge browning could help strengthen and expand the fresh-cut lettuce industry. The objective of this study was to characterize the quality and browning potential of 15 Romaine lettuce cultivars: Braveheart, Clemente, Green Forest, Green Towers, Heart's Delight, King Henry, Lobjoits, Paris Island Cos, PI 4912242, RH11-1506, Siskiyou, SM13-R2, Sun Valley, Tall Guzmaine, and Triple Threat. Lettuce cultivars were selected, grown, and harvested by the United States Department of Agriculture (USDA) lettuce breeding program in Salinas, CA. Lettuce was shipped to the USDA Food Quality Laboratory in Beltsville, MD for processing, packaging, and shelf-life assessment. Romaine lettuce was trimmed, cut into 2.5 × 2.5 cm slices, washed for 30 seconds in a 100 mg L^{-1} free chlorine solution adjusted to pH 6.5, centrifugally dried for 2 minutes at 666 rev min^{-1}, and packaged in polypropylene bags with a film oxygen transmission rate at 5°C of 16.6 pmol O_2 s^{-1} m^{-2} Pa^{-1}. Packaged lettuce (4 replicates) was stored at 5°C for up to 14 days. The cut lettuce pieces were analyzed for sensorial quality attributes (freshness, browning, overall quality, and off-odor), head-space gas composition (O_2, CO_2), and color. A new image analysis tool was developed to quantify the browning severity in cut lettuce pieces using high resolution images taken under controlled lighting and analyzed using a smart segmentation computer software (Image Pro Premier). Sensory results showed that Clemente had the lowest browning score (16.0±4.0) and highest overall quality score (75.2±9.1), while Triple Threat had the highest off-odor score (74.2±12.2) and lowest overall quality score (17.3±15.7) after 14 days of storage. Image analysis confirmed that Clemente had less extensive browning than Triple Threat, as demonstrated by the amount of lettuce leaf pixels that had a brown color after 14 days of storage (4.7±0.8% for Clemente, 15.1±3.0% for Triple Threat). Triple Threat also had the largest headspace CO_2 concentration compared to the other cultivars (12.4±0.9% CO_2 after 14 days), indicating that this variety had a higher respiration rate. These results and the image analysis tool developed in this research can be used in the selection and development of new Romaine lettuce cultivars with improved quality.

9:15 AM Vapor Phase Application of Volatile Phenols Inhibits Growth of *Botrytis Cinerea* and Reduces Disease Incidence of Strawberry Fruit

Ariane Vasilatis[*]; Jeanne Peters; James Simon and Thomas Gianfagna, *Rutgers University*

Abstract: Postharvest losses of strawberries and other horticultural small fruits is estimated to be as high as 25% due to disease, dehydration and over ripeness, resulting in economic losses to farmers and consumer dissatisfaction. Both physiological and environmental factors contribute to the limited storage life of fresh fruit particularly when the fruit becomes overripe and begins to show symptoms of disease. In this study, a series of volatile monoterpene and ethyl phenols known for their

antimicrobial properties were tested to determine their growth inhibitory effects on the fungus *Botrytis cinerea* (gray mold) , the most common postharvest spoilage organism in strawberry. In a two-factor three-level experimental design, compounds were tested at 3 concentrations and 3 temperatures (4, 10 and 22C) for growth inhibition of a pure culture of *B. cinerea*, and for disease incidence of strawberry fruit inoculated with the fungus. The experiment was conducted in Magenta boxes with the volatile phenol compounds applied at specific concentrations to filter paper discs fixed to the inner lid. The concentration of volatile phenols in the box was determined by SPME-HS using a Shimadzu TQ8040 GC-MS. Results indicated that fungal growth inhibition and fruit disease incidence were correlated with the vapor pressure of the volatile phenolic compounds tested.

Specified Source(s) of Funding: Teaching Assistantship

9:30 AM Role of Hexanal Based Formulations in Enhancing the Shelf Life of Nectarines

Shanthanu Krishna Kumar[*1]; Walid El-Kayal[1]; Alan J. Sullivan[2]; Gopinadhan Paliyath[2] and Jayasankar Subramanian[1], *(1)University of Guelph, Vineland, (2)University of Guelph*

Abstract: Post-harvest technologies play a key role in enhancing shelf life and maintaining quality characteristics of tender fruits such as nectarines (*Prunus persica* [L.] Batsch var. nectarina). This research investigated the effects of an 'Enhanced Freshness Formulation' (EFF) with hexanal as the key ingredient to improve shelf life of nectarines. Pre-harvest sprays of EFF on 'Fantasia' nectarines, conducted at two commercial orchards in the Niagara region, ON, showed a general improvement in shelf life. Application of EFF delayed the incidence of chilling injury symptoms (internal browning and mealiness/woolliness) by one week. Treated fruits maintained significantly higher firmness until 38 days post-harvest. There were no differences in total soluble solids, titratable acidity and color values between treated and control fruits, suggesting an otherwise normal ripening behaviour. The volatile analysis study (GC-MS) indicated for the first time that hexanal is naturally present within the nectarine fruit. Further, it was observed that reduced levels of volatile compounds associated with fruit ripening such as lactones, and an increased level of acetates associated with unripe fruit, were present in EFF treated fruit. qRT-PCR was conducted to evaluate the expression levels of 22 genes potentially involved in ripening, to understand the regulatory effects of the hexanal formulation. EFF application induced a highly significant reduction in transcript levels of three Phospholipase D genes, five N-glycoprotein group genes, and other genes involved in ripening and softening processes. These findings indicate that, a delay in the ripening process caused by EFF, may be associated with the modulation of the expression of key ripening related genes, enhancing shelf life and quality of nectarines. Internal Browning and Mealiness Symptoms.JPG (76.6KB)

Specified Source(s) of Funding: IDRC (International Development Research Center), Canada

9:45 AM Quantitative Evaluation of Phenolic Compounds and Anthocyanins Reveals Their Phenotypic Variation in Apples

YiHui Gong[1]; Kendra McClure[2]; Jun Song[*3]; Melinda Vinqvist[4]; Leslie Campbell Palmer[3]; Lihua Fan[3]; Charles F. Forney[3] and Sean Myles[2], *(1)College of Horticulture, South China Agriculture University, (2)Dalhousie University, (3)Agriculture and Agri-Food Canada, (4)Agriculture and Agri-Food Canada.*

Abstract: Apple fruit (*Malus domestica*) is one of the most consumed fruit in the world due to its flavor quality and nutritional value. The production of apples plays an important role in economic development in the world. Apple fruit contain significant amounts of phytochemicals including phenolic compounds, anthocyanins and other compounds which are recognized as important bioactive compounds contributing to human health and well-being. Many of these phenolic compounds are strong antioxidants, including simple phenols, phenolic acids, hydroxycinnamic acid derivatives and flavonoids such as quercetin, epi-catechin, catechin, phloridzin, chlorogenic acid, quercetrin and procyanidins. Phenolic compounds in apples are influenced by many pre- and postharvest factors. To determine the diversity of phenolic compounds in apple cultivars, we evaluated 88 and 144 apple cultivars grown in Nova Scotia in 2015 and 2016, respectively. Fruit were harvested at commercial harvest maturity and stored at 3.0 °C for one month prior to phenolic compound analysis. High performance liquid chromatography (HPLC) with photo diode array and fluorescence detection was employed to determine phenolic and anthocyanin composition of apple tissues. Five major polyphenolic groups composed of total phenolics, total hydroxycinnamic acid derivatives, total flavonols, total fluorescence and total anthocyanins as well as 14 individual compounds were identified and quantified. Significant variation of phenolic compounds and anthocyanin among apple cultivars was found. For some compounds, concentrations differed by more than 6 times among the cultivars in the two populations indicating that a strong genetic regulation may control phenolic metabolism in apples. Our study also revealed correlations among the different classes of phenolics with diseases resistance as well as the development of physiological disorder. These research findings will lay the foundation for future genetic improvement of the phenolic composition of apples.

9:00 AM – 12:00 PM

SCRI Project Director Meeting - Day 2

Georgetown West

Coordinator: Megan O'Reilly, *Institute of Food Production and Sustainability*

9:30 AM – 10:00 AM *Lincoln West*

Professional Interest (Formerly Working Group) Chairs and Chairs-elect Meeting - Repeat of Monday Session

Presiding: Carl Sams, *The University of Tennessee*

Objectives:

Meeting of all officers of the ASHS Professional Interest (Formerly Called Working Groups). This session will be offered two times during the conference (Monday and Tuesday). The same material will be covered. Attendance at only one of the sessions is encouraged.

10:00 AM – 12:00 PM

Plenary Session & ASHS Awards Ceremony

International Ballroom West

Objectives:

Keynote Speaker (William A. "Tex" Frazier Lecturer) - Dr. William R. Woodson

10:00 AM The Relevance of The Land Grant University in Today's Economy

William R Woodson[*], *North Carolina State University*

Abstract: The Morrill Act transformed the field of higher education by creating land-grant institutions, offering individuals greater opportunity to pursue higher education in practical areas for employment. With accessibility and economic prosperity at the core of its mission, today's land-grant university is uniquely positioned to drive student success, translational research, and economic growth. Land-grant universities have evolved to become pre-eminent enterprises actively tackling society's grand challenges to the benefit of individuals and communities within -- and beyond -- the United States.

12:00 PM – 1:00 PM

Awards Recipient Reception - By Invitation Only

Jay (Lobby Level)

12:00 PM – 1:00 PM

How to Prepare for Your Visit to Capitol Hill - Tuesday

Piscataway (Lobby Level)

Coordinator: Thomas Björkman, *Cornell University*

Objectives:

A training session to prepare members who are going to do meetings with legislators and staff on Capitol Hill. The session will include the basic protocol of a successful office visit, some tailoring of your pitch, and a review of where legislation of interest to ASHS members stands at that time. You will be able to have a productive and effective visit. The session will be led by ASHS members who have done many visits, as well as our expert, ASHS legislative affairs consultant Jonathan Moore.

12:00 PM – 1:00 PM

Student Welcome Session

Lincoln East

12:00 PM – 4:00 PM *T Street Entrance - Terrace Level*

Tour of the Smithsonian Environmental Research Center Facilities

1:00 PM – 2:00 PM *Piscataway (Lobby Level)*

Association of Horticulturists of Indian Origin (AHIO) Meeting - Open to All Attendees

Chair: Sastry S. Jayanty, *Colorado State University*

Chair-elect: Krishna Nemali, *Purdue University*

Objectives:

To promote fellowship among the horticultural scientists of Indian origin and increase professional opportunities through increased interaction among them and with other American scientists; promote awareness of ASHS membership benefits and encourage membership pool from India; facilitate and support ASHS ad-hoc membership to attract Indian Horticulturists; to act as scientific ambassadors to facilitate an exchange of scientific information and cultural ideas between India and countries in North America; help share and transfer results of scientific research to India to improve agricultural productivity and quality.

1:00 PM – 2:00 PM *Oak Lawn (Lobby Level)*

Fruit Breeding (FRBR) Meeting - Open to All Attendees

Chair: Dario J. Chavez, *University of Georgia*

Chair-elect: Cameron Peace, *Washington State University*

Secretary: Margaret Worthington, *University of Arkansas*

Objectives:

To promote and coordinate research efforts in the genetics and breeding of fruit crops.

1:00 PM – 2:30 PM *Boundary (Terrace Level)*

American Pomological Society (APS) Executive and Advisory Board Meeting

Chair: Michele Warmund, *University of Missouri*

1:00 PM – 2:30 PM *Northwest (Lobby Level)*

Consulting Editors Meeting

Presidings: Ron Robbins, *ASHS* and Neal De Vos, *De Vos & Associates*

1:00 PM – 2:30 PM

Information Is Everywhere! How Do I Protect It and Use It Properly? *CEU Approved*

Jefferson West

Coordinators: Emily Tepe, *University of Minnesota*; Kim Shearer-Lattier, *Morton Arboretum* and Barbara Liedl, *West Virginia State University*

Moderator: Emily Tepe, *University of Minnesota*

Objectives:

The objective of this workshop is to clarify the laws and guidelines for copyright and use of scholarly and creative works. Participants will gain practical knowledge for protecting their work and lawfully using the work of others.

Description: The impacts of information ownership, copyright, and use are woven throughout our professional lives. Do you know how to share your work while protecting your rights? On the flip side, are you sure you're using the work of others lawfully? In this engaging workshop, you'll be guided by legal and policy experts to solve the mysteries of copyright in research, publishing, and instruction.

The bulk of the workshop will consist of a roundtable discussion session which will provide the opportunity to discuss several common copyright scenarios with panelists. Panelists will guide participant groups in discussions of each scenario, and these groups will work together to clarify legalities and come to a consensus on best practices.

Case studies/scenarios to be addressed will include:

1. My government funded research grant has a public access requirement. Once public access has been granted, who owns the data? How does this affect subsequent publication? What if my publisher wants exclusive rights?
2. I want to use someone else's published research data for a follow-on study. Can I do this? From whom do I get permission?
3. I am writing an Extension fact sheet about organic fertilizers. I found a table from another University that clearly lists nitrogen analysis of various organic fertilizers. Can I use this table as-is in my publication? Can I reformat it for my publication?
4. I published an article in a journal. What rights to I retain as the author? How can others use what I've published? Are rights and restrictions consistent across different journals?
5. I want to use images I found online in my presentation. Do I need to get permission? How do I credit images properly? Can I post this presentation on my website or on Slideshare?
6. I am an Extension Educator and developed a powerpoint slideshow on growing tomatoes. A Master Gardener wants to use it to give a presentation to a garden club. Do I own this presentation, or does my University? What are some things I should consider before sharing my powerpoint with others?

1:00 PM **Horticultural Copyright 101**

Hope O'Keeffe*, *Library of Congress*

Abstract: Hope O'Keefe, Senior Associate General Counsel for the Library of Congress, supervises all collections matters including acquisitions, copyright, intellectual property, social media, web archiving, and increasing digital access to Library collections. As we delve into various case studies, Hope will offer broad insight to answer the fundamental copyright questions that arise in our work every day, ranging from publications to open science to big data.

1:20 PM **Publishing in the Electronic Age: Rights and Restrictions**

Vicky Crone*, *National Agricultural Library*

Abstract: Vicky Crone, Licensing and Procurement Librarian at the National Agricultural Library, will offer insight on licensing and paid access terms, rights, and restrictions in publishing, considerations for electronic and international publishing, and communication and collaboration between copyright holders and publishers. Vicky will help us explore and discuss case studies that illustrate these topics to foster a clearer understanding of licensing issues.

1:40 PM **Fair Use: What Is It and How Do I Apply It?**

Krista Cox*, *Association of Research Libraries*

Abstract: Krista Cox, Director of Public Policy Initiatives for the Association of Research Libraries, will guide participants through fair use, which is an essential right that allows the use of copyrighted material without permission from the rightsholder under certain circumstances. The law encourages authors by giving them limited control over certain uses of their works, and it encourages everyone (including authors) to use existing cultural and scientific material without permission, under certain circumstances, to engage in a wide variety of vital activities. Krista will help us determine how fair use applies to different areas of research, instruction, and publishing through discussion of various practical case studies.

2:00 PM **Question and Answer Period**

Emily Tepe*, *University of Minnesota*

Abstract: The workshop will conclude with a Q and A session in which the floor will be opened to specific participant questions. Speakers will provide insight and answers to these questions, and promote discussion to clarify the application of copyright and use laws, principles, and best practices to a broad range of situations. Participants will come away from the workshop with practical tools and resources for protecting their own work and properly using the work of others.

1:00 PM – 2:30 PM

Systems Approach to Ecophysiology and Instrumentation: Technology and Instrument Demonstration *CEU Approved*

Jefferson East

Coordinators: Yan Chen, *Louisiana State University Agriculture Center & Research Station* and Catherine Simpson, *Texas A&M University, Kingsville Citrus Center*

Moderator: Yan Chen, *Louisiana State University Agriculture Center & Research Station*

Objectives:

The objective of this workshop is to showcase innovative and exciting technologies and products recently developed for measuring plant water and nutrient status and related stresses. Workshop format includes presentations, videos, hands-on demonstrations, and a panel discussion. Through these activities, we expect to facilitate the learning of new technologies and the future application of featured devices in the research fields of workshop attendees.

Description: New development of innovative technologies and products have opened up exciting opportunities for more directly and precisely quantifying plant water and nutrient status and the responses of plants to related stresses. New technologies showcased in this workshop include (by the order of presentation) (1) overview of instruments developed to measure plant water status, such as tree hydration, (2) microtensiometer for measuring stem water potential, (3) thermal imaging devices for quantifying plant water stress, (4) sensing technology for analyzing nutrient status in fruit trees, and (5) laser mediated nucleic acid delivery system that can enhance the uptake of foliar applied chemicals by fruit trees.

Renowned experts from both industry and academia will introduce the design theories, review the scientific promises of the featured products, and demonstrate the applications either by videos (nutrient sensors, TDR system, and laser mediated nucleic acid delivery system) or on-site installation and remote data collection (i.e., microtensiometer, infrared radiometers, sap flow velocity and nutrient sensors). There are, however, limitations to have some of the instruments available at the workshop. For example, operating an x-ray instrument requires different levels of certification in different states.

At the end of the workshop, a 15-minute panel discussion facilitated by organizers will address questions from the audience and provide networking opportunities among researchers and product developers. Speakers will have additional video materials ready to address some of the questions that are expected based on their experiences.

1:00 PM **Instruments and Approaches to Measure Tree Water Status**

Bruce Bugbee*, *Utah State University*

1:15 PM **Continuous in-Situ Monitoring of Plant Stem Potential with an Embedded Microtensiometer**

Alan N Lakso*, *Cornell University*

Abstract: Plant water potential is increasingly recognized as key for regulating both growth but also product quality. Directly measuring plant water potentials (preferably stem potential and continuously) is a key goal to replace the pressure chamber. To do this we have developed, using nanofabrication, a small size (in a probe about 6mm diameter and 1 cm length), inexpensive, electronic, large-range, continuous-reading water potential sensor for monitoring soil water potential and embedding directly in the stems to monitor stem potentials, especially in woody plants. The sensor is a microfluidic device with the same principle as the common soil tensiometer, but with a much smaller volume and about 100X greater range. The microtensiometer has been successfully tested embedded in the stems of field apples, grapes and almonds over months. The high spatial and temporal resolution of plant and soil Y_w provided by the microtensiometer should be a valuable tool for precision irrigation programs, research, and modeling.

1:30 PM **Thermal Imaging of Plant Canopies for Quantifying Water Stress**

Bruce Bugbee*, *Utah State University*

1:45 PM **Using Stable Isotope Tracers and X-Ray Fluorescence to Track Nutrient Movement and Distribution in Plants**

Lee Kalcsits*, *Washington State University*

2:00 PM **Laser Mediated Nucleic Acid Delivery System**

Ed Etxeberria*, *University of Florida*

Abstract: Application of nucleic acid phytoremediation technology in agriculture has been stifled by the inability to target the nucleic acid components to the desired tissues. Under laboratory conditions using young seedlings, nucleic acid absorption through roots has been partially successful in treating a variety of biotic stresses. However, such techniques are not applicable to larger plants whether in pots or in the field. Laser technology has been shown effective in amplifying the uptake of applied substances, nano-particles and RNAi when applied to leaves. The technique consists of using laser energy to create perforations on the plant surface to allow the movement of nucleic acids (or other substances) into the plant and their eventual distribution by the vascular tissue. Trial experiments using RNAi against chlorophyll formation and targeted experiments against disease-carrying feeding insects have demonstrated the usefulness of this technology.

1:00 PM – 2:45 PM *Lincoln West*

Growth Chambers and Controlled Environments 1

Moderator: Hunter Hammock, *University of Tennessee*

1:00 PM **Far-Red Light-Emitting Diodes during Production Improves Quality and Flavor of Tomato Fruits**

Meng-Yang Lin*; Andrea Liceaga and Hye-Ji Kim, *Purdue University*

Abstract: Light-emitting diodes (LEDs) becomes popular supplemental lighting (SL) in greenhouse because of high illuminating efficiency without compensating crop productivity. Accumulation of phytochemicals can be also induced by LEDs with specific spectrum in many crop species. Besides phytochemicals, mineral nutrients are essential for human

nutrition and contribute to the quality and flavor of tomatoes. Ion uptake, partitioning, and assimilation are mediated by phytochrome, whose actions highly depend on red (600-700 nm) and far-red (700-750 nm) light. The objectives of this study were to determine how red and far-red light affects fruit mineral composition and taste of greenhouse tomato. 'Merlice' scions grafted onto 'Maxifort' rootstocks were supplemented with (FR, 29% far-red :71% red) or without (R, 100% red) far-red LEDs lighting, compared with the most common SL, high-pressure sodium (HPS) lamps. Tomatoes at the stage 6 were selected for mineral and sensory evaluation. The concentration of nitrate, nitrite, sulfate, phosphate, chloride, sodium, potassium, magnesium, and calcium in fruit were determined by ion chromatography. The ends of the tomatoes were cut off and then the tomatoes were cut into fourths. Panelists were given one piece of each sample, sequentially with sample order being randomized, and were asked to rate the degree of liking (DOL) regarding aroma, sweetness, saltiness, acidity, and texture on a 9-pt scale as well as aroma, sweetness, saltiness, acidity, and texture on a 5-pt just about right (JAR) scale. The panelist was given water and a cracker to cleanse their palate between samples. When complete, the panelist was given a $5 gift card as reward. The concentration of sodium and dry matter ratio were increased significantly by FR, compared to R and HPS. Interestingly, there was a significant difference between the samples for DOL on aroma (FR was rated higher than R), sweetness (FR was rated higher than HPS and R), saltiness (FR was rated higher than HPS), acidity (FR was rated higher than HPS and R), and texture (FR was rated higher than R). Like DOL, there was a significant difference between the samples for JAR on sweetness (FR was rated higher than HPS and R), and texture (FR was rated higher than R). Our results suggest that supplemental lighting with far-red LEDs induces the accumulation of sodium and dry matter in fruit, and that customers can tell the chemical differences from aroma, sweetness, saltiness, acidity, and texture.

Specified Source(s) of Funding: NE-1335 Resource Management in Commercial Greenhouse Production

1:15 PM Green and Far-Red Light Antagonize Blue Light in Regulation of Lettuce and Kale Growth

Qingwu Meng* and Erik S. Runkle, *Michigan State University*

Abstract: Although red and blue light can be sufficient for plants grown indoors, other wavebands have potential to increase crop yield and quality by regulating plant morphology, photosynthesis, and secondary metabolism. The objective of this study was to determine how blue, green, red, and far-red light interacted to regulate growth of leafy greens grown indoors under light-emitting diodes (LEDs). We grew kale (*Brassica oleracea* var. sabellica 'Siberian') and lettuce (*Lactuca sativa* 'Rex' and 'Rouxai') under warm-white light at 180 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for 9–11 days and then transplanted them in a hydroponic system with ten different lighting treatments. The air temperature (20 °C), photoperiod (20 hours), total photon flux density (180 $\mu mol \cdot m^{-2} \cdot s^{-1}$, 400–800 nm), and fertility were maintained the same across treatments. In addition to warm-white and equalized-white controls, combinations of blue (peak = 449 nm), green (peak = 526 nm), and far-red (peak = 733 nm) light, each at 0, 20, 40, or 60 $\mu mol \cdot m^{-2} \cdot s^{-1}$, were delivered in a red-light (peak = 664 nm) background at 120 $\mu mol \cdot m^{-2} \cdot s^{-1}$. One month after seed sow, we collected data on shoot biomass, leaf morphology, and pigmentation. Substituting green or far-red light for blue light promoted leaf expansion and increased biomass but decreased chlorophyll concentration in all crops. For example, lettuce 'Rex' grown under green + red light was 35% greater in plant diameter and 40% greater in shoot dry weight compared to those under blue + red light. Green light at 60 $\mu mol \cdot m^{-2} \cdot s^{-1}$ also reduced red coloration of lettuce 'Rouxai'. At the same intensity, far-red light increased leaf expansion and decreased pigmentation more than green light. We conclude that green light can counter blue-light-induced growth suppression and trigger the shade-avoidance response, accelerating growth while decreasing pigment concentration.

1:30 PM Daily Light Integral Supplements Alter Key Flavor Volatiles in Hydroponically Grown Basil

Hunter Albright Hammock*, *University of Tennessee*; Carl E. Sams, *The University of Tennessee* and Dean A. Kopsell, *The University of Tennessee*

Abstract: Light quantity, quality, and duration are three primary factors that impact plant growth and development. Light emitting diodes (LEDs) offer control for each of these parameters and allow commercial growers to optimize biomass yield and plant quality throughout growing seasons. While many studies show LED supplementation is useful for high-value specialty crop production, research is needed to determine the value and efficacy of LED lighting systems in comparison to traditional lighting systems. Research determining the impact of daily light integral (DLI) and spectral distribution on secondary metabolism and flavor volatile production could be of value to producers. The objective of this study was to establish the effects of progressive DLIs using LED and high-pressure sodium (HPS) supplementation on key flavor volatiles in hydroponic basil (*Ocimum basilicum* var. 'Genovese') across different growing seasons. A total of nine lighting treatments were used: one non-supplemented natural light control, two HPS treatments with DLIs as 6 h and 12 h, and six 20B/80R LED treatments with progressive DLIs as 3 h, 6 h, 9 h, 12 h, 18 h, and 24 h. Each supplemental lighting treatment provided 100 $\mu mols \cdot m^{-2} \cdot sec^{-1}$. The DLI of the natural light control averaged 9.9 $mol \cdot m^{-2} \cdot d^{-1}$ during the growth period (ranging from 4 to 20 $mol \cdot m^{-2} \cdot d^{-1}$). Relative humidity averaged 50%, with day/night temperatures averaging 29.4 °C/23.8 °C, respectively. Basil plants were harvested 45 d after seeding, and flavor volatile profiles were measured using GC-MS. Flavor volatile concentrations varied significantly among seasons and lighting treatments. Many compounds showed a non-linear relationship as DLIs increased, with the greatest flavor volatile concentrations observed in LED ratios ranging from 12-24 h and the 6 h HPS treatment. The 6 h HPS lighting treatment produced comparable volatile organic compound (VOC) concentrations to the 24 h LED treatment, suggesting that DLI is only one of the many factors that drives secondary metabolism resource allocation. Further, concentrations of some compounds, such as methyl eugenol, were 3-4x higher in the 3 h LED treatment and decreased significantly for basil subjected to higher DLI increments. As DLI supplements were increased, secondary metabolism partitioning was significantly impacted; compared to the 3 h LED treatment, the 24 h LED treatment commonly showed significant increased mono and diterpenes, with reduced sesquiterpenes and phenols. The results of this study show that using LEDs to supplement natural photoperiods has the potential to manipulate secondary metabolism and flavor volatile production.

1:45 PM Morphology and Growth Rate Responses of Red Lettuce to Dynamic Spectral Changes in Indoor LED Sole Source Lighting

Hans Spalholz*, *North Carolina State University* and Ricardo Hernández, *NC State University*

Abstract: The use of static or fixed spectral recipes is the predominant strategy for illumination in the indoor crop production industry, regardless of lighting technology used. However, with LED fixtures, it is possible to change the emitted spectrum at different plant growth stages (dynamic spectral recipes) in order to maximize plant biomass and phytochemicals. The objective of this experiment was to compare the effects of fixed and dynamic spectral recipes and end of day far-red (EODFR) light using different percentages of blue (B) and red (R) photon flux (PF) ratios to produce 'Red Oakleaf' lettuce. Plants were grown for a total of 47 days with four treatments consisting of two fixed spectral recipes (1) 20B:80R and (2) 20B:80R-EODFR and two dynamic light recipes (3) 20B:80R-EODFR (day 3-19) followed by 100B (day 20-39) (20B:80R-100B), and (4) 20B:80R+EODFR (day 3-19) followed by 100B-EODFR (day 20-39) (20B:80R-100B-EODFR). From day 3-11 plants were provided with 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ photosynthetic photon flux (PPF) for 18 h and increased to 200 $\mu mol \cdot m^{-2} \cdot s^{-1}$ PPF for 18 h from day 12-47. For treatments that included EODFR, far-red light consisted of 6 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for 30 min. From day 40-47 a "finishing" light recipe (50B:50R) was applied to all treatments to evaluate anthocyanin accumulation in the plant. Plants in all treatments had no significant differences in shoot fresh mass. Plants from the dynamic 20B:80R-100B treatment had 12% greater shoot dry mass than the static treatment of 20B:80R. Dynamic treatment 20B:80R-100B-EODFR plants had 64% longer stem length and 109% greater stem fresh mass, respectively, than plants in 20B:80R. Stem elongation altered the leaf dry mass:stem dry mass ratio resulting in 20B:80R-100B-EODFR having the lowest ratio and 20B:80R having the highest ratio. In terms of canopy diameter, 20B:80R-100B was 26% larger than 20B:80R plants. There were no differences in leaf area and leaf net photosynthetic

rate. These results demonstrate that dynamic spectral recipes can be used to significantly impact plant morphology and growth while using similar power consumption.

Specified Source(s) of Funding: USDA NIFA, project 1007454

2:00 PM Refined Spectrum of Growing Light Could Improve Photosynthetic Rate

Jun Liu*, *University of Gerogia* and Marc W. van Iersel, *University of Georgia*

Abstract: Green light has lower leaf absorptance than red and blue light, and therefore is often considered to be less photosynthetically efficient at the same photosynthetic photon flux density (*PPFD*). However, green light can penetrate deeper into leaves and excite deeper cell layers more effectively than red and blue light. We hypothesized that, at high *PPFD*, green light may excite more leaf cells than red and blue light, and may achieve a higher leaf photosynthetic rate. To characterize the interactive effect of light quality and intensity, we explored the effect of light quality and *PPFD* on photosynthetic rate. Photosynthetic rate of 'Green Tower' lettuce was measured under different *PPFD*s of red, blue and green light, and photosynthesis-light response curves were fitted for the three colors. The maximum quantum yield of photosynthesis (moles of CO_2 fixed per mole of photons) was determined as the initial slope of the light-response curve. To account for differences in absorptance among the three colors, data was expressed both on an incident and absorbed *PPFD* basis. At low *PPFD*, plants under green light had the lowest photosynthetic rate among plants under red, blue and green light. The maximum quantum yield of photosynthesis was significantly higher under red than under blue or green light, indicating that the lower photosynthesis under green light is not only due to lower absorptance, but also to less efficient use of absorbed photons. At *PPFD* above 800 µmol/m^2/s, however, photosynthetic rate under green light was higher than under red and blue light, likely because red and blue light were absorbed by the top cell layers of the leaf. This likely saturated the reaction centers in those cells, while deeper cell layers receive few photons. Green light, on the other hand, penetrates deeper into the leaf and excites more cell layers than red and blue light. Consequently, a higher *PPFD* is required for green light to saturate a larger numbers of reaction centers. Because green light can effectively excite more photosynthetic reaction centers, the light saturation point and light-saturated photosynthesis under green light are likely higher than those under red or blue light. In conclusion, green light is more effective at driving photosynthesis at high *PPFD* than red and blue light. This knowledge could lead to refined design of LED grow lights that will enhance the light use efficiency, reduce energy cost, and ultimately reduce production cost for greenhouse growers.

Specified Source(s) of Funding: American Floral Endowment

2:15 PM Growth and Subsequent Flowering Responses of Annual Bedding Plants Under Sole-Source Lighting at Least Partly from White Light-Emitting Diodes

Yujin Park* and Erik S. Runkle, *Michigan State University*

Abstract: A mixture of blue (B, 400-500 nm) and red (R, 600-700 nm) radiation used for horticultural applications makes plants appear purplish, causing difficulties in detecting nutritional deficiencies, disease, and physiological disorders compared to a broad (white) spectrum. White light-emitting diodes (LEDs) have a high efficacy, but little research has been published about their use in sole-source lighting of plants. We grew seedlings of begonia (*Begonia* ×*semperflorens*), geranium (*Pelargonium* ×*horturum*), petunia (*Petunia* ×*hybrida*), and snapdragon (*Antirrhinum majus*) at 20 °C under six sole-source LED lighting treatments with an 18-h photoperiod. Six treatments delivered a photosynthetic photon flux density (PPFD) of 160 µmol·m^{-2}·s^{-1} using B (peak= 447 nm), green (G, peak= 531 nm), R (peak= 660 nm), and/or mint white (MW, peak=558 nm) LEDs, which emitted 15% B, 59% G, and 26% R plus 6 µmol·m^{-2}·s^{-1} of far-red radiation. The lighting treatments (with percentage from each LED in subscript) were MW_{100}, $MW_{75}R_{25}$, $MW_{45}R_{55}$, $MW_{25}R_{75}$, $B_{20}G_{40}R_{40}$, and $B_{15}R_{85}$. At the transplant stage, seedling height, total leaf area, and fresh and dry weight were similar among treatments in all species except for seedling height of snapdragon. In snapdragon, seedlings grown under MW_{100}, $MW_{75}R_{25}$, and $MW_{25}R_{75}$ were 26-33% taller than those grown under $B_{15}R_{85}$. Unexpectedly, when petunia seedlings were grown longer (beyond the transplant stage) under the sole-source lighting treatments, the primary stem elongated and had flower buds earlier under MW_{100} and $MW_{75}R_{25}$ compared to under $B_{15}R_{85}$. We conclude that B+R and MW LEDs have generally similar effects on seedling growth and morphology at the same PPFD when they emit a similar portion of B radiation, but MW LEDs can cause stem elongation and promote flowering in some species.

2:30 PM Effects of Supplemental UV-B Radiation and Ppfd on the Growth and Nutritional Quality of Sweet Basil

Haijie Dou*, *Texas A&M University*; Genhua Niu, *Texas A&M AgriLife Research Center at El Paso, Texas A&M University* and Mengmeng Gu, *Texas A&M AgriLife Reseach & Extension*

Abstract: Sweet basil (*Ocimum basilicum*) is widely used as a culinary herb and medicinal plant due to its unique aromatic flavor and relatively high content of phenolic compound. Effects of supplemental UV-B radiation and photosynthetic photon flux density (PPFD) on the growth and nutritional quality of green basil 'Improved Genovese Compact' and purple basil 'Red Rubin' were evaluated. The experiment was setup in a 2×5 full factorial split-plot design with light intensity as the main plot and UV-B radiation as subplot. Uniform basil seedlings with one pair of fully-expanded true leaves were transplanted and moved into a walk-in growth room for two PPFD treatments, 160 and 224 mmol·m^{-2}·s^{-1}. Five or two days before harvest, basil plants were applied with one of the five supplemental UV-B radiation levels (no UV-B radiation, control; UV-B radiation of 1 h per day for 2 days, 1H2D; 1 h per day for 5 days, 1H5D; 2 h per day for 2 days, 2H2D; and 2 h per day for 5 days, 2H5D). All plants were sub-irrigated as needed using a nutrient solution with electrical conductivity of 2.0 dS·m^{-1} and pH of 6.0, and the room temperature was maintained at 23.9/21.2ºC day/night. The results showed that 2H5D treatment significantly decreased the net photosynthetic rate, transpiration rate, stomatal conductance, and Fv/Fm of green/purple basil plants by 68%/70%, 55%/68%, 65%/76%, and 9%/12%, respectively, and PPFD had no effects. Plant height, total leaf area, and shoot FW and DW of green and purple basil plants were decreased by supplemental UV-B and lower PPFD treatments, and no interactive effects were observed. The shoot dry matter percent of green and purple basil plants were increased by 14% and 19%, respectively, under 2H5D UV-B treatment compared with control. The anthocyanin, total phenolics, and flavonoid concentration of green basil plants under supplemental UV-B treatments were enhanced by 18%-22%, 35%-126%, and 80%-169%, respectively, whereas anthocyanin concentration of purple basil plants showed no difference, and phenolic and flavonoid concentration of purple basil were slightly decreased under 1H2D treatment. Considering the yield reduction and nutritional content enhancement of basil plants by supplemental UV-B radiation, 1H2D/1H5D UV-B treatments with PPFD of 224 mmol·m^{-2}·s^{-1} was recommended for green basil production under controlled environment, and supplemental UV-B radiation was not recommended for purple basil production.

Specified Source(s) of Funding: USDA National Institute of Food and Agriculture Hatch project TEX090450

1:00 PM – 3:00 PM

How to Build a Blockbuster Funding Program for Horticulture through Politics, Partnerships and Perseverance. *CEU Approved*

International Ballroom West

Coordinator: Thomas Björkman, *Cornell University*

Objectives:

The Specialty Crop Research Initiative (SCRI) was the result of a stakeholder-driven initiative in partnership with USDA. In response, Congress created a competitive grant program to allow a scale of horticultural research not seen before in the U.S. Much of its impact has been achieved because of its systems approach with trans-disciplinary expectations and genuine stakeholder engagement. The SCRI has never received full funding, but project outcomes are helping protect and transform diverse specialty crop industries throughout the country. This session will describe how the initiative began and how continuing alliances keep this influential program growing and effective.

Description: People deeply involved with the creation of SCRI will describe how this novel initiative came to be, and how we can build on it. The session will open with a description of how specialty crop research was funded before SCRI, and the needs that were going unmet. Pairs of researchers and industry stakeholders will describe how their alliances began and have prospered. ASHS leaders will describe their organizing and advocacy role. ARS and NIFA leaders played essential communication roles. Finally, members of Congress and their agricultural staffers wrote excellent legislation that was adopted.

1:00 PM **Specialty Crop Research & Extension: Then & Now**

Thomas A. Bewick*, *USDA-NIFA*

1:15 PM **The Specialty Crop Farm Bill Alliance**

John Keeling*, *National Potato Council*

1:25 PM **The Tree Fruit Road Map**

Chalmers Carr III*, *Titan Farms* and Amy F. Iezzoni*, *Michigan State University*

1:35 PM **National Grape and Wine Initiative**

Nick K Dokoozlian*, *E & J Gallo Winery* and Terence R. Bates*, *Cornell Lake Erie Research and Extension Lab*

1:45 PM **Our Professional Society Commits to Engaging with Policy Makers**

John R. Clark*, *University of Arkansas*

1:55 PM **ASHS Members Begin Direct Communication with Congress**

Jonathan Moore*, *ASHS*

2:05 PM **Agricultural Research Service Communication and Research Supports SCRI Objectives**

Dariusz Swietlik*, *USDA ARS North East Area*

2:15 PM **The Success That Followed**

James R. McFerson*, *Washington State University, TFREC*

1:00 PM – 3:00 PM *Georgetown West*

Tropical Crops: Emerging Threats and Evolving Consumer Trends

Moderator: Alan H Chambers, *UNIVERSITY OF FLORIDA*

Coordinator: Alan H Chambers, *UNIVERSITY OF FLORIDA*

1:00 PM **Breeding for the Hawaii Anthurium Industry: What Do Flower Designers Need?**

Teresita D. Amore*, *Tropical Plant and Soil Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa*

Abstract: The flower breeding program at the University of Hawaii has historically focused on growers' needs such as increased yield, vigorous growth, and resistance to pests and diseases. Although the Hawaii Floriculture Nursery Association initiated collaboration with floral designers in 2007 to explore and expand the use of Hawaii-produced floral products, a floral design workshop brought growers, designers and researchers together for the first time in 2016, to familiarize researchers with the design process and the desirable attributes of cut flowers for event designs. The importance of attributes such as spathe and spadix color, stem length, and retainment of spathe turgidity after cutting, was stressed in selecting anthuriums for design needs. The additional criteria improves seedling selection and evaluation.

Specified Source(s) of Funding: USDA-NIFA Hatch project HAW09031-H and HAW0868-H managed by the University of Hawaii College of Tropical Agriculture & Human Resources.

1:15 PM **Susceptibility to Laurel Wilt Related to Physiology of Three Clonal Avocado Rootstocks**

Raiza Castillo*; Bruce Schaffer; Randy C. Ploetz; Ana I. Vargas; Joshua Konkol; Randy Fernandez and Aime Vazquez, *University of Florida*

Abstract: Laurel wilt (LW) is a lethal vascular wilt disease caused by the fungus *Raffaelea lauricola* that affects members of the laurel family, including avocado (*Persea americana* Mill.). Since the early 2000s, it has spread across the south Atlantic coastal region and has significantly impacted Florida avocado production. There is concern that it may reach California because it has already spread as far west as Texas. Previous work has demonstrated that LW susceptibility varies among cultivars and that this variation may be related to their physiology. We evaluated the effects of LW on three clonal avocado rootstocks commonly used in California, 'Toro Canyon', 'Dusa', and 'Duke-7'. Two-year-old plants were inoculated with *R. lauricola*; control plants were inoculated with sterile water. Chlorophyll fluorescence [the ratio of variable to maximum fluorescence (Fv/Fm)], leaf chlorophyll index (LCI) net CO_2 assimilation, transpiration, and stomatal conductance were measured on inoculated and non-inoculated plants of each cultivar every 2-3 days. Xylem sap flow was monitored continuously in all plants. External symptoms (leaf wilting and stem dieback) were assessed daily using a visual scale (1 to 10). At the end of the experiment, the amount of vascular staining was assessed using the same scale and stem sections were assayed for the pathogen on potato dextrose agar. External LW symptoms developed 22, 33, or 36 days after inoculation (dai) for 'Dusa', 'Duke-7', and 'Toro Canyon', respectively. The LCI was lower for inoculated than non-inoculated plants 45 dai in 'Toro Canyon' and 48 dai in 'Dusa'. The Fv/Fm was lower for inoculated than non-inoculated plants 27 dai in 'Toro canyon' and 31 dai in 'Dusa'. Inoculation did not affect the LCI or the Fv/Fm in 'Duke-7'. Net CO_2 assimilation, transpiration, and stomatal conductance decreased as a result of inoculation 34, 41, and 48 dai for 'Dusa', 'Toro Canyon' and 'Duke 7', respectively. We did not observe significant differences in xylem sap flow between inoculated and non-inoculated plants of any cultivar. The amount of vascular staining was low in each cultivar, with inoculated plants exhibiting 20-30% internal stem discoloration. Based on this study and previous results with other cultivars, it appears that these rootstocks are not highly susceptible to LW. However, further studies comparing these rootstocks to susceptible cultivars are needed to confirm this.

1:30 PM **Emerging Pests and Diseases of Date Palm (*Phoenix dactylifera* L)**

Marylou Polek, *USDA-ARS-NCGRCD* and Robert R Krueger*, *USDA ARS NCGRCD*

Abstract: The United States date industry is small and specialized, requiring specific climatic conditions found only in a limited area in California and Arizona. While the industry has benefitted from low pest and disease pressure that is supported by Federal and State phytosanitary regulations, some pests and diseases have recently been reported from California or have become more prominent in other areas and could inadvertently be introduced to California or the date production area. These are outlined here. Two species of palm weevil (*Rhyncophorus* spp), which are highly destructive of date palms and other *Arecaceae*, have recently been reported from California. One, *R vulneratus*, has been eradicated, whereas the other, *R palmarum*, remains established approximately 120 miles from the date production area. Palm weevils are destructive on their own but also vector the nematode-associated red-ring disease. The red palm mite, *Raoiella indica*, has not yet been reported from the date production area but is present in other parts of the United States, Mexico, and the Caribbean Basin. The Giant Palm Borer, *Dinapate wrighti*, is present in the date production area but is not a problem in healthy, well-maintained orchards; however, periods of stress can cause outbreaks. Fungi are the predominant pathogens of date palms, the most important being caused by *Fusarium* spp. *Bayoud*, caused by *F oxysporum* f sp *albidensis*, is the most devastating disease of date palms world-wide but is confined to North Africa. *F oxysporum* f sp *canariensis* is endemic in coastal California but has not become established in the date production area. Recently a different form, *F oxysporum* f sp *palmarum*, has been reported from Florida. Both of these forms can kill date palms. Diseases of date palms associated with *Candidatus* Phytoplasma spp have been reported from the Middle East, Florida, and Texas, but are not known to occur in California. *C* P asteris is associated with the Al-Wijam disease in Saudi Arabia, whereas *C* P cynodontis is the causal agent of white-tip dieback and slow decline in Sudan. Lethal yellows (LY), caused by *C* P palmae, is a devastating disease of coconut and *Phoenix* spp are

also susceptible. This phytoplasma has been confined to the Caribbean Basin, but a different subgroup of the LY phytoplasma is associated with Phoenix Palm Decline, reported in Texas and Florida. Additional uncharacterized phytoplasmas have been associated with declining palms in Florida and Mexico.

1:45 PM Citrus Greening Disease or Huanglongbing (HLB) Effect on Orange Fruit/Juice Quality

Elizabeth A. Baldwin*; Jinhe Bai; Anne Plotto; John Manthey; Wei Zhao and Smita Raithore, *USDA-ARS*

Abstract: Citrus greening disease or huanglongbing (HLB) is devastating the citrus industry in Florida and elsewhere around the world. The presumed pathogen is *Candidatus liberibacter asiaticus (*CLas*)*, vectored by a psyllid, *Diaphorina citri*. The disease weakens and eventually kills citrus trees, but in addition, affects the quality of the fruit. Oranges, symptomatic for the disease, are smaller and greener than healthy fruit and are often asymmetrical. Since the disease affects the phloem, the fruit may not be getting normal nutrients and hormones and appear slow to mature. Thus, the disease effects on quality are greater earlier in the season. HLB-symptomatic fruit generally contain less sugars, higher acidity, higher bitter limonoids and astringent flavonoids than do healthy fruit or asymptomatic HLB fruit. Studies on the juice oranges, 'Hamlin' and 'Valencia' showed that flavor degradation is worse for 'Hamlin' than for 'Valencia'. Pre-harvest fruit drop is associated with this disease and fruit that are loose on HLB trees (abscission zone partially formed) have the more flavor degradation compared to fruit that are tightly held on the tree. The amount of *C*Las in the fruit juice correlates with sour, bitter and astringent flavor characteristics, typical of HLB-affected oranges.

Specified Source(s) of Funding: Southern Gardens Citrus Nursery

2:00 PM Optimizing Quality of Fresh Cut Mangoes

Anne Plotto*[1]; Elizabeth A. Baldwin[1]; Jinhe Bai[1]; Anna Marin[1]; Carlos H Crisosto[2]; Gayle M Crisosto[3]; Carolina Abrahan[4]; Yurui Xie[4]; Sonya Leonore Stahl[4] and Jeffrey K. Brecht[4], *(1)USDA-ARS, (2)University of California - Davis, (3)University of California Davis, (4)University of Florida*

Abstract: Mango fruit have always been considered a desired addition to the growing fresh-cut fruit industry. However, unlike apples or melons, mangoes are challenging to process as fresh-cut because they ripen unevenly. A market survey was performed in 2017 in California and Florida to find that most fresh-cut mangoes available to the consumer were often too firm and too sour (less mature than for optimal eating). The objectives of a follow-up study were to find a compromise to process fruit that are ripe enough for optimum taste and texture, and to develop postharvest treatments (coatings or modified atmosphere) that would provide a desired shelf life of 14 days. Imported mangoes were obtained from tropical fruit importers. Upon arrival, fruit were ripened at room temperature, and firmness was monitored until three firmness groups were obtained: 25 N, 30 N and 35 N. Processed fruit were stored in commercial containers (clamshells) for fresh-cut fruit at 5 °C. Fruit cut at 35 N firmness had the least browning, translucency and fermented off flavor, and the greatest cut edge sharpness after 9 days in storage, all positive quality attributes of fresh cut mangoes. Calcium ascorbate, polysaccharide coatings and modified atmosphere will be tested to extend ripe fruit shelf life. Promising maturity and treatment protocols will be transferred to the fresh-cut mango processing industry.

Specified Source(s) of Funding: National Mango Board

2:15 PM Cacao Genetic Resources Research at the USDA

Ricardo Goenaga*[1]; Tomas Ayala-Silva[1]; Brian Irish[2]; Dapeng Zhang[1]; Tracie K Matsumoto[3] and Osman Gutierrez[4], *(1)USDA-ARS, (2)USDA-ARS, TARS, (3)USDA ARS Daniel K. Inouye US Pacific Basin Agricultural Research Center, (4)USDA - ARS*

Abstract: The current USDA ARS Tropical Agriculture Research Station's (TARS) cacao (*Theobroma cacao* L.) collection in Mayaguez, Puerto Rico, consists of 262 clonally propagated accessions. Each accession is represented by six individual trees grafted onto a common 'Amelonado' seedling rootstock and planted in a completely randomized block design with three blocks and two trees per block. Most of the accessions were established in 2001 and all are established with a spacing of 2 m between plants and rows under irrigation and in full sun. Data being collected include: black pod disease reaction, production, pod index, as well as liquor and chocolate qualities. Phenotypic traits such as the length, width, weight, shape, and color of pods, husk weight and number of seeds per pod are also measured. In 2010, all replicate trees for the existing 154 clones in the collection at the time were fingerprinted using 15 microsatellite markers. Intra-plant error (mislabeling among replicate trees) and synonymous sets (unique accessions with identical genotypes) were identified. The average number of alleles and gene diversity estimates indicate good genetic diversity representativeness in the collection. Several genetic gaps in coverage have been identified, including underrepresented genetic populations and efforts are currently underway to introduce diverse accessions into the collection. Twenty ancient Criollo accessions were recently incorporated into the collection to fill a specific gap. Fingerprint profiles for cacao accessions as well as voucher images showing flowers, pod shape, color, texture and size as well as bean shape color and size for most accession are available through the USDA, National Plant Germplasm System, Germplasm Resources Information Network (GRIN-Global) database (*http://www.ars-grin.gov/*). Recent cacao research focused on field experiments to compare performance of 12 cacao varieties propagated by grafting vs. somatic embryogenesis. This work showed that although there were significant differences between plant propagation treatments for some of the variables measured, these were not of a magnitude that would preclude the use of somatic embryogenesis as a viable propagation system. Ongoing collaborative work on evaluation of new disease-resistant clones for yield performance and bean/chocolate quality along with the contribution of propagative material from the USDA-ARS cacao germplasm collection in assisting cacao growers in Puerto Rico recover from damages caused by Hurricane Maria are discussed herein.

2:30 PM Classification and Origins of Cultivated Tea [*Camellia sinensis* (L.) O. Kuntze] Based on SNP Analysis

Devajit Borthakur[1]; Hua-Wei Tan[2]; Lyndel Meinhardt[3]; Boyi Wang[4]; Lin Zhou[2]; Wanping Fang[2] and Dapeng Zhang*[3], *(1)Tocklai Tea Research Institute, (2)Nanjing Agricultural University, (3)USDA-ARS, (4)Yunnan Forestry Tech. College*

Abstract: Tea is the most widely consumed beverage in the world next to water. Knowledge of genetic diversity is fundamental for improving, conservation and utilization of tea plant [*Camellia sinensis* (L.) O. Kuntze] genetic resources. However, the distribution and structure of genetic diversity in the primary gene pool of tea plant is poorly understood. One hundred fifty Single Nucleotide Polymorphism (SNP) markers were used to assess the genetic diversity in 710 tea accessions covering a wide geographic origin and morphological variation. Multivariate and Bayesian clustering analysis revealed four distinctive genetic lineages of tea germplasm, corresponding to small leaved China type and three broad leaved Assam type *viz*. Indian Assam, Chinese Assam, and Cambod Assam. The four groups can freely inter-bred, resulting in a wide array of hybrids in farmer fields and *ex situ* tea collections. The result of present study demonstrates, that there are four main genetic lineages in the primary gene pool of tea plant. Each lineage has its independent origin and site of domestication. Our result also reaffirms the old postulate that Cambod Assam (*C. assamica sub spp lasiocalyx (Planchon ex Watt.)* or "Southern form") is a distinctive member of Assam tea *C. assamica* (Masters). Research on assessment of intra-varietal genetic diversity and history of domestication, focusing on small leaved China type, is also discussed.

2:45 PM Yield and Fruit Quality of Commercial and Alpine Strawberry Varieties in Southern Florida

Alan H Chambers*[1]; Pamela Moon[1]; Yuqing Fu[2]; Anne Plotto[3]; Jinhe Bai[3] and Juliette Choiseul[1], *(1)UNIVERSITY OF FLORIDA, (2)University of Florida-TREC, (3)USDA-ARS*

Abstract: Increased strawberry cultivation in southern Florida could be achieved through the adoption of modern and niche strawberry varieties. Current strawberry cultivation in southern Florida is challenged by environmental factors including calcareous soils, growing a temperate crop in a subtropical climate, and high labor and land costs. Additionally, the major market opportunities to date include mixed business models incorporating agro-tourism and value-added product offerings. Data from systematic trailing of modern, commercial strawberry

cultivars with improved yield potential and disease resistance is lacking for southern Florida, and field trials of niche alpine strawberries has not been conducted previously. This two-year study demonstrates the superior yield of University of Florida cultivars 'Strawberry Festival' and 'Sweet Sensation'. Year 2 marketable yield for 'Sweet Sensation' was up to 60% higher than 'Strawberry Festival' with a notable contribution from increased Anthracnose fruit spot resistance. Alpine strawberry yield data over a single season showed that accessions 'Reine des Vallees', 'Baron Solemacher', 'Fragolina di Bosco', 'Reugen', and the white fruited 'White Delight' had the highest yields of sixteen cultivars tested. Overall, fruit quality data showed few differences for sugars, Brix, or acidity among cultivars. Aroma profiles showed significant differences among cultivars (eg methyl anthranilate), but the impact on sensory quality is yet to be determined. These results demonstrate the rapid yield gains that can be made through the adoption of superior cultivars, and provides foundational information for the establishment of niche alpine strawberry cultivation as a new crop for southern Florida.

1:15 PM – 2:45 PM *Georgetown East*

Citrus Crops 1

Moderator: Ute Albrecht, *Southwest Florida Research and Education Center, University of Florida/IFAS*

1:15 PM Rootstock Effects on the Metabolite Profile of Field-Grown Navel Orange (*Citrus sinensis* L.) Trees

Ute Albrecht*[1]; Indu Tripathi[1]; Hoyoun Kim[2] and Kim Bowman[3], *(1)Southwest Florida Research and Education Center, University of Florida/IFAS, (2)Korea Institute of Science and Technology, (3)USDA-ARS*

Abstract: Rootstock is important for commercial citrus production in Florida and in other citrus production areas around the world. Although the beneficial influence of rootstock on stress and disease tolerance and productivity is clearly documented, the biochemical interaction of rootstock with the scion in a grafted tree has not been much investigated in citrus. In this study, we applied untargeted gas chromatography-time of flight mass spectrometry (GC-TOF MS) to investigate the metabolic influence of four rootstock varieties with different genetic backgrounds on two-year old field-grown 'Cara Cara' navel orange (*C. sinensis*) trees. The rootstocks included were 'Cleopatra' mandarin (*C. reticulata*), 'Ridge Pineapple' sweet orange (*C. sinensis*), sour orange (*C. aurantium*), and 'Swingle' citrumelo (*C. paradisi* x *Poncirus trifoliata*). In total, we detected 500 unique metabolites in leaves and roots; of these, 147 were identified by their chemical structure. The concentrations of 48 metabolites varied significantly among roots from the four different rootstocks. Of the chemically known metabolites, allantoic acid and gamma tocopherol were among the most discriminating compounds. Whereas allantoic acid is implicated in the transport of nitrogen from roots to leaves in other tree species, tocopherols are important plant antioxidants and essential for the proper functioning of carbohydrate metabolism. Discrimination of root samples was mainly due to significantly higher concentrations of these compounds in 'Swingle' compared with the other three rootstocks. In contrast, 'Swingle' exhibited lowest concentrations of conduritol-beta epoxide, an important inhibitor of beta glucosidases, enzymes that are involved in the chemical defense against pests and pathogens. Other metabolites were found in highest concentrations in 'Cleopatra' roots, notably raffinose and myo-inositol. Both compounds are intermediates of the raffinose family oligosaccharides biosynthetic pathway and important osmoprotectants of plant cells. The most dramatic differences between rootstocks were found for the large group of chemically unknown metabolites, suggesting their involvement in important metabolic pathways. Several metabolites identified in this study may be suitable for use as biochemical markers for rootstock-specific traits. Rootstock was also found to influence the metabolic profiles of leaves in the navel orange scion. In total, 226 metabolites differed significantly in concentrations among leaves depending on the rootstock. Similar to roots, conduritol-beta-epoxide and myo-inositol were among the most discriminating metabolites. This demonstrates that rootstock variety can influence the metabolic profile of leaves in a grafted tree. However, the majority of root metabolites that discriminated most between rootstocks did not display the same rootstock-specific discrimination in the leaves.

Specified Source(s) of Funding: Citrus Research & Development Foundation

1:30 PM Timing of Asian Citrus Psyllid Sprays to Canopy Flush Development

L. Gene Albrigo* and Lukasz L. Stelinski, *University of Florida*

Abstract: The Asian citrus psyllid (ACP), *Diaphorina citri*, is the vector for the bacteria *Candidatus* Liberibacter asiaticus that causes huanglongbing (HLB). It lay eggs on young leaves of new flush in order to reproduce. To minimize ACP population build-up minimum adults should be present when new flush leaves are developing. On bearing citrus trees the synchronized spring and first summer flushes should be targeted for maximum ACP control. The Citrus Flowering Monitor is an on-line program that determines when citrus flower buds begin to grow and full bloom will occur. Using this model to determine spring bud break, an adult ACP insecticide was sprayed in spring of 2017 and 2018. By monitoring all stages of ACP from this point forward it was determined when a second spray was needed. The two sprays timed in this way provided more than 60 days of reasonable ACP control. This allowed the flush to develop past the stage when adult ACP will lay eggs on it and past the 10 % open flower stage when honey bees find citrus to be a preferred nectar source. A similar timing can be developed for the first summer flush. Two sprays for ACP should allow that flush to develop past the susceptible stage for egg laying by adult ACP also. These two flushes produce about 2/3rd of the leaf area on a mature healthy citrus tree. Unfortunately HLB affected trees have some additional flush that was monitored and also treated in 2018. This procedure has the potential to minimize the direct reinfection of the new seasons major leaf area during ACP feeding.

Specified Source(s) of Funding: Florida Citrus Research and Development Foundation

1:45 PM Mulching Practices for Sustainable Citrus Production

Cindy Fake*[1]; Louise Ferguson[2] and Robert M Bonk[1], *(1)University of California Cooperative Extension, (2)University of California, Davis*

Abstract: Citrus growers in the foothills of Northern California are challenged by poor soils with low organic matter and fertility, limited water, and high production costs. Many foothill growers use non-traditional practices such as mulching to mitigate these issues. We have been conducting field research in five commercial mandarin orchards to determine the impacts of mulching on tree health, water use, fruit yields and quality.

The research questions are to determine if mulching can reduce herbicide, fertilizer, and water use while maintaining or improving soil and tree health and orchard productivity. Mulch is applied annually in the spring, and comprised of 50% composted horse manure and 50% wood chips, placed along the tree row under the canopy. Data collected includes soil moisture status, organic matter, microbial activity, and overall soil health; mulch composition and microbial activity; ambient temperature and relative humidity; tree growth, nutrient status, fruit yields, and fruit quality.

This paper will present results of the mulching trials to date. We have observed significantly higher available soil moisture with concomitant impacts on reduction of tree stress in periods of high heat or dry winds. We developed specific mulching methods to prevent the growth of troublesome weeds under the canopy and root sprouts on Cleopatra rootstock. We have also learned key lessons on optimal soil conditions and timing of mulch applications.

Specified Source(s) of Funding: California Department of Food and Agriculture Specialty Crop Block Grant Program

2:00 PM Assessment of Tolerance to Huanglongbing in Citrus Scion Genotypes

Ed Stover*[1]; Randall Driggers[2]; Elizabeth A. Baldwin[1]; Jinhe Bai[1]; David Hall[3]; Qingchun Shi[1]; Mikeal L Roose[4]; Chandrika Ramadugu[4]; Fred Gmitter[5]; Qibin Yu[5] and Ming Huang[5], *(1)USDA-ARS, (2)USDA/ARS, (3)USDA, ARS, (4)University of California, (5)University of Florida*

Abstract: The disease huanglongbing (HLB) continues to devastate the Florida citrus industry, has become widespread in Texas, and

infected tree discovery is accelerating in California dooryard citrus. While highly resistant or even immune trees are the long-term sustainable solution, HLB-tolerant planting material will likely be crucial in the near term. In Florida, where ubiquitous infection provides ample disease exposure, some mandarin hybrid cultivars display potentially useful tolerance. At the USDA/ARS Ft. Pierce, FL farm, there are several replicated trials of cultivars and advanced selections exposed to endemic HLB that are providing further insights into potential tolerance. In a trial that is in its fifth year in the field, accessions in the least diseased statistical categories include some with predominately mandarin pedigree, one that is predominately pummelo and several with *Poncirus* in their pedigrees. The susceptible sweet orange 'Valencia' remains in the best categories for all traits except that its growth rate declined markedly in the last year. Many of the cultivars and selections displaying tolerance include 'Clementine' in their pedigree. A large trial of diverse 'Clementine'-derived material is being phenotyped and genotyped to identify markers associated with HLB-tolerance in a collaboration between UC Riverside, USDA/ARS and the U of Florida, and statistical separation is now apparent for HLB-tolerance parameters after 2.5 years. A large trial of diverse *Poncirus* hybrids focusing primarily on citranges (sweet orange x Poncirus), another collaboration but led by U of Florida, has been in the field for 6.5 years and may also provide markers for HLB-tolerance, as might an adjoining trial of *Poncirus* and its hybrids, led by UC Riverside. Verification that HLB-tolerance in growth parameters translates into economic-tolerance through adequate crops of high quality fruit with require several additional years of trial data. A new collaborative NIFA grant will capitalize on these plantings and explore juice quality parameters of HLB-tolerant accessions. Single replacement cultivars or complementary cultivars in blends may provide a solution to inadequate supplies of sweet orange and grapefruit juice in FL.

Specified Source(s) of Funding: Citrus Research and Development Foundation

2:15 PM Oxidative Metabolism in Greening-Affected Fibrous Root Orders in Citrus

Naveen Kumar*, *University of Maryland Eastern Shore* and Robert C Ebel, *Integrated Plant Health Services LLC*

Abstract: Oxidative metabolism is an integral component of plant defense against both biotic and abiotic stresses. Current work showed decline in oxidative defense in HLB-affected fibrous root orders. One-year-old 'Valencia' sweet orange (*Citrus sinensis* L. Osbeck) trees on *Swingle citrumelo* were budded with HLB-infected budwood to determine the HLB-induced oxidative damage in fibrous root orders. Three independent experiments (2011-2013) were conducted in a randomized complete block design with seven blocks, and one plant of each treatment per block in the greenhouse. Seven trees were used for each treatment. The means per plant was determined and subjected to analysis of variance (SAS Institute, Cary, NC) and separated using a protected least significant difference (LSD) at $P < 0.05$. The standard error of the mean was also calculated. Four fibrous root orders were observed in one-year-old healthy 'Valencia' sweet orange (*Citrus sinensis* L. Osbeck) trees on rootstock *Swingle citrumelo.* First order (1^{st}) roots were subtending on second order (2^{nd}) and second order roots on third order (3^{rd}) and third order on fourth order roots (4^{th}), which are finally spanned on thick rudimentary taproot. The thickness of roots within various root orders declined from 4^{th} order to 1^{st} order. The concentration of hydrogen peroxide (H_2O_2) was higher in HLB-affected root orders in comparison to healthy controls. Similarly, the steady state levels of H_2O_2 concentration also varied in different root orders of healthy trees. However, these levels were low in comparison to HLB-affected roots orders. The specific activity of total superoxide dismutase (SOD), Cu-Zn-SOD, peroxidase, and catalase was higher in HLB-affected fibrous root orders. However, the specific activity of ascorbate peroxidase (APOD) declined in HLB-affected fibrous root orders. APOD is an essential part of H_2O_2 catabolism machinery in plant cells. Severe declined in APOD activity limits the normal functioning of ascorbate-glutathione cycle and concomitant higher levels of H_2O_2 caused the severe decline in fibrous root orders.

2:30 PM Plant Density and Irrigation Systems for Sweet Orange Production at the Indian River District

Rhuanito Soranz Ferrarezi*; Mark A. Ritenour; Alan L. Wright and Kayla A. Thomason, *University of Florida*

Abstract: Sweet oranges (*Citrus sinensis*) are impacted by huanglongbing (HLB), a disease associated with Candidatus *Liberibacter asiaticus*. The disease is threatening the citrus industry, with devastating effects on fruit production. Higher plant density can increase fruit yield per area under high HLB pressure, maximizing income and extending grove survival until a definite cure is found. This study evaluated the effect of tree planting density and irrigation systems on fruit yield and quality. 'Valencia' orange on 'Kuharske' citrange (*C. sinensis* × *Poncirus trifoliata*) trees were planted in Sept/2013 (2,995 trees in 1.61 ha). We tested three treatments: standard tree spacing (3.8×7 m, 357 trees/ha) + dry granular fertilizer + microsprinkler irrigation (one emitter per tree; microsprinkler 50 green nozzle, 16.7 GPH at 20 psi) (Bowsmith, Exeter, CA), high density staggered ([2.7×1.5×0.9 m]×6.1 m, 953 trees/ha) + fertigation + microsprinkler irrigation (one emitter per two trees), and high density staggered + fertigation + drip irrigation (two lines per row; Emitterline 0.58 GPH at 10 psi, 12-inch spacing) (Jain Irrigation), in a complete randomized block design with eight replications. A 16N-2.2P-16.2K dry granular fertilizer was applied twice a year at 200 kg N/ha. We scouted monthly for citrus pests and diseases. Foliar nutrients, insecticides and fungicides were sprayed following citrus standard practices. HLB incidence increased over time, reaching 87.5% in March/2017 ($p<0.0001$). Trunk diameter was 8% higher ($p=0.0004$) and canopy volume 29% higher ($p=0.0003$) on standard tree spacing compared to other treatments ($p<0.001$). Leaf nutrient concentrations were influenced by plant density, and differed among years ($p<0.05$). Fruit diameter and total number of fruit were measured in the last two seasons, and were not different even after hurricane Irma ($p>0.05$). However, there was a 38% reduction in yield in 2017/2018, with high density staggered treatments yielding on average 68 boxes of 40 kg per hectare compared to 25 boxes on standard tree spacing ($p<0.0001$). Soluble solids and ratio decreased from 2016/2017 to 2017/2018 ($p<0.0001$), while acidity increased 29% ($p<0.0001$). Fruit weight and diameter, juice weight and volume were higher in 2017/2018 ($p<0.0001$) without any treatment differences ($p>0.05$). Fruit from both high-density treatments were sweeter than single row, low-density treatment ($p=0.0009$). Staggered, higher plant density resulted in higher fruit yield and quality, producing thrice more soluble solids per area ($p<0.0001$), representing an important advantage to the juice processing industry. However, labor cost and long-term effects still need to be determined for commercial recommendation.

Specified Source(s) of Funding: UF/IFAS Citrus Initiative

1:15 PM – 3:00 PM *Monroe*

Teaching Methods

Moderator: Natalie Bumgarner, *University of Tennessee*

1:15 PM You Want Me to Teach Horticulture Where? Developing a Distance Section of a Plant Physiology and Horticulture Course.

Whitney N Griffin*, *Texas A&M University*

Abstract: Planning, development, and execution of a distance section for a high-enrollment introductory horticulture course. Course content includes plant morphology, plant physiology, metabolic processes, and general horticultural applications in the green industry. Overview of videoing mini lectures, developing interactive learning modules, graphics and animation development, and anticipating future accessibility requirements. The face-to-face course meets university CORE science requirements and thus most enrollees are non-majors. The presenter will provide the project budget, including costs of animation and graphics development and projected annual income from online differential tuition. Tips and tricks for meeting current accessibility requirements and suggestions for accessible assessment activities will be covered.

Specified Source(s) of Funding: Texas A&M University Instructional Technology Services

1:30 PM CEA in the Classroom: Connecting Secondary Students to Agricultural Career Possibilities

Natalie Bumgarner*; Jennifer Richards; Carrie Stephens; Daniel Sarver and James Swart, *University of Tennessee*

Abstract: Many challenges await agriculture's next generation including increasing food production while conserving natural resources and meeting food quality and nutrition standards. Compounding these challenges is the insufficient pipeline of students in science, technology, engineering, and math (STEM) entering the field. To address these hurdles in the STEM fields related to agriculture and food production, this project developed innovative agricultural science curriculum and professional development trainings focused on controlled environment agriculture (CEA) and soilless vegetable production systems. The curriculum was designed to use CEA to connect basic science with food production to provide material flexible enough to be used in agriculture education, as well as biology and chemistry classes. By linking agriculture with basic science concepts, the topic of food production becomes applicable to students across a spectrum of STEM classes. This enables students not currently engaged in agriculture to be introduced to scientific, engineering, and technology needs and applications of the CEA field that fit their interest areas. Professional development workshops were also developed to equip secondary agriculture and science teachers with the background and foundation to deploy the new curriculum and connected research questions in their classrooms. Modern agriculture requires skills in production techniques and technology, and this project can equip educators to reach an ever-expanding student audience with interests in both. This presentation will describe the curriculum development process as well as outcomes of professional development workshops and trainings integration of this curriculum with Extension programs.
Specified Source(s) of Funding: NIFA

1:45 PM Effort Portfolios: Student Reflections on Effective Study Strategies in a Plant Identification Course

Cynthia L. Haynes*, *Iowa State University*

Abstract: For the past five years more than 100 students in Herbaceous Ornamentals (Hort 330) at Iowa State University have practiced several different strategies to learn how to identify plants. Students were asked to summarize and reflect on their efforts and the effectiveness of at least six strategies in an "effort portfolio" at the end of the semester. At least ten strategies were presented to students as options every year. Each strategy was selected to engage students in meaningful and mindful effort while learning about herbaceous plants. Some of the strategies used each year included; perennial poetry, perennial pictionary, perennial garden selfies, practice quizzes, flash-cards, comparison matrix, repetitive writing, perennial designs, and annual videos. Students were asked to reflect on the effectiveness of each strategy on their learning and why (or why not) it was effective. While the effectiveness of each strategy varies with each student, almost all students (>90%) ranked flash cards, perennial designs, and annual videos as highly effective strategies. All the strategies that students regarded as effective required students to actively engage in meaningful or mindful effort to learn plant identification.

2:00 PM Effectiveness of Using Google Sheets with University Students to Assess Diversity in Vegetable Crops

Chanelle Angeny[1]; Jared Barnes*[2]; Shelby Laird[3]; Michael Maurer[2] and Candice Carraway[2], *(1)Louisiana State University, (2)Stephen F. Austin State University, (3)Stephen F Austin State University*

Abstract: In the 2016 spring and fall semesters, students enrolled in Crop Science at Stephen F. Austin State University (SFA) were given an assignment where they were instructed to use Google Sheets to assess diversity of traits in a seed catalog. Students were assessed before and after the assignment on their experience level with agriculture, gardening, and seed catalogs, their comfort level with Google Sheets and Microsoft Excel, collecting and analyzing data, and their opinion on the effectiveness in using multiple people to collect data and using Google Sheets. In total, 102 students assessed 1056 cultivars in Google sheets. Overall, students were able to use Google Sheets to compile data from multiple people to gain insight on which traits occur most often in seed catalogs. All students, agriculture students, female students, and fall semester students showed a higher level of comfort using Google Sheets/ Microsoft Excel after the assignment. The results also showed that students had a better grasp of what a trait was after completing the assignment. Additionally, students created more robust definitions for a trait and a cultivar post-assignment. From the comments provided on the survey, it was evident that students learned about agriculture and gardening, traits and cultivars, how to interpret seed catalogs, how to use technology, and collaboration. This activity could be useful for agriculture educators.

2:15 PM Enhancing Student's Experiential Learning with a Home Country Urban Food Systems Study Tour

Eleni D. Pliakoni*; Cary L. Rivard and Candice A. Shoemaker, *Kansas State University*

Abstract: HORT 795 Urban Agriculture Study Tour is a one-credit course that was added to our Horticulture Masters of Science specialization in Urban Food Systems (UFS) in 2015. Through this course students experience the breadth of urban food systems found in large urban settings. Thus far we have led three study tours to Chicago (2015), Seattle (2016) and Honolulu (2017). During pre-tour class sessions, students are assigned sites that they will serve as the discussion leader for, research the sites and present what they have learned in class prior to the tour. During the week-long study tour students and faculty visit up to 15 sites representing as many aspects of an urban food system as possible, such as urban farms and local food-related businesses, community development and social service groups, and not-for-profit organizations. They have the opportunity to learn from farmers, processors, distributers, planners, community activists, and retailers; and subsequently gain awareness of the complexity of issues surrounding urban agriculture and food systems. Students work on a food security project during the tour, assessing each site to its role in contributing to food security in urban areas and then post-tour present their findings in class. Pre- and post-tour surveys are conducted to assess the *value addition* of home country study tours regarding student-learning outcomes. Students enrolled in HORT 791 Urban Agriculture were used as a comparison group. Additionally, the graduate students that help organize the trip are interviewed, and written feedback is gathered from all the students and faculty that participate. Our data support the educational value of study tours. Students that participated in the tours demonstrated greater positive changes in confidence to perform UFS skills than students in a traditional classroom setting. The study tour experience fostered development of students' capacity to collaborate and share knowledge. Students developed their UFS knowledge and professional skills (soft skills) through guided experiences at the tour sites. Our data supports the value of experiential learning through experiencing the actual context of UFSs.

2:30 PM Developing Appropriate International Horticulture Technologies through UC Davis D-Lab Curriculum

Erin McGuire*, *Horticulture Innovation Lab* and Kurt Kornbluth, *UC Davis*

Abstract: UC Davis D-Lab offers an interdisciplinary, design-led approach to solving community challenges through new systems and technologies. At UC Davis the course teaches innovation, creativity and problem solving skills to graduate students. In 2013, the USAID Feed the Future Lab for Horticulture sought to test whether these methods could be effectively used to create a hands-on pathway to new appropriate technologies for small-scale horticulturists in developing nations.

Through the work of Dr. Kurt Kornbluth, the D-Lab curriculum was modified and implemented at Zamorano University in Honduras and at Kasetsart University in Thailand. Through observation, guided interviews, and post-class surveys, the impact and effectiveness of this intervention was assessed, as well as the method of implementation recorded. Results included students at both universities reporting over 90% increase in their design knowledge and a significant increase in a likelihood of approaching problem solving more creatively. At Zamorano University, community members were able to use many of the technologies created by the students, and in both cases, the university was able to test these new technologies at their demonstration centers.

One of the technologies tracked during the evaluation was the vermi-composter. Students first identified the need, which was increased soil health in the permaculture garden on campus

while creating a workable vermi-composter that would hold a specific variety of worms. The students also found that the need applied to greater Latin America due to increased pressure to reduce waste through sustainable initiatives. They felt that the composter could address some of this problem by supplying "alternatives to handling organic waste by presenting an option that could be of interest to gardeners that would take advantage of the waste from homes." The resulting composter is still in use at Zamorano University.

This evaluation also took into account positioning within the institution, class space and size, and logistical challenges to establishing a D-Lab course internationally. Results showed that partnering early with academic administrators, providing enough time to students to develop technologies, and establishing community clients, were essential elements to a successful program, along with access to the D-Lab curriculum. Challenges included material costs (and quick access to funds) and more time needed for market analysis.

This work exhibits the effectiveness of the D-Lab strategy within the international academic setting, and offers implementation lessons to establish a D-Lab for appropriate horticulture technology design at other universities.

Specified Source(s) of Funding: USAID Feed the Future Horticulture Innovation Lab

2:45 PM Impact of Implementing a Project across Different Majors to Investigate Low-Cost Hydroponic Technique to be Utilized in Ghana

Uttara Chandani Samarakoon*; Diana Rose Elder and Nathan C. Crook, *The Ohio State University*

Abstract: HORTTEC 2189 Greenhouse Management Practicum, FAES 3797 Ghana Education Abroad, and COMLDR 2530 Introduction to Agricultural Communication, Education, and Leadership (ACEL), are three courses within different majors at the Ohio State University Agricultural Technical Institute with a common approach to teaching: Project Based Learning (PBL). This interdisciplinary approach brought students and professors together to research, develop, and test a low-cost hydroponic system to be utilized by subsistence farmers in Ghana, West Africa. Following the project we evaluated our challenges and successes in researching, developing, and implementing a PBL project to suit the curricular needs of three different disciplines. During fall 2016 and spring 2017, our student researchers in HORTTEC 2189 and COMLDR 2530 developed a hydroponic system capable of functioning off an electrical grid, using all locally available materials. An additional undergraduate research PBL was conducted to investigate the feasibility of growing leafy vegetables similar to African cultivars and to determine changes in nutrient and water uptake overtime. In summer 2017, FAES 3797 enrollees traveled to Ghana to help farmers to implement the tested technology to grow leafy vegetables for personal use and for sale. As a result of the project, students from all majors were exposed to issues in global food security and resource scarcity. Students in HORTTEC 2189, who had previous exposure to hydroponics, found new crops that can be introduced to diversify US hydroponic crop production systems and identified challenges in running low-tech hydroponic systems. Students COMLDR 2530 got the exposure to greenhouse crop production and hydroponic techniques that will be useful for them as agricultural classroom and extension educators. This project provided a strong foundation to students in FAES 3797, before dissemination of knowledge in Ghana by providing a hands-on experience from seeding to harvest. Students also identified common crop production issues during technology transfer across continents. In conclusion, a single PBL provided variable learning outcomes based on the discipline and introduced a real-world experience to the class room.

1:30 PM – 3:00 PM *Lincoln East*

Human Issues in Horticulture

Moderator: Michael Schnelle, *Oklahoma State University*

1:30 PM Jefferson Science Fellowships – a Program Tailor-Made for Horticulturists

Peter M. Hirst*, *Purdue University*

Abstract: The Jefferson Science Fellowship program provides an opportunity for tenured faculty members to contribute to the policy and decision-making processes in the US Federal government, through one-year placements at the Department of State or USAID. The degree to which knowledge of horticulture, agriculture and environmental issues impact federal decision-making are immense, but seldom are those in the academic community privy to such processes. The JSF program provides fellows an opportunity to provide input on US international policy and program development and thereby gain experience and viewpoints from a different perspective than usually seen in academia. The JSF program has been in existence for 15 years and has accepted a total of 137 fellows. The fields of engineering and technology have been well represented, but only two JSFs have been horticulturists. Horticulturists have much to offer. For example, many, especially those with extension appointments, have expertise translating science and research information into language that is easily understood by their audience. They also are adept at applying scientific information from many fields of study to a given situation. Horticultural production can often result in high crop values from small land areas, is of high nutrient status and can empower women and youth – these attributes align with many of the goals of USAID. Fellows spend one year on-site in Washington DC, although extended stays at US foreign embassies and/or missions are possible. The program is a collaborative effort between the US academic community and USAID and the Department of State. Home academic institutions provide salary and benefits while a living allowance is provided through the National Academies of Sciences, Engineering and Medicine. Horticultural scientists have much to offer this program and to gain from it. Increased participation from ASHS members is encouraged.

1:45 PM Food Insecurity in U.S. Seniors

Michael A Schnelle*, *Oklahoma State University*

Abstract: Food insecurity occurs throughout the U.S. in varying degrees of severity depending upon the state. While people from all stages of the human lifespan are vulnerable, senior citizens are often overlooked and thus referred to as the "hidden hungry". Nearly 10% of seniors face hunger on a daily basis. Experts agree that senior citizens are the fastest-growing food insecure population in the country. Because of ever-improving health care and other factors, the number of U.S. citizens age 65 or older will double by 2050. Reasons for and solutions toward mitigating food insecurity in the elderly will be discussed.

2:00 PM World Food Prize Global Youth Institute

Sarada Krishnan*, *Denver Botanic Gardens*

Abstract: The Global Youth Institute is an international education program offered by the World Food Prize. Exceptional students from state youth programs as well as international students and their teacher mentors travel to Des Moines, Iowa in mid-October to attend the three-day event at which they interact with World Food Prize Laureates and get the opportunity to explore pressing food security and agricultural issues with international experts, expanding their knowledge on global issues. Students research and select a topic related to poverty, agricultural productivity, and food security and write a research paper, the findings of which

they present and discuss with international experts and their peers. The Global Youth Institute serves as a forum for students to connect with other students from around the world, attend symposia featuring discussions by global leaders in food security, and tour agricultural research facilities. Since its inception in 1994, the Global Youth Program has grown tremendously. Among the participating states, Colorado had been missing. Denver Botanic Gardens' Center for Global Initiatives (CGI) partnering with Colorado State University offered Colorado's first state youth institute in 2017. The program is expanding in 2018, reaching additional schools and offering a teacher training workshop in the summer to provide high school teachers the tools to administer this program. Details about this program will be discussed.

2:15 PM Training Horticulture Students through a Charitable Garden Project

Jacqueline A. Ricotta*, *Delaware Valley University*

Abstract: Started in 2012 with one acre on the Delaware Valley University campus farm, the Hope for the Harvest garden uses DelVal land to grow fresh, nutritious food for families who are slipping through the food safety net. It is both an educational tool for students wanting experience in vegetable production, as well as a charitable endeavor supported by numerous donors and volunteers. In its inaugural growing season, the garden produced 35,000 pounds of produce. That has since grown to approximately 50,000 pounds each year, and a second location on the DelVal Roth Farm was added in 2014. Over 250,000 pounds of food have been grown and donated over six seasons. DelVal students who are employed by the Horticulture production unit work side-by-side with community volunteers to provide the labor for the entire growing process from seeding transplants, to caring for the plants in the greenhouse, to tillage and laying plastic, and field planting. If weather permits, some of the initial work is done by the "Commercial Vegetable Production" course during a hands-on lab. Crops grown include peas, corn, peppers, tomatoes, collard greens, kale, watermelons, cantaloupes, potatoes and onions. The garden exposes students to farm work, community service, and the regional web of agencies working on behalf of those in need.

The Bucks County Opportunity Council, a non-profit organization devoted to "reducing poverty and promoting economic self-sufficiency", coordinates volunteers. Once produce is ready to be picked, another non-profit, Rolling Harvest Food Rescue, also provides volunteers to harvest and pack the produce for transport to Philadelphia for distribution through Philabundance, the Delaware Valley's leading hunger relief organization. Multiple local food pantries also receive some of the bounty. Sponsored by the United Way, Bucks Knocks Out Hunger is a community-driven hunger fighting project that unites thousands of donors, advocates, and volunteers; produce from the charitable garden is often included in the meals they distribute. In addition, DelVal students and staff have worked with students and residents of Bucks County, PA to provide training and assistance in growing their own food.

As an art and a science, Horticulture has made many contributions to the health and well-being of numerous individuals. The Hope for the Harvest Charitable garden at DelVal not only provides food to the hungry but also functions as a training ground for our students and a bridge to the community.

2:30 PM Improving Crop Production in the Developing Counties

Mohammad Babadoost*, *Univ of Illinois-Dept Crop Sci*

Abstract: According to the reports by the United Nations, more than 800 million people in the world in 2016 were chronically undernourished. To establish a sustainable global food security, not only increasing yield and quality of food crops is needed, but also preventing/minimizing losses of the crops and products is essential. Despite losing some of the productive agricultural lands to urban developments throughout the world, there are still considerable land areas with plenty of water that can be utilized for production of food crops. However, despite vast efforts on plant protection, more than 30% of food crops and products are lost to plant pests (diseases, insects, and weeds). The losses are much higher in the developing countries than developed countries. To improve crop production and minimize the losses, establishing/strengthening national agricultural programs is essential. Productive agricultural programs require strong teaching, research, and extension establishments in every nation. Problem-solving in every area of the world should be based on the credible local research, complimented with credible and timely information-delivery to the end users. External helps are valuable, but they will be more productive if the helpers have satisfactory knowledge of the ethnical cultures of the assigned areas. With all international efforts, effective problem-solving in production of food crops, and alleviating hunger problem, in the developing countries will be achieved by local specialists.

2:45 PM Food Production in Guyana

Robin G. Brumfield*, *Rutgers, The State University of New Jersey*

Abstract: In 2010, the Hydroponic Shade House Vegetable Production and Marketing Project was launched in Guyana in response to the floods and heavily saturated coastal soils to improve the economic welfare of rural households and the disadvantaged through food production and self-employment. The objective of the project, implemented and funded by Partners of the Americas and the Caribbean Self Reliance International (CASRI), was to provide rural households and the disadvantaged with the know-how, guidance and support mechanisms to be self-employed entrepreneurs with sustainable low-cost shade house vegetable production facilities. By 2013, 52 shade houses were established throughout the targeted regions. Today's market sees knowledgeable consumers, demanding distribution networks and high quality and low price competition from domestic and international suppliers. Therefore, to gain domestic and export markets, suppliers of hydroponic grown crops have to provide the finest with the highest up-to-date quality standards at a competitive price.

Suzanne's Project began in the Antalya province of Turkey in 2011 as a program to empower women farmers through agricultural business management training. It was envisaged that Suzanne's Project could help empower female farmers in Guyana, beginning with the female shade house operators. In 2013, 7 female shade house growers in Guyana participated in Suzanne's Project with 4 sessions on business management, 1 on computer skills, and 1 on technical topics. The women all completed business plans. Evaluations showed that they felt that the course was very

valuable and they wish they had had the workshop sooner. Three of the women want to teach other women what they have learned. They were particularly proud of their mission statements, goals, and the fact that they understand financial statements now. They understand the importance of record keeping to calculate costs and returns and profitability and also appreciated networking with each other. They now feel that they can make more income from producing food in shade houses as businesses, than they can in alternative employment opportunities.
Specified Source(s) of Funding: Farmer to Farmer Partners of the Americas

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2:00 PM – 5:00 PM *Van Ness/Woodley (Level 1)*

Undergraduate Commodity Judging Contest

Sponsor: Undergraduate Interest Group

Coordinator: Stephanie Burnett, *University of Maine*

Objectives:

Contest open to all undergraduates

2:30 PM – 3:00 PM *Jefferson East*

Ecological Physiology (formerly Crop Physiology and Environmental Stress Physiology) Meeting - Open to All Attendees

Chair: Yan Chen, *Louisiana State University Agriculture Center & Research Station*

Chair-elect: Catherine Simpson, *Texas A&M University, Kingsville Citrus Center*

Secretary: Zachary Brym, *N/A*

Objectives:

To provide a cross commodity forum for discussions of the integrative physiology of horticultural crop growth, development, and cropping. Areas of interest include (but are not limited to): patterns of vegetative and reproductive development; crop radiation interception and microclimate; dry matter production and partitioning; cultural and environmental influences on crop physiology and productivity; integration of carbon, water and nutrient physiology; modeling of physiological processes. To promote basic and applied research on the physiology of horticultural crops with primary emphasis on crop physiological responses to environmental stresses, specifically including temperature, water, and air pollution stresses.

2:30 PM – 3:00 PM *Jefferson West*

Intellectual Property Rights (IPR) Meeting - Open to All Attendees

Chair: Emily Tepe, *University of Minnesota*

Chair-elect: Kimberly Shearer, *N/A*

Objectives:

To provide a forum that will promote the exchange of information and discussion of issues concerning the protection of intellectual properties.

2:30 PM – 4:00 PM *Boundary (Terrace Level)*

HortTechnology Editorial Board Meeting

Chair: Neal De Vos, *De Vos & Associates*

Members: Susan Barton, *University of Delaware*; Peter Hirst, *Purdue University*; Kimberly Moore, *University of Florida/IFAS* and Joan Davenport, *WSU Prosser*

2:30 PM – 4:00 PM *Concourse Level Foyer*

Recruiter Talks

Objectives:

Representatives from companies, government, and universities will present information about careers, jobs, and programs within their respective organization.

2:30 PM **Young Professional Council, AFE**

Krishna Bhattarai, *Gulf Coast Research and Education Center, University of Florida*; Sadikshya Sharma, *University of Florida* and Debi Chedester, *N/A*

2:45 PM **University of Hawaii**

Russell Galanti and Kauahi Perez, *University of Hawaii at Manoa*

3:00 PM **Driscoll's**

Logan McCollum*, *Driscoll's*

3:15 PM **DowDuPont**

Brian Krug*, *DuPont Pioneer*

3:00 PM – 4:00 PM *Piscataway (Lobby Level)*

BioEnergy (BioE) Meeting - Open to All Attendees

Chair: Vanessa Gordon, *USDA-ARS SEA Sugarcane Field Station*

Chair-elect: Stevens Brumbley, *University of North Texas*

Objectives:

To provide a platform for promoting and expanding the opportunities to apply expertise and technologies of horticulture to bioenergy crops and for sharing and disseminating information related to bioenergy research and expanded funding potential.

3:00 PM – 4:00 PM *Northwest (Lobby Level)*

Emeriti (EMER) Meeting - Open to All Attendees

Chair-elect: L. Gene Albrigo, *University of Florida*

Objectives:

To provide a forum for retired horticulturists where some issues of concern to ASHS can be defined, analyzed, and acted on; to establish a registry of retired horticulturists; and to identify an accessible reservoir of research, extension, and teaching talent that may be called on for help and guidance.

3:00 PM – 4:00 PM *Oak Lawn (Lobby Level)*

Floriculture (FLOR) Meeting - Open to All Attendees

Chair: Shaun Broderick, *Mississippi State University*

Chair-elect: Martha Glenn, *University of Florida IFAS Extension*

Objectives:

To identify problem areas (and propose approaches to resolving them), to develop higher standards of quality, and to share information about activities occurring in floriculture research, education, and extension.

3:00 PM – 5:00 PM *Georgetown East*

Vegetable Crops Management 1

Moderator: Chiwon W. Lee, *North Dakota State University*

3:00 PM **Yield and Quality of Sweet Corn Grown with Biodegradable Plastic Mulches**

Shuresh Ghimire*, *Washington State University* and Carol A. Miles, *Washington State University, NWREC*

Abstract: Polyethylene (PE) and biodegradable mulches are commonly used for many vegetable crops, but use is relatively new for sweet corn and interest is increasing especially due to decreased days to harvest and water conservation attributes. Biodegradable mulch that can provide crop production benefits and completely biodegrade in the soil after tillage incorporation would serve as a sustainable alternative to PE mulch. We carried out a field experiment in 2017 to compare five potentially biodegradable plastic mulches (BioAgri, Organix, clear Organix,

Experimental, and Naturecycle), a cellulose mulch [WeedGuardPlus (100% biodegradable)], PE mulch (non-biodegradable), and a bare ground treatment for their effect on sweet corn (*Zea mays* cv. Xtra Tender 2171) growth, yield and quality at Mount Vernon, WA, where average air temperature during the growing season was 16.3 °C (range 11 °C to 23 °C). All mulches were black except clear Organix and brown WeedGuardPlus. Weed pressure was minimal throughout the growing season in all mulch treatments except clear Organix. While most mulches remained sufficiently intact until the end of the growing season, clear Organix split, starting shortly after laying, and fresh weight of weeds at 3 weeks after seeding was 39 % more compared to the bare ground treatment. Plant height at 90 days after seeding was lowest for plants grown on bare ground (103 cm), intermediate for clear Organix and WeedGuardPlus (average 118 cm) and greatest for all black plastic treatments (average 139 cm). Days to 50 % tasseling and 50 % silking were delayed for bare ground and WeedGuardPlus by 9 and 13 days, respectively, compared to all other treatments. Marketable ear yield was higher with PE, Organix, and Experimental (average 10.8 $t{\cdot}ha^{-1}$), intermediate with BioAgri and Naturecycle (average 9.5 $t{\cdot}ha^{-1}$), and lower with bare ground, WeedGuardPlus and clear Organix (average 6.6 $t{\cdot}ha^{-1}$). There was no difference among treatments in total soluble solids of kernels (average 15.4 °Brix), but ear length and diameter were 8% smaller on average for ears grown on bare ground, WeedGuardPlus, and clear Organix compared to other mulch treatments. The length of the unfilled ear tip was greater for bare ground (2.95 cm) compared to all other treatments (average 1.2 cm). These results indicate that yield and quality of sweet corn grown with black biodegradable plastic mulches can be comparable with PE mulch, but that crops grown with clear and paper biodegradable mulches may need different management practices than with PE mulch.

Specified Source(s) of Funding: National Institute of Food (NIFA) and Agriculture, U.S. Department of Agriculture, under award number 2014-51181-22382, and NIFA Hatch project 1008680

3:15 PM Compost Combined with Nitrogen Fertilizer Influences Performance of Russet Potato in the Field

Samuel YC Essah*, *Colorado State University*

Abstract: Compost application studies conducted in potato production systems have reported yield increases with compost application or no difference in yield between compost applied treatments and commercial fertilizer only applied treatments. Rate of compost application may explain the lack of yield increase when compost is applied compared to commercial fertilizer application only. Studies were conducted at Colorado State University San Luis Valley Research Center, to evaluate the effect of compost application rate with optimum or reduced nitrogen (N) (one half of the optimum N rate) application on the performance of fresh market Russet potato. Treatments included application of 1, 3, and 5 tons per acre of compost, and each compost application rate combined with optimum or reduced N application rate. A control treatment was included where only commercial fertilizer was applied with optimum N rate. Application of compost combined with varied N application rates influenced plant uptake of nitrate nitrogen, phosphorus, and potassium. Application of compost at rates of 3 or 5 tons per acre with optimum N fertilizer application rate did prolong green leaf area duration (LAD), delayed leaf senescence, and enhanced early tuber bulking. For each rate of compost applied, optimum and reduced N application rates produced similar tuber yields. However, one ton per acre of compost applied with reduced N rate produced economically higher marketable (> 4 oz.) and large marketable size (> 6 oz.) tuber yields compared to all other treatments. The yield increases were 13.0% and 28.0%, respectively, when compared to the control treatment. In this study, the application of compost combined with N fertilizer application reduced tuber external and internal defects, when compared to the control treatment. Data from this study indicate that application of the proper rate of compost with appropriate N rate improves marketable tuber yield and reduces tuber external and internal defects. To improve economic yield of Rio Grande Russet, application of 1 ton compost per acre with reduced N rate is recommended.

3:30 PM Preharvest and Postharvest Effects on Internal Necrosis Incidence and Severity in 'Covington' Sweetpotato, 2016 and 2017.

Fernando Montero de Espinosa*, *College of Agriculture and Life Science*

Abstract: The North Carolina sweetpotato industry has been concerned with a physiological disorder internal necrosis (IN) that can occur at high levels in its predominantly grown cultivar Covington. IN symptoms of brown and black areas in the root cortex can only be discovered when the root is thinly sliced at the proximal end of the root. Certain cultivars like Covington are more prone to IN, but various factors that cause this problem continue to be investigated. The goal of our research was to evaluate several preharvest and postharvest conditions and how it affected occurrence of IN. Three replicated field studies in 2016 and two in 2017 were conducted. Application of a high chlorine versus minimal chlorine fertilizers and mowing versus not mowing prior to harvest were the four preharvest treatment combinations evaluated. For the postharvest treatments, 30 roots were obtained from each preharvest plot and placed in 75ºF and 82ºF rooms in 2016, with the addition of a 95ºF room in 2017. Fresh harvested sweetpotatoes were stored in these rooms for duration after harvest of ½, 1, 2, 3 & 5 weeks in 2016, and for up to 2 weeks in 2017, then placed in a 58ºF storage room. A control treatment was included where roots were not cured and placed immediately after harvest in a 58ºF storage room. Samples were cut approximately 90 days after harvest and IN incidence and severity recorded. Data were statistically analyzed with SAS Mixed procedure, comparing main effects (preharvest & postharvest) and its interactions. Preharvest treatments showed no differences in the main effects but were significant when combined with postharvest treatments. No mow treatments showed higher incidence than Mowed treatments as temperatures and duration increased in one of the three 2016 studies, increasing from 4% to 6% and 11% when cured for ½, 1 and 2 weeks, respectively, then leveling off at 3 & 5 weeks. The no mow treatment showed higher incidence when cured at 85ºF (11%) vs 75ºF (6%) versus the mow treatment (85ºF (6%) vs 75ºF (5%), which has similar IN incidence. The same trend was observed in 2017 studies in both locations. The no mow treatments showed higher incidence when curing duration increased from ½ to 2 weeks (6% to 18% in location 1 and 3% to 32% in location 2) while the mowed treatment increased less (3% to 11% in location 1 and 3% to 14% in location 2. When no mow treatment was combined with temperature in 2017 studies, incidence was higher at 85ºF (21% and 22%, for locations 1 and 2, respectively) vs 75ºF (11% and 10%,for locations 1 and 2, respectively) than the interaction for mow treatment at 85ºF (11% and 10%, for locations 1 and 2, respectively), versus 75ºF (3% and 8%, respectively) for locations 1 and 2. Postharvest main effects were significant both years at all locations. Curing at 85ºF had higher incidence than the 75ºF, while the control (58ºF) treatment was as low as 0% the second year. Duration of curing treatment from ½ to 2 weeks is a key factor, increasing IN significantly at all locations both years.

Specified Source(s) of Funding: NC Sweetpotato Commission

3:45 PM Evaluating Resistance to Verticillium Wilt and Productivity of Grafted Eggplant

Abigail Attavar*, *Washington State University* and Carol A. Miles, *Washington State University, NWREC*

Abstract: In Washington state Verticillium wilt (caused by *Verticillium dahliae*) negatively affects the productivity of eggplant (*Solanum melongena*). The pathogen colonizes the roots and vascular system, leading to plant wilting and yield loss. This study, done in 2016 and 2017, evaluated the resistance of susceptible eggplant cv. Night Shadow grafted onto five commercial solanaceous rootstock cultivars, Estamino, Java, Meet, Shield and Survivor, and heirloom tomato, cv. Cherokee Purple, for resistance to Verticillium wilt. The study also included non-grafted rootstocks and scion controls. 'Shield' was included only in 2017. The field site was naturally infested with *V. dahliae*, 28 cfu g^{-1} and 5 cfu g^{-1} of soil in 2016 and 2017, respectively. Seedlings were splice grafted in a greenhouse, healed, and roots were drenched with 5mL of *V. dahliae* conidial suspension (8 x 10^6 conidia per mL in 2016 and 2.35 x 10^6 conidia per mL in 2017) at the time of transplanting to the field. In 2016, Verticillium wilt incidence and severity were noted near harvest (108 DAT) and were lowest for 'Night Shadow' grafted onto 'Estamino' and 'Java' (severity only)

and non-grafted rootstocks 'Estamino', 'Java', 'Meet' and 'Survivor' (P = 0.01). In 2017, disease severity near harvest (103 DAT) was least for 'Night Shadow' grafted onto 'Survivor' and greatest for non-grafted 'Meet' (P = 0.04); disease incidence was not significantly different among treatments. AUDPC values were only calculated in 2017 and were least for 'Night Shadow' grafted onto 'Estamino' and 'Survivor'. Fruit yield was greatest for 'Night Shadow' grafted on 'Meet' (p=0.03) in 2016, and in 2017 for 'Night Shadow' grafted on 'Cherokee Purple' (P = 0.0003) for replicates one and three (these replicates exhibited normal growth). In replicates two and four, where plant growth was stunted due to soil conditions, there was no significant difference in fruit yield among treatments. Our results indicate that different rootstocks may interact uniquely and vary with the level of *V. dahliae* infestation and environmental conditions in the field.

4:00 PM Intercropping Winter Greens between Cane Fruit Rows for Year-Round High Tunnel Production

Jacqueline Cormier*[1]; Robert Heyduck[2]; Shengrui Yao[2]; Steve Guldan[2] and Ivette Guzman[1], *(1)New Mexico State University, (2)New Mexico State University Sustainable Agriculture Sciences Center*

Abstract: With the help of USDA-NRCS Environmental Quality Incentives Program (EQIP) small acreage growers in New Mexico (NM) may receive funding for installing and operating high tunnels. In Alcalde, NM, a year-round study was designed to compare fruit yield of two varieties of uncovered blackberry canes to those intercropped in a high tunnel. The long-term goal of the study is to create a year-round model of blackberries intercropped with winter greens in a high tunnel. High tunnels are a temporary structure that are passively solar heated. For the study, 'Chester' and 'Triple Crown' blackberry varieties are being grown at the NMSU Sustainable Agriculture Science Center in Alcalde. Two rows of blackberry canes were planted in a field and two rows were planted in a high tunnel. Each row consisted of replicated and randomized plantings of both blackberry varieties. In winter, four rows, containing randomized plots of 'Red Russian' kale and 'Bloomsdale' spinach were planted at the base of dormant canes in the high tunnel. Yields of the two blackberry varieties were compared by weight and fruiting date to study how berry yields were affected by the high tunnel winter intercrop. Both varieties of winter greens were harvested, and fresh yield weight were compared to discern fitness as a possible intercrop. Preliminary data indicates that 'Triple Crown' canes outperform 'Chester' in both high tunnel and field trials. However, a negative impact to high tunnel berry production can be seen in both varieties, possibly due to warmer high tunnel temperatures during the winter. As a winter intercrop, kale appears to be marketable in fewer days and with higher overall yields than spinach. This sustainable agriculture model utilizes intercropping in a high tunnel setting to provide farmers a second crop and year-round utilization of high tunnels. This system diversifies their crops and doubles their land use efficiency and year-round farm income.

4:15 PM Effect of Plastic Color on Yield and Quality of Eight Broccoli Hybrids

Brian Ward*[1]; Matthew Horry[2]; Christopher Simmons[2]; David M. Couillard[3] and Mark W Farnham[4], *(1)Clemson University CREC, (2)Clemson, (3)USDA-ARS US Vegetable Lab, (4)USDA-ARS*

Abstract: Broccoli consumption and production acreage along the eastern U.S. is increasing, and growers are looking to capitalize on cultural practices that maximize production. Although broccoli has been traditionally grown on bare ground, there is an increase in production utilizing plasticulture, especially as a second crop after commercial cucurbit and solanaceous crops. This study was implemented to determine yield and quality of the commercial hybrids Bay Meadows, Castle Dome, Belstar, Iron Man, Gypsy and three experimental hybrids (1, 2, and 3) planted in three environments on black, reflective and white polyethylene mulch. The trials used a randomized block design and plots were set on 6' centers as twin rows 14" apart and within row spacing at 6". Planting dates were March 21, 2016, September 19, 2016 and September 21, 2017. Quality was graded for the traits head extension, head color, head shape, head uniformity, head firmness, bead size, bead uniformity, bracting, overall quality, plot uniformity and holding ability. Soil temperatures under the plastic across all environments were lowest with reflective, and increasingly higher with white and black, respectively. Air temperatures in the canopy zone directly above the mulch were highest with reflective, and lowest with white. Yield and quality varied among environments and color of plastic mulch. In spring 2016, Gypsy out-yielded all other cultivars on black plastic with a total of 31,972 lbs/Ac. On reflective mulch, Hybrid 1 had the highest yield of 32,985 lbs/Ac, and on white mulch, Castle Dome was highest at 33,258 lbs/Ac. Yields were generally better in the fall of 2016, with Belstar outperforming all other cultivars at 41,085 lbs/Ac. In that same environment, Iron Man outperformed all other cultivars yielding 43,097 lbs/ Ac on reflective mulch, while Belstar was the best hybrid on white mulch yielding 37,459 lbs/Ac. In fall 2017, Gypsy was the top performer on black, reflective and white mulches at 39,706, 35,473 and 37,196 lbs/Ac, respectively. Quality characteristics varied with regard to cultivar, environment and color of mulch. Results of this trial indicate certain hybrids perform better with regard to yield, quality and earliness depending on the mulch used, which will help growers better plan their future broccoli productions.

4:30 PM Integrating Cover Crops in High Tunnel Vegetable Production

Ajay Nair* and Kristine M. Lang, *Iowa State University*

Abstract: The environment without rainfall, limited space, and potential climate control in a high tunnel calls for sustainable crop and soil management approaches. With high tunnel production primarily dominated by tomatoes and the potential to grow crops year-round, a cohesive and focused approach is needed to tackle issues that would arise due to continuous crop production under these structures. Some common issues experienced include high salt build up, resurgence of soil-borne and foliar diseases, poor soil structure, lack of microbial diversity, and reduced crop yields. One of the strategies to mitigate these issues would be include cover crops in high tunnels. This study conducted in a 9.1 m x 29.2 m high tunnel for two years at the Horticulture Research Station, Ames, Iowa comprised of three treatments – oilseed radish, yellow mustard, or no-cover crop. Tomato 'Mt. Spring' was transplanted after cover crop termination each year. The experimental design was a randomized complete block design with four replications. Each treatment plot was 3.1 m wide and 6.1 m long with a 1.2 m buffer between the blocks. The study investigated the effect of cover crops on weed biomass, tomato growth characteristics, soil properties, and tomato yield and quality. Cover crop biomass ranged from 3362 to 4483 $kg{\cdot}ha^{-1}$. There were no statistically significant differences in soil pH at any of the sampling dates. Soil electrical conductivity showed significant differences at the start of the experiment but those differences gradually evened out. Plant height and width measured in the month of July in both years did not show any difference. Cover crops significantly decreased weed biomass when compared to no-cover crop treatment but there were no differences between cover crops. There were no statistically significant differences in marketable or non-marketable tomato yields between treatments. To observe positive changes in soil properties and crop yield, due to cover cropping, requires continuous cover cropping for extended period of time. Longer term studies are needed to document the impact of cover cropping in high tunnels on soil quality and health. Integration of cover crops in high tunnels has the potential to build soil organic matter, improve soil quality and health, and serve as a crop rotation tool.

4:45 PM Hydroponic Production of Leafy Green Vegetables for Local Foods Market

Chiwon W. Lee*, *North Dakota State University*

Abstract: Trends toward local foods are an important aspect of community health and influence factors ranging from human nutrition to economic and environmental sustainability. In response to these movements, new businesses of growing and supplying fresh and nutritious vegetables year-round for local consumption can well be established in any community or region. This study was carried out to evaluate different systems for hydroponic production of leafy greens as well as selection of suitable cultivars. Over 60 different commercial lettuce cultivars were grown in the nutrient film techniques (NFT) as well as hydroponic tub cultures. Cultivars were evaluated for their fresh biomass yield, nutritional quality, growth rate, tendency for bolting, and developing such physiological disorders as leaf margin burns. In general, the hydroponic tub culture allowed faster growth than the NFT system for most cultivars. The tub

culture in which seedling plants are anchored on Styrofoam boards and floated on nutrient solution inside tubs (9 plants/tub) is a convenient way of growing healthy plants for small-scale production. Proper balancing of nutrient ions according to the analysis of local water supply is important for optimum plant growth. Temperature and humidity control is essential for the prevention of physiological disorders. Use of artificial lights like LED and LEP may be needed for winter production. Planning and scheduling of leafy green production according to market demand are important. Cultural recommendations for growing lettuce as well as other leafy green vegetables will be discussed.
Specified Source(s) of Funding: NDDA Specialty Crop Block Grant

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3:15 PM – 4:45 PM

Cheap Sensors for Good Data: Economical Approaches for Research *CEU Approved*

Jefferson West

Coordinator: Christopher J. Currey, *Iowa State University*

Objectives:

The objective of this interactive workshop is to demonstrate equipment that can be used to quantify the growing environment and plant growth and stress that is not only accurate and informative, but economical to build and/or purchase.

Description: Quantifying the growing environment, substrate moisture and irrigation, and plant growth, development and stress are essential for horticultural science. However, the instrumentation to collect these data can be cost-prohibitive for researchers. Fortunately, there are economical alternatives. This workshop is designed to provide cost-effective, economical sensor and instrument solutions. In this workshop, attendees will be placed into groups and participants will rotate among five different interactive stations, each with demonstrations of different economical sensors and instruments that are broadly applicable across horticultural research.

3:15 PM **Welcome and Workshop Orientation**
Christopher J. Currey*, *Iowa State University*

3:30 PM **Low-Cost Sensors for Logging Light, Temperature, Humidity, and Crop Height (Station 1)**
Marc W. van Iersel*, *University of Georgia*

3:45 PM **Quick, Easy and Cheap Measurements of Leaf Area and Canopy Coverage.* (Station 2)**
Jun Liu*, *University of Gerogia* and Theekshana C Jayalath*, *University of Georgia*

4:00 PM **Plant Robotics: Precision Labor with Arduino and Raspberry Pi (Station 3)**
Alexander G. Litvin*, *Iowa State University*

4:15 PM **Smartphone Accessories for Measuring Plant Input Needs (Station 4)**
Krishna Nemali*, *Purdue University*

4:30 PM **Monitoring and Controlling Irrigation Using Soil Moisture Sensors (Station 5)**
Rhuanito S. Ferrarezi*, *University of the Virgin Islands*

3:15 PM – 5:00 PM *Lincoln West*

Genetics and Germplasm 2

Moderator: Elisheba Young, *North Carolina State Unviversity*

3:15 PM **Identification of Historic Homestead and Orchard Apple Cultivars in Wyoming**
Jonathan T. Magby*[1]; Gayle M. Volk[2]; Adam D. Henk[2] and Steve L. Miller[1], *(1)University of Wyoming, (2)USDA-ARS National Laboratory for Genetic Resources Preservation*

Abstract: There were thousands of apples planted in Wyoming's orchards and homesteads in the 1800s, many of which are still alive today. The purpose of this research was to identify heritage apple cultivars in Wyoming using genetic fingerprinting (microsatellite) techniques and then use this information to suggest candidate cold-hardy cultivars for specialty crop and breeding programs. Leaf samples were collected from 510 heritage apple trees from 88 sites in 18 cities across Wyoming. In addition, known cultivars from the USDA-National Plant Germplasm System, Seed Savers Exchange and Washington State University apple collections were used as standards to determine cultivar identities. Overall, 335 (65%) of the previously unidentified apples trees matched to 47 known cultivars. Fifteen of these known cultivars comprised over 80% of the samples that were identified, with 14 of those cultivars developed in states and countries with average temperatures or winter conditions similar to Wyoming (including Minnesota and Russia). Seventy one of the heritage trees were the cultivar, 'Wealthy', and other commonly identified cultivars were 'Haralson', 'Patten's Greening', 'Yellow Transparent', 'Northwestern Greening' and 'McMahon'. The popularity of 'Wealthy' may be the result of its promotion in Agricultural Extension Bulletins from 1870-1940 and its frequent use in developing novel varieties for Wyoming's climate. Although many original Wyoming heritage apple trees are reaching the end of their lifespan, many surviving trees continue to produce fruit. These results provide insights into possible cultivars that could be grown in Wyoming and also in other states with similar harsh growing conditions.
Specified Source(s) of Funding: USDA-National Institute of Food and Agriculture and Wyoming Department of Agriculture Specialty Crops Program

3:30 PM **Linkage and Association Analysis of Dihydrochalcones in Apple Germplasm and Hybrid Populations.**
Benjamin Gutierrez*[1]; Jie Arro[1]; Gan-Yuan Zhong[1] and Susan K Brown[2], *(1)USDA-ARS Plant Genetic Resources Unit, (2)Cornell University*

Abstract: Dihydrochalcones (DHCs), including phloridzin, sieboldin, and trilobatin are phenolics found in *Malus* species, with phloridzin as the primary form found in most species, including cultivated apple. DHCs in apple have unique chemical properties with commercial and nutritional value. To understand the genetic basis of these DHCs in *Malus,* five F_1 populations were developed with a common male parent *(Malus prunifolia* PI 589816*)*. DHC content was measured in each population and we observed segregation of phloridzin, sieboldin, and trilobatin into five distinct profiles, fitting a model for three independently segregating loci. QTL on linkage groups 7 and 8 associated with trilobatin and sieboldin were identified with linkage analysis and association mapping using the USDA *Malus* collection in Geneva, NY.
Specified Source(s) of Funding: USDA-ARS Plant Genetic Resources Unit

3:45 PM **Development of Simple Sequence Repeat DNA Markers for Muscadine Grape Cultivar Identification.**
Shanshan Cao*, *The University of Georgia* and Patrick J Conner, *University of Georgia, Tifton Campus*

Abstract: Muscadine grapes, *Vitis rotundifolia,* are native to North America and became commercial in the middle of 18th century. Breeding programs have produced large collections of *V. rotundifolia* cultivars and hybrids with other related species. Muscadine germplasm is currently documented through the use of breeding records and examination of morphological traits, which can be both unauthentic and equivocal. In this study, 190 individuals (180 *V. rotundofolia* and 10 *V. vinifera*) were examined with 10 pairs of simple sequence repeat (SSR) primers. A total number of 138 alleles were amplified in the 190 individuals. The number of effective alleles for each SSR marker was on average 5.19, ranging from 2.35 to 11.16. The SSR profile was used to identify the true-to-type cultivar by estimating pairwise similarity of individuals with the same name as well as by comparing shared alleles of parents and progeny. A total of 75 true-to-type cultivars were identified and homonyms were found exist in 12 cultivars. In addition, unique barcodes for molecular identity cards for the true-to-type cultivars were established using the fingerprints from those SSR markers. Each muscadine cultivar will have a unique barcode identity card, which can make it much easier for growers to identify muscadine cultivars in the future.

Specified Source(s) of Funding: Southern Regional Small Fruit Consortium

4:00 PM Single Nucleotide Polymorphic (SNP) Marker Discovery in a Diverse Panel of Blueberry (*Vaccinium* sp.) Species

Elisheba Young*, *North Carolina State Unviversity*; James R. Ballington, *North Carolina State University (emeritus)* and Hamid Ashrafi, *North Carolina State University*

Abstract: Cultivated southern highbush blueberries are among the high value crops in North Carolina with an estimated annual ~$70 M farm-gate value. Blueberry contains many beneficial components like flavonoids, which can help combat cardiovascular disorders, neurodegenerative diseases, diabetes and cancer thus contributing significantly to the current popularity of the crop. Blueberries are members of the Ericaceae family and include several subgenera or sections. *Vaccinium* section *Cyanococcus* is native to North America and all species of this section have contributed to the genetic background of most commercially important cultivars. Traditional breeding efforts to develop superior blueberry cultivars began in 1908 and, as a result, many of today's cultivars are the product of interspecific hybridization followed by backcrossing. Consequently, modern cultivars are segmental allopolyploids, which share a complex ancestry resulting from the intercrossing of different wild accessions and cultivated varieties. The outbreeding nature of blueberry and the use of inter- and intra-specific hybridization during the past century has generated a lot of speculation about the relationship between the founder species and the modern cultivars. With the advent of next generation sequencing (NGS) technologies, it is currently possible to uncover their interrelation at the whole genome level at a lower cost by sequencing each founder and cultivated species. In this study, using Illumina sequencing, we re-sequenced 28 accessions at 20X genome coverage. The 28 accessions were comprised of 19 different wild and cultivated species from 6 sections in *Vaccinium* that represent 16 diploids (2n = 2x = 24), 9 tetraploids (2n = 4x = 48), and 3 hexaploids (2n = 6x = 72). The 16 diploids represented 12 different species including: section *Cyanococcus* [*V. caesariense, V. darrowii*, *V. elliottii*, *V. fuscatum*, *V. myrtilloides, V. pallidum* and *V. tenellum*]; section *Batodendron* [*V. arboreum*]; section *Herpothamnus* [*V. crassifolium*]; section *Hemimyrtillus* [*V. cylindraceum*]; section *Pyxothamnus* [*V. ovatum*]; and section *Polycodium* [*V. stamineum*]. The 9 tetraploids were representative of 6 different species including: section *Cyanococcus* [*V. angustifolium, V. corymbosum, V. formosum, V. myrsinites*]; section *Hemimyrtillus* [*V. arctostaphylos*] and section *Pyxothamnus* [*V. consanguineum*]. The 3 hexaploids were all classified section *Cyanococcus* [*V. virgatum*] or Rabbiteye blueberries. The re-sequencing data allowed for the discovery of SNP markers within and between different groups. These SNP markers are easily adaptable to various SNP genotyping platforms that can be used in breeding programs, calculation of minor allele frequency, and defining haplotype blocks.

Specified Source(s) of Funding: NIFA-NCSU

4:15 PM Maternal Lineages of Peach Genotypes

Chunxian Chen*, *USDA, ARS, SEFTNRL*

Abstract: Simple sequence repeats (SSRs) in chloroplast genomes are useful markers to determine maternal lineages. The SSR mining results revealed that most chloroplast SSRs among three *Prunus* chloroplast genomes were conserved in locations and motif types, but polymorphic in motif and/or amplicon lengths. Fifty seven of the 67 shared SSRs were polymorphic between at least two of the three chloroplast genomes. Eight SSRs with most in silico polymorphisms were selected to genotype a large collection of peach (*P. persica*) genotypes and determine their maternal lineages. The genotyping data distinguished these peach genotypes into eight unique maternal lineage groups (MLGs). MLG-1 included most peach cultivars. They apparently belonged to Chinese peach lineage because Chinese Cling in this group was heavily used in early peach development in the US. MLG-2 was the next largest group that presumably belonged to European peach lineage. MLG-3 consisted of only a few ornamental accessions. MLG-4 to 6 included genotypes derived from three wild peach species respectively. MLG-7 and 8 contained only 'Flordaking' and 'Reliance', respectively. The SSR amplicons from eight representative genotypes, one for each MLG, were sequenced, revealing additional single nucleotide polymorphisms (SNPs) within the amplicon sequences and presumably dividing each MLG into subgroups based on these SNPs. Identification of the maternal lineages may be somewhat helpful for optimal combination of crossing parents. The polymorphisms of these chloroplast SSRs have been validated and may be useful in other phylogenetic studies.

4:30 PM Unveiling the Genetic Background of the Peach Tree Short Life Syndrome

Goran Barac[1]; Gregory L. Reighard*[2]; Christopher Saski[2] and Ksenija Gasic[2], *(1)University of Novi Sad, (2)Clemson University*

Abstract: Peach Tree Short Life (PTSL) is a complex disease syndrome caused by different biotic, climatic, and edaphic factors. The PTSL disease etiology is associated with the presence of high population densities of ring nematode (*Criconemoides xenoplax* Raski syn. *Mesocriconema xenoplax* (Raski) Loof and de Grisse). The resulting injury and physiological response to nematode feeding increases susceptibility of peach trees to bacterial canker (*Pseudomonas syringae* pv. *syringae* van Hall) or cold injury, or an interaction of both. The genetic basis of tolerance/susceptibility to PTSL in peach is not well understood. Thus, four different F_2 families, derived from a cross between a PTSL susceptible rootstock Nemaguard and tolerant rootstock Guardian®, were evaluated for PTSL tolerance in the field, and genotyped using Genotyping by Sequencing (GBS). A meta-analysis approach was used to refine QTL positions detected in family specific genetic linkage maps, and revealed a total of six metaQTLs that largely drive PTSL resistance, two on each linkage groups (LG)1, 4 and 6. All metaQTLs except PTSL.meta-1.2 showed significant effects on PTSL. Individuals heterozygous for PTSL.meta_1.1, with a haplotype originating from both Guardian® and Nemaguard, exhibited the best phenotypic performance. Both metaQTLs on LG4 exhibited the best PTSL field performance when the haplotype derived from Guardian® was in a homozygous state. Candidate gene analyses in the metaQTL genomic regions detected over 180 resistance genes, including genes associated with resistance to bacterial diseases. A *denovo* Guardian® genome assembly revealed multiple duplications in resistance genes, most of them in PTSL.meta_4.1 and PTSL.meta_4.2 regions, suggesting a disease resistance hot spots on chromosome 4 of the peach genome. MetaQTLs identified in this work suggested that genomic regions associated with PTSL response in peach are associated with response to bacterial canker as a main cause of death after nematode infection weakens a peach tree.

Specified Source(s) of Funding: USDA-AMS-SCMP-2015 "Short and Long-Term Solutions for Armillaria Rot Rot in Prunus (ME#44165761)

4:45 PM Genome Wide Association Study for Brown Rot Tolerance in Peach

Wanfang Fu*; Cassia Da Silva Linge; Ralph Burrell III; Guido Schnabel and Ksenija Gasic, *Clemson University*

Abstract: Brown rot, caused by *Monilinia* spp., is one of the most important diseases for stone fruit worldwide. The fungi affect peach in both pre and post-harvest stages and can cause severe yield loss. Although some degree of tolerance has been reported in stone fruits (peach and almond), the genetic resistance in peach cultivars is still lacking. To date, few genomic regions in peach associated with brown rot response in fruit skin and flesh have been detected. Limited knowledge suggested brown rot tolerance in peach is a quantitative trait controlled by multiple genes with small effect. To further understand the genetics behind brown rot tolerance in peach, we phenotyped 26 cultivars and 138 progeny from 9 crosses across two seasons (2015 and 2016) for skin and flesh response to brown rot infection, and genotyped using newly developed 16K peach SNP array. Association mapping, using GModel2, revealed a total of 32 SNPs (P<1E-07) significantly associated with brown rot response in either peach fruit skin (21) and/or flesh (12) across the whole genome. Candidate gene analyses within the haplotype regions of the detected markers identified 23 predicted genes associated with pathogen infection response/resistance. Two candidate genes, Prupe.7G072600 and Prupe.7G072700, in haploblock (Hap) 7_2, shared high identity with polygalacturonase-inhibiting protein (PGIP), a highly conserved antifungal gene in *Rosaceae* family. Detailed analysis of the brown rot response associated

with the haplotypes (H) in Hap7_2, suggested that absence of H5 significantly reduced brown rot disease severity index in skin and flesh. The information presented here provides an important foundation for further dissection of the genetics behind brown rot tolerance in peach.

Specified Source(s) of Funding: USDA-NIFA-SCRI "RosBREED: Combining disease resistance with horticultural quality in new rosaceous cultivars" (2014-51181-22378)

3:15 PM – 5:15 PM *International Ballroom West*

Clean WateR^3 – the Big Picture, Why Clean Water Matters

Coordinator: Sarah White, *Clemson University*

3:15 PM Clean WateR3 for Specialty Crop Production: Past, Present, and Future

Sarah A. White*, *Clemson University*

Abstract: Developing alternative water resources for irrigation of specialty crops is a critical need. Many growers have current access to adequate water supplies for irrigation, but in the future as urban populations grow, specialty crop producers may need to use lower quality water sources to remain in business. The Clean Wate*R*^{3} Research and Extension Team has developed and are working to develop technologies and tools growers can use to *reduce* water and agrichemical inputs on-farm, to *remediate* agrichemical and plant pathogen contaminants from production runoff with the ultimate goal of increasing adoption of water *recycling* practices at specialty crop facilities. Our team interviewed producers to determine perceived barriers to change in practice, to understand current use patterns, and to develop effective outreach technologies by which research-based information is delivered to best affect propensity for adoption. The tools developed are grounded in both economic and biological efficacy data. Our research has helped to visualize how water moves through soilless substrates, which in turn influences both how water runs off production areas and the mass of agrichemicals and phytopathogens carried in that water that need to be treated prior to water reuse. We have also developed and refined production site risk assessment evaluation tool to help growers determine the critical control points for minimizing phytopathogen impact on crop production. Gaining an understanding of the system as a whole helps to better manage individual system components and select specific components for modification that will have the greatest influence on enhancing system wide water- and resource-use efficiency.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

3:45 PM The Economics of Water Use

Charles R. Hall*[1]; Dewayne L. Ingram[2] and Joshua Knight[2], *(1)Texas A&M University, (2)University of Kentucky*

Abstract: The economics of water use in the green industry was studied by the economics team of the Clean WateR3 grant project by utilizing an economic engineering approach to estimate the initial capital investment and production costs for baseline and alternative nursery and greenhouse irrigation models. The models simulated representative characteristics of nursery and greenhouse operations and proper irrigation equipment and protocols for the crops being studied. Partial budgeting modeling procedures were then used to measure the costs and potential benefits of short-run changes in cultural practices in the production systems analyzed. This proven technique is used when comparing two or more similar production systems (e.g. a benchmark system and one or more alternatives). All systems compared faced the same conditions, the same fixed or overhead cost parameters, and varied only in explicitly-specified components.

The partial budgeting technique was also used to compare the negative effects (costs added) of applying a new irrigation treatment relative to a base or standard treatment to the positive effects (cost savings) associated with the new treatment. Therefore, this project required the consideration of the returns associated with treatments and changes in the structure of the production/irrigation costs. Aspects of costs and returns that do not change with the treatment relative to the base were not considered in this portion of the analysis. Thus, we examined only the effect of the proposed changes in practice, assuming all other aspects of the green industry value chain remain unchanged.

The overall economic impacts were evaluated by measuring four separate effects including: (1) added costs of production incurred by the use of alternative materials, cultural practices, and/or irrigation treatments; (2) added income resulting from increased levels of production and/or price premiums associated with higher quality crops; (3) costs savings realized through more efficient management practices or reduced inputs; and (4) income that may be lost when substituting one crop for another in the production system. Data will be presented to show the potential impact of such practices on the overall cost structure of the model systems studied.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

4:15 PM Phytopathogens, Plant Production and Water

Jennifer L. Parke*[1]; Neelam Redekar[1]; Joyce Eberhart[1]; Cassandra Swett[2] and Johanna Del Castillo-Múnera[2], *(1)Oregon State University, (2)University of California Davis*

Abstract: Plant pathogens can cause crop losses and reduce the quality of greenhouse and nursery plants. Plant pathogens can also be moved long distances by the plant trade, potentially spreading diseases to new hosts and habitats. Phytosanitary approaches based on quarantines and end point inspections have reduced but not eliminated the interstate spread of *Phytophthora ramorum* with nursery stock, for example. It is therefore important for plant production facilities to identify potential sources of contamination and to take corrective measures to prevent disease. We applied a systems approach to identify sources of contamination within horticultural nurseries and demonstrated that irrigation water can be an important source of contamination by waterborne plant pathogens such as *Phytophthora* and *Pythium* species. We will present case studies from nurseries in Maryland, South Carolina, Oregon, and California to illustrate how recycled irrigation water contributes to the spread of waterborne pathogens, and show how nursery management practices can reduce disease risk.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

4:45 PM Barriers to Adoption: How to Work to Overcome Them

Alexa J. Lamm* and Laura A. Warner, *University of Florida*

Abstract: Despite being supportive of water conservation and protection efforts, nursery and greenhouse growers are one of the largest users of agricultural water allocations. Water conservation and treatment techniques that encourage and enable water recycling and reuse are being developed at a rapid pace, but adoption across the industry has been limited. Extension programs must accompany scientific acceleration to ensure growers can overcome their barriers to adopting new treatments and technologies. Unfortunately, the barriers to adoption are largely unknown. A team of researchers conducted a nationwide survey to identify the reasons growers do or do not adopt technologies focused on water conservation. The results were used to create a cognitive map that describes the decision-making process growers go through when choosing whether or not to adopt, providing insight into how extension programs can be developed to encourage adoption. One key finding is that nursery growers have a positive attitude towards water conservation but do not feel the technologies and techniques being developed are easily integrated into their existing irrigation systems. The respondents also expressed the financial cost of replacing equipment keeps them from adopting and that there needs to be a balance between cost and ultimate efficiency when new technologies are being developed. New technologies were also perceived to be complex and concerns existed related to ability to operate new technologies successfully. Extension programs can be developed to leverage the positive attitudes expressed by growers and social norms can be used to overcome some of the barriers uncovered. Recommendations include a) creating partnerships between growers so new technologies can be observed in action, b) creating field days where new technologies are exhibited and can be tried in a real way, and c) developing a series of online videos that are easily accessed

online highlighting how to use equipment, thereby reducing perceived complexity.
Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

3:15 PM – 5:15 PM *Georgetown West*

Floriculture and Nursery Crops: Nutrition

Moderator: Jennifer Boldt, *USDA-ARS*

3:15 PM Monthly Levels and Criteria Considerations of Nutrient, pH, Alkalinity and Ionic Variables in Run-Off Containment Basins in Ornamental Plant Nurseries

Warren E. Copes[1]; Andrew G. Ristvey[*2]; Patricia A. Richardson[3]; Bruk E. Belayneh[4]; Haibo Zhang[3]; John D. Lea-Cox[4] and Chuanxue Hong[5], *(1)United States Department of Agriculture, (2)University of Maryland, WyeREC, (3)Virginia Polytechnic Institute and State University, (4)University of Maryland, (5)Virginia Tech*

Abstract: Triplicate water samples were collected monthly from 9 waterways (8 recycling containment basins (RCBs) and 1 stream) on 4 commercial ornamental plant nurseries from February to July, and from 1 RCB and nursery from April to October. Four RCBs, one per nursery, were actively utilized as an irrigation water source. Analysis was done for 18 water quality variables including ammonium-nitrogen (NH_4^+-N), nitrate-nitrogen (NO_3^--N), ortho phosphate-phosphorus (PO_4-P), Total-phosphorus (T-P), potassium, calcium, magnesium, sulfur, aluminum, boron, copper, iron, manganese, zinc, pH, total alkalinity (T-Alk), electrical conductivity and sodium. The degree and rate of monthly change varied considerably between RCBs. Macronutrients generally increased at most nurseries in one to two months after fertilizer application particularly in 3 RCBs (MD21, VA11 and VA12), with levels of N and P forms exceeding preferred criteria for irrigation water by June and July in VA11 and VA12. Micronutrients fluctuated less, but did vary per RCB with the most monthly change occurring in MD21. Even though pH fluctuated, pH tended to remain alkaline or neutral to acidic respective of the RCB during the entire sample period. T-Alk tended to increase over the summer. EC primarily fluctuated in RCBs with high macronutrient levels. Although levels of N- and P-forms were mostly suitable by irrigation water criteria, they were frequently above U.S. Environmental Protection Agency nutrient criteria for promoting healthy water environments of lakes and reservoirs, and are discussed.

Specified Source(s) of Funding: USDA NIFA SCRI

3:30 PM Limiting Phosphorus and Potassium Controls Plant Growth of Floriculture Species

Jared Barnes[*1]; John Dole[2]; Brian E. Whipker[2]; Jennifer Boldt[3] and Ingram McCall[2], *(1)Stephen F. Austin State University, (2)North Carolina State University, (3)USDA-ARS*

Abstract: **Four floriculture crop species ['Magellan Cherry' zinnia (*Zinnia elegans* Jacq.), 'Festival Golden Yellow with Eye' gerbera *(Gerbera jamesonii* Bolus ex Hook. F.), 'Pacino Gold' sunflower (*Helianthus annuus* L.), and 'Accent Salmon Premium' impatiens (*Impatiens walleriana* Hook. F.)] were grown under fertilizer treatments of varying concentrations of phosphorus (P) (20, 10, 5, and 0 mg·L^{-1} P) and potassium (K) (150, 112.5, 75, 37.5, and 0 mg·L^{-1} K). For marketable plants that exhibited limited nutritional disorder symptoms, limiting P controlled height of impatiens and diameter of gerbera, impatiens, sunflower, and zinnia, and lower concentrations of K limited the height of gerbera inflorescence and the diameter of impatiens. Reducing P resulted in fewer lower yellow leaves during postharvest on gerbera, sunflower, and zinnia. However, low concentrations of K resulted in higher numbers of yellow leaves during postharvest conditions for impatiens, sunflower, and zinnia. Our results suggest that growers can limit P and K to levels of 5 mg·L^{-1} P and 37.5 mg·L^{-1} K, respectively, to potentially control growth on floriculture crops with limited impact on quality during production.**

3:45 PM Greenhouse Rose Responses to Nitrogen Confounded By Collateral Effects on Rootzone pH and Micronutrient Availability.

Raul I Cabrera[*], *Rutgers University*

Abstract: A study was established to re-evaluate the relationships of rose leaf nitrogen (N) status - expressed both on leaf weight and area basis - and flower productivity/quality in own-rooted and grafted (Peach Avalanche® on 'Natal Briar') rose plants. The plants were irrigated with six complete nutrient solutions (based on a modified 0.5X Hoagland solution) differing in total N concentration: 2, 4, 6, 8, 10 and 12 mM; tap water added an extra 1.5 mM of N to all treatments. Nitrogen was applied with an average 12% ammonium fraction, using sulfate salts as substitute for nitrate salts in the lower N treatments, thus producing iso-equivalent solutions with electrical conductivities averaging 1.74 dS/m. While no statistical differences in flower yield parameters were detected after four flowering flushes, chlorosis symptoms, supported by chlorophyll index readings, started to be noticeable in the foliage of plants receiving the lowest N concentrations. Leaf tissue analyses pointed out to a progressing manganese (Mn) deficiency (< 30 mg/kg), along with relatively low concentrations of iron (Fe). Micronutrient levels in the nutrient solutions were increased to 1.25X Hoagland solution concentrations and the study continued for another four flowering flushes. The flower yield and quality responses displayed thereafter a classical asymptotic behavior, which were not or minimally correlated with leaf N status. Leaf N concentrations remained similar across all N treatments, averaging 30.8 g/Kg and 1.48 g/m2 on a dry mass and leaf area basis, respectively, pointing to a remarkable control of plant N uptake and partitioning. Leaf tissue concentrations of Mn, and Fe as well, provided significantly high correlations with the observed flower yield and foliage quality responses. Evaluation of the applied nutrient solutions and drainage (leachate) solutions collected at several points through the study suggest that despite initial pH adjustments across all N solution treatments, nitrification activity increased with total applied N concentrations, leading to concomitant reductions in pH values. While the soil solution pH differences were within 1 pH unit across all treatments, the range in which it occurred (5.8 to 6.9) was deemed critical for a differential availability of micronutrients in solution, more acutely for the non-chelated Mn supply, despite increases in their application rate during the second half of the study. As this particular scenario is a first occurrence in our rose nutrition studies, a specific cultivar (varietal) response is strongly suspected to be in play as well.

Specified Source(s) of Funding: Floriculture and Nursery Research Initiative (USDA-ARS); Horticultural Research Institute; NJ Agricultural Experiment Station; Texas A&M AgriLife

4:00 PM Comparison of Substrate Silicon Amendments for Greenhouse Sunflower Production

Jennifer Boldt[*], *USDA-ARS* and James Altland, *USDA-ARS, MWA ATRU*

Abstract: Silicon (Si) is a plant-beneficial element that can alleviate the effects of abiotic and biotic stress. Substrate components, substrate amendments, liquid fertilization, and foliar sprays can supply supplemental Si to plants. Substrate amendments can provide extended release of Si throughout the production cycle, but information on incorporation rates and effects on plant growth are not well known. Our objective was to evaluate substrate amendments as potential sources of Si for production of ornamentals in soilless substrates. The base substrate was an 85 : 15 sphagnum peatmoss : perlite substrate. Amendments included parboiled rice hulls at 5%, 10%, or 20% (by volume); ground parboiled rice hulls at 5%, 10%, or 20% (by volume); rice hull biochar at 1.5%, 3%, or 6% (by volume); steel slag at 2.37, 4.75, or 7.12 kg·m^{-3} (PlantTuff); hydrous potassium silicate at 0.38, 0.76, or 1.14 kg·m^{-3} (AgSil); calcium silicate at 0.39, 0.78, or 1.17 kg·m^{-3} (wollastonite); a non-amended control; and a non-amended control fertilized with 2 mM potassium silicate at each irrigation. Lime was added (1.19 to 2.97 kg·m^{-3}) as needed to adjust initial substrate pH of each treatment to 6.2 – 6.5. Four-week old sunflower (*Helianthus annuus* L. 'Pacino Gold') seedlings were transplanted into 11.5-cm pots. They were arranged in a completely randomized design, with five pots per treatment, and grown for six weeks. Greenhouse conditions were 22 °C day/18 °C night, a 14 h photoperiod, and supplemental irradiance from high-pressure sodium lamps when ambient irradiance was less than 300 µmol·m^{-2}·s^{-1} photosynthetic photon flux density (*PPFD)*. Plants were fertilized with 20N-4.4P-16.6K at a concentration of 150 mg·L^{-1} N at every irrigation. Plant growth and quality (height,

width, relative chlorophyll content, and dry mass) were similar to the non-amended control for all treatments except steel slag at 4.75 and 7.12 kg·m^{-3}, which were greater. Leachate Si concentration ranged between 0.3 and 67.4 mg·L^{-1} (non-amended control and 2 mM liquid potassium silicate, respectively), although substrate amendment leachates ranged between 1.0 and 19.0 mg·L^{-1} Si. Foliar Si concentration ranged from 519 mg·kg^{-1} in the non-amended control to 24,671 mg·kg^{-1} in the 2 mM liquid potassium silicate treatment, but between 1900 and 12,468 mg·kg^{-1} for the substrate amendment treatments. Within each amendment, leachate Si and foliar Si increased as incorporation rate increased.

4:15 PM The Effect of Calcium Application Method to Increase Plant Resistance to *Botrytis*

Katherine Bennett*[1]; Mary Vargo[1]; Uttara Chandani Samarakoon[2]; Guido Schnabel[1] and James E. Faust[1], *(1)Clemson University, (2)The Ohio State University*

Abstract: Previous research has demonstrated that *Botrytis* infection of petunia flowers decreases when calcium levels increase in the petal tissue. The objective of this experiment was to determine the optimal method to deliver calcium to petunia flower petals. The two methods tested were: 1. supplying calcium in the fertigation solution, and 2. supplying calcium in spray applications using calcium chloride. A two-factor factorial design was used to test both methods. All nutrients in the fertigation treatments remained the same except for calcium, sodium and chloride. The fertigation treatment provided calcium concentrations of 0, 100, and 200 mg·L^{-1} for 3 weeks prior to flower opening. The spray applications provided calcium concentrations of 0, 750, and 1500 mg·L^{-1} once a week for 3 weeks. Growing medium, leaves, and flowers were analyzed for calcium content to determine the effect of application method and concentration on the tissue calcium concentrations. *Botrytis* efficacy trials determined which treatment method provided the most plant resistance to *Botrytis* infection upon inoculation. The results showed that increasing calcium concentration in the fertigation solution improved the calcium concentration in the leaves but not the flowers. Spray applications of calcium significantly increased the calcium concentration of the flower petals compared to the fertigation treatments and also had the lowest incidence of *Botrytis* infection. These results demonstrate the benefit of using calcium chloride spray applications to increase calcium content in reproductive tissue and increase petunia flower petal resistance to *Botrytis* infection.

Specified Source(s) of Funding: Floriculture Research Alliance, American Floral Endowment

4:30 PM Estimating Tissue Nitrogen (N) Content in Floriculture Crops Using Image Analysis

Ranjeeta Adhikari* and Krishna Nemali, *Purdue University*

Abstract: Tissue N content should be maintained at optimal level to achieve the maximum growth and good quality in floriculture crops. Laboratory analysis is the only direct method available to growers for accurate measurement of whole-plant N status. However, this method is expensive and time-consuming. Other indirect methods (chlorophyll meters and normalized difference vegetation index (NDVI) sensors), can only measure small leaf sections or contain background signal when measured on groups of plants, especially small plants. There is an urgent need to develop alternate techniques for easy, rapid, accurate and inexpensive measurement of tissue N content. Tissue N affects chlorophyll content of leaves, thereby red light absorption/reflectance in plants. Thus, measuring changes in red light absorption or reflectance can be used to indirectly measure changes in tissue N content. The purpose of the current study is to test the efficacy of camera based image analysis technique as an alternative to indirectly measure whole-plant N content. An experiment was setup in greenhouse maintained at 26/20 °C (day/night) temperature and daily light integral (DLI) of 10-20 mol·m^{-2}·d^{-1}. Petunia (*Petunia* × *hybrida* L. 'Hurrah Peppermint Stick mix') and poinsettia (*Euphorbia pulcherrima* Willd. ex Klotzsch 'Maren') plants were grown under five different fertilizer treatments with electrical conductivity (EC) of 0.75, 1.5, 2.0, 2.5 and 3.5 dS·m^{-1} (74, 148, 198, 248, and 346 mg·L^{-1} N) to generate a range of tissue N levels. A TopView imaging station with multi-spectral camera was used for capturing grayscale images at red (*r*, 630nm) and near infrared (*nir*, 870 nm) wavebands. Each pixels on a grayscale image contain information on the extent of reflected light from plants. The grayscale images were analyzed using MultiSpec V2.0 image processing software to obtain mean gray or reflectance value (R625 and R870) of plant pixels in the image, from which an image derived reflectance ratio (R_{630}/R_{870}) was calculated. Tissue N content was measured at harvest using laboratory analysis. Results showed that tissue N content increased linearly with increasing fertilizer EC. A statistically significant inverse relationship was observed between tissue N content and R_{625}/R_{870} in both species indicating that the ratio can be used to indirectly estimate whole-plant N content in poinsettia and petunia. We are currently developing cheap accessories for smartphones, which can aid in image capture, image processing, generation of reflectance ratios and estimation of tissue N based on algorithms for easy, rapid, accurate and inexpensive estimation of tissue N content in plants.

Specified Source(s) of Funding: The Fred C Gloeckner Foundation

4:45 PM Effects of Phosphorus Nutrition on the Betacyanin Concentration and Foliar Coloration of *Alternanthera Brasiliana*

Josh Brady Henry*; Penelope Perkins-Veazie; Ingram McCall and Brian E. Whipker, *North Carolina State University*

Abstract: Plants experiencing a phosphorus (P) deficiency commonly develop a red to purple coloration of the foliage. This pigmentation is typically attributed to foliar anthocyanins, and the relationship between P nutrition and anthocyanin accumulation is well known. Betacyanins are another red pigment produced in certain species that do not produce anthocyanins, but the relationship between P nutrition and betacyanin accumulation is not documented. We conducted this study to record the effects of P nutrition on the betacyanin concentration and subsequent foliar coloration of alternanthera [*Alternanthera brasiliana* (L.) Kuntze]. In an initial experiment, we grew 'Purple Prince' alternanthera with P concentrations of 0, 2.5, 5, 10, and 20 mg·L^{-1} P. After four weeks, we restricted half of the plants from each non-zero concentration to 0 mg·L^{-1} P, resulting in nine total treatments. In further experiments, we grew 'Brazilian Red Hots' and 'Little Ruby' alternanthera with the same treatments plus three additional fertilization treatments where plants initially grown with > 2.5 mg·L^{-1} P were restricted to 2.5 mg·L^{-1} P. Plants grown without P for the duration of the study were dark red or purple in coloration and had high concentrations of betacyanins. Alternanthera grown with high P concentrations for the duration of the study had the lowest betacyanin concentrations and exhibited less red and more green coloration as measured by a handheld colorimeter. This demonstrates that betacyanin accumulation is affected by P nutrition similarly to anthocyanin accumulation. Alternanthera grown with low or restricted P fertilization were stunted compared with those that were grown with sufficient P. Plants that were initially grown with 10 mg·L^{-1} P but then restricted to 0 mg·L^{-1} P also developed a dark red coloration and accumulated high concentrations of betacyanins, but were not stunted. This indicates that betacyanin accumulation may be enhanced without compromising growth. These findings may be used to improve fertilizer recommendations to enhance the foliar coloration and aesthetic appeal of horticultural species such as alternanthera.

Specified Source(s) of Funding: Fred C. Gloeckner Foundation, USDA Floriculture and Nursery Research Initiative, American Floral Endowment Altman Family Scholarship, and The Garden Club of America

5:00 PM Treatment of Calcium Chloride Enhances Water Deficit Stress Tolerance in Viola (*Viola cornuta*)

Suejin Park*; Youyoun Moon and Nicole L. Waterland, *West Virginia University*

Abstract: Water deficit stress during shipping and retailing can reduce postproduction shelf life and marketability of floriculture crops. To alleviate damage by water deficiency, plants need to limit transpirational water loss by inducing stomatal closure. Osmotic stress induces stomatal closure similar to water deficit stress in plants, and could be used as a convenient tool to enhance water deficit stress tolerance. The objective of this research was to investigate whether treatment with a high concentration of $CaCl_2$ could trigger a response to osmotic stress that induces stomatal closure and enhances water deficit stress tolerance in viola (*Viola cornuta* 'Sorbet XP Yellow'). Leaf relative water content (RWC) and stomatal conductance were measured

daily after $CaCl_2$ application. Preliminary studies that included various chemicals showed $CaCl_2$ was the most effective agent at delaying wilting under water deficit stress in viola. Compared to control, viola treated with $CaCl_2$ at 200 and 300 mM showed increased shelf life by 3.7 and 2.7 days, respectively. Leaf RWC of control plants was dramatically reduced 3 days after treatment and continued to decrease, while $CaCl_2$-treated plants maintained leaf RWC as high as that of well-watered plants until 6 days after treatment. On day 7, leaf RWC of plants treated with $CaCl_2$ was about twofold higher than that of control plants. Stomatal conductance was reduced by 73% to 86% within 4 hours after treatment with $CaCl_2$ compared to that of control plants. Our results indicated that osmotic stress induced by the treatment of high concentration of $CaCl_2$ might have caused stomatal closure, resulting in reduction of water loss and extension of shelf life under water deficit stress in viola. Pre-treatment of high concentration of chemicals such as fertilizers prior to shipping could enhance tolerance to water deficit stress in certain bedding plants.

3:15 PM – 5:15 PM *Lincoln East*

Pomology I

Moderator: Esmaeil Fallahi, *University of Idaho Parma Research and Extension Center*

3:15 PM Transcriptomics Analysis of Spatial and Temporal Regulation of Apple Fruit Growth

Shan Jing[1]; Anish Malladi[*1]; Yi-Wen Wang[1]; Savithri U. Nambeesan[1] and Ann Loraine[2], *(1)University of Georgia, (2)University of North Carolina*

Abstract: Apple fruit consists of multiple tissues of distinct origins, primarily: the cortex derived from the floral cup, and the pith derived at least in part from the ovary. The cortex and the core tissues display differences in growth characteristics during fruit development. Temporally, fruit growth is achieved through an early phase of cell production followed by post-mitotic cell expansion. Regulation of growth across the fruit tissues and during different stages of development is not well understood. To determine the dynamic gene expression networks regulating apple fruit growth, we performed transcriptome profiling of the cortex and pith tissues at different stages of development and in response to crop load reduction (thinning) in 'Golden Delicious Smoothee'. Thinning was performed at 11 days after full bloom, and resulted in increased fruit size at harvest, primarily due to differences in the size of the cortex. The pith and cortex tissues were sampled for RNA-Seq analyses at 8 days after thinning treatment (8 DAFT), 19 DAFT, and 47 DAFT, corresponding to the period of high cell production, transition from cell production to expansion, and high cell expansion, respectively. The average sequencing depth of all samples was around 20 million reads. Multidimensional scaling analyses indicated that the largest transcriptomic differences were between the earliest stage and the two later stages, suggesting distinct regulatory programs between early and later stages of fruit development. Within each stage, the cortex and pith tissues displayed major differences in gene expression, indicating tissue specific regulatory networks facilitating fruit growth and development. Relatively, lesser differential gene expression was noted in response to thinning. This was especially apparent at 47 DAFT where only a few genes were differentially expressed between these samples, suggesting that the transcriptome changes induced by thinning during early fruit development (19 DAFT) had diminished by later stages. A weighted gene co-expression network analysis (WGCNA) uncovered a network module significantly correlated with the pith/cortex area, fructose and glucose concertation. Several hub genes within the module were discovered that may contribute to differences in growth patterns within the cortex and pith tissues. Data from this study provide insights into the spatial and temporal mechanisms regulating fruit growth in apple.
Specified Source(s) of Funding: HATCH

3:30 PM Fruit Quality at Harvest and after Storage and Fluctuations in the Mineral Nutrient Partitioning in 'Honey Crisp' Apple, Influenced By Thinning and Rootstock

Esmaeil Fallahi[*]; Bahar Fallahi and Michael Kiester, *University of Idaho Parma Research and Extension Center*

Abstract: The use of size-controlling rootstocks and crop load adjustment are routine practices in the high-density apple orchards. The influence of five thinning levels and five rootstocks on yield, fruit quality, and mineral fluctuations in leaf and fruit tissues were studied in 'Honey Crisp' apple. Both early and late thinning of fruit down to one fruit per spur reduced fruit firmness but increased fruit size, and color compared to the lighter thinning levels. Trees receiving early thinning had less bitter pit than those with late fruit thinning. Thinning influenced mineral nutrient fluctuations in leaf and fruit. Trees on G.30 and V.1 rootstocks had larger fruits with lower firmness in 2016. Fruit from trees on G.202 had higher firmness in both 2016 and 2017. Fruit from trees on G.30 were largest in 2016 but smaller in 2017. Trees with G.30 had higher but those on G.202 had lower yield per tree than those on other rootstocks in 2016. Trees on M.26 EMLA had higher but those on G.202 had lower leaf N, Mg, Mn and fruit N, leading to better color in the scion fruit with G.202 in 2016. Trees on G.969 and G.202 had higher but those on G.30 and V.1 had lower fruit Ca in 2016. Trees on G.969 also had high leaf Ca in 2016. The magnetite of fruit Mg in trees on G.969 and G.202 were opposite to their fruit Ca. Although year-to-year yield variations may lead in to different results in some fruit attributes and mineral concentrations, some obvious consistent rootstock effects were observed in both years. For successful production of high quality 'Honey Crisp' apple, the combined impact of rootstock and thinning on tree growth, yield, fruit quality and mineral nutrient concentrations should be considered, and we are closer to achieve this combination in our study.
Specified Source(s) of Funding: SCRI Block Grant Idaho Department of Agriculture

3:45 PM Strategies to Improve Defoliation of Apple Nursery Trees in the Eastern US

Poliana Francescatto[*1]; Bruno Carra[2]; Suelen Cristina Uber[3]; Jaume Lordan[1] and Terence Lee Robinson[1], *(1)Cornell University, (2)Universidade Federal de Pelotas - UFPEL, (3)Universidade do Estado de Santa Catarina - UDESC*

Abstract: Chemical and/or manual defoliation of apple trees is a common commercial practice in the apple nurseries before digging. Premature defoliation by hand is time-consuming and therefore, costly, and can cause damage to young trees. Hence, leaf removal is greatly facilitated by chemical treatments and this has long been desired by nurseryman. In order to find alternative chemicals or chemical combinations that would provide the most effective leaf senescence and defoliation of apple nursery trees, a two-year study was conducted at an on-farm nursery located in the Western New York. Four chemicals and their combinations were applied to nursery trees of 'Gala'/B.9 and 'SweeTango'/B9: copper, urea, a commercial formulation of abscisic acid – ABA (Protone®, Valent BioSciences, Libertyville, IL) and organosilicone surfactant (Silwet® L-77; Helena Chemical Co.), in the fall of 2016 and 2017. Rates and timing of application were tested. Timing of application was set according to a projected date determined by the nurseryman of when trees would be harvested for subsequent cold storage. Percentage of defoliation (%) was assessed weekly after treatment application in both years. In the following spring of each year trees were re-assessed for any type of bud injury that the products applied could have caused and for initial growth. Temperature was one of the major driving factor that influenced the efficacy of the defoliants. Warm temperatures (above 55^{o}F) during and after spray application (at least 3 to 4 days) are required for better defoliation. In both years, the maximum defoliation of some treatments was observed in one to three weeks after application. In some cases, a frost event is desired for previously treated trees to complete defoliation. ABA has shown great efficacy in promoting leaf senescence and defoliation. However, previous studies have shown that the application of ABA itself is not sufficient for full defoliation of young trees. Therefore, the addition of quelated copper, Silwet or urea in the ABA tank provided substantial increase of defoliation. Based on the two-year experiment, we have found several promising alternatives, however, the best option that has shown the most consistent results over the two years was, so far, the combination of ABA + CuEDTA + Silwet. Some choices will depend on how much defoliation is desired (50 to 100% defoliation) and

the additional benefits the combination may provide. Cost-benefit will be probably favorable.

Specified Source(s) of Funding: International Fruit Tree Association - IFTA

4:00 PM Self-Compatibility and Comparison of Its Impact on Fruit and Seed Set in the North American Pawpaw

Srijana Thapa Magar*; Kirk William Pomper; Jeremiah Lowe and Sheri B. Crabtree, *Kentucky State University*

Abstract: Pawpaw (*Asimina triloba*), America's forgotten tree fruit, is emerging as an alternative high-value niche crop for small farms in Kentucky. Some literature states that pawpaw is a cross-pollinated crop; however, there is evidence of self-compatibility in some varieties such as 'Sunflower'. The objective of this study was to determine if the pawpaw cultivars Sunflower and Susquehanna display self-compatibility and if this impacts fruit set. Two pawpaw cultivars, 'Sunflower' and 'Susquehanna', were examined in this study at the Kentucky State University Harold R. Benson Research and Demonstration Farm. In total 1000 crosses, including 250 self and cross pollinations for each variety, were carried out with open flowers in April, 2016 and 2017; competing flowers were removed after pollination. In 2016, the number of fruit clusters and fruit per cluster were recorded on three dates: May 24th, July 22nd and August 22nd. Similarly in 2017, the data were recorded on: May 31st, June13th, and August 21st. The seeds from each treatment were extracted from the fruit and stratified (4^0C) in wet peat moss for at least 110 days. The seeds from 2016, 20 of each self or cross, were then germinated in pots in a greenhouse. Young leaves of parent material and the newly germinated offspring were collected for DNA extraction. Primers for three pawpaw simple sequence repeat (SSR) for the loci Pp-B3, Pp-B103, and Pp-G124 with unique fingerprint patterns for each variety were selected for parentage confirmation. This is the first study to report DNA evidence supporting self-compatibility in pawpaw. The DNA fingerprinting results confirmed the occurrence of some self-fruit set in both 'Sunflower' and 'Susquehanna'. Surprisingly, Susquehanna was found to exhibit greater self-compatibility compared to Sunflower based on the percentage of self-pollinated offspring. Although both cultivars served as pollinizers to each other; the ultimate fruit set seemed to have a direct relationship to the genetic yield potential of the maternal tree.

KEYWORDS: Horticulture, Pawpaw, Self-compatibility, New crops

Specified Source(s) of Funding: USDA Evans Allen Research Grant

4:15 PM Nutrient Storage in Dormant Peach Trees Following Variable Fall Climate

Brian Lawrence* and Juan Carlos Melgar, *Clemson University*

Abstract: Variability in autumn climate resulting in warmer and drier conditions can delay leaf senescence in deciduous fruit trees. As leaves remain for an extended season, trees may allow additional nutrient mobilization to the reserves (stem and roots), which can impact nutrient uptake in the following spring. In this study, we evaluated the nutritional responses of two-year-old peach trees to fall temperatures and soil moisture on two cultivars ('Scarletprince' and 'Autumnprince' both on Guardian™ rootstock). We applied four treatments to the two cultivars: 1) well-watered trees (100% ET_c needs) grown under ambient outdoor temperatures; 2) water deficient trees (50% ET_c needs) grown under ambient outdoor temperatures; 3) well-watered trees grown in a greenhouse; and 4) water deficient trees in a greenhouse. Average temperature in the greenhouse was 5 °C warmer than ambient outdoor temperature. Trees inside the greenhouse had delayed senescence and there were no significant differences in total leaf number or leaf area between the trees in the greenhouse and outdoor environments prior to senescence. We measured nutrient concentrations in leaves during the fall and in the reserve tissues (new shoots, one-year old shoots, stem above and below the graft union, lignified roots, and fibrous roots) during the winter to assess mobilization. Across fall sampling, leaf nitrogen and phosphorus concentrations were significantly lower inside the greenhouse while potassium was significantly higher in trees outside. Across all tissue locations during winter, nitrogen and potassium concentrations were significantly higher in greenhouse trees than in trees outside, while both nitrogen and phosphorus were significantly higher in water deficient trees than in well-watered trees. Significantly higher levels of potassium were also found in 'Autumnprince' compared to 'Scarletprince' across tissue locations during the winter. Provided consistent differences between treatments regarding remobilized nutrients, this study could provide a model for the larger climate change discussion within deciduous fruit tree cultivation and provide a platform for further research to optimize management practices encouraging environmental and orchard sustainability.

4:30 PM The Relationship between Peach Fruit Weight, Crop Density and Early Season Temperature

R P. Marini*[1]; Esmaeil Fallahi[2]; Poliana Francescatto[3]; Gregory L. Reighard[4]; Jaume Lordan[3]; Terence Lee Robinson[3]; Dwight Wolfe[5] and Michael J. Newell[6], *(1)Pennsylvania State University, (2)University of Idaho Parma Research and Extension Center, (3)Cornell University, (4)Clemson University, (5)Univ. of Kentucky, (6)Wye Research and Education Center*

Abstract: A multi-location study was conducted over four years to evaluate the effect of crop density (CD) and early-season temperatures, alone and in combination, on fruit weight (FW) at harvest. 'Redhaven' and 'Cresthaven' peach trees growing at five sites were hand-thinned each of four years to provide a range of CDs. For each site, cumulative growing degree days were calculated from minimum and maximum daily temperatures for the first 30 days after 50% full bloom using 4ºC as the base temperature ($CGDD_{30}$). The relationships between average fruit weight (FW) and CD and $CGDD_{30}$ were fairly variable, but FW was generally negatively related to both CD and $CGDD_{30}$. Variability in the data likely resulted from differences in orchard practices and environmental conditions at the different sites. The interaction of CD and $CGDD_{30}$ was rarely significant at an individual site, indicating that the two factors are independent and have an additive effect on FW and days from bloom to harvest.

Specified Source(s) of Funding: NIFA and USDA and Agr. Expt. Stations in PA, NY, MD, SC, and KY

4:45 PM Fertilize Less and Irrigate: Improving the Recommendations for Young Peach Trees in the Southeastern U.S.

Bruno Casamali*; Marc W. van Iersel and Dario J. Chavez, *University of Georgia*

Abstract: Drought has been common in the southeastern U.S. in the past years, affecting peach production. Traditionally, young peach trees (one to three-year-old) are not irrigated until the third year and rely on rain as water source. There is growing interest in irrigating young plants; however, no scientific guidelines are available for the region. Similarly, current fertilizer recommendations for young peach plants are outdated and/or based on studies performed in Mediterranean regions or California and may not be applicable to the southeastern U.S. Improvement of the irrigation and fertilization recommendations is paramount and the objective of this research. 'Julyprince' plants grafted onto 'Guardian' rootstock were planted in 2015, at a density of 358 plants per hectare. Two irrigation systems (drip and micro-sprinkler), two irrigation rates (irrigated and non-irrigated), and four fertilizer rates (16, 33, 65, and 129 kg of N per hectare for one-year-old plants; and 23, 48, 95, and 191 kg of N per hectare for two-year-old plants) were tested. A network of sensors and nodes controlled the irrigation and maintained the soil volumetric water content (VWC) above an established threshold (varied from 15 to 25% of VWC). Granular fertilizer was hand-applied following current recommendations: one application of 10.0N-4.4P-8.3K in March and 2 applications of 15.5N-0P-0K, in May and July. Irrigated plants grew more than non-irrigated plants, with trunk cross-sectional area (TCSA) and canopy volume ~1.5X and ~1.7X greater, respectively, for both years. Fertilizer rates did not affect TCSA and canopy volume if plants were drip irrigated; however, higher fertilizer rates induced greater TCSA and canopy volume when micro-sprinkler irrigated, in general. Irrigation alleviated drought stress in 2016, increasing water potential and photosynthesis by ~0.6X and ~1.8X, respectively, for both years. However, no significant physiological responses were found in 2017, likely because it rained more than in 2016. The negative effects of the lack of precipitation and irrigation in 2016 carried over to 2017: the commercial yield of non-irrigated plants was ~20% lower when compared to irrigated plants. The fertilizer rates did not induce major differences for water potential, photosynthesis, and commercial yield. Compared to micro-sprinklers, drip irrigation increased stem water potential

and photosynthesis in 2016, and commercial yield in 2017, while applying ~36% less water. In conclusion, drip irrigation was beneficial to young peach trees' growth and fruit production; and fertilization can be adjusted/cutback by ~50% to reduce the environmental impacts and increase growers' profit.

Specified Source(s) of Funding: Peach Commodity Commission Grant

5:00 PM Impact of Nitrogen Fertilization on Apple Tree Growth, Fruit Development, and Cider Fermentation Kinetics

Adam Karl*; Gregory Michael Peck and Michael G Brown, *Cornell University*

Abstract: Nitrogen fertilization is a little studied area of hard cider apple (*Malus x domestica* Borkh.) production that potentially impacts tree growth, yield, fruit polyphenol concentration, yeast assimilable nitrogen in juice, and fermentation kinetics. In the spring of 2016, a multi-year nitrogen fertilization study was started on two-year old Golden Russet and Medaille d'Or tall spindle trees on G.30 rootstock in Ithaca, NY. Low (28 kg·ha^{-1} N), medium (56 kg·ha^{-1} N), and high (112 kg·ha^{-1} N) nitrogen fertilizer treatment rates, plus an unfertilized control, were implemented by applying calcium nitrate granular fertilizer each spring. Greater nitrogen fertilizer rates resulted in increased tree size, as measured by trunk cross sectional area (TCSA) and central leader growth for both cultivars. In 2016, the low, medium, and high treatments had 28%, 25%, and 26% greater TCSAs than the control, respectively, and leaders were 36%, 46%, and 31%, longer than the control, respectively. In 2017, the high nitrogen fertilizer treatment increased TCSA by 66% relative to the control, but no other differences in tree growth were found for either cultivar. No differences in leaf nitrogen content were found among treatments for either cultivar in 2016 or 2017. Nitrogen fertilization advanced fruit maturity during the 2017 harvest. When data for both cultivars were analyzed in a single statistical model, fruit from the medium and high nitrogen treatments had an average of 0.5 and 0.8 greater starch index measurements than the control. Fruit from the high nitrogen treatment had 15% lower firmness than the control, and the high and medium nitrogen treatments had 8% and 17% lower delta absorbance reading (chlorophyll content). No differences in juice polyphenol content were found in 2017, as measured by the Folin Ciocalteu assay. Golden Russet juice from the high nitrogen treatment had 43% greater yeast assimilable nitrogen than the control. During fermentation of the Golden Russet juice, the unfertilized control produced more hydrogen sulfide (a negative attribute) than fermentations from the low and high treatment fruit. This preliminary data suggests that nitrogen fertilization in the orchard impacts tree growth, fruit quality, and fermentation kinetics. However, additional years of data are needed to determine the consistency of these results.

Specified Source(s) of Funding: United States Association of Cider Makers

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3:15 PM – 5:15 PM *Monroe*

Propagation

Moderator: Sandra B. Wilson, *University of Florida*

3:15 PM Quantification of Root Growth of Transplants By Two-Dimensional or Three Dimensional Root Scans in Propagation Substrates

Erin J. Yafuso*; Paul R. Fisher and Ana C. Bohórquez, *University of Florida*

Abstract: Digital scanning of roots using two-dimensional (2D) scanners or three-dimensional (3D) X-ray computed tomography (CT) are established research techniques. However, CT methodology is lacking in the wide range of substrates used in propagation. The objective was to quantify root growth by 2D or 3D scans for peat, rockwool, and phenolic foam (Oasis^{TM}) during mist propagation of *Euphorbia pulcherrima* 'Prestige Red' (poinsettia). The experimental design was a randomized block design with two blocks (growth chambers) and two replicate substrate moisture levels (capillary mats) per block. Unrooted cuttings were grown at three constant moisture levels. Three cuttings per treatment combination were harvested on day 14 of propagation. In one experiment, poinsettia were grown in peat (55-mL volume cell) held constant at 53, 58, or 63% volumetric water content (mL water/mL volume). Washed roots were scanned with an image scanner at 800 dpi and analyzed for total root length, surface area, and volume using WinRHIZO^{TM}. Root growth using 2D imaging did not differ between moisture levels, and averaged 46.3-cm in total length, 13.8-cm^2 surface area, and 0.34-cm^3 volume. In a second experiment, poinsettia were propagated in rockwool or foam. The substrate moisture levels were 11, 19, or 53% volumetric water content for rockwool (45-mL volume) and 18, 34, or 89% for foam (29.7-mL volume). Plants were scanned using nano-CT at 49.8 µm voxel resolution, 1,200 images, and a 20 min. run time. Image segmentation of roots was achieved by drying the substrate down. Root growth was quantified by measuring total surface area, volume, and root count. In rockwool, the high moisture level resulted in a significant increase (p=0.05) in root growth resulting in 760-mm^2 surface area, 153-mm^3 volume, and 19 roots per cutting, relative to moisture levels. Contrast, in foam root growth was similar at 396-mm^2 surface area, 75-mm^3 volume, and 14 roots per cutting across moisture levels. Root growth was also quantified by spacial distribution through image segmentation at 0.5-cm increments from the base of the stem to 2.0-cm depth in plug cells. Root scans by 2D quantified total root growth variables in substrates where roots could be washed. Imaging by CT scans preserves root system architecture in opaque growing media at high resolution and can be quantified for total root growth as well as root spacial distribution.

3:30 PM Developing a Micropropagation Protocol for *Abelia* 'Raspberry Profusion'

Leynar Leyton Naranjo*, *University of Georgia* and Carol D. Robacker, *University of Georgia, Georgia Campus*

Abstract: *Abelia* is a genus of flowering woody shrubs with high ornamental and landscape potential. Among the cultivars commercially available *A.* 'Raspberry Profusion', a hybrid between *A. '*Edward Goucher' x *A. chinensis*, stands out for its superior ornamental characteristics of rapid growth, drought tolerance, dark green glossy leaves, long flowering period, unique pink-red flowers, and pink sepals that remain in the plant during fall. Even though *A.* 'Raspberry Profusion' roots successfully from shoot cuttings, the propagation rate is limiting commercial production. A more efficient and faster protocol is needed. In this study we report the development of an *in vitro* micropropagation protocol.

One node microcuttings from greenhouse-grown plants of two genotypes, *A.* 'Francis Mason' (as a control) (FM) and *A.* 'Raspberry Profusion' (RP), were cultured on Murashige and Skoog (MS) medium with vitamins or Woody Plant Medium (WPM) with vitamins both supplemented with 30 g·L^{-1} sucrose, 8 g·L^{-1} agar, pH adjusted to 5.9 and either 1 or 2 mg·L^{-1} of 6-Benzylaminopurine (BA). Genotype and type of media had a significant effect on the number of shoots and nodes/shoot obtained *in vitro* after 4 weeks. FM produced more shoots on WPM (1.6 shoots and 3.2 nodes/shoot) than MS (1 shoot and 1.5 nodes/shoot), but no significant differences were observed between RP on WPM (0.7 shoots and 1.2 nodes/shoot) and RP on MS (0.9 shoots and 1.2 nodes/shoot).

The effect of the origin of the explant was tested on RP. One node microcuttings from greenhouse or field-grown plants were cultured on WPM supplemented with 30 g·L^{-1} sucrose, 8 g·L^{-1} agar, pH adjusted to 5.9 and either 1 or 2 mg·L^{-1} of BA. After 4 weeks of culture, BA had no significant difference in the number of shoots and nodes/shoot obtained *in vitro*; however, the field-grown explants performed significantly better (1.2 shoots and 2.2 nodes/shoot) than the greenhouse explants (0.2 shoots and 0.2 nodes/shoot).

The effect of type of cytokinin was also tested using 1 mg·L^{-1} of Thidiazuron (TDZ) or Kinetin (Kn) on FM and RP cultured on WPM. Type of cytokinin and genotype had significant effects on the number of shoots produced *in vitro* after 4 weeks. Best overall treatment was RP with TDZ producing an average of 3 shoots, FM only produced 1.4 nodes with TDZ. RP with KN produced 0 shoots and FM with KN produced 0.3 shoots.

3:45 PM Hazelnut (*Corylus* L.) Propagation Techniques Used in Breeding, Cultivar Increase, and Orchard Establishment

Shawn A Mehlenbacher*, *Oregon State University*

Abstract: The OSU breeding program routinely uses tie-off layerage (stooling with shoot girdling) to clonally propagate hazelnut trees for yield trials and field exposure to eastern filbert blight (EFB) for disease susceptibility screening. For greenhouse EFB inoculations, trees are grafted in a heated greenhouse to promote callusing at the graft union. A hot-callusing pipe can be used for bench grafting in lieu of a greenhouse, and is suitable for many other species where dormant season open-field grafting is unsuccessful. Grafting also allows establishment of new orchards on clonal rootstocks that produce few suckers. Field grafting with a high success rate is possible if it is delayed until late spring, using scions collected in mid-winter and stored at -1 °C. Micropropagation is now used for rapid increase of new cultivars from the breeding program for commercial orchard planting and establishment of layering beds. Propagation by softwood cuttings from suckers and side branches on container-grown micropropagated trees is also successful in mid- to late- spring.

Specified Source(s) of Funding: Oregon Hazelnut Commission

4:00 PM Immature Embryo Germination --- a Key Step to Speed up Woody Plant Breeding

Donglin Zhang*[1]; Yujie Yang[2] and He Li[1], *(1)University of Georgia, (2)Yangtze University*

Abstract: Woody plant breeding is a long-term commitment and a breeding cycle usually takes 5-30 years. Cross incompatibility (late abortion) and seed germination are challenging and time-consuming. To speed up woody plant breeding cycles, immature embryo germination in vitro were investigated and reviewed. To avoid embryo abortion and pest and disease contamination, immature embryos should be excised from the mother plants as soon as they are visible and could be removed from the fruits. After fruit maturation, it is hard to dissect embryos and prepare sterilized explants for culture. Timing to collect immature embryos should be investigated bi-weekly or monthly. Majority of immature embryos should be placed in dark conditions for the first two weeks for initiation of germination. Quarter strength of Murashige and Skoog (MS) medium should be explored for the initial germination and other media such as WPM with extra sugar could work as well. Each germinated micro-seedling is a clone and we can regenerate it through micro-cuttings and/or somatic embryogenesis. Woody horticultural plants (*Ilex crenata* and *Kalmia latifolia* as examples) with successful immature embryo germination (embryo rescue) had been reviewed and summarized. Successful immature embryo germination should be able to avoid late embryo developmental abortion and yield cross breeding seedlings at the same growing season for woody plants, instead of additional 1-3 years for seed harvesting and germination. The procedures for immature embryo germination were technically challenged, but significantly speeded up woody plant breeding cycles.

4:15 PM Impact of Irradiance and Carbon Dioxide Concentration on Photosynthetic Rate of Five Ornamental Plant Species/Hybrids Grown in Tissue Culture Containers.

John Erwin* and George Guethner, *University of Minnesota*

Abstract: Separate plastic tissue culture containers containing four ornamental plant species/hybrids (*Anigozanthus flavidus*, *Aloe vera*, *Dionea muscipula*, a *Trichopilia* hybrid, and a *Phalaenopsis* hybrid) that differed in perceived irradiance requirements were acquired from two commercial laboratories. Holes were drilled in the sides of the containers and a plastic tube and rubber stopper were inserted in each (a hole was drilled in the stopper to insert the plastic tube) to create an air-tight flow-through system compatible with a portable photosynthesis meter (LiCor LI-6400) to determine initial container carbon dioxide concentration (CO_2) under typical lab conditions (50 umol $m^{-2}s^{-1}$, 23 ^oC). Following this initial CO_2 measurement, photosynthetic CO_2-response curves were developed for the change in CO_2 entering versus exiting each chamber (approximates photosynthesis) as CO_2 levels increased from 25 up to 1300 ppm (species specific) while maintaining irradiance at 50 umol $m^{-2}s^{-1}$. Photosynthetic irradiance-response curves (0 up to 1300 umol $m^{-2}s^{-1}$; species specific) were then determined (based on changes in CO_2 concentration entering versus exiting containers) at the initial CO_2 levels measured for each flask (approx. 25 to 275 ppm for each species) to ascertain the impact of increasing irradiance under lab conditions. Lastly, both irradiance and CO_2 were simultaneously increased from lab conditions to the irradiance and CO_2 saturation levels determined above to establish the maximum potential increase in photosynthesis of each species. Implications of this work in tissue culture production when considering increasing irradiance and/or injecting CO_2 will be discussed.

Specified Source(s) of Funding: USDA-ARS; FRA; Minnesota Agriculture Experiment Station

4:30 PM New Online Supplemental Resources for Hartmann and Kester's Plant Propagation: Principles and Practices, 9th Edition

Sandra B. Wilson*[1]; Robert L Geneve[2]; Frederick T Davies Jr.[3] and Aaron Sotala[1], *(1)University of Florida, (2)University of Kentucky, (3)Texas A&M Univ*

Abstract: The world's standard for plant propagation and horticulture since 1959, Hartmann and Kester's Plant Propagation: Principles and Practices just unveiled its 9th edition in 2018. Twenty one chapters are organized into five sections discussing: 1) general aspects of plant propagation, 2) seed propagation, 3) vegetative propagation, 4) tissue culture propagation, and 5) propagation of selected plants. Supplemental to the text are instructional resources that include captioned PowerPoint slides for each of the 679 Figures as well as a test bank and key of 422 exam questions. These are comprised of short answer, fill in the blank, multiple choice, and true/false and can be downloaded from the Pearson website with a unique access code. Separately, online resources have been prepared to complement important concepts in the text and facilitate learning. These include 1) storyline interactions for each chapter, 2) animation of a typical angiosperm lifecycle, 3) a web application for nearly 500 glossary terms with images/video, 4) videos of propagation practices, and 5) guest lectures of experts in the field.

4:45 PM Seed Dormancy and Germination in the *Iris Raevigata* fisch. (Iridaceae)

Chung Ho Ko*; Ki Cheol Lee; Sang Yong Kim and Seung Youn Lee, *Useful Plant Resources Center, Korea National Arboretum, Korea Forest Service*

Abstract: *Iris laevigata* Fisch., which belongs to the Iridaceae, is a perennial plant native to Korea, China, Japan, and Russia, grows in the mud of a pond, stream, or river bank. Purple flowers, which are about 12cm in diameter, are highly valued in May and June. However, it is now designated as a "Data Deficient" (DD) grade (Korea Forest Service) because it does not have many natural sites known for its reckless development and damage to its natural habitats. Preservation and reproduction and further development into coronary plants require the development of reproductive methods. This study was carried out to determine the dormancy type of *I. laevigata* seeds and to establish the germination conditions to restore the native habitat of the *I. laevigata* and to preserve its status outside of its current habitat. Temperature requirements for embryo growth and germination were determined by incubating seeds under controlled laboratory conditions. The seeds had underdeveloped embryos, which had grown to about 55% of those of fully matured seed before germination. When tested at the time of dispersal, seeds did not germinate during 16 weeks of without chilling treatment. Therefore, the seed dormancy type for *I. laevigata* was morphophysiological. In the controlled laboratory experiment, after cold stratification at 5℃ for 0, 4, 8, or 12 weeks, the seeds germinated to 0, 11.7, 43.4, or 51.7%, respectively, after 2 weeks of incubation at 25℃. After warm (25℃, 8 weeks) followed by cold stratification for 0, 4, 8, or 12 weeks, the seeds germinated to 0, 51.7, 85.0, or 88.3%, respectively, after 2 weeks of incubation at 25℃. Additionally, GA_3 treatment did not overcome the dormancy. Therefore, the seeds expressed deep simple morphophysiological dormancy (MPD).

(The results of this research were introduced at KSHS 2017 Annual Autumn Conference through poster presentation)

5:00 PM Seed Dormancy and Germination of *Coreanomecon Hylomeconoides* Nakai (Papaveraceae), a New Ornamental Plant in Korea

Seung Youn Lee*[1]; Ki Cheol Lee[1]; Ki Sun Kim[2] and Sang Yong Kim[1], *(1)Useful Plant Resources Center, Korea National Arboretum, Korea Forest Service, (2)Seoul National University*

Abstract: Korea National Arboretum has recently started the project 'Wild Flowers' for the commercialization of wild flowers native to Korea. In this project, we have selected 30 herbaceous (*Euphorbia jolkinii*, *Minuartia laricina*, *Veronica kiusiana* var. *diamantiaca*, *V. pusanensis*, *Coreanomecon hylomeconoides*, and etc.) and 6 woody species (*Hydrangea serrata* f. *fertilis*, *Exochorda serratifolia*, *Lonicera insularis*, and etc.) as new ornamental crops. The project consists of four contents : 1) floral market survey, propagation, and cultivation physiology including flowering control, 2) ornamental plants breeding, 3) model garden development, 4) finding traditional knowledge with the potential plants. Among the potential plants, *Coreanomecon hylomeconoides* (Papaveraceae) is a perennial herb and is endemic to Korea. This species has great potential as garden and landscape plant because it has long flowering period from May to September in Korea. However, *C. hylomeconoides* has seed dormancy at dispersal, and thus seed propagation is difficult. Ripe seeds were collected between 16~19 June. The seeds were sown in field soil in an experimental garden. We investigated the phenology of embryo growth, germination, and seedling emergence in the natural environment. Temperature requirements for embryo growth and germination were also determined by incubating seeds under controlled laboratory conditions. The effect of GA_3 concentrations (0, 10, 100, or 1000mg·L^{-1}) on dormancy breaking was also tested to characterize the type of seed dormancy. Seeds had underdeveloped embryos, which was about 13% in length of fully matured seed. When tested at the time of dispersal, seeds did not germinate during 4 weeks of incubation at 25/15 °C. Thus, *C. hylomeconoides* seed has morphophysiological dormancy. In natural conditions, embryos grew at temperature between 5 and 15 °C (average 10 °C) on late October. However, the seed did not germinate immediately after embryo elongation. After cold temperature season during winter, the seed germinated to about 80% when the temperature increased to 0~5 °C. More than 80% of seedlings emerged when the temperature increased to about 10 °C in the natural environment. None of the seeds germinated at 25/15 °C during 40 weeks of incubation whereas the seeds germinated to about 40% when the seeds were subjected to the temperature sequence (25/15 °C → 20/10 °C → 15/6 °C → 5 °C → 15/6 °C → 20/10 °C). The GA_3 treatment increased embryo growth in the seeds, but less than 20% of them germinated at 25/15 °C with 1000 mg·L^{-1}. Based on these results, seed dormancy of *C. hylomeconoides* can be broken through warm followed by cold temperature sequence and classified as having deep simple morphophysiological dormancy (MPD).

3:15 PM – 5:15 PM

Strategies for Recruiting Students into Horticulture Programs *CEU Approved*

Jefferson East

Coordinators: Mary Meyer, *University of Minnesota*; John Dole, *North Carolina State University* and Susan Yoder, *Seed Your Future*

Moderators: Mary Meyer, *University of Minnesota*; John Dole, *North Carolina State University* and Susan Yoder, *Seed Your Future*

Objectives:

1. To present Seed Your Future's BLOOM! campaign and show how it is increasing interest in horticulture and horticultural programs.2. To learn from universities and industry organizations about their effective recruiting strategies and programs.

Description: All across the United States, universities and organizations are working to recruit young people into horticultural programs to help them find their passions and fill the need for well-trained employees. Leading the charge is Seed Your Future, which is comprised of a broad range of horticultural industry, universities and organizations. Seed Your Future's National Leadership Cabinet and Advisory Council continue to lead the national movement to promote horticulture in collaboration with FleishmanHillard, the Washington, D. C.-based marketing and communications firm. Progress in the past year included finalizing the BLOOM! campaign: BLOOM! is the movement **to improve the world through the power of plants** through a comprehensive multi-year plan to create and curate content (both in and outside of the classroom) and deploy a social media strategy.

In March 2018 the Scholastic site for BLOOM! was launched, where all the materials developed through Scholastic for teachers and youth program leaders are accessible. This great start is providing resources to those who work with middle schoolers: *www.Scholastic.com/BLOOM*. Additionally, the youth-focused WeAreBLOOM.org microsite went live on March 7, 2018, when teachers began to distribute the student magazines and held the first student contest, entitled plant mash-up, encouraging students to create their own new plants.

BLOOM! has exciting attractive images, words and information that are designed to connect with young people. Elements of the movement include promoting #GreenCollar careers, ground-breaking interviews with horticulturists, identifying horticulture heroes, and creating videos made specially to attract and inform middle and high school students about careers in horticulture.

BLOOM! educational materials include websites, interactive quizzes, plant powers, horticulture vignettes, social first videos, social media campaigns, education multi-media with Scholastic, student magazines, online learning modules and life lessons. The campaign will run from April to October 2018, which will be followed by assessment and year two planning.

Seed Your Future is not working in a vacuum. Universities and industry organizations are successfully implementing their own programs to increase the number of horticulture students. In this workshop we will learn from universities and industry organizations about their effective recruiting strategies and programs.

3:15 PM **Seed Your Future – the Education and Marketing Campaign Has Been Launched!**
Susan Yoder*, *Seed Your Future*

4:00 PM **Undergraduate Recruitment of Horticulture Students: A West Texas Perspective**
David Thayne Montague*, *Texas Tech University*

4:15 PM **ISU Horticulture: Branding Our Identity**
Cynthia L. Haynes*, *Iowa State University*

4:30 PM **Center for Growing Talent - Bringing New Talent to the Fresh Produce and Floral Industry**
Alicia Calhoun* and Margi Prueitt, *Center for Growing Talent*

4:45 PM **Discussion**

4:00 PM – 5:00 PM *Boundary (Terrace Level)*

Industry Division Advisory Council Meeting - Open to All Interested Members

Chair: Holly Little, *Acadian SeaPlants*
Member: Angela Davis, *N/A*

4:00 PM – 5:00 PM *Northwest (Lobby Level)*

ASHS Member Representative Meeting

Moderator: Cindy Slone, *ASHS*

4:00 PM – 5:00 PM *Piscataway (Lobby Level)*

Computer Applications in Horticulture (COMP) Meeting - Open to All Attendees

Chair: Kent Kobayashi, *University of Hawaii at Manoa*
Chair-elect: Tongyin Li, *Mississippi State University*
Secretary: Brian Krug, *Univ of New Hampshire Coop Extn*
Objectives:
To study the application of computers in research, extension, and teaching of horticulture.

4:00 PM – 5:00 PM *Oak Lawn (Lobby Level)*

Local Food Systems (LOCSY) Meeting - Open to All Attendees

Chair: Rebecca Brown, *University of Rhode Island*
Chair-elect: Jeremy Cowan, *Washington State University*
Objectives:

To promote academic and research information exchange on scientific development, scholarship, and educational activities related to and regarding local and regional production systems, including definition and measurement of food systems, foodsheds, small and mid-scale production systems, beginning/new farmers, local farmers and farmers markets, farmers expanding from direct sale to local/regional wholesale, scale neutral technologies, agriculture at the urban/rural interface, urban horticulture production (community gardens, school gardens, home gardens), farm-to-consumer marketing, farmer-to-institution /school marketing, local food system and farmland policy, and relationships of local horticulture to rural and urban communities and economies.

4:45 PM – 5:15 PM *Jefferson West*

Growth Chambers and Controlled Environments (CE) Meeting - Open to All Attendees

Chair: Christopher J. Currey, *Iowa State University*
Chair-elect: Roberto G. Lopez, *Michigan State University*
Secretary: Ricardo Hernández, *NC State University*

Objectives:
To provide leadership for horticulturists in the use of growth chambers and controlled environments and to provide a means for cooperative research and teaching among those using or interested in such facilities in their programs.

5:30 PM – 6:30 PM

Welcome Reception

International Terrace

7:30 PM – 10:00 PM *T Street Entrance - Terrace Level*

Monuments By Moonlight

7:00 AM – 6:00 PM

Speaker Ready Room - Wednesday
Cabinet

7:30 AM – 5:00 PM

Registration Open - Wednesday
Concourse Level Foyer

8:00 AM – 9:00 AM *Piscataway (Lobby Level)*

Nursery Crops (NUR) Meeting - Open to All Attendees

Chair: Chris Marble, *University of Florida, Mid-Florida Research and Education Center*

Chair-elect: James Altland, *USDA-ARS, MWA ATRU*

Secretary: John Majsztrik, *Clemson University*

Objectives:

To identify those conducting nursery crop research and to ascertain the scope and direction of their studies, to develop and share information for teaching nursery management and production courses, and to provide staff development opportunities for nursery crop specialists, teachers, and researchers by developing information programs and interacting with the nursery industry and profession.

8:00 AM – 9:00 AM *Oak Lawn (Lobby Level)*

Organic Horticulture (ORGH) Meeting - Open to All Attendees

Chair: Brian Ward, *Clemson University CREC*

Chair-elect: Annette Wszelaki, *University of Tennessee*

Secretary: Javier Fernandez-Salvador, *Oregon State University*

Objectives:

To stimulate discussion on horticultural research techniques that enable growers to produce horticultural crops according to organic standards, and on the processes that make organic production systems function.

8:00 AM – 9:00 AM *Georgetown West*

Weed Control and Pest Management 1

Moderator: Mohammad Babadoost, *Univ of Illinois-Dept Crop Sci*

8:00 AM **Rapid Imaging of Verticillium Wilt Strain Cultures and Confluency Estimation in an Automated Manner Using the InCellis® Smart Cell Imaging System**

Laima Antanaviciute[*1]; Sophie Dubacq[2] and Olivier Varet[2], *(1)Bertin Corp, (2)Bertin Instruments*

Abstract: In cell biology and microbiology related studies, accuracy and efficiency in cell culture quality checks are crucial in order to avoid any potential complications in downstream analysis. Usually, different cell parameters such as cell counting, cell size measurement and cell culture confluency are assessed and estimated visually in a subjective way. However, visual assessments are unreliable, time consuming and often yielding inaccurate results which lead to incorrect conclusions and incorrect recommendations. In this study, a novel imaging system was evaluated using Verticillium wilt strain cultures. Strawberry pathogenic strains were used to accurately estimate cell line confluency and total spore counting in an automated manner using embedded applications on the InCellis® Smart Cell Imaging System. A series of images of the cultures were taken in phase contrast mode using 10x and 20x objectives at exactly the same time of day over a three-day period in order to check the accuracy of cell confluency. The confluency ranged between 10% - 76% with the 10x objective, and between 14% - 77% with the 20x objective over the three-day experiment. Furthermore, cell counting application embedded on the InCellis® was used to compare the results obtained following the manual approach performed with Malassez cell counting method. A total of five images of the wilt culture were taken at different field of view using 20x magnification on InCellis®, and were further used to estimate a total number of wilt spores in the culture plate. The results demonstrated that both methods are correlated and showed an increase of the total spore number as expected (40K on day-1 - 270K on day-3). The confluency and cell counting applications ensured a rapid and efficient quality control of the strains and allowed to obtain robust results with a stain-free method in comparison to the standard method. The automated applications not only provide consistent results but also significantly reduce the hands-on time for all cell-based assays.

8:15 AM **Managing Phytophthora Blight, Caused By *Phytophthora Capsici*, in Cucurbits**

Mohammad Babadoost[*], *Univ of Illinois-Dept Crop Sci*

Abstract: Phytophthora blight, caused by the oomycete *Phytophthora capsici*, is one of the most important diseases of cucurbits worldwide, causing up to 100% crop losses. Major symptoms caused by *P. capsici* on cucurbits are seedling death, foliar blight, and fruit rot. *P. capsici* also infects more than 40 species in 15 plant families. There is no cucurbit cultivar with measurable resistance against Phytophthora blight available. Cultural practices and chemical use are the options for management of this disease in cucurbit fields. We developed effective strategies for managing Phytophthora blight of cucurbits by integrating cropping rotations, seed treatment, field scouting, and fungicide sprays. Cropping rotations of ³ 3 years with nonhost crops was established after the host range and survival of *P. capsici* in soil were determined. Seed treatment with mefenoxam (0.42 ml Apron XL LS/kg of seed) and spray applications of effective fungicides reduced yield losses from up to 100% to less than 10% in commercial fields. In the past 15 years, more than 10 new fungicides with different modes of action were registered for management of Phytophthora blight of cucurbits. Field scouting and removing/disking infected plants in small areas in the early disease development stage helped to delay the spread of the disease in the fields. Plant should not be irrigated from pounds that contain water drained from infested fields.

8:30 AM **Evaluation of Weed Management Techniques in East Coast Broccoli Production**

Matthew Cutulle[*1]; Mark W Farnham[2]; Harrison Campbell[1] and David M. Couillard[2], *(1)Clemson University, (2)USDA-ARS*

Abstract: The majority of the broccoli grown in the US is located in California and Arizona. However, USDA-SCRI-funded grants have focused on establishing an east coast broccoli industry. One of the reasons it can be more difficult to grow broccoli on the east coast from a weed management perspective is higher rainfall, which can lead to greater and more consistent weed pressure as well difficulties utilizing a soil cultivator due to high soil moisture. Thus a better understanding regarding weed control strategies is needed for Research was conducted at the United States Vegetable lab in Charleston, SC to evaluate the impact of herbicides and cultivation on weed control and crop health. The experiment was conducted as a randomized complete block with 3 replications and 10 treatments. Two Broccoli cultivars, Lieutenant and Emerald Crown were transplanted to the field on September 22nd 2017. The treatments were structured as a factorial with 5 herbicide treatments (pyroxasulfone, oxyflurofen, S-metolachlor, napropamide or no herbicide) x 2 cultivation treatments (Cultivated or Not Cultivated). The herbicides were applied to the soil 3 days prior to transplanting. Cultivation treatments were applied three weeks after transplanting. Weed species in the plots included yellow nutsedge, carpetweed, purslane, and yellow foxtail. Twelve weeks after transplanting the best treatments for controlling theses weeds were oxyflurofen with Cultivation and S-metolachlor with cultivation, which

provided 85 and 88% respectively. No injury was observed from any of the treatments.

8:45 AM MS79 Is a Microbially Derived Selective Cellulose Biosynthesis Inhibitor

Mohammad Radhi Alsabri*, *university of kentucky*

Abstract:

Herbicides are used to control weeds in agricultural systems and to beneficially shift the competition between crops and weeds. Despite their importance, few new mechanisms of action have been elucidated in recent decades. Here, we describe the identification of a bio-derived herbicidal mixture from an endophytic bacterium named MS79. The MS79 strain was isolated from switchgrass tissue. A preparation of concentrated cellular material disturbs the biosynthesis cellulose in plants exposed to the mixture. Accordingly, isolation with XAD18 resin to purify metabolites results in a herbicidal mixture with similar activity against cellulose biosynthesis. The application of the MS79 to a range of plant genera suggests that it caused substantial reduction in cellulose content *Sorghum bicolor* L and other monocotylenous plants. However, Solanaceous broad leaf crops, for instance *Nicotiana tobaccum* and *Solanum lycopersicum*, are less sensitive. The genome of MS79 was sequenced, revealing the presence of plant-microbe association genes and several genes encoding proteins capable of binding to or degrading plant cell wall carbohydrates. Thus, we propose that MS79 is a Class L herbicide, with specificity towards grass control in Solanaceous crops.

8:00 AM – 9:30 AM

Teachers Ignite! *CEU Approved*

Lincoln West

Coordinator: Andrew R. King, *Texas A&M University*

Moderator: Andrew R. King, *Texas A&M University*

Objectives:

A fast-paced introduction by 10 presenters into pedagogical techniques utilized. Attendees will be able to take topics discussed during the workshop and incorporate them into their teaching efforts. They will also have opportunity to ask questions and take part in group discussions about how to most effectively integrate the topics discussed.

Description: A fast-paced format in which presenters have 3 minutes and 1 PPT slide to introduce and describe novel pedagogy techniques (teaching techniques, methods and/or activities) that they have found to be successful in the classroom or in extension teaching efforts. Various interests and focus areas will be discussed in the workshop. Attendees will be encouraged to take part in group discussion about effective methods for incorporation of these ideas or methods that they find helpful.

8:00 AM Developing Pedagogical Strategies for Incorporating Plant Trials into the Classroom

Andrew R. King*, *Texas A&M University*

8:05 AM Utilizing Social Media (Instagram) Outside of the Classroom to Enhance Learning Experience.

Todd P. West*, *North Dakota State University*

Abstract: Face-to-Face time is limited in the classroom. Social media is an integral part of student lifestyles. Using social media such as Instagram allows more interaction with students outside of the classroom environment. Instagram is used to enhance two courses at NDSU (PLSC 355 Woody Landscape Plants and PLSC 485 Arboriculture Science). Posts of either woody plant identification or woody plant issues are made to Instagram accounts (PLSC355 and PLSC485) and students who subscribe can reply to the post. For example, a picture of an Ohio Buckeye will be posted with accompanying text of: “I have opposite leaf/bud arrangement, I have a palmately compound leaf and often suffer from leaf scorch, who am I?”. After approximately an hour, the answer to the woody plant identification or issue is replied to the post, “I am Aesculus glabra, Ohio Buckeye, Sapindaceae”. This gives more opportunities for students to test their knowledge with respect to subject matter. Many past students keep following the course Instagram accounts and often answer the post’s question.

8:10 AM Creating an Interactive Syllabus

Kimberly Moore*, *University of Florida/IFAS*

8:15 AM Utilization of a Service Learning Project to Engage Classrooms of 300+ Students

Charles R. Hall*, *Texas A&M University*

8:20 AM Horticulture Is Awesome: Assessing Student Learning and Interest Via Blog Posts

Jared Barnes*, *Stephen F. Austin State University*

Abstract: In spring of 2017, we created a portfolio website for the horticulture program at Stephen F. Austin State University to promote student work to help engage potential students. Learning opportunities with this platform and blog will be discussed.

8:25 AM Virtual Field Trip—Fantastic Voyage!

Kent D. Kobayashi*, *University of Hawaii at Manoa*

Abstract: Classes go on actual field trips to supplement in-class learning and activities, visiting places such as farms and nurseries. The instructor contacts the farm or nursery owner, explaining the purpose of the visit and what the class would like to see. A date and time is finalized, and transportation is arranged. However, field trips have some shortcomings. They are limited to visiting places on the island of Oahu and close to the University of Hawaii because of the transportation costs and time. Once at the farm or nursery, it is sometimes difficult for everyone in the group to see or hear the speaker. Some students wander off from the group or are inattentive. Transportation can be costly. To complement field trips, I created the virtual field trip assignment. Each student contacts the owner of a farm or nursery, explains the assignment, and gets permission to visit for a personal tour. The student interviews the owner about the operation and takes pictures. Later, each student gives a PowerPoint talk in class about the farm and writes a report about the visit. The advantages of a virtual field trip include students are free to choose the farm or nursery that they want to visit. This could be a farm on another island in Hawaii, the US mainland, or in a foreign country. The student may be able to see and hear about things that the owner would not show or tell to a large group of students. The class gains experience in oral and written communication. This networking opportunity could possibly lead to an internship or a job. One of the things that did not work was when students were given the option of working in pairs, the work was sometimes not equally divided. Only one student in a group visited the farm or nursery. In conclusion, virtual field trips can complement actual field trips. The class learns firsthand about a diverse range of farms and nurseries. Students have the opportunity to improve oral and written communication. Virtual field trip visits have led to students getting future internships or jobs.

8:30 AM The Use of Student Preceptors to Make a Large Class Smaller

Dennis T. Ray*, *University of Arizona*

8:35 AM An Interdisciplinary Project: Creating the Marketing Tools for Horticultural Business

Jacqueline A. Ricotta*, *Delaware Valley University*

8:40 AM The Good, the Bad, and the Ugly: Critique As a Teaching Tool in a Landscape Design Course

Whitney N Griffin*, *Texas A&M University*

8:00 AM – 9:45 AM *Lincoln East*

Growth Chambers and Controlled Environments 2

Moderator: Shane Palmer, *University of Georgia*

8:00 AM Photoperiodic Effect on Growth and Development of Basil Species and Cultivars

Charlie Garcia* and Roberto G. Lopez, *Michigan State University*

Abstract: Retailers and consumers generally do not desire or accept potted or fresh cut culinary herbs with flowers as vegetative growth can be negatively impacted. This in turn creates problems for greenhouse growers who often struggle to keep basil (*Ocimum*) vegetative. Limited photoperiodic studies have

been conducted on common herbs such as basil to determine how changes in day length can influence flowering. The objective of this study was to quantify how photoperiod influences growth and development of 4 basil species and 11 cultivars. Seeds of 'Genovese Basil', 'Sweet Thai', 'Cinnamon Basil', 'Red Ruben', 'Sweet Dani Lemon', 'Purple Ruffles', and 'Nufar OG' (*Ocimum basilicum*), 'Lime Basil' (*Ocimum ×citriodorum*), 'Holy Basil' (*Ocimum tenuiflorum*), 'Mrs. Burns' Lemon' (*Ocimum basilicum* var. *citriodora)*, and 'Pluto Basil' (*Ocimum minimum*) were germinated and grown at 25 °C, under supplemental lighting provided by red:white:blue (R:W:B) light-emitting diodes (LEDs) providing a *PPFD* of 90 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and under eight different photoperiods. Photoperiods were a 9-hour day extended with LEDs providing 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of R:white:far-red (R:W:FR) light to create 11, 12, 13, 14, 15, or 16 hours; an additional treatment was a 9-hour day with a 4-hour night interruption (NI). Time to first visible bud and flower, node number below the first open flower, and plant height at flowering were recorded for each plant. Photoperiod did not significantly influence days to visible bud or flower for 'Cinnamon', 'Genovese', and 'Red Rubin' (*Ocimum basilicum*). However, height of 'Cinnamon', 'Nufar', 'Sweet Thai', and 'Red Rubin' were significantly influenced by photoperiodic treatments. Generally, plants were more compact under shorter day lengths. Flowering of 'Mrs. Burns' Lemon' and 'Holy basil' was hastened under 9-hour photoperiods. For example, 'Holy basil' (*Ocimum tenuiflorum*) under a 9-hour day generally flowered 6, 7, or 10 days earlier than plants under a 15-h, 16-h, or NI treatment, respectively. From this preliminary study, it appears that cultivars investigated of *Ocimum basilicum* var. *citriodora* and *Ocimum tenuiflorum* can be considered facultative short-day plants and *Ocimum basilicum* and *Ocimum ×citriodorum* are day-neutral.

8:15 AM Longer Photoperiods with the Same Daily Light Integral Increase Daily Electron Transport through Photosystem II

Claudia A. Elkins*; Michael Martin and Marc W. van Iersel, *University of Georgia*

Abstract: The annual energy cost for horticultural lighting in the US is approximately $600 million. To lower these costs, it is essential to provide light in a way that allows for efficient photochemistry. Because the quantum yield of photosystem II (ΦPSII), the fraction of absorbed light used for photochemistry, decreases with increasing photosynthetic photon flux density (*PPFD*), we hypothesized that electron transport through photosystem II integrated over 24 hr, the daily photochemical integral (DPI), increases if the same amount of light (daily light integral, DLI) is spread out over longer photoperiods. To test this, we measured chlorophyll fluorescence to determine ΦPSII and the electron transport rate (ETR) of lettuce (*Lactuca sativa* 'Green Towers'). Plants were grown at a *PPFD* of ~ 250 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Chlorophyll fluorescence measurements were taken in a growth chamber equipped with LED lights. A datalogger controlled *PPFD* and photoperiod and collected ΦPSII and ETR data. DLIs of 15 and 20 $mol \cdot m^{-2} \cdot d^{-1}$, provided over photoperiods of 7, 10, 13, 16, 19, and 22 hours, were tested. *PPFD* during these measurements ranged from 189 to 796 $\mu mol \cdot m^{-2} \cdot s^{-1}$. ΦPSII decreased from ~ 0.69 at a *PPFD* of 189 $\mu mol \cdot m^{-2} \cdot s^{-1}$ to ~ 0.29 at a *PPFD* of 796 $\mu mol \cdot m^{-2} \cdot s^{-1}$, while ETR increased from ~54 to 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$. DPI increased as a function of photoperiod and this increase was more pronounced at high DLI. At a photoperiod of 7 hours DPI was ~ 2.5 $mol \cdot m^{-2} \cdot d^{-1}$, regardless of DLI. However, with a photoperiod of 22 hr and a DLI of 15 $mol \cdot m^{-2} \cdot d^{-1}$, the DPI was ~ 4.2 $mol \cdot m^{-2} \cdot d^{-1}$ (68% higher than with a photoperiod of 7 hr), and with a DLI of 20 $mol \cdot m^{-2} \cdot d^{-1}$ the DPI was ~ 5.5 $mol \cdot m^{-2} \cdot d^{-1}$ (120% higher). Our results show that DPI is significantly higher with lower *PPFD* over a longer photoperiod than with higher *PPFD* over a shorter photoperiod, because the light is used more efficiently at low *PPFD*. Subsequent longer-term growth trials have shown that longer photoperiods with the same DLI do increase crop growth. These short-term physiological trials, combined with results from longer-term growth trials, indicate that applying supplemental light out over longer photoperiods results in more energy-efficient stimulation of crop growth. This research should encourage growers who use photosynthetic lighting to re-evaluate their current lighting protocols and consider using longer photoperiods.

Specified Source(s) of Funding: Georgia Research Alliance, American Floral Endowment, USDA-NIFA-SBIR

8:30 AM Night Interruption with Light Emitting Diodes Applied Using Simulated Moving Greenhouse Booms Promotes Flowering of *Petunia x Hybrida*

Eric Stallknecht* and Marc W. van Iersel, *University of Georgia*

Abstract: Long-day plants (LDP) require night interruption to promote flowering when grown out-of-season (i.e., early spring). Accelerating flower development shortens the cropping cycle and thus reduces crop inputs like water and fertilization. There are multiple ways to promote flowering in LDP. Cyclic night interruption, night interruption applied in many short periods rather than one long continuous period, is less studied than other methods but can effectively provide night interruption. Many greenhouses use moving booms to apply irrigation, fertilization, and pesticides. Small lighting fixtures attached to these booms can successfully provide cyclic night interruption, often termed "boom lighting". We hypothesize that boom lighting from light emitting diodes (LEDs) can promote flowering of *Petunia x hybrida* as well as traditional methods. A growth chamber with programmable lighting fixtures can accurately mimic moving irrigation booms by gradually increasing and decreasing the provided light intensity. The effects of cyclic night interruption on flowering was tested using night interruption lighting provided at 30, 60, 120, and 240 second intervals between simulated boom passes. Cyclic night interruption applied to seven-week-old petunia seedlings slightly reduced days to first open flower, by up to 3 days. Our highest cyclic night interruption frequencies, boom passes every 30 and 60 seconds, increased total number of visible inflorescences, but also increased plants height and resulted in less compact plants. To account for additional light from night interruption we also calculated days to flower and the number of inflorescences divided by the total light over a 24-hour period (daily light integral + treatment light integral). This showed that increasing cyclic night interruption frequency does not proportionally reduce days to flower but does proportionally increase the number of inflorescences. Further exploration into the lowest light intensity and lowest frequency that promote flowering are required to make boom lighting more commercially viable.

Specified Source(s) of Funding: American Floral Endowment and Fluence Bioengineering

8:45 AM Quantifying the Influence of Light Intensity and CO_2 Concentration during Sweet Basil Seedling Production on Subsequent Growth, Development, and Volatile Content

Kellie J. Walters* and Roberto G. Lopez, *Michigan State University*

Abstract: Under indoor sole-source lighting (SSL), light intensity and carbon dioxide (CO_2) can be precisely controlled to influence growth, development, and volatile oil content. However, there is currently limited information on physiological and biochemical responses of culinary herbs to varying light intensities and CO_2 concentrations under SSL. Due to increased plant densities during seedling production, fewer inputs per plant are required, creating the potential to increase production efficiency. Therefore, the objectives of this research were to: 1) quantify if light intensity and CO_2 concentration under SSL influence volatile oil content of sweet basil seedlings and if differences remain present through subsequent greenhouse finishing; and 2) determine if light intensity and CO_2 during seedling production influence morphology and yield at harvest. Sweet basil (*Ocimum basilicum*) 'Nufar' seeds were sown in rockwool cubes and placed in a growth chamber with CO_2 concentrations of 500 or 1,000 $\mu mol \cdot mol^{-1}$. Broad spectrum white light-emitting diodes (LEDs) provided 19:39:39:3 blue:green:red:far-red light ratios (%) and light intensities of 100, 200, 400, or 600 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for 16-h to create daily light integrals (DLIs) of 6, 12, 23, or 35 $mol \cdot m^{-2} \cdot d^{-1}$. After two weeks, seedlings were transplanted into deep flow technique (DFT) hydroponic systems in a greenhouse with an average daily temperature of 23 °C and DLI of 14 $mol \cdot m^{-2} \cdot d^{-1}$. At transplant and three weeks after transplant, height, leaf area, stem diameter, node and branch number, and fresh and dry mass were recorded and tissue samples were frozen -80 °C for volatile analysis. Relative linalool, eugenol, methyl eugenol, methyl chavicol, and 1,8-cineole concentrations were analyzed using SPME and GCMS. Carbon dioxide and the interaction of CO_2 and DLI did not have an effect on growth or development. However, DLI affected height, leaf area, stem diameter, and fresh and dry mass of seedlings at transplant and height, branch and node

number, leaf area, and fresh and dry mass of plants three weeks after transplant. For example, the fresh mass of seedlings increased by 287% as light intensity increased from 100 to 600 $\mu mol \cdot m^{-2} \cdot s^{-1}$ while subsequent greenhouse grown plant fresh mass increased by 80%. Therefore, environmental parameters under SSL production of seedlings can be used to increase quality and yield.

9:00 AM Yield and Growth of Organically Managed Day-Neutral Strawberries in Low Tunnels within a High Tunnel

Tekan Rana*[1]; Sanjun Gu[1]; John Evan Beck[2]; John Kimes[1] and Amy Ballard[1], *(1)North Carolina Agricultural and Technical State University, (2)The Cooperative Extension Program at North Carolina Agricultural and Technical State University*

Abstract: Temperature increment in low tunnels inside high tunnels (HT) could potentially promote plant productivity and extend the growing season, which benefits direct market oriented strawberry growers. This study aimed to find out the effect of low tunnels in the HT system on growth and yield of strawberries. Cultivars Albion and San Andreas were planted on September 1 (D1) & 29 (D2) in raised beds with low tunnel (LT) and without low tunnels (NLT) inside a high tunnel on NC A&T State University farm in Greensboro, NC (hardiness zone 7b). This is a two-year study with the 1st season from Sept 2016 to May 2017 and the 2nd season from Sept 2017 to May 2018. The result presented here is from the 1st season and up to February 28 of the 2nd season. In the 1st season, LT did not significantly increase the total yield, but they slightly increased total marketable yield compared to NLT. LT had no significant effect on marketable and total yield before winter (Oct-Dec), during winter (Jan-Mar) and the peak harvest period (Apr-May). The peak harvest took place in April for both LT and NLT treatments. LT significantly increased total biomass of the whole season (581g/plant, dry weight) compared to NLT (526g/plant). There were no significant differences on leaf, crown, runner, and root biomass between LT and NLT treatments, although LT significantly increased fruit biomass compared to NLT. LT also did not significantly reduce the number of days to 50% bloom, although the first harvest occurred 6 days earlier than that of NLT. In the 2nd season, the total yield with LT and NLT were not significantly different before winter and in January or February, although plants in LT bloomed earlier by 12 days than that in NLT. Our results suggest that including low tunnels in HT may increase yield during winter and shift the peak harvest to early April.

9:15 AM Improved Photochemical Efficiency of Supplemental Lighting Increases Dry Mass and Leaf Size of Greenhouse-Grown Lettuce.

Geoffrey Weaver* and Marc W. van Iersel, *University of Georgia*

Abstract: Photosynthetic responses to light intensity are generally asymptotic; light is used more efficiently to drive photosynthesis at lower light intensity. Thus, providing supplemental light at low intensities over longer periods should lead to increased photosynthetic gains, compared to an equivalent amount of light at higher intensities and shorter periods. To test this hypothesis, we used an adaptive LED lighting system in a greenhouse, which dynamically controls supplemental LED light intensity to reach, but not exceed, a specified light intensity. Using this system, 'Little Gem' lettuce (*Lactuca sativa*) plants were grown under a constant daily light integral (DLI) of 17 $mol \cdot m^{-2} \cdot d^{-1}$ provided over 4 different photoperiods; 12, 15, 18, and 21 hours. The average DLI in the control treatment (no supplemental light) was 7.89 ± 3.02 $mol \cdot m^{-2} \cdot d^{-1}$. Thus, the 4 treatments received slightly more than half of their light from the LED lights. Threshold light intensity was calculated as: Threshold PPFD ($\mu mol \cdot m^{-2} \cdot s^{-1}$) = 1,000,000 x [17 $mol \cdot m^{-2}$ – Current DLI]/Time remaining (s)]. Hence, while each treatment received the same amount of light within each 24-hour period, extending the photoperiod allowed the same amount of supplemental light to be provided at lower instantaneous intensities. The study was terminated after 22 days. Dry weight increased quadratically with photoperiod (R^2 = 0.50, p=0.003), from an average of 0.53 g/plant with 12-hour photoperiods to 0.75 g/plant with 21-hour photoperiods. In the control treatment, average dry weight was 0.17 g/plant. Leaf chlorophyll content and leaf size of the fully expanded leaves increased linearly as photoperiod increased. Leaf size increased from 57.2 cm^2 in the 12-hour treatment to 68.2 cm^2 in the 21-hour treatment (p = 0.023), and chlorophyll content index similarly increased from 9.81 to 12.1 (p = 0.0015). Leaf area and chlorophyll content were higher in all supplemental lighting treatments than in the control (p < 0.0001). These results may be partly attributed to an increased photosynthetic light use efficiency as photoperiod increased and supplemental lighting was provided at lower intensities over longer photoperiods. However, morphological acclimation to photoperiod or light intensity also occurred, as plants developed larger leaves with higher chlorophyll content under longer photoperiods. In conclusion, providing supplemental light in a photochemically-efficient manner improves overall growth of this lettuce variety.

9:30 AM Effects of Different Photoperiods with Constant Daily Light Integral on Growth and Photosynthesis of Mizuna, Lettuce, and Basil.

Shane Palmer*; Eric Stallknecht and Marc W. van Iersel, *University of Georgia*

Abstract: Most studies of photoperiodic effects on plant growth have used constant instantaneous photosynthetic photon flux densities (*PPFD*), which leads to different total daily light integrals (DLI) received in each photoperiod. Our objective was to quantify the effect of different photoperiods, all providing the same DLI, on crop growth. Because photosynthesis is more efficient at lower *PPFD*, we hypothesized that longer photoperiods with lower *PPFD* would result in faster growth than shorter photoperiods with higher *PPFD*. Mizuna (*Brassica rapa* var. *japonica*), 'Little Gem' lettuce (*Lactuca sativa*), and 'Genovese' basil (*Ocimum basilicum*) were grown from seed in a controlled environment chamber (20°C and 800 ppm CO_2) under six photoperiods (10, 12, 14, 16, 18, and 20 hr). White LEDs provided light and *PPFD* was adjusted so each treatment received a DLI of 16 $mol \cdot m^{-2} \cdot d^{-1}$. Mizuna, lettuce, and basil were harvested 30, 41, and 55 d after planting, respectively. Light interception, chlorophyll content, and quantum yield of PSII were positively correlated with duration of photoperiod in all three species. Mizuna plants grown with a 20 hr photoperiod had 10.9% greater light interception, 94.6% higher leaf chlorophyll content index, and 10.1% greater quantum yield near the end of the growing period than those grown with a 10 hr photoperiod. Lettuce plants grown with a 20 hr photoperiod had 11.4% greater light interception, 13.7% higher leaf chlorophyll content index, and 10% greater quantum yield than those grown with a 10 hr photoperiod. Mizuna and lettuce plants both also had greater shoot dry mass (28.1% and 18% greater, respectively) when grown with 20 hr photoperiods compared to 10 hr photoperiods. There was no apparent correlation between photoperiod and dry mass in basil. Basil plants grown with a 20 hr photoperiod had 13.7% higher leaf chlorophyll content index and 10% greater quantum yield than those with a 10 hr photoperiod. Lettuce plants grown under shorter photoperiods had notably yellower leaves, steeper leaf angle, and more upright growth than those in longer photoperiods. These results show that plants receiving the same DLI can have markedly faster growth when provided light over a longer photoperiod, but the effect appears to be species-specific. This is an important consideration when determining optimal lighting strategies for crop growth. Photoperiod, *PPFD*, and DLI cannot be studied isolation without accounting for simultaneous effects of the other two variables on plant responses.

Specified Source(s) of Funding: Georgia Research Alliance, American Floral Endowment, USDA-NIFA-SBIR

8:00 AM – 9:45 AM *Georgetown East*

Vegetable Breeding 1

Moderator: Stephanie J. Walker, *New Mexico State University*

8:00 AM Threshold Vernalization and Dormancy Requirements for Annualization of Long Day Onion Breeding Programs

Irwin L Goldman* and Chris D'Angelo, *University of Wisconsin, Madison*

Abstract: Vernalization, the process in which exposure to cold temperatures over an extended period expedites or induces floral initiation, is an important feature for cultivating and producing seed from biennial root vegetables. Onion (*Allium cepa* L.) is biennial and is widely understood to require vernalization to induce flowering. Additionally, long day onion bulbs undergo a

period of endodormancy which begins prior to harvest and lasts for several weeks, depending upon the genotype. Understanding the appropriate duration of vernalization and techniques for overcoming bulb dormancy are important for onion breeding and seed production. Endodormant bulbs of two long-day cultivars, 'Cortland' and 'Sherman' were treated with hydrogen peroxide solutions at various concentrations over a three-year period and were monitored for root and leaf (sprout) development. We found a two to four-hour exogenous treatment of 20% (weight by volume) hydrogen peroxide to be highly effective at initiating uniform root growth in endodormant bulbs. When compared to a purified water control, the 20% treatment resulted in a 61.3% average reduction in the time to rooting in 2016. We also observed improved uniformity in rooting time between 'Cortland' and 'Sherman' in all three years of this work. A series of time course experiments were conducted over four years with F_1 hybrid and doubled haploid onion bulbs stored at 10°C for varying lengths of time. For all genotypes, a strong negative relationship was observed for sprouting, scape emergence, flowering, and time from sprouting to scape emergence as storage lengths at 10°C increase. Additionally, the bulb-to-bulb variation in the number of days to conversion showed significant decreases between 10 and 14 weeks of cold storage. We found the optimum chilling time at 10°C for the genotypes studied to be 14 weeks. However, on a percentage basis, we observed scape emergence and flowering across all cold storage treatment groups, including 90% of the bulbs in treatments which were not exposed to vernalizing temperatures. We propose a combination of precise vernalization with hydrogen peroxide for breaking bulb dormancy as a novel method for breeders, researchers, and seed producers seeking rapid, uniform flowering and seed production in onion in the span of a single calendar year.

8:15 AM Evaluating Specialty Lima Beans (*Phaseolus lunatus*) As Alternative Crops in Delaware

Gordon C Johnson* and Emmalea Garver Ernest, *University of Delaware*

Abstract: Lima bean (*Phaseolus lunatus*) is the most widely grown vegetable crop in Delaware. Green seeded baby lima bean types predominate (over 95% of the crop). Specialty lima beans of other types currently represent less than 5% of the lima beans grown in Delaware. The University of Delaware initiated a breeding program in 2005, focusing on green baby lima types. In the breeding program, diverse lima bean germplasm is used for crosses and a wide variety of colors, forms, and qualities result in the progeny. Seed of several specialty succulent lima beans already collected or developed as offshoots of the UD green baby lima breeding program have been identified and increased for use in 2018 field trials. This includes three red speckled baby types, two white seeded baby types, 5 multicolored baby types, and one striped Fordhook type. Seed of 12 additional fixed breeding lines from the UD breeding program not previously evaluated and selected germplasm from USDA germplasm collections have been identified for increase to use in small plot trials in 2018 and further increase. In addition, an additional 16 indeterminate specialty pole types have been identified and will be used for seed increase in 2018. A collection of 220 diverse lines maintained by the UD lima bean breading program has been obtained and has evaluated for cooking and eating characteristics for use in further breeding of specialty limas. To evaluate consumer acceptance of available specialty succulent and dry stage lima beans from the UD breeding program, each breeding line was grown to succulent and dry stage in 2017. Succulent seed was shelled from pods, and was then blanched and frozen. Consumer tests were conducted on from December 2017 through March of 2018. Ten succulent and 9 dry stage samples were cooked and then used for consumer evaluations. A Hedonic ranking test was performed on the following attributes: Overall Appearance, Color, Taste, and Texture. Rankings were 5 Like a lot, to 1 Dislike a lot. Tasters were also encouraged to list descriptors including: buttery, nutty, bland, sweet, metallic, or bitter. The specialty lima bean line DE0901201B, which produced a blend of green and white seed when cooked, had the highest overall oganolepic ratings (appearance, color, taste, and texture). Two additional lines DE1002303A (light purple mix when cooked) and DE0900604 Light Red (light purple green mix cooked) had high ratings for taste and texture but lower ratings for overall appearance and color. Dark red and speckled selections that cooked brown to chocolate in color had more mixed ratings for all properties.

8:30 AM Breeding Dwarf Tomato Varieties for Growers in the Northern and Short Season Locations

Ryan Murphy; Vincenzo Averello and Changbin Chen*, *University of Minnesota*

Abstract: Tomato (*Lycopersicon esculentum*) is native to South and Central America and extensively cultivated throughout the world as a rich source of vitamins and antioxidants valuable to human health. Americans consume nearly 80 pounds per capita each year, making tomato the 2nd most popular vegetable crop behind potato. Most cultivars, however, are adapted to tropical and subtropical climates. These varieties take between 60 and 95 days to mature. Currently, only a few cultivars have been introduced for use in the high northern latitudes. These northern cultivars can reach maturity in 45 days, making tomato production feasible for areas with a short growing season. However, these cultivars often have low yield. This limits growers' choice of economically valuable fresh tomato cultivars for production in short-season farms and home gardens. Researchers at the University of Minnesota aim to breed cultivars for the Upper Midwest region. Since 2008, the University of Minnesota tomato breeding program has selected 4 dwarf, short season cultivars with high yield and good flavor, including *Ground Jewel*™, *Ground Dew*™, MTX851, and MTX956. In this presentation, we report the results collected from our initial selection and farm and home garden trials of these newly developed tomato varieties.

Specified Source(s) of Funding: Minnesota Department of Agriculture, Minnesota Agricultural Experimental Station

8:45 AM Earthy Flavor Due to Geosmin Is Endogenously Produced and Responsive to Selection in Table Beet

Irwin L Goldman*, *University of Wisconsin, Madison* and Lynn Maher, *University of Wisconsin-Madison*

Abstract: The flavor profile of table beet is dominated by the earthy-flavored terpene derivative geosmin. Geosmin can be a desired characteristic in beet or a deterrent to the consumption of the vegetable. Geosmin is also produced by Streptomyces spp., various cyanobacteria, and fungi often found in soil and water environments. A long-held presupposition suggests that geosmin production in beets is due to an association with geosmin-producing microbes in the soil. Four beet accessions were grown in an aseptic tissue culture environment. Lack of microbial contamination was demonstrated by sequencing 16S ribosomal RNA to identify potential contaminating microbes. Operational taxa units (OTUs) returned from this analysis were identified as either chloroplast (98%) or mitochondria (2%), demonstrating that beet plants free of microbes were capable of endogenous geosmin production. Bidirectional half-sib recurrent selection for geosmin concentration over four breeding cycles resulted in the development of low (LGC) and high (HGC) geosmin concentration populations. From Year 1 to Year 3, the LGC mean shifted from 17.3 to 4.3 µg geosmin kg–1 tissue and the HGC mean shifted from 22.3 to 33.8 µg geosmin kg–1 tissue. Taken together, these results demonstrate that geosmin is endogenously produced by beets and is responsive to selection, making it another target trait for breeding.

9:00 AM Progress in New Mexico Green Chile (*Capsicum annuum*) Cultivar Development for Mechanical Harvest

Israel Joukhadar[1]; Stephanie J. Walker*[1] and Paul Funk[2], *(1)New Mexico State University, (2)USDA Agricultural Research Service Southwestern Cotton Ginning Research Lab*

Abstract: New Mexico green chile (*Capsicum annuum* L.) is one of New Mexico's most valuable horticultural crops; however, large-scale production in New Mexico is at risk due to the high cost and unavailability of labor for hand harvest. Harvest mechanization is critical for the continued strength of the industry. Specific plant architecture is necessary for optimal green chile mechanical harvest efficiency. Taller plants, fewer basal branches, higher primary branch angle heights, and thicker main stem diameters are all plant traits that have been noted to increase the mechanical harvest efficiency of NM type chile. The second year evaluation of green chile breeding lines developed with traits for mechanical harvest efficiency was completed in 2017 at New Mexico State University's Agricultural Science Center in Los Lunas, New Mexico. Six breeding lines and two commercial cultivars

('NuMex Joe E. Parker' and 'AZ-1904') were evaluated for plant architectural traits and harvest efficiency with a double, open-helix Moses 1010 mechanical chile pepper harvester. The field was direct seeded on 4 Apr. 2017 in a randomized complete block design with seven replications, then managed according to standard production practices. Plant attributes including plant width, plant height, height to primary branch angle, length between primary branch angle and first node, and stem diameter were measured before harvest. Mechanical harvest yield components, including harvested marketable green fruit, damaged fruit, trash (sticks and leaves), ground fall losses, and unharvested fruit remaining on plants were assessed 29 Aug. 2017. Breeding line 54W17 had significantly higher marketable yield and the highest harvest efficiency (81%), and breeding line 61W17 had the least marketable yield and lowest harvest efficiency (60%) when mechanically harvested. Breeding line 54W17 also had the highest primary branch angle height, while 61W17 had the shortest primary branch angle height. 'AZ-1904' had the thickest pericarp (fruit wall), but also significantly more broken, harvested fruit, indicating that there was no benefit to higher pericarp thickness for reduced fruit breakage in this study. 'AZ-1904' had the most ground fall losses and unharvested fruit remaining on plants. We found breeding line 54W17 to be most suitable for mechanical harvest in this trial compared to commercially available cultivars based on overall mechanical harvest efficiency and plant architecture traits.

Specified Source(s) of Funding: New Mexico Chile Association, New Mexico Chile Commission, and the New Mexico State University Agriculture Experiment Station

9:15 AM Development of Molecular Markers Associated to Spinach Growth Parameters

Henry Awika*[1]; Thiago Marconi[1]; Juan Enciso[1]; Jinha Jung[2] and Carlos A. Avila[1], *(1)Texas A&M AgriLife Research, (2)Texas A&M Corpus Christi*

Abstract: Spinach (*Spinacia oleracea* L.) is an economically important leafy green crop widely grown in the US. Spinach production must thrive in a dynamic environment constantly challenged by abiotic and biotic stresses. Such stresses have a profound effect on plant growth and development, ultimately reducing yield. Selecting for resistance and tolerance to these stresses is one of the main focus of breeding programs. Growth rate has direct effect on yield and agronomical practices in the field such as irrigation, fertilization, and harvesting time. With the advancements in next-generation sequencing tools and the completion of the reference spinach genome, as well as the identification of a large panel of SNPs by high-throughput genotyping, it is now possible to identify markers associated to traits of interest to improve breeding efficiency. In order to determine plant growth parameters, a population of 315 spinach accessions from the USDA National Germplasm System and the Texas A&M AgriLife spinach breeding program was monitored from germination to plant senescence using a drone equipped with a RGB camera. Canopy cover, canopy volume, and plant height for each accession was measured once a week. Changes on those parameters between measurements were used to determine crop growth rates. Genotype by sequencing was performed (GBS) using ddRadSeq. Genome-wide association (GWAS) analysis was performed to develop molecular markers associated with plant growth variables using mixed linear model (MLM) from TASSEL and GAPIT. Identification of molecular markers associated with crop growth parameters will facilitate selection and development of cultivars with improved agronomic characteristics. Furthermore, changes in growth rates can be used to screen breeding populations for resistance and tolerance to biotic and abiotic stresses.

Specified Source(s) of Funding: USDA-NIFA-SCRI 2017-51181-26830 and Texas A&M AgriLife Vegetable Seed Grant

9:30 AM Comparison of Tomato Genotypes Grown Under Conventional and Organic Production System for Nutrient Composition and Fruit Quality

Dilip R. Panthee* and Penelope Perkins-Veazie, *North Carolina State University*

Abstract: Recently organic vegetable market is growing rapidly. There is a wide perception that organic product is better than conventional product. However, there are little data to support this claim. Because of this perception, there is a growing interest in the fruits and vegetables produced under organic production system. While some of the reports on subjective comparison of quality of fruits and vegetables produced under conventional and organic systems are already available, we were interested to determine the genotypic differences under conventional and organic production system for nutrient composition in tomato. We evaluated six tomato genotypes with two replications under organic and conventional production system at Mountain Research Station, Waynesville, NC. Nutrient analysis was performed from vegetative (leaf) and reproductive (fruit) parts at three different stages. Fruit quality was also performed. Nutrient data and quality data were analyzed to see if nutrients in vegetative stage can translate into fruit quality. Results indicated that conventional system was significantly ($p<0.05$) better than organic system for almost all nutrient availability except Potassium. Fruits from conventional system were firmer whereas soluble solid content (SSC), lycopene and phenolics was higher from organic production system. There as a significant ($p<0.05$) difference among genotypes for most of the nutrients except nitrogen and sulfur. A significant difference ($p<0.05$) was found among genotypes for firmness, SSC and organic acid content whereas it was a non-significant difference ($p>0.05$) for lycopene, pH and phenolics. A detailed correlation analysis was performed and analytical perspective between nutrient availability in vegetative parts and its impact on fruit quality is presented. This information may be useful to address the questions related to these two production systems with respect to nutrient utilization and fruit quality.

8:00 AM – 10:00 AM *Jay (Lobby Level)*

Administrators Breakfast

8:00 AM – 10:00 AM

Early Plant Collectors: Contributions and Tribulations *CEU Approved*

Jefferson West

Coordinator: Nahla V. Bassil, *USDA-ARS Corvallis*

Moderator: Nahla V. Bassil, *USDA-ARS Corvallis*

Objectives:

Give an overview of early US Plant Explorers who were responsible for introducing the variety of fruits we enjoy now: Their adventures, contributions and challenges

Description: The United States has a rich history of plant collection. As emigrants came to this country, they transported familiar plants with them. During the 1700's, merchants, naval officers, and government officials imported plant material. Wealthy collectors also sponsored expeditions for exotic plant species. In 1728, John Bartram purchased land in Pennsylvania and began collecting North American plants for his private garden and nursery business. It was not until 1858 that federal funds provided by the U.S. Commissioner of Patents were used for the collection of tea by Robert Fortune in China. With the creation of the Office of Foreign Seed and Plant Introduction in 1898, plant explorers were sent to remote areas of the world to search for useful germplasm that would survive harsh climatic and edaphic conditions in the United States. In spite of life-threatening hardships endured during these expeditions, David Fairchild, Niles Hansen, Walter Swingle, and Frank Meyer collected many progenitors of the commercial fruit and nut cultivars grown today in North America.

8:00 AM Introduction to the Workshop

Michele Warmund*, *University of Missouri*

8:10 AM John Bartram: America's First Botanist

R P. Marini*, *Pennsylvania State University*

Abstract: John Bartram (1699 – 1777) was born in Marple, PA. He was a Quaker farmer turned botanist and journeyed throughout eastern North America, from Canada to Florida, and described the plant and animal life he encountered. He corresponded with and sent seeds of native plants to European scientists and gardeners. He was appointed the "Royal Botanist" by King George III, and along with Benjamin Franklin he was a founding member of the American Philosophical Society. Carl Linnaeus said he was the "greatest natural botanist in the world". Bartram purchased a

farm in Philadelphia and started the first botanical garden in America, where he planted many of the specimens he collected on his trips. He collected apple cultivars and had a cider press. Part of the farm (Bartram's Garden) is currently preserved by the city of Philadelphia. His son, William Bartram, continued to explore the southeastern North America and described the Native Americans and the native plants he encountered.

8:25 AM Neils Ebbesen Hansen: A Man with a Vision for the Unfathomable

Marvin P. Pritts*, *Cornell Univ*

Abstract: Neils Hansen was a man of the north. While other plant explorers ventured to tropical islands and rainforests in search of potentially economical plants, Hansen ventured to the high latitudes of Europe and Asia to find hardy species that would perform well in the cold, dry, windy northern tier of states. Hansen was born in Denmark in 1866 and immigrated to New York at the age of seven. In 1883 he enrolled in Iowa Agriculture College in Ames. After graduation he worked at a grape nursery where his interest in fruit took hold. He later returned to Iowa for his M.S. where he worked for Dr. J. L. Budd, an expert on Russian plants and fruit crops. In 1890 he and Budd wrote and published a "Handbook of Fruit Culture and Tree Planting for the Northwestern States." Upon graduation in 1895, Hansen was appointed chair of the new horticulture department at South Dakota State University and, later, appointed head of the experiment station. This position afforded him the opportunity to travel eight times to northern Europe and Asia in search of hardy plants. James Wilson, U.S. Secretary of Agriculture, asked Hansen if he would accept an offer to go on a federally-funded 10-month plant collection expedition to northern Asia during the winter of 1895. He accepted and, "outfitted with a dagger on his right side, a revolver in his belt, field glasses, and magnifying lenses," collected five car loads of seeds and buds. Wilson said, "I have 12,000 men under me, but none who knows how to work like Hansen." He was the originator of many new fruit cultivars, among them hybrid plums, apricots, and red-fleshed apples, and also alfalfa and grasses. At one point his collection of fruit seedlings (250,000) was among the largest in the world, second only to the collection of Luther Burbank. He released 113 varieties of apples and crabapples; 72 varieties of plums, cherries and sand cherries; and 35 varieties of grapes. Few have ever heard of Professor Hansen, but he did more than perhaps any other man to transform the Great Plains from a desert to the bread basket of America.

8:40 AM Walter Tennyson Swingle: A Relentless Intellect That Transformed American Pomology

Ed Stover*, *USDA-ARS*

Abstract: Walter Tennyson Swingle grew up outside of Manhattan, Kansas, and was notorious in his passion for botany. Based on observations, he made up his own names for plants that were demonstrably different. His formal engagement with science was ignited when he discovered that plant names and taxonomic distinctions could be found in books! He attended classes at Kansas Agricultural College at 15, and when he graduated at 20 he had already published 27 scientific papers in plant pathology, plant breeding and genetics. Swingle joined the USDA in 1891, and in July was sent to Florida to investigate diseases in orange trees. He established a USDA laboratory and began a comprehensive program to breed disease- and frost-resistant citrus. He recognized the need for genetic diversity in crops and the risks of growing them in monocultures. He discovered some new species and several new genera: the genus *Swinglea* and several cultivars were named in his honor. In the citrus crosses he made or directed, he originated several new categories of citrus: the tangelos, citranges and citrumelos (now critical as rootstocks), and several other intergeneric hybrids. He conducted plant exploration, mainly in countries surrounding the Mediterranean, and introduced date palms, figs, table grapes, and 'Clementine' mandarins. He also brought in the *Blastophaga* wasp to pollinate Smyrna-type figs. In his duties in the USDA section of Seed and Plant Introduction, he received over 2000 plant introductions, but hundreds of accessions in GRIN list Swingle as the collector. After his retirement from the USDA, Swingle moved to Miami in 1943. It was here he completed his treatise on the taxonomy of the citrus subfamily. "Even in his retirement, Swingle inspired a generation of students with his knowledge, curiosity of nature, and insights into plants. His simple advice to students was 'Look and look, again and again,' words still relevant today".

9:00 AM David Grandison Fairchild: Plant Hunter Extraordinaire and Father of Foreign Seed and Plant Introduction

Nahla V. Bassil*, *USDA-ARS Corvallis*

Abstract: Dr. David Fairchild was born in 1969 in East Lansing, Michigan. He became a plant pathologist, geneticist and world renowned plant explorer. At 20 years of age, he joined the United States Department of Agriculture as a pathologist. In 1897, Fairchild and his friend Walter Swingle convinced Secretary James Wilson to start a new program he named "the Section of Foreign Seed and Plant introduction". Fairchild was immediately hired to run it. He traveled the world with wealthy sponsors Lathrop Barbour and later on with Alison Armour who funded some of his plant explorations. He was passionate about introducing Americans to the foods of the world he visited through introductions and subsequent selection. By the time he retired from the USDA, 111,857 varieties of plants and seeds were introduced into the US by Fairchild and his plant hunters. Among them were apricots, apples, muskmelons from Chinese Turkestan; citron from Corsica; nectarines from Pakistan; cherries from Siberia; dates from Egypt and Algeria; pear cultivars from Germany; and many clones of mango and avocado now important to Florida's industry. In 1912, he also helped coordinate the arrival of the Japanese flowering cherry trees that blossom each spring around Washington's Tidal Basin. He published over 400 articles and four books. The Fairchild Tropical Botanic Garden was established with his help on an 83-acre site south of Miami purchased by Colonel Robert Montgomery and named in his honor of his friend. The garden opened its doors to the public in 1938 and continues his work collecting, documenting, preserving and studying tropical and subtropical plants from around the world.

9:15 AM Frank Nicholas Meyer: An Emigrant's Lifelong Search for Plant Immigrants

Michele Warmund*, *University of Missouri*

Abstract: Rarely sedentary, Frank N. Meyer labored and studied plants diligently in Europe to earn passage to the United States. After holding several jobs briefly in the U.S. to fund his botanical exploration, Meyer was hired by the Foreign Plant Introduction Section of USDA. During his four expeditions to Asia (1905 to 1918), he collected many pomological species that could withstand abiotic stress for testing in the U.S. and exchanged germplasm with botanical gardens worldwide. Traveling thousands of miles by foot, Meyer endured harsh weather, scarce food, vermin-infested lodgings, sickness, bandits, poor funding, and multiple bureaucracies, but was only content when collecting economically useful plants. While collecting more than 2,500 plant introductions, he drowned under mysterious circumstances on the Yangtze River. Many of the genetically-useful traits in commercial fruit and nut cultivars today originated from germplasm introduced to the U.S. by this dauntless plant collector.

8:00 AM – 10:00 AM *Monroe*

Ornamentals/Landscape and Turf

Moderator: Mary Meyer, *University of Minnesota*

8:00 AM Few Residual Effects of Planting Stock Size Remain Five Years after Transplanting to the Landscape

Michael A. Arnold*[1]; Lauren M. Garcia Chance[2]; W. Todd Watson[1]; Leonardo Lombardini[1]; Charles R. Hall[1]; Sean T. Carver[1] and Andrew R. King[1], *(1)Texas A&M University, (2)Clemson University*

Abstract: Three species of trees, *Vitex agnus-castus* L. (an unnamed white flowering clone), *Acer rubrum* L. var. *drummondii* (Hook. & Arn. *ex* Nutt.) Sarg. 'Maroon', and *Taxodium distichum* (L.) Rich. (test clone TX8DD38) were propagated clonally in a sequential manner over two growing seasons and transplanted to consecutively larger containers to obtain five different containers sizes of each species conforming to ANSI A300 specifications. Trees from the five container sizes, 3.5, 11.7, 23.3, 97.8, or 175.0 L (#1, #3, #7, #25, or #45, respectively), were transplanted to a

sandy clay loam soil in adjacent plots for each of the three species. Each species and container size combination were placed on independent irrigation systems and soil moisture tensions were monitored to time irrigation to avoid systematically over or under-irrigating the different species and size trees. Height, trunk diameter, and canopy spread were measured at transplant and then at the end of each growing season in the field for the next five years. After just two growing seasons in the field trees from the four larger containers of *V. agnus-castus* did not differ statistically ($P < 0.05$) in height, with only the trees from the 3.5 L containers lagging behind. By the third year no differences in height were found among trees from all five container sizes of *V. agnus-castus*. *Acer rubrum* trees did not differ in height among the various container sizes by the end of the fourth growing season. For slower growing *T. distichum* trees no differences existed among the heights of the three largest container sizes by the end of the fifth growing season and the *T. distichum* trees from the two smaller size containers lagged only slightly behind. For trunk diameter, no differences were present among trees from the various container sizes by the end of the fifth growing season for *V. agnus-castus* and *A. rubrum*, and only the trees from 3.5 L containers had statistically smaller trunk diameters than those from larger containers for *T. distichum*. No differences in canopy spread were present in *V. agnus-castus* by the end of the second growing season, *A. rubrum* by the end of the fourth growing season, and *T. distichum* by the end of the fifth growing season. If one is willing to forego the immediate aesthetic impacts, ecosystem services, and greater ability to withstand mechanical damage of larger-size container stock, similar longer-term sizes in the landscape can be achieved by transplanting less expensive, more easily handed, smaller container-size trees.

Specified Source(s) of Funding: Support for this project was provided by the Tree Research and Education Endowment (TREE) Fund and Hatch funding from the National Institute of Food and Agriculture (NIFA).

8:15 AM Salting the Earth: An Emerging Issue in Green Infrastructure Systems?

Sasha W. Eisenman*; Joshua S. Caplan and Michael Cappon, *Temple University*

Abstract: Salinity stress in plants is typically regarded as an issue of dryland and maritime regions. However, salinity stress is also a concern along roadways in inland mesic regions, where winter precipitation and freezing temperatures warrant the use deicing salt. In this context, stormwater runoff has historically been channeled into local streams and rivers, but there are rapidly expanding efforts to divert roadway runoff into green infrastructure elements such as raingardens and bioswales. Salinity could therefore become an increasing challenge as more vegetated stormwater infrastructure systems are installed along roadways. As part of an investigation on plant health in bioswales that capture runoff from a section of Interstate 95 in Philadelphia, we measured soil electrical conductivity (EC) to assess sodium chloride levels across a topographical gradient. In June and August 2017, $EC_{1:5}$ was measured in soils beneath 72 focal plants; it ranged from 0.34-0.78 and 0.13-0.80 dS/m, respectively, the highest values of which are indicative of "high" soil salinity. Monthly measurements were made in the spring of 2018 at 18 sampling locations spanning topographically low and high areas. Soils reached "severe" salinity levels in January (EC range = 0.08-2.11 dS/m) and February (0.12-2.85 dS/m), and "extreme" levels in March (0.09-4.2 dS/m). Areas of elevated $EC_{1:5}$ correlated spatially with the flow paths of storm water, low lying areas, and depressions where pooling occurs. These results provide support to a hypothesis that salinity stress is contributing to topographic differences in plant growth. Further data collection efforts will determine if high salinity persists in the soil into the growing season, and if water stress and/or toxicity responses are directly evident in plants.

Specified Source(s) of Funding: Pennsylvania Department of Transportation and AECOM

8:30 AM Prairie Dropseed Germination

Mary Hockenberry Meyer*, *University of Minnesota*

Abstract: *Sporobolus heterolepis*, prairie dropseed, is a warm season grass native to upland, drier sites in central and northeastern U.S. An attractive bunchgrass with numerous fragrant flowers and yellow fall color, prairie dropseed should be used more in urban plantings where native grasses provide ecosystem services such as reduced runoff, minimal soil erosion and food sources for native Lepidoptera larvae. A survey of grass growers confirmed that this species often has low seed germination rates and can be a slow, difficult plant to increase with crown division. Seed quality and germination techniques were investigated using commercially available seed as well as garden and wild collected seed from locations in Minnesota and Wisconsin. Although historic germination research has not shown cold moist seed treatments to improve germination, some growers do use this as standard treatment for prairie dropseed. Cold moist treatments in soil or petri plates were compared to cold dry seed treatments. Seed purity, germination and tetrazolium staining varied depending on seed source, age and treatment. Cleaning, grading and pre-germination examination of seed, using fresh seed, and maintaining consistently moist conditions appear to be requirements for the highest germination of prairie dropseed.

8:45 AM Leveraging Technology to Coordinate Collaborative Landscape Management at the University of Arizona Campus Arboretum

Tanya Quist*, *University of Arizona*

Abstract: The University of Arizona Campus Arboretum is the oldest, continually maintained public green space in Arizona. As the Land Grant School in Arizona since 1891, the University of Arizona addresses practical state and global needs through research and education. For more than 120 years, university faculty have used the campus grounds as a proving grounds for the testing and introduction of arid adapted trees which have been introduced for use as agricultural commodities or urban ornamentals. As a result, the campus displays both tremendous botanical diversity and holds important historic and cultural significance. In 2002, the University of Arizona main campus was designated an Arboretum. The Campus Arboretum serves as a living laboratory promoting stewardship and conservation of urban trees through research, education and outreach.

Integration of the arboretum into main campus necessitates cross-cutting collaborations and communication in sharing grounds management that effectively protects landscape resources and collections standards while also improving operational efficiency. To this end, The Campus Arboretum partnered with Facilities Management to develop and implement a customized digital asset management system that tracks and shares landscape maintenance records between their respective organizations. In so doing, we created a system that formally integrates the university units who share grounds oversight. Further, we were able to leverage and combine previous investments to create a customized database and mobile application that facilitates communication, recording keeping and record sharing.

For Grounds Services, this database system will provide decision support, optimize use of personnel and resources, and ultimately improve maintenance efficiency. For the Campus Arboretum, the system will improve accuracy of our records, inform collections development, management policies, and training needs for grounds workers and allow direct creation of service requests to the grounds staff. Both units will benefit as resultant plant health improvements enhance the value of the collection and a landscape that models institutional expertise in science-based landscape practices.

Specified Source(s) of Funding: Institute of Museum and Library Services

9:00 AM Evaluation of Cercospora Leaf Spot Severity on Garden Roses in Texas

Stella Kang*[1]; Ellen L. Young[1]; Jeekin Lau[1]; Brent Pemberton[2]; Cody Bishop[2]; Patricia Klein[1] and David H. Byrne[1], *(1)Texas A&M University, (2)Texas A&M AgriLife Research and Extension Center, Texas A&M University*

Abstract: Cercospora leaf spot of roses is a fungal disease caused by the pathogen *Rosisphaerella rosicola* (teleomorph: *Mycosphaerella rosicola*, syn: *Passalora rosicola*, *Cercospora rosicola* Pass.). It mainly causes lesions on the leaves, and in severe cases, chlorosis and defoliation. This disease seems to be especially prevalent in the southern region of the USA. Disease severities and landscape traits were evaluated monthly in replicated field trials in both College Station and Overton, Texas during 2016-

2017. The rose trials were a mix of species, modern hybrid and modern shrubs. They were rated on a 0-9 scale which is percentage based with respect to the number of cercospora lesions on the rose canopy. Overton had higher cercospora ratings during both years (2.66 and 3.45) than College Station (0.44 and 1.28). This is due to the higher inoculum and precipitation in Overton. The temperature and humidity were similar in both locations. There was a wide range for cercospora incidence on roses for both years, in which ~20% of the accessions had less than a rating of 5 in Overton and in College Station, only one rose accession had a rating over 5. Only seventeen and seven rose accessions showed no cercospora lesion in College Station in 2016 and 2017 respectively, while in Overton, five rose accession had no cercospora lesions in 2016 and three showed no lesions in 2017. The incidence of cercospora leaf spot was negatively correlated with black spot and weakly negatively correlated with defoliation in both locations. This may be explained by the effects of black spot and other environmental factors on defoliation.

Specified Source(s) of Funding: USDA's National Institute of Food and Agriculture (NIFA) Specialty Crop Research Initiative project, "Combating Rose Rosette Disease: Short Term and Long Term Approaches" (2014-51181-22644/SCRI)

9:15 AM Mid-Winter Hardiness and Seasonal Deacclimation Response of Some Evergreen Azaleas

Bing Liu*[1]; Hong Zhou[1]; Sha Cao[1]; Rajeev Arora[2] and Yiping Xia[1], *(1)Zhejiang University, (2)Iowa State University*

Abstract: Occurrences of extreme temperature fluctuations during late winter/early spring can subject overwintering perennials to unseasonal de-acclimation. Consequently, these dehardened plants become vulnerable to returning freezing temperatures. Freeze-damage from such scenario to economically important horticultural species has been noted in recent years with increasing frequency. But little is known about the physiology of deacclimation response (timing and speed). To that end, mid-winter hardiness and seasonal de-acclimation were investigated during January to March 2014 in the leaves of 10 evergreen azalea cultivars (*Rhododendron* section *Tsutsusi*) ('Changchunerhao', 'Dazhusha', 'Elsie Lee', 'Hongshanhu', 'Nuccio's Pink Bobble', 'Shiyandujuan', 'Yudaizhirong', 'Zhuangyuanhong', 'Zihudie' and 'Zi'e') grown under natural conditions in eastern China. Leaf samples were collected bi-weekly and leaf freezing tolerance (LFT) was evaluated using a temperature-controlled freeze-thaw protocol followed by ion-leakage-based injury assessment. Based on the mid-winter / cold-acclimated LFT, these cultivars were grouped as *'more-hardy'* ('Changchunerhao', 'Elsie Lee', 'Nuccio's Pink Bobble', 'Shiyandujuan' and 'Yudaizhirong') *versus 'less-hardy'*. 'Elsie Lee' was the hardiest and 'Dazhusha' was the least-hardy in midwinter. Eight of the 10 cultivars first showed de-acclimation when daily mean temperature over two-week period preceding the LFT measurement was ~9.5 °C. De-acclimation for other two cultivars ('Nuccio's Pink Bobble' and 'Shiyandujuan') was somewhat delayed and might have involved 'de-acclimation-reacclimation' cycling before eventual de-acclimation. Our data indicate that the *'more-hardy'* group de-acclimated slower than the *'less-hardy'* ones over the first half of the de-acclimation period. This trend reversed during second half of the de-acclimation period. Accordingly, *'more-hardy'* and *'less-hardy'* cultivars depicted a 'curvilinear' and 'reverse curvilinear/linear' de-acclimation kinetics, respectively. Though somewhat preliminary, these results may indicate suitability/ vulnerability of these cultivars to various scenarios of changing climate; for example: *'more-hardy'* group may survive hard frosts after unseasonal warm spells during midwinter, whereas *'less-hardy'* group could survive sudden frost in the early spring. *'More-hardy'* cultivars generally had higher total soluble sugars (TSS) than *'less hardy'* ones at acclimated state. TSS declined during de-acclimation in all cultivars and the loss was positively correlated with the loss in LFT. Leaf starch content generally followed opposite trend to that of TSS, i.e. it was at lowest during acclimated state and increased during de-acclimation.

Specified Source(s) of Funding: Zhejiang Province, China (Project- 'The evaluation of germplasm resources and variety breeding of azaleas'- 2016C02056-12)

9:30 AM An Investigation on the Impact of Compost Tea Applications on Turf Quality and Soil Microbial Activity

Joel Loveland[1]; Kevin Walsh[1]; John E. Montoya Jr.[2] and Tina Cade Waliczek*[3], *(1)Texas State University, (2)Texas A&M University, (3)N/A*

Abstract: The purpose of this study was to investigate the effect of compost tea applications on overall turf quality and soil microbial activity. Two 60 ft^2 bermudagrass (*Cynodon dactylon*) study sites were included in the study. Each site was divided into a 30 ft^2 control and a 30 ft^2 treatment area. One study site received artificial irrigation while the other did not. Compost tea was created using an industrial-sized compost tea brewer (Erath Earth, Dublin, TX). The compost tea recipe included water, air, finished compost, ammonium nitrate and molasses and was applied to study sites within two hours of brewing. The study utilized the soil drench method of application where each treatment area received twelve gallons of compost tea applied by hand. Both study areas were maintained normally by landscape maintenance crews which included regular mowing but no fertilizer applications. Fifteen soil samples and turf quality observations were first drawn for pretest data and then taken after each of three additional seasonal test periods over the course of one year for each of the four locations (irrigated and non-irrigated control and treatment sites). A point intercept method was used to sample plots randomly. Evaluations of turfgrass were based on The National Turfgrass Evaluation Program's guidelines for turfgrass evaluation and included measuring color, turf density, overall density, percent living and texture. Soil samples were drawn and analyzed for microbial activity using tetrazolium tests. Results presented provide evidence on the value of compost tea to overall turf quality and beneficial soil microbial populations.

9:45 AM 2,4-D Antagonism from Tank-Mixtures with Iron Fertilizers

Aaron Patton* and Geoff Schortgen, *Purdue University*

Abstract: Iron (Fe) is commonly used in the turfgrass industry to correct nutrient deficiencies in high pH soils, for disease suppression, moss suppression, or improved turf aesthetics. Particularly in the lawn care industry, Fe may be tank-mixed with 2,4-D containing herbicides to control weeds in the lawn while simultaneously providing Fe nutrition. Since $FeSO_4$ is known to antagonize certain herbicides and since other cations are known to antagonize water soluble 2,4-D formulations, our objective was to evaluate the influence of various sources of iron on 2,4-D dimethylamine efficacy when tank-mixed. Greenhouse and field experiments evaluated three iron sources: $FeSO_4$ heptahydrate, Fe diethylenetriaminepentaacetic acid (DTPA), and Fe *hydroxyethylenediaminetriacetic* acid (HEDTA). $FeSO_4$ and FeDTPA are commonly marketed for nutrition, whereas FeHEDTA is marketed for broadleaf weed control. Iron application rates were chosen based on label recommendations or common use rates. The iron sources were applied to dandelions with or without 2,4-D dimethylamine at 1.6 kg ae ha^{-1} in the greenhouse experiment. The field experiment applied six treatments (nontreated, 2,4-D + $FeSO_4$, 2,4-D + FeDTPA, 2,4-D + FeHEDTA, and FeHEDTA) to dandelions in October of 2016 and 2017. Without the inclusion of 2,4-D, FeHEDTA reduced dandelion mass compared to other iron sources and the nontreated plants in the greenhouse experiment. This was from a rapid injury to dandelion foliage from FeHEDTA after application followed by a partial recovery of the dandelion. Both 2,4-D applied alone and 2,4-D tank-mixed with FeHEDTA, controlled dandelions in the greenhouse experiment. However, both $FeSO_4$ and FeDTPA reduced weed control when tank-mixed with 2,4-D. In the field, 2,4-D alone provided the highest control of mature dandelions and superior control to a single application of FeHEDTA alone. All three iron sources ($FeSO_4$, FeDTPA, FeHEDTA) antagonized 2,4-D when applied as tank-mixtures to field plots. Overall, results suggest that each of the iron fertilizers can antagonize 2,4-D dimethylamine and that applicators should avoid tank-mixing iron fertilizers when applying postemergence broadleaf herbicides.

8:00 AM – 10:00 AM *International Ballroom West*

Tactics for success in the Specialty Crop Research Initiative

Coordinator: Thomas Bewick, *USDA-NIFA*

Objectives:

A growing proportion of research funding for horticulture is coming from the Specialty Crop Research Initiative (SCRI) and similar

funding programs. The competition for this funding is intense. Nevertheless, successful proposals come from many types of institutions and investigate diverse aspects of horticulture. This session will be helpful to anyone contemplating applying (or reapplying) for SCRI funding, and understanding some of the distinctive characteristics that set this program apart from traditional grants programs.

8:00 AM How SCRI Is Distinctive, the Current Approach to Stakeholder Relevance Review, and the Growing Future Opportunity

Thomas A. Bewick*, *USDA-NIFA*

8:15 AM How to Read the Request for Applications Accurately

Megan O'Reilly*, *Institute of Food Production and Sustainability*

8:30 AM Panel Manager Perspectives

Thomas A. Bewick*, *USDA-NIFA*; James R. McFerson, *Washington State University, TFREC*; Dewayne L. Ingram, *University of Kentucky* and Sarah A. White, *Clemson University*

Abstract: Panel managers understand the nuances and dynamics of panel function, and what builds consensus in favor of supporting a particular application

8:45 AM Successful Applicants

Thomas A. Bewick*[1]; Ryan Warner; Jim Walgenbach[3]; Jim Walgenbach[3] and Bhimanagouda S. Patil[4], *(1)USDA-NIFA, (2)N/a, (3)Texas A&M University*

Abstract: There are diverse models for a successful project. Building support, doing good science, and delivering outcomes that make a difference to stakeholders are all common features. Successful applicants have found distinctive ways to develop those features.

8:00 AM – 10:00 AM *Jefferson East*

Vegetable Crops Management 2

Moderator: David Suchoff, *North Carolina State University*

8:00 AM Grafted Tomato Shoot and Root Responses to Drying Soils

David Suchoff*[1]; Frank J. Louws[1]; Jonathan R. Schultheis[1]; Matthew D. Kleinhenz[2] and Chris Gunter[1], *(1)North Carolina State University, (2)The Ohio State University-OARDC*

Abstract: Improvement of crop water use is imperative. How plants respond to limited water can dictate their ability to better utilize available resources and avoid prolonged and severe stress. The following study was conducted to determine how tomato (*Solanum lycopersicum*) rootstocks with different root system morphologies respond to drying soils. Plants were grown in pots containing an inorganic substrate composed of calcined clay and sand in a greenhouse on North Carolina State University's campus. The heirloom tomato cultivar Cherokee Purple was used as the scion for 'Beaufort' and 'Shield' rootstocks as well as the self-grafted control. These rootstock treatments were assigned either normal or reduced irrigation treatments. Plants receiving normal irrigation were weighed and watered daily to maintain container capacity for one week. Those receiving reduced irrigation had all water withheld for one week, at which point strong midday wilting became evident. Shoot physiological and morphological data as well as root morphological data were collected at the end of the study. A constitutive positive effect on relative water content, leaf area, stomatal conductance, and net CO_2 assimilation rate was observed with 'Beaufort'. This rootstock had a significantly longer total root system (118.6 m) compared to 'Shield' (94.9 m) and the self-grafted control (104.2 m). Furthermore, 76.40% of the total root length observed in 'Beaufort' was composed of very thin diameter roots (< 0.5 mm), which was higher than 'Shield' (73.67%) and the self-grafted control (69.07%). The only significant rootstock irrigation interaction observed was for effective quantum yield of photosystem II (ϕ_{PSII}). At normal irrigation there were no differences among the rootstock treatments; however, at reduced irrigation 'Beaufort' had significantly higher ϕ_{PSII} than both 'Shield' and the self-grafted control. This study represents one of the first to compare both root and shoot morphological and physiological responses to soil drying in grafted tomatoes. These results may explain some of the improved production and water use efficiency observed in field trials utilizing 'Beaufort' rootstock and allow for better screening of rootstocks for improved water use efficiency in the future.

Specified Source(s) of Funding: NIFA USDA award # 2016-51181-25404

8:15 AM Improving Tomato Cold Tolerance through Grafting

David Suchoff*[1]; Penelope Perkins-Veazie[1]; Heike W Sederoff[1]; Jonathan R. Schultheis[1]; Matthew D. Kleinhenz[2]; Frank J. Louws[1] and Chris Gunter[1], *(1)North Carolina State University, (2)The Ohio State University-OARDC*

Abstract: Tomatoes (*Solanum lycopersicum*) are a warm-season, cold-sensitive crop that show depression in growth and development with temperatures below 18 °C. Improving suboptimal temperature tolerance would allow for earlier planting of field-grown tomatoes as well as a reduction in energy inputs for heating greenhouses. Grafting tomatoes onto high-altitude wild *Solanum habrochaites* accessions has proven effective at improving scion suboptimal temperature tolerance. The following study was conducted to determine whether commercially available tomato rootstocks with differing parental backgrounds and root system morphologies can improve scion suboptimal temperature tolerance. Two controlled environment growth chambers were utilized and maintained at either optimal (25 °C day / 20 °C night) or suboptimal (15 °C day / 15 °C night) temperatures. The cold-sensitive tomato cultivar Moneymaker was used as the non-grafted and self-grafted control as well as scion on 'Multifort', 'Shield', and *S. habrochaites* LA 1777 rootstocks. We found that 'Multifort' rootstock significantly reduced the amount of cold-induced leaf area reduction and maintained higher levels of CO_2 assimilation and photosystem II quantum efficiency. 'Multifort' maintained significantly longer roots, having 42% to 56% more fine root (diameter less than 0.5 mm) length compared to the other rootstock treatments. Leaf starch concentration was significantly lower in 'Multifort'-grafted plants at suboptimal temperatures. The ability for 'Multifort' to maintain root growth at suboptimal temperatures may improve root system sink strength, thus allowing for proper movement of photosynthate from leaf to root even under cold conditions. This study represents one of the first attempts to characterize whole root system morphology responses in tomato rootstocks at suboptimal temperatures. Furthermore, we show that commercially available rootstocks can be selected to improve suboptimal temperature tolerance in cold-sensitive scions at early stages of plant development.

Specified Source(s) of Funding: NIFA USDA award # 2016-51181-25404

8:30 AM In the Absence of Soil-Borne Disease Pressure, Does Tomato Grafting Still Benefit Midwest Vegetable Growers?

Kristine M. Lang* and Ajay Nair, *Iowa State University*

Abstract: In the absence of soil-borne disease, tomatoes grafted to hybrid rootstock RST-04-106-T showed minimal yield increase. This result indicates the need for more trials of tomato rootstocks that meet the need of localized soil conditions in the Midwest, and our additional research was designed to address this gap in localized roostock performance data. We hypothesized that alternative rootstocks would outperform non-grafted plants even without the effect of soil-borne disease. Our research objectives were to assess marketable yield, fruit quality (soluble solids, titratable acids, and firmness), and plant growth characteristics (SPAD, plant height, stem diameter, petiole-sap, and biomass) of eight different hybrid tomato rootstocks compared to a self-grafted and non-grafted control. Hybrid tomato BHN 589 was grafted to all rootstocks in addition to non-grafted and self-grafted controls. The roostock treatments included commercially available Arnold, Beaufort, DRO141TX, Estamino, Maxifort, RST-04-106-T, and two trial rootstocks not yet commercially available, 946 TRS and 980 TRS. This research took place during 2017 in a 9.1 × single-poly high tunnel in central Iowa. There were five plants per plot in a randomized complete block design with five replications. The crop was harvested thirteen times between 5 July and 27 September. Non-grafted and self-grafted plants had the lowest marketable yield per plant with means of 5.5 and 5.6 kg respectively. Plants grafted to Maxifort, DRO141TX, and

Estamino had the highest marketable yield ranging from 8.1 to 8.6 kg per plant. Fruit total soluble solute concentration ranged from 4.6 ºBrix (Maxifort rootstock) to 5.4 ºBrix (RST-04-106-T rootstock). Estamino and Arnold had the largest mean root biomasses of 21.0 and 19.1 g, respectively. Shoot biomass was largest for tomatoes grafted on Maxifort (323.1 g) and Estamino (320.7 g) rootstocks. Our results indicate that grafting tomatoes may still be a viable option for Iowa vegetable growers even in the absence of soil-borne disease. This work identifies several rootstocks that are well-suited for high tunnel production systems in the Midwest.

8:45 AM High Tunnel and Field Production System Comparison of Grafted Tomato in Texas

Daniel I Leskovar*, *Texas A&M AgriLife Research & Extension Center, Texas A&M University*; Desire Djidonou, *Texas A&M AgriLife Reserach, Texas A&M University*; John Jifon, *Texas A&M AgriLife Research Center*; Carlos A. Avila, *Texas A&M AgriLife Research*; Joseph G. Masabni, *Texas A&M AgriLife Research & Extension Center* and Kevin Crosby, *Texas A&M University*

Abstract: Successful integration of vegetable grafting into current tomato production practices could open new opportunities for the Texas tomato industry to exploit vigorous rootstocks for effectively managing soil diseases, abiotic stresses, and improve fruit quality and yield. A multi-location (Uvalde, Overton, and Weslaco) trial was conducted to evaluate the yield performance of grafted tomatoes in protected environment and open-field conditions during the growing season of spring of 2017. In each location, two determinate tomato cultivars, TAMU Hot and Tycoon, were grafted onto two interspecific hybrid rootstocks, 'Estamino' and 'Multifort'. Non-grafted 'TAMU Hot' and 'Tycoon' were used as controls. Field experiments were arranged in a randomized complete block design with four to five replications, depending on location. Yield performance of the graft combinations varied with location and production system. In the Uvalde location, the high tunnel system enhanced marketable yields by 116% to 161% relative to open-field system, with an additional of 8% to 23% significant increase due to grafting with interspecific rootstocks. Yield increase in grafted plants was mainly due to significant increases in average fruit weight. In the Overton location where only open-field trial was conducted, grafting 'Tycoon' on 'Estamino' and 'Multifort' significantly increased the marketable yield by 59% and 44%, respectively, as compared to the non-grafted control. Similar yield increases due to the grafting were also achieved under open-field conditions in the Weslaco location, although yield levels were generally lower than those of other locations. Results from this study demonstrate that grafting along with protected environment system clearly have the potential to significantly increase tomato production across Texas regions.

Specified Source(s) of Funding: Texas A&M AgriLife Vegetable Seed Grant

9:00 AM Anaerobic Soil Disinfestation and Herbicide Effects on Nutrient Cycling, Plant Growth, and Yield of Fresh-Market Tomato

Francesco Di Gioia*[1]; Zhuona Li[1]; Monica P. Ozores-Hampton[1]; Patrick Christopher Wilson[1]; John Thomas[1]; Xin Zhao[1]; Haichao Guo[1]; Jason Hong[2] and Erin N. Rosskopf[2], *(1)University of Florida, (2)USDA-ARS*

Abstract: Anaerobic soil disinfestation (ASD) is a non-fumigant pre-plant soil disinfestation technique proposed for the management of soilborne pests and diseases. In Florida, ASD is applied by amending the soil with sugarcane-molasses (C-source) and composted poultry-litter (CPL), irrigation to soil saturation, followed by mulching with totally impermeable film (TIF). While ASD may provide higher yields compared to the standard chemical soil fumigation (CSF), its large-scale application is currently limited by the cost of the C-source. Moreover, there are concerns regarding the fate of the nutrients applied with the amendments combined with soil saturation, especially in terms of nitrous oxide emissions and nutrient leaching. Therefore, a study was performed in Immokalee, FL on fresh-market tomato during the 2015 fall-season to investigate nutrient dynamics. Standard CSF with Pic-Clor 60 was compared with ASD application using two rates of organic amendments: ASD1 (13.86 m^3 ha^{-1} molasses and 22 Mg ha^{-1} CPL) and ASD0.5 (6.93 m^3 ha^{-1} molasses and 11 Mg ha^{-1} CPL), in combination or not with the pre-emergence herbicide halosulfuron-methyl. Treatments were arranged in a split-plot design with four replications. The objective of the study was to determine the impact of the treatments on soil redox-potential, plant growth, fruit production, and nutrient fate. During the three-week treatment, both ASD treatments achieved similar anaerobic conditions, regardless of herbicide application. Nitrous oxide emissions were minimized by the TIF during the three-week treatment, and only immediately after punching were higher with CSF than with ASD. At the same time, both ASD1 and ASD0.5 increased the availability of K in the soil solution compared to CSF. Conversely, 7 days after treatment (DAT), NO_3^- concentrations in the soil solution were 86% lower in ASD compared to CSF. At transplanting (21 DAT), ASD increased P and K soil content compared to CSF, and increases were proportional to amendment rate, regardless of herbicide application. At 58 days after planting, above-ground total plant dry-weight was 82% and 41% higher with ASD1 and ASD0.5 than CSF, respectively; while herbicide application had no effect. Consequently, plant nutrient accumulation was positively affected by ASD and by increasing amendments rate, but it was not influenced by herbicide application. In conclusion, ASD showed lower risk of N loss compared to CSF, while it increased the availability of P and K for the crop. Therefore, the crop fertilization program should be adjusted considering the input of nutrients associated with the application of molasses and CPL.

Specified Source(s) of Funding: USDA, ARS, Areawide Project on Anaerobic Soil Disinfestation.

9:15 AM Interaction between Bell Pepper Rootstocks and *Phytophthora Capsici* Under Salinity Stress

Francesco Di Gioia*[1]; Cristina Pisani[2]; Jason C. Hong[2]; Joseph Albano[2] and Erin N. Rosskopf[2], *(1)University of Florida, (2)USDA-ARS*

Abstract: Bell pepper is the second leading vegetable crop in Florida. The profitability of bell pepper has been endangered by the increasing incidence of *Phytophthora capsici*, an important soilborne plant-pathogen known for its destructive potential, especially in subtropical areas. While periods of high rainfall and raised water levels are considered major causes of *P. capsici* outbreaks, the incidence of the disease seems to be favored by salinity stress, a condition increasingly affecting the coastal areas of South Florida, where a significant amount of bell pepper production occurs. Under such conditions, vegetable grafting may represent a potential solution to manage both biotic and abiotic stress. Therefore, a greenhouse pot-study was conducted to evaluate the plant growth, nutrient accumulation, yield, and stress response of different bell-pepper grafting combinations to *P. capsici* in presence of 0, 30, and 60 mM of NaCl. Non-grafted and self-grafted plants of 'Blitz' (susceptible to *P. capsici*) were compared with plants grafted onto 'Dorado' and 'Robusto', both commercial rootstocks claimed to be resistant to *P. capsici*. Plants were grown in pots on a sandy-soil:perlite mix (50:50, v:v) and fertigated daily through drip-irrigation. Salinity treatments started 14 days after planting (DAP) and plants were inoculated with *P. capsici* at 28 DAP. At 64 DAP, all three factors affected plant growth and a significant interaction was observed among all three factors for leaf area and leaf dry weight. Significant three- and two-factor interactions were also observed for most measured plant nutrient accumulation parameters. Total-plant sodium accumulation increased with increasing salinity level, while a significant interaction was observed between *P. capsici* and rootstock. At harvest, total fruit number and fruit fresh weight per plant were affected by salinity level and grafting combination, and a significant interaction was observed between grafting combination and *P. capsici*. A significant interaction between the three factors was also observed for disease incidence. In infested soil, non-grafted and self-grafted plants of 'Blitz' showed consistently higher incidence of Phytophthora blight compared to those grafted onto 'Dorado' and 'Robusto'. Moreover, plants grown under moderate salinity (30 mM of NaCl) had a higher disease incidence compared to those grown with 0 and 60 mM of NaCl. It is concluded that irrigation with moderately saline water may increase the incidence of Phytophthora blight in susceptible cultivars of bell pepper. However, commercial rootstocks resistant to *P. capsici* may assure the control of the disease either with no, moderate, or moderately-high salinity levels.

Specified Source(s) of Funding: Growing New Roots: Grafting to Enhance Resiliency in US Vegetable Industries

9:30 AM **Effects of Humic Substances and Growth Environments on the Rhizosphere Microbial Biomass in a Bell Pepper System**

Kuan Qin*[1]; Daniel I Leskovar[1]; Xuejun Dong[1] and John Jifon[2], *(1)Texas A&M AgriLife Research & Extension Center, Texas A&M University, (2)Texas A&M AgriLife Research Center*

Abstract: The microbiota in the root rhizosphere is essential for mutualistic benefits with plant growth. Due to the dynamic and complex environment, the community of rhizosphere microbes is highly affected by root growth and abiotic factors. Humic substances (HS) are widely used as soil organic amendments to improve plant root growth and soil properties, and also to enhance soil microbial activities due to the additional carbon input. However, there is limited information on the effects of HS on the rhizosphere microbial composition, especially in vegetable crop systems. In this two-year field experimental study, we applied HS as carbon input, and evaluated their responses under two distinctive environmental factors: soil type (clay, sandy) and water content (deficit, well-watered) to illustrate the shaping effects of abiotic factors on the microbial activity of a bell pepper rhizosphere. The results using a path analysis revealed that soil type was the main factor driving the microbial changes. Clay soil tended to increase bacteria population through changes in root length, soil pH and K content, and fungi population through the enhancement in pepper yield. HS application acting as organic input may have a long-term positive influence on soil microbial activity through improvements in soil organic carbon content, and this benefited more to bacteria community. Water content became a less influential factor compared to soil type and organic input on the microbial activity. Higher water content tended to increase fungal biomass but decrease soil respiration through the enhancement in pepper aboveground growth. This study distinguished key abiotic factors that affected the rhizosphere microbial biomass in a bell pepper growth system, which can act as a reference to establish applied approaches to improve the persistence and benefits from rhizosphere microbial community.
Specified Source(s) of Funding: NOVIHUM TECHNOLOGIES GMBH

9:45 AM **Placement of Shade Cloth on High Tunnels Affects Colored Bell Pepper Yield and Marketability in Iowa**

Kristine M. Lang* and Ajay Nair, *Iowa State University*

Abstract: Colored bell peppers provide an opportunity for vegetable growers to receive a price premium over un-ripened, green bell peppers. Utilizing high tunnels to produce colored bell peppers increases fruit quality and ripening speed. While there are benefits to high tunnel pepper production, high heat can lead to plant stress, blossom drop, sunscald and reduced marketable yields. The objective of this study was to identify colored bell pepper cultivars that perform well within high tunnels and test shade cloth treatments as a means to mitigate heat stress and improve yield and fruit quality. This study took place in six 4.5 m × 10.7 m single-poly passively ventilated quonset high tunnels during 2017 in central Iowa. Shade cloth treatments were 30% and 50% light-reducing, black woven shade cloth compared to a no-shade control applied to individual tunnels in two replications. Within each tunnel (shade treatment), seven bell pepper cultivars were planted in replicates of three. Cultivars included Archimedes, Delirio, Flavorburst, Red Knight, Sirius, and Tequila. Data was collected on plant growth characteristics (SPAD, plant height, leaf area, and biomass), marketable and non-marketable yield, and fruit quality (soluble solids, titratable acids, fruit shape, and lobe number). Environmental parameters (PAR, soil and air temperature) were monitored throughout the growing season. Mature fruit was harvested fifteen times between 5 July and 11 October. As expected the use of a shade cloth reduced the incidence of sunscald from 4.7% to 1.9%. Sirius had the highest incidence of sunscald (4.4%) and Tequila had the lowest incidence (1.0%). Marketable yield was 1.6 kg for the control compared to 1.2 and 1.1 kg for 30% and 50% shade cloth; however, the mean percentage of marketable fruit ranged from 64.3% (30% shade cloth) to 66.8% (50% shade cloth). When considering cultivar, the percentage of marketable fruit ranged from 55.3% (Tequila) to 75.1% (Red Knight). Dry shoot biomass was lowest for plants grown under the 30% shade cloth (92.4 g) compared to 50% shade cloth (93.1) and the control (102.5 g). Our data shows that the use of a shade cloth holds promise for reducing losses in fruit marketability of colored bell peppers, but research should continue to optimize the production of colored bell peppers within Midwest high tunnels.
Specified Source(s) of Funding: Iowa Department of Agriculture and Land Stewardship

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8:00 AM – 3:00 PM *T Street Entrance - Terrace Level*

Tour of U.S. Botanic Garden

8:30 AM – 10:00 AM *Boundary (Terrace Level)*

HortScience Editorial Board Meeting

Chair: Ron Robbins, *ASHS*

Members: Jianjun Chen, *University of Florida, Mid-Florida Research and Education Center*; Penelope Perkins-Veazie, *North Carolina State University*; Clinton Shock, *Oregon State University* and David Bryla, *USDA-ARS Horticultural Crops Research Unit*

9:00 AM – 10:00 AM

How to Prepare for Your Visit to Capitol Hill - Wednesday

Piscataway (Lobby Level)

Coordinator: Thomas Björkman, *Cornell University*

Objectives:

A training session to prepare members who are going to do meetings with legislators and staff on Capitol Hill. The session will include the basic protocol of a successful office visit, some tailoring of your pitch, and a review of where legislation of interest to ASHS members stands at that time. You will be able to have a productive and effective visit. The session will be led by ASHS members who have done many visits, as well as our expert, ASHS legislative affairs consultant Jonathan Moore.

9:00 AM – 10:00 AM *Oak Lawn (Lobby Level)*

Plant Biotechnology (BTCH) Meeting - Open to All Attendees

Chair: Youping Sun, *Department of Plants, Soils, and Climate, Utah State University*

Secretary: Krishna Bhattarai, *Gulf Coast Research and Education Center, University of Florida*

Objectives:

To communicate research ideas, techniques, and progress on the emerging techniques in micropropagation, cell selection, protoplast culture, embryo culture, haploidy, gene transfer, and molecular biology as they relate to horticultural crop improvement; and to encourage collaboration among researchers in the fields of plant genetics, germplasm and breeding, stress physiology, tissue culture, growth regulator research, and plant growth and development on problems of concern in improvement and propagation of horticultural crops.

9:00 AM – 10:00 AM

Resume Review Session I

Concourse Level Foyer

Objectives:

Schedule a time to go over your CV and ask career questions with a professional mentor. These will be scheduled in 20 minute sessions.

9:30 AM – 10:00 AM *Lincoln West*

Teaching Methods (TCHG) Meeting - Open to All Attendees

Chair: Jill Bushakra, *USDA/ARS*

Chair-elect: Andrew King, *Texas A&M University*

Secretary: Jacqueline Ricotta, *Delaware Valley University*

Objectives:

To provide information and an area of interaction among educators at all levels and extension personnel interested in teaching, with emphasis on teaching procedures, effective use of photographic equipment and materials, and lists of source materials.

9:30 AM – 11:00 AM *Georgetown West*

Root Growth and Rhizosphere Dynamics/Invasive Plants Research

Moderator: Lyn A Gettys, *University of Florida Ft Lauderdale Research and Education Center*

9:30 AM Temperature Effects on Root Respiration Rate of Heat Tolerant and Intolerant Tomato Varieties.

George Guenthner* and John Erwin, *University of Minnesota*

Abstract: Eight tomato cultivars (Accession LA-1994, 'Nacgarlang', 'Saladette', 'Campbell-28', 'Moskvich OG', 'Amana Orange', 'Solar Set', and 'Solar Fire') previously identified as heat tolerant or intolerant based upon photosynthesis and/or yields were compared for variation in root respiratory temperature thresholds. Root respiration rates were measured at temperatures ranging from 44.1-59.1C (+/- 0.4C) by measuring changes in oxygen concentration in sealed containers over a thirty-minute sampling period. Roots and their associated media were heated in a water bath (in a sealed tray) from 44.1 to 59.1 ^{o}C (at 3^{o}C sequential increments) and were then transferred to sealed jars at each media temperature with vertically mounted oxygen sensors to evaluate oxygen depletion rates. Absolute oxygen concentration in jars was measured every second for 30 min after samples were placed in jars. Only data from 15 - 30 min was used for analysis, as data collected from 0 to 15 min was highly variable and impacted by the initial adjustment of sensors to conditions within the jars. A linear function was fit to the data, with the slope of that line representing oxygen depletion (root respiration rate) over time. Root respiration rates were divided by root sample fresh and dry mass (after washing media from roots) to determine root respiration rate per unit mass. Data were analyzed to determine whether there was an association between reported above ground heat tolerance and the heat tolerance of roots as identified by maximum temperatures at which root respiration still occurred.

Specified Source(s) of Funding: USDA-ARS; FRA; Minnesota Agriculture Experiment Station

9:45 AM Unravelling Direct and Nutrient Uptake-Dependent Rhizosphere Acidification in Southern Highbush Blueberry

Gerardo H. Nunez*; Christopher S. Imler and Camila I. Arzola, *University of Florida*

Abstract: Soil pH is a major factor affecting horticultural productivity. Site selection and soil amendments are routinely used to provide optimum pH for cultivation. Nevertheless, some plants are capable of changing the pH in their rhizospheres. Plants acidify their rhizosphere by means of H+-ATPase-mediated proton extrusion (direct rhizosphere acidification) and/or as a consequence of nutrient uptake (nutrient uptake-dependent acidification). N uptake -in particular- can have large effects in rhizosphere pH. Nitrate uptake leads to rhizosphere alkalization, whereas ammonium uptake leads to rhizosphere acidification. Acid-loving plants (family Ericaceae) thrive in acidic soils where ammonium is the most prevalent form of N. Thus, these plants could exhibit both direct and nutrient uptake-dependent acidification. The relative importance of both of these processes for acid-loving plants is unknown. We hypothesized that ammonium uptake plays a greater role than H+-ATPase activity in the rhizosphere acidification of acid-loving plants. We grew one-year-old rooted cuttings of southern highbush blueberry 'Emerald' (SHB, *Vaccinium corymbosum* interspecific hybrids) in a split-root hydroponic system where each half of the root system was in a different reservoir. One reservoir was supplied with a buffered, complete nutrient solution containing 2.5 mM ammonium. The other reservoir was supplied with a non-buffered nutrient solution containing either 2.5 mM ammonium or no nitrogen. Plants were arranged in a completely randomized design with two treatments (NH4+ buffered/NH4+ non-buffered and NH4+ buffered/none). We measured rhizosphere pH, N uptake from solution, tissue N concentration, and root electrolyte leakage (REL). Additionally, we measured the expression of genes that encode glutamine synthethase (GS) and plasma membrane-bound H+-ATPases. We found that N uptake and tissue N concentrations were not different between plants in both treatments. Additionally, roots in all reservoirs exhibited similar REL, suggesting the split-root hydroponic system did not stress the root systems. Nutrient solution pH measurements indicated that SHB exhibits both direct and nutrient uptake-dependent rhizosphere acidification. Gene expression data supported this notion. Furthermore, ammonium uptake acidified the rhizosphere at a significantly higher rate than H+-ATPase activity. Altogether, these results suggest that nutrient uptake-related rhizosphere acidification plays a pivotal role in promoting adequate soil pH for cultivation of SHB and other acid-loving plants.

Specified Source(s) of Funding: Thad Cochran Southern Horticultural Laboratory, U. S. Department of Agriculture Agricultural Research Service, under award number 58–6062–5-004

10:00 AM Recent Advancements in Mapping and Evaluation of Tree Root Systems with Ground Penetrating Radar

Dilruba Yeasmin*[1]; John T. Bushoven[1]; Charles F. Krauter[1]; Anthony Mucciardi[2] and Allen Vizcarra[1], *(1)California State University Fresno, (2)TreeRadar Inc.*

Abstract: Tree Root Mapping with Ground Penetrating Radar (GPR) is a non-invasive/non-destructive method of studying underground root distribution. Although there has been some application of this technology over the past few decades, the feasibility, efficiency, and accuracy of this method have not been widely examined. Recent advances in hardware and software have fostered a need to revisit use of such technology in agriculturally and horticulturally important tree species. Such applications have the potential to monitor root growth and health in a wide range of environments, including orchards or urban forests. To date, there have also been few studies directly focused on assessing such in intact, live root systems in undisturbed soil profiles. To address such this study utilized a state-of-the-art tree radar unit (TRU™) hardware and software system. The root systems of small and large deciduous and coniferous landscape trees were scanned, flagged and methodically excavated using portable hydro-excavation equipment, and hand tools. Scanned and actual XYZ coordinates, as well as root diameter were compared for each site. In addition, use of the updated GPR system was assessed for locating non-excavated roots, the presence and depth of which were confirmed via potholing. The results of these validation studies suggest that recent advancements to this technology have significantly improved our ability to cost-effectively and non-destructively assess *in situ* root growth. Application of such has the potential to better understand below-ground aspects of tree health and performance in both agricultural and horticultural environments.

Specified Source(s) of Funding: California State University Fresno Agricultural Research Institute Grant

10:15 AM Mesocosm Trials to Evaluate Herbicide Efficacy on Submersed Plants

Lyn A Gettys*; Kyle L Thayer and Ian J Markovich, *University of Florida Fort Lauderdale Research and Education Center*

Abstract: South Florida relies on a system of interconnected canals to prevent flooding of the mostly flat topography during severe storms. These canals must be kept free of dense vegetation to ensure that stormwaters can flow unobstructed. Aquatic nuisance species that hinder water movement in canals include crested floatingheart (*Nymphoides cristata*), fanwort

(*Cabomba caroliniana*) and hygrophila (*Hygrophila polysperma*). Replicated mesocosm studies conducted in a covered greenhouse in south Florida utilized a single water-column treatment of one of 33 treatments (11 aquatic herbicides alone or in combination with another herbicide, plus an untreated control). After 16 weeks of culture under experimental conditions, mortality of all three species was greatest in mesocosms treated with ProcellaCOR, triclopyr, triclopyr+diquat, penoxsulam, penoxsulam+diquat, penoxsulam+flumioxazin, imazamox+diquat, imazamox+flumioxazin, carfentrazone and carfentrazone+diquat. These results suggest that resource managers in south Florida have a number of chemical tools at their disposal to manage aquatic weeds in canals. These findings are valuable because reliance on a single active ingredient can drive the development of herbicide resistance by selecting for resistant genotypes.

Specified Source(s) of Funding: South Florida Water Management District

10:30 AM **Development of Sterile Non-Invasive Euonymus Alatus for the Ornamental Industry**

Huseyin Yer[*1]; Rania EL-Tanbouly[2]; Jon Mahoney[1]; Chandra Sekhar Thammina[3] and Yi Li[4], *(1)University of Connecticut, (2)University of Connecticut, Storrs, USA, (3)USDA-ARS, U.S. National Arboretum/Rutgers University, (4)Nanjing Agricultural University*

Abstract: Euonymus alatus, also known as “burning bush” or “Winged Euonymus”, is an extremely popular landscape plant in the United States because of its brilliant red color in fall. However, burning bush is also highly invasive because of its prolific seed production and effective seed dispersal by birds. Hence, development of sterile, non-invasive burning bush is in high demand. We have used several approaches, including mutagenesis and tissue culture-mediated production of triploids, to create cultivars of sterile, non-invasive burning bush plants. We have observed that a number of triploid plant lines produced few fruits and seeds. Some of these sterile lines are also dwarf with reduced stem internode length. Further characterization show that pollen from some sterile lines is infertile. We have also produced several sterile plant lines of burning bush via mutagenesis. One mutant plant line has its flowers aborted at later stages due to non-viable pollen. Successful development of sterile, non-invasive cultivars of burning bush plants may help the ornamental industry and reduce seed-mediated undesirable spread of burning bush plants.

10:45 AM **Genetic Sterilization of *Lantana Camera* to Produce Infertile, Non-Invasive Cultivars**

Zhanao Deng[*1]; Sandra B. Wilson[1]; Gary W. Knox[1] and Rosanna Freyre[2], *(1)University of Florida, (2)Univ of Florida*

Abstract: *Lantana camara* is an important nursery and landscape plant in many states including Florida. This species has been listed as an invasive species by the Florida Exotic Pest Plant Council and classified as invasive in Florida by the University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS) Assessment of Non-Native Plants in Florida’s Natural Areas. A research program was initiated in 2004 at the UF/IFAS’s Gulf Coast Research and Education Center to understand the reproductive biology of *L. camara* and develop new infertile, non-invasive cultivars. Polyploidy, formation of unreduced female gametes, and production of apomictic seeds have been associated with the invasive potential of this species. Two infertile triploid cultivars (‘UF-T3’ and ‘UF-T4’) were released in 2011, followed by releasing of another two infertile triploid cultivars (Bloomify™ Red and Bloomify™ Rose) in 2016. Compared to ‘Pink Caprice’, a *L. camara* variety that is most close to the naturalized type, the pollen stainability of these new cultivars has been reduced by 85% or more, and fruit production has been reduced by greater than 99%. The new cultivars do not hybridize with the Florida native lantana species *L. depressa* or produce viable seeds after hand pollination. Based on the male and female fertility data of these cultivars and their lack of hybridization potential with *L. depressa,* the UF/IFAS Assessment of Non-native Plants in Florida's Natural Areas concluded that these cultivars are not likely problematic taxa in Florida. Two of these cultivars, Bloomify™ Red and Bloomify™ Rose, became commercially available in spring 2018.

Specified Source(s) of Funding: USDA hatch projects (FLA-GCR-005065 and FLA-GCC-005507), USDA/TSTAR program, Southwest Florida Water Management District, Florida Department of Agriculture and Consumer Service (FDACS) Specialty Crop Block Grant program (Project #021747).

9:45 AM – 10:15 AM

Coffee Break

International Ballroom East/Center

10:00 AM – 11:00 AM *Boundary (Terrace Level)*

Finance Committee Meeting

Chair: Joan Davenport, *WSU Prosser*

Members: John Dole, *North Carolina State University*; Peter Hirst, *Purdue University*; Wayne Mackay, *Univ of Arkansas*; Michael Neff, *ASHS*; Carl Sams, *The University of Tennessee* and Janet Cole, *Oklahoma State Univ*

10:00 AM – 11:00 AM *Piscataway (Lobby Level)*

Orchid Meeting - Open to All Attendees

Chair: Kenneth Leonhardt, *University of Hawaii at Manoa*

Chair-elect: Hideka Kobayashi, *Kentucky State University, College of Agriculture, Food Science, and Sustainable Systems*

Secretary: Teresita Amore, *Tropical Plant and Soil Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa*

Objectives:

To provide a platform for promoting fellowship, expand the opportunities, exchange ideas, and share information about activities occurring in orchid research, education, and extension.

10:00 AM – 11:00 AM *Oak Lawn (Lobby Level)*

Plant Growth Regulation (PGR) Meeting - Open to All Attendees

Chair: Tripti Vashisth, *University of Florida*

Chair-elect: Christopher J. Currey, *Iowa State University*

Secretary: Shinsuke Agehara, *University of Florida*

Objectives:

To foster excellence in plant growth regulator research, to help and encourage new research talent in plant growth regulators, to unify research and industry workers in an attempt to solve horticultural problems related to plant growth regulator research between ASHS and other related organizations.

10:00 AM – 11:30 AM *Georgetown East*

International Horticultural Issues & Networking

Moderator: Elizabeth Mitcham, *University of California Davis*

10:00 AM **An in-Country Assessment of the Apricot Supply Chain in Tajikistan**

Ariana P Torres[*]; Peter M. Hirst; Klein Ileleji and Amanda J. Deering, *Purdue University*

Abstract: Fruit drying can add value and decrease perishability of various fruits, including apricots. Dried apricots are an established agricultural product in northern Tajikistan (Sughd region), but a relatively new industry for southern Tajikistan (Khatlon region). The north has a more developed supply chain, characterized by established tree varieties, harvesting and drying protocols, and the existence of domestic and export markets. Advancing the dried apricot industry in southern areas is likely to increase income for small-scale farmers and promote economic and social development. We conducted a study to evaluate the market and technological factors involved in the production, harvest, and

drying of apricots; as well as the potential barriers to the production of export-grade dried apricots by farmers in the Khatlon province. n June 2017, we conducted a baseline assessment of the apricot supply chain in north and south Tajikistan using surveys to farmers and interviews to apricot buyers, processors, and marketing cooperatives. Our results show that, regardless of the district and gender, southern farmers had lower yields and were less knowledgeable regarding harvesting, drying, and selling practices than their counterparts in the northern production areas. We also found they had fewer years of experience selling dried apricots, and apricots sales represented a lower proportion of the household income, when compared to northern farmers. All southern farmers correctly perceived that quality was the most important factor driving price premiums. Regardless of the gender and district, most farmers perceived they lack the knowledge and technology to produce dried apricots that meet market grade standards for export markets. This study provides a baseline assessment of the apricot supply chain in Tajikistan. Quality of dried apricots is a major barrier to market access and price premiums. Our data showed that fruit quality seems to be correlated with the lack of tree varieties suited for export markets, knowledge of drying technologies, and knowledge of export-grade market standards. The economic viability and livelihood of apricot farmers in Khatlon province could likely be improved by the introduction of adapted apricot varieties, insuring access to appropriate agronomic inputs and practices, strengthening post-harvest and drying knowledge, introducing good food safety practices, and accelerating the farmers' access to apricot buyers for export and domestic markets. Government, policymakers, researchers, and businesses can use our findings to assist farmers in developing new and maintaining existing market linkages.

Specified Source(s) of Funding: USAID, Feed the Future - Horticulture Innovation Lab

10:15 AM Empowering Turkish Women Farmers with Agricultural Business Management Training

Robin G. Brumfield*[1]; Burhan Özkan[2]; Rabia Vezne[2] and Eda Ilbasmis[2], *(1)Rutgers, The State University of New Jersey, (2)Akdeniz University*

Abstract: Farming is the principal economic activity in most rural areas of Turkey. Women represent a substantial share of the total agricultural labor force. Therefore, they need vocational training and guidance in their work places, but unfortunately, that was missing. The Empowering Women Farmers with Agricultural Business Management Training Project (EMWOFA) is a comprehensive training program for women farmers developed so that women farmers can develop technical, entrepreneurial and managerial skills. Turkish extension educators trained the first group of 34 women in Kozagacı village in Turkey last year using materials developed by EMWOFA. First, we trained extension educators using a teachers' manual called the EMWOFA Educational program. The extension educators trained the women farmers using a workbook designed to help women farmers develop a business plan for their farms and review best management production methods for growing horticultural crops. The women could access E-learning videos that summarized the curriculum in the educational program and workbook on the EMWOFA website. Seventy percent of these women were the sole owner of their farming business, and their average age was 32.1 with an average 12.7 years farming. The greenhouse vegetables that they produced included tomatoes, cucumbers, lettuce and beans. Over eighty percent of the women felt that the business management and technical production sections of the program were valuable or very valuable. Nearly half of the participants selected management as the most useful part of the course. The majority of them plan to make changes in their production and management components of their business because of attending the program. Over 75% plan to keep better records after participating in EMWOFA training.

Specified Source(s) of Funding: Funded by the Erasmus+ Program of the European Union

10:30 AM A Train-the-Trainer Program to Empower Women Farmers

Burhan Özkan[1]; Robin G. Brumfield*[2] and Rabia Vezne[1], *(1)Akdeniz University, (2)Rutgers, The State University of New Jersey*

Abstract: The "Empowering Women Farmers with Agricultural Business Management Training" (EMWOFA) is an EU Erasmus+ funded project to extend empower small-scale women farmers to manage their farms as businesses. It provides a comprehensive educational program to develop technical, entrepreneurial and managerial knowledge of extension educators in agriculture. These trained extension educators will train women farmers who are not likely to have vocational education training about the technical and managerial aspects of managing their farms. However, these women must work on farms. The EMWOFA Project developed educational materials to "Train the Trainers". These educators will then train women farmers to improve their business skills and farms. This will have a multiplier effect by reaching women farmers in the EU and other countries. A teacher's workbook or educational program gave the trainers educational material to train women farmers. We designed a workbook to help women farmers develop a business plan for their farms and review best management production methods for growing horticultural crops. Short, e-learning videos summarize the educational program and workbook. The videos are tagged one after another to make it easy for the user to follow. The educational program, workbooks, and e-learning videos are available in four languages: Turkish, English, German, and Spanish. We shared the videos, educational program manuals, and workbooks for women farmers with extension bodies in the EU and posted them on the EMWOFA web portal for free use. We conducted a survey of 13 extension educators from Turkey and Germany who attended the first EMWOFA Train-the-Trainer session in Freising, Germany in October 2016. The average age of the participants was 39 with an average of 9 years of experience as an extension educator. They all had positive impressions about the Educational Program. They felt confident about their knowledge in business management and technical production topics and scored their ability to teach every part of a business management and greenhouse production an average of 4.5 on a 5-point scale. Training materials are on the EMWOFA website: *www.emwofa.eu* to guarantee both dissemination and the sustainability of the EMWOFA project

Specified Source(s) of Funding: Funded by the Erasmus+ Program of the European Union

10:45 AM Internationalizing Extension through Agricultural Volunteer Opportunities

E. Vanessa Campoverde*, *University of Florida Extension, Miami-Dade County*; Norma Samuel, *South Carolina State University* and Andrea Fión Góngora, *Farmer-to-Farmer*

Abstract: Through international experience Extension educators learn desirable skills to meet clientele needs and professional expertise working with other cultures in local communities while addressing global issues. Although highly encouraged, some challenges do arise for agricultural and Extension educators seeking opportunities to participate in international assignments. The US Agency for International Development (USAID) Farmer-to-Farmer (F2F) program provides technical assistance from U.S. volunteers to farmers, farmer groups, agribusinesses and other agriculture sector institutions in developing and transitional countries with the goal of promoting sustainable improvements in food security and agricultural processing, production and marketing. The purpose of this proposal is to provide a practical overview of an F2F international extension assignment. The following questions will be addressed in this talk: (1) What are the requirements to be selected as an international F2F volunteer? (2) What are the perceptions of a young Extension agent professional during a first assignment overseas regarding expertise scope, preparation, challenges and expenses? and (3) What are the outcomes and benefits from the international experience? Recruitment: The F2F program recruits volunteers from all 50 United States and the District of Columbia. Volunteers usually have domestic careers, farms and agribusinesses or are retirees. Logistics: The time frame for the assignment was a two-week period, and targeted small, medium, and large producers of non-traditional horticultural crops in Guatemala. Field work and final lectures to clientele: F2F international volunteers visited agricultural operations that differed in size and geographical area and delivered two final lectures on topics of interest to local program participants. End of assignment reporting: A comprehensive report to in-country hosting organization was submitted before returning home. Extension agents who participated in international programs returned home with a

global awareness to deliver a better service to diverse clientele in local communities.

Specified Source(s) of Funding: USAID Farmer-to-Farmer

11:00 AM Preserving the Harvest with Horticulture Technologies in Emerging Economies

Elizabeth Mitcham*[1]; Angelos Deltsidis[1]; Michael Reid[1]; James Thompson[2] and Erin McGuire[3], *(1)University of California Davis, (2)University of California, (3)Horticulture Innovation Lab*

Abstract: Fruits and vegetables are critical components to healthy diets, providing important micronutrients from prenatal to adulthood. In many parts of the developing world, rural and peri-urban families eat a very limited diet focused on staple crops, and are frequently not able to consume adequate amounts of nutritious foods. In these countries, horticultural crops are consumed only during a short period due to inadequate cooling, handling and storage facilities, leading to high losses after harvest. Horticulture crops provide important income and business opportunities in emerging economies. However, fruits and vegetables are perishable crops forcing farming families to sell their products at harvest when quality is high, but market prices may be low. Furthermore, high perishability prevents nutrient-rich fruits and vegetables from being consumed throughout the year. Cooling is the most efficient way of delaying the spoilage of fresh fruits and vegetables by slowing their metabolic processes. **CoolBot®** regulated cold rooms, which operate with household type air conditioners, can be installed in rural areas to provide moderate cost cold storage. Drying fruits and vegetables can stabilize and allow for storage of products that have not been sold or consumed due to gluts in supply. In tropical or humid areas, the drying process can be challenging, with high rates of spoilage due to torrential rains and high air humidity. A UC Davis-invented **solar dryer**, which has a chimney attached on one end of the drying table, facilitates airflow and reduces drying times while improving the quality of the dried products. The UC Davis **DryCard** is an important tool to measure the dryness of products before they are stored. This simple, inexpensive tool allows farmers and storage operators to quickly test if products have been dried enough to prevent harmful molds and toxins from developing in the product, affecting family health and the market viability of the products. Once the product is tested and determined to need additional drying, Zeolite clay **Drying Beads,** developed by Rhino Research, can be used to finish the drying process. These can be used on any dried product that needs to be stored, including high-value vegetable seeds. Once fully dried, the product can be stored or packaged in moisture-tight containers/packages. The implementation, operation, quality impacts and economic feasibility of these four technologies will be discussed, with evidence from several emerging economies. Successful adoption of these technologies is expected to support household nutrition and foster inclusive economic development.

Specified Source(s) of Funding: USAID Horticulture Innovation Lab

11:15 AM Low Cost Technologies to Increase Fruit and Vegetable Availability in Rural Bangladesh

Angelos Deltsidis*; Amrita Mukherjee; Mohd Rezaul Islam; Michael Reid and Elizabeth Mitcham, *University of California Davis*

Abstract: According to recent studies and despite the efforts of the government and international donors, the rural population of Bangladesh suffers from chronic malnutrition. Climate change results in longer cyclone seasons and erratic weather that reduce the capacity of local population to secure year round availability of nutritious crops. It has been shown that horticultural crops can provide the necessary micronutrients for a healthy lifestyle. The lack of accessible, low cost methods to maintain produce quality after harvest along with the high prices of imported produce further reduce off-season consumption of fresh horticultural crops. A number of previously-tested, low cost technologies have been implemented in selected locations in southern Bangladesh. These technologies aim to reduce food losses and extend the availability of nutritious foods while they support the incomes of smallholder farmers and entrepreneurs. Cooling is the most important method of food loss reduction, but is out of reach for most smallholder farmers due to high setup and running costs. The Horticulture Innovation Lab has installed 12 low cost CoolBot-operated cold rooms that act as local, short-term cold storage points. In addition, data is being collected remotely on usage, power availability, and temperature settings, along with a high tech alarm notification system called ColdTrace. Drying is a popular preservation technique in Bangladesh which often produces lower quality or contaminated products due to high humidity levels. Our team has installed innovative UC Davis-invented solar dryers, which facilitate airflow and reduce drying times while improving the quality of dried products. Seasonal flooding and expansion of aquaculture reduce the availability of suitable locations for family gardens which provide safe and nutritious vegetables and herbs. A bamboo raft was designed to hold soilless media for vegetable production, and these are floated in the sunny part of fishponds. This technology can combat food insecurity when water levels in the region rise by providing small plant-growing platforms that can be used even during the rainy season. Our team gathers an extensive number of data points including inputs and outputs to extrapolate the profitability prerequisites and potentials for each technology using a UC Davis-developed model. Based on the preliminary data of this ongoing study, the implementation, operation and scaling of the above technologies supports household nutrition, adequate quality and quantity of food intake, and can potentially reduce illness while supporting inclusive economic development.

Specified Source(s) of Funding: USAID

10:00 AM – 11:30 AM *Lincoln East*

Organic Horticulture 1

Moderator: Bodh R. Paudel, *University of Florida*

10:00 AM A Pilot Study of Using Sunn Hemp Biomass for Anaerobic Soil Disinfestation in Organic Pac Choi Production

Bodh R. Paudel*[1]; Xin Zhao[1]; Zack Black[1]; Francesco Di Gioia[1]; Jason C. Hong[2]; Cristina Pisani[2] and Erin N. Rosskopf[2], *(1)University of Florida, (2)USDA-ARS*

Abstract: Anaerobic soil disinfestation (ASD), based upon supplying a labile carbon (C) source, tarping, and watering the soil to field capacity to achieve soil anaerobic conditions, has shown to be a promising strategy for controlling soil-borne plant pathogens and parasitic nematodes and to improve vegetable production. To test the effectiveness of a summer leguminous cover crop, sunn hemp, as a potential carbon source for ASD, a pilot study of organic pac choi production was conducted at the University of Florida Plant Science Research and Education Unit in Citra, FL during the fall 2017 season. Summer-planted sunn hemp was used as the carbon source for ASD treatment using two approaches: terminated and incorporated into the soil in situ (SH_I) vs. aboveground biomass harvested and transported off site for soil incorporation (SH_T). In addition, composted poultry litter (CPL) was incorporated with sunn hemp (SH+CPL) or without (SH) in the ASD treatments. A standard ASD treatment with molasses and CPL and an untreated control (UTC) were also included. The raised beds for pac choi planting were irrigated to saturation and covered with black totally impermeable film (TIF) to initiate a 3-week ASD treatment beginning Oct. 19, 2017. Twenty-four-day-old pac choi seedlings were transplanted on Nov. 13 and the mature heads were harvested 38 days after planting. Two field trials each using a completely randomized design with four replications were conducted simultaneously. In trial 1, SH_I+CPL, SH_T, SH_T+CPL, and the standard ASD had significantly greater yields than SH_I and UTC. In trial 2, treatments that utilized CPL resulted in higher yields than treatments that included only the cover crop and UTC. Interestingly, yellow nutsedge, the predominant weed in the beds and planting holes, grew in significantly higher numbers in SH_I+CPL compared to UTC and other treatments in trial 1, while both SH_I and SH_I+CPL had significantly greater nutsedge counts than UTC and other treatments in trial 2. The crop yield discrepancy between the two trials might have resulted from the different levels of weed pressure present in the field. Nevertheless, the potential of using sunn hemp biomass as a carbon source for ASD treatment deserves more in-depth studies, together with analysis of the contribution of sunn hemp to soil fertility and quality

Specified Source(s) of Funding: USDA-ARS

10:15 AM Assessing the Influence of Microbe-Containing Crop Biostimulants on Vegetable Crops and Farms

through on-Station and on-Farm Study

Nicole Wright[1]; Stephanie Short[1]; Julie Laudick[2]; Zheng Wang[2]; Subbu Kumarappan[3] and Matthew D. Kleinhenz[*2], *(1)The Ohio State University, (2)The Ohio State University-OARDC, (3)The Ohio State University-ATI*

Abstract: Commercial microbe-containing crop biostimulants are advertised to maintain or enhance crop growth, perhaps especially under sub-optimal conditions (e.g., drought, nutrient deficiency, high temperature). More than two-hundred such products ranging in composition (e.g., bacterial, fungal, both; cfu/ml) are currently available, complicating product selection. Regardless, to be effective, users must establish and maintain conditions supporting the plant-microbe interactions from which they seek to profit. These conditions are largely unknown, thereby: a) helping to explain the erratic and context-specific outcomes from inoculation in field and high tunnel settings reported to date, b) impeding key research, and c) slowing the transmission of related research-based recommendations for product use, all of which raise serious questions about the product category. In response, a program consisting of ongoing sets of integrated and complementary on-station and on-farm experiments (many involving a citizen-science/farmer-led approach) testing hypotheses specific to the effect of product composition, crop, application timing, application rate, and/or experimental setting on crop yield and quality was developed. Since 2015, program experiments have been completed in seven states (IA, IL, MI, MO, OH, PA, TN), on fifteen farms and two research stations, on seven crops (broccoli, carrot, lettuce, pepper, spinach, squash, tomato) grown in field or high tunnel settings, and with ten OMRI-listed products (Azos Blue, Biogenesis 1 TM NP, BioYield, EcoFungi, Environoc 401, Hydroguard, MycoApply All Purpose Granular, MycoApply Endomax Concentrated WP, Mycogenesis, NP Bioplin). Individual on-station experiments begin spring, summer, or fall with treatment factorials including multiple levels of product (e.g., four-six) and multiple levels of either rate or timing (e.g., seeding, transplanting, after transplanting), with plots arranged in a randomized complete design and applications made as a root-zone drench. On-farm experiments, however, while also collectively completed over much of each calendar year, involve fewer experimental variables and levels of each. To date, outcomes from standard statistical approaches common in product evaluations, variety trials, and cultural management comparisons show that significant increases in yield or quality have been rare, regardless of inoculation parameters or experimental conditions. When found, yield increases were most common following the application of mixed inocula (single products containing multiple species or strains of bacteria, fungi, or both) and typically below eight percent. Analysis of crop data using approaches (e.g., transformation) common in other areas of study in which skewed data are common (e.g., pathology, entomology, weed science) and economic analyses exploring the return on investment from microbe-containing crop biostimulant use are also underway.

Specified Source(s) of Funding: USDA ORG, USDA NCR-SARE, Warner Foundation, The OSU

10:30 AM Soil Balancing Effects on Specialty Crops and Their Soils, Weeds, Farms, and Growers

Sonia Walker[1]; Cathy Herms[1]; Bill McKibben[2]; Steve Culman[1]; Doug Doohan[1]; Subbu Kumarappan[3]; Douglas Jackson-Smith[1] and Matthew D. Kleinhenz[*1], *(1)The Ohio State University-OARDC, (2)Soil Tech, Inc, (3)The Ohio State University-ATI*

Abstract: Opinions on the "soil balancing" philosophy of soil management among growers and private- and public-sector grower advisors and researchers range wide and, so far, rarely achieve consensus. Proponents, including increasing numbers of specialty crop growers (many sustainable-organic) and some advisors, report that soil chemistry -- specifically, percentages and ratios of calcium, magnesium, and potassium – can be altered through applications of lime, gypsum, and other materials to improve soil physics (tilth) and biology and, thereby, crop yield and quality and weed control, also. Investigators and other advisors, however, report that soil balancing claims are unsupported by the data (at minimum) and potentially injurious to farms (at worst). That disconnect is both a problematic trend and important opportunity. As part of a larger effort to understand the use and outcomes of soil balancing as practitioners do while also providing needed data, eight certified-organic main plots (17.1 m x 18.3 m) were established in 2015-2018 at the OSU-OARDC in Wooster, OH. Main plots contained two (17.1 m x 9.1 m) subplots based on their having received an annual application of composted dairy manure every year since 2003 or no compost application. Three (5.3 m x 9.1 m) sub-subplots/subplot were created on June 11, 2015 by applying one of three soil amendment treatments: 1) gypsum (1681.5 kg ha^{-1}), 2) potassium sulfate (560.5 kg ha^{-1}), and 3) gypsum + potassium sulfate (same rates). Rock phosphate was also applied at 560.5 kg ha^{-1} to minus-compost subplots. Treatment applications were repeated at the same locations each mid-May 2016-2018. Sub-subplots were direct seeded with four rows of both edamame soybean and dwarf popcorn on June 12, 2015, May 25, 2016, and May 23, 2017, with edamame being reseeded on June 21, 2016 and June 14, 2017. Two rows of butternut squash were also direct-seeded into each sub-subplot on June 18, 2015, May 31, 2016, and May 26, 2017. All crops received multiple applications of fish fertilizer (analysis of 2-4-1) each season either by hand (edamame, popcorn) or via fertigation (squash). Percent stand, above-ground canopy development, mass of mature leaves at the onset of reproductive growth, and crop yield (total, marketable) and quality were recorded each year along with measures of soil macro- and micronutrient levels. Treatments have resulted in few significant differences in either plant growth, or crop yield or quality to date. Weed seedbank analysis and comprehensive assessments of grower attitudes and farm economics are also underway.

Specified Source(s) of Funding: USDA OREI

10:45 AM Linking Phytochemicals in Cucumber Plants to Striped Cucumber Beetle Population and Parasitism

Gladis M. Zinati[*1]; Andrew Smith[1]; Tara A. Caton[1]; Casey Barickman[2] and Emily L. Lesher[1], *(1)Rodale Institute, (2)Mississippi State University*

Abstract: Plants respond to pest attack by triggering several changes in biochemical contents namely primary and secondary metabolites. Phenolic acids are organic compounds that influence pest behavior, feeding efficiency and could limit herbivore damage based on their activity as feeding deterrents. These organic compounds play a role in indirect plant defense by attracting natural enemies and may vary with management systems used for production of organic vegetables. A research project was conducted with a goal to link phytochemicals to striped cucumber beetle (SCB) population and parasitism when organic cucumber plants were grown in rolled-crimped cover crop plots and compared to those in plastic mulch with and without insectary strips. Results showed that SCB populations in 2017 were much lower compared to 2016 and was slightly greater, although not significantly, in plastic compared to rolled mulch. Proportion of SCB parasitism by tachinid fly was slightly greater in plastic than in mulch but did not differ between insectary and no insectary treatments as anticipated. Concentration of rosmarinic acid and syringic acid were significantly greater in leaves of cucumber plants grown in plastic mulch than in rolled mulch. Syringic acid is known to attract parasitoids. However, feurlic and *p*-coumaric acids were significantly greater in cucumber plants grown in rolled mulch systems. These latter compounds were documented to serve as feed-deterrent for certain pest insects and could explain the lower level of SCB density and parasitism in rolled mulch treatment. There was no direct and measurable effect of presence or absence of insectary strips on SCB density, parasitism, and concentrations of polyphenols in cucumber plants. However, this tactic was found to enhance densities of ground beetle and wolf spiders (other ground natural enemies to SCB). This multi-tactic approach could serve as a potential biocontrol management system for attracting insects and controlling SCB.

Specified Source(s) of Funding: Frontier Natural Products Co-oP and Pennsylvania Department of Agriculture

11:00 AM Impact of Management Practices on Yield, Soil Properties, and Plant Phytochemicals Content in Organic Winter Squash

Gladis Zinati[*1]; Casey Barickman[2]; Tara A. Caton[1]; Andrew Smith[1]; Daniel Kemper[1] and Dana Smith[1], *(1)Rodale Institute, (2)Mississippi State University*

Abstract: Small-scale organic vegetable growers are interested in cost-effective management practices that conserve soil health by reducing frequent soil cultivation, reduce labor and energy cost, and increase profitability and sustainability. In partnering with Quiet Creek Farm owners, organic winter squash "Waltham" plants were compared under three management systems: 1) low-input technology (0.6 m wide walk-behind BCS roller-crimper with hand-planting), 2) high-input technology (tractor-driven 3m wide roller crimper with no-till planter) and 3) grower's standard practice (bare-ground and in-season cultivation). Results showed that cover crop biomass (wheat, clover, and hairy vetch mix) was very low and averaged about 4,100 kg/ha, well below the threshold value (greater than 8,000 kg/ha) identified for consistent suppression for annual weeds under rolled-crimped management systems. Low- and high-input technology treatments resulted in significantly lower yields and were 3 times lower than those in cultivated standard treatment. The reduction in yield can be attributed to high infestation of weeds in grower's field prior to conducting this trial. Soil compaction was measured using a penetrometer at 300 psi and results showed that soil compaction was reduced in low- and high-input technology treatments compared to standard grower (bare ground) treatment. Soil bulk density did not vary among treatments. Winter squash fruits were assessed for carotenoids and sugar content after being stored for 0, 30, and 60 days. Sugar content increased with storage period and carotenoid levels were similar in tested treatments. The use of BCS roller crimper technology can be considered a viable option for beginning and young organic growers who are on low and tight budget. Growers who can afford the cost of high-technology equipment may benefit from farming bigger sized- farms and reduce labor cost. Both technologies will conserve soil health. However, for successful organic winter squash production growers must select plots with minimal weed seed bank to ensure greater yields and low weed biomass when compared to tilled system with in-season cultivation. Extending the storage period of winter squash did not impact stored fruit quality even after 60 days. Organic winter squash growers may reap additional revenues by offering community supported agriculture's (CSA) members nutritive and healthy fruits during fall season.

Specified Source(s) of Funding: NE-SARE ONE 17-307

11:15 AM Evaluation of Eight Organic Cucumber Cultivars in a High Tunnel with Insect Screens

Sanjun Gu* and John Kimes, *North Carolina Agricultural and Technical State University*

Abstract: Cucumber (*Cucumis sativus*) is one of the most popular vegetable species in high tunnels. English and Beit Alpha cucumber are well suited to the enclosed high tunnel environment because they are often parthenocarpic and gynocious, have better taste, and are very productive. However, most English and Beit Alpha cucumber cultivars have not been tested in high tunnels. These cultivars are also intolerant to bacterial wilt disease transmitted by cucumber beetles. The objective of this trial was to evaluate the yield potential of English and Beit Alpha cucumber cultivars in high tunnels with insect screens. Eight organic cucumber cultivars Corinto, Diva, Kalunga, Katrina, Picolino, Socrates, Tasty Jade and Tyria were tested in an organic high tunnel (30'W x 96'L) in Greensboro NC (hardiness zone 7) from April to September in 2017. The experiment was conducted as a completely randomized design with four replications. There were six vines per replication. Insect netting (mesh size of 0.0138" x 0.0138") was installed on both side-walls of the high tunnel. Cucumbers were trained to one leader per vine and trellised with the Tomato Roller Hooks® system. All cultivars grew vigorously. The length of a vine was 15 to 26 feet long at the end of season, with 'Socrates' and 'Corintoa' had more than 100 nodes on a vine. The insect netting totally blocked cucumber beetles and other insect pests. There were significant different among cultivars in terms of yield and number of fruit per vine. The marketable yield and number of fruit ranged from 8.9 lb and 21.3 fruit per vine for 'Diva' to 20 lb and 53.3 fruit per vine for 'Socrates'. 'Socrates' had the consistently highest yield throughout the season, followed by 'Corinto', 'Picolino' and 'Tasty Jade'. Most cultivars had their first fruit at node three. On average there was one fruit per two to four nodes on a vine depending on cultivars. The °Brix ranged from 3.1 for 'Katrina' to 4.7 for 'Diva'. In conclusion, insect screen totally controlled cucumber beetles. English or Beit Alpha cucumbers are good options for high tunnel production. Cultivars Socrates and Tasty Jade were the most productive, Kalunga and Tyria were medium productive but with the longest fruit, and 'Diva' was not an ideal cultivar for high tunnel production.

10:00 AM – 12:00 PM *International Ballroom West*

Clean WateR^3 – Big Picture Outreach

Moderator: Sarah White, *Clemson University*

10:00 AM Comparing the Cost of High-Quality and Recycled Irrigation Runoff Water in Container Plant Production: A Southern California Nursery Case Study

Bruno J.L. Pitton*[1]; Charles R. Hall[2]; Darren L. Haver[3]; Sarah A. White[4] and Lorence R. Oki[1], *(1)UC Davis, (2)Texas A&M University, (3)University of California, (4)Clemson University*

Abstract: In the U.S., container plant growers often use expensive, high-quality water sources for irrigation. Irrigating with recycled irrigation runoff water has potential to reduce production costs. The objective of this study was to compare the cost of capturing and recycling irrigation runoff water to the cost of untreated municipal water at a nursery in Southern California during water years (WY) 2010-2016. Water year begins October 1 and ends September 30 of the following year. The untreated municipal water was supplied by Western Municipal Water District (Western), with the majority from Lake Mathews and a lesser portion from groundwater. The total cost of Western water consisted of variable charges based on volume used and fixed charges associated with the water delivery infrastructure. The irrigation runoff water capture and recycling system was installed at the end of water year 2014 and recycling began in water year 2015. The system included polyethylene and weed barrier lined growing beds and runoff channels, a lower capturing pond (10 ac-ft), an upper holding pond (27 ac-ft), pumps, rapid sand filters, and a chlorine dioxide injection system. The total price of recycled irrigation water consisted of consumable and capital costs. Consumable costs included electricity to operate two sets of pumps, one set for transferring water from the lower capturing pond to the upper holding pond and the other set for irrigating from the upper pond. Capital costs included the infrastructure and construction of the capturing and recycling system. Cost for Western supplied water ranged from $2.26 to $2.91 per 1,000 gallons for WY 2010-2016. The cost of recycled water was $0.92 and $1.21 per 1,000 gallons for WY 2015 and 2016, respectively. However, water provider rebates and a Natural Resource Conservation Service (NRCS) grant further reduced per unit volume cost of recycled water to $0.43 and $0.53 per 1,000 gallons for WY 2015 and 2016, respectively. Greater recycled water volume use resulted in lower per unit volume price for both scenarios, with and without rebates and grant. This is because the majority of recycled water cost is attributed to the large capital cost for the recycled water system. Due to its potential cost savings, recycled irrigation runoff water is a viable alternative to many high-cost water sources and public funding can help further reduce the cost of recycled water for growers of containerized plants.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

10:15 AM Tailoring Outreach to Your Audience

Alexa J. Lamm*[1]; Laura A. Warner[1] and Peyton N. Beattie[2], *(1)University of Florida, (2)UF/IFAS Center for Public Issues Education*

Abstract: Tailoring educational programming and communication messages to specific audiences has been found to have a strong impact on behavior change within the environmental space. Social marketing, a discipline that applies the principles of traditional marketing to alter behaviors focused on enhancing and protecting the environment, are especially effective. Social marketing is a new approach for extension education because it uses research on an audience to craft a strategy for behavior change based on the unique characteristics of the target audience identified. Social marketing strategies are specifically designed to enhance and highlight the benefits an audience associates with the adoption of a new behavior while decreasing their perceived barriers. The recent adoption of social marketing strategies among environmental outreach professionals has proven its effectiveness as a tool to encourage engagement in water

conservation behaviors within homeowner populations. Although social marketing has been successful in encouraging environmental behaviors, its potential application to agricultural irrigation conservation technology integration has not been fully explored. A team of researchers conducted a nationwide survey to identify specific characteristics of nursery and greenhouse growers to inform the adoption of new techniques and technologies focused on water conservation and treatment. While regional differences across the U.S. did not exist between growers, we did find growers with larger facilities were more likely to adopt and sustain their use of new technologies than those working in smaller operations. In addition, younger growers were more likely to take risk, innovate and try new technologies than their older counterparts. The findings indicated that extension education programming focused on encouraging the adoption of new technologies with nursery and greenhouse growers should be target specific audiences within the larger group. Recommendations include a) building partnerships between younger and older growers, b) focusing on reducing the costs of systems that could be integrated into smaller facilities, and c) developing opportunities for growers of all ages to connect with agricultural economists to conduct cost/benefit analysis for their operations associated with adoption.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

10:30 AM Tools for Growers to Assess Disease Risk

Jennifer L. Parke, *Oregon State University*; Cassandra Swett, *University of California Davis* and John Majsztrik*, *Clemson University*

Abstract: Plant disease management is an integral part of ornamental plant production. Nurseries and greenhouse operations typically take certain actions to limit disease incidence and spread, but they may be unsure which practices would be the most effective or have the lowest cost to implement. A system-based approach considers the whole operation to identify situations or practices that are most likely to spread plant diseases. There are printed assessments that growers could use to better understand practices that increase or decrease their risk of cultivating plant diseases at their operation. These written tools can be cumbersome, require specialized knowledge to complete, and are not linked to additional educational resources. To address these challenges, we developed a new online decision-support tool which prioritizes the most important disease hazards, so users can determine where to invest limited resources to have the greatest impact. The online tool also allows the user to select only those practices that are relevant to them (i.e. greenhouse production but not field production). The user receives immediate feedback to identify disease hazards associated with their current practices, and suggestions for corrective actions. Links to additional resources are provided. This decision-support tool should decrease disease losses and increase profitability over time, for growers who are willing to make the necessary changes in their production practices.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

10:45 AM Coordinating Water Quality Outreach to Best Reach Your Audience

Paul R. Fisher[1]; Maria Paz Kinslow[1]; Erin J. Yafuso*[1]; Bruce R. MacKay[2] and Sarah A. White[3], *(1)University of Florida, (2)thomasBaine Ltd, (3)Clemson University*

Abstract: A feature of irrigation water quality and conservation topics is the breadth of issues that horticulture growers face, each requiring specific recommendations. This diversity in water issues creates an opportunity and challenge for education. One approach we have taken is to develop detailed and representative case studies, for example a southern California nursery where water conservation practices were detailed and a positive economic return could be shown on investment in equipment for runoff capture and treatment. The CleanWater3.org website has research report components typical of grant projects, but we have maximized impact of publications and presentations with a biweekly posting of new research outputs in an email newsletter using Mailchimp™, in addition to Facebook™ updates.

Other notable features of CleanWater3.org include a modern tile appearance whereby each site visit cycles through a different set of highlighted solutions to water-related issues; an “Ask the Expert” function where questions are routed to the grant team and are turned into frequently-asked-question topics; and a training section that features upcoming face-to-face and online workshops. Interactive decision-support tools include Waterborne Solutions, which is a searchable database of research on efficacy of sanitizing technologies against plant pathogens; a WaterQC tool to interpret water test results such as ion levels and turbidity; and GroZone Tracker for organizing onsite monitoring soil testing data. With this social media and website presence, in 2018 we reached 2075 users per month.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

11:00 AM How Extension Can Use Social Media As a Tool for Outreach

Peyton N. Beattie*, *UF/IFAS Center for Public Issues Education*

Abstract: Communication methods have progressed over the years from traditional media, such as magazine, newspaper, radio, and television broadcasting, to newer approaches of media that involve the internet and social media. Media has evolved with the progression of its audience and today 69% of the public is using social media as a media source. Since a majority of the public is present on social media, Extension can use social media platforms as a way to communicate information to their nursery and greenhouse grower audiences. However, to make sure social media is an effective communication tool, there are a few key pieces of information to know before using social media or to assist in social media efforts. There are a number of social media platforms options that have different functions to reach different audiences. Such platforms include Facebook, Instagram, Twitter, and Snapchat. Facebook is the social media platform used by the largest number of people and will be the primary focus of this session. There are two options for setting up a Facebook account for organizational purposes, a *group* or a *page*. There are pros and cons for each option to be discussed in order to make an educated decision how to best communicate your outreach information to your audience. It is important to communicate your science in terms that are easily understandable to your audience. This can be done in a number of different ways that do not include having to create new content. Content that has already been generated can be repurposed using simple terms and additional resources to make it more comprehendible and visually appealing for your audience. Additional resources include Canva, an online platform that provides pre-designed templates that allow you to insert your information into these templates. The WateR3 grant team has recently integrated social media into their outreach efforts to disseminate information for nursery and greenhouse growers about reducing, remediating, and recycling water for their operations through Facebook. The outreach team creates posts that include a variety of content to engage their nursery and greenhouse grower audience with facts, tools, and research that could be beneficial in improving their water treatment and conservations practices in their operations. The purpose of this session is to help the session participants understand the basics of social media for them to then feel comfortable in using social media as an effective communication tool to meet their outreach needs.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

11:15 AM Water Security and Life Cycle Assessment - Impact of Water Recycling

Dewayne L. Ingram*[1]; Charles R. Hall[2] and Joshua Knight[1], *(1)University of Kentucky, (2)Texas A&M University*

Abstract: Life cycle assessment (LCA) is a research tool for systematically evaluating the inputs and processes in a product’s life cycle relative to potential environmental impacts. LCA has been used to analyze the production systems for trees, shrubs, flowering annuals and potted flowering crops, focusing on global warming potential and water consumption. Information from these analyses have been used to calculate water consumption and water footprints (WF) for these products using international standards relying on monthly water scarcity index for specific locations. The calculation of water scarcity has evolved over the last decade from a simple ratio of withdrawal-to-availability (WTA) in 2006 to the current method recommended for characterizing water use in life cycle assessment (WULCA) to a ratio relative to a global average of available water remaining (AWARE) in 2016.

Consumptive use in a location includes water used or degraded by human populations and our activities as well as water requirements to maintain ecosystems. The consumptive use portion of this equation for nursery and floriculture crops can be modified by increased irrigation efficiency, the capture, storage and recycling runoff water, and remediation of any potential contaminants in water discharged from the nursery or greenhouse site. Data will be presented to show the potential impact of such practices studied and proposed by the Clean WateR3 team on the model systems studied using LCA.
Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

***10:15 AM – 11:30 AM** Monroe*

Ornamental Plant Breeding 1

Moderator: David Byrne, *Texas A&M University*

10:15 AM Photoperiod Effects on Flowering and Propagule Production in *Gladiolus* Hybrids

Jaser A Aljaser* and Neil O. Anderson, *University of Minnesota*

Abstract: Photoperiod is flowering inductive for many species, along with other influential parameters. Cultivated gladiolus, *Gladiolus xgrandiflorus,* a geophytic species producing corms, is known to be a long day plant. New seed-propagated gladiolus hybrids have been developed although the interaction and influence of photoperiod on asexual propagules (cormel, corm production) is unknown and poorly understood in commercial hybrids. In this research our objective was to study the influence of photoperiod on flowering and foliage height, number of leaves, and asexual propagule production (corm weight, number of cormels and weight). Clonal replications of three new seed-propagated gladioli breeding lines of the University of Minnesota and 'Galmini', a commercial cultivar comparison, were tested in both long and short day treatments. Short days inhibited flower bud initiation and development, but also significantly reduced foliage height, the number of leaves, corm weight, number of cormels and weight by treatment and genotype. The short day treatment negatively influenced gladiolus overall performance in growth and development.
Specified Source(s) of Funding: Kuwait University and the MN Agricultural Experiment Station

10:30 AM Direct Organogenesis and Bulblet Regeneration of a Wild Bulbous Flower *Lycoris Sprengeri*

Ziming Ren*; Yiping Xia; Xuesi Lyv and Dong Zhang, *Zhejiang University*

Abstract: *Lycoris* is a bulbous plant of high medicinal, ornamental and ecological value; mainly distributed in East and South Asia. *Lycoris* has attracted the attention of synthetic organic chemists for their alkaloids that exhibit immunostimulatory, anti-tumor, anti-viral, and anti-malarial properties. Also, due to its distinctive flowers, *Lycoris* is a popular ground cover and cut flower crop. However, commercial *Lycoris* production and breeding have been hindered by its extended juvenile period and low regeneration rate under natural conditions. To date, no efficient regeneration system in *Lycoris* is available and the massive exploitation of bulbs has already caused considerable damage to wild resources and their natural habitats. In vitro propagation using different explants, including twin scales, multi scales, and floral organs, has had limited success. One factor hampering successful micropropagation of *Lycoris* might be the extremely high contamination rate. Another factor might be the difficulty in obtaining optimal explants since the accumulation and oxidation of phenolic compounds in mature tissues results in tissue browning and inhibited cell division. Here we established a bulblet regeneration system through direct organogenesis from the in vitro-derived probulbs of *Lycoris sprengeri*. The highest frequency (95.5±3.2%) of direct organogenesis was obtained on medium supplemented with 6.0 mg L^{-1} 6-benzyladenine (6-BA) and 1.0 mg L^{-1} α-naphthaleneacetic acid (NAA), of which a mean of 36.3±6.8 regenerated bulblets per explant were obtained after 6 weeks of culture. Histological studies at different developmental stages revealed the mode of direct organogenesis from the probulbs. An increasing amount of cytoplasmically dense cells were observed to rapidly form adventitious meristems, which later gave rise to multiple shoot buds, suggesting direct organogenesis for bulblet regeneration via this system. The optimal medium for rooting was MS medium with 1.0 mg L^{-1} NAA and 60 g L^{-1} sucrose. More than 98% of rooted bulblets survived after acclimation. Based on the establishment of this bulblet regeneration system, multiple genetically identical clones can be generated from a single seed-derived probulb in a relatively shortened breeding cycle (approximately 20 weeks).
Specified Source(s) of Funding: New Agricultural Variety Breeding of Zhejiang Province, Project NO. 2016C02056-13

10:45 AM Synthesis and Cleavage of Carotenoids Contributed to the Color Difference between Chinese Narcissus and Its Yellow-Tepal Mutant

Yi Zhou, *School of Landscape Architecture , Beijing Forestry University*; Ming Cai*, *Beijing Key Laboratory of Ornamental Plants Germplasm Innovation & Molecular Breeding, National Engineering Research Center for Floriculture and College of Landscape Architecture, Beijing Forestry University*; Qixiang Zhang, *Beijing Key Laboratory of Ornamental Plants Germplasm Innovation & Molecular Breeding , National Engineering Research Center for Floriculture , Beijing Laboratory of Urban and Rural Ecological Environment and College of Landscape Architecture, Beijing For* and Donglin Zhang, *University of Georgia*

Abstract: Chinese narcissus (*Narcissus tazetta* var. *chinensis*) was introduced 1300-1400 years ago and naturalized in coastal areas and offshore islands of southeastern China. It is one of popular Chinese traditional indoor flowers and famous flowering bulbs in the world with only two white-tepal triploid cultivars, 'Jinzhan Yintai' and 'Yulinglong'. Recently, a yellow tepal mutant was discovered and gained popularity quickly. We conducted pigment metabolite analysis and comparative transcriptome profile for 'Jinzhan Yintai' and the mutant. The tepal epidermis of the mutant had much more and larger chromoplasts than those of 'Jinzhan Yintai'. UV-visible spectroscopy concluded that total flavonoids and carotenoids were semi-quantified in five flowering stages, from green-tepal to semi-perish stage. Although no significant difference between the mutant and 'Jinzhan Yintai' when quantitative determination of total flavonoid content, the total carotenoids of the mutant were more than 10-fold higher. Using comparative KEGG pathway enrichment analysis, carotenoid related pathways in the two cultivars showed significant variations. The structure of carotenoids biosynthetic pathway in both cultivars was completed and *DXS* and *GGPS* genes expressed even higher in white narcissus. The downstream *PSY* and *NCED* genes, which played the essential roles in synthesis and cleavage of carotenoids respectively, were found to express in an opposite way. In white narcissus, the expression of *PSY* was decreased, while *NCED* genes in carotenoids degradation sub-pathway was increased. In mutant, though *PSY*, *ZDS*, *LCY*, even *NCED* were accumulated along with the flower open process, *PSY* displayed up-regulated expression and *NCED* down regulated remarkably when compared to the transcriptome of 'Jinzhan Yintai'. Therefore, adequate color pigments synthesized from carotenoids metabolic pathway in chromoplasts of the mutant tepals were not degraded, which led to the color differentiation.
Specified Source(s) of Funding: The Science and Technology Project of Zhangzhou

11:00 AM Screening of Rose Varieties for Rose Rosette Virus Resistance in Texas

Madalyn Shires*[1]; Kevin Ong[2] and David H. Byrne[1], *(1)Texas A&M University, (2)Texas A&M AgriLife Extension Service*

Abstract: Genetic resistance to diseases is an ideal trait to have in plants. One crop where resistance is needed is in roses. This is because of a viral disease that is decimating the rose industry. The *Rose Rosette Virus* (RRV) causes the disease known as Rose Rosette Disease. This virus is vectored by a microscopic Eriophyid mite, *Phyllocoptes fructiphlus*. This mite feeds on roses and females overwinter on the rose plant. There is research that suggests the mite can be controlled with miticides, however treatment only prevents infection if started before mites feed on plants. Unfortunately, once the rose is infected, there is no cure. Thus, the management approach is to eliminate infected plants to avoid disease spread. Efforts to identify resistance in a rose variety have been ongoing for four years. As of now, no resistant variety has been confirmed, however through ongoing screening activities, it is hoped that a resistant variety will be identified. Over

the last three years, field trials have been established in various parts of Texas to screen rose varieties. The plots were/are located in Wichita Falls (2 years), Dallas (Year 3), Farmers Branch (Year 2), Denton (Year 2), Cleburne (Year 2), and Dallas-Coit Rd. (Year 1). Approximately 160 rose varieties have been screened or are being screened through these plots. We have identified 3 roses (Bayse's Purple, Chuckles, Caldwell Pink) that appear tolerant to the disease. These varieties have tested positive for the virus (plants from Wichita Falls plot), but through the 3 years of screening have not developed symptoms. There is also one rose, 'Lafter', which is being screened in 7 locations across the United States that has not yet shown symptoms.

11:15 AM Rapid Phenotyping for Rose Breeding

David H. Byrne*[1]; Wenji Xu[2]; Yeyin Shi[3]; Ellen Young[1]; Jeekin Lau[1]; Stella Kang[1]; Jinha Jung[4]; Juan Landivar[1] and Sungchan Oh[4], *(1)Texas A&M University, (2)Shenyang Agricultural University, (3)Univ. Nebraska–Lincoln, (4)Texas A&M Corpus Christi*

Abstract: Ornamental cultivars need to be attractive throughout the growing season so there is a need for repeated evaluations on a range of ornamental and adaptation traits. Essential traits would be growth rate, flower productivity, flower size, flower color, leaf density, and disease resistance. Traditionally breeders evaluate their materials 2-3 times per year that results in an incomplete picture of the plant performance. In 2016, selected rose genotypes in a rose variety trial were photographed using with a tablet with a camera mounted on a selfie stick to obtain an overhead picture (2 m height) of the plant. In 2017, the entire field was photographed using an octocopter with a RGB camera at an altitude of 18 m. Concurrently the plots were evaluated on a monthly basis for flower intensity, defoliation, black spot incidence, cercospora incidence and landscape quality. The calculation of flower intensity of the digital images correlated well with the visual ratings of flower intensity. Using this approach, the rose plants were assessed for their ability to produce flowers through the year.

Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches" 2014-51181-22644/SCRI

10:15 AM – 11:45 AM

How Agricultural Research Gets Done in the US Federal Government: From Congress and Budgets to University and Industry Partnerships *CEU Approved*

Jefferson West

Coordinator: John Beaulieu, *USDA ARS*

Moderator: John Beaulieu, *USDA ARS*

Objectives:

The Federal Partners Professional Interest Group presents a significant speaker session and panel of USDA UnderSecretary, Administrators and National Program coordinators. They will deliver information regarding the major agricultural research agencies, importance from farm to fork, and the relevant interact mechanisms between agencies, universities and the industry. Ultimately, the panel will discuss broadly how the mission statements of the USDA and ARS are important to scientific research, food security and horticulture. This too embodies the Interest Group's goals. After the presentations, there will be a round-table forum discussing scientific exchange between Federal labs, Universities and the Industry.

Description: The four invited speakers will deliver roughly 15-20 minute talks followed by a panel session, round-table format Q&A. Dr. Chavonda Jacobs-Young will give a USDA overview in her role as the Acting Undersecretary for REE and Chief Scientist. Dr. Simon Liu, Associate Administrator, will give an overview from ARS' perspective: regarding how five year research projects operate. In the USDA ARS, the National Program Staff (NPS) directs research, and the Office of Scientific Quality Review (OSQR) program functions whereby review teams are our university and industry colleagues. Dr. Gene Lester will discuss several horticultural issues and how research and development in some national programs address societal and horticultural needs. Finally, Mojdeh Bahar, JD, will wrap everything together as she discusses how partnerships, patents and technology transfer paradigms and horticultural crops research and innovative are intertwined.

10:15 AM Advancing Agricultural Research

Chavonda Jacobs-Young*, *United States Department of Agriculture*

Abstract: At the United States Department of Agriculture (USDA), much of our work is focused on finding solutions to the unprecedented challenges facing the world's food and agricultural system. The global population is expected to reach over 9 billion people by 2050 and farming alone will not produce the food and fiber we will need. With diminishing land and water resources, we must use science and creativity to develop new technologies to help sustain our food production.

USDA recognizes the role scientific research plays in spawning innovation and supports maintaining a vigorous research infrastructure. The Research, Education, and Economics mission area responsibilities are carried out by four agencies: (1) the Agricultural Research Service (ARS) conducts intramural research in natural and biological sciences; (2) the National Institute of Food and Agriculture (NIFA) provides research grant funding to scientists who work at U.S. land-grant universities and other public organizations, including Federal agencies; (3) the Economic Research Service (ERS) performs intramural economic and social science research; and (4) the National Agricultural Statistics Service (NASS) conducts the Census of Agriculture and provides the official, current statistics on agricultural production and indicators for the economic and environmental welfare of the farm sector.

REE programs work to solve some of the most challenging problems in food and agriculture. Our scientists are researching ways to enhance crop production, including breeding new varieties, creating cost-saving technologies such as precision agriculture, and developing methods to adapt agriculture to changing climate conditions. Our research also provides scientific approaches for protecting agriculture while producing a food supply that is abundant and safe.

10:35 AM The 5-Year ARS Project Cycle: Research, Review, Revise

Simon Liu*, *United States Department of Agriculture*

Abstract: At the Agricultural Research Service (ARS), the chief in-house scientific research agency of the U.S. Department of Agriculture (USDA), our job is finding solutions to agricultural problems that affect Americans every day from field to table. To meet this mission, we have 2,000 scientists and post docs and 6,000 other employees who support 690 ARS research projects at more than 90 research locations across the United States and overseas. This work is funded by an annual appropriated budget of around $1 billion.

Research by ARS scientists ensures the production of high-quality, nutritious, and safe food, as well as other agricultural products and co-products. Their work helps to protect and enhance our natural resources and the environment. Just as important, their findings help support a competitive agricultural economy, and create economic opportunities in rural communities and other markets.

The 1998 Farm Bill called for USDA to establish procedures to perform scientific peer reviews of all ARS research projects to verify that its investigations have scientific merit and programmatic relevance. This review process is required at least once every 5 years, and uses a panel of external reviewers to assess the projects prior to implementation. To meet this mandate, ARS created the Office of Scientific Quality Review (OSQR) to manage and facilitate the ARS peer review process. This presentation will discuss how the OSQR process works, and how the peer-review process fits into the 5-year cycle of an ARS research project.

10:50 AM Horticultural Research: A USDA Perspective

Gene E Lester*, *USDA ARS/Quality and Utilization of Agricultural Products*

Abstract: Climate, water, food waste and quality are the interrelated areas of research. Food – in order to feed an estimated nine billion people by 2050 food supplies will need to double from current levels. The United States food system will have to increase the accessibility of safe and nutritious food, mostly from novel uses of plant products, as well as prevention of postharvest losses. It is one thing to produce more food, and it is

another to insure that the food produced is consumed. Researchable, interrelated postharvest factors which impact food involve: Climate change – do changes in CO_2, drought and temperature affect food quality and shelf-life? Water – concerns for drought mitigation, which impacts production and environmental sustainability, must include 'non-traditional' waters involved in fruit and vegetable processing, grading, and storage. And food waste and quality – new approaches to prevent, reduce or recover food waste by reducing food perishability, improving storage atmosphere/ temperature/ humidity/ lighting conditions, and food packaging systems which employ nanotechnologies with anti-microbial, antifungal and antioxidant properties. Consumer sensory (tastes, color and aroma), preferences and food habits will need to be exploited to enhance or develop new foods or food uses which aides food security.

11:05 AM Partnerships, Patents, Publications, Products: An Overview of Tech Transfer

Mojdeh Bahar*, *USDA ARS*

Abstract: This session covers an overview of technology transfer paradigm, policies and innovative partnerships. The examples will be drawn from horticultural crops.

10:15 AM – 11:45 AM *Jefferson East*

Marketing and Economics

Moderator: Julie Campbell, *University of Georgia*

10:15 AM Consumer Preferences and Willingness-to-Pay for Rose Attributes

Daniel Chavez; Marco Palma and David H. Byrne*, *Texas A&M University*

Abstract: Discrete Choice Experiments (DCE) are used to investigate consumer preferences and willingness-to-pay for roses. DCE is a technique for measuring buyers' tradeoffs among multiple attributes of products and services. It has been widely used in the field of marketing research to determine consumer's preferences for products. It is based on the simple premise that consumers evaluate the overall value of a product, service, or idea by combining the separate amounts of value provided by each product attribute.
In this DCE the evaluated features include price, disease tolerance, heat resistance, drought resistance, bloom size, and leaf coverage on perceptions, liking and willingness-to-pay for rose characteristics. With price ranging from $10-$25 and relative to the average price of around $12.70, large blooms generated price premiums of $4.40. Tolerance to disease, heat, and drought resulted in $12.80, $13.20, and $8.50 premiums, respectively. Full leaf coverage resulted in a $5.00 premium. While these were the average premiums, there was some heterogeneity in willingness-to-pay for all the product attributes. Eye-tracking was used to reveal visual attention to the rose attributes. The eye-tracking data is used to complement the choice data for attribute attendance in order to obtain more accurate measures of willingness to pay.

Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches" 2014-51181-22644/SCRI

10:30 AM Actively Interested and Passively Disinterested in Water Conservation Cluster Segments on Horticulture Product Spending in 2016

Melinda Knuth*[1]; Bridget K. Behe[2]; Charles R. Hall[1]; Patricia Huddleston[2] and Tom Fernandez, *(1)Texas A&M University, (2)Michigan State University*

Abstract: The strain on potable water supplies heightens the competition for water resources and potentially reduces demand for outdoor plantings and landscaping. Approximately 35% of domestic potable water is used for irrigation, 45% is used for thermoelectric production, but only 9% for public potable water supplies. Lifestyle influences water use. For individuals with high aesthetic and recreational priorities, outdoor water use is high. Recent research suggests attitudes towards the uses of potable water supplies have changed in other countries due to greater social awareness and increasingly widespread exposure to drought conditions. Education about and adoption of sustainable water use practices may help ensure an adequate supply of irrigation water while conserving water sources for human and ecosystem services. Other research suggests that consumers are willing to pay more for plants grown using more environmentally-friendly practices, including water conservation in plant production. We hypothesized that water conservation involvement and expertise may be negatively related to plant expertise and involvement and the importance of landscaping since individuals with high aesthetic and recreational priorities, use more water outdoors.
We conducted an online survey with 1,543 respondents in 2016 to ascertain their water conservation and plant expertise and involvement, horticultural importance, and demographic characteristics using a principal component analysis with orthogonal rotation which is used to describe the strength and direction of correlated variables in terms of their potential to quantify unobservable constructs. We then took the component results and conducted a K-means cluster analysis to find groupings in the data. Cluster analysis results identified two key market segments comprising ~50% of the sample each: those who are Actively Interested in Water Conservation and those who are Passively Disinterested in Water Conservation. Results show the Actively Interested Cluster segment spent almost twice as much as the Passively Disinterested segment in spending on plants and related supplies excluding equipment in 2015 and 2016. The Actively Interested in Water Conservation segment also purchased more annuals, vegetable transplants, herb transplants, perennials, flowering shrubs, evergreen shrubs, fruit producing trees, evergreen trees and shade trees in 2016. Findings suggest that pro-water conserving attitudes are found among consumers who value outdoor landscapes and those individuals who spent more on plants. Results suggest that producers and retailers should focus marketing and communication efforts on low-water use cultivar selection and operationalizing water conserving behaviors more than convincing consumers that plant purchases and landscaping are important.

Specified Source(s) of Funding: USDA SCRI Clean WateR3 – Reduce, Remediate, Recycle Grant Number 2014-51181-22372; USDA NIFA Hatch Projects MICL 02085 and 02473, and TEX0-1-7051; Michigan State University AgBioResearch, and MSU Project GREEN and Texas A&M AgriLife Research

10:45 AM Reasons for Use and Non-Use of Farmer's Markets and Roadside Stands

Julie Campbell*, *University of Georgia*

Abstract: The state of Connecticut is one of the most progressive states with respect to the local food movement. As such, there are numerous farmer's markets located throughout the state. However, many consumers still do not frequent farmer's markets to buy their goods, mainly produce. Using results from an online survey of around 850 consumers within Connecticut, we examine Connecticut consumer use and non-use of farmer's markets. Specifically, we examine the reasons why consumers shop at a farmer's market as well as the barriers for lack of shopping at a farmer's market. Our results indicate that 85% of consumers frequenting a farmer's market travel 20 minutes or less to shop at the market. The top two reasons why they shop farmers markets is for product freshness and the availability to buy local produce. With respect to non-users, 71% live less than 20 minutes from a farmer's market. However, respondents cited distance to the farmer's market and high prices as the main barriers for shopping at the market. Based on these and other findings, we make recommendations for farmer's market retailers and policy makers to increase farmer's market use.

11:00 AM U.S. Consumers Perceptions of Uses and Contents of Recycled and Reclaimed Water

Nikki McClaran[1]; Bridget K. Behe*[1]; Patricia Huddleston[1] and Charles R. Hall[2], *(1)Michigan State University, (2)Texas A&M University*

Abstract: Water is becoming a more scarce resource. Domestically, reduced potable water supplies may endanger current and future landscape plantings. Water recycling, the process whereby water undergoes treatment for reuse, could contribute to lessening the impact of impending water crises and mitigate economic damage to the horticulture industry. Positive (and accurate) consumer perceptions, and ultimately use, of recycled water is essential to its adoption for watering landscapes. Yet, consumer perceptions of differences between

terming such water as reclaimed versus recycled water have not been investigated. Our study objective was to fill the gap in the literature regarding consumers' perceptions of the content, perceived risk, and potential uses for recycled and reclaimed water. Funded by a USDA-SCRI grant, we developed an online survey (Qualtrics platform) with informed consent. We obtained 1265 complete responses from U.S. residents in September, 2017; half (n=634) responded to questions about reclaimed water and half (n=631) responded to identical questions regarding recycled water. Results showed mean ratings of the risk of using recycled water (versus reclaimed water) had significantly lower perceived risk (as rated on a 5-point Likert scale with 1=extremely risky and 5=extremely safe) for use in cooking (2.61 v. 2.77, p=0.009), bathing/showering (2.99 v. 3.14, p=0.016), watering lawn (3.77 v. 3.92, p=0.003), flushing toilet (3.97 v. 4.10, p=0.020), washing car (3.86 v. 3.97, p=0.049), and watering public park areas (3.72 v. 3.85, p=0.016). Analyses also showed that subjects' mean rating for risk in using recycled compared to reclaimed water for drinking and fire-fighting were similar. When asked what contents were in either recycled or reclaimed water, a lower percentage of participants perceived that reclaimed water contained 12 potentially harmful items (dyes, harmful chemicals, heavy metals, human waste, herbicides, insecticides, hormones, prescription drugs, pesticides, animal waste, composted plants, and composted animal waste). A similar percentage believed that recycled or reclaimed water contained chlorine, disinfectants, harmful bacteria, helpful bacteria, plant nutrients, pathogens, sanitizers, vitamins, and salts. We also found that a greater proportion of participants believed reclaimed water contained “nothing harmful”. The findings have substantial policy and educational implications. While perceptions drive behavior, education about water contents and potentially safe uses may help bring the U.S. closer to a tipping point where recycling water for non-potable uses can become more acceptable.

Specified Source(s) of Funding: USDA-SCRI

11:15 AM The North American Pawpaw Industry in the US – Supply, Demand, Challenges and Opportunities

Zhen Cai* and Michael A. Gold, *University of Missouri*

Abstract: The North American Pawpaw Industry in the US – Supply, Demand, Challenges and Opportunities

Abstract: The North American pawpaw (*Asimina triloba*) is a native specialty fruit crop that has been consumed seasonally by Native Americans for millennia. Conversely, pawpaw is largely unknown to the American consumer. This study aims to examine the current pawpaw industry in the US using the Porter Five Forces Model. A questionnaire was sent to pawpaw value chain market participants in 2017. Responses from 81 market participants were collected including: pawpaw fruit harvesters, tree and fruit growers, value added producers, distributors, retailers and wholesalers. Results indicate that the emerging pawpaw market has great potential with respondents uniformly indicating that demand is likely to increase over the next five years. However, the supply of grafted pawpaw cultivars and fresh pawpaw fruit is limited and fresh fruits are not shelf stable. At present, there is little competition within the US pawpaw industry, and pawpaw products have few substitutes. Lack of consumer awareness of pawpaws; short shelf life; unstable pawpaw product supply; lack of knowledge in growing, harvesting and marketing pawpaws; and strict shipping and food safety policies are potential barriers to entry that must be considered for potential and current producers to achieve success in the pawpaw industry.

Specified Source(s) of Funding: US Department of Agriculture: Agriculture Research Service

11:30 AM Assessing the Market Opportunities for Fruit and Vegetable Farmers: An Overview of Fresh Market Retailers’ Preferences

Ariana P Torres* and Maria Marshall, *Purdue University*

Abstract: The increasing demand for fresh fruit and vegetables offers important market opportunities to US farmers. Increasing popularity of local and organic foods and the expansion of direct-to-consumer and new intermediate market outlets allow farmers to capture a higher share of the consumer dollar. Despite these economic opportunities, developing new market linkages is challenging for fruit and vegetable farmers; particularly in light of the seasonality and volatility of the fresh market industry (Klonsky et al., 2002). Moreover, it is unclear what are the main trends driving retailers’ purchases as supply shortages, contract work, and small procurements become commonplace in the fresh market industry. This study investigates fresh market retailers’ preferences and requirements with respect to their produce suppliers. Face-to-face interviews with fresh produce retailers in Indiana were conducted in 2014 and 2015 about their current retailing operation, the buying decision-making process, supplier attributes, supplier-buyer contracts, retailers’ perceptions, and the importance of organic, conventional, and local attributes for retailers. The article also draws from a growers’ survey to tackle on the marketing gaps between growers and buyers of fresh market fruit and vegetables. Results show that Indiana fresh market retailers source from a variety of suppliers ranging from local farmers to local and regional wholesalers. Large grocery chains source mainly from regional distributors and wholesalers, for which formal written contracts and specific packaging, labeling, delivery, and traceability are key suppliers’ attributes. Smaller retailers in urban and rural counties source mostly from local farmers where flexible sales arrangements, trust-based transactions, and supply reliability are important farmers’ attributes. While product pricing is an important supplier attribute, most retailers offer farmers price premiums for locally grown produce. Regardless of size or location, most retailers recognize the effect of television and internet on customer purchasing behavior. Large and small retailers reported the value of capturing consumers’ preferences for developing marketing strategies, but they tend to gather consumer demand differently. Large grocery chains capture consumer trends through inventory turnover and weekly sales, while small specialist retailers strive to know their customers, understand their needs, and encourage employees to answer customers’ questions. Increasing the marketing opportunities for local fruits and vegetable farmers is important to assure the sustainability of the specialty crop industry. This research shows that quality produce, affordable prices, and reliability are key attributes sought by retailers Policymakers, researchers, and extension agents can use these findings to assist farmers in developing new and maintaining existing market linkages.

Specified Source(s) of Funding: NIFA-OREI

10:15 AM – 11:45 AM

National Programs and Resources in Pest Management for Horticulture Researchers and Professionals *CEU Approved*

Lincoln West

Coordinator: Mary Rogers, *University of Minnesota*

Moderator: Mary Rogers, *University of Minnesota*

Objectives:

1. Provide an overview of current national programs and resources available to horticultural professionals that aid in pest management, including weeds, diseases, and insects2. Discuss ways horticulturists can use these resources to improve their work in research, Extension, and teaching3. Allow time to discuss new and emerging pest (insects, weeds, diseases) threats to horticultural industries

Description: Management of weeds, diseases and insect pests in horticultural crops remains considerably challenging for producers. Stakeholders and land owners depend on knowledge and recommendations from professional horticulturists, including Extension educators, crop consultants, and researchers in order to manage endemic and invasive species. These challenges are increasing in complexity as we are faced to address risks posed by new invasive species, chemical resistance, labor shortages, new regulations on pest protectants, and climate change. In the horticultural crops sector, there is increasing demand from stakeholders for environmentally sustainable management practices that protect beneficial species such as pollinators and monarch butterflies, for example. Increasingly, management practices need to be effective but at the same time selective to limit negative effects on beneficial organisms. There are a number of national programs that can help horticulturists address these management challenges and develop robust research projects and outreach programs. The ASHS conference is the ideal venue for knowledge sharing and provides an opportunity for continued education, dialogue and discussion around dynamic national priority issues. In this workshop, we will highlight resources that

horticulturists can connect with to improve research and outreach programs devoted to sustainable practices for weed, disease and pest management in fruit and vegetable production systems. Speakers will provide an overview of their programs and initiatives and describe how horticulturists may connect with or benefit from their programs. Participants will discuss the utility of current resources, identify any gaps in resources, and generate ideas for future endeavors.

The last 30 minutes of the workshop will feature an interactive panel discussion with the three speakers to allow for general discussion. The moderator will be prepared with questions to stimulate discussion between the speakers and the audience members on the utility of the resources identified as well as highlighting other resources not covered here. We will also spend time discussing needs and priorities for managing newly emerging pests, diseases, and weeds significant to various horticultural industries.

10:15 AM **USDA-NIFA's Programs in Crop Protection**
Herbert Bolton*, *USDA NIFA*

10:35 AM **How the Regional IPM Centers Can Support Horticultural Science**
Joseph LaForest*, *University of Georgia*

10:55 AM **The First Detector Program: Training and Tools to Promote Early Detection**
Rachel McCarthy*, *Northeast Regional Center for the National Plant Diagnostic Network*

11:00 AM – 12:00 PM *Boundary (Terrace Level)*

Annual Conference Technical Program Committee

Chairs: Dennis Ray, *University of Arizona* and Carl Sams, *The University of Tennessee*

Members: William Baird, *Michigan State University*; Casey Barickman, *Mississippi State University*; Jeanine Davis, *North Carolina State University*; William Evans, *Mississippi State University*; Justine Vanden Heuvel, *Cornell University*; William Miller, *Cornell University*; Michael Neff, *ASHS*; Dayton Wilde, *University of Georgia* and Tracie Matsumoto, *USDA ARS Daniel K. Inouye US Pacific Basin Agricultural Research Center*

11:00 AM – 12:00 PM *Oak Lawn (Lobby Level)*

Citrus Crops (CITR) Meeting - Open to All Attendees

Chair: Catherine Simpson, *Texas A&M University, Kingsville Citrus Center*

Chair-elect: Manjul Dutt, *University of Florida*

Secretary: Davie Kadyampakeni, *University of Florida*

Objectives:

To provide a forum for exchange of ideas between the various specialists in citrus research and citrus extension personnel.

11:15 AM – 12:15 PM *Georgetown West*

Undergraduate Student (UG) Meeting - Open to All Attendees

Chair: Ashlyn Perry, *Auburn University*

Chair-elect: Connor Hagemeyer,

Secretaries: John Scott, *N/A* and Alonso Loredo Gaspar, *TAMU*

Objectives:

To foster collegiality among undergraduate students in horticultural sciences.

11:30 AM – 12:30 PM *Jay (Lobby Level)*

Research Advisory Council Meeting - Open to All Interested Members

Chair: Randolph Beaudry, *Michigan State Univ*

Member: Dean Kopsell, *The University of Tennessee*

11:45 AM – 12:15 PM *Jefferson West*

Federal Partners (FP) Meeting - Open to All Attendees

Chair: John Beaulieu, *USDA-ARS*

Secretary: Jerry E. Weiland, *USDA-ARS Horticultural Crops Research Unit*

Objectives:

To provide a network for horticultural professionals who work for national, federal, state, and local governments. To provide linkages to university and industry colleagues to promote exchange of ideas, common research goals, and multilevel approaches to large and/or complex issues affecting horticulture and food security.

11:45 AM – 12:15 PM *Lincoln West*

Weed Control and Pest Management (WCPM) Meeting - Open to All Attendees

Chair: Mary Rogers, *University of Minnesota*

Chair-elect: Craig Ramsey, *USDA-APHIS*

Secretary: Ajay Nair, *Iowa State University*

Objectives:

To share new ideas and other research information concerning pest control in the varied areas of horticultural crop production.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Citrus Crops (Poster)

Citrus Root Production and Fruit Yield Improves with Raised Bed and Groundcovers (poster)

Catherine Simpson*, *Texas A&M University, Kingsville Citrus Center*; Julian Gonzales, *Texas A&M University Kingsville*; Mamoudou Setamou, *Texas A&M University, Kingsville Citrus Center* and Shad Nelson, *Texas A&M University, Kingsville (Poster Board #367)*

Abstract: Improved citrus management practices have become important as yields decline due to diseases, pests, and drought. Plastic mulch groundcovers are among some of the most promising practices being evaluated; improving water conservation by reducing evaporative losses from the soil, improving management of some pests and soil borne diseases, and limiting weed growth. These groundcovers can also promote deeper root systems and fine root production. In southern Texas, citrus are particularly vulnerable to drought due to the predominate method of flood irrigation, the subtropical climate, sporadic rainfall, and limited water resources. Flood irrigation causes significant water losses, nutrient losses, salt buildup, and erosion. Using alternative citrus management practices can potentially reduce the frequency and amount of water applied, but also has the potential to maintain water in the soil during times of drought and water scarcity. However, the initial cost of groundcover installation is a deterrent to many growers who would like to know if trees will come into production faster or yield more to defray the cost. To evaluate this, four management strategies were studied to evaluate tree growth rates and yield over 4 years and root growth and turnover for 2 years. Raised beds with groundcovers have led to increased root biomass, surface area, yields, and fruit weight. There were various impacts of groundcover and raised bed, but the combination of raised bed and groundcover seemed to have an additive impact on tree growth, yield, root production, and fruit quality. Furthermore, root biomass and area at deeper soil depths was increased compared to the conventional flat bed with no groundcover

production system. Trees come into production faster and have greater yields, which should defray the costs associated with groundcover installation. Overall, using a raised bed with groundcover system shows positive impacts on production and holds much promise for citrus producers facing challenges due to water shortages, drought, or resource limitations.

Specified Source(s) of Funding: USDA/NIFA NNF Award No. 2014-38420-21798 Title: Sustainable Agriculture in Semiarid Areas: An International & Interdisciplinary Approach to Graduate Education, Texas Water Development Board Contract No#1513581823,

Assessment of Cold Hardiness of Citrus in North Florida after a Decade of Global Warming (poster)

Peter Andersen*, *University of Florida* and Brent Brodbeck, *University of Florida North Florida Research and Education Center (Poster Board #368)*

Abstract: A warming climate during the last decade has renewed interest in the culture of citrus in north Florida and in the states bordering the northern Gulf of Mexico. This industry mainly consists of satsuma. Satsuma can withstand about – 10 to -12 ^{o}C when properly cold acclimated. The fruit have few seeds, have a narrow harvest interval during November and must be clipped from the tree. There is ample justification for the diversification of citrus in north Florida to encompass the production of fresh market citrus from Mid-September thru December. Citrus packing houses and a juice plant have been established in north Florida to facilitate industry growth. Citrus Greening, which has decimated citrus production in the Florida peninsula, has not yet been detected in commercial groves in north Florida. Some of the cold hardy citrus that have been grown successfully in north Florida include Early Pride, Minneola Honey Belle, Navel, Orlando Tangelo and Sugar Belle. The UF Citrus Breeding Programs at the Citrus Research and Education Center in Lake Alfred have released the mandarin hybrids Seedless Snack and Bingo and several numbered selections (UF 900, UF 950 and UF C4-15-19) are under trial. In addition, the Citrus Breeding Program in Gainesville has just released the mandarin hybrids UF Dawn, UF Glow and UF Sunrise. The above genotypes are currently under trial at the NFREC-Quincy. Young tree survival and tree growth have been improved by microjet freeze protection. One major goal is to identify fresh market commercial citrus that can compete in the Cutie/Halo Market from September thru December.

Specified Source(s) of Funding: Florida Department of Food and Agriculture Specialty Crop Grant

Intra-Plant Movement of *Candidatus* Liberibacter Asiaticus in Citrus (poster)

Robert Ebel*, *Integrated Plant Health Services LLC (Poster Board #369)*

Abstract: Huanglongbing (HLB) is a disease complex that in Florida putatively involves the gram-negative bacteria *Candidatus* Liberibacter asiaticus (*C*Lasiaticus), the psyllid vector *Diaphorina citri* Kuwayama that introduces *C*Lasiaticus into sieve tube elements of phloem, and secondary stresses that take advantage of the weakened tree. In commercial groves, the combined factors promote the most serious symptoms of decline. In greenhouses where psyllid vectors are excluded and secondary stresses minimized, a single inoculation of trees promotes only mild symptoms. The better growing conditions in greenhouse studies have also demonstrated that *C*Lasiaticus is capable of moving into new growth, but the pathway is currently not known. Four hypotheses on *intra-plant* movement of *C*Lasiaticus are presented and discussed, including 1) sieve tubes naturally develop into a network that extend the full length of the tree and develop across growth flushes, 2) the presence of *C*Lspecies promotes development of a network of sieve tubes that extend the full length of the tree and develop across growth flushes, 3) the host's cell walls become debilitated allowing *C*Lasiaticus to traverses the apoplast, and 4) sieve tube injury by mechanical or pathogenic processes allows *C*Lasiaticus to move from infected to uninfected sieve tubes. Elucidating the mode of *intra-plant* movement of *C*Lspecies will facilitate development of strategies that impede movement and coupled with strong psyllid-vector suppression programs in commercial groves should help citrus trees "grow" out of HLB by restricting *C*Lasiaticus to old phloem.

Specified Source(s) of Funding: Integrated Plant Health Services LLC

Oxidative Stress in HLB-Affected Fibrous Root Orders in Citrus (poster)

Naveen Kumar*, *University of Maryland Eastern Shore* and Robert Ebel, *Integrated Plant Health Services LLC (Poster Board #370)*

Abstract: Oxidative stress is a critical component of plant metabolism and play an important role in plant defense against both biotic and abiotic stresses. Our work showed partial suppression of oxidative defense in HLB-affected fibrous root orders. One-year-old 'Valencia' sweet orange (*Citrus sinensis* L. Osbeck) trees on *Swingle citrumelo* were budded with HLB-infected budwood to determine the HLB-induced oxidative damage in fibrous root orders. Three independent experiments (2011-2013) were conducted in a randomized complete block design with seven blocks, and one plant of each treatment per block in the greenhouse. Seven trees were used for each treatment. The means per plant was determined and subjected to analysis of variance (SAS Institute, Cary, NC) and separated using a protected least significant difference (LSD) at $P < 0.05$. The standard error of the mean was also calculated. Four fibrous root orders were observed in one-year-old healthy 'Valencia' sweet orange (*Citrus sinensis* L. Osbeck) trees on rootstock *Swingle citrumelo.* First order (1st) roots were subtending on second order (2nd) and second order roots on third order (3rd) and third order on fourth order roots (4th), which are finally spanned on thick rudimentary taproot. The thickness (visual observation) of roots within various root orders declined from 4th order to 1st order. The concentration of hydrogen peroxide (H_2O_2) was higher in HLB-affected root orders in comparison to healthy controls. H_2O_2 concentration declined from higher (1,310 nmol g^{-1}fw) to lower (620 nmol g^{-1}fw) root orders. Similarly, the steady state levels of H_2O_2 concentration also varied in different root orders (4th order; 820 nmol g^{-1}fw, 1st order; 320 nmol g^{-1}fw) of healthy trees. However, these levels were low in comparison to HLB-affected root orders. The specific activity of total superoxide dismutase, guaiacol peroxidase, and catalase was higher in HLB-affected fibrous root orders. However, the specific activity of ascorbate peroxidase (APOD) declined in HLB-affected fibrous root orders. APOD is an integral part of ascorbate-glutathione cycle, which detoxify deleterious levels of free radicals in plant cells. Limited activity of APOD can restrict normal functioning of ascorbate-glutathione cycle and accompanied higher levels of H_2O_2, which caused the severe decline in fibrous root orders.

Field Evaluations of *Trichoderma Asperellum* As Biocontrol Agent Against *Phytophthora* foot and Root Rot in Citrus (poster)

Meena Gurung*, *Texas A&M University-Kingsville*; Catherine Simpson, *Texas A&M University, Kingsville Citrus Center* and Veronica Ancona, *Texas A&M University-Kingsville (Poster Board #371)*

Abstract: Citrus production in south Texas is largely affected by *Phytophthora* foot and root rot disease. The causal agent, *Phytophthora nicotianae*, is an oomycete that causes root rot and trunk gummosis, leading to poor yield, tree decline, and eventually tree death. *Trichoderma spp.* is a soil fungi capable of suppressing several plant pathogenic fungi including *Phytophthora* spp. Our previous studies revealed that native *Trichoderma* isolates possess anti-fungal activity against *P. nicotianae* in vitro. One isolate showed strong mycoparasitism and sequence analysis confirmed it as *Trichoderma asperellum*. Greenhouse evaluations showed that *T. asperellum* protected citrus seedlings from *P. nicotianae* infection and promoted seedling growth. The aim of this study was to continue the evaluations of *Trichoderma* by performing field evaluations on the effectiveness of *T. asperellum* in preventing *Phytophthora* infections and its impact on tree growth. Applications of *T. asperellum* were performed in three different locations in South Texas, with each site planted with Rio Red grapefruit trees at different developmental stages (new planting, 2 years old and mature trees), *Phytophthora* populations, and infection levels. Initial measurements were recorded to assess differences between treated and untreated trees. Evaluation of tree growth parameters such as tree height, leaf area and trunk diameter have been performed every three months in each location for a year. *Phytophthora* quantification revealed that soil propagules were reduced after six months post application. Significant

differences were not observed in growth parameters of trees between treated with *T. asperellum* and untreated control within first year of the study. The ongoing field studies will further determine *T. asperellum* as potential biocontrol agent against *Phytophthora* foot and root rot.

Specified Source(s) of Funding: Texas Citrus Producers Board

Interaction of Huanglongbing and Foliar Applications of Copper on Growth, Nutrient Acquisition, and Water Relations of *Citrus sinensis* Cv. 'Valencia' (poster)

Robert Ebel*, *University of Florida*; Said Hamido, *University of Florida* and Kelly Morgan, *University of Florida (Poster Board #372)*

Abstract: The following study was conducted to determine the impact of frequent foliar Cu applications, which are used to suppress citrus canker caused by *Xanthmonas citri* subsp. *citri* in commercial groves, on Huanglongbing (HLB)-affected *Citrus sinensis* cv. 'Valencia'. The experiment was conducted in a psyllid-free greenhouse with HLB positive and non-HLB control trees grown in Immokalee fine sand soil and well-maintained to promote health. Cu was applied to the foliage at 0x, 0.5x, 1x, and 2x of the commercially-recommended rate, which were 0, 46, 92, and 184 mM, respectively, with applications made 3x in both 2016 and 2017. The impact of HLB and Cu treatments on leaf and root Cu concentrations, vegetative growth, *Candidatus* Liberibacter asiaticus titer, acquisition of other essential nutrients, and water relations were determined. HLB acidified the soil more than non-HLB controls, which promotes Cu availability and promoted higher Cu contents in leaves and roots. HLB and Cu application treatments suppressed leaf area and total root length observable in rhizotron tubes such that by the end of the experiment leaf, stem, root and whole plant dry weights were reduced. HLB reduced foliar concentrations of Ca, Mg, Mn, Zn and possibly Fe, but HLB did not affect root concentrations of these same essential nutrients. Cu application treatments did not affect leaf or root concentrations of other essential nutrients except foliar content of Fe which may have been suppressed. HLB suppressed stem water potential slightly compared to the non-HLB controls. Stomatal conductance and transpiration flux were reduced at the higher rates of Cu applied. Traditional recommendations for Cu applications to control HLB may have to be reconsidered in commercial citrus groves due to the impact on growth and development.

Effect of Propagation Methods on Citrus Rootstock Water Uptake (poster)

Ricardo Alberto Lesmes-Vesga*, *University of Florida*; Rhuanito Soranz Ferrarezi, *University of Florida*; Ute Albrecht, *Southwest Florida Research and Education Center, University of Florida/IFAS* and Kim Bowman, *USDA-ARS (Poster Board #373)*

Abstract: Huanglongbing or greening disease increased the need for new plantings and resetting in the field. To meet the high tree demand, citrus nurseries need high-quality, fast-growing rootstocks. Vegetative propagation is an alternative to the traditional seedling production due to the increased turnaround in the nursery. However, it may induce changes in the root system architecture and the development of adventitious roots instead of the taproot, altering root morphology and potentially the water uptake performance. The objective of this study was to compare the plant water uptake of citrus rootstocks propagated using different methods. We tested four citrus rootstocks {'Swingle' [*Citrus paradisi* × *Poncirus trifoliata*], 'US-942' ['Sunki' (*Citrus reticulata*) × 'Flying Dragon' (*Poncirus trifoliata*)], 'US-897' ['Cleopatra' (*Citrus reticulata*) × 'Flying Dragon' (*Poncirus trifoliata*)], and 'US-802' ['Siamese' (*Citrus grandis*) × 'Gotha Road' (*Poncirus trifoliata*)]} and three propagation methods (seed propagation, stem cuttings and tissue culture). The study was arranged in a split-plot design with rootstocks as the main plot factor, and propagation methods as the subplot factor. Main plots were arranged in a completely randomized design with four replications with four trees each. Trees were planted in November/2017, spaced 1.2 × 7.0 m apart, and received the same cultural practices. Microsprinklers were set under a daily irrigation schedule, and trees were fertilized using control-released fertilizer. Plant water uptake was measured using 48 sap flow sensors (SF3; Edaphic Scientific, Port Macquarie, Australia) to estimate transpiration rate. Data were obtained every 15 minutes using a set of data loggers (CR1000X; Campbell Scientific, Logan, UT) and multiplexers (AM16/32B; Campbell Scientific) installed in the field in waterproof boxes. The system was completely powered by rechargeable batteries and solar panels. The 3-needle sap flow sensor was inserted into the trunk of 1-cm diameter young trees selected randomly in the field. Daily water uptake followed the evapotranspiration pattern as reported by the Florida Automated Weather Network. 'US-802' propagated by stem cuttings and tissue culture presented lower transpiration rates, while seed propagation the higher values. 'Swingle' and 'US-897' presented the lowest transpiration rates when propagated by seeds. Propagation methods affected the water uptake in field conditions for the initial tree development stages (4-6 months after planting) in some rootstocks tested. New propagation methods have the potential to accelerate rootstock production and meet the existing tree demand without interfering in adequate water uptake. However, long-term effects are unknown and still under evaluation.

Specified Source(s) of Funding: Funding for this research was provided by the UF/IFAS 2017-2018 Citrus Initiative.

Effect of Stimplex on Nutrient Uptake in HLB-Affected Citrus Plants (poster)

Lushan Ghimire*, *Citrus Research and Education Center, University of Florida*; Holly Little, *Acadian SeaPlants* and Tripti Vashisth, *University of Florida (Poster Board #374)*

Abstract: Huanglongbing (HLB) is one of the most devastating diseases of citrus . In preliminary studies, it has been found that HLB-affected leaves often display deficiency for several nutrients. In addition, it has been reported that HLB-affected plants have compromised roots system as compared to healthy plants, which likely can reduce the water and nutrient uptake among HLB-affected plants, eventually leading in reduced productivity and decline. Several citrus growers within the state of Florida have reported to use intense and enhanced plant nutrition to compensate for the reduced root system. Commercial extracts from *Ascophyllum nodosum* are found to contain trace amounts of macro and micro elements, amino acids, vitamins, cytokinins, auxins, ABA-like compounds and quarternary ammonium compounds. Thus, application of Stimplex (a commercial alkaline extract of *Ascophyllum nodosum*) to the growing media can increase availability of mineral nutrients to the plant. Therefore, the overall goal of this study was to determine the effect of stimplex in improving nutrient uptake among healthy and HLB-affected plants.The scion and rootstock combination of 'Valencia' sweet orange (*Citrus sinensis*) and 'Swingle citrumelo' (*C. paradisi* Macf. x *Poncirus trifoliata*) was used in this study. Healthy (HLB-negative) and HLB-affected plants were grown on the liquid media of Hoagland solution. The plants were arranged in randomized complete block design (n=6). The four treatments included, healthy plants, HLB plants, healthy+Stimplex plants, HLB+Stimplex plants. A considerable leaf drop was observed in HLB positive plants however, HLB+Stimplex had least leaf drop during the course of experiment. HLB+Stimplex was the only treatment in which leaf chlorophyll content stayed constant throughout the experiment compared to other three treatments where the chlorophyll content decreased over time. At the end of experiment HLB+Stimplex treatment had 23% and 15% more chlorophyll compared to HLB and healthy plants, respectively. Overall, this data suggests that Stimplex application has potential to improve the performance of HLB-affected plants by improving the nutrient uptake. Nutrient analysis of the growing media, leaf nutrient analysis, assessment of reactive oxygen species, gene expression analysis for HLB and nutrient related genes is underway to understand the mechanism of HLB and Stimplex interaction. We expect that the results of this study will benefit the citrus growers in developing economical and environment friendly grove nutrient management strategies with limited use of fertilizer and enhancing nutrient availability with use of seaweed extract.

Evaluation of Pruning and Controlled Release Fertilizer to Rehabilitate Huanglongbing-Affected Sweet Orange Trees (poster)

Tripti Vashisth*, *University of Florida* and Taylor Livingston, *University of Florida (Poster Board #375)*

Abstract: Previous research has shown that Huanglongbing (HLB) -affected trees have a reduced root system and a higher rate of root turnover. The diminished root system cannot support the existing above ground canopy and fruit production; as a result,

the tree enters into a continuous carbohydrate stress cycle and the tree declines in overall health. Therefore, the objective of this study was to evaluate different levels of pruning as methiod to correct for root to shoot ratio and improve growth and productivity of HLB-affected trees. In January of 2015, a 3 year trial was initiated, 15-year-old grove of 'Hamlin' on 'Swingle' rootstock were divided for four pruning treatments. The four pruning treatments were: (1) 0%, no canopy removal; (2) 25% reduction; (3) 50 % reduction; (4) 80% reduction. The two sources of fertilizer used were: (1) conventional fertilizer (dry granular; CNV) applied at 200 lb/acre nitrogen in 5 split applications and (2) controlled release fertilizer (CRF) applied at150 lb/acre nitrogen, split in 3 applications. Within each pruning treatment, half of the trees received conventional fertilizer (CNV) and the other half received CRF. All the trees that were pruned produced new flush that looked healthy with no HLB symptoms (initially). The 80% pruned trees grew vigorously over the course but are still significantly smaller than the canopy of control trees (0% pruning) for both CRF and CNV. The 25% and 50 % pruned tree canopies grew back and were similar in canopy size as 0% control pruning treatment by end of year 2. In the first year, the yield for 25%, 50%, and 80% were significantly lower. In the second and third year, the yields of all pruned trees were significantly improved and there was no significant difference between 0, 25, and 50% pruning. A significant correlation was observed between canopy volume and yield. The brix value of juice from the fruit was observed to decrease with a decrease in canopy volume. A clear inverse relationship between canopy volume and pre-harvest fruit drop was observed. Overall, our results indicate that pruning did not improve the productivity HLB-affected trees over the course of 3 year. Therefore, pruning may be viable option to rejuvenate the HLB-affected trees. No significant differences were observed between the two forms of fertilizer for any of the measured parameters, therefore with use of CRF amount nitrogen and frequency of application can be reduced.

Stop the Drop: A Comparative RNA-Seq Analysis of Sugar Belle and Hamlin Fruit Abscission Zones (poster)

Flavia Tabay Zambon*, *University of Florida*; Tripti Vashisth, *University of Florida* and Jude Grosser, *University of Florida (Poster Board #376)*

Abstract: Fruit drop is one of the many HLB symptoms and is the main cause of yield loss in citrus production. Results from the UF-CREC citrus breeding program show that Sugar Belle has tolerance to HLB, good yield, vigorous growth, and can retain its fruit for 30 days past optimum maturity. Compared to Hamlin, which is very susceptible to HLB and subjected to a high fruit drop rate. Our hypothesis is that Sugar Belle abscission zone (AZ) has a low expression of cell wall degradation, ethylene, auxins and abscisic acid pathway biosynthesis, thereby decreasing fruit abscission when compared to Hamlin AZ. Twenty Sugar Belle and Hamlin fruits were collected from 16 trees (8 per variety) in November 2016. Fruits were pulled from stems and the force to detach was measured. Fruit that detached with a force below 5 kgf were considered loose fruit, and equal or above 5 kgf were considered tight fruit. Fruit abscission zone RNA from homogenous samples of loose and tight Sugar Belle and Hamlin fruit were extracted and sequenced. Over 16,000 genes were differently expressed. A threshold of four-fold change was used to filter the full sequence data resulting in 699 different expressed genes. Genes related to pectin, carbohydrate transport, response to hormones, and abscisic acid signaling were downregulated in Hamlin. Lignin-related genes were overexpressed in Hamlin. Upregulation of ethylene and cell wall degradation related genes were found in Sugar Belle AZ, indicating initiation of the abscission pathway, however Sugar Belle fruit remain attached to the stems. Our RNAseq results suggests that low fruit drop in Sugar Belle is not associated with altered expression of abscission related genes. Further, anatomical and physio-chemical studies could explain why Sugar Belle fruit endure the abscission process.

Specified Source(s) of Funding: UF/IFAS Early career seed grant and Citrus initiative

Quantifying Citrus Tree Health & Disease Progression Using True Color UAS Images (poster)

Blanca N. Garza*, *Texas A&M University-Kingsville*; Veronica Ancona, *Texas A&M University-Kingsville*; Juan Enciso, *Texas A&M AgriLife Research*; Humberto Perotto, *Texas A&M University-Kingsville* and Catherine Simpson, *Texas A&M University, Kingsville Citrus Center (Poster Board #377)*

Abstract: Citrus diseases, like Huanglongbing (HLB) and Phytophthora, are challenging to citrus growers in the Lower Rio Grande Valley (LRGV) due to their impacts on yield and production. These diseases are associated with symptoms and physiological changes which can be evaluated through field measurements to help quantify their impacts on tree health. Nonetheless, physiological measurements, such as tracking crop physiological stages, health status, disease progression, and yield potential, can be difficult to determine due to environmental factors, inaccessibility, etc. To address this concern, unmanned aerial systems (UAS) have recently been introduced as an innovative way to monitor crop growth and production factors. Current UAS research has focused on a graphical display using near infrared (NIR) cameras to determine tree health. While this has had promising success in tree evaluation and health assessment, equipment and cameras are cost prohibitive to many growers. One less expensive alternative is red/green/blue (RGB) or true color imaging, for remote sensing and crop evaluation. True color images can provide farmers with data that is informational and practical for monitoring citrus trees. To assess its feasibility in tree evaluation, we will fly a DJI Phantom 4 Pro Quadco aircraft with a RGB camera every 4 months in 2017 and 2018. The objective is to determine if true color images can provide accurate data on citrus health using less expensive and labor intensive methods. Preliminary assessments of tree health in a HLB affected field of Rio Red grapefruit trees on three different rootstocks indicate that HLB distribution varies by location and rootstock. Of the rootstocks surveyed, trees on C146 rootstocks had a lower incidence of *Phytophthora* infection and HLB + *Phytopthora* infection. Additionally, the percentage of healthy trees was highest in trees on C146 rootstocks followed by trees on C22 rootstocks and C57 rootstocks. UAS images have been collected and are currently being processed for correlation with these field findings.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Commercial Horticulture (Poster)

LSU Ag Center 2017 Red Cabbage Variety Trial (poster)

Mary Sexton*, *LSU AgCenter (Poster Board #085)*

Abstract: Red cabbage is a commonly grown cool season vegetable. In Louisiana, cabbage is primarily sold at fresh markets, where head size is of concern to buyers. Typically green cabbage produces a larger and heavier head than red cabbage produced in Louisiana. Therefore a variety trial was conducted to determine if a particular variety of red cabbage yields heavier weights than others grown when grown in the fall season. Nine varieties were planted at a farm in southeast Louisiana. The heaviest yielding red cabbage variety was 'Rio Grande Red'.

Crop Load Reduction in Peach (*Prunus persica* L.): The Effects of Timing and Intensity (poster)

Mary K. Sutton*, *University of Georgia*; Anish Malladi, *University of Georgia* and Dario J. Chavez, *University of Georgia (Poster Board #086)*

Abstract: During the early growing season, fruit growth is limited by competition among fruits for available resources. Thinning is a cultural practice commonly performed in tree fruits to reduce this competition and maximize fruit growth. Reducing crop load can lead to a larger fruit size and ultimately a higher total yield. The timing of thinning in relation to fruit development, and its intensity impact the efficacy of the treatment. Furthermore, the response to thinning can be cultivar dependent and can be affected by local weather, especially during early spring. The objective of the current study was to evaluate various timings and intensities of thinning for several cultivars grown in Georgia. We evaluated the effects of three thinning times (at bloom, ~40 days after bloom, ~60 days after bloom) and two intensities (fruit spaced either at around 15 cm or at 20 cm on the shoot) in three peach cultivars, CaryMac, Springprince, and Juneprince in 2017. No significant differences were observed among thinning treatments for final yield, fruit weight, diameter, titratable acidity, or soluble solids content. Substantial lack of chill hour accumulation as well as a late spring freeze in 2017 likely had a major effect on thinning responses in these cultivars. Under such

winter and early spring weather conditions, thinning is not likely to benefit the resulting crop.

Specified Source(s) of Funding: Georgia Department of Agriculture

Pitahaya (Hylocereus spp) Irrigation and Its Effect on Fruit Yield and Quality (poster)

Ramiro Lobo*, *UC Cooperative Extension*; Jose Fernandez de Soto, *UC Hansen Agricultural Research & Extension Center*; Jose Aguiar, *University of California Davis* and Gary Tanizaki, *University of California Cooperative Extension (Poster Board #087)*

Abstract: **Pitahaya or Dragon Fruit (Hylocereus spp.) Irrigation and the Effect on Fruit Yield and Quality**

Pitahaya or dragon fruit (Hylocereus spp.) is the name of a vining cactus and the edible fruit it produces which adapts well to field growing conditions in Coastal Southern California counties, from San Luis Obispo to San Diego County. Pitahaya appears to be a profitable alternative for growers in Southern California Counties to replace less profitable, less water efficient crops including citrus and avocados. As a result, interest among growers, and acreage planted has increased considerably. The distribution range of pitahaya extends from Southern Mexico to Northern South America where various species or accessions are found in a variety of microclimates ranging from semi-arid coastal plains at sea level to very humid tropical conditions up to 4000 feet above sea level. The plant can survive under drought conditions, but fruit production is almost non-existent. When irrigated regularly, fruit yields increase considerably. Initial observations showed that different varieties require varying amounts of irrigation water to optimize fruit production and fruit quality. To assess the effect of varying amounts of water on yield and fruit quality of pitahaya, irrigation trials were established under an organic production system in Fillmore, Ventura County and under a conventional production system at South Coast Research and Extension Center (SCREC) in Irvine, Orange County. The trials were established using a randomized complete block design with six irrigation treatments and four replications. Irrigation treatments and frequencies were determined using the avocado crop coefficient and local evapotranspiration data from a California Irrigation Management Information Systems (CIMIS) weather station on site. In addition to collecting biomass, fruit yield and fruit quality data, water sensors were placed at two different depths (6 and 12 inches) to determine the water depletion curve. While preliminary results demonstrate a direct correlation between the amount of water applied and pitahaya plant biomass and marketable fruit yields, the impact of the same treatments on pitahaya fruit quality is not as clear yet. This poster will discuss pitahaya irrigation practices, water absorption curves and the effect of various irrigation treatments on pitahaya fruit yields and quality.

Specified Source(s) of Funding: UC Hansen Trust

12:15 PM – 1:00 PM *International Ballroom East/Center*

Floriculture 1: Cut Flowers, Water Quality (Poster)

Development and Evaluation of Long-Stemmed Pepper (*Capsicum*)Lines for Use As Ornamental Cut Stems (poster)

H Wien*, *Cornell University*; John Stommel, *USDA, ARS, GIFVL* and Richard H. Uva, *Seaberry Farm (Poster Board #089)*

Abstract: Inclusion of stems of showy fruits or vegetables bearing colorful small fruits can make a welcome and attractive addition to summer and fall floral bouquets. Although pepper (Capsicum annuum) plants have been developed as high-value ornamental bedding plants, with prominent small fruits, stem length of these plants is too short for use in floral arrangements. This limitation is being overcome by two means: (A) Selection of C. annuum lines at USDA, ARS, Beltsville, with tall stature, black/dark violet-colored foliage and small fruits; and (B) Tall selections of Capsicum baccatum, sourced from the USDA National Plant Germplasm System. The C. annuum material is derived from initial crosses between the black foliage USDA pepper germplasm release 90C44 and diverse heirloom cultivars including 'Christmas Cheer', 'Royal Black' and others. In contrast with black foliage ARS releases such as 'Black Pearl' and Midnight Creeper™, early generation selections for cut stem lines focused on tall indeterminate growth habit. Selection was practiced for plants that produce greater than three basal shoots and have vigorous indeterminate upright growth habit. Selections exhibited good retention of black foliage on cut stems in 7-day trials. Fruits are oriented upright, of various shapes from round to blocky to pointed, glossy black when immature, and mature to orange or red when mature. The C. baccatum lines were first grown at Cornell University in 2011, and evaluated for stem strength, lodging resistance and ease of leaf removal in the next four years. Primary interest of the C. baccatum selections resides in colorful red, yellow or orange upright oriented fruit of diverse size and shape. Ease of manual leaf removal varied from year to year, but placing the cut stems in a dark, humid box and subjecting them to 30° C for 3 days accomplished complete defoliation. Selections from five lines, namely PI 159252, PI 441525, PI 441542, PI 441552 and PI 441575 had the most desirable traits and are being offered for distribution to seed companies for commercialization and distribution as named varieties. Both the C. annuum and C. baccatum lines are being evaluated by cut flower growers in field plantings in Maryland and Virginia in the 2018 planting season.

Plant Growth Regulator Pulses Improve Dahlia Flower Quality and Extend Vase Life (poster)

Ben A. Bergmann*, *North Carolina State University*; Iftikhar Ahmad, *University of Agriculture* and John M. Dole, *North Carolina State University (Poster Board #090)*

Abstract: Cut dahlia (*Dahlia* Cav.) flowers are perennially popular with consumers and command a relatively high per-stem price. Due to their short postharvest longevity, growers are always seeking ways to extend dahlia vase life for consumers. Pulsing cut flowers with plant growth regulators achieves this goal in species such as alstroemeria, carnation, gladiolus, and iris. Gibberellic acid (GA) delays flower wilting and senescence in some species and is an antagonist to abscisic acid, which promotes those processes. Cytokinins can extend vase life of some cut flowers and has been shown to do so in a few dahlia cultivars. We investigated the influence of pulse treatments of benzyladenine (BA), GA_{4+7}, and the commercial solutions Fresco® and Chrysal BVB on vase performance of dry-shipped, cut dahlias 'Amora', 'Natalie G', and 'Prospero'. Fresco®, which provides equal amounts of both BA and GA_{4+7} at the concentrations indicated in one solution, was used at 5, 10, 20, 30, and 50 $mg \cdot L^{-1}$. The five other treatments were 20 $mg \cdot L^{-1}$ BA, 20 $mg \cdot L^{-1}$ GA_{4+7}, 2 $mg \cdot L^{-1}$ Chrysal BVB, combined 20 $mg \cdot L^{-1}$ Fresco® and 2 $mg \cdot L^{-1}$ Chrysal BVB, and tap water control. Fresh-cut stems were pulsed for 24 h in a 5 °C cooler before placing them into vases for consumer vase life determination. Most of the variables assessed were not influenced by the pulse treatments: solution uptake during pulse treatment, water uptake while in vase, change in vase water pH or EC, stem fresh weight change or dry weight at termination. Fresco® increased vase life (by 35% across cultivars) and flower quality after 4 days in vase compared to tap water in all three cultivars, and 5 $mg \cdot L^{-1}$ ('Natalie G', 'Prospero') or 10 $mg \cdot L^{-1}$ ('Amora') were as good as or better than higher concentrations. Pulsing flowers with 2 $mg \cdot L^{-1}$ Chrysal BVB did not improve vase life or flower quality after 4 days in vase compared to tap water, and adding it with 20 $mg \cdot L^{-1}$ Fresco® could negate the benefit of Fresco®. Depending on the cultivar, the increased vase life and/or higher flower quality after 4 days in vase achieved by using Fresco® was seen with BA alone, GA_{4+7} alone, or neither plant growth regulator on its own.

Specified Source(s) of Funding: Bloomia USA

The Influence of Planting Density on the Production of Specialty Cut Sunflowers. (poster)

Michael Maurer*, *Stephen F. Austin State University*; Bilawal Cheema, *Stephen F. Austin State University* and Jared Barnes, *Stephen F. Austin State University (Poster Board #091)*

Abstract: Plant density is critical in the growth and development of specialty cut sunflower (*Helianthus annuus* L.) cultivars. An experiment was conducted to evaluated four plant spacings; 8 x15, 15 x15, 23 x23, and 30 x 30 cm using three non-branching sunflower cultivars 'Pro Cut Gold', 'Sunrich Lemon', and 'Superior Gold'. Stem length, stem diameter, flower diameter disk diameter, days-to-harvest and number of marketable stems were determined at harvest. The 30 x30 spacing resulted in the largest stem diameter, flower diameter, disk diameter, fewest days-to-harvest and higher percentage of marketable stems. Stem length

was not significantly different for the other spacings, but tended to increase with plant density. The percentage oof stems that were marketable declined significantly to 54% for the 8 x 15 cm spacing compared to 96% for the 30 x30 cm spacing. While the percentage of marketable stems declined, the number of stems per area increased from 10, 15, 28, and 44 stems m^2 for the 30 x30, 23 x 23, 15 x 15, and 8 x15 cm spacing, respectively. 'Superior Gold' a vigorous cultivar produced marketable stems at all four spacings. 'Pro Cut Gold' produced marketable stems at the 23 x23 and 30 x 30 cm spacing and 'Sunrich Lemon' failed to produce marketable stems. This initial experiment indicates that increased plant density reduced sunflower size while producing more marketable sunflower stems, however cultivar selection may be critical.

Reducing Post-Infection Botrytis Damage in Cut Roses with Essential Oil Vapor (poster)

Ben A. Bergmann*, *North Carolina State University* and John M. Dole, *North Carolina State University (Poster Board #092)*

Abstract: Even with the best management practices during production and harvest, botrytis (*Botrytis cinerea* Pers. ex. Fr.) can cause significant damage to cut roses (*Rosa* × *hybrida*). Latent and new *B. cinerea* infections often become known only after storage and transport because conditions during postharvest handling are conducive to *B. cinerea* growth. Cut roses are typically treated with synthetic fungicides before storage/transport to reduce postharvest botrytis damage, but interest has grown in finding natural, organic compounds for this purpose for a few reasons: resistance of *B. cinerea* to synthetic fungicides, including strains with multiple resistances, increasing restrictions on use of conventional fungicides, and retailers and consumers preferring safer and biodegradable alternatives to synthetic compounds. Plant-derived essential oils (EO) have shown potential as alternatives to synthetic fungicides to mitigate postharvest disease in several systems. We assessed the degree to which 16 synthetic and non-synthetic fungicide treatments controlled botrytis damage in cut roses infected with *B. cinerea*. We investigated whether EOs of cinnamon leaf (CLO), clove bud (CBO), and thyme (TO) could reduce damage in botrytis-infected roses to the same degree as a successful, traditional, synthetic fungicide. The 16 treatments applied to 'Light Orlando' flowers protected against botrytis damage and caused phytotoxicity to differing degrees. Only the synthetic fungicide fludioxonil (0.250 $g{\cdot}L^{-1}$ Medallion®) resulted in the desirable combination of greatly reduced stem termination frequency due to flower botrytis damage and relatively minor flower phytotoxicity damage. When applied to cut rose 'Freedom' or light colored cultivars (Cool Water, Jessika, Polar Star, Tiffany), all EO aqueous solutions caused pronounced phytotoxicity damage, but only TO reduced botrytis damage compared to untreated flowers. Roses exposed to EO vapor rather than EO aqueous solution tended to exhibit less phytotoxicity. Vapor of CLO and CBO tended to reduce botrytis damage less and caused greater flower phytotoxicity than TO vapor and aqueous fludioxonil. The greater phytotoxicity caused by higher EO concentrations was not accompanied by greater reductions in damage with either application method. The lack of botrytis damage control may have been because the phytotoxicity damaged tissue allowed additional infection and/or more extensive penetration of botrytis. In summary, thyme oil vapor exposures of 4.6 and 9.1 $\mu L{\cdot}L^{-1}$ were the most promising of the EO treatments and warrant further investigation.

Specified Source(s) of Funding: ICFG/Hill Foundation

Evaluating *Botrytis* spore Density in Commercial Cut Rose Production (poster)

Melissa Munoz*, *Clemson University*; Guido Schnabel, *Clemson University* and James Faust, *Clemson University (Poster Board #093)*

Abstract: *Botrytis cinerea* is a large problem during cut rose production and in the postharvest environment. Cultural practices that take place during rose production in greenhouses can lead to spore dispersal that increases the infection risk. The objective of this research was to evaluate the relationship between *Botrytis* spore density and cultural practices in commercial greenhouses of cut rose production, additionally changes on *Botrytis* spore density were evaluated across weeks. To achieve this, two spore samplers were placed in commercial greenhouses to collect daily air samples, and a daily report of all the cultural practices performed at the greenhouse was obtained. After 300 days of data collection, analysis of variance was used to determine the correlation between each cultural practice on the *Botrytis* spore density. The results showed that mechanical removal of plant debris from the rose canopy, plant growth regulator application (which involves removal of plant debris from the surface of the growing media, movement of the top layer of growing media, and drench application of the growth regulator), sweeping of floors, realigning the canopy (returning errant shoots to the plant canopy) and harvesting were more closely correlated to the spore density data. Variations on the spore density were determined between weeks. Additionally, Wednesday, Thursday and Friday (days with more cultural practices) presented a consistently higher spore density while Sunday (day with the less or none cultural practices) showed the significantly lowest spore density.

Specified Source(s) of Funding: American Floral Endowment Endowment

Agrobacterium Infiltration for Transient Expression of F3'5'H, Rosea1, and Delila in Detached Anthurium Spathes (poster)

Peter J. Toves*, *University of Hawaii*; Maureen Fitch, *Hawaii Agriculture Research Center*; Richard Criley, *University of Hawaii*; Xiaoling He, *Hawaii Agricultural Research Center*; CR Martin, *John Innes Centre* and Teresita Amore, *Tropical Plant and Soil Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa (Poster Board #094)*

Abstract: Anthurium is the highest selling cut flower in the Hawai'i floriculture industry. The major colors in the market include red, orange, pink, white, and green. Continuous development of novel colored anthuriums will help to keep the Hawai'i industry globally competitive. One approach for the development of novel color is genetic modification of the anthurium color pathway with exogenous genes. However, anthurium is slow growing and the visualization of exogenous gene expression on spathe color takes several years from transfection to flowering. Alternatively, transient expression via *Agrobacterium* infiltration is a rapid method to visualize the functionality of exogenous color genes introduced to the anthurium anthocyanin pathway. Detached spathes of anthurium 'New Era' were agroinfiltrated with structural gene F3'5'H, or the transcription factors Rosea1, or Delila, individually or as a combination of all three genes. Control plants were treated with only the infiltration buffer and no *Agrobacterium*. Color change was observed at the sites of infiltration in spathes treated with Delila and the combination of F3'5'H, Rosea1, and Delila approximately 134 hours post treatment. Control spathes and spathes infiltrated only with F3'5'H or Rosea1 did not show any color change at the sites of infiltration. Additional experiments will examine the transient expression of paired combinations of F3'5'H, Rosea1, and Delila.

Growth of Vinca in Response to Irrigation with Saline Water (poster)

Kimberly Moore*, *University of Florida/IFAS*; Luci Fisher, *University of Florida - FLREC*; Mun Wye Chng, *National Parks Board* and Ragab S. Taha, *Fayoum University (Poster Board #095)*

Abstract: Salinity stress is a major factor limiting crop production. Excessive salts in the root zone create osmotic stress limiting the ability of plants to take up water leading to reductions in growth. It is well established that plant growth will be reduced when watering with water high in salts due to salt water intrusion, reclaimed waste water use or over fertilization. We questioned if the use of plant hormones applied prior to a salt event would improve plant performance when irrigated with salt water. We compared growth and flowering of vinca (*Catharanthus roseus*) watered with tap water or saline water and treated one time with no hormone, 0.75 mM jasmonic acid (JA) or 0.75 mM abscisic acid (ABA). The tap water had an electrical conductivity (EC) level of 0.5 $dS{\cdot}m^{-1}$ while the salt water had an EC of 12 $dS{\cdot}m^{-1}$. Vinca shoot dry weight was greater for containers watered with tap water than salt water. There was no difference in shoot dry weight due to hormone application. There also was no difference in flower numbers due to hormone application but there were more flowers on plants watered with tap water than salt water. We also observed greater final tissue electrolyte leakage for all hormone treatments for plants watered with salt water. Final tissue proline levels for plants without hormone were not different between tap and salt water but tissue proline levels for plants treated with JA and ABA were greater in plants watered with salt water than tap

water. It appears that the one time application of JA and ABA were insufficient to mediate damages due to watering with salt water.

Grey Water As a Viable Alternative for the Growth of 10 Common Geophytes (poster)

Maren Blohm*, *Loyola University Maryland*; Eliana Marzullo, *Loyola University Maryland* and Ellen Roussel, *Loyola University Maryland (Poster Board #096)*

Abstract: Ornamental plants are an integral part of landscapes, and maintaining their visual quality is imperative to the their success. The premium placed on fresh water as a valuable resource makes it increasingly more difficult to plant ornamentals in urban areas or other areas where water scarcity is common. As high quality water becomes scarcer and more valued it is important to know which ornamental plants can tolerate stress while maintaining visual quality. In areas facing increased water scarcity, it is possible that grey water can be used for ornamental production and maintenance. The purpose of the research was to determine the viability of utilizing grey water for greenhouse production of 10 common autumn bulbs (3 daffodil, 2 tulip, 2 crocus, 1 allium, 1 iris, and 1 hyacinth cultivars). Growth, flowering time, flower duration, and nutrient analysis were utilized to determine the impact of grey water. Grey water irrigation did not significantly alter leaf length, leaf number, flower number, flower duration and leaf water status compared to the control. However shoot biomass was significantly reduced in the grey water treatment, with the greatest reduction in hyacinth (reduction of 30%). Leaf chlorophyll content was comparable between the grey water treatment and the control after 119 (28 days of treatment) of treatment, but by 140 days of treatment (49 days in the greenhouse) chlorophyll content was reduced in the grey water treatment compared to the control. Despite this decrease we did not observe a decrease in carbon assimilation, stomatal conductance and transpiration rate. Our results indicate that grey water would be a viable irrigation source for 10 fall bulb species.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Growth Chambers and Controlled Environments 1 (Poster)

Capabilities of the Controlled-Environment Lighting Laboratory Propel Vertical Farming Research (poster)

Qingwu Meng*, *Michigan State University*; Erik Runkle, *Michigan State University*; David Hamby, *OSRAM Innovation*; Rodrigo Pereyra, *OSRAM Innovation*; Charles Brunault, *OSRAM Innovation*; Alan Sarkisian, *OSRAM Innovation* and Dorian Spero, *OSRAM Innovation (Poster Board #139)*

Abstract: Indoor vertical farming has been gaining momentum as the demand for healthy, fresh, and local produce keeps increasing. Its high productivity is enabled by technologies such as environmental control, light-emitting diodes (LEDs), sensors, and automation. We recently renovated a storage room on the campus of Michigan State University to become the Controlled-Environment Lighting Laboratory (CELL), which is a vertical farming research facility developed to improve indoor production of leafy greens and ornamental transplants. It consists of two independent and environmentally controlled 12.3-m^2 compartments, each containing four growing racks with three 0.7-m^2 shelves stacked vertically in a deep-flow recirculating hydroponic system. OSRAM Innovation developed customized and integrated LED hardware and software that precisely deliver light intensities and qualities to each plant canopy. Each LED module has seven independently controlled radiation channels (peak wavelengths = 386, 449, 526, 559, 639, 664, and 733 nm), allowing simultaneous tests of numerous spectral combinations. The LED fixtures are programmable in real time for demonstrations or in advance for scheduling experiments. Environmental sensors are incorporated in CELL to monitor photosynthetically active radiation, air and leaf temperatures, relative humidity, and CO_2 concentration. In addition to research, CELL supports outreach activities and undergraduate teaching and captures the interest of visitors and students, who can see research in action from the corridor through the large windows of CELL.

Effects of Light Quality on the Growth and Nutritional Quality of Sweet Basil (poster)

Haijie Dou*, *Texas A&M University*; Genhua Niu, *Texas A&M AgriLife Research Center at El Paso, Texas A&M University* and Mengmeng Gu, *Texas A&M AgriLife Reseach & Extension (Poster Board #140)*

Abstract: Sweet basil (*Ocimum basilicum*) is widely used as a culinary herb and medicinal plant due to its unique aromatic flavor and relatively high content of phenolic compound. Effects of light quality on the growth and nutritional quality of green basil 'Improved Genovese Compact' and purple basil 'Red Rubin' were evaluated. Uniform basil seedlings with one pair of fully-expanded true leaves were transplanted and moved into a walk-in growth room for six light quality treatments, including two full spectrum light treatments (white fluorescent lamp, WFL; and white light-emitting diode lamp, WLED) and four combinations of red and blue LED light treatments with different red: blue (R:B) ratios (R:B=1.18, R1B1; R:B=3.44, R3B1; R:B=6.39, R6B1; R:B=7.84, R8B1). All plants were sub-irrigated as needed using a nutrient solution with electrical conductivity of 2.0 $dS \cdot m^{-1}$ and pH of 6.0, and the room temperature was maintained at 23.9/21.3ºC day/night. The results showed that the gas exchange rate, namely, net photosynthetic rate, transpiration rate, and stomatal conductance of green and purple basil plants were the highest under R1B1 treatment, and the net photosynthetic rate of green basil plants were 57% higher than purple basil plants, whereas its transpiration rate was 76% lower. The total leaf area of purple basil plants was the highest under R8B1, followed by R6B1 and R3B1, and was the lowest under WLED, but no difference was observed on total leaf area of green basil plants among six light quality treatments. The shoot FW of green and purple basil plants were higher under combinations of red and blue LED light treatments compared with full spectrum light treatments and increased with increasing R: B ratios. The anthocyanin concentration of green basil plants was decreased with increasing R: B ratios, and no difference was observed between R6B1 and R8B1 treatments. The total phenolics and flavonoid concentration of green basil plants were both the highest under R3B1 treatment. Considering the yield and nutritional quality of basil plants, combinations of red and blue LEDs with red light percentage higher than 75% was recommended for green and purple basil production under controlled environment.
Specified Source(s) of Funding: This research is supported partially by the USDA National Institute of Food and Agriculture Hatch project TEX090450 and Texas A&M AgriLife Research

Light Resource Influences High-Wire Tomato Ion Accumulation, Partitioning and Fruit Quality (poster)

Meng-Yang Lin*, *Purdue University* and Hye-Ji Kim, *Purdue University (Poster Board #141)*

Abstract: Supplemental lighting (SL) is necessary for optimal plant growth and yield in greenhouse tomato production, particularly during winter months in temperate climates. Over-head (OH) high-pressure sodium (HPS) lamps presently are the most common type of SL because of their high-intensity capabilities. The leaves at high canopy receive more light than the leaves at low canopy due to light gradient caused by OH-HPS and shading of high canopy on low canopy. Intracanopy (IC)-light-emitting diode (LED) towers provide a uniform lighting environment vertically along the plant canopy without emitting radiant heat and have a more efficient light spectrum to enhance photosynthesis. Ion uptake, partitioning and assimilation are highly dependent on photosynthesis and transpiration. However, there is no report about how microenvironment created by light resource affects photosynthesis and transpiration, thus ion accumulation, partitioning and fruit quality. The objective of this study was to determine how different SL sources [OH-HPS vs. IC-LED] affect ion accumulation, partitioning and fruit quality of high-wire greenhouse tomato. 'Merlice' scions grafted onto 'Maxifort' rootstocks were supplemented with IC-LED (100% red light) and OH-HPS (4% blue light: 48% green light: 48% red light). Un-supplemental lighting control (ULC) was also included. Plants were fertigated with a commercial complete fertilizer mix (4.5N–14P–34K; CropKing, Lodi, OH) to maintain acceptable electrical conductivity and pH in the root zone, and irrigation duration and frequency were adjusted to provide a daily leaching fraction of 30%. Photosynthetic and transpiration rates were measured with a portable photosynthesis system. The concentration of nitrate,

nitrite, sulfate, phosphate, chloride, sodium, potassium, magnesium and calcium in leaf, stem, root and fruit were determined by ion chromatography. Compared to OH-HPS, IC-LED-grown tomato with uniform lighting accumulates more nitrate, nitrite, sodium, potassium, magnesium and calcium in whole plant due to higher photosynthesis and dry mass accumulation. Vertical light gradient of OH-HPS induced stem elongation and higher biomass allocation to stem, which significantly increased the partitioning of sodium, potassium and calcium to stem compared to IC-LED. Moreover, OH-HPS induced more partitioning of nitrate from root to leaf compared to ULC resulting from higher transpiration at higher canopy. Compared to OH-HPS, IC-LED increased concentration of manganese by 38% and lowers the concentration of sulfate by 68% in tomato fruits, which may improve the fruit quality and aroma. Overall, IC-LED optimized photosynthesis, thus ion uptake, partitioning and assimilation, possibly improving fruit quality and aroma.

Specified Source(s) of Funding: NE-1335 Resource Management in Commercial Greenhouse Production

Accurate PAR Measurements: Spectral and Directional Errors of Seven Quantum Sensors (poster)

Schuyler Smith*, *Apogee Instruments* and Mark Blonquist, *Apogee Instruments, Inc. (Poster Board #142)*

Abstract: Photosynthesis is driven by photosynthetically active radiation (PAR), which is almost universally defined as photosynthetic photon flux density (PPFD, the integral of photon flux density in units of mmol m^{-2} s^{-1} from 400 to 700 nm). Accurate measurement of PPFD is essential because of the close relationship between photosynthesis and plant growth. Quantum sensors (so called because a photon is a single quantum of radiation) are the most common device used for PPFD measurement because they are simple and relatively low cost. Quantum sensor accuracy is determined by both spectral response and directional response. Spectral response is the sensitivity to photons at each wavelength, or a measure of how well a sensor matches the defined plant response (equal weighting to photons between 400 and 700 nm, no weight outside this range). Directional response is the sensitivity to radiation incident at different angles, or a measure of how well a sensor matches Lambert's cosine law (radiation intensity is proportional to the cosine of 90-minus-the-angle between the incident radiation beam and a horizontal surface). Here we compare spectral and directional errors for seven quantum sensors/meters: Apogee original (model SQ-100) and full spectrum (model SQ-500); Kipp & Zonen (model PQS 1); LI-COR original (model LI-190) and improved (model LI-190R); Spectrum LightScout; and Hydrofarm Quantum PAR Meter. Spectral and directional errors were less than 5 % for the Apogee full spectrum, Kipp & Zonen PQS 1, and both LI-COR models. The Apogee original and Spectrum LightScout use photodetectors that are not sensitive to photons with wavelengths greater than about 660 nm, which can cause significant spectral errors under some radiation sources. These errors are partially accounted for by calibrating to specific radiation sources (as is the case for the Apogee SQ-100), but these sensors should be used with caution when measuring deep-red LEDs or other electric lights with significant radiation at wavelengths greater than 660 nm. The Hydrofarm Quantum PAR meter was found to have directional errors of up to 20 % in the diffuse light that is characteristic of growth chambers, with larger errors in low-angle directional light. This meter should be used with caution in commercial and research applications.

Growth and Physiological Responses of Lettuce Grown Under Pre-Dawn or End-of-Day Sole-Source Light-Quality Treatments (poster)

Celina Gomez*, *University of Florida* and Skarleth Chinchilla, *University of Florida (Poster Board #143)*

Abstract: In order to understand the physiological factors that drive plant responses to spectral changes over time, the objective of this study was to evaluate growth and gas-exchange of 'Cherokee' and 'Waldmann's Green' lettuce (*Lactuca sativa*) treated with light-quality changes within a 24-hour period. Three pre-dawn (PD; 0600 to 0700 $_{HR}$) and three end-of-day (EOD; 2100 to 2200 $_{HR}$) treatments were evaluated in the study, each providing 50 ± 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of either blue, red, or white light from light-emitting diodes (LEDs). To account for the main daily light integral (DLI), white LEDs provided 210 ± 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ from 0700 to 2200 $_{HR}$ or from 0600 to 2100 $_{HR}$ for the PD or EOD treatments, respectively. A control treatment was included which provided 200 ± 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of white light from 0600 to 2200 $_{HR}$. All treatments provided a DLI of 11.5 $mol \cdot m^{-2} \cdot d^{-1}$ a 17-h photoperiod. Regardless of cultivar, no treatment difference was measured for hypocotyl length or leaf number. However, plants grown under EOD-blue or PD-white had up to 26% larger leaves than those grown under PD-red and 20% larger leaves than control. In addition, plants grown under EOD-blue produced up to 18% more shoot fresh mass (FM) compared to those grown under control, EOD-red, or PD-red. Contrasts for gas-exchange data collected during the main photoperiod showed that light quality was not significant within PD or EOD for any of the parameters evaluated. However, regardless of light quality, stomatal conductance (g_s) and transpiration (E) were up to 34% and 42% higher, respectively, for EOD-grown plants compared to control. Our results suggest that 1 h of low intensity EOD-blue light has potential to promote lettuce growth by increasing leaf area and FM when the main DLI from sole-source lighting is provided by white light. Furthermore, they indicate that regardless of light-quality, short-term exposure to EOD-light stimulates higher g_s and E during the day, which may increase the photosynthetic efficiency of plants during the light period.

The Effect of UV-a for Coloring of Red Leaf Lettuce Under Plant Factory Condition (poster)

Takashi Ikeda*, *Meiji University*; Midori Itagaki, *Meiji University*; Kaho Ooki, *Meiji University*; Yoshiaki Yamagishi, *Ryonetsu Kogyou Co., Ltd.*; Kai Iwasawa, *Ryonetsu Kogyou Co., Ltd.*; Tei-ichiro Kato, *Ryonetsu Kogyou Co., Ltd.* and Yasushi Yamamoto, *Ryonetsu Kogyou Co., Ltd. (Poster Board #144)*

Abstract: We investigated the effect of UV-A for coloring red-leaf lettuce (*Lactuca sativa* L. s. var. *crispa*) under controlled culture conditions (plant factory). It is well known that anthocyanin which is the main pigment in red-leaf lettuce induces by UV. Red-leaf lettuce varieties do not turn red in plant factory condition, because recent artificial lights (like as white LEDs or fluorescent lights) do not contain UV enough. We tested additional UV-A equipped with white cold cathode fluorescent lamp. We grew plants on hydroponic culture in plant factory condition. The result showed that applying UV-A accelerated coloring of red-leaf lettuce. However, the growth was inhibited under long-term exposure condition to UV-A. This technique might be efficient for growing red-leaf lettuce cultivation in plant factories although we have to find more suitable treatment.

Light Spectrum Affects the Response of Greenhouse Cucumber to Long Photoperiod of Intra-Canopy Lighting (poster)

Xiuming Hao*, *Agriculture and Agri-Food Canada*; Yun Zhang, *Agriculture and Agri-Food Canada*; Melanie Yelton, *LumiGrow Inc.* and Shalin Khosla, *Ontario Ministry of Agriculture Food and Rural Affairs (Poster Board #145)*

Abstract: Supplemental lighting is essential for year-round greenhouse crop production in regions with low natural light conditions. The supplemental lighting for increasing daily light integral can be added via lengthening photoperiods or increasing light intensity or both. Light addition via long photoperiods is more economical because less light fixtures are required, assuming the long photoperiods don't affect the response of plants to lighting. However, photoperiods longer than 17 or 18 hours cause photo-injury such as leaf chlorosis in greenhouse tomatoes, cucumbers and sweet peppers, limiting the yield increase at long photoperiods of lighting. Light spectrum could affect the response of plants to long photoperiods of lighting. Therefore, this study was conducted to investigate the influence of light spectrum on the response of greenhouse cucumber to long photoperiods of intra-canopy LED lighting. The study was conducted in a large greenhouse (200 m^2) during the winter 2017-18. The greenhouse was divided into 4 sections (50m^2/section) so that 2 top LED light spectral compositions (100% red or mixed - red:blue:white =76:16:8, at 18 h photoperiod and 140µmol m^{-2} s^{-1}) could be applied with 2 replications. Four intra-canopy light photoperiods (18, 20, 22, and 24 h at 40µmol m^{-2} s^{-1} of LED lighting, 87% red and 13% blue) were applied to the 4 plots inside each section. The long photoperiods (even if at 24 hours) did not cause any significant difference in leaf chlorosis but did result in

mis-shaping (cupping) in the middle leaves. The plants grown at 100% red top light had less mis-shaped leaves than at the mixed top light. Therefore, leaf chlorosis might not be photoperiodic in nature or might be more related to the physiological age of the leaf at the time of light exposure, and light spectrum did impact the response to long photoperiods. The perspectives of using different light spectra and intra-canopy lighting to extend photoperiods and reduce initial light fixture costs in supplemental lighting will be discussed.

Effects of Narrow Bandwidth Light Emitting Diodes (LEDs) on Petunia and Spathiphyllum (poster)

Sadikshya Sharma*, *University of Florida* and Thomas A. Colquhoun, *University of Florida (Poster Board #146)*

Abstract: Plant growth and physiology are regulated by light quality, duration and intensity. Light emitting diodes (LEDs) have the potential to be used as supplemental and sole light sources in greenhouses and growth chambers respectively. However, quality of light required by many ornamental plants including petunia and spathiphyllum are still unknown. In this study, we used different narrow bandwidth LEDs to determine specific wavelength of light required by petunia and spathiphyllum. The vegetative cuttings of '*Petunia* x *hybrida*' cv 'Mitchell Diploid' and two varieties of spathiphyllum, 'Ty's pride' and 'Mojo' plantlets were grown under five LEDs; red (660 nm), yellow (600 nm), green (525 nm), blue (450 nm) and white (control) which delivered a photosynthetic photon flux (PPF) of 100 m mol m^{-2} s^{-1} for 16 hours per day. Maximum plant height was observed under blue light for both petunia and spathiphyllum. The maximum number of flowers and earlier flowering in petunia were observed under blue light. Dry shoot biomass was maximum under blue light while dry root biomass was maximum under red light for petunia whereas under yellow light for both varieties of spathiphyllum. Leaf area was maximum under green and yellow light for petunia and spathiphyllum respectively. Maximum root length was observed under white light for petunia and Ty's pride and under blue for Mojo. Maximum chlorophyll content under white and red light for petunia and blue light for spathiphyllum. There were no significant differences for leaf number, fresh shoot weight and fresh root weight for petunia whereas leaf number, fresh shoot and root weight were maximum under yellow light for spathiphyllum. Root shoot ratio was maximum under red for petunia and Mojo but maximum under yellow for Ty's pride. Thus, red and blue light are better for petunia whereas blue and yellow for spathiphyllum propagation and production. This research highlighted the effects of light quality on morphology and physiology of petunia and spathiphyllum and the application of narrow bandwidth LEDs for better quality ornamental plant production in a commercial scale.

Effect of Light Spectrum on Pigment Accumulation and Expression of Pigment Biosynthesis Genes in Red Leaf Lettuce (poster)

Renwei Huang*, *Cornell University*; Tessa Pocock, *Rensselaer Polytechnic Institute*; Zengtian Deng, *Rensselaer Polytechnic Institute* and Neil Scott Mattson, *Cornell University (Poster Board #147)*

Abstract: Previous studies have demonstrated the impact of light quantity and quality on anthocyanin accumulation in red leaf lettuce. In this experiment we studied the effect of a 48-hr spectral shift on the temporal dynamics of pigment concentrations and expression of genes in the anthocyanin pathway. Seedlings of lettuce (*Lactuca sativa*) 'Rouxai' were grown for 18 days from seeding under white (broad spectrum) light emitting diodes under sole source light in environment controlled growth chambers. Growth chamber temperature was 23 °C and a light intensity of 185-200 $\mu mol \cdot m^{-2} \cdot s^{-1}$ with a 24 hr photoperiod was provided. At 18 days, the light source was switched to cool white fluorescent (CWF) fixtures providing continuous light at 185-200 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for 48 hr. Anthocyanin and chlorophyll concentration, and expression of anthocyanin pathway genes were measured. Following shift to CWF, leaf color gradually became darker red over time. The CWF spectrum stimulated the biosynthesis of total anthocyanin and chlorophyll a and b. For all pigments measured, highest concentrations were observed in plants which were shifted from white LEDs to the CWF spectrum for 42h. To determine the molecular regulation of pigment biosynthesis by the light spectrum, we examined the expression of anthocyanin and chlorophyll a/b-binding proteins genes using real-time PCR. Anthocyanin biosynthesis genes (CHS, DFR, ANS and UFGT) and chlorophyll a/b-binding proteins genes (Lhca1-4 and Lhcb1) exhibited increased expression in response to CWF. While pigment accumulation, also tended to increased over time, response lagged several hours behind gene expression. Interestingly, while the experiment was conducted with continuous lighting, a pattern of 24 hr oscillations in gene expression were evident suggesting that genes responsible for pigment accumulation were regulated by both light treatment as well as circadian rhythm. Our findings help elucidate the role of the chlorophyll and anthocyanin pathway genes in response to light spectrum and suggest further study to understand the involvement of circadian clock genes in the regulation of anthocyanin and chlorophyll pathways.

Specified Source(s) of Funding: NYSERDA GLASE

Selecting High-Quality Head Lettuce for Greenhouse Production Under Differing Supplementary Light Sources (poster)

Erica R. Hernandez*, *Cornell University*; Kale Harbick, *Cornell University* and Neil Scott Mattson, *Cornell University (Poster Board #148)*

Abstract: Variety testing of vegetables is an important step for beginning businesses to narrow down product focus, generate example product for potential customers, and determine performance of varieties under one's own environmental conditions. Greenhouse grown lettuce has a reputation of being more tender, having grown with fewer environmental stressors, than field grown counterparts. Greenhouse lettuce receives a shifted spectrum of light than outdoor plans due to solar interception by greenhouse glazing materials, which can lead to differences in plant morphology. High pressure sodium (HPS) fixtures are currently the most commonly used supplemental lighting source in greenhouse lettuce production. The introduction of light emitting diodes (LEDs) into the greenhouse industry can allow growers to adjust light spectrum and potentially alter plant morphology, biomass, pigmentation, and development of the physiological disorder, leaf tip burn. The objective of this experiment was to determine response of 13 varieties of head lettuce to greenhouse performance under HPS or LED light.

Lettuce was grown from seed in a common area until seedlings had 3-4 true leaves. Seedlings were then transplanted into a split nutrient film technique (NFT) system with two lighting arrays established above each half of the NFT system. The NFT system shared a common nutrient solution reservoir the location of the channels was separated by 3 m so that the two lighting arrays could share the same greenhouse but avoid light pollution between treatments. One lighting array used HPS fixtures while the other array had LEDs set to a fixed red:blue ratio (80% red : 20% blue). Both arrays were adjusted to provide a similar light intensity of about 200 $\mu mol \cdot m^{-2} \cdot s^{-1}$. which had been split in half. Quantum sensors were placed under each lighting array and were connected to a microprocessor which used the LASSI (Light and Shade System Implementation, Albright et al., 2010) control algorithm to adjust the daily supplemental lighting period to complement ambient light to achieve a fixed daily light integral (17 $mol \cdot m^{-2} \cdot d^{-1}$). Data were collected on plant fresh weight and tip burn index. Qualitative data were collected on taste, color, and texture.

Four cultivars exhibited a significant response ($p \leq 0.05$) to light source: 'Lotus', 'Seurat', 'Teodore', and Xandra. Three additional cultivars had a moderate response ($p \leq 0.10$) to light source: 'Crunchita', 'Greenstar', and 'Rex'. For these seven cultivars fresh weight under LED was less than HPS. Qualitatively, several varieties were found to have an unacceptable bitter taste. In some cases, taste varied between the HPS and LED grown plants. Regarding leaf color, red leaf varieties showed greater red pigmentation when grown under the LED array.

Specified Source(s) of Funding: NYSERDA GLASE

Warm and Cool Full Spectrum LED Supplements Impact Key Flavor Volatiles in Hydroponically Grown Basil (poster)

Hunter Hammock*, *University of Tennessee*; Dean A. Kopsell, *The University of Tennessee* and Carl Sams, *The University of Tennessee (Poster Board #149)*

Abstract: Blue (B) and red (R) wavelengths within the photosynthetically active radiation (PAR) spectrum drive primary metabolism in plants. Spectral quality is an important factor in greenhouse production and directly impacts plant growth and development. Light emitting diodes (LEDs) offer excellent spectral control and allow growers to optimize biomass yield and plant quality throughout growing seasons. Full spectrum white LED lights are becoming popular for commercial production of high value specialty crops, but research is needed to determine the impact of warm and cool full spectrum supplemental lighting in comparison to narrowband B/R LEDs on secondary metabolism and flavor volatile production. The objective of this study was to establish impacts of full spectrum LEDs and narrowband B/R LEDs on key flavor volatiles in hydroponic basil (*Ocimum basilicum* var. 'Italian Large Leaf'). A total of four treatments were used: warm white LEDs (3200 K), cool white LEDs (5600 K), 20B (447 nm)/80R (627 nm) narrow band LEDs, and one non-supplemented natural light control. Each supplemental lighting treatment provided 150 $\mu mols \cdot m^{-2}.sec^{-1}$ for 24 h. The daily light integral (DLI) of the natural light control averaged 9.8 $mol \cdot m^{-2}.d^{-1}$ during the growth period (ranging from 4 to 20 $mol \cdot m^{-2}.d^{-1}$). Relative humidity averaged 55%, with day/night temperatures averaging 29.8 °C/23.6 °C, respectively. Basil plants were grown in a closed gutter hydroponic system with standard fertility regimen and harvested 45 d after seeding. Flavor volatile compounds were quantified using GC-MS. Concentrations of key flavor volatiles varied significantly across lighting treatments. Eucalyptol, linalool, limonene, β-myrcene, and α/β-pinene showed increased concentrations under the 3200 K LED treatment in comparison to the 5600 K LED treatment. With the exception of methyl eugenol, all compounds evaluated were significantly higher in LED treatments as compared to the natural light control. Concentrations of some undesirable flavor compounds, such as dimethyl sulfide and benzaldehyde, followed a similar trend as many of the evaluated compounds, with increased concentrations found in the 3200 K LED treatment in comparison to the 5600 K treatment and natural light control. In general, plants under the full spectrum treatments showed increased VOC concentrations than plants under the 20B/80R treatment, suggesting that fluence and spectral quality influence secondary metabolism. The results of this study show that full spectrum LEDs can manipulate secondary metabolism and flavor volatile production in basil, making the selection of LED spectral quality critical to maximize quality.

Optimizing Spectra for Mizuna Grown on International Space Station (poster)

Asmaa Morsi*, *Purdue University (Poster Board #150)*

Abstract: **Optimizing spectra for Mizuna grown on international space station**

Astronaut diets on the International Space Station (ISS) consist of resupplied, packaged food. However, missions to Mars of 3-5 years, will not accommodate re-supply. In addition, many human macro and micro nutrients decrease during long-term storage. Thus, growing plants aboard ISS is essential for providing astronauts with fresh, healthy produce. Thus, NASA is testing an experimental vegetable production unit called VEGGIE to grow fresh salad crops aboard ISS to provide astronauts with healthy diets. VEGGIE is a small plant growth chamber designed as a garden for astronauts that is low in mass and has a low power requirement. Veggie is equipped with light emitting diodes (LEDs) but is exposed to the ISS cabin environment. Plants initially were grown with roots in plastic "pillows" containing baked-ceramic substrate incorporating controlled-release fertilizer and a wick delivering water by capillary action from a reservoir. NASA is testing a next-generation growth unit for VEGGIE called PONDS, consisting of a cylinder with gas-permeable interfaces and capillary-mat slots. The Purdue Mitchell lab in collaboration with NASA is testing growth of salad crops in PONDS within VEGGIE analogs under ISS environments. Specifically, we are evaluating effects of light spectrum and fertilizer treatments on "cut-and-come-again" on productivity and quality of Mizuna. ISS environments being tested include 24/21°C D/N, CO2: 2800 PPM, RH: 45-50% D/N, and photo period: 16hours. Arcillite growing mix with 15 g18-6-8 T 70 fertilizer/liter. LED Light treatments provide total intensity of 330 $\mu mol\ m^{--2}s^{-1}$ PAR; with different Red(R): Blue (B): Green (G) ratios. Our treatments are 270R: 30B: 30G, 210R: 90B: 30B, and 150R:150 B: 30G. Plants are grown under those conditions for 8 weeks, and harvested five times at 28, 35, 42, 49, and 56 days. Currently we have our experiment running, and we will have our first harvest in two weeks.

12:15 PM – 1:00 PM *International Ballroom East/Center*

History of Horticultural Science (Poster)

The Downward Trend in Post-Secondary Horticulture Programs between 1997 and 2017 (poster)

Alyssa Brown*, *Brigham Young University*; Phil S Allen, *Brigham Young University* and Greg V Jolley, *Brigham Young University (Poster Board #088)*

Abstract: Over the past several years, horticulture programs appear to have experienced a decline in undergraduate enrollment or have been eliminated completely. The scale of this phenomenon remains to be quantified and characterized. In order to determine the accuracy of these observations and identify existing trends, we compared post-secondary horticulture educational programs offered in the U.S. in 1997, which issued certificates and 2- and 4-year degrees, with those offered in 2012 and 2017. Sources for the 1997 data included college blue books, state horticulture-related associations, and local industry professionals. Data for 2012 were obtained through an internet search and phone calls, while the 2017 data were obtained through internet searches only. In 1997, 464 schools in the U.S. offered degrees and/or certificates in horticulture. In 2012, this number had decreased by 45% to 253 schools, which consisted of 98 4-year-degree-, 215 2-year-degree-, and 330 certificate programs. In 2017, the total number of schools offering horticulture-related degrees or certificates decreased to 212, which represents a nearly 16% decrease from 2012. All considered, schools in 2017 offered 136 four-year degrees, 134 two-year degrees, and 212 certificate programs. These represent a 39% increase, 38% decrease, and 12% decrease between 2012 and 2017 for 4-year, 2-year and certificate programs, respectively. Overall, these findings indicate a 54% drop in the number of schools with horticulture programs between 1997 and 2017. The trajectory toward the elimination of 2-year and certificate programs is of particular concern for industries and agencies that rely on horticultural knowledge to satisfy workforce needs.

Specified Source(s) of Funding: Brigham Young University

12:15 PM – 1:00 PM *International Ballroom East/Center*

Invasive Plants Research (Poster)

Comparisons of Growth and the Effect of Substrate Fertility on North American and Eurasian *Lonicera Caerulea* and the Invasive *Lonicera Tatarica* (poster)

Darren J. Hayes*, *University of Maine* and Bryan J. Peterson, *University of Maine (Poster Board #167)*

Abstract: The sale and planting of many Eurasian honeysuckles (*Lonicera* spp.) is largely discouraged within the horticulture industry of North America. Increasingly, states legislatures have sought to ban the sale of *Lonicera* and other nonnative, invasive plants from commerce. A notable exception is the recent introduction of various cultivars of honeyberry (*Lonicera caerulea*) of Eurasian origin into the North American market, where they may have value in landscaping and as a berry crop. Because honeyberry is already listed as a serious invader of boreal forests in Norway, we decided to assess the potential competitive ability of honeyberry in a North American context by comparing the growth of rooted cuttings in containers to the growth of both mountain fly honeysuckle (*Lonicera caerulea* var. *villosa*), a diminutive, ecologically rare conspecific native to North America, and Tatarian honeysuckle (*Lonicera tatarica*), an invasive congener. We grew cuttings of each in a peat-based substrate in #1 nursery containers, which were top-dressed at the start of the experiment with Osmocote Pro 17-5-11 4-month controlled-release fertilizer (CRF) at rates of 5, 10, 15, 20, and 25 grams of fertilizer per container. After four months, Tatarian honeysuckle produced the greatest dry biomass, with nearly five times the shoot dry weight (SDW) and root dry weight (RDW) of honeyberry, which in turn produced about twice the SDW of mountain fly honeysuckle. SDW of Tatarian honeysuckle exhibited a strong response to increased substrate fertility, producing more than twice the SDW when fertilized with 20 grams than with 5 grams of

CRF. Neither mountain fly honeysuckle nor honeyberry displayed a significant SDW response to increasing CRF application rates, indicating they may be less able than Tatarian honeysuckle to quickly respond to flushes of substrate fertility. Although honeyberry produced only one-fourth the RDW of Tatarian honeysuckle, it produced between two to three times the RDW of mountain fly honeysuckle. Finally, honeyberry rivalled Tatarian honeysuckle in cumulative length of primary stems, far exceeding that of its conspecific, and oriented more toward rapid vertical growth. Despite the classification of mountain fly honeysuckle and honeyberry within a single circumboreal species complex, honeyberry produced several measures of growth that were at least double those of mountain fly honeysuckle, a finding that suggests the two taxa may not be ecologically equivalent. We recommend further comparative studies between honeyberry and its native and invasive congeners in North America, to clarify the relative risks and benefits of its cultivation.

Specified Source(s) of Funding: USDA NIFA Hatch Project #ME021614 and USDA ARS Project #1230-21000-147-06S

12:15 PM – 1:00 PM *International Ballroom East/Center*

Organic Horticulture (Poster)

Living Soil for a Sustainable Future: Cover Crop Effects on Soil Health and Productivity (poster)

Samantha Taggart, *Virginia Tech*; Ramon Arancibia*, *Virginia Tech*; Mark Reiter, *Virginia Tech*; Mark Williams, *Virginia Tech* and Megan O' Rourke, *Virginia Tech (Poster Board #219)*

Abstract: Agricultural land management influences the physical, chemical, and biological characteristics of soil, including the structure of the community of soil microorganisms. In turn, the community of soil microorganisms directly influences processes such as nutrient cycling and water infiltration and retention, which shape the long-term fertility and productivity of the soil. The purpose of this study was to examine the effects of cover cropping on the soil biological and chemical features that contribute to soil fertility. The study looked at two summer cover crops – cowpea (Vigna unguiculata) and sorghum-sundangrass (Sorghum bicolor) in comparison with no-cover control – and their effects on soil respiration, soil organic matter and nitrogen availability, and fall lettuce production under black plastic mulch. Using soil samples taken from the in-field experiment, a parallel laboratory aerobic incubation study examined the effects of the cover crop on the transformation of nitrogen over five weeks. Both cover crops increased soil organic matter, total organic carbon, potassium, and magnesium by over 20%, 21%, 27%, and 35%, respectively, compared to the no-cover crop control. There were no differences in C/N ratio. Cowpea increased extractable soil nitrate by 97% and soil respiration rate by three fold compared to the no-cover control. In contrast, sorghum-sudangrass decreased extractable soil nitrate concentration to 21% of the control no-cover, but the increase in respiration was not different from the control. Lettuce growth and production as measured by both fresh weight and leaf area were reduced after sorghum-sudangrass, but were not different between cowpea and the control. In conclusion, the study found that sorghum-sudangrass and cowpeas both increased soil organic matter, but only cowpea increased extractable inorganic N, and that sorghum-sudangrass was detrimental for fall lettuce production under plastic mulch in the Eastern Shore of Virginia.

Specified Source(s) of Funding: Southern SARE

Low Tunnels Provided Frost Protection and Increased Yield of Organically Managed June-Bearing Strawberries in Field Production (poster)

Amy Ballard*, *North Carolina Agricultural and Technical State University*; Sanjun Gu, *North Carolina Agricultural and Technical State University*; John Kimes, *North Carolina Agricultural and Technical State University*; John Beck, *The Cooperative Extension Program at North Carolina Agricultural and Technical State University* and Tekan Rana, *North Carolina Agricultural and Technical State University (Poster Board #220)*

Abstract: Using protected agriculture such as low tunnels can provide a substantial amount of plant protection during frost events. Cold damage to strawberry flowers and fruits occurs when temperatures are below 32 °F, which could result in yield loss throughout the season. The objective of this 2-year study (2016/17 and 2017/18) was to investigate if low tunnels would provide frost protection and increase yield of organically managed June-bearing strawberries in the annual plasticulture system. This study was conducted at the North Carolina Agricultural and Technical State University research farm in Greensboro, North Carolina (hardiness zone 7). June-bearing varieties were Benicia, Camino Real, Florida Radiance and Winterstar. Low tunnels consisted of metal wire hoops covered with 1mil perforated plastic. The experimental design was a completely randomized design (CRD), conducted as a splitplot with three replications. The main plots were beds covered with low tunnels (LT) or without low tunnels; the split plots were cultivars. All strawberry plants experienced cold damage to flowers and fruit from December to March each season. Low tunnels were able to provide some degrees of frost protection in both years. In the 2016/17 season, damage to open flowers in December was 41% with LT and 33% without LT. In January, there were a lower number of fruits and flowers present at the time and no significant differences between the treatments existed. In February, less flowers were damaged with LT (8.6%) than without LT(10.5%). In the 2017/18 season, flowers and fruit damages to frosts were 22.7% and 8.7% with LT and 41.3% and 57.2% without LT, respectively. The frost protection by LT resulted in increased strawberry yield. In the 2016/17 season, the marketable yield in March was 20.45 g/plant with LT compared to 12.05 without LT; and in April, the number were 141.94 and 129.45 respectively. LT also reduced cull yield, for example in May 2017, the cull yield was 70.3 g/plant with LT and 97.7 g/plant without LT. Our results indicated that LT can significantly increase marketable yields of organically managed strawberries by protecting plant, flowers and fruit from cold damages in the field.

Using Tarps to Reduce Tillage in Small Scale Organic Beet Production (poster)

Mark G. Hutton*, *University of Maine*; Nicholas Rowley, *University of Maine*; Mark Hutchinson, *University of Maine*; Ryan Maher, *Cornell University*; Brian Caldwell, *Cornell University*; Anusuya Rangarajan, *Cornell University* and Haley Rylander, *Cornell University (Poster Board #221)*

Abstract: Interest in using impermeable black tarps has increased among farmers. Tarps offer a low-cost option for small scale farmers to prepare land in a reduced or no-till system. Tarping can be used in place of tillage for weed control and cover crop reduction. Lastly, tarps change the soil environment by altering moisture content and temperature effecting soil N mineralization.

In 2017 Research was carried out at the University of Maine Agricultural and Forestry Experiment Station: Highmoor Farm in Monmouth, ME. Two target planting dates were determined, each consisting of four different tarping durations (long, 6 week, 3 week and no tarp) and three tillage treatments: full-till (6 inches); shallow-till (2 inches); no-till laid out in a split block design. Tarps were placed overwinter 24 weeks before planting 1, 10 weeks prior to planting 2, and then 3 or 6 weeks prior to both plantings. Tarps were placed over an oat cover crop for the overwinter treatment and the cover crop residue for the remaining treatments. Upon tarp removal and prior to tillage, weed and cover crop residue were assessed and soils were sampled for nitrogen (NO3-N and NH4-N). 'Boro' beet (*Beta vulgaris*) was then planted by hand. No weeding was performed in any of the plots. Just prior to harvest weed assessments were made and weed biomass was determined A once-over harvest was made when greater than 50% of the crop reached a diameter exceeding 0.75 inch. Harvested beets were graded by size and quality and then counted and weighed.

Tarping significantly increased marketable yields in both plantings. Tillage intensity, deep, shallow or no-till had no effect on marketable yield in either planting of tarped plots. However, in plots without tarps or tillage yields were significantly lower. NO3-N levels increased in planting 1 with tarps, although not significantly. In planting 2, NO3-N levels significantly increased with tarping period while NH4-N levels were significantly lower under tarps. Weed cover immediately after tarp removal was significantly lower in all tarping treatments compared to no tarp; while, cover crop residue was similar between tarping lengths. Weed biomass at harvest was significantly greater in plots without tarps and tillage in both plantings.

Specified Source(s) of Funding: NIFA-USDA OREI program, award #2014-51300-22244

Growing High Tunnel Use for Organic Vegetable Production in the Southeast (poster)

Kaylene Sattanno, *University of Florida*; Marilyn E. Swisher, *University of Florida*; Xin Zhao*, *University of Florida*; Zhifeng Gao, *University of Florida* and Zack Black, *University of Florida (Poster Board #222)*

Abstract: Stakeholder-driven organic high tunnel systems research in the Southeast is lagging behind what has been investigated for cooler climates. Organic vegetable growers in humid sub-tropical climates would benefit from research evaluating how to optimize these protected culture systems in a way that integrates improved crop performance and resilience, environmental stewardship, and economic viability. The objective of the project was to identify critical research needs for developing integrated high tunnel systems to promote the growth and expansion of organic vegetable production in the Southeast. We began by completing in-depth interviews with a panel of organic producers with extensive experience using high tunnels. Collaborators on the project provided a roster of ten farmers and personnel at the University of Florida completed in-depth interviews with eight. We presented the findings at the first meeting involving the stakeholder representatives in October 2016. After an extensive discussion, we identified six related sets of decisions that organic high tunnel users must make and for which there are few, if any, science-based recommendations. These are (1) decisions about the cropping system (crop selection, cover crops, and crop rotations); (2) management of the high tunnel environment through ventilation and heating; (3) soil and nutrient management; (4) pest and disease management; (5) economics; and (6) attracting pollinators and beneficial insects. We summarized our understanding of the major needs expressed by the expert panel and sent a short questionnaire to the panel members. We asked them to rank the six broad topical areas in terms of importance as an area for research and identify the three most important crops to include in the research. This verified our interpretation of what growers indicated in the interviews and made sure we reached valid results about their needs and priorities. They provided two points of clarification. First, pollinators and beneficial insects are a subset of the general topic of pest and disease management. Second, economic issues are specific to each of the key decisions that growers make and are a major factor in assessing the biological research. We then developed and distributed a questionnaire to organic vegetable growers using high tunnels in Florida and Georgia. We asked respondents to rank specific research topics on a scale of 1 (not at all important) to 5 (extremely important). The findings will direct our research objectives in future high-tunnel projects focused on improving organic vegetable production and management.

Specified Source(s) of Funding: USDA NIFA OREI

Integrating Row Covers into Organic Production Systems for Leafy Green Vegetables (poster)

Dilip Nandwani*, *Tennessee State University*; Sochinwechi Nwosisi, *Tennessee State University* and Ramon Arancibia, *Virginia Tech (Poster Board #223)*

Abstract: Row covers are gaining interest in crop production to improve growth and yield in different agricultural climates and production systems. Growers use in low tunnels to extend the production season, frost, and it brings insect pest protection, water use efficiency and higher growth in crops. The objective of this study was to demonstrate the use of row cover (spun-bonded) on the growth and yield efficiency of four different leafy green vegetables in an organic production system. In a demonstration field trial, Kale, Collard, Swiss chard and Lettuce were evaluated on the organic research farm at Tennessee State University, Nashville, TN in the summer of 2017. Twenty plants of each vegetable type were cultivated on 4' by 20' rows with row cover (treatment) and without row cover (control). On maturity, plants were harvested, and data was collected on average per plant yield and percentage of leaves affected by pest and disease. The yield was larger under row cover [collards (443 g/plant), lettuce (248 g/plant), Swiss chard (174 g/plant) and kale (90 g/plant)] in comparison to control [collards (395.5 g/plant), lettuce (150 gm/plant), Swiss chard (17 g/plant) and kale (57 g/ plant)]. The pest incidence was greater without row cover [(13%) in Kale and (10.5%) in Collards] whereas there was no insect damage under row cover in all leafy green vegetables. Thus, employing row covers in a sustainable production system of leafy greens could potentially increase the productivity and income of vegetable growers

Specified Source(s) of Funding: SARE

Cost of Organic Fertilizers Suitable for Fertigation (poster)

Yao Mu*, *Washington State University*; Ed Scheenstra, *Washington State University, NWREC* and Carol Miles, *Washington State University, NWREC (Poster Board #224)*

Abstract: Fertigation is an effective method to quickly deliver nutrients to crops, matching application timing with crop needs. Organic fertilizers can be expensive, especially for fertigation. In this study, commercially available fertilizers in small quantity (e.g. up to 1 gal for one-time purchasing) and bulk-quantity (e.g. >256 gal) in the U.S. were tabulated, and cost per unit (lb) of nitrogen (N) was calculated. The price of N per lb varied significantly between fertilizers within the two categories. For fertilizers sold in small quantities, the cost per lb of N ranged from $13.27 to $269.50. For fertilizer sold in bulk, the cost per lb of N ranged from $8.70 to $36.00. Other considerations for selecting an organic fertilizer for fertigation include solubility, viscosity, and other characteristics that can impact the ease of injecting the fertilizer solution as well as drip tape maintenance (clogging of emitters). Thus, costs for labor and supplies associated with injection and maintenance must also be considered. Another consideration is the odor of the fertilizer, as many soluble organic fertilizers are fish-based. Especially when applied in confined spaces (e.g., tunnels or greenhouses), the odor may have a negative human impact. The amount of time to apply three different organic fertilizers will be presented, and the risk of clogging the drip line and emitters will be discussed. The three fertilizers selected for this study were: 1) fish-based and low price per lb N, 2) corn-based, 3) fish-based and commonly used in our region.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Seed and Stand Establishment (Poster)

Non-Deep Simple Morphophysiological Dormancy in Seeds of *Lonicera Subsessilis* rehder (Caprifoliaceae), an Endemic Species in the Korean Peninsula (poster)

Chung Ho Ko, *Useful Plant Resources Center, Korea National Arboretum, Korea Forest Service*; Seung Youn Lee, *Useful Plant Resources Center, Korea National Arboretum, Korea Forest Service*; Ki Cheol Lee, *Useful Plant Resources Center, Korea National Arboretum, Korea Forest Service*; Do Hyun Kim, *Useful Plant Resources Center, Korea National Arboretum, Korea Forest Service* and Sang Yong Kim*, *Useful Plant Resources Center, Korea National Arboretum, Korea Forest Service (Poster Board #192)*

Abstract: *Lonicera subsessilis* Rehder, which belongs to the Caprifoliaceae, is located in the Baekdudaegan area, ranging from Pyeongangnam-do to Jeollanam-do in the Korean peninsula. *L. subsessilis* is generally known to grow up to 2 meters tall, has high density of the branches, and the rich green leaves and the autumn ripe fruit is attractive. So they are highly valuable for ornamental purposes. In order to utilize the *L. subsessilis*, a sufficient quantity of materials should be supplied to ensure their stability. This experiment was carried out with the goal for developing mass production protocol. The seeds used in the experiment were collected from plants growing the Korea National Arboretum in Pocheon on May 26, 2017. The seeds were sown in field soil in an experimental garden. Every 2 weeks, seeds were exhumed, and phenology of embryo growth, germination, and seedling emergence was observed. Temperature requirements for germination were also determined by incubating seeds under controlled laboratory conditions. As a result of the imbibition experiment, seed fresh weight increased by approximately 91.3% over the previous 24 hours. At the time of seed disposal, *L. subsessilis* has underdeveloped embryo (about 11.3% of seed length). In seeds incubated at 5, 15, 20, and 25℃, germination percentage was 0, 80.0, 85.6, and 76.7% at 27 weeks after sowing, respectively. Most of the seeds incubated at 15 and 20℃ germinated within 12 weeks, whereas the seeds incubated at

25 germinated within 25℃ weeks. In the move-along test [summer start: 25 (12 wk) → 20 (4 wk) → 15 (4 wk) → 5℃ (12 wk) or winter start: 5 (12wk) → 15 (4 wk) → 20°C (4 wk) → 25℃ (12 wk)], summer and winter start seeds started to germinate at 15 and 25 weeks after sowing, respectively. And the final germination rate for each treatment was 83.3% at 17 weeks, and 83.3% at 30 weeks, respectively. The result indicates that germination was promoted at a relatively warm temperature (15-20℃). Therefore, the seeds expressed non-deep simple morphophysiological dormancy (MPD).

Sulfuric Acid Breaks Physical Dormancy in Seeds of *Lespedeza Tomentosa* (poster)

Yong Ha Rhie*, *Pai Chai University*; Han Choi, *Useful Plant Resources Center, Korea National Arboretum, Korea Forest Service* and Ki Cheol Lee, *Useful Plant Resources Center, Korea National Arboretum, Korea Forest Service (Poster Board #193)*

Abstract: *Lespedeza* plants can be resource plants that are used for livestock feed and embankment greening. These seeds are known as fire-activated species that germinate after the fire in the mountains. In previous studies, germination occurred when heat was applied to seeds, but germination rate was low and treatment was not easy. Therefore, this study was carried out in order to increase the germination rate of *L. tomentosa* by chemical scarification with sulfuric acid. Seeds were soaked in 98% sulfuric acid for 0, 1, 3, 6, 12, 24, 48, 96, 192, and 384 min and washed in distilled water for 24 h. Very few seeds were germinated in control (H_2SO_4 for 0 min). More than 90% of seeds were germinated in H_2SO_4 for 24, 48, and 92 min. However, some damage was observed in roots and cotyledons of seedling dipped in H_2SO_4 for a long time. To search the optimal soaking time in H2SO4 without defects, seeds scarified in H_2SO_4 for 30, 60, 90, 120, 150, 180, and 300 min were sown the commercial soil substrate. Seeds treated with H_2SO_4 for 90 min and 150 min emerged by about 92% and 84%, respectively. Therefore, the optimal time of sulfuric acid for germination of *L. tomentosa* is estimated to be 1 to 2 h. The germination was completed within one month after germination began immediately after the seed treatment so that the seed of *L. tomentosa* had physical dormancy without physiological dormancy.

Specified Source(s) of Funding: This research was supported by a grant from Korea National Arboretum (KNA1-2-15,11- 6) and Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2017R1C1B5076774).

Effects of Water Stress and Cold Treatments on the Germination of Two Conifers (*Pinus nigra* and *Pinus brutia*) Species from Turkey (poster)

Ismail Koc*, *Michigan State University* and Pascal Nzokou, *Michigan State University (Poster Board #194)*

Abstract: Determining the establishment success of a tree species requires conducting germination tests before using it in extensive horticultural programs. This is particularly critical in cold, arid or semi-arid climates where there is little or no top-soil. In the study, the germination performance of five Turkish red pine (*P. brutia Ten.*) provenances and one black pine (*P. nigra subsp. nigra*) provenance from Turkey were investigated after exposure to artificial cold temperature and water stress treatments. Cold treatments to decreasing temperatures (0, -5, -10, -15, -20 C) were conducted in an artificial freezer (ScienceTemp model 40-12A, Adrian, MI). The seeds were then sown in a Styrofoam block in a greenhouse where germination rate, speed, and other parameters were determined. Water stress treatments were conducted using polyethylene glycol (PEG) at five different osmotic potential levels (control, -0.2, -0.4, -0.6 and -0.8 Mpa). Seeds were placed in a germination room and the experiment was carried out at 25±1 °C under 12 h photoperiod. Germination counts were performed daily for 30 days and was determined to have occurred if the radicle protruded 2mm from the seed coat. In general, decreasing temperature decreased the germination rate. Antalya-Gundogmus provenance showed the significantly lower germination difference compared to other provenances in each temperature treatments. Higher osmotic potential decreased the germination rate. Control treatment had significantly higher germination rate compared to all other water stress treatment. *P. nigra* was significantly different compared to *P. brutia* provenances in control treatment. Results have strong horticultural implications for understanding the effects of water stress and temperature on germinations rates.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Teaching Methods (Poster)

Produce Department Inventory and Analysis: Value for Hort 310 "Pomology" Students at Washington State University (poster)

Desmond Layne*, *Washington State University (Poster Board #341)*

Abstract: HORT 310 "Pomology" is an undergraduate course focused on temperate-zone tree and small fruit crops with an emphasis on practices utilized in the Pacific Northwest. The course is required for students in the Fruit and Vegetable Management major of the Integrated Plant Sciences interdisciplinary program. Other majors that typically take the course include Viticulture and Enology and Organic Agriculture Systems. Each year, at least 25 percent of the enrolled students are pursuing either a M.S. or Ph.D. degree. Besides the traditional elements of a pomology course, a strong emphasis is placed on management practices to ensure grower profitability and presenting a high-quality product to the consumer. Whether fruits are produced in the U.S. or some other country, students are expected to know the diversity of available fruits, where the fruit are coming from, how they are marketed, packaged and priced in the local commercial chain-store. The course focuses on general pomological concepts in the first several weeks and then the focus shifts to specific commodities - pome and stone fruits, small fruits, etc. A key assignment (20% of final grade) is introduced in the first two weeks of class that forces students to engage with the end-product in a local grocery store to help to inform future discussions that occur throughout the entire semester as we focus on specific commodities. Each student must perform their own, independent, comprehensive inventory of all fresh fruit items in the local grocery store. Only fresh fruit is considered but this includes conventional/organic, temperate and tropical, bulk (by the piece), bagged, fresh-cut, fruit in clam shells, etc. As part of assignment, students must enumerate all fruit types, cultivars, place of origin, price, condition, space occupied, etc. They must identify fruits that traveled the furthest/closest, those that were most/least expensive ($/lb), those that take up the most/least space, those that are offered at discount, etc. The inventory and analysis must be accompanied with high quality photographs and critique on the general condition (e.g., defects, overripe, etc.) of the fruit. Course evaluations each year affirm the significant value of this assignment to course participants. Assignment specifics, examples of student work, and lessons learned will be presented as an example that could be used in other horticulture crop related courses (e.g., olericulture).

Demonstrating the Allelopathic Effect of Horseradish Extract on Lettuce Seeds for Undergraduate Student Lab (poster)

Tyler Simpson*, *West Virginia University* and Kang-Mo Ku, *West Virginia University (Poster Board #342)*

Abstract: Allelopathy plays crucial roles in invasive plant viability and agricultural production systems. However, there is no well-established hands-on learning activity to teach the concept of allelopathy. Nor is there an activity which allows students to gain knowledge about glucosinolates and their corresponding enzyme, myrosinase, which are present in almost all brassica crops. This study explores an inexpensive and easy allelopathy laboratory activity for undergraduate students majoring in chemistry, biology, agronomy, and/or horticulture. Students were split into groups throughout the experiment. Lettuce germination was counted from three different treatments including water-treated with Parafilm sealing, horseradish-treated with Parafilm sealing, and horseradish-treated without Parafilm sealing 22 hours after seed sowing by the students. Additionally, lettuce root length was measured by students using ImageJ software from each treatment using pictures captured by students' smartphones. Students took an identical quiz as a pre-lab and a post-lab assignment. Their average scores on the pre and post-lab quizzes were 3.2 and 6.5 out of 10, respectively, indicating the lab activity improved students' understanding of allelopathy and glucosinolate-myrosinase system. In addition, students (n=76) completed a survey post-lab to assess their self-efficacy. A vast

majority of students agreed “I can utilize a smartphone to collect data for plant science experiment” (88%), “The lab activity improves my knowledge on weed suppression mechanism of brassica cover crops”(83%), and “The experiment was designed to improve my knowledge on allelopathy” (84%). This simple and cost-effective lab activity was very helpful as it made learning more inviting, meaningful, and fun.

Developing a Hands-on Class to Increase Student Awareness of Floricultural Arts in Hawaii (poster)

Teresita Amore*, *Tropical Plant and Soil Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa* and Orville Baldos, *University of Hawaii at Manoa (Poster Board #343)*

Abstract: The floriculture and nursery industry is one of the most profitable agriculture sectors in the state of Hawaii. Despite its economic importance, fewer and fewer people opt to pursue a career in this field. To increase awareness and recruit students in floriculture, an experimental class to introduce the principles and techniques of floricultural arts was developed at the University of Hawaii. The course was designed to: 1) acquaint students with the different aspects of floral design/floristry; 2) provide hands-on experience on making different floriculture products; and 3) provide opportunities to design and develop new floriculture products. The course consists of a 1-hour lecture and a 3-hour hands-on lab. Students learned to forage for and prepare plant materials, press and dry flowers and foliage, as well as design and construct flower bouquets, garlands (leis), botanical jewelry and pressed flower art. Students were also challenged to include native Hawaiian plants in their design. Selected designs were photographed and displayed in a month-long exhibit at the university library. A listing of plant species accompanied each art piece, to educate the viewing public on design possibilities of using various common and underutilized plant materials. Feedback on the public exhibit was positive and generated interest in plant-based arts. As a final project, students prepared table centerpieces for the College’s awards banquet. For each activity, students submitted a report that included a photograph of the completed project, with a listing of both common and scientific names of the plant material and its usage. At the end of the semester, the project portfolio was graded on completeness and accuracy. Students were asked to write a reflection paper to assess which activities were beneficial in applying the principles and elements of design. Feedback from the students will be utilized to institute a new course that will cater to non-majors.

Specified Source(s) of Funding: Hawaii Dept. of Agriculture NEWGERMPLASM grant (funded in part)

Lecture and Laboratory Curricula Influence College Student Knowledge and Attitudes Regarding Invasive Species (poster)

Kathryn Parsley, *The University of Memphis*; Paula Williamson, *Texas State University*; Tina Waliczek*, *N/A* and Florence Oxley, *Austin Community College (Poster Board #344)*

Abstract: Negative impacts from invasive species present a global problem. Consequently, invasive species biology has emerged as an important sub-discipline of conservation biology. One of the goals of invasive species biology is to educate the public about impacts and potential control of invasive species. The purpose of this study was to determine if a lecture and/or a lecture and laboratory learning model influences college student learning gains and whether increase in knowledge results in changes in attitudes about invasive species. A pre- and post-test instrument that measured knowledge and attitudes of invasive species was administered to several different classes of students at a university and community college. One group of students received a lecture and laboratory curriculum between the pre-test and post-test (the lecture and laboratory treatment group). A second group of students received a lecture between the pre-test and post-test (the lecture only treatment group), and a third group received no instruction between tests (the control group). The lecture was in the form of a Powerpoint™ (Redmond, WA) presentation while the lab curriculum included a case study, a visual aid, and a scavenger hunt to educate students about examples of invasive plant and animal species. In all classes and groups, there were at least 2 weeks between administering the pre- and post-test. Results showed that the control group scores were not significantly different between the pre- and post-test. However, both the lecture-only and the lecture and laboratory treatment groups had scores that changed significantly after receiving the curricula. Additionally, there was an effect of curricula on student learning for the three conditions. The differences between the group that received no curricula versus the two that did, indicated the curricula were effective teaching interventions to help students become more educated about invasive species.

Specified Source(s) of Funding: APHIS

Using Zoom for the First Time in a Scientific Communications Course (poster)

Kent Kobayashi*, *University of Hawaii at Manoa*; Alexandra B. Campbell, *University of Hawaii at Manoa* and Natalie R. Hein-Ferris, *University of Hawaii at Manoa (Poster Board #345)*

Abstract: TPSS 654 Communications in the Sciences is a required one credit, two hours a week graduate course covering various aspects of scientific communications. In fall 2017, a student asked the instructor if an online Zoom option might be available. As a parent of several young children and an hour and a half commute to the university, getting to school was not an easy task. The objective is to share the experiences of this course from the perspectives of the instructor, the distance learning student (DLS), and a fellow student in the class (FS). The instructor conferred with an academic support person in our college on how to use the communications software Zoom and a webcam. Participating online would allowed the DLS to be included in lectures, presentations, and class discussions. The instructor considered that this distance learning experience went reasonably well. He had problems setting up the Zoom link so the DLS set it up for each class. With a Macintosh laptop, external speakers were not needed. The laptop screen was projected onto the room screen only when the DLS gave a PowerPoint presentation. The DSL felt that being an online student while the rest of the class was present in class was a challenge to feeling included. Once acclimated to the class environment, interacting and asking questions were natural. As the only online student, sometimes knowing that her face was being projected on a screen and was dominating the room made her feel self-conscious. After getting to know the other students, she interacted naturally with the rest of the class. The FS mentioned that it might have been nice to have a larger image of the DLS's face at times. Since it was a small class, less than ten students, she felt that the class was all able to surround themselves at an angle to see the DSL. In conclusion, the instructor reflected that this first-time distance learning experience opened the possibility of using hybrid distance learning in his course(s) in the future. The DSL remarked that she was fortunate to have an open-minded professor who was willing to try new technology to keep his students in school. The student's experience online in this class was uniquely fulfilling. The FS believed that the hybrid class style provided great opportunity for off campus students, was a unique experience, and added diversity to the class.

Improving Critical Thinking and Writing through Scientific Literature Review in a Greenhouse Production Course (poster)

Kellie J. Walters*, *Michigan State University* and Roberto G. Lopez, *Michigan State University (Poster Board #346)*

Abstract: Student Learning Outcomes (SLOs) are an integral part of a degree assessment and evaluation plan. These are concise statements that indicate the skills, knowledge, and abilities that students in an undergraduate degree program are expected to demonstrate. One SLO for the horticulture major at Michigan State University is for students to use multiple sources, including both primary and secondary literature, to find, evaluate, organize, and manage information related to horticultural systems. Though students gain an understanding of concepts by reading literature and writing summaries in many courses, they may not be readily able to interpret data, apply concepts, and make recommendations from the literature to practical horticultural situations. These skills are especially important for students to improve their critical thinking, interpret written information, and have confidence in their recommendations. Therefore, we implemented a literature review project in a greenhouse production course involving reading a series of primary greenhouse production journal articles from HortScience related to course content, writing summary papers, and discussing the articles. The objectives were to increase students’ confidence in

and ability to critically analyze primary literature, formulate practical recommendations from the literature, and communicate those recommendations to industry professionals. To assess the effectiveness of our primary literature review project, we administered a series of ten pre- and post-reading surveys to track student content knowledge and student confidence over the semester. We also analyzed the article summaries based on a rubric emphasizing the importance of providing accurate, complete, and practical recommendations to a greenhouse industry professional.

Specified Source(s) of Funding: Michigan State University Future Academic Scholars in Teaching (FAST)

Student Perceptions of Lecture Capture in an Introductory Face to Face Course (poster)

Bruce Dunn*, *Oklahoma State University (Poster Board #347)*

Abstract: Use of lecture capture technology has increased in the last decade to enhance the student learning environment, yet is still not used in the majority of courses at most institutions. Lecture capture is used to describe any type of system, where the content of a lecture is recorded for dissemination to students at a later date. The purpose of this study was to evaluate the perceived benefit of have recorded lectures and labs by surveying students in a 1000 level Principles of Horticulture class over two semesters. Student were given access to previously recorded lectures and lab along with lecture slides through the course Desire to Learn platform. At the end of the semester, students were given a paper survey with 10 likert type questions related to use along with student demographics. Of the 92 students who responded to the survey, all student classifications were represented almost equally and ranged from 20% freshman to 30% juniors and 18% considered themselves commuters. Results of the survey showed that the majority (55%) viewed some of the recorded lectures or labs and only 31% viewed both lecture and lab videos. Eleven students did not indicate that having access to recorded videos was useful and may have instead preferred the presentation slides. Only a small percentage (5%) of the students indicated that they preferred to view recorded lectures instead of attending class.

Enhancing Student Learning through Transparent Assignment Design (poster)

Desmond Layne*, *Washington State University*; Scott Benson, *Washington State University*; Lindsey L. Brown, *Washington State University* and Kimberly Green, *Washington State University (Poster Board #348)*

Abstract: With an ever-increasing number of “first gen” (e.g., first generation in their family to attend college) students attending Land-Grant universities, teachers are being challenged to find ways to both effectively reach/teach these students and assess their learning. There is strong scientific evidence supporting the idea that by taking simple steps to make assignments more “transparent”, not only “first gen” but all students can benefit. A simple concept referred to as “transparent assignment design” can be used to improve student learning. There are three key parts to a “transparent” assignment. These include purpose, task, and criteria. A clearly written purpose helps students to understand how the assignment is linked to their learning, the skills they will practice, knowledge that will be gained, relevance to their life and connection to the learning objectives of the class. The task clearly defines what the students will do and how they will do it. This can include steps that they should follow and things they should avoid. The criteria for success can include a checklist or rubric from which the assignment will be graded. It can also include an annotated example of previously graded student work (used with permission, student names redacted) from the past to show what excellence or “A-grade” final product work looks like. In Fall, 2017, teaching faculty from the Agriculture and Food Systems and Integrated Plant Sciences interdisciplinary programs at Washington State University were invited to attend a facilitated workshop/retreat focused on “transparent assignment design”. Faculty were prompted to bring assignments that they were already using in their classes. Following instruction about the concept, review of before-and-after examples, and discussion, faculty were assembled into pairs to work together and help each other to make their assignments more transparent. Faculty response to the workshop was determined afterwards by an on-line survey. By way of example, for the HORT 310 “Pomology” course, a comparison of both the assignment and representative student work before (2016 class) and after (2017 class) the assignment was made transparent will be compared and contrasted. Assignments that are revised to be more transparent need not be any less rigorous than their former version. However, when they are developed and deployed properly, they can help to enhance student learning and result in higher quality student work that is easier and faster to grade.

Increasing Experiential Learning and Student Participation through Poinsettia Fundraising Sales: Lessons Learned from the 2017 Season (poster)

Emily S. Teng*, *University of Hawaii at Manoa*; Aleta K. Corpuz, *University of Hawaii at Manoa*; Kauahi Perez, *University of Hawaii at Manoa* and Kent Kobayashi, *University of Hawaii at Manoa (Poster Board #349)*

Abstract: A critical component of an education in horticulture is hands-on experience growing plants. There are limited opportunities for students in the Department of Tropical Plant and Soil Sciences (TPSS) at the University of Hawaii to gain this experience, and if the opportunities available are voluntary, it can be difficult to achieve good participation from students. Multiple plant sales are held by the TPSS Graduate Student Organization (GSO) and the undergraduate Horticulture Society throughout the year for holidays such as Valentine’s Day and Christmas. In 2016, students started growing the plants instead of purchasing them from local wholesale nurseries for resale, resulting in higher quality plants and very successful plant sales. However, there is still ample opportunity to increase real world experience for horticulture students and for students to gain mentoring experience and leadership skills. Therefore, students doubled production amounts from 200 plants in 2016 to 400 plants in 2017. Additional cultivars were grown for the 2017 poinsettia sale, with three traditional poinsettia cultivars added to the four Princettia hybrids grown. A TPSS Special Topics class created in Fall 2017 to teach students about poinsettia production and marketing increased student participation in the project. Finally, a trial pre-sale at the production greenhouse facility was conducted, in addition to increased advertising and new marketing strategies. The pre-sale and regular campus sale were very successful, with 97% of the 400 plants sold. This resulted in nearly $3000 in revenue for the students to use for team building activities, social events, and travel to scientific conferences. Customers were impressed with the quality of the plants. Collaboration with the Special Topics class was worthwhile, with students participating in major production, marketing, and sales activities. Production will be further expanded for the 2018 season, with plans to add more traditional red poinsettias due to customer demand. A collaboration with a TPSS Horticultural Practices class is planned to involve more students in Fall 2018. Advertising at off-campus sites will be added to increase traffic at the greenhouse pre-sale. Finally, students gained valuable growing, marketing, leadership and mentoring skills in addition to a strong sense of pride and accomplishment. We thank Dümmen Orange, Suntory Flowers, Delilah Onofrey, Angela Mekjian, Craig Okazaki, and Ronald Matsuda for their assistance.

Poinsettia Nursery Production: Horticulture Lab Experiential Learning Activity (poster)

Annie Alcolea, *Florida International university* and Amir Khoddamzadeh*, *Florida International University (Poster Board #350)*

Abstract: Students from the horticulture science lab at Florida International University (FIU) had the opportunity to gain hands-on experience in the growing and marketing of plants through poinsettia production for the 3rd Annual Poinsettia Sale event at FIU. Approximately 500 rooted poinsettia were acquired from the local nursery, transplanted, pinched, fertilized and treated with the plant growth regulator (PGR) B-Nine as part of the production process.

Use of the MSU Community Garden for Teaching, Research, and Outreach Programs (poster)

Tongyin Li*, *Mississippi State University* and Cory Gallo, *Mississippi State University (Poster Board #351)*

Abstract: A case study was conducted to investigate the use of the MSU Community Garden as a living classroom for teaching, research, and outreach programs. The Mississippi State University

Community Garden initiated its first planting in April, 2017. Designed by associate professor Cory Gallo's landscape architecture design/build studio, twelve raised beds were designed and built in the garden in 2017. Construction of the MSU community Garden is planned to be complete in 2018 with a total number of 30 raised beds and an orchard. From a teaching standpoint, three courses including the Gardening Experience (PSS 1113), Grow Your Own Salads and Soups: Vegetable Gardening (LA 1001), and Community Food Systems (LA/PSS/FNH 4990/6990) are using the community garden as experiment site, where students gain hands-on experience of growing vegetables. At the MSU Community Garden, students can volunteer to work in the garden and serve as creative outlets for them. The Community Garden also serves as a base for graduate and undergraduate student research. The garden will provide demonstrations of new and sustainable gardening practices and be available to student, staff, and faculty members in MSU and to Starkville citizens . The community garden provides opportunity to involve people of all ages in promoting inspiration for gardening and a sense of pride in the work that is accomplished there. Therefore, the community garden is making an impact for people in and outside MSU by increasing health consciousness of the community and promoting a healthy local food system.

Enhancing Student International Learning Experiences through a Study Abroad Exchange Program in Tropical Horticulture (poster)

David Picha*, *Louisiana State University Agricultural Center* and Katrina Spillane, *Universidad Nacional de Agricultura (Poster Board #352)*

Abstract: An international academic partnership between Louisiana State University (LSU) and the Universidad Nacional de Agricultura (UNAG) in Honduras was strengthened by a Partners of the Americas-funded study abroad award. The main activities included a one-week tropical horticulture field study course in Honduras for LSU and UNAG students, followed by a three-month visiting scholar program at LSU for five UNAG students. The study abroad course provided some of the most impressionable horticulture-related learning experiences for all student participants and fortified their career interest in horticulture. It also gave LSU students the opportunity to see crops that do not grow in the continental U.S. and understand the entire value chain from production through marketing. The visiting scholar program developed UNAG student competencies in field and laboratory research from faculty and staff-supervised training. It also provided U.S.-university classroom learning experiences in a diversity of horticulture-related subjects. The most outstanding student scholars are included in a pool of potential future graduate students. Reciprocal study abroad programs are very effective methods to build collaboration among universities and facilitate impactful global learning experiences for the individual student participants.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Weed Control and Pest Management 1 (Poster)

Influence of Physical Properties of Common Landscape Mulch on Emergence of Two Weed Species (poster)

Debalina Saha*, *University of Florida - Mid Florida Research and Education Center*; Chris Marble, *University of Florida - Mid Florida Research and Education Center*; Brian Pearson, *University of Florida, Mid-Florida Research and Education Center*; Hector E. Perez, *University of Florida*; Dennis C. Odero, *University of Florida* and Gregory E. MacDonald, *University of Florida (Poster Board #168)*

Abstract: Mulch can reduce weed growth but it not clear how physical properties of mulch affect weed emergence. To determine how different mulch materials and physical properties affect weed emergence, outdoor and greenhouse experiments were conducted in Apopka, FL. For the greenhouse experiment, containers (3.8 L) were filled with standard substrate and divided into two halves using plastic sheets. Crabgrass (*Digitaria sanguinalis*) or garden spurge (*Chamaesyce hirta*) seeds were sown to half of each container either above or below pinestraw, pinebark or hardwood mulch at depths of 0, 1.3, 2.5, 5.1, or 10.2 cm. For the outdoor experiment, nursery containers (11.4 L) were filled, mulched, and seeded in a similar manner. A square transparent plastic tube was inserted in the center of each container, below the mulch layer and light intensity measurements were recorded using a LICOR® LI-191R sensor. Particle size analysis of mulch materials was conducted separately using soil sieves ranging in size from 1 to 25 mm. Moisture retention by mulch was also recorded using moisture sensors and by recording water retention in the mulch layer following 2.5 cm of irrigation at 1, 4, and 24 hr after application using Buchner funnels. Data collection included biweekly weed counts, light measurements under mulch layers, moisture levels in the mulch layer, and drainage through mulch layers. Weed emergence decreased 37 to 90% when seeds were placed below the mulch layer in all mulch types for both weed species compared with seeds placed above mulch. Mulch type had no influence on emergence when weeds were placed below layers of 2.5 cm or greater. When seeds were placed above the mulch layer, pinestraw or pinebark had 63 to 83% fewer weeds compared to hardwood. Particle size analysis showed hardwood was composed of smaller particle size and had 60% greater moisture holding capacity compared with other mulch materials. Light sensor data showed mulch depths > 2.5 cm excluded 99.5% of light and there was no difference in light readings at higher mulch depths. Results from these trials suggest that for the species evaluated, weed emergence will likely increase when seeds are present (introduced) above mulch layers compared with seeds already present in the soil. Pinebark and pinestraw may provide greater weed control compared with hardwood mulch due to less moisture holding capacity but mulch type will have less influence on emergence of seeds already present in the soil when as depths increase.

Use of Topramezone Herbicide for Weed Control in Native and Ornamental Grass Plantings in Florida (poster)

Chris Marble*, *University of Florida - Mid Florida Research and Education Center* and Annette Chandler, *University of Florida/IFAS Mid-Florida Research and Education Center (Poster Board #169)*

Abstract: Ornamental grasses are popular in golf course natural areas and in landscapes due to their pest resistance and ability to thrive in low-input environments. While many grass species are naturally disease and or insect pest resistant, weed control continues to be a challenge for both landscape pest control operators and golf course superintendents managing large monocultures of native/ornamental grasses. Research was conducted in 2016 and 2017 in Apopka, FL to determine the response of 14 different ornamental grasses to over-the-top applications of topramezone, a new HPPD inhibiting herbicide. Uniform and fully-rooted liners were planted in the field and allowed 2 months to establish prior to treatment. At this time, topramezone was applied over-the-top to each species at rates of 0.05 and 0.10 kg ai ha^{-1} using a CO_2 backpack sprayer. A sequential application followed 6 weeks later using the same rates. Species evaluated in 2016 included *Schizachyrium scoparium* 'The Blues' (little bluestem), *Tripsacum dacyloides* (eastern gamagrass), *T. floridanum* (florida gamagrass), *Chasmanthium latifolium* (wild oats), *Muhlenbergia capillaris* 'White Cloud' (white cloud muhlygrass), *Eragrostis elliotti* 'Wind Dancer' (wind dancer lovegrass), *Panicum virgatum* (Red switchgrass), and *Spartini bakeri* (sand cordgrass). *Andropogon virginicus* (broomsedge), *Miscanthus sinensis* 'Purpurescens' (purple miscanthus), little bluestem, *Sorghastrum nutans* (indian grass), *Carex appalachica* (Appalachian sedge), *Muhlenbergia capillaris* (muhlygrass), *Eragrostis curvula* (weeping lovegrass), and *Pennisetum alopecuroides* 'Cassian' in 2017. Data collected included visual injury ratings at 3, 7, 14, 28, and 42 days after the first and second treatment. In 2016, growth index [(plant height + plant width1 + plant width2)/3] was recorded and plant shoot dry weights were recorded in 2017.The trial was designed as a completely randomized block design and each species was considered a separate experiment. Eastern gamagrass, Florida gamagrass, and little bluestem showed no injury or growth reduction following either application. No injury was seen on broomsedge but a growth reduction was evident at both topramezone rates. Purple miscanthus and Indian grass showed a high degree of tolerance following one application but injury was observed following the second. Wind dancer love grass, wild oats, sand cordgrass, red switchgrass, cassian fountaingrass, pink muhly, white cloud muhly, and weeping lovegrass were severely injured at both rates following only one

application. Results suggest there is potential for future use of tropramezone in and around certain ornamental grass species, but testing a small group of plants prior to large-scale application would be needed due to potential phytotoxicity.

Influence of Pinebark Particle Size on Preemergence Herbicide Efficacy and Growth of Four Container Nursery Weed Species (poster)

Chris Marble*, *University of Florida - Mid Florida Research and Education Center*; Cody Stewart, *University of Florida - Mid Florida Research and Education Center*; Brian Jackson, *North Carolina State University* and Brian Pearson, *University of Florida, Mid-Florida Research and Education Center (Poster Board #170)*

Abstract: Many pinebark suppliers now organize inventories based on particle size (e.g. 2 or 1 cm, etc.) to create custom blends for growers. Experiments were conducted in 2016 and 2017 to determine the influence of pinebark particle size on weed growth and preemergence herbicide efficacy when subjected to similar irrigation regimes. Pinebark was obtained from a local supplier in Apopka, FL and separated into three particle sizes including 6.3 (large), 2.8 (medium), and 1.4 mm (fine) using soil sieves. Standard amendments (fertilizer, lime, micronutrients) were incorporated in each substrate. Substrates were then treated with two rates of prodiamine [0.84 and 1.7 kg active ingredient (a.i.) ha^{-1}], dimethenamid-P (0.84 and 1.7 kg a.i. ha^{-1}) or indaziflam (0.04 and 0.08 kg a.i. ha^{-1}) using a CO_2 sprayer at 468 l ha^{-1} application volume. Seeds of *Eclipta prostrata* (eclipta), *Digitaria sanguinalis* (crabgrass), *Oxalis stricta* (oxalis), and *Pilea microphylla* (artilleryweed) where then surface sown onto pots. *Eclipta* were sown to pots treated with indaziflam, oxalis were sown onto pots treated with dimethenamid-P, and artilleryweed and crabgrass were sown onto two separate groups of pots treated with prodiamine. Pots were kept inside a greenhouse and irrigated 0.8 cm per day. Data collected included weekly weed counts and shoot fresh weights at 8 weeks after seeding. The trial was designed as a 3 × 2 factorial with three particle sizes and two rates of herbicide. In nontreated pots, substrate particle size significant for all four weed species with growth increasing as particle size decreased. Shoot fresh weight increased by 33, 117, 49, and 318% for crabgrass, eclipta, oxalis, and artilleryweed, respectively, when comparing weeds growing in small particle substrates to those growing in large particle substrates. This was likely due to higher water holding capacity of the smaller particle substrates as irrigation was not adjusted for different particle sizes. In herbicide treated pots, particle size did not influence herbicide efficacy for any species. Rate was significant in both eclipta and oxalis, however both rates provided over 90% control, and there were no rate × particle size interactions for any species. Based on these results, normal particle size ranges used in nursery production will likely have little effect on herbicide efficacy if proper herbicides and rates are applied for problematic species. In outdoor production where total water applied (irrigation and rainfall) is more difficult to manage, weed growth will likely increase in substrates with higher water holding capacities.

The Effect of Three Different Mulches on Weed Presence, Zinnia Growth , and Soil Characteristics (poster)

Anmar A Muttaleb*, *Murray State University (Poster Board #171)*

Abstract: **Abstract**

The use of organic and inorganic mulching helps plants to grow by inhibiting the growth of weeds, retaining soil moisture, and regulating the

temperature of soil. The objective of this study was to determine the effects of different organic mulches on weed presence, soil characteristics, and

growth of *Zinnia elegans*. The mulches used in studying *Zinnia elegans* were wheat straw, non-shredded *Miscanthus* (*M.* × *giganteus*), and shredded *M*.

× *giganteus* mulch. A Randomized Complete Block Design (RCBD) was used in the study, with different quantitative methods used to collect data, and

ANOVA tests were utilized to statistically analyze data. The research found that shredded *Miscanthus* × *giganteus* was the most useful mulch in reducing

weed pressure. The results of the study also showed a statistically significant difference between mulch treatments and the control, on *Zinnia*

elegans growth. The use of non-shredded *M.* × *giganteus* and wheat straw resulted in significant increased macronutrient and micronutrient levels in

the soil. Also, non-shredded *M*. × *giganteus* mulch correlated with increased stem diameter, stem length, flower set, and the formation of flower buds,

as compared to wheat straw and shredded *M*. × *giganteus*.

Abrasive Weeding Paired with Mulch Film Increases Yield and Profitability of Organic Pepper Production (poster)

Sam E. Wortman*, *University of Nebraska - Lincoln*; Emily Braun, *University of Illinois*; Frank Forcella, *USDA-ARS Soils Lab*; Sharon Clay, *South Dakota State University* and Daniel Humburg, *South Dakota State University (Poster Board #172)*

Abstract: Weeds are a top management concern among organic vegetable farmers. Abrasive weeding is a newly developed non-chemical tactic that uses air-propelled abrasive grits to destroy weed seedlings within crop rows. Many different grit types are effective, but if organic fertilizers are used as abrasive grits it could allow farmers to integrate weed and nutrient management in one field pass. Our objective was to determine if abrasive weeding with organic fertilizer grits can be used in combination with agricultural mulches to increase weed suppression, yield, and profitability in organic vegetable systems. A two-year factorial experiment was conducted in organic red pepper (*Capsicum annuum* 'Carmen') at Urbana, IL with four replicates of five abrasive grit treatments (walnut shell grits, soybean meal fertilizer, Sustâne composted turkey litter fertilizer, a weedy control, and a weed-free control) and four mulch treatments (straw mulch, bioplastic film, polyethylene plastic film, and a bare soil control). Abrasive weeding alone reduced in-row weed density by 35%, and mulch films alone reduced in-row weed density by 86%. Combining the two tactics reduced weed density by 94-98%, regardless of grit type. In-row weed biomass was greater in planting holes of films compared to bare soil, but abrasive weeding reduced that biomass by 77-87%. Films alone increased yield 6-fold, whereas films plus abrasive weeding increased yield 8-fold. Abrasive weeding combined with mulch films for weed control increased net income by an average of $29,260/ha, but that profit could be doubled if weed-free conditions are achieved via hand-weeding or two additional grit applications.

Specified Source(s) of Funding: USDA NIFA OREI award # 2014-51300-22233

Utilizing Industrial Hemp As a Cash or Cover Crop to Address Weed Pest Issues and Enhance Soil Health in Organic Agriculture (poster)

Tara A. Caton*, *Rodale Institute (Poster Board #173)*

Abstract: Industrial hemp, a versatile plant grown for its fiber, seed or oil, was a valuable cash crop and a major industry in Pennsylvania for more than 260 years prior to its ban in 1933. Due to its close relationship to the marijuana plant, hemp production became a casualty of a 1933 law banning marijuana, and was later named a Schedule 1 drug by the Controlled Substances Act of 1970. In 2017, Rodale Institute was one of 16 organizations that received a permit for the inaugural planting of hemp in Pennsylvania in more than 80 years as part of the Pennsylvania Department of Agriculture Industrial Hemp Pilot Program. A four-year research project was initiated to evaluate industrial hemp varieties that are most suited to soil and climatic conditions in Pennsylvania. Organic farmers are interested in growing hemp but require research-based information that will help them make informed decisions about integrating hemp into their rotations. The project has two components; – a variety trial that aims to determine available varieties with greatest seed yield and fiber content and a weed suppression trial that aims to establish hemp as a dual cover and cash crop. Three varieties are being assessed for weed suppression, viability, height, hemp biomass, seed yield and effect on soil physical and chemical properties. The weed competition trial is evaluating potential of hemp to act as a substitute cover crop in common organic tilled and no-till crop rotations, as a weed suppression cover crop. Preliminary results indicate that both 'Santhica' hemp variety and

sorghum Sudan grass equally suppress weeds compared to control. The data indicate that hemp suppresses ragweed better than Sudan grass, while the latter suppresses lambsquarters better than hemp. Data also suggest that 'Santhica' hemp and Sudan grass reduce soil bulk density. After nearly 80 years, there are encouraging signs that industrial hemp may soon be legal to grow again in the United States. However, the knowledge needed to grow hemp has largely been lost. Our research will help growers make informed decisions and avoid costly mistakes when hemp is legalized.

Specified Source(s) of Funding: Dr. Bronner's; Nutiva

12:30 PM – 1:00 PM *Boundary (Terrace Level)*

Plenary ("Tex" Frazier) Lecturer & Invited Speakers Selection Committee Meeting

Chair: Kim Hummer, *USDA ARS*

Members: Peter Hirst, *Purdue University*; Susan Miyasaka, *University of Hawaii at Manoa* and Thomas Ranney, *North Carolina State University, Dept. of Horticultural Science*

12:30 PM – 1:30 PM *Jay (Lobby Level)*

ASHS Events & Education Planning Committee

Chair: Curt Rom, *University of Arkansas*

Members: David Butler, *The University of Tennessee*; Sofia Carvalho, *University of Florida*; Feng Chen, *Univ of Tennessee - Plant Sciences*; Brooke Edmunds, *Oregon State University Extension Service*; Whitney N Griffin, *Texas A&M University*; Rebecca Grummet, *N/A*; Kauahi Perez, *University of Hawaii at Manoa*; Brian Trader, *Longwood Gardens*; Michael Wisniewski, *USDA-ARS, AFRS* and Mengzi Zhang, *Michigan State University*

12:30 PM – 2:00 PM *Van Ness*

Featured Speaker Luncheon: Gabriele Ludwig, Almond Board of California

12:30 PM California Almonds: Success through Research

Gabriele Ludwig*, *Almond Board of California*

Abstract: California grows some 80% of the world's almonds. Through the Almond Board of California, almond growers have been funding research for over 40 years, and research in horticulture and in nutrition has been foundational to the growth of the almond industry. What role has and can horticultural research play as growers face the increasing complexity of market forces, regulatory issues, and growing issues (sustainability)?

12:45 PM – 2:00 PM *Georgetown West*

Undergraduate Student

12:45 PM Vegetative Propagation of Guayule

Daryan Godfrey*; John Willmon; Valerie H. Teetor; Carl Schmalzel and Dennis T. Ray, *University of Arizona*

Abstract: Guayule is a desert-adapted woody perennial, having been used as a landscape plant and presently being commercialized for rubber production. It is difficult to establish guayule from seed, and an alternative method of propagation is by cuttings. Success in this process is dependent on multiple environmental and endogenous factors, including: humidity, media, age of cutting material, and hormone treatment. The factor manipulated in this study was auxin. The hypothesis was a low concentration of auxin would have minimal effect on rooting, and a high concentration would have a negative effect. A range of 500 ppm to 2000 ppm (in steps of 500 ppm) of Indole Butyric Acid (IBA) in solution with water were tested. The same range was applied with Napthaleneacetic Acid (NAA). Many commercial rooting hormone products use a mix of IBA and NAA, so one treatment of 750 ppm IBA:750 ppm NAA treatment was included. A DI water treatment was the control. The cutting material was late first-year growth from shoot tips, cut between 6-9 cm, and the bottom two-thirds stripped of foliage. The cuttings were treated in batches of 10; the basal cuts dipped into a treatment solution, agitated for 10 seconds, and allowed to soak for another 50 seconds. Cuttings were planted approximately 5 cm deep in a media of 1:1 coco coir and perlite. A total of 1,600 cuttings, for the 10 treatments, 4 varieties (AZ-3, R1100, 593 and 11693), and 4 reps were treated. Each repetition was fitted into two plug-trays, for a total of 400 cuttings. Each treatment was randomly assorted into a 2x5 cell region of the tray. After 46 days, the cuttings were scored: 0 – dead, 1 – no change, 2 – cell differentiation (but no rooting), 3 – root initiation, 4 – 1/3 of plug rooted, 5 – 2/3 of plug rooted, 6 – fully rooted plug. Just considering total number rooted (rooting scores of 4, 5, and 6 combined), there were few differences among auxin treatments. That the treatments were generally not different from water, the auxin concentrations were neither high or nor low enough to confirm the hypothesis. There were significant differences among lines for treatments. Lines 593 and R1100 produced fewer roots in comparison to AZ-3 and 11693. The combination IBA:NAA treatment produced a higher number of rooting scores of 5 and 6. Thus, the experiment is continuing by testing different ratios of IBA:NAA, and varieties AZ-3 and 11693.

Specified Source(s) of Funding: USDA-NIFA

1:00 PM Organic Strawberry Transplant Production for Season Extension in Oregon: Effects of Container Size on Cost, Ease of Planting and Plant Development.

Tessa A Barker*; Javier Fernandez-Salvador and Erica Chernoh, *Oregon State University*

Abstract: The strawberry industry in Oregon has historically focused on the production of June-bearing cultivars primarily sold for processing, a market which has continued to decline over time. In recent years, fruit grown for fresh consumption has increased in acreage and market share. Fresh market production, particularly for organic growers, has the potential to offer farmers greater profits due to increased price premiums and an extended harvest season. Currently, the supply of fresh organic strawberries produced in Oregon is not meeting the consumer demand for a locally grown crop. In addition, there is a need for region-specific organic production research-based guidelines for fresh market, day-neutral strawberries. Day-neutral cultivars are the optimal choice for fresh market because their fruit production relies on temperature rather than day-length, allowing plants to be harvested earlier. Strawberries grown from containerized transplants rather than bare-root plants have better field establishment with higher plant survival and earlier yields, but information is needed on best practices for organically approved on-farm production of transplants. The objective of this study is to determine the optimal size of transplant container for ease of planting and reduced production costs, without affecting plant development in an organic strawberry production system. 'Albion' strawberries were grown in two container sizes (234 cm^3 and 614 cm^3) and with organically approved planting media (Peat-moss plus forest product with fertilizer). Bare-root strawberries were planted into containers in late February and kept in a greenhouse at Oregon State University (Corvallis, OR). Plants were watered at planting and once per week thereafter. Plants are measured every week for leaf development and mortality. Albion leaf number increase on average 1.8 and 1.6 times per week from planting for the larger size cells and 1.6 and 1.4 times for the smaller size cells per week, respectively. Total leaf area was 7 percent greater on average for plants grown in larger size cells. Plant mortality has been minimal (less than 2 percent) for both cell sizes. Media, supplies used and labor costs for each container size were compared. Total transplant production cost for a one-acre field (24" beds with 2 rows with plants spaced 12" apart) is 1.8 times greater for larger size cell transplants ($3,800) than for the smaller size cells ($2,100). Transplants from the two container sizes will be grown in a certified organic field to determine ease and speed of planting and cost benefits for extended season production.

1:15 PM Increasing Farmer and Undergraduate Participation in on-Farm Research on Vegetable Farms in Indiana

Tamara Benjamin*; Kevin Gibson and Amy Thompson, *Purdue University*

Abstract: This project introduced participatory research to vegetable farmers in the North Central region, utilizing biochar, a soil amendment with the long-term potential to improve soil fertility and crop yields in the region. The growers who participated in the study are considered early adopters of new technology and are interested in low-input agriculture. The project increased the knowledge of the potential effects of biochar on soil fertility and the potential for reduced fertilizer inputs, by providing the growers with information on biochar from on-farm participatory research. The research was conducted in a variety of climatic areas of the state and on different soil. Final results from the participatory research were inconclusive for biochar impacts on vegetable production but we did find that the knowledge gained from the project helped guide the participating growers to conduct additional research. The project also created a model for using interns in on-farm participatory research. Our novel approach of pairing undergraduate students with growers in a structured summer research project resulted in increased understanding among student participants of farm life and farm management (for example students gained an appreciation for working conditions on successful farms) and had the long-term potential for influencing student interest in farming as a career. This project also increased our understanding of how to optimally pair growers and students to provide on-farm experiential learning opportunities. The project increased the short and long-term capacity and interest of growers in conducting on-farm research and increased collaboration among farmers, extension educators, and researchers. This project built a novel and robust network for participatory learning.

Specified Source(s) of Funding: North Central Sustainable Agriculture Research and Education (NC SARE)

1:30 PM Pre-Growing Season Oomycete Sampling to Identify Plant Pathogen Risk

Stephen C. Boushell*; Justine R. Beaulieu and Christopher Walsh, *University of Maryland*

Abstract: Irrigation with water containing plant pathogens, such as species of oomycetes, has the potential to induce high levels of root and crown rot in plants. To test the prevalence of these pathogens in early January, the irrigation ponds of a group of local Maryland pick-your-own operations were sampled. These operations harvest a wide variety of crops, including strawberries, apples, pumpkins, and raspberries. Many of these specialty crops are known for being highly susceptible to oomycetes, which can cause heavy economic losses.

Rhododendron leaves were used as a pathogen trap to sample the irrigation ponds for the presence of oomycetes. Once collected, the leaflets were plated and monitored for mycelial growth. Next, differential plating was used to segregate the groups of *Phytopythium* and *Phytophthora* cultures. The DNA was extracted from each of the samples and underwent a polymerase chain reaction (PCR). This allowed the samples to be tested using the Blast technique to identify the particular species and isolate of the samples collected. During the spring, the pathogenicity of these particular isolates was tested using strawberries and pumpkins. Each crop was inoculated with a different isolate of the pathogens in a growth chamber and their growth and general health were recorded.

The positive results of the irrigation pond sampling during early January highlighted the resilience of these plant pathogens. These results demonstrate the opportunity for growers to screen their irrigation water for plant pathogens and then deploy preventative measures prior to the growing season.

1:45 PM Predictive Breeding: A Study of the Effectiveness of Tissue Storage Methods for Genome Analysis

Jed Donald Grow*; W. Wesley Crump; Jason M. Stettler and Mikel R. Stevens, *Brigham Young University*

Abstract: Understanding the genome size and ploidy level of the species and specimens in our beardtongue (*Penstemon* Mitch.) breeding program is essential to making appropriate crosses, and to assess the success of induced polyploid plants. Frequently in plants, flow cytometry (FCM) analysis is used to estimate the genome size of a specimen in question by comparing it with an internal standard of a known plant genome size. FCM generally requires fresh tissue and uses a fluorescent dye to stain the nuclei of the cells, where they are then passed through a laser. The fluorescence of the DNA is measured and compared to the internal standard. Unfortunately, fresh tissue is not always available to immediately process for analysis. We have read in the literature that FCM has been used to identify the genome size of well preserved herbarium samples. We hypothesized that other types of stored tissue may be used in place of fresh tissue. To test our hypothesis we compared FCM analysis of fresh tissue to samples stored in -20º C, -80º C, lyophilized fresh tissue, lyophilized frozen tissue stored at -20º C and -80º C, and air dried (herbarium specimens).We examined each treatment, in triplicate with tissue from (*Penstemon eatonii, P. fruticosus, P. cyaneus, P. laevis, P. palmeri, P. venustus*). We found that, compared to fresh tissue, all treatments showed degradation up to a 35% reduction in genome size. Contrary to our hypothesis, this reduction in genome size was not uniform across treatments for each species. It was concluded that with the current technology and procedures, there does not exist a good substitute for fresh tissue in the collection of FCM data of plant genomes.

1:00 PM – 1:30 PM *Boundary (Terrace Level)*

Horticultural Landmarks Selection Committee Meeting

Chair: Rose Ogutu, *Delaware State University*

Members: Mary Albrecht, *University of Tennessee*; Mary Arpaia, *University of California*; Stephanie Walker, *New Mexico State University*; Suping Zhou, *Tennessee State University* and Janice Uchida, *University of Hawai'i*

1:00 PM – 1:45 PM *International Ballroom East/Center*

Ecological Physiology (Poster)

Infrared Thermography Applications in Stress Response (poster)

Amanda Lewis*, *Texas A&M University Kingsville and Texas A&M University*; Luis Cisneros-Zevallos, *Texas A&M University*; Shad Nelson, *Texas A&M University, Kingsville*; Greta Schuster, *Texas A&M University-Kingsville* and Catherine Simpson, *Texas A&M University, Kingsville Citrus Center (Poster Board #260)*

Abstract: Infrared thermography is a measurement of an objects emittance of long wave radiation that allows us to visualize the temperature of an object. Stomatal conductance is a parameter frequently measured in plant science research; primarily to determine the effects of stressors on stomata and plant water relations. This gives us insight into plant photosynthesis, water, and stress status of plants. Porometry is a common measure of stomatal conductance, which requires contact with the leaf surface, and can influence the measurement being taken. Thermal imaging offers advantages over porometry for measurement of stomatal conductance. The objective of this study is to explore applications of thermal imaging during plant development. Aspects of this study include defining the relationship between thermal image parameters and stomatal conductance in *Capsicum annum* under ambient and drought stressed conditions. It is expected that the relationship between stomatal conductance and thermal index, calculated using thermal imaging data, will be linear and proportional. Preliminary research conducted on three tomato cultivars found a linear relationship between thermal index and stomatal conductance in all cultivars, and proportionality in one cultivar. It was also found that thermal index could be used to identify phenotypic differences in response to light stimulus in the tomato cultivars tested. Ongoing research to establish the relationship between stomatal conductance and thermal index will allow us to use thermal imaging to quantify and visualize dynamic stomatal response to drought stress in *C. annum*. This will be confirmed by analysis of stress response compounds in plant tissue samples.

Specified Source(s) of Funding: USDA/NIFA NNF Award No. 2014-38420-21798 Title: Sustainable Agriculture in Semiarid Areas: An International & Interdisciplinary Approach to Graduate Education

Impact of High Root Temperature on Heat Tolerant and Intolerant *Lycopersicon Esculentum* Variety Photosynthetic Rate. (poster)

George Guenthner*, *University of Minnesota* and John Erwin, *University of Minnesota (Poster Board #261)*

Abstract: In many cases, testing tomato cultivars for temperature tolerance involves subjecting the entire plant (including roots) to high or low temperatures and fails to distinguish the impact of root system stress in overall plant photosynthetic responses. We previously determined root respiration rates of eight tomato cultivars varying in heat tolerance that also vary in root respiration responses to root zone temperatures ranging from 44.1 to 59.1 ^{O}C (+/- 0.4 ^{O}C). In this study, root temperatures of heat tolerant and heat intolerant tomato varieties were maintained at 25 ^{O}C and 55 ^{O}C (previously determined as a non-stressful and stressful temperature, respectively) while aboveground stem and leaf tissues were maintained at 26^{O}C (previously identified as optimal for photosynthesis in tomato) to determine whether photosynthetic activity of heat tolerant and intolerant tomato varieties was impacted by high root temperatures differently. Specifically, we sought to determine the degree to which aboveground photosynthetic activity is associated with root sensitivity to high temperature.
Specified Source(s) of Funding: USDA-ARS; FRA; Minnesota Agriculture Experiment Station

Effect of Incremental Temperature Increase on Blueberry Pollen Production and Viability (poster)

Sarah A. Mills*, *West Virginia University* and Nicole L. Waterland, *West Virginia University (Poster Board #262)*

Abstract: Blueberry is a popular and economically important crop that is primarily pollenated by bees. Crops that require bee pollination must produce a sufficient amount of viable pollen, since bees pack pollen onto their scopae most of the pollen collected is unavailable for pollination. Changes in climate have yielded warmer temperatures impacting flower development including pollen production and the activity of pollinators. Many studies have investigated the viability of pollen exposed to elevated temperatures for short time periods. In other studies pollen was collected under ideal temperatures and then placed under temperature treatments. The objective of this study was to determine the impact of long term exposure to incrementally increasing temperature on the production, release, and viability of pollen from two cultivars of highbush blueberry (*Vaccinium corymbosum* L.) 'Blueray' and 'Jersey'. Plants were grown at five temperatures 18, 20, 24, 28, and 31 °C under natural irradiance in a greenhouse. Pollen release was evaluated by rolling the flower. Pollen viability was determined by plating pollen on germination media, plated pollen was stored for two hours at the same temperature treatment. Pollen viability, mean number of pollen tubes per germinated tetrad and pollen tube length were evaluated. The longest pollen tube length was observed from plants grown at 18 °C. Few flowers were produced, however, at 31 °C and most of the pollen collected failed to germinate. Our data suggested that long term exposure to even relatively small increases in temperature negatively affected pollen viability. Temperature increase due to climate change could decrease not only activity of pollinators, but also pollen production and viability raising a great concern since it has been liked to poor fruit set, potentially decreasing fruit yield.

Shade Avoidance: Can We Breed for Weed Resistance? (poster)

Emily L. Lesher*, *Rodale Institute (Poster Board #263)*

Abstract: The ability of plants to respond to disease causing pathogens by acquiring systemic resistance when exposed to those pathogens has been widely studied. Previous research with Arabidopsis has established that such acquired defenses can be even more pronounced in the progeny than the parental plant population, analogous to vaccinating a parent and seeing immunity in their children. The ability of weeds to similarly induce weed resistant crops has not yet been established. Plants can sense when other plants are close, a response referred to as shade avoidance, attributed to their response to red:far-red ratio of the light spectrum. Given that plants absorb the red-light spectrum for photosynthesis, far-red light spectrum is normally reflected. Consequently, there would be a lower red:far-red ratio in densely spaced plants such as a weedy environment compared to a non-weedy environment. This study aims to determine if these responses are heritable and can make the progeny more tolerant to weeds, without compromising their productivity. Greenhouse studies were started in 2015 at Rodale Institute and the University of Wyoming to determine if resistance to weed pressure is a heritable trait induced through competition in the F1 generation. The experiment was designed as a one by three factorial completely randomized block design replicated three times. Oat or wheat plants were planted in cone-tainers surrounded by annual ryegrass, redroot pigweed or soil (control). Test plant measurements of plant height, leaf length and width, and seed counts were taken on a weekly basis. At Rodale, F1 generation seed were saved and planted in the same environment as F1 generation. In Wyoming, saved F1 seed were factorially inter-planted in such a way that they had all possible combinations of weed/soil environments. Preliminary results from Rodale indicated that F2 oat plants exposed to ryegrass tended to be taller than controls. Preliminary results from Wyoming revealed that F2 progeny exposed to weeds or soil, whose parents were exposed to weeds, had 63% and 75% heading respectively while F2 progeny whose parents were not exposed to weeds had only 0% and 13% heading respectively. These results suggest that heading date in second generation wheat was influenced by previous generation's growing environment than current growing environment– implying that shade avoidance response to weed exposure is heritable.
Specified Source(s) of Funding: Towards Sustainability Foundation

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1:00 PM – 1:45 PM *International Ballroom East/Center*

Herbs, Spices, and Medicinal Plants (Poster)

Wild-Simulated Production Guide for Ginseng Farmers in Tennessee (poster)

Shannon A. Smith*, *Middle Tennessee State University*; Nathan Phillips, *Middle Tennessee State University*; John DuBois, *Middle Tennessee State University* and Arvazena Clardy, *Tennessee State University (Poster Board #386)*

Abstract: Asian ginseng (*Panax ginseng*) is a fleshy root plant that has been used for millennia in Asian medicines. American ginseng (*Panax quinquefolius*) is the North American cousin to the Asian species and both are members of the ivy family. Both the Asian and American species have been valued throughout history, and collected or cultivated for use. The demand for ginseng is highest in the Eastern markets. To meet this demand, both farmers and wild ginseng harvesters have increased output to leverage a growing far-eastern economy. Agricultural scientists have been researching methods to aid farmers in their production of American ginseng. The goals of this paper are (1) to summarize the research of several specialists into one coherent narrative; and (2) to give agricultural producers in Tennessee a working understanding of several variables that affect the growth and value of North American ginseng. By focusing on the wild simulated method, information from a diverse set of disciplines can be delivered to the public in a fashion that allows for its practical use. Also, switching production of ginseng for human consumption from harvesting dwindling wild sources to wild simulated methods can lessen harvest pressure on threatened populations.
Specified Source(s) of Funding: Greenway herbal producers LLC, Middle Tennessee State University

Effects of Environment, Bine Age, and Cultivar on Chemical Quality Metrics of Hops Grown throughout New Jersey (poster)

Megan Muehlbauer, *Rutgers University*; David Hlubik*, *Rutgers University*; Michelle Infante-Casella, *Rutgers Cooperative Extension*; Martin Zorde, *Rutgers University*; Robert Pyne, *Rutgers University* and James Simon, *Rutgers University (Poster Board #387)*

Abstract: Hops are considered a key essential ingredient in brewing beers. They are added to beer to impart bittering flavors and aroma compounds, and are known to vary in their chemical composition of each component. Major production areas of the United States are in the Pacific Northwestern areas of Washington, Oregon and Idaho. Growers and processors of hops in this region have set quality standards, which growers in newer regions (i.e. the Northeastern U.S.) must meet to ensure brewers will purchase their crop. The purpose of this study was to determine the variation in hop quality characteristics due to age

of planting, growing location in New Jersey (NJ), and cultivar. Quality was measured by results of alpha and beta acids and aromatic compound testing. Over 50 samples of hops were collected from 10 farms throughout NJ over a 3 year period, representing over 10 cultivars. Alpha and beta acids were analyzed using the ASBC published (International) method (Hops-14), and compounds were separated and identified by HPLC-UV. Aromatic profiles were determined according to the ASBC method (Hops-17), and the total volatiles were separated and quantified using a Shimadzu TQ8040 gas chromatograph MS. Interestingly, a number of cultivars (i.e. Nugget) showed differences in quality when grown at different locations throughout NJ. In addition, data indicated that several cultivars included in the study showed improvement in chemical composition as a planting aged. Two noteworthy cultivars, Cascade (alpha acid=5.6% and beta acid=6.3%) and Ultra (alpha acid=9.5% and beta acid=3.9%) reached optimum quality levels by 2017 (3 years after planting at that site). This preliminary data indicates that NJ grown hops have the potential to meet hop quality industry standards, but growing location, and age of planting have an effect on the quality of NJ grown hops.

Specified Source(s) of Funding: Northeast Sustainable Agriculture Research and Education

Evaluation of Ginger Cultivars in a Greenhouse (poster)

Guochen Yang*, *North Carolina Agricultural and Technical State University*; Sanjun Gu, *North Carolina Agricultural and Technical State University*; Zhongge (Cindy) Lu, *North Carolina Agricultural and Technical State University*; Julia Robinson, *North Carolina A&T State University* and John Kimes, *North Carolina Agricultural and Technical State University (Poster Board #388)*

Abstract: This study evaluated three ginger cultivars (Chinese White - CW, Hawaii Yellow - HY, Kali Ma - KM) on their growth and rhizome yields in a greenhouse on the farm of North Carolina A&T State University. Seed gingers were pre-sprouted using coconut coir as the initial substrate. The pre-sprouted seedlings were then potted in 10-liter pots filled with pre-mixed substrate containing Metro Mix 360 and compost at 1:1 ratio. Potted plants of all three cultivars were then randomly placed on top of a bench in the greenhouse with drip irrigation. A completely randomized design was used. One tablespoon of fertilizer (Weaver 17-17-17) was added to each pot one month after potting. During the ginger growth period additional substrate was added as needed for hilling purpose. All three cultivars demonstrated vigorous and healthy growth. Among the three cultivars tested, only HY plants had strong aroma and attracted caterpillars that was also observed from our study in a high tunnel. Our data indicated that the three cultivars had very similar growth in terms of stem diameter and plant height, but with significantly different productivity in terms of yield (rhizome weight). Stem diameter data indicated that both CW and KM plants had a little thicker stems than HY plants. Rhizome weight data indicated that CW (625 g/plant) produced slightly higher yield than KM (613 g/plant), and both CW and KM produced significantly higher yield than HY (417 g/plant). According to our observation, the 10-liter size pot is too small for adequate ginger growth.

Exploring Industrial Hemp Production in Western North Carolina (poster)

Jeanine Davis*, *North Carolina State University*; Margaret Bloomquist, *North Carolina State University* and Leonora Stefanile, *North Carolina State University (Poster Board #389)*

Abstract: 2017 was the first year that industrial hemp could legally be grown in North Carolina. North Carolina State University researchers conducted field studies across the state on production of industrial hemp for grain, fiber, and floral parts production. We were responsible for the fiber and grain studies in western North Carolina. Fifteen varieties of grain, fiber, and dual purpose varieties were planted in a variety x planting method study at the Mountain Research Station in Waynesville, NC. The study was a split plot design with varieties as the main plots and the planting methods, broadcast and drilled, as the subplots. There were three replications. The well prepared field was fertilized as recommended for corn with 100 lbs N/acre and overhead irrigation was applied as needed. A similar study was established at a research station in Mills River but was lost to torrential rains shortly after sowing. Due to delays in obtaining seed, the field studies were planted much later than planned. This was a big concern since industrial hemp is photoperiod sensitive and many of the varieties were from Canada where the spring day lengths are substantially longer than in our growing region. Our study was planted on June 19. Germination was fast, high, and uniform in the drilled plots and the plants quickly established themselves and effectively out competed most weeds. The broadcast plots were much more irregular in germination and weeds, particularly pigweed, grew right along with the hemp seedlings. Many diseases and insects were found and identified in the plots but none caused any noticeable problems. There were big differences in plant height, flowering dates, and weed presence among the varieties, but in general, all varieties grew well. Stalks were harvested from three varieties and provided fresh weight yields of 10-13 t/ha. Grain was harvested from the remaining 12 varieties with a combine and averaged between 0.9 to 1.5 dried kg/ha.

Specified Source(s) of Funding: North Carolina Agricultural Foundation

Productivity and Quality Traits of Citron Essential Oil from *Jindo* (poster)

Sung-jin Park*, *Jindo Agricultural Technology Center*; Gyeong-suk Jo, *Jeollanamdo Agricultural Research & Extension Services.* and soo-Hyun Ji, *Jeollanamdo Agricultural Research & Extension Services (Poster Board #390)*

Abstract: Citron from *Jindo* is a tree grafted with trifoliate orange grafted fruit that has good environmental adaptability against low or high temperatures. Due to its hard pulp and sour taste, it is more beneficial to use as a fragrance source than an edible resource. In this study, citron was harvested by each harvest time in October, November and December, and researched productivity and quality of oil to use citron produced in Jindo as a fragrance resource. The crops of citron by the harvest time were 3,288㎏ in October, 3,587㎏ in November and 4,200㎏ in December per 10a: indicating that the later the harvest time, the more the crop. When oil productivity of citron was researched based on 1kg of the citron peel extracted through steam distillation, the October yield was 24 (㎖/㎏), the November yield was 22.2 (㎖/㎏) and the December yield was 18.0 (㎖/㎏). With regard to the intensity of fragrance of natural oil, the crop harvest in October had strongest fragrance with 3,203 (A.U./1g) and the intensity fragrance decreased as the later harvest times. It shows that the best time for harvesting citron for oil production is October.

In Search of "Nutri-Chemicals" in Yellow *Capsicum* Spp. Fruits (poster)

Krystal A. Vargas*, *New Mexico State University*; Richard D. Richins, *New Mexico State University*; Paul Bosland, *New Mexico State University* and Ivette Guzman, *New Mexico State University (Poster Board #391)*

Abstract: There are over 700 different carotenoids in nature. Carotenoids are the yellow, red, and orange pigments. They are found in plant chloroplasts and are used to protect plants from taking in too much light which can create reactive oxygen species. We see these pigments every day in our fruits and vegetables such as carrots, which contain high amounts of beta-carotene, an orange pigment. Xanthophylls are the yellow carotenoids. They make up one of the two major carotenoid groups. One specific xanthophyll, lutein, has been proven to aid improvement of cognitive health and decrease risks of age-related macular degeneration. The cognitive function that lutein helps with is memory loss. Macular degeneration is vision loss due to the wear and tear that happens to our eyes over time and after long exposure times to blue light. Lutein has been shown to be part of the macular pigment that sits on the nerves of the retina and help absorb the blue light that we are subjected to daily. Macular degeneration and memory loss risks increase with age, but what if it was possible to slow this process down? Chile peppers, *Capsicum* species fruits are one of the few fruits and vegetables that accumulate xanthophylls such as lutein. For this reason, forty-eight genetically diverse yellow chile peppers from New Mexico State University's Chile Pepper Institute Teaching Garden and Leyendecker Plant Science Research Center were harvested for lutein and beta-carotene analysis. These peppers were cut up, frozen in liquid nitrogen, ground up and extracted. All carotenoids were extracted from the peppers. After extraction, peppers were filtered and qualitative analysis was done using thin-layer

chromatography (TLC). Afterwards, high performance liquid chromatography (HPLC) along with carotenoid standards were used to quantify exact amounts of beta-carotene and lutein. These results found that five of the forty-eight yellow peppers were found to have high amounts of only lutein, while the other 43 peppers contained a mixture of carotenoids. This research profiled chile carotenoids, including lutein which has been shown to combat macular degeneration and aid in cognitive brain function. Future research will quantify the amount of lutein that is bioavailable to the body.

Specified Source(s) of Funding: USDA NIFA Broadening Agricultural Science for Hispanics

Phenolic and Capsaicinoid Concentrations and Antioxidant Capacities in Chili Peppers Grown in the Delmarva Peninsula As Affected By Cultivars and Maturity (poster)

Byungrok Min, *University of Maryland Eastern Shore*; R. Dadson, *University of Maryland Eastern Shore*; E. Intsar, *University of Maryland Eastern Shore*; A. Sokabi, *University of Maryland Eastern Shore* and Fawzy Hashem*, *University of Maryland Eastern Shore (Poster Board #392)*

Abstract: Chili peppers are fruits of genus *Capsicum* plants of which are grown worldwide. They are goods sources of bioactive phytochemicals, such as phenolic compounds and capsaicinoids, whose health protective effects are well-known. Capsaicinoids are the major bioactive phytochemicals in chili peppers, responsible for their hotness. Concentrations of bioactive phytochemicals in plants depend on genetic (cultivar and maturity) and environmental (climate) factors. In addition, their concentrations differ among parts of the fruit. This study compared phenolic and capsaicinoid concentrations and antioxidant capacities in different cultivars of chili peppers at different maturity stage. They were also compared in different parts (seed, placenta, and flesh) of the chili peppers. These cultivars were grown in the temperate climate of the U.S. Delmarva Peninsula. Six chili pepper cultivars (Scotch Bonnett (SB), Habanero Red and Orange (HR and HO, respectively), Hot Lantern (HL), Numex Suave (NS), Bangkok F1 (BF), and Sahuaro (S)) were grown in the field in the University of Maryland Eastern Shore Experiment Station in 2015. They were harvested at green and ripe mature stages. Immediately after harvest, seeds, placenta, and flesh were separated. Subsequently, the whole pepper and separated parts were freeze-dried, and stored at -18 °C freezer until analysis. Concentrations of phenolic compounds (as total phenolic and flavonoid contents) and capsaicinoids and antioxidant capacities (as 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging capacity and oxygen radical absorbance capacity) were determined using 80% ethanol extracts from the dried samples. Data were analyzed using analysis of variance and means were compared using the Student-Newman-Keuls multiple comparison method (p<0.05). At the green maturity stage, the phenolic concentrations and antioxidant capacities were likely higher in HO, SB, and BF than in HL, NS, and S, and the concentrations of total capsaicinoids (capsaicin + dihydroxycapsaicin) varied among the cultivars as follows: HO=SB>HR>HL=BF>S=NS (p<0.05). As they became matured, the phenolic concentrations and antioxidant capacities in HL significantly increased (p<0.05) and those in BF significantly decreased (p<0.05). In addition, the capsaicinoid concentrations in HR and BF significantly decreased (p<0.05). No change was observed in other cultivars during maturation. Consequently, at the ripe maturity, the phenolic concentrations and antioxidant capacities were greatly higher in HO and SB than in NS and S, and the concentrations of total capsaicinoids varied among the cultivars as follows: HO=SB>HR=HL=BF>S=NS (p<0.05). The results indicated that HO and SB grown in the Delmarva Peninsula could be good sources of bioactive phenolic compounds and capsaicinoids at any maturity stage.

Comprehensive Transcriptome Analysis of *Ligularia Fischeri* to Identify Isoforms and Biosynthesis Genes Associated with Medicinal Components (poster)

Byung-Kon Choi*, *Gangwon Agricultural Research & Extension Services*; Rahul Vasudeo Ramekar, *Kangwon National University*; Yong-Bog Kim, *Gangwon Agricultural Research & Extension Services*; Sewon Kim, *Gangwon Agricultural Research & Extension Services*; Yun-Gi Moon, *Gangwon Agricultural Research & Extension Services*; Hyun-Teak Seo, *Gangwon Agricultural Research & Extension Services*; Ki-Deok Park, *Gangwon Agricultural Research & Extension Services*; Heesun Noh, *Gangwon Agricultural Research & Extension Services*; Yong-Jin Ahn, *Gangwon Agricultural Research & Extension Services*; Soon-Bae Kwon, *Gangwon Agricultural Research & Extension Services*; Ik-Young Choi, *Kangwon National University* and Kyoungcheul Park, *Kangwon National University (Poster Board #393)*

Abstract: *Ligularia fischeri* is a popular edible herb in Korea containing broad ranges of pharmacologically important compounds. It is used in traditional medicine for treating infectious and inflammatory diseases. Despite its importance as herbal medicine, there are no transcriptome/genome sequences available in the public database limiting its research at molecular level. To address this issue, a transcriptome analysis of *L. fischeri* was performed using Pacific Biosciences single molecule long-read isoform sequencing platform. We identified 60,646 polished, high-quality non-redundant full-length transcripts with a total length of 116.5Mb. Among these 27,453 transcripts were annotated to known genes in different species based on non-redundant and uniport database. Functional classification using Gene ontology identified 11,279 transcripts of which majority were associated with the cellular and metabolic process. The Kyoto Encyclopedia of Genes & Genomes pathway analysis identified 1332 transcripts encoding 160 enzymes related to secondary metabolism with a higher number of transcripts for biosynthesis of antibiotics. Furthermore, we observed alternate splicing, in a total of 1,030 transcripts covering a total of 2250 isoforms with a variable of 2-11 isoforms. This data led us to identify 117 transcripts containing 271 isoforms involved in various metabolic pathways along with 36 transcripts containing 84 isoforms involved in various stress responses. This is the first detailed transcriptome analysis of *L. fischeri*. The resulting transcriptome along with the identified alternative splicing events provides insights into the biological process including the genes related to biosynthesis of characteristic secondary metabolites. This data will be valuable resource as transcriptome reference for further studies in the genetics and breeding of *L. fischeri*.

Specified Source(s) of Funding: RDA(Rural Development Administration)

Optimizing Extracting Conditions of Citrus Junos Oleoresin Rich in Naringin and Hesperidin Contents (poster)

soo-Hyun Ji*, *Jeollanamdo Agricultural Research & Extension Services*; Gyeong-suk Jo, *Jeollanamdo Agricultural Research & Extension Services.*; Jeong-Hwa Kang, *Jeollanamdo Agricultural Research & Extension Services*; You-Seok Lee, *Jeollanamdo Agricultural Research & Extension Services*; Sun-Kyung Lee, *Jeollanamdo Agricultural Research & Extension Services*; Sung-jin Park, *Jindo Agricultural Technology Center* and Hwang Hong-Sik, *National Center for Agricultural Utilization Research, US. Department of Agricultural, (Poster Board #394)*

Abstract: Citrus junos is a universally consumed fruit in Eastern Asian countries such as Korea, China and Japan and the fruit is originally from those countries. In Korea, Jeollanamdo, one of provinces, about 81.6% of citrus junos fruits are produced per year. The fruit has very strong sour taste, so it makes hard for consumers to eat raw. Thus, consumers generally make the fruit tea with sweeteners. Citrus junos is known to containe significant amount of antioxidants including vitamins and phenolic compounds but only limited information is available how well those antioxidants are extracted when it is consumed as tea and what the best extraction condition is. The objectives of this study were to determine optimize extraction conditions and to quantified active compounds as flavonoids content (naringin and hesperidin) in extracted citrus junos oleoresin for application of food and cosmetic ingredients in the future. Citrus junos skins were mixed with several different ratios (Wt/Vol %) ethanol (>95%) for determination of yield for extraction. The best extract yield was 1:10 ratio (Wt/Vol %). For factors of temperature and time for extraction, the best conditions of temperature and time were at 40℃ and 5 hours which yield was 10.8% for extraction of oleoresin. Also other results of activity compounds of the fruit were as: 88.2 Vitamin C eq. mg/100g for antioxidant activity, 518.2mg/100g for total flavonoids [hesperidin (107.3mg/10g), narirutine (80.8mg/100g), neohesperidin (58.5mg/100g), and naringin (58.1mg/100g)]. Utilizing the results of this study, Citrus junos is higher application areas for food ingredients for

producing functional drinks and snacks and cosmetics ingredients due to high content of flavonoids of the fruit.

Microsatellite Markers Assess Diversity of *M. Suaveolens* and *M. Aquatica* at the NCGR (poster)

Nahla V. Bassil*, *USDA-ARS Corvallis*; Kim Hummer, *USDA ARS* and Kelly J. Vining, *Oregon State University (Poster Board #395)*

Abstract: The U.S. Department of Agriculture (USDA), Agricultural Research Service (ARS), National Clonal Germplasm Repository (NCGR) in Corvallis, Oregon, preserves a living *Mentha* collection of 453 accessions representing 13 species and 9 recognized published hybrid species from 46 countries. The taxonomy of *Mentha* is complex because of interspecific hybridization in native populations of crop wild relatives. The plant accessions at the NCGR include commercially important cultivars and their wild relatives. Plant accessions are vegetatively propagated and many grow vigorously. This can lead to cross plant contamination and misidentification in field cultivation or container grown plants. Genetic analysis has proven useful in many crops to confirm horticultural and botanical identity. In mint, microsatellite or simple sequence repeat (SSR) markers were reported in one study which identified six primer pairs that cross amplified in four species. The objective of our study was to expand the number of SSR markers for developing an efficient fingerprinting set for mint. In this study, we designed primer pairs to 48 SSRs flanking long core repeats (≥ 3) from a draft genome assembly of PI 557767 (CMEN 585), a *Verticillium* wilt resistant accession of *Mentha longifolia* subsp. *capensis* from South Africa. The primer pairs were evaluated in a test panel of eight mint accessions consisting of three accessions each of *M. suaveolens* and *M. aquatica* and two genotypes of *M. longifolia*. Thirteen of these 48 primer pairs appeared to generate polymorphic and easy to score products. The amplicons were pooled into four multiplexes to genotype 32 mint accessions that included 2 *M. longifolia*, 13 *M. aquatica* and 17 *M. suaveolens* individuals. Preliminary analyses uniquely distinguished each accession and separated them into species groups. Some of these SSRs will be used to develop an efficient fingerprinting set that can quickly confirm genetic identity of each accession.

Specified Source(s) of Funding: Oregon State University, Mint Council, and USDA-ARS CRIS project 2072-21000-044-00D

1:00 PM – 1:45 PM *International Ballroom East/Center*

Nursery Crops (Poster)

Relative Salt Tolerance of 11 Varieties of Hydrangea (poster)

Genhua Niu*, *Texas A&M AgriLife Research Center at El Paso, Texas A&M University*; Triston Hooks, *Texas A&M AgriLife Research, Texas A&M University*; Christina Perez, *Texas A&M AgriLife Research, Texas A&M University*; Youping Sun, *Department of Plants, Soils, and Climate, Utah State University* and Haijie Dou, *Texas A&M University (Poster Board #130)*

Abstract: A greenhouse study was conducted to assess the relative salt tolerance of 11 varieties of hydrangea: *Hydrangea macrophylla* 'Ayesha', 'Emotion', 'Mathilda Gutges', 'Merritt's Supreme', and 'Passion', *H. paniculata* 'Pink Diamond' and 'Quickfire', *H. quercifolia* 'Snowflake', *H. serrata* 'Preciosa', *H. serrata* x *macrophylla* 'Sabrina' and 'Selina'. Softwood cuttings received from a commercial company were rooted in a mist propagation bench. Seven weeks after propagation, rooted cuttings were transplanted to one-gallon containers filled with Metro-mix 360. Six weeks after transplanting, uniform plants were selected for experiment. Plants were irrigated with a nutrient solution at an electrical conductivity (EC) of 1.2 $dS{\cdot}m^{-1}$ (control), or nutrient-solution based saline solutions at EC of 5.0 $dS{\cdot}m^{-1}$ (EC 5) or 10 $dS{\cdot}m^{-1}$ (EC 10) for eight weeks. Four weeks after treatment, 'Quickfire' plants in EC 10 exhibited severe salt damage with most of them dead. 'Pink Diamond' is the next sensitive cultivar showing salt damage in EC 10, while 'Passion' also showed some damage with lower yellow leaves. By the end of the eight week experiment, most 'Quickfire' were dead in both EC 5 and EC 10, while 'Pink Diamond', 'Preciosa', and 'Passion' had severe salt damage in EC 10. 'Ayesha' and 'Sabrina' did not have obvious visual salt damage. 'Merritt's Supreme' and 'Mathilda' plants in EC 5 had minimum salt damage. Total shoot dry weight of all cultivars were significantly reduced compared to the control in the elevated salinity, except for 'Selina'. A second experiment was conducted two weeks later than the first one using the same plant materials, that is, plants were two weeks old at the start of treatment compared to those in the first experiment. Both experiments indicated that 'Ayesha' and 'Sabrina' were relatively salt tolerant, 'Selina, 'Merritt's Supreme' and 'Mathilda' were moderately tolerant, 'Emotion' and 'Snowflake' were moderately sensitive, while 'Quickfire' was the most sensitive followed by 'Pink Diamond', 'Preciosa', and 'Passion'.

Specified Source(s) of Funding: Floriculture and nursery research initiative

Evaluation of a Web-Based Irrigation Control System for Container Nursery Plant Production (poster)

Thomas Yeager*, *University of Florida/IFAS* and Jeff B. Million, *University of Florida/IFAS (Poster Board #131)*

Abstract: A web-based irrigation control system (CIRRIG, Container IRRIGation) developed at the University of Florida was evaluated in two production nurseries. CIRRIG inputs were onsite weather data, recent leaching fraction (LF) percentage, and sprinkler irrigation duration when LF was determined. CIRRIG used these inputs to calculate daily sprinkler duration needed to satisfy water demand for plants grown with pine bark and Florida peat substrates in 8-11 L containers. A programmable logic controller was used to control solenoid valves based on irrigation duration outputs from CIRRIG. An adjacent irrigation zone with the same plants was irrigated based on standard nursery practices. Six irrigation zone pairs of *Ilex cornuta* 'Burfordii Nana', *Juniperus davurica* 'Parsonii', *Loropetalum chinensis* 'Plum', *Rhaphiolepis indica*, and *Viburnum odoratissimum* were evaluated during 2016 and 2017. There were two zone pair evaluations for *Ilex*. The production time for each zone pair ranged from three to nine months depending on plant growth rate, plant size when evaluation started, and plant size when marketed. Plant heights and widths were measured when plants were of marketable size and total irrigation water applied was metered. The growth indices (height plus average width) were similar for all pairs except for *Rhaphiolepis*, which had a growth index of 28.8±0.6 for the CIRRIG zone compared to 23.3±0.4 for plants irrigated based on standard practices used at the nursery. CIRRIG resulted in 1% to 13% decrease in water applied for *Ilex*, *Loropetalum*, *Rhaphiolepis*, and *Viburnum*, and 8% and 35% increased in water applied for *Juniperus* and *Ilex* (second evaluation), respectively. These results indicate that similar plant growth was achieved with CIRRIG that automatically adjusted daily amounts of irrigation water applied compared to plants irrigated with traditional practices used at the nurseries. Irrigation water applied in four of the six zone pairs was less or similar when CIRRIG was used compared to the nurseries' irrigation practices. However, it is important to consider other benefits of CIRRIG such as; electronic history of daily irrigation applications, the ability to control and monitor irrigation offsite via the internet, and time saved with automatic adjustment of irrigation duration.

Specified Source(s) of Funding: Southwest Florida Water Management District, Cherrylake

Influence of Root Substrate Composition and Container Size on the Growth of Tissue Culture Propagated Apple Rootstock Plants (poster)

Ki-Young Choi*, *Kangwon National University*; Jaekyung Kim, *Kangwon National University*; YeoJoong Yoon, *Uni Plantech Co. Ltd.*; Hyungchul Lee, *Kangwon national University* and Chiwon Lee, *North Dakota State University (Poster Board #132)*

Abstract: This study investigated the influence of root substrate composition and container volume on the growth of apple rootstock plants propagated by tissue culture. Rooted dwarf apple rootstock (M-9) plants (15±1 cm tall) grown from shoot tip cultures and acclimated were transplanted into cell packs containing various ratios of peat moss (PM), vermiculite (VL), and perlite (PL) and cultured for 11 weeks in a greenhouse. For the study of root substrate composition, 3 different mixtures (1:1:1, 1:2:3, 3:1:2 mixes of PM:VL:PL by volume) were contained in plug trays (7.5 cm diam., 16 cm deep round cell packs, one plant per cell). For the substrate volume study, stock plants were grown in cell packs containing 300(φ5.5cm, H17cm), 500(φ7.5cm, H16cm) and 1000ml(φ13cm, H10.5cm) of 1:1:1 mixture of PM, VL and PL. During the experiment, the greenhouse temperature, humidity,

and light intensity were 30±5℃, 72±5% RH, and 150±10 µmol·m^{-2}·s^{-1}, respectively. Plants were irrigated weekly with a weak nutrient solution (EC 1.3 m*S*/cm) using a dripper and sprayed over twice a day with tap water using an atomizer. After 11 weeks of culture, the plant height (70-78 cm) and stem diameter (4.2-4.5 cm) measured at 30 cm above ground, leaf chlorophyll content (SPAD) and photosynthetic rate were unaffected by variation in media composition. However, the number of nodes and leaves as well as shoot fresh and dry weights were greater when plants were grown in the 3:1:2 mixture of PM:VL:PL, compared to those grown in the 1:1:1 mixture. While SPAD readings and plant heights (66-74 cm) were unaffected by root substrate volume, the number of nodes, root length, shoot and root fresh weights of the plants grown in the 1000 ml volume were the highest compared to those grown with 500 ml or 300 ml root substrates. However, plants grown in 1000 ml substrate had a lower photosynthetic rate than those grown in smaller substrate volumes. The stomatal conductance and transpiration rate were unaffected by root substrate volume. In conclusion, the initial growth and development of the tissue culture propagated M-9 apple rootstock plants were more favorable when grown in 1000 ml of the 3:1:2 mixture of PM:VL:PL in comparison to other treatments.

Specified Source(s) of Funding: This research was supported by IPET, funded by Ministry of Agriculture, Food and Rural Affairs (C1013132-01)

Pine Bark Substrate "Contaminants": Determining Sand and White Wood Percentages (poster)

Brian Jackson*, *North Carolina State University*; Laura Kaderabek, *North Carolina State University* and William Fonteno, *North Carolina State University (Poster Board #133)*

Abstract: Aged pine bark is the one of the most common organic substrate components in the U.S., with bark from loblolly or longleaf pines being the most prominent in the southeastern U.S. Aging is a process in which the bark is piled on the ground in windrows and allowed to age for a period of time, usually six months to one year. Aging time can vary between suppliers, or even for the same supplier, based on factors such as space shortages, product demand, or preference. A long-term study was implemented to quantify the changes in the physical properties of longleaf pine bark over the course of twelve months of aging and how sand and white wood contaminants influence those properties. In this study the amount of white wood decreased from 6.3% at month 0 to 3.8% (by volume) at month 12 as a result of decomposition. Bark supplies/suppliers may have higher percent white wood present but that does not suggest the bark quality is bad. White wood is not detrimental to crop growth like once believed so this should have no negative effect on the quality of the bark substrate. The amount of sand that accumulated in the bark as a result of being piled on the ground and turned every month with a front-end loader was also calculated. At the beginning of the study (month 0) the sand content was 0.43% by volume and 2.8% by weight of the pine bark. At month 6 the sand content was 0.02% by volume and 14.05% by weight. At month 12 the sand content was 3.19% by volume and 20.15% by weight. The high sand content found in this study was a result of the sandy soil of the testing location. All bark supplies/suppliers may not have the same sand accumulations. This sand percent (and weight) can be significant in shipping weights and should be monitored/considered.

Hydrological Changes in Pine Bark Substrates during the Handling and Aging Process (poster)

Brian Jackson*, *North Carolina State University*; Laura Kaderabek, *North Carolina State University* and William Fonteno, *North Carolina State University (Poster Board #134)*

Abstract: Aged pine bark is the one of the most common organic substrate components in the U.S., with bark from loblolly or longleaf pines being the most prominent in the southeastern U.S. Aging is a process in which the bark is piled on the ground in windrows and allowed to age for a period of time, usually six months to one year. Aging time can vary between suppliers, or even for the same supplier, based on factors such as space shortages, product demand, or preference. A long-term study was implemented to quantify the changes in the hydrological properties of longleaf pine bark over the course of twelve months of aging. The hydration efficiency of the aged pine bark samples were assessed by measuring the water retention after 10 hydration events (simulated irrigation's). Bark samples were analyzed at 50% moisture content (moist) and at a 25% moisture content (dry). At 50% moisture content, we found that bark hydrated similarly for all ages. This means that after the first irrigation event, bark was wetted to its maximum capacity (reached container capacity). At 25% moisture content all samples showed less water uptake than at 50% moisture content, regardless of sample date. At 25% moisture content fresh bark (month 0) never hydrated (reached container capacity). At month 6 the bark was able to reach its maximum hydration potential after five irrigation events. At month 12 it reverted back to a more hydrophobic state and never reached full hydration. In regards to water percolation, month 0 bark (fresh) had a water flow rate of 119 cm/min, month 6 bark had a flow rate of 80 cm/min and month 12 bark was recorded at 55 cm/min. This is likely due to the reductions in particle size over time resulting from mechanical breakdown by turning and microbial degradation, as well as an increase in sand content. The smaller particles result in smaller pore sizes and an increased bulk density. The decreased percolation of older bark compared to fresher bark would make significant changes to irrigation practices on a nursery especially if bark of different ages was being used in the production system.

Pine Bark Windrow Temperature Profiles during Twelve Months of Managed Aging (poster)

Brian Jackson*, *North Carolina State University*; Laura Kaderabek, *North Carolina State University* and William Fonteno, *North Carolina State University (Poster Board #135)*

Abstract: Aged pine bark is the one of the most common organic substrate components in the U.S., with bark from loblolly or longleaf pines being the most prominent in the southeastern U.S. Aging is a process in which the bark is piled on the ground in windrows and allowed to age for a period of time, usually six months to one year. Aging time can vary between suppliers, or even for the same supplier, based on factors such as space shortages, product demand, or preference. A long-term study was implemented to quantify the changes that occur in temperature profiles in longleaf pine bark windrows over the course of twelve months of aging. Temperature profiles during the aging process are characterized by (1) a rapid initial increase in temperature, (2) a sustained high-temperature period, and (3) a decline to near-ambient temperatures. Pile temperatures were measured on the research site at each month for twelve months. Measurements were taken at three different heights at depths of 1, 2, 3, and 4 ft. using three 4 ft. compost monitoring temperature probes. Temperature data were analyzed as separate readings at each height and depth, as well as averaged across all pile heights and depths to give an average pile temperature per sample date. There was an initial increase in pile temperature from ambient temperatures at project installation, followed by a 4 month long thermophilic phase of the decomposition process. During months 2 through 4, piles maintained average temperatures between 127–135 °F, then decreased during months 5 and 6 as microbial activity and ambient temperatures decreased, followed by a gradual increase throughout the remainder of the study, presumably in response to warmer ambient temperatures throughout the spring and summer months. Thermal imaging with a FLIR C2 handheld camera was also investigated as a potential technique to measure pile temperature.

Cold Stratification Improves Seed Germination of *Ptelea Trifoliata* and *Ptelea Crenulata* (poster)

Anna J. Talcott*, *Iowa State University* and William Graves, *Iowa State University (Poster Board #136)*

Abstract: North American shrubs in the genus *Ptelea* (Rutaceae) have unfulfilled potential to increase the diversity of managed landscapes and to support populations of pollinators and swallowtail butterflies. White flowers of *Ptelea* are highly fragrant, and pistillate flowers give rise to clusters of distinctive samaras. Vague information on how to optimize germination of seeds of *Ptelea trifoliata*, and no recommendations for *P. crenulata*, prompted us to investigate effects of cold (4 ˚C) stratification periods of 0, 4, 8, 16 weeks on the germination of seeds of these two species. Samaras were collected from multiple plants of both species in the Midwestern United States (*P. trifoliata*) and California (*P. crenulata*). Eight and 16 weeks of stratification led to 89% and 100% germination, respectfully, for *P. crenulata*, and to 73% and 91% germination, respectively, for *P. trifoliata*; shorter periods of stratification resulted in lower germination

percentages for both species. Germination value, a measure of speed and uniformity of germination, was higher for seeds of *P. crenulata* stratified for 16 weeks and for seeds of *P. trifoliata* stratified for 8 and 16 weeks than germination value of seeds treated with shorter stratification periods. Peak day, germination distribution, and mean daily germination of the two species did not differ, nor did stratification period affect these measures. All values were calculated based on the number of viable seeds, which was determined with tetrazolium tests on ungerminated seeds. About half of the seeds of both species were not viable. Propagators seeking to grow these two species of *Ptelea* from seed should cold-stratify the seeds for 16 weeks.

Soil Solarization for Managing Weeds and Soilborne Pathogens in Tree Seedling Nurseries in the Pacific Northwest (poster)

Jennifer L. Parke, *Oregon State University*; Carol Mallory-Smith, *Oregon State University*; Maria Dragila, *Oregon State University*; Brian Hill, *Oregon State University*; Nami Wada, *Oregon State University*; Clara Weidman, *Oregon State University*; Lloyd L. Nackley*, *Oregon State University*; Leonard B. Coop, *Oregon State University* and Fumiaki Funahashi, *Copine LLC (Poster Board #137)*

Abstract: Soil solarization employs solar radiation to heat the soil under a transparent plastic film to achieve temperatures detrimental to certain soilborne pathogens and weed seeds. Most soil solarization studies have been conducted in warm climates, but recent advances in plastic film technology have made it feasible to successfully solarize soil in regions with cooler climates such as the Pacific Northwest. In 2016 and 2017, we conducted pre-plant soil solarization trials for 3-9 weeks during each summer in three tree seedling nurseries in Oregon and Washington. Soil temperature and moisture were measured continuously in solarized and nonsolarized plots at depths of 5 and 15 cm. Mesh packets containing soil from each nursery were buried at the same two soil depths, and after the trial, soil was dilution plated onto selective media for pathogen quantification. Seeds of four weed species (*Poa annua, Polygonum pensylvanicum, Amaranthus retroflexus,* and *Portulaca oleracea)* were placed in mesh packets and buried at 5 and 10 cm. After the field trials, seeds were tested for germinability; viability was tested with the tetrazolium chloride assay. Fall and spring weed emergence *in situ* was also quantified, and time required for hand weeding was determined. We found significant reductions in soil populations of *Pythium* spp. and *Fusarium oxysporum*. Of the weed seeds tested, solarization was most effective on *Polygonum pensylvanicum,* least effective on *Portulaca oleracea,* and resulted in increased dormancy in *Amaranthus retroflexus.* Results with *Poa annua* differed in the two years. In the year following solarization, the time required to hand weed solarized plots in each of two nurseries was reduced by 55% or 69% relative to nonsolarized plots. In 2017, crop growth was greater in solarized plots than in nonsolarized plots in two of three nurseries; data for the 2018 crop year is not yet available. We developed an online model *http://uspest.org/soil/solarize* for growers to estimate the time necessary to solarize soil based on their farm location, start date, and target pest. The model forecasts soil temperatures from solar radiation and air temperature data at local weather stations, and predicts the amount of time necessary to kill target species based on results from controlled environment studies. Soil solarization is a cost-effective, non-chemical approach for managing weeds and certain soilborne pathogens that could potentially be applied to other Pacific Northwest cropping systems such as organic vegetables and berry crops.

Specified Source(s) of Funding: Western SARE, Western IPM Center

Managing Crapemyrtle Bark Scale Infestation in Container Production with Non-Neonicotinoid Insecticides (poster)

Yan Chen*, *Louisiana State University Agriculture Center & Research Station*; Erfan Vafaie, *Texas A&M AgriLife Research & Extension*; Michael Merchant, *Texas A&M AgriLife Research & Extension* and Mengmeng Gu, *Texas A&M AgriLife Reseach & Extension (Poster Board #138)*

Abstract: Crapemyrtle bark scale is a newly introduced insect pest of crapemyrtles. Many challenges present when managing this scale in nursery production, including a lack of chemical trials conducted with infested plants. Two container trials were conducted during 2017, each with 60 'Natchez White' crapemyrtles in 1-gal pots. Treatments included in Trial 1 were: Mainspring 200SC, its tank mixes with CapSil, NuFilm17 or SuffOil-X, Acelepyrn, and its tank mix with CapSil. Treatments included in Trial 2 were: Fulcrum, Molt-X, SuffOil-X, tank mix of Fulcrum and SuffOil-X, and tank mix of Molt-X and SuffOil-X. Imidacloprid 75WP and an untreated control were included in both trials. Plants were inoculated with a greenhouse colony of crapemyrtle bark scale 8 weeks prior to treatments, and plants were inspected for crawlers, 2nd instar nymph and female adults/ovisacs at d14, 28, and 56 after the treatment application. Imidacloprid provided moderate control effect in both trials. Compared with the untreated control, Acelepyrn and its tank mix with CapSil, and the tank mix of Mainspring with SuffOil-X provided moderate control at d28 but the effect was not significant by d56 in Trial 1. Fulcrum and its tank mix with SuffOil-X provided effective control up to d56 in Trial 1. SuffOil-X and Molt-X provided moderate control as stand-alone products.

Specified Source(s) of Funding: IR4

1:00 PM – 1:45 PM *International Ballroom East/Center*

Pomology 1 (Poster)

A Comparison of Ploidy Level of Claypool Selected American Persimmon Germplasm to Currently Available Commercial Cultivars (poster)

Kirk Pomper*, *Kentucky State University*; Jeremiah Lowe, *Kentucky State University*; Sheri Crabtree, *Kentucky State University*; Clifford England, *England's Orchard and Nursery* and Krit Raemakers, *Plant Cytometry Services (Poster Board #416)*

Abstract: The American persimmon (*Diospyros virginiana*) is a tree fruit native to the forests of Kentucky. The golden orange fruit are sweet when fully ripened and astringency is reduced. There are two races of persimmon, a tetraploid (60 chromosome) race is centered in the southern Appalachian mountains and adjacent areas, and a hexaploid (90 chromosome) race occupies the range north and west of the tetraploid range. Many current American persimmon varieties have been selected in the wild and are thought to be in the 90 chromosome race. American persimmon improvement began in the late 19th century with the work of Dr. James Troop at Purdue University. In 1880, the first named American persimmon cultivar, Early Golden, was selected out of the wild in Illinois. James Claypool continued breeding of American persimmon in the 1970's. Over the course of 20+ years Claypool evaluated over 2,000 trees and has made a number of cultivar releases. The objective of this study was to examine the ploidy level of Claypool selected American persimmon germplasm to determine if these varieties contain both the 60 and 90 chromosome races of persimmon as compared to commercially available varieties using flow cytometry. Leaf samples were collected from 18 Claypool selections and 10 commercially available cultivars from the budwood mother blocks at England's Orchard and Nursery in McKee, Kentucky. Flow cytometer analysis of the leaf samples showed all Claypool selections, including Dollywood, Elmo (A-118), F-34, F-62, H-118 Early Jewel, H-120, H-55a, H-55a, H-63a Claypool, I-115, J-127, J-59 Claypool, K1, K2, K6, Prairie Star, Prairie Sun, as well as the non-Claypool selected cultivars Early Golden, Garretson, Golden Supreme, Meader, Mohler, NC-10, and Yates were all from the 90 chromosome strain. Three non-Claypool selected commercial cultivars were from the 60 chromosome strain: Enis Seedless, Weeping, and Sugar Bear. This data supports that the 90 chromosome strain is also strongly represented in the high quality material of the Claypool germplasm that was selected.

Specified Source(s) of Funding: McIntire-Stennis Funding

Efficacy of Sulfur As a Fungicide to Control Pawpaw Leaf and Fruit Spot (poster)

Sijan Pandit*, *Kentucky State University*; Jeremiah Lowe, *Kentucky State University*; Sheri Crabtree, *Kentucky State University* and Kirk Pomper, *Kentucky State University (Poster Board #417)*

Abstract: Pawpaw (*Asimina triloba*) is a tree fruit native to the Eastern United States and is grown on a small-scale commercially as a niche crop for local markets. A leaf and fruit fungal spot has been observed in pawpaw consisting of a complex of *Mycocentrospora asiminae*, *Rhopaloconidium asiminae* Ellis and

Morg., and *Phyllosticta asiminae* Ellis and Kellerm. Symptoms include tan spots with dark brown borders on leaves, and dark brown to black superficial spots on the fruit epidermis, followed by cracking of fruit. In some pawpaw varieties, such as 'Sunflower' and 'Susquehanna', this disease can cause significant loss of yield. Sulfur is known to be the oldest of all pesticides, although sulfur based fungicides are usually applied as a preventive measure and not a cure. The objective of this study was to determine the efficacy of organic certified sulfur based fungicide for the management of leaf and fruit fungal spot in 'Sunflower' and 'Susquehanna' varieties of pawpaw. The testing of fungicide was conducted on KSU Harold R. Benson Research and Demonstration Farm in Franklin County, Kentucky. Sulfur sprays (water control, 0.05 lbs/gal and 0.1 lbs/gal) were applied after fruit set during mid-May. Disease incidence was scored in treatment and control groups of two given varieties. Quantification of disease was done by visually scoring the percentage coverage of lesions on treatment and control fruit. The selection 'Sunflower' had a significantly higher incidence of Phyllosticta lesion coverage(20.9%) compared to 'Susquahanna' (13.8%). There was also positive correlation between cracking and fungal lesion as well as fruit weight and cracking.

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Specified Source(s) of Funding: USDA Evans Allen Research

Evaluating Shade Netting and Other Strategies to Overcome Lack of Winter Chill Accumulation in Pistachios (poster)

Gureet Brar*, *California State University Fresno* and Daniel YP Syverson, *California State University Fresno (Poster Board #418)*

Abstract: Lack of chill accumulation in pistachios has been a growing production issue in the California for the past several years. Growers have been facing crop losses as a consequence of these changes and there is a dire need to address this very important issue. This study hypothesized that some mechanical and chemical methods could be beneficial to compensate for lack of chill or to induce physiological changes in the trees so as to have a normal bloom and crop load. Fifteen-year-old pistachio trees of Kerman variety on UCB-1 rootstock were selected for this study at the California State University Campus in Fresno. The treatments included covering the trees with two type of shade netting (Black and Gray), spray of horticultural oils and kaolin clay dust. These treatments were compared with an unsprayed control over two years. Trees were covered by November 1 and the shade nets removed in late February both years. In the kaolin clay treatments, trees were sprayed with clay material throughout the winter months as and when need depending on rain events. The idea was to keep the trees covered throughout the chill accumulation period. Temperature and light intensity data were collected both inside and outside the shade netting using dataloggers. Chill accumulation was calculated using dynamic chill accumulation model as described by Glozer (2009). Data on bloom progression, nut growth, nut weight and volume, shell strength progression, yield and number of blanks were collected. The trees under oil spray bloomed significantly earlier than the trees under kaolin clay and shade netting treatments. Oil treatment trees were also ahead of other treatments in progression of nut growth and shell strength until the start of nut fill stage (Stage 3) of nut development. Oil and kaolin treatments resulted in significantly higher number of blanks. The treatments were not statistically significantly, different in terms of total yield or split in-shell percentage.

Specified Source(s) of Funding: CSU ARI

Early Performance of Pawpaw (*Asimina triloba*) Cultivars and Advanced Selections in Grower Trials at Three Locations (poster)

Sheri Crabtree*, *Kentucky State University*; Kirk Pomper, *Kentucky State University* and Jeremiah Lowe, *Kentucky State University (Poster Board #419)*

Abstract: The pawpaw (*Asimina triloba*) is a tree fruit indigenous to eastern North America, with small-scale commercial production in the US and worldwide on the rise. Over 50 pawpaw cultivars are available in the nursery trade, but many older cultivars have small fruit, low yields, and inferior flavor. Seedlings and controlled crosses at the National Clonal Germplasm Repository for *Asimina* spp. located at Kentucky State University (KSU) have been evaluated for yield, fruit size, and flavor; and several superior selections have been identified for evaluation and potential future cultivar release. To determine the performance of these selections at different locations, pawpaw variety trials including commercially available cultivars ('Sunflower' at all sites; KSU-Atwood™ and KSU-Benson™ at the Urbana, OH site) and five advanced selections identified in the KSU Repository Collection (G6-120, G9-109, G9-111, Hi4-1, and H3-120) were established in plantings at three grower cooperator sites, in central Ohio (Urbana, OH; USDA Plant Hardiness Zone 5b), southern Ohio (Aberdeen, OH; USDA PHZ 6a), and southern Kentucky (Bowling Green, KY; USDA PHZ 6b). Tree survival, trunk diameters, and flowering and yield data were collected at all sites. Trees began to fruit in 2015. Hi4-1, Sunflower and KSU-Atwood™ were the most precocious-fruiting selections in the trials. Survival and vigor were greatest in selections Hi4-1, H3-120, and G9-111. Survival was slightly higher at the central Ohio site, likely due to better soil type than the other two sites, both of which had rocky soils. Number of fruit did not significantly vary among cultivars or location, possibly because they are in early production; differences may be seen once the trees reach full mature production. However, there was a trend for Sunflower, G6-120, Hi4-1, and G9-111 to have the most fruit per tree. Fruit weight varied significantly among selections, with the selections H3-120 and Hi4-1 and cultivars KSU-Atwood™ and KSU-Benson™ having the largest fruit, while G6-120 had the smallest fruit; G5-23, G9-109, G9-111 and Sunflower were intermediate in fruit size. Based on data from these trials and an earlier KSU trial, Hi4-1 will likely be named and released in fall 2018, and other selections will continue to be evaluated for potential commercial release.

Specified Source(s) of Funding: USDA Evans-Allen

Investigating the Effect of Warm Temperature Interruption on the Winter Chilling Accumulation of Kiwifruit (*Actinidia chinensis* Planch. and *deliciosa* A. Chev.) Using Excised Canes (poster)

Timothy Hartmann*, *Texas A&M University*; James Spiers, *Auburn University*; Frederick Davies, *Texas A&M Univ*; Sam Feagley, *Texas A&M University*; Larry A. Stein, *Texas A&M University* and Justin Scheiner, *Texas A&M AgriLife Extension (Poster Board #420)*

Abstract: Golden kiwifruit (*Actinidia chinensis* Planch) has recently emerged as a new potential fruit crop for the Southeastern United States. Successful trials in Alabama, along with initial success at Stephen F. Austin State University, Nacogdoches, TX, has led to more extensive trialing of this crop in Texas. Both *A. chinensis* and *A. deliciosa* require winter chilling for overcoming dormancy and for flowering. Texas is subject to both inconsistent chilling and erratic winter temperatures. Warm temperature exposure during winter has resulted in the apparent negation of chilling in other fruit species. This study was conducted to investigate the floral and vegetative response of two pistillate kiwifruit cultivars to warm temperature interruption during chilling accumulation. Dormant one-year-old canes of *A. chinensis* 'AU Golden Dragon' and *A. deliciosa* 'AU Fitzgerald' were collected in December 2018 (335 C.U.), shortly after leaf abscission. Canes were cut to ten nodes after removing the first six basal nodes, placed in jars filled with distilled water, and transferred to respective chilling treatments. Treatments included continuous chilling (in addition to base chilling) at one-week (168 C.U.) increments (0 to 5 weeks) and chilling exposure at the same increments with intermittent warm temperature. For the warm temperature treatments, each week of chilling was followed by three days of exposure to warm conditions. Chilling and warm temperature exposure were simulated by 7°C / 4°C and 25°C / 17.2°C (day / night) temperatures, respectively, using separate climate-controlled growth chambers. Following chilling treatments, canes were forced in a third chamber at 22.8°C to 26.0°C with LED lighting. Vegetative bud break, along with floral bud number and development stage, were recorded for each cane and with respect to nodal position at two-day intervals. Maximum flower bud number was highly dependent on chilling exposure (R^2 = 0.99 for 'AU Fitzgerald') for the consistent chilling treatments. A strong node-position influence was also observed, with distal nodes producing more vegetative shoots and floral buds. While warm temperature interruption resulted in an insignificant reduction in average flower bud number (per-cane) for 'AU Fitzgerald', a significant increase was observed for the 'AU Golden Dragon' at higher chilling treatments. At 4- and 5-week chilling treatments, 634% and 449% more flower buds,

respectively, were recorded as compared to treatments with the same amounts of consistent chilling. These results suggest that the two species may respond differently to intermittent warm winter temperatures, and perhaps even favorably in the case of *A. chinensis*.

Specified Source(s) of Funding: Texas Department of Agriculture Specialty Crops Block Grant Program

Fruit Characteristics of Kentucky State University's Pawpaw (*Asimina triloba*) Cultivars and Advanced Selections (poster)

Jeremiah Lowe*, *Kentucky State University*; Sheri Crabtree, *Kentucky State University* and Kirk Pomper, *Kentucky State University (Poster Board #421)*

Abstract: The North American Pawpaw (*Asimina triloba*) is a tree fruit native to the Eastern U.S. which is being produced in commercial orchards across the U.S. and internationally, with a small but growing market. There are approximately 50 pawpaw cultivars available, with many of these varieties producing low yields with fruit sizes of 120 grams or less. Pawpaw varieties with fruit weighing over 120 grams are considered to have a large enough fruit size for commercial sale and processing. New high yielding cultivars with excellent fruit quality would further assist in the development of the pawpaw industry. Kentucky State University serves as the National Clonal Germplasm Repository for Pawpaw. Two goals of the Repository research efforts are germplasm acquisition and evaluation. The repository contains over 2000 accessions from 16 different states; additionally, both open pollinated seedlings from superior genotypes and crosses of superior selections have been incorporated into the repository collection. Fruit from five KSU advanced selections (G4-25, G6-120, G9-109, Hi 4-1, and Hi 7-1) were compared to fruit from the commercially available cultivars 'KSU-Atwood™' 'KSU-Benson™', 'Mango', 'Sunflower', and 'Susquehanna' on the basis of fruit weight, percent seed, and soluble solids. The selections Hi 4-1, G4-25, and 'KSU-Atwood™' had the largest fruit, averaging over 200 grams per fruit. Hi 4-1 and 'Susquehanna' had the lowest percent seed (4.9% and 6.1%), while Hi 7-1 had the highest (11.7%). 'KSU-Benson™' had the lowest Brix reading (16.7) while the selections Hi 4-1, G9-109, and 'Susquehanna' had the highest levels at over 25 brix. Several advanced selections show potential to be promising new releases and have been budded onto seedling rootstock for further evaluation.

Specified Source(s) of Funding: Evans Allen

Effect of Foliar Application of Plant Growth Regulators on Yield and Vivipary of Pecan Trees Growing Under Dry and Hot Conditions (poster)

Humberto Nunez-Moreno*, *INIFAP (Poster Board #422)*

Abstract: Pecan growers experience profitability loses due to nut vivipary when orchards are growing under warm and dry conditions. The goal of this study was to evaluate the effect of three plant growth regulators on pecan nut yield and vivipary. Treatments evaluated were: 1) Azoxystrobin (AZ, 150 g per ha), 2) Trinexapac ethyl (TE, 500 g per ha), 3) Paclobutrazol (PB, 125 g per ha), 4) the mixture of treatments 1 and 2, AZ+TE, and 5) the Control, without application. Treatments were sprayed to drip irrigated adult 'Wichita' pecan trees (~40 years old) using 1800 L per ha of water and an adjuvant was added at a rate of 0.5 ml per liter. Treatments were applied three times, and application dates were August 31, September 13 and September 20 of 2011. Pecan nut yield per hectare and nut vivipary was evaluated in 2011 and the effect of treatments on pecan nut yield in 2012 and the cumulative yield was also measured. Nut vivipary percent was 49.3±4.5% in the control treatment. Treatments TE and AZ+TE have 49.3±5.0% and 45.1±5.6% percent of nut vivipary, respectively. Treatments AZ and PB have the lower pecan nut vivipary with 34.5±3.1 and 31.0±1.5%, respectively; about 30% lower than the Control treatment. Pecan nut yield (non viviparous nuts), ranged from 1878 Kg per ha in the Control treatment Kg per ha to 2201 Kg per ha in the AZ+TE treatment, but differences were not significant. Nevertheless yield in 2012 ranged from 725 Kg per ha to 1888 Kg per ha differences were not significant, and the same occurred with the cumulative nut yield. According to results, nut vivipary levels can reach up to 49.3% in this hot and dry region located in the northwest of Mexico; and that some plant growth regulator evaluated could decrease nut vivipary of pecan trees cultivated in these conditions, hot and dry.

Specified Source(s) of Funding: Fundacion Produce Sonora, AC

Phenotype Characterization of Pistachio Bushy Top Syndrome-Affected Trees Entering Maturity (poster)

Narges Moosavi Mahvelati, *UC Davis*; Hector Facundo, *CSU Fullerton*; Jennifer J. Randall*, *New Mexico State University*; Isolde M. Francis, *CSU Bakersfield*; Craig Kallsen, *Univ of California Cooperative Extension/kern County* and Elizabeth Fichtner, *University of California (Poster Board #423)*

Abstract: Pistachio bushy top syndrome (PBTS) has affected pistachio (*Pistacia vera* L.) orchards planted on an interspecies clonal rootstock ('UCB-1') between 2011 and 2016 in California, Arizona, and New Mexico. PBTS is caused by concurrent infection by two plant-pathogenic *Rhodococcus* spp., both of which harbor virulence genes typically housed on a linear plasmid. Because of the unprecedented nature of PBTS, no research-based data are available to predict the long-term productivity of PBTS-affected trees in orchards, and affected orchards have largely been removed due to a concern of future economic productivity. The objectives of this work include: i) phenotypic characterization of PTBS symptomatic and asymptomatic trees entering maturity (i.e. yield, frequency of suckering, bark morphology, trunk caliper, total scaffold caliper diameter), ii) assessment of variability within symptomatic and asymptomatic populations for phenotypic characteristic estimates, and iii) determination of endo- and epiphytic populations of PBTS *Rhodococcus* isolates associated with foliage of rootstocks on symptomatic and asymptomatic trees. Phenotypic data on trees entering their 8th leaf indicate that PBTS-symptomatic trees are both smaller and more variable in size then asymptomatic trees, and have over 70% reduction in yield. Symptomatic trees also exhibit greater suckering than asymptomatic trees and unique bark morphology on the rootstock. PBTS-affected trees had significantly more blank nuts and higher variability in edible yield than asymptomatic trees. Epiphytic populations PBTS *Rhodococcus* spp. were prevalent on both symptomatic and asymptomatic trees, indicating bacterial transmission within the field. Endophytic populations were only detected on symptomatic trees, suggesting that infectivity in the field is limited. The higher phenotypic variability in symptomatic than asymptomatic trees suggests that PBTS-affected trees exhibit varying levels of disease severity. The current study illustrates that PBTS causes reduction in yield and nut value at harvest. The economic cost of PBTS is compounded by the long-term land use opportunity cost and tree maintenance costs associated with pistachio, a crop that typically has its first economic yield 7 years after planting.

Specified Source(s) of Funding: California Pistachio Research Board

Effect of Elevated Temperature and Drought Stress on Accumulation of Photosynthatein Jujube Cultivar 'lingwuchangzao' Assessed By ^{13}c Isotope Tracer Technique (poster)

Lihua Song*, *School of Agriculture, Ningxia University*; Bing Cao, *School of Agriculture, Ningxia University*; Yaping Ma, *School of Agriculture, Ningxia University*; Fang Qin, *School of Agriculture, Ningxia University* and Xinmeng Yang, *School of Agriculture, Ningxia University (Poster Board #424)*

Abstract: Photosynthetically assimilated carbon (C) is transported form source leaves to stems and fruits depending on their development stage and environmental conditions. Knowledge about the effect of elevated air temperature and drought stress on photosynthetic assimilation and allocation is important for developing best crop management practices. To examine the translocation of assimilated C in fruit-bearing shoots throughout the development process, we constructed an in situ $^{13}CO_2$ exposure polyethylene bag for stems and fruits of a Chinese jujube cultivar 'Lingwuchangzao". We used an infrared radiation equipment to control simulating elevated temperature environment, an automatic irrigation system to control soil water levels and the method of ^{13}C labeling to measure assimilation of ^{13}C in leaves and its translocation to the stems and fruits. Fruit-bearing shoots were sampled 12h, 24h and 7days after exposure treatment, followed by analysis of ^{13}C inventory in leaves, stems and fruits). We evaluated the translocation of ^{13}C using nested design (two air temperature environment, and three soil water levels) and analyzed ^{13}C remaining ratio and ^{13}C distribution ratio. C（^{13}C）in stem, leaf and fruit under elevated temperature

condition were greater than under normal temperature, but gradually reduced with the intensified drought stress. The $\delta^{13}C$ and C（^{13}C）accumulation of every organ increased under elevated temperature and drought stress, but C（^{13}C）accumulation decreased with the increase of drought stress. Elevated temperature increased photosynthates accumulation and $\delta^{13}C$ values in different organs, but drought stress decreased this accumulation. The rank of photosynthates allocation in different organs of jujube cultivar 'Lingwuchangzao' was fruit > stem > leaf.

Specified Source(s) of Funding: The National Nature Science Fundation of China

1:00 PM – 1:45 PM *International Ballroom East/Center*

Propagation (Poster)

Micropropagation of *Nandina Domestica* Thunb. Clones (poster)

Xiaohong Zhou, *University of Georgia*; Jinying Dong, *University of Georgia* and Donglin Zhang*, *University of Georgia (Poster Board #310)*

Abstract: Nandina domesticaThunb. (Berberidaceae) is an evergreen ornamental shrub with compact habit, colorful foliage, and wide adaptation to the landscapes and gardens in the southern US. Three newly selected clones with red, yellow and apricot foliage were trialed and desperately needed to be rapidly propagated for the market. Micropropagation was adapted and the youngest new growing tips with a naked bud were harvested as the explant. Contamination and bacteria invasion limited the 3rdor earlier newly sprouted nodes as additional plant materials. Both red and apricot clones preferred 1/2MS basal salt while yellow one performed better under B5 without any vitrification. Both hormones, 1.0 mg/L benzylaminopurine (BA) and 2.0 mg/L gibberellic acid (GA_3), were added to the initiation media. For multiplication stage, 1/2MS basal salt with hidiazuron (TDZ) at 0.05 mg/L helped red and apricot clones to reach the average multiplication rate of 7.7 in five weeks. For yellow clone, B5 with 0.03 mg/L TDZ yielded the highest rate of 3.0. Shoot length and number of shoots per cluster also significant regulated the proliferation. Shoots of 2.5-3.0 cm long worked better for multiplication instead of 1.0 cm, 2.0 cm and >3 cm. Two shoots per cluster could significantly improve the proliferation. Shoots longer than 3 cm didn't proliferated well but could reach 100% rooting within one month on B5 medium plus 2.0 mg/L Indole-3-butyric acid (IBA). Newly selected clones of *Nandina domestica* could be regenerated by micropropagation and the multiplication rate was 3 or higher.

Chemotherapy with in Vitro Multiplication for Producing Strawberry Mild Yellow Edge Virus (SMYEV) Free Strawberry Plants from Infected Cultures (poster)

Courtney Weber*, *Cornell Univ (Poster Board #311)*

Abstract: Producing virus free plants from infected plants is difficult using standard heat treatment/apical meristem excision procedures for virus elimination due to challenging technical aspects of the procedures and less than optimal growth conditions for plant cells. In this study, the use of the antiviral agent ribavirin (RIB) to produce strawberry mild yellow edge virus (SMYEV) free strawberry plants (*Fragaria* x *ananassa* Duch.) from infected in vitro cultures was examined. Well developed in vitro strawberry crowns infected with SMYEV grown on modified Murashige and Skoog medium were used for each treatment. For the first treatment, 0.5 µM thidiazuron (TDZ) was added to the medium for 26 days, followed by 26 days with 200 µM RIB but without TDZ. These were then transferred to hormone and RIB free media for plantlet development. For the second treatment, the plantlets were cultured with RIB for 26 days without the TDZ pretreatment, and for the third treatment plantlets were multiplied with TDZ without RIB. After the treatments, plantlets were transplanted to the greenhouse over the next 3 month period of the experiment as they became large enough. A total of 34, 87 and 50 plants from each respective treatment (TDZ then RIB; RIB no TDZ; TDZ no RIB) were grown to maturity during the experiment in preparation for SMYEV testing by ELISA. Initial tests showed 2 (5.9%), 8 (9.2%) and 0 plants negative for SMYEV, respectively. Repeat testing of the putatively virus negative plants reduced the number to 1 (2.9%) and 6 (6.9%) virus negative plants. One plant, #76TDZ, was chosen as an explant donor to initiate new in vitro cultures because it produced numerous runners in the greenhouse suitable for culture initiation. After successful initiation and culture multiplication, five plants from the new culture were established in soilless media in the greenhouse for maturation. These plants subsequently tested negative for SMYEV. The combination of TDZ for rapid in vitro multiplication followed by ribavirin proved to be 2.3 times more effective at producing SMYEV virus free strawberry plants compared to culture without TDZ, and no virus negative plants were developed in the absence of ribavirin. The procedure is less technically demanding than heat treatment/apical meristem culture procedures for virus elimination and may be less likely to produce soma-clonal variants commonly produced from apical meristem culture. It may also be a viable procedure for elimination of additional viruses in strawberry besides SMYEV.

Effects of Selected Media and Cytokinins on the Micropropagation of *Vernonia* Sp. (poster)

Darren Touchell*, *North Carolina State University* and Thomas Ranney, *North Carolina State University, Dept. of Horticultural Science (Poster Board #312)*

Abstract: The genus *Vernonia* Schreb., commonly known as ironweeds, comprises ≈ 1000 species worldwide and are widely known for their pharmaceutical qualities. Several species also have desirable ornamental characteristics. Many ornamental varieties are often difficult or slow to propagate through conventional methods such as stem cuttings or divisions. The development of micropropagation systems may facilitate faster propagation and the release of new varieties. In vitro regeneration studies on *Vernonia* have focused on medicinal species such as *Vernonia cinerea*. However little work has been done to develop in vitro propagation systems for ornamental species. Therefore, the objective of this study was to develop an efficient micropropagation system for a novel ornamental *Vernonia* hybrid and to examine the effects of selected media and cytokins on shoot proliferation. Multiplication was evaluated by culturing on either MS, WPM, DKW, Q&L or B5 basal salts. DKW produced the highest number of shoots (3.5 plants per explant), longest shoots (66 mm), and the highest multiplication rate (3.8 fold). A second study evaluated the effects of cytokinins BAP, 2iP, meta-Topolin and TDZ at concentrations of 0, 1.25. 2.5, 5.0 or 10.0 µM. Explants cultured on media containing 2.5 µM TDZ produced the highest number of shoots (12.7 shoots per explant) and the highest multiplication rate (15.6 fold), while explants cultured on media containing meta-Topolin produced the longest shoots (86 mm). To test the long-term effects of TDZ, explants were maintained for 4 subculture cycles on 1.25, 2.5, 5.0 and 10.0 µM. At 1.25 and 2.5 µM TDZ, shoot regeneration increased to 27 fold during the second subculture period and remained high. For higher concentrations of TDZ, shoot multiplication rate and quality declined with increasing subcultures. Shoots from 1.25 and 2.5 µM formed roots in vitro and were successfully transferred ex vitro through 4 sub culture cycles.

Developing a Modified Hydroponic Stock Plant System for Minicuttings of Redbud (poster)

Sharon Kester, *University of Kentucky* and Robert Geneve*, *University of Kentucky (Poster Board #313)*

Abstract: Budding and micropropagation are the typical clonal propagation methods for difficult-to-root nursery crops. These methods can be more time consuming and expensive that cutting propagation. The forestry industry has adopted a commercially viable hydroponic stock plant strategy for difficult-to-root species that emphasizes plant nutrition and juvenility to establish cuttings that root at high percentages. A similar system was developed for a difficult-to-root nursery crops using eastern redbud (*Cercis canadensis*) as a model. Redbud stock plants grow vigorously in the modified hydroponic sand beds. It was determined that plants responded equally well when irrigated at full or half-strength nutrient solutions. Stock plants produce shoot growth that permitted cutting harvest every two to three weeks. The highest rooting for seedling and clonal cuttings was at 10,000 and 15,000 ppm auxin as a quick dip. Rooting was very similar for cuttings taken from hedged greenhouse and field-grown stock plants. Seedling cuttings were easier to root compared to cuttings from clonal plants. The highest rooting for clones was approximately 30% compared to 55% rooting in cuttings from

seedling stock plants. Also, 'Oklahoma' cuttings consistently rooted at lower percentages than 'Appalachian Red'. This research is supported by a grant from the Horticultural Research Institute.

Specified Source(s) of Funding: Horticultural Research Institute

Speed in a Slow Lineage: The First Indole-3-Butyric Acid Dose Response Study on Cycads (poster)

Benjamin E. Deloso*, *University of Guam* and Thomas Marler, *Univ of Guam (Poster Board #314)*

Abstract: An indole-3-butyric acid (IBA) dose response study was conducted on a model cycad species, *Zamia furfuracea* L.f.. Stem cuttings were subjected to one of five IBA concentrations within the range of 0 to 30,000 ppm in order to determine the IBA dosage that would induce adventitious root formation in the shortest amount of time. Stem cuttings were planted in perlite within clear containers, and the bottom surface of each container was checked daily until the first sign of root contact for each cutting. Less than two months were required to reach 50% rooting success. Cuttings receiving IBA dosages between 3,000 and 16,000 ppm developed roots more quickly than the control cuttings. In contrast, cuttings receiving IBA of 30,000 ppm developed roots more slowly than the control plants. The results suggest that IBA between 16,000 and 30,000 ppm would be optimum for inducing adventitious roots most rapidly for this species. Published IBA dose response studies have been conducted on various angiosperm and a few gymnosperm species. To our knowledge, this is the first IBA dose response study for any cycad species. This information will inform cycad horticultural practices and add to an important conservation agenda, as cycads are the most threatened group of plants worldwide.

Effects of Nutrient Salt Formulations and PGRs on Micropropagation of Cornelian Cherry (*Cornus mas* L.) (poster)

Meredith A. Swanson*, *North Dakota State University* and Todd West, *North Dakota State University (Poster Board #315)*

Abstract: The utilization of tissue culture for rapid multiplication and micropropagation has become one of the fundamental ways ornamental plants are propagated for the nursery trade. *Cornus mas* L. (Cornelian cherry) is an underutilized ornamental landscape plant that boasts an early flowering habit and edible fruits. With it being an underutilized plant, little information regarding tissue culture of this species exists. The objective of this study was to evaluate and expand the micropropagation protocol developed by Ďurkovič (2008). Ďurkovič's evaluation was limited, it did not focus on evaluating nutrient salt formulations and the impact on microshoot development and subsequent development. In this study, three different nutrient salt formulations were evaluated: Murashige and Skoog, Woody Plant Media, and LP. These nutrient salt formulations were compared in a factorial experiment with two plant growth regulators (PGRs): 6-benzylaminopurine (BA) and 1-naphthaleneacetic acid (NAA). The concentrations of the two PGRs used in the factorial were 0, 2, and 4 µM for BA and 0 and 0.5 µM NAA. The plant material used was 6-week old explants of the cultivar 'Schonbrunner Gourmet' grown on LP medium supplemented with 2.0 µM BA and 0.5 µM NAA, 30 g/L sucrose, 7 g/L agar, and adjusted to a pH of 5.8. Each treatment was replicated seven times in both runs and the experimental design was a CRD factorial. Plantlets were subcultured three times at six-week intervals for a total of 18 weeks of incubation time. The LP medium supplemented with 2.0 µM BA and 0.5 µM NAA significantly performed better than the other media types with respect to shoot number and microshoot quality. This is contrary to Ďurkovič's claim that a modified WPM media is best for micropropagation of *C. mas*. In conclusion, micropropagation can be seen as a viable method for propagation of the species.

Catberry, Rhodora, and Sweetgale Vary in Their Responses to Auxin Treatment and Substrate Composition during Propagation By Stem Cuttings (poster)

Bryan J. Peterson*, *University of Maine (Poster Board #316)*

Abstract: Catberry (*Ilex mucronata*), rhodora (*Rhododendron canadense*), and sweetgale (*Myrica gale*) are three horticulturally promising shrubs of wetlands in North America. Although all three can be rooted from stem cuttings, root system quality may be inconsistent. To explore two factors that might improve quality of adventitious root systems, a minimum of 270 semi-hardwood cuttings of each species were collected in June or July 2016, treated with 0 to 15,000 ppm of the auxin K-IBA, and inserted into propagation media with 0, 25, or 50% peat moss by volume, with coarse perlite for the remainder. Cuttings were evaluated after eight weeks under intermittent mist. Rooting percentage of catberry cuttings was high, and averaged more than 80% across hormone treatments when either 25 or 50% peat moss was included in the medium; rooting averaged only 33% in perlite alone. Greatest root ratings, root lengths, root numbers, and root dry weights among cuttings of catberry occurred when they were treated with 5,000 to 15,000 ppm K-IBA, and inserted into media with 25 or 50% peat. The use of perlite alone was unsatisfactory, as it caused catberry cuttings to proliferate callus excessively instead of rooting. Rooting percentage of rhodora cuttings averaged more than 90% when either 25 or 50% peat moss was included in the medium, but only 64% in perlite alone. Curves fit to these rooting responses showed that maximum root ratings, root lengths, and root dry weights can be obtained with concentrations of K-IBA between 5,000 and 10,000 ppm for cuttings rooted in media containing peat. In contrast, cuttings inserted into perlite alone showed only modest gains in these measures when K-IBA was applied. Rooting percentage of sweetgale exceeded 80%, whether peat moss was included in the medium or not. The greatest average root ratings, root lengths, and root dry weights of sweetgale cuttings were produced when they were treated with 0 to 5,000 ppm K-IBA. Although the number of roots on sweetgale cuttings did not vary markedly with K-IBA application, auxin concentration had a consistently negative effect on root elongation, root rating, and root dry weight. Collectively, these results show that media with 25 to 50% peat are appropriate for all three wetland species, and only sweetgale tolerates pure perlite during propagation. Catberry and rhodora respond well to concentrations of K-IBA exceeding 5,000 ppm, whereas rooting in sweetgale is not enhanced, but may be diminished, by K-IBA application at concentrations used in this study.

Specified Source(s) of Funding: USDA NIFA Hatch Project #ME021423

Vegetative Propagation of *Lonicera Caerulea* var. *Villosa,* a North American Blue Honeysuckle, By Overhead Mist and Subirrigation (poster)

Darren J. Hayes*, *University of Maine* and Bryan J. Peterson, *University of Maine (Poster Board #317)*

Abstract: One of many strategies available to limit the potential for future plant invasions is to introduce and promote the use of regionally native taxa for horticulture. As various honeysuckles (*Lonicera* spp.) of Eurasian origin have proven to be invasive outside their native ranges, we evaluated methods to propagate a potential North American alternative, mountain fly honeysuckle (*Lonicera caerulea* var. *villosa*). This species of northern climates has low population densities through much of its native range, and seems ineffective at displacing other species. Nonetheless, our observations of this plant in horticultural landscapes suggest that it could be used in landscapes more varied than its native distribution implies. To conduct propagation trials, we collected softwood terminal stem cuttings from plants indigenous to Maine in June 2017, treated each with one of several concentrations of potassium salt of indole-3-butyric acid (K-IBA), and stuck them into media with different proportions of perlite and milled peat moss. We conducted two separate experiments to independently evaluate the suitability of overhead mist or subirrigation during rooting. The percentage of cuttings that rooted was high and not significantly affected by treatments. Root dry weight, as well as root volume and number of root tips measured by scanning fresh roots and analyzing the images using WinRHIZO software, increased with concentration of applied K-IBA and proportion of perlite in the substrate. Within each system, K-IBA application rates from 8,000 to 12,000 $mg \cdot L^{-1}$ and a porous mineral substrate produced well rooted cuttings with the high success rate necessary for commercial propagation. Our results illustrate that a simple subirrigation approach to cutting water management can produce quality rooted cuttings of mountain fly honeysuckle when overhead mist is not available. Moreover, a residential landscape trial that we initiated in August 2016 confirms that this North American member of the circumboreal species complex can establish and grow in a mesic and predominantly mineral soil,

despite its tendency to persist in peat wetlands throughout much of its range. Rooted cuttings planted in a landscape soil in Maine established readily and produced annual shoot elongation on par with the more robust natural populations observed, and far exceeding the several centimeters of growth we often observe among mountain fly honeysuckles indigenous to bogs and fens in New England.

Specified Source(s) of Funding: USDA NIFA Hatch Projects #ME021423 and #ME021614

Propagation Methods for Blue Elderberry (*Sambucus cerulea* Raf.) (poster)

Tiffany Maughan, *Utah State University*; Brent Black*, *Utah State University* and Larry Rupp, *Utah State University (Poster Board #318)*

Abstract: Native to western North America, blue elderberry (*Sambucus cerulea* Raf.) is well adapted to the alkaline soils and short growing seasons of the arid, high elevation conditions found in the Intermountain West. However, domestication of this species for local fruit production has been hampered by difficulty in propagating superior selections. Experiments were conducted over 4 seasons to develop viable propagation protocols. Semi-hardwood cuttings from wild-grown plants collected at full bloom, and treated with a commercial NAA formulation had rooting success greater than 60%. The highest success rates (approaching 100%) were from two-node hardwood cuttings taken from greenhouse-grown stock plants. The cuttings were from the previous season's growth, dipped in 0.2% NAA, and then cold callused for 14 to 18 wk at 4 to 6°C before being placed in a greenhouse at 24/18°C for six weeks. These methods will allow for commercial-scale propagation of blue elderberry for both the landscape and the specialty food products industries.

Adventitious Shoot Regeneration from Leaf Explants of Peach Rootstock 'Hansen 536' ([*P. davidiana* x *P. persica*] x *P. persica* 'Okinawa') x *P. Amygdalus*) (poster)

Xiaojuan Zong*, *Michigan State University* and Guo-qing Song, *Michigan State University (Poster Board #319)*

Abstract: 'Hansen 536' is an important commercial rootstock for peach and almond. However, susceptibility to wet soil and bacterial canker are the main disadvantages of this cultivar. Genetic engineering techniques offer an attractive approach to efficiently improve the problems existing in this cultivar. In this study, an efficient protocol for organogenesis regeneration from leaf explants were developed. Leaf explants were cultured on Murashige and Skoog (MS) and Woody Plant Medium (WPM) supplemented with different plant growth regulators to induce shoot regeneration. Nine potential media were evaluated and adventitious shoot regeneration occurred on five media at frequencies ranging from 0-34.5%. The optimal regeneration at a frequency of 34.5% occurred on the WPM medium containing 8.88 µM 6-benzylamino-purine (BA) and 1.97µM indole-3-butyric acid (IBA). The regenerated shoots were rooted successfully and transplanted to soil. This study provided a prerequisite for developing an efficient genetic transformation system.

Propagation and Evaluation of *Balduina Angustifolia*, a Native Wildflower with Ornamental and Ecosystem Value (poster)

Sandra Wilson, *University of Florida*; Carlee Steppe*, *University Florida*; Mack Thetford, *University of Florida*; Gabriel Campbell-Martínez, *University Florida* and Hector E. Perez, *University of Florida (Poster Board #320)*

Abstract: Native plants have significantly increased in popularity over the last few years due to the demand for more environmentally suitable urban landscapes that are low maintenance (reduced water, fertilizer and pesticides), tolerant of Florida's climate, and beneficial in supporting wildlife and pollinators. Consumers are also increasingly aware of the threat non-native invasive species pose to Florida's ecosystems and are seeking native alternatives.

Balduina angustifolia (Coastal Honeycombhead) is native to most of Florida and the coasts of Alabama, Georgia and Mississippi. It is characterized as an herbaceous annual/biennial having green linear foliage, bright yellow ray and disk flowers, and persistent, honeycomb-shaped seed heads. Due to its charismatic nature and fall flowering time, *Balduina angustifolia* is a suitable candidate for introduction into the commercial ornamental plant industry. It is also an important pollinator species, attracting a number of butterfly and bee species, including the Florida endemic balduina bee (*Hesperapis oraria*).

The objective of this research was to evaluate the germination, flowering, and landscape performance of *Balduina angustifolia* under varying conditions. For the germination experiments, seeds were collected from two sites in the Florida Panhandle (Perdido Key and Navarre Beach) after overwintering on the plants. Pre-germination viability tests indicated that seeds averaged 76% viability. Germination was evaluated for 28 days at four different alternating temperature regimes: 20°C/10°C, 25°C/15°C, 30°C/20°C, and 35°C/25°C with a 12 hr photoperiod. Highest germination (79%) was achieved at 30°C/20°C with seeds from Navarre Beach.

Germinated seedlings from a south Florida population were finished in one gallon pots and transplanted in three trial sites located in north (Gainesville), northwest (Milton), and south (Fort Pierce) Florida. Visual quality and flower intensity were evaluated monthly for 40 weeks, beginning in July. Peak flowering was observed in September for north and south Florida and in October for northwest Florida. Overall, visual quality was best for plants located in northwest Florida, followed by north Florida and then south Florida. Regardless of location, plants declined by December and did not recover the following spring. Results indicate that *Balduina angustifolia* would make an excellent addition to a fall garden or urban landscape.

Specified Source(s) of Funding: Florida Wildflower Foundation

Hardwood Cutting Propagation of Shumaka™ Crape Myrtle (poster)

Jenny B. Ryals*, *Mississippi State University Coastal Research and Extension Center*; Patricia Knight, *Mississippi State University Coastal Research and Extension Center*; Scott A. Langlois, *Mississippi State University Coastal Research and Extension Center*; Eugene Blythe, *Mississippi State University Coastal Research and Extension Center*; J. Skylar Baldwin, *Poplarville High School*; Christine H. Coker, *Mississippi State University Coastal Research and Extension Center*; Gary Bachman, *Mississippi State University Coastal Research and Extension Center* and James DelPrince, *Mississippi State University Coastal Research and Extension Center (Poster Board #321)*

Abstract: Crape myrtles provide a reliable source of color for many southern landscapes, often flowering for more than 100 days. Mississippi State University has released six new crape myrtle selections, including Shumaka™. Shumaka™ is a hybrid resulting from the cross of *Lagerstroemia* 'Arapaho' and an unknown pollen donor. Shumaka™ has a unique very light pink flower color and large growth habit. Three-year-old plants in a research setting are 20+ feet and have flowered from early June through late August. The bark is smooth to exfoliating, with outer bark that is grayish brown in color. The objective of this research was to evaluate ease of rooting and determine optimal commercial auxin formulation and concentration for hardwood cutting propagation of Shumaka™. Five-inch (12.7-cm) medial cuttings were harvested from the parent plant and inserted to a depth of 1 inch (2.5 cm) in propagation medium on 1 Feb. 2017. Propagation medium was 100% perlite placed in 3-inch (7.6-cm) containers. Treatments included two basal wounding treatments (wounded or non-wounded), three auxin formulations [Hortus IBA (Hortus IBA Water Soluble Salts™), Dip'N Grow® (IBA + NAA at 50% the rate of IBA), or Hortus IBA + KNAA (Hortus IBA Water Soluble Salts™ + NAA potassium salt at 50% the rate of IBA)], and three levels of auxin (0, 1000, or 5000 ppm IBA). Data collected after 60 days included rooting percentage, growth index (new shoots), cutting quality (0-5, with 0 = dead and 5 = transplant-ready cutting), total root number, average root length (of three longest roots), and root quality (0-5, with 0=no roots and 5=healthy, vigorous root system). Results showed that rooting percentage, number of roots, average length of the three longest roots, and growth indices were similar among treatment combinations. No benefits were observed from wounding of the cutting. Cuttings dipped in Hortus IBA did have better root quality compared to cuttings dipped in DNG; when Hortus IBA concentration was increased, root and cutting quality and root number increased. Overall, the results suggested that dipping Shumaka™ hardwood cuttings in Hortus IBA at 5000 ppm resulted in a higher quality liner.

Comparing Grafting Methods for *Cornus Mas* (L.) Clonal Propagation (poster)

Meredith A. Swanson*, *North Dakota State University* and Todd West, *North Dakota State University (Poster Board #322)*

Abstract: A major limitation in a species or cultivar being sold to consumers is the initial propagation required to produce genetically identical plants. *Cornus mas* (L.) is a dogwood native to eastern Europe where it has historically been used in foods such as preserves and pies. It has promising aspects for edible landscaping (ediscaping) and is an overall quality plant. With its high disease and pest resistance, it makes for a great species to include in a landscape for diversity. However, *C. mas* is an underutilized species in the U.S. and therefore information on propagation techniques is lacking. Many woody plant species are propagated using grafting or budding onto a rootstock to maintain genetic homogeneity. The only available research on grafting for *C. mas* was performed in a nursery field rather than in a greenhouse (Bijelić et al., 2016). While Bijelić tested two different graft types (bud and whip) at separate times of the year (spring whip grafting in April and bud grafting in August), this study tested two graft types in a factorial of different times of the year. Two selections were used for this study; 'Pyramidalis' and an individual (TS79239) from the NDSU Research Arboretum (near Absaraka, North Dakota, USA; Lat: 46.9859, Long: -97.3549). The graft types used were the side graft and the chip bud graft. Two runs were conducted on 13 April 2017 and 19 April 2017. The experiment was a CRD factorial consisting of graft type by selection. Each treatment had five replicates. The side graft had a significantly higher success rate (100%) as compared to chip bud graft (40%). The side graft had a significantly higher grafting success rate as reported by either methods by Bijelić et al. (2016). There was no significant difference between germplasm selections with respect to grafting success. The experiment was attempted again in late August with no success in either type of graft or selection. It is unclear whether or not the failure of the late summer runs was caused by the rootstocks going dormant. It can be concluded from this study that grafting is an effective way of propagating *C. mas* using the side graft method on rootstocks in the spring

Dormant Propagation of Neshoba™ Crape Myrtle (poster)

Patricia Knight*, *Mississippi State University Coastal Research and Extension Center*; Scott A. Langlois, *Mississippi State University Coastal Research and Extension Center*; Eugene Blythe, *Mississippi State University Coastal Research and Extension Center*; J. Skylar Baldwin, *Poplarville High School*; Jenny B. Ryals, *Mississippi State University Coastal Research and Extension Center*; Christine H. Coker, *Mississippi State University Coastal Research and Extension Center*; Gary Bachman, *Mississippi State University Coastal Research and Extension Center* and James DelPrince, *Mississippi State University Coastal Research and Extension Center (Poster Board #323)*

Abstract: Mississippi State University has developed several new crape myrtle selections, including Neshoba™. Objective was to determine optimal hormone source and concentration for hardwood cutting propagation of Neshoba™. Medial cuttings (12.7 cm) were harvested and stuck to a depth of 2.6 cm on 1 Feb. 2017. Medium was 100% perlite in 7.6 cm containers. Treatments included two basal treatments (wounded or non-wounded), three hormone mixtures (Hortus IBA, Dip & Gro, or Hortus IBA + NAA), and three levels of hormone (0, 1000, or 5000 ppm IBA). Experimental design was a RBCD with five single plant replications. Data collected included percent rooting, new shoot growth, cutting quality, root number, average root length (length of three longest roots/three), and root quality. Cuttings dipped in Hortus IBA 5000 ppm, regardless of basal treatment, had more roots compared to controls, or non-wounded Dip'N Grow 1000 ppm. Non-wounded cuttings dipped in Hortus IBA 1000 ppm had higher root quality compared to all cuttings except those wounded and dipped in Hortus IBA 5000 pm or non-wounded and dipped in Dip'N Grow 5000 ppm. Cutting quality was greater for wounded cuttings dipped in Hortus IBA 5000 ppm compared to wounded control, non-wounded and dipped in Dip'N Grow 1000 ppm, wounded and dipped in Dip'N Grow 5000 ppm, or non-wounded and dipped in Hortus IBA 5000 ppm + KNAA 2500 ppm. Growth was greater for cuttings that were wounded and dipped in Hortus IBA 5000 ppm compared to controls or cuttings dipped in Dip'N Grow 5000 ppm, non-wounded and dipped in Hortus IBA 1000 ppm + KNAA 500 ppm, or non-wounded and dipped in Hortus IBA 5000 ppm + KNAA 2500 ppm. When direct comparisons were made, wounding, increasing concentrations of Dip'N Grow or Hortus IBA + KNAA had no influence on measured characteristics. Cuttings treated with hormone had more roots compared to controls, but increasing hormone concentration only resulted in additional roots for cuttings dipped in Hortus IBA. Cuttings dipped in Hortus IBA had higher root and cutting quality ratings compared to controls, those dipped in Dip'N Grow, or Hortus IBA + KNAA. Cuttings dipped in Hortus IBA had greater growth compared to controls or cuttings dipped in Hortus IBA + KNAA. Results suggest hardwood cuttings of Neshoba™ crape myrtle may be successfully rooted without wounding or use of auxin, but use of Hortus IBA did improve cutting quality and growth.

Specified Source(s) of Funding: Mississippi Agricultural and Forestry Experiment Station. National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 58-6062-6-003.

Four Grafting Techniques and Their Impact on Success Rate in Pawpaw (*Asimina triloba*) (poster)

Matthew Behrends*, *Kentucky State University*; Sheri Crabtree, *Kentucky State University*; Jeremiah Lowe, *Kentucky State University*; Srijana Thapa Magar, *Kentucky State University* and Kirk Pomper, *Kentucky State University (Poster Board #324)*

Abstract: The pawpaw (*Asimina triloba*) is a fruit bearing tree native to North America. Its rising popularity has led to small-scale commercial production in the U.S. and worldwide. There is growing interest from processors, retailers, and restaurants. A large number of wild and seedling pawpaws grown by homeowners and small farmers produce fruit of poor taste, quality, or size. Two new advanced selections, Hi7-1 and Hi4-1, being studied at Kentucky State University (KSU) have shown more favorable reviews about flavor, texture, and appearance than many commercially available varieties. KSU-Atwood is a trademarked cultivar developed at Kentucky State University that was released in 2011 and is available in the nursery trade. Whip and tongue grafting and chip budding are common ways to grow desired pawpaw varieties on healthy rootstocks. Grafting can also be done using tools like a Topgrafter or a grafting tool. A previous study found that Hi7-1 and KSU-Atwood™ have a 33% higher rate of grafting success than Hi4-1 using all four methods. In the same study, pawpaw grafted via whip and tongue grafts had a 12-18% higher success rate than those that were chip budded or grafted using the Topgrafter or grafting tool. The purpose of this study was to determine the optimal method for grafting the pawpaw cultivar KSU-Atwood™ and advanced selections Hi7-1 and Hi4-1. Four potted two-year-old trees of each cultivar were grafted using each grafting method or tool at the Kentucky State University H.R. Benson Research and Demonstration Farm greenhouses. Although whip and tongue grafting had a high success rate, results will be discussed at the meeting.

Specified Source(s) of Funding: USDA SARE

1:00 PM – 1:45 PM *International Ballroom East/Center*

Vegetable Breeding 1 (Poster)

Evaluation and Association Analysis of Downy Mildew Resistance in USDA Spinach Germplasm (poster)

Bazgha Zia*, *University of Arkansas*; Gehendra Bhattarai, *University of Arkansas*; Ainong Shi, *University of Arkansas*; Chunda Feng, *University of Arkansas*; Wei Zhou, *University of Arkansas*; Jim Correll, *University of Arkansas*; Jun Qin, *University of Arkansas*; Yuejin Weng, *University of Arkansas*; Waltram Ravelombola, *University of Arkansas* and Beiquan Mou, *USDA-ARS (Poster Board #038)*

Abstract: Downy mildew, caused by the plant fungal pathogen *Peronospora farinosa f.* sp. *spinaciae (Pfs),* is an important disease of spinach, particularly for *Spinacia oleracea,* the most commonly cultivated spinach species in United States and Europe. To date, 16 races of the downy mildew (DM) pathogen are recognized but new isolates are continuously emerging each year. The ability of new strains of the pathogen to overcome resistance in spinach plants makes the development of spinach varieties with increased levels of resistance to *Pfs* challenging and essential. Genome wide association mapping offers a promising tool to identify QTLs

associated with downy mildew resistance against emerging new races of *Pfs.* The identified QTLs can be readily used to improve genetic resistance against downy mildew disease in spinach. A total of 481 spinach genotypes are evaluated to identify potential resistant germplasm to be used in spinach breeding programs. The evaluated population will be subjected to genome wide association mapping. As a result of this study, SNP markers for downy mildew resistance will provide breeders with a tool to select resistant plants and lines in spinach against downy mildew resistance. Downy mildew, caused by the plant fungal pathogen *Peronospora farinosa f.* sp. *spinaciae (Pfs),* is an important disease of spinach, particularly for *Spinacia oleracea,* the most commonly cultivated spinach species in United States and Europe. To date, 16 races of the downy mildew (DM) pathogen are recognized but new isolates are continuously emerging each year. The ability of new strains of the pathogen to overcome resistance in spinach plants makes the development of spinach varieties with increased levels of resistance to *Pfs* challenging and essential. Genome wide association mapping offers a promising tool to identify QTLs associated with downy mildew resistance against emerging new races of *Pfs.* The identified QTLs can be readily used to improve genetic resistance against downy mildew disease in spinach. A total of 481 spinach genotypes are evaluated to identify potential resistant germplasm to be used in spinach breeding programs. The evaluated population will be subjected to genome wide association mapping. As a result of this study, SNP markers for downy mildew resistance will provide breeders with a tool to select resistant plants and lines in spinach against downy mildew resistance.

Specified Source(s) of Funding: USDA's National Institute of Food and Agriculture

Biochemical and Molecular Events Underlying Cucumber Resistance to Downy Mildew (*Pseudoperonospora cubensis*) (poster)

Wojciech Szczechura, *Research Institute of Horticulture*; Urszula Klosinska, *Research Institute of Horticulture*; Marzena Nowakowska, *Research Institute of Horticulture*; Monika Markiewicz, *Research Institute of Horticulture*; Anna Niezgoda, *Research Institute of Horticulture*; Katarzyna Nowak, *Research Institute of Horticulture* and Marcin Nowicki*, *University of Tennessee - Knoxville (Poster Board #039)*

Abstract: Downy mildew caused by the oomycete *Pseudoperonospora cubensis* generates significant yearly losses of cucumbers and related crops in Poland and worldwide. In our study, we chose five cucumber cultigens showing a broad range of *P. cubensis* reactions, and submitted them to laboratory bio-assays with an aggressive local pathogen isolate, to observe the important subcellular, biochemical, and transcriptomic reactions. DCFDA staining evidenced participation of the reactive oxygen species (ROS) in response to *P. cubensis* infections. An increasing proportion of ROS was found over time, with only a slight increase in their content in the resistant cultigens compared to the susceptible ones. Differences in the activitiy of SOD, PPO, and POX, corresponded with the *P. cubensis* resistance level of the tested cultigens. The resistant cultigens showed a significant increase in enzymatic activity at 8 hours after inoculation (hpi), whereas the susceptible ones displayed such increase only after 36 hpi. In case of the protective substances, there was an upward trend in the content of free phenols and lignins, with a clearer tendency in the resistant cultigens. Transcriptomic analyses included qPCR investigations of 19 cucumber transcripts (salicylic acid related: 2; jasmonic acid related: 4; *PR* genes: 8; *PAL*; *LOX*; *CalSyn*; *VPE*) normalized to housekeeping genes. All these analyses pointed to a comparatively earlier activation of the defenses in the *P. cubensis*-resistant cultgens.

Specified Source(s) of Funding: Polish Ministry of Agriculture and Rural Development

Genetic Analysis of Young Fruit Resistance to *Phytophthora Capsici* in Cucumber (poster)

Ying-Chen Lin, *Michigan State University* and Rebecca Grumet*, *Michigan State Univ (Poster Board #040)*

Abstract: Phytophthora blight caused by *Phytophthora capsici*, a soil-borne pathogen, can be a devastating disease for cucumber. In cucumber, *P. capsici* specifically infects fruit, especially young fruit, leaving vines and leaves uninfected, necessitating a search for resistance in young fruit. The objective of this work is to identify quantitative trait loci (QTLs) associated young fruit resistance to *P. capsici* in cucumber. Cucumber accession, PI 109483, was previously identified as a source of resistance. The S_5 generation (line 109483-53) was used for doubled haploid (DH) production, and three resistant lines selected. The S_6 generation (109483-53 B5) was crossed with the susceptible pickling cucumber inbred line, Gy14, to develop F_2 and backcross populations. In the summer of 2017, 400 progeny from the F_2 population [(Gy14 x B5)x] along with parent lines and F_1 were screened in the field. In order to facilitate accurate phenotyping, plants were trellised to reduce contact of the fruits with the soil. This reduced wounding that can occur during the cleaning process to remove soil prior to inoculation, as well as lessening the probability of cross-contamination resulting from other pathogens in the soil. Harvested fruits were sanitized with 1% bleach, placed in sealed trays to maintain high humidity, and inoculated with 1×10^4 zoospores/mL of *P. capsici* isolate Bartley's 1. For the initial stage of screening, three replicate harvests were performed providing 5-25 fruits for each plant. The normal distribution of disease scores for the F_2 population indicated that young fruit resistance is a quantitative trait. Based on the initial result, the top and bottom 12% of plants were selected. Fruits were harvested from these individuals three additional times and inoculated with an elevated pathogen concentration (5×10^4 zoospores/mL). The results from re-screening showed reproducibility of the disease scoring and accuracy of selection. To provide a second population for QTL-seq analysis, 400 F_2 progeny derived from DH line (A4-3) [(Gy14 x A4-3)x] is currently being phenotyped in the greenhouse. For QTL-seq analysis, 15 resistant and susceptible individuals will be selected from each F_2 population. DNA will be extracted and pooled for sequencing and analyzed for QTL to determine genomic regions associated with the resistance.

Specified Source(s) of Funding: USDA-SCRI 2015-51181-24285

Breeding for Fusarium Basal Rot Resistance in Short-Day Onions (poster)

Subhankar Mandal*, *New Mexico State University* and Christopher Cramer, *New Mexico State University (Poster Board #041)*

Abstract: Fusarium basal rot (FBR), caused by a soil-borne fungus *Fusarium oxysporum* f. sp. *cepae* (FOC) is one of the most devastating diseases of onion worldwide. FBR disintegrates the compressed stem and is particularly damaging to the bulbs in storage, as the initial decay is difficult to detect. The development of resistant cultivars could be the best possible alternative over the conventional methods to control FBR, viz., crop rotation and soil fumigation, allowing farmers to utilize the same fields for multiple crops without the need for soil fumigation. Failing to increase FBR resistance via seedling and field screening methods, which were used to develop FBR-resistant long-day and intermediate-day cultivars, the New Mexico State University onion breeding program used a mature bulb screening method to evaluate selected populations of seven short-day Grano-type cultivars originated from two different artificial inoculation mature bulb selection processes. Transversely-cut basal plates were inoculated with PDA plugs containing different concentrations of spore suspensions of a virulent FOC isolate 'CSC-515'. After 20 days of incubation, 20 randomly-selected inoculated bulbs were cut transversely again to measure FBR severity and incidence percentage. A high disease severity and incidence observed during both 2016 and 2017 seasons that could be linked to congenial disease causing environments in addition to higher spore concentrations. The advantage of using a spore inoculation as compared to a mycelium plug inoculation was realized in 2017, when a reduced disease severity and incidence was observed in FBR3, FBR1-2 and selected populations of the checks, all generated by the former method. A further evaluation of the old and newly-selected populations is underway along with a digital image analysis for objective scoring and screening based upon antifungal secondary metabolites.

Novel Sources of Resistance to Florida Isolates of Bacterial Leaf Spot in Lettuce (*Lactuca sativa* L.) (poster)

German Sandoya*, *University of Florida*; William Wadlington, *University of Florida*; Richard Raid, *University of Florida - Institute of Food and Agricultural Sciences*; Ivan Simko, *USDA-ARS* and Carolee Bull, *The Pennsylvania State University (Poster Board #042)*

Abstract: Bacterial Leaf Spot (BLS) caused by the bacterium *Xanthomonas campestris* pv. *vitians* (Xcv) affects yield and quality of lettuce production in North America. Due to unpredictable nature of outbreak, preventive and post-infection control of the disease are impractically expensive. Therefore, breeding lettuce with high resistance to BLS is a priority for public and private breeding sectors. In Florida, environmental conditions are conducive for disease development, due to the high humidity and temperatures. In conditions favorable for disease development, the entire crop may be lost. During the season of 2017 – 2018 we recovered five new isolates of *Xcv* which caused disease outbreak in susceptible lettuce cultivars. Our previous tests indicate that plant introduction (PI) 358001-1 has complete resistance to Florida strains of BLS. PI is a leaf-type lettuce that bolts faster than commercial cultivars used at the EAA (Everglades Agricultural Area). Breeding efforts are in place by the University of Florida to transfer the resistance from this PI into romaine and crisphead lettuce. The lettuce breeding program of the University of Florida continues to screen lettuce PIs and cultivars from the National Plant Germplasm System (NPGS) of the GRIN – USDA to identify additional sources of resistance. Fifty-eight PIs and seven cultivars were tested with two isolates of BLS collected in Florida; with the resistant PI 358001-1 and susceptible 'Okeechobee' as controls. Significant differences were found in disease severity of tested material when inoculated with isolates Sc8b (*P<0.0001*) and L7 *(P=0.0136)*. PIs 278080, 342898, 667690 and cv. Batavia Reine des Glaces showed none to minimal disease when inoculated with isolate Sc8b; PIs 342516, 419088, 601115 612665, 667709, 667690 and cv. La Brillante were as resistant as PI 358001-1 when inoculated with isolate L7. Furthermore, 44 PIs plus 6 cultivars were tested in California for their reaction to isolate BS0347. Cultivar 'La Brillante' and PI 251246 were used a resistant and susceptible controls, respectively. Significant differences (*P<0.0001*) in disease severity were found among accessions tested in California. PIs 278080, 342441, 342473, 591052,657639, 665198, 665203, 667690, 667709did not show any disease symptoms or were as resistant as the check cv. 'La Brillante'. Further tests are needed to confirm these findings and to assess if resistance in PIs 278080 and 6667690 is strain specific. Accessions with resistance to multiple strains of the pathogens could be used in Florida and California lettuce breeding programs.

Specified Source(s) of Funding: Specialty Crop Block Program. Florida Department of Agriculture & Consumer Service

Fine Mapping of the Tomato Spotted Wilt Virus-Resistance Gene *Sw7* (poster)

Tong Geon Lee*, *University of Florida*; Sadal Hwang, *University of Florida*; John Scott, *University of Florida*; Mikel Stevens, *Brigham Young University*; Steve M. Olson, *University of Florida* and Samuel F. Hutton, *University of Florida (Poster Board #043)*

Abstract: Tomato spotted wilt virus (TSWV) is an economically damaging pathogen of tomatoes. Typical symptoms of TSWV include wilting or stunning plants and chlorotic or necrotic rings on leaves and fruits. The symptoms can cause yield losses. The precise positioning of TSWV resistance genes on genetic maps is critical for improving the effectiveness of marker-assisted selection (MAS). The objective of this study was to fine map the TSWV resistance gene *Sw7* from *S. chilense* accession LA1938. The fine mapping was initiated by identifying recombination events from F_4 plants using molecular markers. Four different types of co-dominant molecular markers including high resolution DNA melting analysis (HRM) based on single nucleotide polymorphisms (SNPs) were used. The rate of natural thrips-vectored TSWV infection was evaluated in field trials conducted in Florida (2007, 2011, 2012, 2013) and Hawaii (2014). Further, whole genome sequencing (WGS) of two resistant breeding lines, Fla. 8516 and Fla. 8820, and plotting of SNPs and insertions and deletions of DNA segments on tomato chromosomes were conducted to identify the introgression of the wild tomato genome. Together, TSWV resistance gene *Sw7* has been fine mapped into 4.0-Mbp interval close to the telomere (within 10% of the chromosome length) on tomato chromosome 12.

SNP Markers Linked to QTL for CMV_{P1} Resistance in Chili Pepper (*Capsicum annuum* L.) (poster)

Nidhi Chakma, *Chonbuk National University*; Jundae Lee, *Chonbuk National University* and Bora Geum*, *Chonbuk National University (Poster Board #044)*

Abstract: Viral diseases severely limit the production of vegetable crops, and *Cucumber mosaic virus* (CMV) is one of the most recurrent viruses in chili pepper (*Capsicum annuum* L.) worldwide. An extensive host range and diverse pathogen strains make CMV control difficult in the field hence CMV-resistant pepper variety is required. In this study, we developed SNP markers linked to the QTLs for CMV_{P1} resistance through genotype-by-sequencing (GBS) and high-resolution melting (HRM) analyses. The single seed descent (SSD) F_3 segregating population obtained from a cross between a resistant line 'A1' and a susceptible line '2602' was assessed for CMV_{P1} resistance. The individuals were inoculated with CMV_{P1} strain, and 30 days after inoculation the phenotype was confirmed by RT-PCR. A total of 96 individuals including 48 resistant and 48 susceptible plants were selected for GBS analysis. QTL analysis with composite interval mapping (CIM) exhibited two QTLs, *cmvP1-5.1* and *cmvP1-10.1,* resistant to $CMV_{P1,}$ detected on chromosome 5 and 10, respectively. SNP markers linked to these two QTLs were developed by performing HRM analysis. For validity test of the HRM markers, an SSD F_5 population of the same cross was used and evaluated. In chromosome 5, a total of 20 markers were developed and mapped, and QTL analysis revealed a marker SNP07838 with LOD value 7.0 strongly linked to CMV_{P1} resistance. In addition, a total of 15 markers on chromosome 10 were developed, and a marker SNP13607 with LOD value 3.2 was detected by QTL analysis. These two SNP markers are expected to be useful for pepper breeding with CMV_{P1} resistance.

Specified Source(s) of Funding: Cooperative Research Program for Agriculture Science & Technology Development (Project No. PJ01114501)"of the Rural Development Administration, South Korea.

Examinations in Heat Inheritance and the L*ov* locus in Chile Pepper (poster)

Jack McCoy*, *New Mexico State University* and Paul Bosland, *New Mexico State University (Poster Board #045)*

Abstract: Chile pepper (*Capsicum* species) has important economic and cultural significance worldwide. One of its most distinctive attributes is the burning sensation when consumed. This heat sensation is caused by a class of alkaloid compounds known as capsaicinoids that typically accumulate in vesicles located on the placental walls of mature fruit. Several studies have been conducted on the genetics of heat inheritance in chile pepper. A single, dominant gene, *Pun1*, plays a role in the production of capsaicinoids in *C. annuum*. A second locus is suspected of controlling the production of vesicles in the placental wall. The locus, termed the "loss of vesicle" gene (*lov*), is the explanation for a no-heat phenotype in some *Capsicum* species. In this study, a segregating population constructed using two no-heat parents, *C. annuum* bell-type, 'Jupiter', and the commercial F_1 cultivar, 'Paladin', were hybridized. 'Jupiter' has vesicles and is no-heat. 'Paladin' displays a smooth placental wall (i.e., no vesicles) and is heterozygous at the *Pun1* locus. The F_1 progeny displayed a hot phenotype, and were selfed and the subsequent F_2 generation was evaluated. Fruit in the F_2 population segregated displaying 3 phenotypes: hot with vesicles, no-heat with no vesicles, and no-heat with vesicles. The segregation did not fit the expected phenotypic ratio 9:4:3. Results suggest that vesicle production is a quantitative trait. This also proves that capsaicinoid production and vesicles production are independent genes. This study provides further insight into the various modes of heat production in *Capsicum* and will aid breeding programs with cultivar development.

Development of Heat Tolerant Chili Variety through Marker-Assisted Backcrossing (poster)

Mohd Rafii Yusop*, *Universiti Putra Malaysia*; Usman Magaji, *Universiti Putra Malaysia*; Mohd Razi Ismail, *Universiti Putra Malaysia* and Mohammad Y Martini, *Universiti Putra Malaysia (Poster Board #046)*

Abstract: Marker-assisted backcrossing contributes significantly to get over the main drawbacks in the ancient manual breeding approach (conventional) and speeds up the genome recovery of the recurrent parent (RPG). Recently, chilli output in Malaysia plunged due to El Nino, leading to the shortage of supply. El Nino is a complex series of climatic changes that occurs irregularly and affects sea surface temperature in most tropics and subtropics.

To increase production there is the need to improve/produce varieties having high yielding potentials as well as tolerance against high temperature that will be suitable for lowland cultivation.

The strategy was adapted to introgress *Hsp* genes from AVPP0702, donor, into the genetic profile of Kulai variety, recipient. Parents were crossed and backcrossed to generate F_1 hybrids and backcross generations. Sixty-eight markers appeared to be polymorphic between the parents and used to assess the backcross generations; BC_1F_1, BC_2F_1, BC_3F_1 and BC_3F_2. The average RPG percentage of the recurrent parent in BC_1F_1, BC_2F_1, BC_3F_1 and BC_3F_2 was found to be 81, 90, 95 and 97% respectively. To confirm the presence of *Hsp* genes, gene expression analysis was carried out for the selected plants with high recovery of the recurrent parent. Polymorphic Hsp-linked markers were identified between the parents, F_1, BC_1F_1, BC_2F_1, BC_3F_1 and BC_3F_2 and their *Hsp* expression levels (up-regulated with more than 4-fold increase) were similar with the donor parent indicating successful introgression of the target gene. Furthermore, selected BC_3F_2 plants were evaluated for agro morphological performance which was found to be similar with the recurrent parent.

Improved high-yielding heat tolerant chilli lines showed tolerance to high temperature as well as did not express any negative effect on agronomic traits in comparison with Kulai variety. It is expected that the newly developed heat tolerant lines would increase chilli production to enhance and sustain future livelihoods and food security in Malaysia and other heat prone areas vis-a-vis climate change.

Specified Source(s) of Funding: Ministry of Higher Education, Malaysia

1:00 PM – 1:45 PM *International Ballroom East/Center*

Vegetable Crops Management 1 (Poster)

Evaluation of Vertical Grow Tower for Organic Leafy Greens Production (poster)

Dilip Nandwani*, *Tennessee State University*; Sochinwechi Nwosisi, *Tennessee State University* and Saidullah Chowdhary, *Tennessee State University (Poster Board #001)*

Abstract: Vertical tower is an aeroponic vertical standing structure that allows plant growth without chemical pesticides, herbicides or soil. Vertical towers save land, space, and water; produce no weed, pest or disease issues; and are ecofriendly. The objective of this preliminary research trial was to evaluate the yield performance of green leafy vegetables. Five crops, Mustard, Swiss Chard, Collard, Kale and Lettuce, were grown in summer 2017 at the Tennessee State University organic farm. Organic seeds were started in planting trays in an organic potting mix in a greenhouse. Transplants (3 weeks old) were transferred onto rock wool cubes (2.5 cm) in an indoor vertical grow tower, 62 inches tall in a 3 square feet unit area. A tower held up to 20 plants each in 20 evenly spaced compartments. There were four compartments for each vegetable type in each tower. The experiment was replicated in a second tower and both towers were spaced a few feet from each other. Water and nutrient solution were administered to the plants using an inbuilt pump within the tower system. Vegetables were harvested at maturity and total fresh weight per plant was recorded for each tower. The Giant Mustard produced 154.38 g, the Pink Russian Swiss Chard yielded 141.50 g, Georgia Collard yielded 132.50 g while the Lacinto Kale and Parris Island Romaine Lettuce produced yields of up to 110.63 g and 96.88 g respectively. The preliminary trial confirms that the vertical grow tower can serve as a viable alternative to growing vegetables horizontally on land as it uses less space and increases number of vegetables produced per unit area, due to the higher number of plants obtainable per growing floor area.

Specified Source(s) of Funding: Cooperative Extension

LED and Fluorescent Lighting Effects on Hydroponically Grown Hawaiian Chili Pepper (poster)

Kent Kobayashi*, *University of Hawaii at Manoa* and Teresita Amore, *Tropical Plant and Soil Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa (Poster Board #002)*

Abstract: Food safety, environmental impact, and efficient energy usage are growing concerns in horticultural production systems. Producing chili pepper under artificial lighting could be a solution addressing these concerns. Light-emitting diodes (LED) offer the advantages of a narrow light spectrum, low power consumption, and little heat production. The objective of this study was to compare the effects of LED and fluorescent light on the growth of young Hawaiian chili pepper plants in a noncirculating hydroponic system. Chili pepper (Capsicum fruitescens 'Hawaiian') seeds were started in Oasis cubes under T5 high output fluorescent lighting in the lab. Seedlings were then transferred to 5.1-cm net pots, which were placed in 1.9-liter containers containing a hydroponic nutrient solution of Hydro-Gardens' Chem-Gro lettuce formula 8-15-36 hydroponic fertilizer with added calcium nitrate (19% Ca and 15.5% N) and magnesium sulfate (9.8% Mg and 12.9% SO_4). Half of the seedlings were grown under red+blue+white LEDs (110 µmol/m^2/s, 12-hr photoperiod) and half under T5 high output fluorescent lighting (111 µmol/m^2/s, 12-h photoperiod). At the end of the study, differences among treatments were significant for plant height and stem diameter. Fluorescent lighting resulted in greater plant height, whereas LED lighting resulted in greater stem diameter. There were no significant differences among treatments for leaf chlorophyll content, leaf dry weight, stem dry weight, root dry weight, total plant dry weight, percent dry weight partitioned to the leaves, percent dry weight partitioned to the stems, percent dry weight partitioned to the roots, and shoot-root ratio. In conclusion, LED lighting could be an alternative to fluorescent lighting for young Hawaiian chili pepper plants.

Specified Source(s) of Funding: Hatch

Does Fruit Cluster Pruning Improve the Yield and Quality of Organic High Tunnel Tomatoes? (poster)

Brian A. Mitchell*, *Colorado State University* and Mark Uchanski, *Colorado State University (Poster Board #003)*

Abstract: The successful production of high-quality, high-yielding crops is important for fruit and vegetable producers, especially growers who use high tunnels. The valuable space within a high tunnel is well-suited to organic farming and can be used to grow many specialty crops. Fruit load management is practiced in tree fruit production (e.g. apples and peaches), but there is little consensus concerning the effectiveness of fruit cluster pruning on tomato (*Solanum lycopersicum*) when considering its impact on yield, quality, and marketability. There is also no research on tomato cluster pruning within organic systems, intensively-managed high tunnels (e.g. densely-planted, trellised, vegetatively pruned plants), or the Front Range of Colorado. The objective of this research was to address and add to the present knowledge of production techniques for cultivating indeterminate tomatoes in a high tunnel under organic management. In 2016 and 2017, a randomized complete block design was used to test the effects of cluster pruning within a high tunnel on certified organic land at Colorado State University's Agricultural Research, Development, and Education Center (ARDEC) South. Two treatments and three cultivars of tomato were selected for the study; the treatment-cultivar combinations were replicated six times within a high tunnel. The treatments involved reducing fruit loads to three fruits and six fruits per cluster while plants with unpruned clusters, which developed up to ten fruits, served as the control. Tomato cultivars evaluated were Cherokee Purple, a widely-studied heirloom, and hybrids Jet Star and Lola. Parameters measured included total yield, individual fresh fruit weight, soluble solids content, marketable yield, and non-marketable yield. Each plant was trained to have a single leader, a useful technique allowing for high-density production. Averaged over two growing seasons, individual fresh fruit weight increased for both hybrids in the three-fruit treatment, but Cherokee Purple did not respond positively or negatively to treatments. There was no decrease in total yield between treatments and the unpruned control; however, cultivars performed differently with Jet Star yielding more than the other two cultivars. Soluble solids content and marketability measurements were more influenced by cultivar than cluster pruning treatments. Jet Star had the highest marketable yields of all cultivars tested while Cherokee Purple produced larger non-marketable yields. In summary, cluster pruning produced larger organic tomatoes without reducing yield or quality for two of the three cultivars used in the study. Cultivar selection remains one of the largest factors in determining yield, quality, and marketability of a crop.

Specified Source(s) of Funding: Colorado State University Department of Horticulture and Landscape Architecture; CSU Agricultural Experiment Station

Effects of Grafting with Estamino and Multifort on Yield and Plant Growth Parameters of Tycoon and Tamu Hot Tomato (Lycopersicon esculentum) Under Field Conditions (poster)

Joseph Masabni*, *Texas A&M AgriLife Research & Extension Center*; Daniel Leskovar, *Texas A&M AgriLife Research & Extension Center, Texas A&M University*; Desire Djidonou, *Texas A&M AgriLife Reserach, Texas A&M University* and Kevin Crosby, *Texas A&M University (Poster Board #004)*

Abstract: An experiment was carried out in Overton, TX in spring 2017 to test the effects of commercial tomato rootstocks on growth and yield performance of determinate tomato (*Lycopersicon esculentum*) varieties. The Overton trial was part of an internal statewide grant funded by Texas A&M AgriLife Research (led by Dr. Daniel Leskovar) with trials conducted in 4 locations in Texas. to understand regional performances that would benefit all Texas producers. Results in this poster reflect only the field trial conducted at Overton on Kirvin fine sandy loam soil. The experiment consisted of two scions (TAMU Hot and Tycoon) grafted on two rootstocks (Estamino and Multifort) with non-grafted scions as controls for a total of 6 treatment combinations. The experimental design was a RCBD with 4 replications and eight plants per treatment - replication with a total of 196 plants. Transplanting was conducted on 21 March and the trial was terminated on 11 July after 6 harvests. A fertilization program by Vital Fertilizer Co. was adopted. Pest and disease control followed local recommendations by Texas A&M. Data collected consisted of: number of fruits per plant, marketable and total yields, and final shoot dry weight and leaf area. Results indicated that grafting significantly increased total and marketable yields, and total and marketable number of fruits per plant for Tycoon, but not for TAMU Hot. Marketable yield ranged from 54.1 for non-grafted Tycoon to 81.4 Mg/ha for Tycoon-Estamino combination. No significant differences in average fruit weight were observed between grafted and non-grafted Tycoon plants, while that of Multifort rootstock was significantly higher than non-grafted TAMU Hot. There were no statistical differences in fruit or shoot dry weights among all treatments. Leaf area was highest with Tycoon-Multifort combination and lowest with TAMU Hot non-grafted, with no significant differences among other treatments.

Performance of Seedling Grafted Tomato Plants Grown in Northern Climate (poster)

Suman Parajuli*, *North Dakota State University* and Chiwon W. Lee, *North Dakota State University (Poster Board #005)*

Abstract: Influence of tomato seedling grafting on the growth, fruit yield and quality, and plant health was investigated using 3 cultivars (Big Beef, Celebrity, Cannonball) as scions and two rootstock cultivars (Blocking, Maxifort). Plants of most graft combinations outperformed non-grafted plants in terms of plant size, number and quality of fruits harvested, and general foliage health. The number of days required for first flowering was significantly delayed in grafted plants of Cannonball/Maxifort (60 days) and Celebrity/Maxifort (61 days) compared to non-grafted Cannonball (57 days) and Celebrity (54 days) plants. Similarly, the days to fruit maturity for Cannonball/Maxifort (95 days) and Celebrity/Maxifort (92 days) were significantly greater than their non-grafted counter parts Cannonball (84 days) and Celebrity (86 days). The yield, average weight of fruits and number of fruits per plant in Big Beef/Maxifort (10.4 kg per plant, 0.5 kg/fruit, and 33 fruits/plant) were significantly higher than the non-grafted Big Beef (2.3 kg per plant, 0.2 kg/fruit, and 9.4 fruits/plant). Grafted plants were taller than non-grafted plants as shown by Big Beef/Maxifort (137 cm) and Big Beef/Blocking (127 cm) as compared to Big Beef (94.8 cm). The number of fruits per plant in grafted plants (33 fruits in Big Beef/Maxifort, 23 fruits in Big Beef/Blocking) was greater than that in non-grafted plants (10 fruits in Big Beef). In general, fruits harvested from grafted plants had slightly higher sugar contents (as determined by Brix reading) and greater firmness (as determined by a hand-held penetrometer). All grafted plants had healthier foliage with less blemishes compared to non-grafted plants. However, there was no statistical differences in the size and diameter of individual fruits and fruit tissue pH between grafted and non-grafted plants.

Specified Source(s) of Funding: NDDA Specialty Crop Block Grant

Effects of Phosphorus Nutrition on the Anthocyanin Concentration and Foliar Coloration of *Lactuca sativa* (poster)

Josh Henry*, *North Carolina State University*; Penelope Perkins-Veazie, *North Carolina State University*; Ingram McCall, *North Carolina State University* and Brian Whipker, *North Carolina State University (Poster Board #006)*

Abstract: Phosphorus (P) nutrition in plants can influence foliar coloration, typically due to increased concentrations of pigments such as anthocyanins. The foliar coloration of edible crops can affect their aesthetic appeal, perceived health benefits, and overall marketability to consumers. We conducted this study to record the effects of P fertilization on the leaf color, chlorophyll content, and anthocyanin concentration in 'Salanova® Red Butter' lettuce (*Lactuca sativa* L.). At the beginning of the first experiment, we fertilized the lettuce with P concentrations of 0, 2.5, 5, 10, and 20 $mg{\cdot}L^{-1}$ P. After three weeks, half of the plants from each non-zero concentration were restricted to 0 $mg{\cdot}L^{-1}$ P. We took biweekly measurements of height, diameter, and chlorophyll content, and a final determination of anthocyanin concentrations. Plants grown with low or no P for the duration of the study were dark purple in coloration with high concentrations of anthocyanins. However, these plants were extremely stunted and had developed severe necrosis on the lower leaves. Plants grown initially with 2.5–10 $mg{\cdot}L^{-1}$ P but were later restricted to 0 $mg{\cdot}L^{-1}$ P also developed necrosis on the lower foliage. Lettuce grown with 20 $mg{\cdot}L^{-1}$ P for the duration of the study were greener in coloration, but were also the largest. Based on these results, we conducted a second experiment in which we used nine total treatments of 2.5, 20, and 40 $mg{\cdot}L^{-1}$ P for the duration of the study, and 20 or 40 $mg{\cdot}L^{-1}$ P restricted to 2.5 $mg{\cdot}L^{-1}$ P after 3, 4, and 5 weeks. Regression demonstrated trends in plant size, weight, chlorophyll content, and anthocyanin concentration in response to P nutrition. Commercial lettuce growers can manipulate P fertilization in order to enhance the red pigmentation of 'Salanova® Red Butter' lettuce, but this may come at the cost of decreased fresh weight and deficiency symptoms if nutrition is not monitored sufficiently. Growers implementing this fertilization strategy should use ≥20 $mg{\cdot}L^{-1}$ P during the first half of production, and then lower the P fertility 3 weeks before harvest. Further refinement and cultivar trialing is necessary to improve fertility recommendations for red lettuce.

Specified Source(s) of Funding: American Floral Endowment Altman Family Scholarship and The Garden Club of America

Effect of Spectral Quality of Light on Growth and Accumulation of Phytochemicals in Lettuce (poster)

Myungjin Lee*, *Kansas State University*; Samuel Sumpter, *Kansas State University*; Jingwen Xu, *Kansas State University*; Eleni Pliakoni, *Kansas State University*; Cary Rivard, *Kansas State University*; Weiqun Wang, *Kansas State University* and C.B. Rajashekar, *Kansas State University (Poster Board #007)*

Abstract: Quality of light plays an important role not only in photosynthesis and plant morphogenesis but also in the accumulation of many health-promoting phytochemicals. In this study, we investigate the effect of blue, red and far-red spectra on the growth characteristics and the phytochemical accumulation in lettuce (*Lactuca sativa* L. green-leaf variety 'Two Star' and red-leaf variety 'New Red Leaf') using light emitting diodes (LEDs). Seedlings were grown in Metro-Mix 360 in a growth chamber equipped with fluorescent lighting (PPFD 288 $\mu mol.m^{-2}.s^{-1}$) at 22°C and 12 h photoperiod. Two-week old seedlings were treated with supplemental LEDs until harvest in a growth chamber at 22°C and 12 h photoperiod. Control plants were grown with fluorescent lighting (274 $\mu mol.m^{-2}.s^{-1}$) as described above. Supplemental lighting generally produced better growth in both green and red-leaf varieties, however, the largest increase in the accumulation of biomass and plant height was in plants exposed to supplemental far-red LEDs. In red-leaf lettuce, red LEDs increased the accumulation of many phenolic acids and flavonoids while far-red light appeared to have a negative effect on the content of these phytochemicals. Significant increase in the accumulation of phenolic acids namely, caffeic acid and chicoric acid, and flavonoids such as luteolin, rutin and kaempferol occurred in red-leaf lettuce under supplemental red light while conversely, far-red light reduced the content of these phytochemicals compared to the control. For example, the caffeic acid content in 'New Red Fire' increased by 13-fold under supplemental red light while it decreased to less than 30% of the control value under far-red light. In the case of green-leaf lettuce, blue light had a positive impact on the accumulation of health-promoting phytochemicals. Levels of phenolic acids such as chlorogenic acid and chicoric acid, and flavonoids such as rutin, apigenin and kaempferol increased significantly under blue light. The largest increase was in the level of rutin which was approximately 20 times higher than that in the control. The results show that supplemental lighting and its spectral quality have a significant effect on the growth and the phytochemical content of lettuce and the response, however, varied depending on the variety.

Specified Source(s) of Funding: USDA-NIFA

Supplemental UV Affects Plant Growth and Nutritional Quality of Lettuce, Spinach and Tomato (poster)

Myungjin Lee*, *Kansas State University*; Samuel Sumpter, *Kansas State University*; Eleni Pliakoni, *Kansas State University*; Cary Rivard, *Kansas State University* and C.B. Rajashekar, *Kansas State University* *(Poster Board #008)*

Abstract: A greenhouse study was conducted to examine the effects of supplemental ultraviolet light (UV-A and UV-B) on the nutritional quality of lettuce (*Lactuca* sativa L. 'New Red Fire' and 'Two star'), spinach (*Spinacia oleracea* 'Bloomsdale') and tomato (*Solanum lycopersicum* L. 'BHN-589 F1'). Three-week old plants were transferred to a greenhouse and grown under full sun with supplemental UV light. The plants were exposed to UV just prior to harvest and nutritional quality was determined by mineral nutrient composition and phytochemical content in edible parts of the plants. The plants were subjected to UV treatment consisting of UV-A (8.11 W/m^2), UV-B (1.97 W/m^2), UV-A+UV-B (5.08+1.55 W/m^2) for various lengths of time. Supplemental UV did not affect the biomass accumulation, leaf area or the leaf-shape index in green-leaf lettuce (Two Star). However in red-leaf variety (New Red Fire), UV-B and UV-A+UV-B suppressed leaf area, but not the biomass accumulation compared to UV-A treatment and the control. In addition, the total phenolic content and antioxidant capacity in red-leaf variety were significantly higher under UV-A compared to the control, although there were no significant differences in green-leaf variety. UV increased the leaf concentration of Ca and Mg in both varieties of lettuce, and N only in green-leaf variety. Similar response was observed in spinach where UV increased Ca, Mg and N levels along with P, S and Cu. However, no significant increase in phytochemical content was observed. While N content of green-leaf varieties (in both leafy vegetables) increased there was a significant decrease in carbon accumulation in response to UV exposure. With regard to tomato fruits, UV exposure did not significantly affect the fruit yield or the total phenolic content. The results show that the UV effect on growth and nutritional quality among leafy vegetables is quite variable, and thus, further analyses with regard individual phenolic and carotenoid compounds are being conducted.

Specified Source(s) of Funding: USDA-NIFA

Passive Diurnal Temperature Manipulation Effects on the Growth, Pigmentation, and Consumer Response to Spring and Fall High Tunnel-Grown Red Lettuce (*Lactuca sativa)* (poster)

Dana Hilfinger*, *The Ohio State University*; Matthew Kleinhenz, *The Ohio State University-OARDC*; Joseph C. Scheerens, *The Ohio State University-OARDC* and Chieri Kubota, *The Ohio State University* *(Poster Board #009)*

Abstract: Detailed study in highly controlled environments featuring active temperature maintenance and supplemental lighting has helped explain the influence of light and temperature on lettuce primary productivity and secondary metabolite levels. However, crop responses in moderately and passively manipulated environments important to a large and increasing number of growers are less clear. Responses by high tunnel-grown baby red lettuce experiencing diurnal temperature fluctuations modified by day and/or night aerial coverings during the dynamic spring and fall periods are particularly under-investigated. In this study, twenty 4.47-m^2 wood-framed beds containing a soil-based medium within a 9.1 m x 24.4 m single-layer high tunnel at The OSU-OARDC in Wooster, OH, were seeded with '*Outredgeous*' lettuce (*Lactuca sativa*) on October 27, 2017, and February 20, 2018. Each bed contained 14 rows (1.2 g seed/row) spaced 7 cm apart. One week after seeding, beds were assigned to one of four treatments (high day/high night - H/H, high day/ambient night - H/A, ambient day/high night - A/H, and ambient day/ambient night - A/A) arranged in a randomized complete block design with five replications. "High" daytime temperatures were achieved by covering beds with vented 0.1524-mm thick polyethylene film, while "high" nighttime temperatures were achieved by covering beds with 50-AG Agribon fabric, both supported by standard low tunnel hoops. Thus, individual beds were either uncovered or covered with film during the day (approx. 08:00 – 17:00; all treatments) and either uncovered (A/A) or covered with film (H/A), fabric (A/H) or both materials (H/H) during the night. Canopy temperature was recorded every 15 minutes in all beds using HOBO U23-Pro Data Loggers throughout the seven weeks of each experimental run, with spontaneous readings of canopy light intensity (PAR) taken eight times over the experimental period. All vegetative tissue 1 cm above the soil line was removed from a 0.25-m^2 area/bed four weeks after seeding and a 0.18-m^2 area/bed seven weeks after seeding for measures of fresh and dry weight, total soluble solids (ºBrix), leaf area and total anthocyanin concentration (Week 7 only). Samples were also included in sensory panel evaluation (discrimination tests based on color only) beginning in Spring-2018. The experiment will be repeated in Fall-2018 and Spring-2019. Differential day- and nighttime coverings resulted in treatment differences in diurnal temperature profiles in Fall 2017. Preliminary analysis indicates a significant positive relationship between day and night temperatures and Week 7 sample fresh weight (g), dry weight (g) and leaf area (cm^2).

Specified Source(s) of Funding: The Ohio State University Fellowship

Evaluation of Head Lettuce (*Lactuca sativa* L.) and Leafy Greens for Year-Round Institution Markets in West Virginia (poster)

Lewis Jett*, *West Virginia University* *(Poster Board #010)*

Abstract: Lettuce (*Lactuca sativa* L.) is a leafy green vegetable which can be grown year-round in high tunnels in West Virginia. The summer growing season at higher elevation areas provides a suitable microclimate for warm season head lettuce production. The high tunnel also provides sufficient low temperature protection during the winter for extended season production. Like many U.S. states, there has been a tremendous expansion of high tunnel production of specialty crops within the last ten years. These same high tunnels provide tremendous capacity for wholesale marketing of lettuces and other leafy greens to institutional buyers such as schools and hospitals. From 2014-2018 approximately 70 lettuce and other leafy green cultivars have been critically evaluated for stress tolerance, quality, shelf life, disease tolerance and marketable yield within high tunnels. From these evaluations, select cultivars for year-round production have been identified.

Specified Source(s) of Funding: SARE

Extending Tomato Production Season in South Texas Using Protected Structures (poster)

Carlos A. Avila*, *Texas A&M AgriLife Research*; Thiago Marconi, *Texas A&M AgriLife Research*; Juan Enciso, *Texas A&M AgriLife Research*; Ismael Badillo, *Texas A&M AgriLife Research* and Kevin Crosby, *Texas A&M University (Poster Board #011)*

Abstract: The Lower Rio Grande Valley in Texas is one of the most productive vegetable areas in the State. However, environmental conditions limit production to Spring and early Fall seasons when temperatures allow open field production. Furthermore, open field production is severely affected by strong winds, and high pressure of endemic/new insects and diseases. Protected structures such as high-tunnels offer an alternative to extend production season. High tunnels or hoop houses are relatively low investment structures that protect crops from the weather and pests. In order to determine the feasibility of production under high tunnels, two determinate and three indeterminate tomato cultivars including commercial available and Texas A&M developed hybrids were evaluated at two planting dates (October and November). Harvesting started in late December and was extended to the middle of June. October planting resulted in higher yields (56,104 kg/ha) and overall higher tomato total soluble solids (brix 4.16%) as compared to November planting (36,869 kg/ha and Brix 3.76%, respectively). It is hypothesized that early seedling establishment when temperatures were higher contributed to observed yield and quality parameters differences between planting dates. Determinate cultivar tomato yields were higher as compared to indeterminate cultivars during first planting date but were lower during second planting. Observed differences between growing habit cultivars may have been in response to cold temperature resistance of indeterminate tomatoes, and to better light capture due to pruning during winter months. Finally, tomato taste panel was performed to determinate consumer preference. Blind samples including a supermarket tomato control were offered to participants. Overall, high-tunnel tomatoes were preferred as compared to supermarket control. Texas A&M cultivar TAM “Hot Ty” had the highest levels of consume rating in terms of flavor and color. In summary, our results indicate that winter production in high tunnels is feasible in South Texas resulting in good yields and quality.

Specified Source(s) of Funding: Texas A&M AgriLife Vegetable Seed Grant and Texas Department of Agriculture-Specialty Block Crop Grant

Yield Decrease with Delayed Fall Planting of Kale, Lettuce, and Spinach in High Tunnels (poster)

Elizabeth T. Maynard*, *Purdue University*; Erin A. Bluhm, *Purdue University*; Analena Bruce, *Indiana University* and James A. Farmer, *Indiana University (Poster Board #012)*

Abstract: Fall-planted leafy greens are important crops for producers who harvest from high tunnels in late fall and winter. A survey of Indiana high tunnel producers identified planting schedules as an area in which more information is needed. We conducted trials to quantify the effect of planting date on yield of kale (*Brassica oleracea* var *acephala* DC), lettuce (*Lactuca sativa* L.), and spinach (*Spinacia oleracea* L.) grown in soil in unheated high tunnels at Wanatah, IN. 'Darkibor' kale was transplanted and 'Gazelle' spinach was seeded in tunnels on six dates at two-week intervals beginning 30 Aug. and ending 11 Nov. 2016. 'Salanova Red' and 'Green Reef' lettuce were transplanted in tunnels on 30 Aug., 15 Sept., and 14 Oct. Each tunnel was 914 X 1463 m and had three replications of each planting date for each crop. Kale leaves with blades at least 20 cm long were harvested approximately biweekly from 27 Sept. through 14 Mar. 2017. Cumulative kale yield was 7.47 kg•plot^{-1} (1.11 m^2) for the 30 Aug. planting, and 4.99, 2.08, 0.32, 0, and 0 kg•plot^{-1} for subsequent planting dates. Days to first harvest from transplanting were 28, 26, 42, and 98 for the first four planting dates, respectively. Spinach leaves with blades at least 7 cm long were harvested from 0.372 m^2 in each plot weekly from 28 Sept. through 16 Nov. and then biweekly through 16 Mar. 2017. Cumulative spinach yield was 1.92 kg•plot^{-1} for the 31 Aug. seeding and 1.49, 1.06, 0.73, 0.18, and 0.17 kg•plot^{-1} for the subsequent planting dates. Days to first harvest from planting were 28, 28, 36, 48, 120, and 126 for the six planting dates, respectively. A single lettuce head of each variety was harvested from each plot biweekly once most heads for that planting date were 15 cm across. Harvest began 29 Sept. and 6 Oct. for the first and second plantings, respectively, and ended 13 Dec., after which heads were not marketable. The 14 Oct. planting was harvested from 1 Dec. through 18 Apr. 2017. Cumulative yield per m^2 of harvested area was 4.04, 4.94, and 1.91 kg for 'Green Reef', and 3.63, 2.95, and 2.53 kg for 'Salanova Red', for the Aug., Sept. and Oct. plantings, respectively. These results contribute to available information on planting date and yield in high tunnels that will help producers plan crop schedules to optimize their production systems.

Specified Source(s) of Funding: USDA

Organic Sweetpotato Slip Yield and Quality from a Central United States High Tunnel System (poster)

Zachary N. Hoppenstedt*, *Kansas State University*; Jason Griffin, *Kansas State University*; Cary L. Rivard, *Kansas State University*; Eleni Pliakoni, *Kansas State University* and Mykel R. Taylor, *Kansas State University (Poster Board #013)*

Abstract: Sweetpotatoes (*Ipomoea batatas*) are nutritious, easily stored and well-adapted to fit large or small organic farming operations. This widely consumed root crop is propagated through use of cuttings, known as slips, which are grown primarily in the Southeastern United States. Consequently, growers in the Central U.S. have limited control of and access to local planting material. Production of organic slips in high tunnels could be a profitable enterprise for growers in the Central U.S. that would allow them to diversify their operation and encourage the use of crop rotations in high tunnels. Our study evaluated the yield and performance of slips grown in high tunnels as compared to the open-field. Similar trials were conducted in 2017 at two research stations in Northeast and South Central Kansas. We utilized a randomized complete block design for all trials, with at least 4 replications per treatment. Slip beds of ‘Orleans’ sweetpotato were established in high tunnels (HT) and open-field (OF) under identical cultural methods and planting schedule. Seed roots were planted at three planting densities (45, 65, and 85 seed roots/m2) in both the HT and OF. Slips were harvested from HT and OF plots and transplanted to field plots to investigate the impact of slip origin (HT vs. OF) on root crop production. At both locations, marketable slip yields (slips/m2) from the first harvest were similar in HT and OF plots. There was also no change in slip yield from increasing planting densities. However, slips from the first harvest at the South Central location only, planted at 65 roots/m2 were shorter, had greater stem diameter, and had more nodes per length of stem than the other planting densities. Slips grown in HT at the Northeast location were 12% less compact (slip dry wt/cm length) then their OF counterparts. Total marketable sweetpotato yield was not influenced by HT or OF treatments (1.7 and 2.1 lbs/plant, respectively). Similarly, the number of marketable roots was not affected by the HT or OF treatments (3.4 and 3.8 roots/plant, respectively). More research is needed to evaluate the feasibility of sweetpotato slips grown in high tunnel systems and to determine recommendations for seed root planting densities. However, the results of this study suggest that organic sweetpotato slip production could add to diversity in high tunnel systems. Moreover, local slip production might further promote the adoption of an underutilized vegetable crop that can be grown throughout the region.

Specified Source(s) of Funding: NCR SARE

Evaluation of Lettuce Cultivars for Hydroponic Culture (poster)

Chiwon W. Lee*, *North Dakota State University*; Casey McCollum, *North Dakota State University*; Jae-Bom Ohm, *USDA-ARS, Red River Valley Ag. Res. Center* and Tae Seok Ko, *North Dakota Stae University (Poster Board #014)*

Abstract: Lettuce (*Lactuca sativa* L.) is one of the major leafy and salad vegetables. A total of sixty-four lettuce cultivars with green or red leaves in 5 different subtypes (butterhead, crisphead, loose leaf, oakleaf, and romaine) were evaluated for hydroponic culture using the NFT (nutrient film technique) system. Two-week old rockwool-grown seedlings were anchored 6” apart on an NFT system and grown for AN additional 4 weeks with a nutrient solution containing 200 ppm N prepared with a 20-20-20 commercial fertilizer. The lettuce crops reached marketable size within 3-4 weeks of transplanting into the hydroponic system. Performance factors evaluated for each cultivar 4 weeks after transplanting included fresh and dry weights, plant size and shape, stem diameter and length, leaf tissue pH, nitrate (NO_3^-),

calcium (Ca^{2+}), and sugar contents, and tendency for bolting, molding and leaf tip burns. The cultivars of Adriana, Four Seasons, and Red Cross in butterhead type; Simpson Elite, Green Star, Tropicana, Two Star, Red Sails, and New Red Fire in loose leaf type; 3Sx4203 in oak leaf type; Concept, Magenta, Muir, Nevada, Lettony, and Cherokee in crisphead type; Parris Island, Green Forest, Jericho, Giant Caesar, Parris White, and Outredgeous in romaine type performed well for hydroponic culture on NFT system. Four cultivars (Tango, 3Sx4102, Burpee Bibb, Arctic Crisp) were sensitive to bolting and five cultivars (Tennis Ball, Emerald Oak, 3Sx4403, 3Sx497, 3Sx3410) were identified as developing undesirable leaf tip burns. Evaluation of photosynthetic pigments (chlorophylls, carotenoids, anthocyanin), chlorophyll indices (SPAD) and photosynthetic reflectance index (PRI) associated with lettuce leaf color and type revealed that SPAD values were better indicators of leaf chlorophyll and carotenoid status and PRI values were better indicators of anthocyanin status with a more reliable differentiation between levels. Anthocyanin levels correlated negatively with PRI values. Chlorophyll and carotenoid levels in leaf tissues correlated either positively or negatively, respectively, with SPAD values. The relationship between PRI, SPAD and PSII photochemistry among different lettuce cultivars associated with their leaf color and lettuce type was characterized. Lettuce cultivars greatly varied in their performance under the NFT hydroponic culture system. Information obtained in this study may well be used by greenhouse growers in selecting lettuce cultivars suited for their production practices.

Specified Source(s) of Funding: NDDA Specialty Crop Block Grant

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1:00 PM – 1:45 PM *International Ballroom East/Center*

Viticulture and Small Fruits 1 (poster)

Assessing Secondary Bud Fruitfulness of *Vitis Vinifera* 'Grenache' and 'Cabernet Sauvignon' Vines Grown on the Texas High Plains: A Second Year Update (poster)

David Montague*, *Texas Tech University*; Edward Hellman, *Texas Tech University*; Pierre Helwi, *Texas A&M AgriLife Extension Service* and Emily Graff, *Texas Tech University (Poster Board #396)*

Abstract: In 2017, there were approximately 1,767 grape bearing hectares, and 394 wineries in the state of Texas. Within the state, the grape and wine industry had an overall economic impact of $13.1 billion. The vast majority of producing vineyards in Texas are located in regions which are subject to late spring frosts (which can severely reduce crop yield). Primary grape (*Vitis vinifera*) buds are considered less hardy, but more fruitful when compared to secondary buds. If Texas growers were more informed regarding grape cultivar secondary bud fruitfulness, secondary bud fruitfulness could possibly influence cultivar selection during vineyard planning. Therefore, objectives of this two growing season experiment were to compare growth and fruitfulness of shoots grown from primary and secondary buds of two *V. vinifera* cultivars on the Texas High Plains. *V. vinifera* 'Cabernet Sauvignon' and 'Grenache' vines on 110R rootstocks (trained to vertical shoot positioning with 2 cordons, 4 spurs / cordon, and 2 buds / spur), and planted in a randomized complete block design in 2006 were used for the experiment. Year one treatments included: primary bud remained (P), and following bud break (5 to 15 cm of new growth) primary buds removed (S). Year two treatments for 'Grenache' were repeated as in year one (PP, primary year one and year two, and SS, secondary year one and year two). Growing season two treatments for 'Cabernet Sauvignon' included PP, primary bud year one, and secondary bud year two (PS), secondary bud year one, and primary bud year two (SP), and SS. Pruning weights, gas exchange data, and fruit quality data were collected each growing season. For each cultivar, pruning data indicate P, or PP shoots had greatest vegetative growth. Gas exchange, soluble solids (ºbrix), and mean berry weight data indicate few differences between treatments. However, PP 'Cabernet Sauvignon' and 'Grenache' vines had greatest cluster weights. For 'Grenache' vines, yield was reduce 30% in SS vines. In addition, compared to PP vines, yield of 'Cabernet Sauvignon' vines was reduced 45, 55, and 66% for PS, SS, and SP vines, respectively. Future research will look to determine additional cultivar differences, vine maturity response, and economic assessments.

Specified Source(s) of Funding: State of Texas Viticulture and Enology Funding

Characterization of Leaf Trichome Features for Their Potential Role in Resistance to Foliar Phylloxera in Cold Hardy Hybrid Grapes (poster)

Lu Yin*, *University of Minnesota* and Matthew D. Clark, *University of Minnesota (Poster Board #397)*

Abstract: Phylloxera has devastated the roots of wine grapes in Europe since the 19th century. Major measures to control this pest include grafting European wine grape variety, *Vitis vinifera*, onto resistant American rootstocks and hybrid breeding. However, many hybrids such as 'Frontenac' are susceptible to the leaf-galling form of phylloxera. Limited studies have investigated foliar phylloxera, including its genetic resistance and resistance mechanisms. Antibiosis, antixenosis, and tolerance have been the classical resistance mechanisms that a plant uses to combat an insect pest. This study investigates the role of leaf trichome features (the presence, density, and type of hair on leaf) in resistance to foliar phylloxera, as a potential morphological antixenosis/non-preference mechanism. Two advanced hybrid grape breeding lines, MN1264 and MN1246, and a resulting F1 population, GE1025 (N = 125), are examined on a 0 to 5 scale for trichome density on leaf blade and vein of the adaxial and abaxial sides of the leaf, as well as on leaf edge and petiole. The type of trichome is also examined: ribbon, simple, or glandular. This population has previously been evaluated for leaf phylloxera severity and sequenced using genotype-by-sequencing with a major resistance QTL found on linkage group 14 (LG14). Preliminary results show that vein trichome density and petiole trichome density differ significantly between MN1264 and MN1246, compared with that of 'Frontenac' (susceptible) and 'Louise Swenson' (resistant) where vein, leaf, edge, and petiole trichome density differ significantly. Vein and petiole trichome type differ between MN1264 and MN1246, whereas vein, edge, and petiole trichome type differ between 'Frontenac' and 'Louise Swenson'. Trichome density and type variation do exist in GE1025. The age and the side of the leaf measured might also play a role in contributing to trichome density differences. With these preliminary pieces of information, the population of GE1025 is under the process to be characterized for leaf trichome features, the relationship of which will be analyzed with foliar phylloxera severity (phenotypic correlation and coincidence of QTL). The significance of this study is to 1) develop a protocol to characterize leaf trichome in hybrid grape populations and 2) shed light on the underlying mechanisms of genetic resistance to phylloxera, whether leaf trichome plays a role, as high-resolution genetic mapping for resistance on LG14 is underway.

Specified Source(s) of Funding: Minnesota Department of Agriculture

Defining Water Stress Thresholds for 'Edelweiss' Grapevines (poster)

Benjamin Loseke, *University of Nebraska* and Paul Read*, *University of Nebraska (Poster Board #398)*

Abstract: Irrigation is an important tool to increase grapevine vigor and fruit yield across the Midwest USA. However, with enhanced pressure on water resources, vineyards are soon likely to experience water restrictions. Growers will need relevant information about grapevine water levels in order to efficiently irrigate their vineyards. This research focused on defining water stress thresholds for 'Edelweiss' (Minnesota 78 x Ontario) grapevines using midday leaf water potential (Ψ_{md}) and high resolution thermal infrared images from two different thermal sensors. Potted grapevines were subjected to a range of water stress treatments to evaluate water content levels (Control – fully irrigated and 2 to 14 days of water being withheld). After the 14-day water withholding period, thermal images were taken of the vines using an expensive Flir S62 camera and an inexpensive Flir C2 camera. Immediately following, a mature fully-expanded leaf was excised from the plant and tested for Ψ_{md}. Fully irrigated and 14-day dry vines exhibited a Ψ_{md} of -8.7 bars and -13.3 bars, respectively. The grapevines exhibited a mild, moderate and severe water stress level at 8, 10 and 12 days-dry, respectively (Ψ_{md} of -12 bars, -12.5 bars and -13 bars). The Crop Water Stress Index (CWSI) more accurately predicted Ψ_{md} when using leaf temperature data collected by the inexpensive Flir C2 thermal camera (p = 0.016). The CWSI has been shown to be a good

indicator of vine water status in more arid growing regions, but has not been well documented in more humid climates. The CWSI calculated from the Flir C2 temperature data had moderate correlations to Ψ_{md} ($r^2 = 0.511$). Our results document the thresholds for mild, moderate and severe water stress levels for greenhouse grown potted 'Edelweiss' grapevines. Additional research and refinement is necessary in order to use the CWSI to accurately predict Ψ_{md} in humid growing regions.

Cultivar Evaluation of Strawberries in Mississippi (poster)

Tongyin Li*, *Mississippi State University* and Guihong Bi, *Mississippi State University (Poster Board #399)*

Abstract: Strawberry (*Fragaria ananassa)* is a high value crop in the US. Fresh strawberries are one of the most popular items at local markets. However, strawberry production in Mississippi is relatively small, and the high demand of strawberries in Mississippi are mainly supplied from other states. The objective of this study is to evaluate plant growth and berry yield of five June bearing cultivars ('Chandler', 'Allstar', 'Earlyglow', 'Jewel', and 'Rutgers scarlet') and two day neutral cultivars ('Evie 2' and 'Seascape'). Bare root liners of strawberry were transplanted into 2-gal containers in Feb. 2017 using pine bark: peat most: perlite in a volume ratio of 4:3:1 as growing substrate. Strawberry liners were fertilized with a slow release fertilizer Osmocote plus (15-9-12) at a rate of 20 g per container or with an organic fertilizer (5-3-4) at a rate of 60 g per container. All strawberry plants were grown outdoors on a nursery pad at Mississippi State University and irrigated as needed through drip irrigation. As for vegetative growth, there was no significant difference among strawberry cultivars in shoot or total plant dry weight. 'Earlyglow' produced the highest number of runner per plant (10.1 runners per plant), comparable to 'Allstar' (7.2 runners per plant), 'Chandler' (8.1 runners per plant), 'Jewel' (7.2 runners per plant), or 'Seascape' (6.0 runners per plant), higher than 'Evie 2' (4.4 runners per plant). As for reproductive growth, the two day neutral cultivars 'Evie 2' and 'Seascape' produced higher yield per plant than any tested June bearing cultivar, 165.7 g and 121.1 g berry per plant, respectively. 'Chandler' and 'Evie 2' produced the largest strawberry in terms of single berry weight, averaged 12.46 g and 13.16 g per berry, respectively, with 'Earlyglow' producing the smallest berry averaged 4.9 g per berry. The slow-release fertilizer Osmocote resulted in higher dry weights (root, shoot and total plant), SPAD reading, number of runner per plant, yield per plant, and single berry weight than organic fertilizer. This may have resulted from the slow nutrient releasing rate of the organic fertilizer, which did not satisfy fast growing habit of strawberries.

Yield Benefits of Recruiting Wild Pollinators in a Strawberry Agroecosystem (poster)

Nathan D Hecht*, *University of Minnesota (Poster Board #400)*

Abstract: Around 75% of global food crops benefit to some degree from animal pollination, especially many fruit crops. Given emerging threats to the honeybee industry, including colony collapse disorder, the importance of wild insect pollination services in agroecosystems has been the focus of recent research. Pollinator "farmscaping" practices, which provide habitat and floral resources that support wild insect pollinators, are being investigated for horticultural crops. However, there is relatively little research directly linking pollinator farmscaping practices to crop benefits, especially considering the wide variation in pollination requirements between crops. Strawberries (*Fragaria x ananassa*), though self-fertile, appear to produce higher quality fruit when flowers are more thoroughly fertilized by pollinating insects. Several studies have identified the benefit of additional local floral resources to pollinator populations in strawberry fields. Ensuring effective pollination services for strawberry crops may be even more beneficial in day-neutral varieties, which flower and fruit continuously throughout the growing season, as opposed to the short-day (June-bearing) cultivars commonly grown in the US Midwest. While one study showed increased pollinator abundance in strawberry rows adjacent to annual wildflower strips, there is as yet no literature examining the yield benefits of single-species flower strips in strawberry production, despite evidence that bees may benefit more from flower plantings with clumps of single species rather than heterogeneous mixtures. This research investigates the potential of an annual flower strip to enhance pollination services of wild insects in an organic day-neutral strawberry production system. Flowering borage (*Borago officinalis*) strips were established on one end of three experimental blocks, each containing four, 100 ft rows of day-neutral strawberries. Strawberry yield and pollinator presence were measured in 25 ft plot ranges and were hypothesized to decrease with distance from the flower strip. Average strawberry yield and pollinator abundance appear to decrease, with a significantly lower average berry weight in the plot farthest from the flower strip. Primary strawberry flower visitors were hoverflies (Syrphidae) and native sweat bees (Halictidae), suggesting strawberry pollination may rely more on these insects than larger pollinators like honey bees or bumble bees. This project presents further evidence on the value of pollinator farmscaping practices designed to increase on-farm functional biodiversity and support critical ecosystems services like pollination. Results can help growers and researchers better understand the relative benefits of management practices designed to recruit wild pollinators in small-fruit operations.

Evaluation of Selected Pre-Plant Herbicides for the Enhancement of Strawberry Production Practices in Central Alabama (poster)

Edgar L. Vinson*, *Auburn University*; Elina Coneva, *Auburn University*; James Pitts, *AAES*; J. Raymond Kessler, *Auburn University* and Steve Li, *Auburn University (Poster Board #401)*

Abstract: Sustainable production of strawberries (Fragaria x ananassa) is challenged in Alabama due partly to the relatively restricted arsenal of effective chemistries for pest control. The objective of this study was to evaluate the effectiveness of pre-plant herbicides (four labeled for use and one not labeled for use) in strawberry production in order to develop recommendation for growers. A study was established at the Chilton Research and Extension Center (CREC) in Clanton, AL on a fine sandy loam. Planting rows were prepared and herbicide treatments applied on 4 Oct. 2016. Rows were set on 1.8 m centers. Black plastic and drip irrigation were installed. Plants were set in double rows within a plot (0.9 m x 6 m) at a spacing of 35 cm. Pre-plant herbicides applied were bicyclopyrone (not labeled for use in strawberries) at a rate of (123 g ha^{-1}), Blazer Ultra (0.3 L • ha^{-1}), Devrinol (1.5 L • ha^{-1}), Sinbar (17 L • ha^{-1}), and Spartan 4F (0.5 L • ha^{-1}). An untreated control plots were included. Plugs of 'Camarosa' strawberry plants were planted on October 17, 2017. Treatments were planted according to a randomized complete block design with four replications. An analysis of variance was performed on all responses using PROC GLIMMIX in SAS version 9.4 (SAS Institute, Cary, NC). Early and total season marketable yield per plot and individual berry weight were analyzed using the normal probability distribution. Percent weed cover of plots treated with Devrinol (18 %) was similar to the untreated control. Bicyclopyrone (12 %), Spartan 4F (10.5%) and Sinbar (9.7 %) were similar in weed cover but had a lower percentage of weeds than all other treatments. Early season yields were highest in plots treated with Sinbar (941 g/plot). Other herbicide treatments produced early season yields similar to the untreated control. Total season yield of Sinbar (1,126 g/plant) was similar to Spartan 4F (986 g/plot), Devrinol (1,041 g/plot), and Blazer Ultra (1,053 g/plot). Plots treated with Sinbar produced total season yields that were higher than the untreated control plots (872 g/plot). Individual berry weight from plots treated with Sinbar were numerically higher than all other treatments but there were no significant differences found among treatments. Cull weight of plots treated with Sinbar (353 g/plot) differed significantly from those treated with Devrinol (270 g/plot) and byclopyrone (216 g/plot) but similar to all other herbicide treatments and the untreated control. Total season cull weight was similar among all treatments with the exception of bicyclopyrone, which was statistically lower than all other treatments. Bicyclopyrone was also effective in controlling weeds; however, it is not labeled for use in strawberries and strawberry plants in plots treated with bicyclopyrone were stunted and chlorotic. Sinbar and Spartan 4F were among the most effective in controlling weeds. Sinbar was effective in encouraging the production of the highest yields during the early and late seasons.

Specified Source(s) of Funding: Alabama Nut, Fruit, and Vegetable Industries Minigrant

1:30 PM – 2:30 PM *Jay (Lobby Level)*

Partnership Development & Sponsorship Committee

Chair: Jeff Norrie, *Acadian Seaplants Limited*

Members: Terry Burke, *N/A*; Joshua Gerovac, *Purdue University*; Larry Knerr, *Tanimura & Antle*; Brian Krug, *DuPont Pioneer*; Peter Petracek, *Valent BioSciences Corp*; Daniel Leskovar, *Texas A&M AgriLife Research & Extension Center, Texas A&M University*; Steven Sargent, *University of Florida* and Mark Uchanski, *Colorado State University*

1:45 PM – 2:30 PM

Keynote Address: Dr. Richard Olsen

International Ballroom West

1:45 PM Plant Diversity: the Leitmotif of Botanical Collections

Richard T. Olsen*, *USDA-ARS, U.S. National Arboretum*

Abstract: Plant diversity, whether for conservational or aesthetic value, is the recurring theme in public gardens that connects our displays, research, and visitor experiences to our missions. While the domestication of crop species has significantly altered their genomes from that of their wild crop relatives, the majority of horticultural crops are not that far removed from their wild relatives. Thus, we still explore, document, and cultivate the untapped diversity in the world's temperate floras to enrich our gardens. Since 1927, the United States National Arboretum has been a leader in germplasm collection and utilization. What legacies remain from early plant explorations? How do we document and capture diversity? Where do we go from here, in a century that will see so much lost to globalization?

2:15 PM – 3:45 PM *Georgetown West*

Organic Horticulture and Eorganic.

Moderator: Alexandra Stone, *Oregon State University*

Objectives:

Communicate Eorganic's Mission, Content Types, and Reach. Showcase Student Research in Organic Horticultural Systems. F

2:15 PM Eorganic: Integrating Research-, Experience- and Regulation-Based Information. 15 Minutes

Alexandra Stone*, *Oregon State University* and Alice Formiga, *Oregon State University and eOrganic*

Abstract: Since the establishment of the Organic Foods Production Act in 1990 there has been an urgent need for science-based information on organic agriculture. eOrganic is the Organic Agriculture Community of Practice at eXtension.org (eXtension.org/organic_production). Launched in 2009, eOrganic's mission is to provide science-, experience- and regulation-based information on organic agriculture to farmers, agricultural professionals, researchers, students, and others. In addition to publishing general information about certified organic farming, eOrganic has partnered with 62 federally-funded organic farming research/outreach projects (NIFA OREI and ORG, Beginning Farmer and Rancher, Risk Management, SARE) in an effort to expand their national and global reach and impact. Over 300 contributors have delivered articles (*http://articles.extension.org/pages/64401*), videos (*https://www.youtube.com/watch?v=uxHs2eM7YzY*), webinars (*http://articles.extension.org/pages/72567*) , and websites (*http://eorganic.info/cornbreeding*), and many more have presented at conferences/symposia (*http://articles.extension.org/pages/33545*) archived by eOrganic. eOrganic has published updates and findings from over 260 organic research projects on critical topics for organic farmers. All eOrganic articles undergo National Organic Program compliance review in addition to eOrganic's peer-refereed review process. eOrganic has hosted over 175 webinars which have been attended by over 20,000 people and the eOrganic newsletter reaches approximately 12,000. The eOrganic YouTube channel currently hosts 645 videos, archived webinars and conference recordings, and this content has attracted more than 7000 subscribers and 2.8 million views. eOrganic was initiated with a grant from NIFA OREI but is currently funded only by subawards and fees in research grants. To find out more or get involved, visit *https://eorganic.info*, where you can sign up for the eOrganic newsletter, find out how to include eOrganic in your next grant proposal, or learn what is required to publish an eOrganic article.

Specified Source(s) of Funding: NIFA OREI, ORG, Beginning Farmer and Rancher, Risk Management Agency, WSARE

2:30 PM Comparing Solarization and Tarping for Weed Management in the Northeast USA 15 Minutes

Sonja Birthisel* and Eric Gallandt, *University of Maine*

Abstract: Mulching prepared beds with polyethylene sheets for several weeks before planting can create a 'stale seedbed,' reducing weed pressure in a subsequent crop. When clear plastic is used, this practice is called solarization; when black plastic is used, it is known as tarping. Though solarization and tarping have been studied and employed for pest control in warmer regions since the late 1970s, their application to weed management in the Northeast USA is new. We conducted three site-years of field experiments near Orono, ME comparing the efficacy of solarization and tarping for stale seedbed establishment. Solarization and tarping applied for 7 weeks in April-May of 2016 both created excellent stale seedbeds: two weeks after plastic removal, there was zero weed emergence in treatment plots, but significant weed emergence in check plots. Subsequent experimental site-years compared solarization and tarping applied for 2 weeks, 4 weeks, and 6 weeks during the summers of 2016 and 2017. Results were inconsistent between years: across treatment durations, 85% fewer weeds emerged following solarization as compared with tarping during the 2016 season, but in 2017, 94% more weeds emerged following solarization as compared with tarping. Factors that may have contributed to this discrepancy between years include soil moisture conditions and weed species. Notably, *Portulaca oleracea* (purslane) was abundant in the 2017 field site, comprising 45% of total weeds emergence in check plots, but a disproportionate 84% of weeds emerging in solarization treatments. This heat-tolerant species was not observed in our 2016 field site. In both years, solarization resulted in higher soil temperatures than did tarping. Solarization efficacy increased with treatment duration, but tarping efficacy was not consistently related to treatment duration. Soil biological activity was measured in 2016 only, and was not affected by treatment while mulch was in place. However, two weeks after plastic removal, soil biological activity was suppressed 18% following tarping and 43% following solarization in comparison with the check, suggesting that these practices can impact soil microbial communities. Overall, our results suggest that the relative efficacy of solarization and tarping for weed control in the Northeast USA may be context dependent.

Specified Source(s) of Funding: Maine Agricultural Center and University of Maine EPSCoR

2:45 PM How to Use Paper Bags to Protect Organic Peaches from Insects and Diseases in the Southeastern United States 15 Minutes

David Campbell*[1]; Danielle Dion Treadwell[1]; Juan Carlos Melgar[2] and Dario J. Chavez[3], *(1)University of Florida, (2)Clemson University, (3)University of Georgia*

Abstract:

Within the organic fruit industry, peaches have experienced the largest increase in organic fruit acreage in the United States, but most of that acreage has increased in the west (Perez and Plattner, 2013). California, Washington, and Oregon currently supply the majority of domestic organic fresh market peaches (Hallberg, 2016). Peach producers in the southeast market fruit up to two months before west coast producers due to earlier warm temperatures and a later frost freeze damage potential. Producers select varieties that will set fruit when chill hour requirements are met (ranging from less to 100 to over 700), and can be harvested from late April through July to meet market demands.

Organic peach production in the southeast has been difficult due to the prevalence of insect and disease pests, as well as the lack of effective organically-approved pesticides (Horton et al, 2005; Blaauw et al., 2017). In addition, many of the compliant, commercially-available pesticides contain copper and other

ingredients that may negatively impact soil health with overuse (NOSB, 2017). Organic fruit producers in the US, Spain, Japan and China have been installing paper bags to provide a physical barrier from both pests and pathogens and have been able to increase fruit quality and increase yield (Sharma et al., 2014), but bagging peaches in the US is an emerging approach. In a pilot study funded by the Southern IPM Center, J. Melgar, and G. Schnabel from Clemson University demonstrated that bagging peach fruit can reduce fruit damage from pests and diseases, increase yield, and increase quality with an estimated net cost of ten to fifteen cents a pound (Hallberg, 2016).

Pests and diseases can affect fruit quality throughout the entire growing season through postharvest. For example, the insect pests green stinkbug (*Chinavia halaris* (Say)) and plum curculio (*Conotrachelus nenuphar* (Herbst)) attack the fruit during initial development. Bacterial spot (*Xanthomonas arboricola*) is typically observed three weeks after petal fall, peach scab (*Cladosporium carpophilum*) is spread early in the season when the humidity and temperature are optimum for growth, and the most prevalent end of season and postharvest fungal diseases include brown rot (*Monilinia fructicola*) and rhizopus (*Rhizopus nigricans*).

To reduce pest-mediated damage, recyclable paper bags coated with a water resistant barrier are placed over fruitlets approximately ten days after full-bloom, when the when the fruitlet is approximately 1.5cm × 3cm, and removed approximately ten days before harvest to increase the blush color.

Specified Source(s) of Funding: NIFA OREI Project Numberr 2016-51300-25726

3:00 PM Food Hub Feasibility in Oregon's Mid-Willamette Valley: Interviews with Conventional and Organic Small and Mid-Sized Farmers 15 Minutes

Eliza Smith*; Javier Fernandez-Salvador and Erica Chernoh, *Oregon State University*

Abstract: A food hub is a centralized physical location or online resource that brings together farmers and food buyers. As such, food hubs can take many forms, including processing facilities, distribution centers, retail or wholesale markets, and educational platforms. They benefit small and mid-sized producers by providing infrastructure and resources that may be unavailable to farmers on their own. Food hubs are most commonly located in larger urban and metropolitan areas to maximize accessibility for growers, buyers, and consumers. A food hub feasibility survey was conducted by OSU Extension Service Small Farms Program in partnership with the City of Salem in the mid-Willamette Valley. Salem is a city of 168,000 people and the second largest city in Oregon. The survey was conducted to determine small and mid-sized farmers' interest in a potential food hub in a low income part of the city slated for urban renewal development. The first section of survey questions covered basic farm information and the second part focused on assessing farmer interest and determining specific requirements to participate in the project. Nineteen farmers were interviewed (7 certified organic, 12 nonorganic) and data were analyzed using one and two-way tables. Three quarters of the participants had heard the term food hub before the survey. Eighteen of the nineteen farmers interviewed were interested in participating in the food hub. All of the meat producers interviewed identified a USDA meat processing facility as the most helpful resource that a food hub could provide for them because of the lack of facilities in the region that will work with small producers. The top three concerns that both organic and nonorganic producers had about a food hub were: 1) prices would have to be set too low to justify participation, 2) possible lack of sufficient consumer demand for farm products, and 3) excessive competition from larger farms that would also participate in a food hub. Participants' concern about a lack of consumer demand led them to request that the food hub provide community education about the value of buying local agricultural products. A higher percentage of organic (29%) than nonorganic (8%) farmers said the food hub was not necessary in the Salem area, citing their concern about a lack of demand for organic products. Establishing a food hub is a significant undertaking and assessing farmer, consumer and buyer interest through preliminary feasibility surveys is essential.

3:15 PM Reusable Black Tarps Suppress Weeds and Make Organic Reduced Tillage More Viable 15 Minutes

Haley Rylander*[1]; Anusuya Rangarajan[1]; Ryan Maher[1]; Brian Caldwell[1]; Mark G. Hutton[2] and Nicholas William Rowley[2], *(1)Cornell University, (2)University of Maine*

Abstract: Organic vegetable farmers rely on intensive tillage to control weeds, incorporate amendments and residues, and prepare seedbeds. Intensive tillage, however, can lead to a decrease in long-term soil health. The use of black, impermeable, polyethylene tarps on the soil surface prior to planting reduces weed pressure, increases crop yield, and preserves prepared soil for several weeks. Cultivar 'Boro' beets were planted on two dates: 16 May 2017 and 15 June 2017. Tarps were applied and left in place for three time periods prior to projected planting dates: 1) either overwinter (early planting) or 10 weeks (late planting), 2) six weeks, and 3) three weeks. After tarp removal, plots were roto-tilled (4 in.), shallow-tilled (1 in.), or left as is (no-till), then direct-seeded with beets. No-till plots received no weed control, tilled plots were cultivated at 10 and 20 days post-planting. Weed pressure, crop yield, and soil conditions were measured at tarp removal, midseason, and at harvest. Use of tarps for any length created a seedbed free of weeds prior to planting and kept weed biomass lower than the control the first three weeks after planting. Total soil nitrogen increased linearly (R2 = 0.7) with increased tarp duration. While there was often a significant difference in weed biomass and crop yield between shallow- and roto-till treatments without tarps, there was never a significant difference between shallow- and roto-till treatments when tarps were used. A tarp duration of three weeks was sufficient to achieve reduced weeds and increased yield.

Specified Source(s) of Funding: NIFA OREI and Toward Sustainability Foundation

3:30 PM Options for Including Cover Crops in High Tunnel Crop Rotations 15 Minutes

Anne Pfeiffer[1]; Elizabeth Perkus[2]; Charlotte Thurston*[1]; Julie Grossman[1] and Fucui Li[1], *(1)University of Minnesota, (2)UMN*

Abstract: High tunnels are a popular season extension tool used by growers to increase yield and produce quality of vegetables, fruits, and flowers. Intensive cropping in these spaces can lead to soil health problems, such as reduced organic matter and increased soil salinity,that may impact yield. Cover crops are a potential management tool to increase soil organic matter and, in the case of legumes, add nitrogen without importing excess salts. Cover crops can also help with weed control and can disrupt certain pest and disease cycles. While cover crops have many benefits, they can be challenging to include in high tunnel crop rotations because there is little time between cash crops and some aspects of management are more complicated than in the open field. This paper discusses management strategies, benefits, and challenges of cover crops in high tunnels and different rotational windows including fall-planted winter-killed, fall-planted overwintered, spring planted, summer planted, and inter-planted cover crops.

2:30 PM – 3:30 PM *Boundary (Terrace Level)*

Fellows Screening Committee Meeting

Chair: Elizabeth Baldwin, *USDA-ARS*

Members: Paul Bosland, *New Mexico State University*; Zong-Ming Cheng, *University of Tennessee*; Robert Paull, *University of Hawaii at Manoa*; Gregory Reighard, *Clemson University*; Michele Warmund, *University of Missouri*; Sandra Wilson, *University of Florida*; Paul Read, *University of Nebraska*; Bhimanagouda Patil, *Texas A&M University*; Brent Pemberton, *Texas A&M AgriLife Research and Extension Center, Texas A&M University* and Carl Sams, *The University of Tennessee*

2:30 PM – 3:30 PM *Jay (Lobby Level)*

Membership Committee Meeting

Chair: Candice A. Shoemaker, *Kansas State University*
Members: Teresita Amore, *Tropical Plant and Soil Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa*; Joseph Kemble, *Auburn University*; Youping Sun, *Department of Plants, Soils, and Climate, Utah State University*; Sarah E. Hulick, *Cornell University*; Dennis Deyton, *University of Tennessee*; Ellen Paparozzi, *University of Nebraska*; Neil Scott Mattson, *Cornell University*; Matthew Kleinhenz, *The Ohio State University-OARDC*; R. Daniel Lineberger, *Texas A&M University*; Josh Freeman, *University of Florida*; Carl Sams, *The University of Tennessee* and Michael Neff, *ASHS*

2:30 PM – 3:45 PM *Georgetown East*

Genetics and Germplasm 3

Moderator: Theodore Kisha, *USDA-ARS*

2:30 PM **Phylogenetic Analyses Confirm the Unique Status of the Wild New World Melon, *Cucumis melo* ssp. *agrestis* var. *texanus*, and Suggest It be Tentatively Designated Group Texanus in the Recent Revision of Melon Nomenclature**

Kaori Ando*; William M. Wintermantel and James D. McCreight, *USDA-ARS*

Abstract: *Cucumis melo* ssp. *agrestis* var. *texanus* Naudin is a wild melon found from the southeastern U.S. to eastern and western. It is weedy, prolific, and bears many small non-sweet fruit with small seeds, and is a potential source of powdery mildew and nematode resistances. Var. *texanus* was, until classified as a separate *varietas*, considered a member of *C. melo* ssp. *melo* var. *chito*, a small melon from Central America and the Caribbean Islands, or var. *dudaim*, a small fragrant melon from the Middle East and Central Asia. The U.S. National Plant Genetic Resources System (NPGS) maintains 2000+ *C. melo* Plant Introductions (PI). Forty-four of them are var. *texanus*, and they were sequenced using the genotyping-by-sequenced method to analyze the phylogenetic position of var. *texanus* in relation to the other 16 melon *varietas*. Principal component and phylogenetic analyses placed var. *texanus* in its own cluster with 8 non-*texanus* PIs. A nearby cluster consisted mainly of a mix of vars. *chito* and *dudaim*. Mean 100-seed weight was not significantly different between var. *texanus* and the 8 non-*texanus* PIs in the *texanus* cluster; the var. *texanus* PIs did, however, differ significantly from the rest of the NPGS *C. melo* accessions. A majority of the var. *texanus* PIs (93%) were negative for cucumis melo endorna virus (CmEV), a pollen-transmitted, persistent virus of melon thought to have co-diverged with the *C. melo* progenitor. Partial CmEV sequences of three CmEV-positive var. *texanus* PIs were subjected to phylogenetic analysis with 25 CmEV-positive melons representing 11 *varietas*. One CmEV-positive var. *texanus* grouped with 'Ananas' (var. *ameri*) and 'Védrantais' (var. *cantalupensis*), while the other two were together with 'Ogon No. 9' (var. *makuwa*) and 'Freeman's Cucumber' (var. *conomon*). This result suggests that pollen from nearby cultivated or domesticated *C. melo* introduced CmEV to var. *texanus*, and that var. *texanus* is distinct among melons. A recent revision of melon classification replaced the two *C. melo* subspecies and 16 *varietas* with 19 horticultural. We propose var. *texanus* either be re-designated Group Texanus or placed as a sub-Group alongside Chito.

Specified Source(s) of Funding: This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2015-51181-24285.

2:45 PM **Characterization of the USDA Germplasm Collections for Watermelon, Melon, Cucumber and Squash Using Genotyping-By-Sequencing**

Zhangjun Fei[1]; Kaori Ando[2]; Kan Bao[1]; Sue A Hammar[3]; Joanne A. Labate[2]; Amnon Levi[2]; Michael Mazourek[4]; James D. McCreight[2]; Takshay Patel[5]; Axel Ramirez Madera[6]; Umesh Reddy[7]; Paige Reeves[4]; Luis Rivera[5]; Xing Wang[1]; Todd C. Wehner[8]; Yiqun Weng[6]; Shan Wu[1] and Rebecca Grumet*[9], *(1)Boyce Thompson Institute, (2)USDA-ARS, (3)Michigan State University, (4)Cornell University, (5)North Carolina State University, (6)University of Wisconsin, (7)West Virginia State University, (8)NC State University, (9)Michigan State Univ*

Abstract: Germplasm collections are a critically valuable source of genetic diversity for plant breeding efforts. Our ability to make optimal use of such resources for crop improvement is facilitated by genetic characterization. Therefore, one of the objectives of the CucCAP project, "CucCAP: Leveraging applied genomics to improve disease resistance in cucurbit crops", is to characterize genetic diversity within the U.S. cucurbit plant introduction (PI) collections and develop sequence-informed functional panels for genetic and phenotypic analyses. To this end, we have performed genotyping-by-sequencing (GBS) analysis of the USDA PI collections of the four major cucurbit crops: watermelon (*Citrullus lanatus*), melon (*Cucumis melo*), cucumber (*Cucumis sativus*), and squash (*Cucurbita pepo* and *C. moschata*). A total of 1,234 cucumber, 2,077 melon, 1,365 watermelon, 850 *C. pepo* and 314 *C. moschata* accessions were genotyped. A total of 1.57, 1.71 and 0.88 billion GBS reads were obtained for cucumber, melon and watermelon, respectively. From these reads, 76.9, 54.2 and 34.6 million unique tags were obtained, of which 593,678, 743,545 and 388,298 tags with at least 10 reads were used for SNP calling for cucumber, melon and watermelon, respectively. A total of 114,338, 89,377 and 62,258 SNPs were called in cucumber, melon and watermelon, respectively, and 23,828, 27,846 and 25,930 SNPs were obtained by applying criteria of missing data rate < 0.5 and minor allele frequency (MAF) > 0.01. The SNPs were well distributed across the genomes with average density of one SNP per 10.6, 14.6, and 15.7 kb for cucumber, melon and watermelon, respectively. Using these SNP data, we have performed population structure and principal component analysis (PCA), and constructed a neighbor-joining trees to infer phylogenetic relationships among the accessions. These analyses are being used to establish functional panels of 300-400 accessions per crop representing ~99% of the genetic diversity along with key disease resistance, fruit quality, horticultural and agronomic traits.

Specified Source(s) of Funding: USDA-SCRI 2015-51181-24285

3:00 PM **Examination of Extractable Phenolics and Non-Extractable Proanthocyanidins from a Selection of "Red" and "Black" Market Class Accessions of Beans (*Phaseolus vulgaris*) from the National Plant Germplasm System.**

Theodore J. Kisha*[1]; Girish Ganjyal[2] and Cristen Frieszell[2], *(1)USDA-ARS, (2)Washington State University*

Abstract: Beans (*Phaseolus vulgaris* L.) are one of the most economically and nutritionally important crops world-wide. They are the most important legume for direct human consumption with a value of over $20 billion harvested (FAO statistics, 2014); more than twice that of the next most important legume, chickpea (*Cicer arietinum* L.). Beans have numerous nutritional qualities, such as high protein, high amounts of starch, dietary fiber, minerals, and an array of healthy phytochemicals associated with health benefits such as reduced cardiovascular disease, the prevention of diabetes, and even the prevention of cancer. One important class of phytochemicals includes polyphenolic compounds which impart color, flavor, and anti-oxidant activity. Growing consumer awareness regarding the health benefit of beans in general will likely increase demand, perhaps especially among those who frequent farmers markets and health food stores. Market classes of "Red" and "Black" beans are thought to be among the highest in phenolic content and antioxidant activity. Preliminary analysis however, showed 2-3 fold differences within each market class. We analyzed extractable phenolics and non-extractable proanthocyanidins from a large selection of red and black beans to provide information to breeders to enhance these nutritional components within each market class.

Specified Source(s) of Funding: Project Number: 2090-21000-032-00-D

3:15 PM **Improving Transfer of Traits from *Solanum Pennellii* to Cultivated Tomato By Understanding Segregation Distortion and Reproductive Barriers**

Barbara Ellen Liedl*, *West Virginia State Univ*

Abstract: The germplasm of many crops including tomato is narrow due to constraints imposed during domestication, thus increasing the importance of wild relatives as a source of genetic variation. However, segregation distortion, linkage drag and reproductive barriers impede the transfer of desirable traits from the wild to cultivated species. This project was undertaken to understand segregation distortion and reproductive barriers in the F_2 and backcross (BC) populations from the interspecific cross between tomato, *S. lycopersicum*, and the wild species, *S. pennellii.*

The three populations derived from crosses between *S. lycopersicum* M82 and S*. pennellii* LA716 and their interspecific F_1 were evaluated for % pollen stainability and % seed germination as well as if plants produced flower, fruit or seed. Percent stainable pollen varied greatly for the parents: 99.22% M82, 16.31% LA716 and 85.7% of the interspecific hybrid, F_1. Both backcross populations had similar means, 57.9% BCLyc and 48.9% for BCPen, while the F_2 mean was 31.7% but varied from zero to 99.2%. The F_2, as expected from previous research had only 27.75% of the population producing fruit, of which, only 9.43% produced seed. As expected, all of the BCLyc flowered and 98% produced fruit with germinable seed. Conversely, the majority of the BCPen produced flowers, but only 8.7% of the plants produced self-fruit and only 3.26% produced seed. Only two populations, F_2 and BCLyc exhibited any abnormal seed germination (18.8% and 1.1% respectively), with all of the germinated seed from the F_2 being abnormal.

Of the 1000 SNP markers, 181 had no data and an additional 184 had no variation or were incorrect, leaving 635 markers used for analysis. The F_2 population had 43% of the markers deviate from the expected 1:2:1 ratio. The BCLyc population had over 63% of their markers deviating from the 1:1 ratio with excess tomato alleles and all of the markers on two chromosomes skewed. The BCPen population, only 21.9% displayed distorted segregation and one chromosome did not skew from the expected ratio. In addition, most of the skewing BCPen markers favored homozygous LA716 combination, but a few skewed towards the heterozygous combination on chromosomes 5 and 9. Each population was examined for the percent of *S. pennellii* genome present with 50% expected for the F1 and 54.4% observed. The two backcross populations were projected to have 25% (BCLyc) and 75% (BCPen), our analysis found an average of 17.8% for BCLyc and 77.6% for BCPen respectively.

Specified Source(s) of Funding: This project was supported by Agriculture and Food Research Initiative Competitive Grant no. 2012-38821-20049 from the USDA National Institute of Food and Agriculture.

3:30 PM Identification of Phosphorus-Efficient Genotypes from Tomato Germplasm

Mary Dixon* and Guodong David Liu, *University of Florida*

Abstract: Phosphorus is the second most essential nutrient element for plants, following nitrogen. Phosphorus fertilizer is made from mining phosphate rock, however, these reserves are finite and depleting. With increasing global demand for fertilizer and a shrinking supply, it is imperative to find efficient means to utilize phosphorus. Phosphorus occurs in soils as organic (Po) and inorganic (Pi) forms, all mainly insoluble and unavailable. Growers commonly use fertilizer as an insurance for crop production, but over-fertilization commonly occurs as a result which causes eutrophication. Some cultivars are able to mobilize insoluble phosphates due to mechanisms such as changing root architecture, microbial associations, or exuding organic acids. The objective of this experiment is to examine seven tomato (*Solanum lycopersicum)* genotypes collected from a pre-identification trial– Great White Og, Japanese Black Trifele, Mariana F1, Juliet F1, Cherokee Green, Chef's Choice Orange, and Pink Bumble Bee – under conditions of insoluble phosphate, tri-calcium phosphate, to identify elite genotypes. This trial will be carried out by growing tomato seedlings in a 10% Hoagland solution-based hydroponics system until two sets of leaves fully expand. Chlorophyll content, pH, height, biomass, and concentration of N, P, and Ca will be determined. Based on the pre-identification data, we hypothesize that Great White Og, Japanese Black Trifele, and Mariana F1 will have the lowest P content, highest P content, and highest Ca content respectively. We also hypothesize that the P-efficient tomato (Japanese Black Trifele) will have greater height, greater biomass, greater root to shoot ratio, greater chlorophyll content, and lower pH. These results will help to aid breeders in selecting for traits that are associated with phosphorus use efficiency. Growing phosphorus efficient crops can minimize environmental damage from over-fertilization and can slow depletion of the finite phosphorus reserves.

2:30 PM – 3:45 PM *Monroe*

Plant Growth Regulation 1

Moderator: Janet Slovin, *USDA/ARS*

2:30 PM The Morphological and Genetic Effects of Exogenous Auxin and Gibberellin Application on Apple Fruit Development.

Kelsey D. Galimba*[1]; Daniel G. Bullock[1]; Ann M. Callahan[1]; Chris Dardick[1] and Zhongchi Liu[2], *(1)Appalachian Fruit Research Station, USDA-ARS, (2)University of Maryland*

Abstract: Fruit set and development are dependent on the plant hormones auxin and gibberellin, which can create parthenocarpic, seedless fruit in many species when applied ectopically. In the apple fruit, a pome, these hormones trigger the enlargement of the hypanthium, a cup-like structure which surrounds the ovary and forms the majority of the fruit flesh. Sprays containing these hormones are available commercially with the purpose of improving apple fruit set, size and shape, but results may vary. This variability, in combination with reports that hormone sprays may cause lower fruit quality at maturity, highlight the need for research in this area. We applied gibberellic acid (GA_3), synthetic auxin (NAA) and both, in addition to the auxin-transport inhibitor NPA to 'Honeycrisp' apple flowers. Our results showed that GA_3 applications alone caused the development of parthenocarpic apples. At maturity, GA_3-treated apples had a slightly different shape but were similar in quality to hand-pollinated controls, though they were less acidic. This contradicts previous reports of accelerated ripening leading to quality issues at harvest. We performed RNA-sequencing analysis on hypanthium, ovary and ovule/seed tissues from GA_3-treated, NAA-treated and control fruits, and found that while GA_3-treated parthenocarpic and hand-pollinated fruit were the most similar in RNA expression profiles, interesting differences do occur. We focused on the apple *GA20ox, GA3ox* and *GA2ox* orthologs, which have been shown in other species to synthesize or degrade bioactive GA. We found that many members of these families exhibit unique responses to pollination, GA_3 and/or NAA treatment, which may play a role in the morphological differences we observed. Taken together, our data have led to a preliminary characterization of the roles of these genes and expands upon the function of GA in apple fruit development.

Specified Source(s) of Funding: NSF-IOS 1444987, Agricultural Research Services

2:45 PM Auxin Metabolic Relationships in the Diploid Strawberry

Qian Tang[1]; Peng Yu[2]; Molly Tillman[1]; Jerry D Cohen[3] and Janet Slovin*[4], *(1)University of Minnesota, (2)Technische Universität München, (3)Univ of Minnesota, (4)USDA/ARS*

Abstract: Strawberry fruit growth is a classic system for studying auxin signaling between tissues during fruit development. The juicy flesh of the strawberry results from enlargement of the stem tip (the receptacle) underlying the carpels in response to auxin and gibberellin produced by the developing achenes, the botanical true fruit. The auxin originates in the achenes, which spiral up the outside of the receptacle. In later stages of berry development, auxin slows the ripening process. The literature describes a pattern of free auxin (IAA)

accumulation in the developing berry suggestive of active metabolic and/or transport activity that sustains the

enlargement of the receptacle after embryo development is complete. In diploid strawberry, *Fragaria vesca,*

embryo development is complete at 10 to 13 days after pollination. Auxin is found in plants primarily

conjugated to various amino acids and sugars. Strawberry tissues are capable of synthesizing auxin

conjugates, and transcriptome data shows the expression of genes involved in IAA conjugate formation and

hydrolysis throughout embryo development and subsequent seedling growth. Using a highly sensitive, high

resolution, liquid chromatography-mass spectrometric method, we have now identified all the low molecular

weight indole-auxin amino acid conjugates in achenes of *F. vesca* as consisting only of IAA-aspartate and

IAA-glutamate. In contrast to what is believed to occur in Arabidopsis, we determined that IAA-aspartate and

IAA-glutamate are hydrolyzed by seedlings to provide a source of free IAA for growth.

Specified Source(s) of Funding: USDA/ARS, NSF PGRP IOS-1238812

3:00 PM Transcriptomic Study of the Early Responses to Bud-Break Agent Hydrogen Cyanamide in 'tropicbeauty' Peach

Lisa Tang*; Shweta Chhajed; Thomas A. Colquhoun; Mercy A. Olmstead; James W. Olmstead and Tripti Vashisth, *University of Florida*

Abstract: Hydrogen cyanamide (HC) is used in deciduous fruit trees to induce bud endo-dormancy release and to offset insufficient chilling hours for bud break. The objective of this study was to gain insight into the mechanism of bud break response to HC in 'TropicBeauty' peach trees (*Prunus persica* L.) by comparing buds from HC-treated and non-HC-treated control trees, respectively, at the global transcriptomic level using RNA sequencing. For HC-treated trees, the peak of bud burst (7 flower buds and 10 vegetative buds/branch) occurred at 32 days after treatment (DAT). In contrast, control trees had maximum release of bud dormancy (10 flower and 14 vegetative buds/branch) at 74 DAT, six weeks later than treated with HC, suggesting HC accelerated bud break in peach. Between HC-treated and control trees, there were 1312 and 1095 deferentially expressed genes (DEGs) at 3 and 7 DAT, respectively. The results of gene ontology (GO) enrichment analysis demonstrated that at 3 DAT, significant GO terms with top enrichment values (EV; absolute logarithm of *P*-value) for up-regulated DEGs included response to stimulus (EV = 18.1), response to stress (EV = 15.7), oxidoreductase activity (EV = 14.6), and oxidation reduction (EV = 10.7), whereas top GO terms for down-regulated DEGs were cell proliferation (EV = 8.0), regulation of multicellular organismal process (EV = 7.1), chromosome organization (EV = 6.7), and anatomical structure development (EV = 6.1). Interestingly, at 7 DAT, top GO terms for up-regulated DEGs shifted to cell cycle (EV = 9.7), chromosome organization (EV = 9.5), chromatin organization (EV = 8.7), and cell cycle process (EV = 8.7), indicating resumption and increase in cell division and growth following the initial suppression by HC treatment. For down-regulated DEGs at 7 DAT, top GO terms included response to stimulus (EV = 6.9), response to chemical stimulus (EV = 6.2), and response to stress (EV = 3.6). The results suggest HC induces oxidative stress in buds shortly after application leading to the release of bud dormancy and subsequently causes increased cell activity, resulting in floral and vegetative bud break.

3:15 PM Interaction between ABA Metabolism and Light Quality on Anthocyanin and Sugar Syntheses in Grapes

Satoru Kondo*, *Chiba University*

Abstract: The interaction between abscisic acid (ABA) and blue or red light irradiation on anthocyanin and sugar syntheses in 'Kyoho' (*Vitis labrusca*×*V. vinifera*) grape berries was examined. The following two experiment groups were created. In the first group, ABA antagonist of PYL-PP2C receptor (AS-6) was treated to the cluster at 38 days after full bloom (DAFB) (one week before veraison) and 48 DAFB (veraison). The second group was the untreated control group. The anthocyanin and sugar concentrations, ABA metabolism, and their related gene expressions were analyzed at 38, 48, 58, and 68 DAFB. The anthocyanin, glucose, fructose, sucrose concentrations, and the *VlMybA2* and *VvUFGT* expression levels were inhibited in AS-6 treated berries. In contrast, the expression levels of *VvPC2C9* in AS-6 treated berries were increased at 48 DAFB. These results suggest that endogenous ABA is associated with anthocyanin and sugar syntheses in grape skin. To consider the effects of light on ABA metabolism and anthocyanin formation, three experiment groups were created. In the first group, blue (clusters)/blue (leaves) LED was irradiated for six hours at night from full bloom to harvest. In the second group, blue (clusters)/red (leaves) LED was similarly irradiated. The third group was the untreated control. The *VvNCED1* expression levels were increased in the first and second groups compared to the untreated control. The *CYP707A1* expression levels in the second group was decreased at 62 DAFB. The *VvPP2C9* expression levels in the first and second groups were inhibited. These expression levels influenced ABA concentrations in the skin. The anthocyanin concentrations were increased in the first and second groups. These results suggest that light quality influences ABA metabolism, resulting in anthocyanin formation in the grape skin.

3:30 PM Abscisic Acid Is Involved in Aromatic Ester Biosynthesis Related with Ethylene in Green Apple 'Orin'

Shanshan WANG; Takanori Saito; Katsuya Okawa; Hitoshi Ohara and Satoru Kondo*, *Chiba University*

Abstract: The production of aromatic volatiles such as esters during the ripening process in climacteric fruits is known to be controlled by ethylene. However, we here show that abscisic acid (ABA) application accelerated the onset of short-chain ester production (hexyl propionate, ethyl-2-methyl butyrate) and the expression of biosynthesis genes (*MdAAT2* and *MdBCAT1*) during ripening of 'Orin' apple. ABA application also promoted the production of ethylene, and caused ethylene peak shifts correlated with the expression of ethylene synthesis genes (*MdACS1/3* and *MdACO1*), suggesting that ABA may act jointly with ethylene as a positive regulator at the ripening stage of 'Orin' apple. Additionally, endogenous levels and expression of biosynthesis (*MdNCED1*) and signal transduction genes (*MdABF2-like*) of ABA increased towards ripening. Finally, the localization of the putative MdABF2-like protein binding element, AREB/ABF, was observed in the 5'-upstream region of *MdACS1/3* and *MdACO1*.

2:30 PM – 4:00 PM

International Horticulture and Foreign Assistance: How Some Aid Agencies and Not-for-Profit Organizations Use Horticulture (and how you can become involved) *CEU Approved*

Jefferson West

Coordinator: John Griffis, *Florida Gulf Coast University*

Moderator: John Griffis, *Florida Gulf Coast University*

Objectives:

1) To provide audience members with information about how horticulture plays an integral part of many Foreign Aid Programs. 2) To provide audience members with information about numerous projects and programs of Aid Agencies and NGO's involved in U.S. foreign aid programs and how they use horticulture and horticulturists. 3) To provide audience members with specific information about how they can become involved in international horticulture programs and projects with these various Aid Agencies and NGOs. Audience members are encouraged to discuss their own experiences with these projects and programs. 4) To allow audience members to ask questions, make comments and discuss topics with regard to the importance of horticulture in various foreign assistance programs.

Description: The program will have two speakers from International Development Agencies - NGOs that subcontract with USAID. The speakers will explain how their programs use horticulture as an important part of their various projects (such as, but not limited to, projects associated with USAID and Feed the Future, Farmer-to-Farmer and some other USAID-funded program) and how our ASHS members can become involved with these programs, whether it be career track, consultant, cooperator, intern or volunteer. Our panel of expert presenters will join together in a round-table question and answer panel discussion session after the two oral presentations. After brief comments/questions to initiate the panel discussion by the moderator, the audience will be invited 1) to ask questions of the panelists, including questions related to working for or with an agency that sub-contracts with USAID, 2) to discuss with the panelists topical international issues of concern or 3) to make comments concerning topics relevant to the general subject matter of international issues & networking that concerns the professional interest group. The moderator and the panelist from CNFA will ask audience members to discuss any previous volunteer horticultural experiences in Southern Africa and how they perceived those experiences. The moderator and the panelist from Winrock

International will ask audience members to discuss or explain any experiences they have had in integrating youth into international horticulture projects of the various types presented by the panelist in his presentation. Audience members are also encouraged to offer responses to questions or comments posed by other members of the audience.

2:30 PM Horticulture in Southern African Economies – Why It Matters?

Margaret Anderson*, *CNFA (Cultivating New Frontiers in Agriculture)*

Abstract: The presentation will focus on the importance of horticulture particularly in Southern Africa and discuss the role that the (USAID) Farmer-to-Farmer program plays in generating rapid, sustained economic growth in the agricultural sector through short-term technical assistance provided by U.S. volunteers. Presentation will include a brief overview of F2F including examples of F2F volunteers and their work as well as short-term opportunities available at CNFA for horticulturalists.

3:00 PM Using Innovation to Engage Youth in Horticulture

Peter Saling*, *Winrock International*

Abstract: Using technology and services as an entry point for engaging young people (aged 18-35), Winrock International is designing innovative programs to draw the next generation of horticulturalists. While global trends suggest youth interest in agriculture is waning, by expanding what's possible in agriculture we can attract men and women while improving productivity, efficiency, and employment opportunities in agriculture. You can help us do this.

3:30 PM Panel Discussion

2:30 PM – 4:00 PM

The National Initiative for Consumer Horticulture: Identifying and Cultivating Consumer Horticulture Research Relationships *CEU Approved*

Lincoln West

Coordinators: Sheri Dorn, *University of Georgia* and Natalie Bumgarner, *University of Tennessee*

Moderators: Sheri Dorn, *University of Georgia* and Pamela Bennett, *Ohio State University Extension*

Objectives:

Capture NICH progress to date Explore examples where interdisciplinary collaborations have produced significant results for Consumer Horticulture (CH) researchExplore the potential for consumer horticulture research Facilitate discussion of ways to make connections and open doors for CH research

Description: The National Initiative for Consumer Horticulture (NICH) is a diverse consortium of leaders who provide a unified voice for promoting the benefits and value of horticulture. NICH endeavors to unite national research efforts with the goals of the diverse stakeholders in the industry, the public sector, and the gardening public in an effort to advance knowledge and increase benefits and application of horticulture for cultivating a healthy world through landscapes, gardens, and plants and an improved quality of life. In the 2017 workshop, a review was presented of research related to the economic, environmental, and community and health benefits of Consumer Horticulture (CH). Following that review, this workshop offers opportunity to discuss strengthening CH research. The 2018 workshop will begin by exploring examples of Consumer Horticulture (CH) research, collaborators, and strategies for reaching out to other disciplines. The latter half of the workshop will use facilitated discussion to identify ways to improve future CH research. Workshop attendees will rotate through stations to contribute to the discussion of questions, such as what are CH research goals? What can CH researchers do to strengthen our research? With whom should CH collaborate to achieve research goals? How do CH researchers meet these people? How do CH researchers have the conversation with other researchers? Attendee contributions will be captured on flip charts as well as by designated listeners so that the information can be compiled and reviewed and action steps identified.

2:30 PM Nich Makes Progress at Its 2018 Planning Meeting

Pamela J. Bennett*, *Ohio State University Extension*

Abstract: The National Initiative for Consumer Horticulture (NICH) received one of 12 USDA grants in 2017 as part of the Specialty Crop Research Initiative (SCRI). The $47,470 planning grant was used to further develop strategies, tactics, and priorities though an in-person planning meeting in June 2018. This major step will help to move NICH closer to its goal of increasing all aspects of horticulture and get 90% of U.S. households gardening by 2025. NICH committee members as well as industry and other stakeholders gathered in Atlanta, GA, to develop and prioritize research and extension goals as well as to develop a governance plan and business model that will serve as the road map for the NICH effort. The meeting also served as an opportunity for committees to meet face-to-face for the first time since 2015, when NICH was in the early planning stages.

2:45 PM Considering Consumer Horticulture in the Human Health Realm

Sheri Dorn*, *University of Georgia*

Abstract: Horticulture has been used for therapeutic purposes for more than 100 years, though scientific understanding of how and why it is so effective for human healing and well-being is relatively new. The dramatic increase in health care costs in recent years has provided incentive to more fully explore consumer horticulture's impact on or role in physical and psychological health at the individual and community level. This presentation provides opportunity to discuss how horticulture can play a prominent role in the research and outreach collaborations with those contiguous to the human health realm, including medical doctors, therapists, psychologists, and human ecologists. It offers us a way to take a fresh look at the profession and practice of consumer horticulture and its influence on the ways in which we live and interact.

3:00 PM Placing Horticulture within the Human/Nature Discussion

Natalie Bumgarner*, *University of Tennessee*

Abstract: Human interactions with the natural environment have been shown to impact health, well-being, and mental function in a range of ways. Researching and then practically integrating the benefits of the natural experience for individuals and societies connects a number of fields that often include urban planning, environmental and natural resource economics, resource management, landscape design, and psychology. As urbanization continues, many of the frequent and everyday connections between humans and nature will increasingly occur in domains where consumer horticulture practitioners and educators play a key (and often leading) role. From urban parks, greenways, and greenspaces, to public gardens and arboreta, consumer horticulture practitioners guide or influence many of the most common human interactions with the soil, water, and plant elements of nature. This presentation will focus on opportunities and facilitated discussions around developing and strengthening research and outreach collaborations with those in natural resources and environmental psychology as well as urban planning.

3:15 PM Rethinking Food and Nutrition

Esther E. McGinnis*, *North Dakota State University*

Abstract: In order to thrive, consumer horticulture must be nimble and seek out far-reaching interdisciplinary research collaborations to expand beyond traditional paradigms. From the consumer perspective, progress on food and nutrition issues has suffered as the majority of horticultural funding and resources promotes breeding and production of food crops with commercial traits such as increased yields, plant disease-resistance, and specific food processing traits. Traits that benefit consumers, such as enhanced flavor and nutrition in horticultural crops, have been neglected. This session will focus on cultivating research relationships to fill this gap. Examples of large and small collaborations will be discussed, including the relationships that an award-winning chef built with land grant universities to breed vegetables and grains with outstanding flavor, texture, and nutritional qualities to benefit restaurant patrons as well as home gardeners.

3:30 PM Strengthening CH Research (Facilitated Discussion)

Pamela J. Bennett*, *Ohio State University Extension*

Abstract: The latter half of the workshop will use facilitated discussion to identify ways to improve future CH research. Workshop attendees will rotate through stations to contribute to the discussion of questions, such as what are CH research goals? What can CH researchers do to strengthen our research? With whom should CH collaborate to achieve research goals? How do CH researchers meet these people? How do CH researchers have the conversation with other researchers? Attendee contributions will be captured on flip charts as well as by designated listeners so that the information can be compiled and reviewed and action steps identified.

2:30 PM – 4:00 PM *International Ballroom East/Center*

Undergraduate Student (Poster)

Relating Harvest Date, Ground Color and Preconditioning Treatments to Likelihood of Physiological Storage Disorder Development and Loss of Fruit Quality in 'honeycrisp' (poster)

Audra Bissett*, *University of Maryland* and Chris Walsh, *University of Maryland (Poster Board #353)*

Abstract: New apple cultivars like 'Gala' and 'Honeycrisp' continue to dominate the market in terms of demand and cost per pound. According to a National Retail Report conducted by the USDA, market price for 'Honeycrisp' apples were $3.11 per pound in March 2017. In March 2018, 'Honeycrisp' continued to have the highest market price of any variety surveyed at $2.39 per pound, 50% more expensive than runner-up 'Fuji'. Farmers nationwide are devoting more acreage to 'Honeycrisp' and still struggling to meet demand, making it more important than ever for farmers to know when to pick and how to store in order to maximize yield and reduce loss. 'Honeycrisp' apples are harvested early and susceptible to several physiological storage disorders such as bitter pit, further increasing the necessitated skill for the venture of growing 'Honeycrisp'. This is particularly critical in hot climates where red color development is difficult. The goal of this study was to test the relationship between harvest date, preconditioning, and both external and internal maturity markers at harvest on fruit quality and storage disorders in 'Honeycrisp' apples. 'Honeycrisp' apples were harvested from the same orchard in Adams County, Pennsylvania in August 2017. They were put into subgroups based on ground color at harvest for subgroup analysis to test the effect of preconditioning treatments of 0, 2, and 4 days. Apples were measured using common maturity indices after harvest and evaluated for physiological disorder after two months of refrigerated storage; the same measurements were taken again after five months of storage. As hypothesized, results indicated that harvest date had a larger impact on resulting fruit quality and physiological disorders than ground color at harvest or preconditioning treatments.

Specified Source(s) of Funding: State Horticultural Association of Pennsylvania (SHAP)

Growth and Yield of Zucchini Fruit Under Hydroponic Culture Condition (poster)

Hinano Okumura*, *Meiji University*; Ryu Nakamura, *Meiji University*; Masato Kawasaki, *Meiji University*; Yuna Seki, *Meiji University*; Kei Kusaba, *Meiji University*; Nao Ando, *Meiji University* and Takashi Ikeda, *Meiji University (Poster Board #354)*

Abstract: Recently, yield of zucchini increases rapidly in Japan. The major production method is in out-field, however as the cultivation term is relatively short, alternative cultivation methods are needed. Soilless culture for zucchini was studies recently, but not hydroponic culture. We investigate the possibility of this technique for zucchini fruit production.
We grew zucchini (*Cucurbita pepo* L. cv. Greenport 2 go) plants in a glass greenhouse from March to June on 2016 and 2017. Two of seedlings were grown in each container which contained 3 different concentration of hydroponic solution. At least 8 plants were grown for each treatment. We investigated the timing of cultivation, fruit size and fresh weight (yield).
Under 3 different conditions of hydroponic solution, the concentration at EC 1.2 had the highest yield, however, fruit yield tended to decrease at the end of cultivation due to the quality of flowers were decreased. These tendencies were observed on both experimental years. We further have to develop the technique to improve the quality and quantities of zucchini yields.

Improving Usability of Composted Horse Waste As a Soil Amendment for Blueberries (poster)

Amelia Loeb*, *University of Maryland* and Christopher Walsh, *University of Maryland (Poster Board #355)*

Abstract: There are numerous benefits of recycling horse barn waste as soil amendment for blueberries. Blueberries are a high value crop which benefit from soil high in organic matter. Horse barn bedding, usually comprised of sawdust bedding and horse manure, is a free and locally sourced waste product that could be used as a mulch or soil amendment on blueberries. However, even composted manures generally have a high salt content and pH, which are thought to be harmful to blueberry plants. Depending on the management practices of the horse farm, aluminum and manganese content may also be a concern. From anecdotal evidence, Pick-Your-Own growers in Maryland have been using composted horse barn waste on blueberry plantings as an organic matter input and a mulch with varied success. Two greenhouse trials were initiated to improve usability of composted horse waste as a soil management practice in blueberry plantings. In November 2016, two blueberry cultivars were potted in either pure soil with gypsum (1 ton/acre) or 1:3 volumetric ratio of composted horse waste to soil. The 6.5-inch diameter pots were placed in a randomized block design in the greenhouse. In May 2017, 3 different volumetric ratios of horse waste to soil (1:1, 3:2, 4:1) were transplanted into 6-inch diameter pots in randomized block design. One of each cultivar was placed into the same pot. In both trials, the composted barn waste was autoclaved and mixed with soil before potting. The soil is a Glenelg loam (fine-loamy mixed semiactive mesic Typic Hapludult receiving 40 inches in annual precipitation of 40 inches), excavated from a farm in Woodbine, MD. The amendment included horse manure and sawdust from horse stalls, and was passively composted for two years on the same farm. The same two cultivars were used in both trials: ‘Blue Ray’, a Northern highbush (*Vaccinium corymbosum*) and ‘New Hanover’, a Southern highbush (*Vaccinium darrowii*)***.*** All pots were irrigated on drip irrigation through the entire trial. In June 2017, both trials were moved outside. Leaf mineral analysis were measured for both trails in October 2017. Most recent year’s growth and bud count was used as a metric for growth and vigor. Data shows that salt content of horse manure can be lowered to an acceptable level through leaching, and suggests a volumetric soil to waste ratio 3:2 may have best results for growth.

Effects of Different Media Formulations on Orchid Seed Germination (poster)

Brandon DeBoer*, *Delaware Valley University* and Adrienne E. Kleintop, *Delaware Valley University (Poster Board #356)*

Abstract: Techniques for orchid seed germination are important for orchid breeding and conservation efforts. Orchid seeds do not contain an adequate endosperm food source and instead derive their nutrients through a symbiotic relationship with mycorrhizal fungi. Orchid seeds cannot germinate without this symbiotic relationship. Tissue culture forms the basis of commercial orchid seed propagation. Using tissue culture and media prepared to provide proper nutrition, orchid seeds can be germinated without the mycorrhizal fungi. The objectives of this research were to measure the germination rate and protocorm and seedling development of different orchid genera using 15 different media formulations supplemented with either coconut water or pineapple powder. The media evaluated included five different formulas of Vacin and Went, Knudson C, and Phytotech Orchid Seed Sowing Media (P723). All media formulations were supplemented with 10% and 20% coconut water and 10% and 20% pineapple powder. Each media was also evaluated without the coconut water or pineapple powder. Orchid seed sowing was conducted aseptically using green seed pods of *Dendrobium, Grammatophyllum*, and *Cymbidium* species. The results compared the germination and development of the different orchid genera on the different media. This research is of significance for improving the techniques for orchid seed germination.

Performance of Capacitance Sensors to Monitor Soil Moisture in Florida Sandy Soils (poster)

Sara Gabriela Cornejo Zepeda, *Zamorano University*; Rhuanito Soranz Ferrarezi, *University of Florida*; Ricardo Alberto Lesmes-

Vesga*, *University of Florida* and Stephen Hubbard Futch, *University of Florida (Poster Board #357)*

Abstract: Irrigation systems are designed to maximize crop productivity and optimize uniform water application. The amount of water applied is usually determined by empirical methods, which are based on timers instead of the actual crop requirements. Several technologies have recently been developed looking for alternative methods to improve water management efficiency based on weather and soil sensing methods. One of the most relevant advances are the capacitance sensors, offering a great potential to estimate soil volumetric water content (VWC) and electrical conductivity. We conducted a laboratory study to evaluate the accuracy of data collected from several commercial capacitance sensors and establish a calibration equation for different soil types. Tested treatments were five sandy soils (Pineda, Riviera, Astatula, Candler and Immokalee) divided in two depths (0-30 and 30-60 cm) representing the majority of Florida soils used for citrus production. We also tested a soilless substrate (peat:perlite 80%:20% v/v). Each sample was oven dried and placed into 5-gal buckets, with three replications. Readings were taken using thirteen capacitance sensors from different manufacturers [CS650, CS616, CS655 (Campbell Scientific), GS3, 10HS, 5TE, GS1 (Decagon Devices), TDT-ACC-SEN-SDI, TDR315, TDR315S, TDR135L (Acclima) and Hydraprobe (Stevens)] connected to a CR1000X datalogger (Campbell Scientific). The bulk density of each soil was determined by following ASTM D7263 standards and the specific gravity according to ASTM D854 standards, defining the reference for further calculations related to VWC. Known amounts of water were added incrementally to obtain a broad range of VWC values until reaching the saturation point; the soil was dumped into a larger container, thoroughly mixed and put back in the original containers. The measurements were performed by inserting the sensor in the middle of the sampling container. Small 450-cm^3 samples were taken and dried in an oven at 75°C for 48 h to determine the gravimetric water content. Gravimetric values were multiplied by the bulk density to determine the VWC used to obtain the soil-specific calibration equations and compare the sensor accuracy. Results indicated that factory-supplied calibration equations performed well for some sensors in sandy soils, especially 5TE, TDT-ACC-SEN-SDI and GS1, with higher correlation between the sensor readings and the determined VWC; that was not the case for 10HS, GS3 and Hydraprobe. The sensor readings were measured successfully in increasing VWC values, establishing soil-specific calibration equations for Florida soils. Those results allow the improvement of sensor reading accuracy, optimizing irrigation scheduling and water management in Florida citrus production areas.

Specified Source(s) of Funding: Funding for this research was provided by 2017 Joye Giglia Endowment for Innovative Agricultural Technology (Project # F0013964)

Screening *Parthenium Argentatum* for Resistance to *Phymatotrichum Omnivorum* (poster)

John Willmon*, *University of Arizona*; Jiahuai Hu, *University of Arizona*; Valerie H. Teetor, *University of Arizona* and Dennis Ray, *University of Arizona (Poster Board #358)*

Abstract: Guayule (*Parthenium argentatum*) is a woody perennial shrub native to Northern Mexico and the Southwest United States. Because of its ability to grow in hot dry environments, it is replacing more water intensive crops in the arid southwest, such as cotton. Guayule is being commercialized on a large scale because of its ability to produce rubber needed by the domestic tire industry. It also produces resins and biomass with potential uses as pharmaceuticals, industrial chemicals, and biofuels. *Phymatotrichum omnivorum*, known as Cotton Root Rot, Texas Root Rot, or *Phymatotrichum* root rot, is an economically important fungal pathogen in eudicot crops, such as cotton, alfalfa, fruit and nut trees, along with a number of ornamental plants grown across the Southwestern U.S. As more acreage of guayule is being planted, cotton root rot has been observed, having the potential to drastically affect this new industry. The best solution to this problem is to develop guayule lines resistant to *P. omnivorum*. Toward developing resistant lines, five guayule germplasm accessions (AZ-1, AZ-2, AZ-5, AZ-6, and 11591) were evaluated for resistance to the fungus. Two-hundred plants per line were inoculated with a solution containing the scleroeca of *P. omnivorum*. Plants were rated on the degree of infection from 0 – dead to 5 – no damage. Cotton was grown as a control to test the viability of the inoculum.

Specified Source(s) of Funding: USDA-NIFA

New Light Shed on *Penstemon* x *Jonesii*'s Phylogenetic Relationship with *Penstemon Eatonii* and *Penstemon Laevis.* (poster)

W. Wesley Crump*, *Brigham Young University*; C.D. Anderson, *Brigham Young University*; Jed Grow, *Brigham Young University*; Jason M. Stettler, *Brigham Young University* and Mikel Stevens, *Brigham Young University (Poster Board #359)*

Abstract: First found in 1894 by Marcus E. Jones, *Penstemon x jonesii* Pennell was later described as a species in 1920 by Francis W. Pennell. In 1967, Frank S. Crosswhite hypothesized that it is a natural hybrid of *P. laevis* and *P. eatonii*. It is now widely accepted as the putative natural hybrid of those two species. It has been identified in relatively concentrated areas in Southwestern Utah. This taxon has long been recognized as a candidate for horticultural selections due to its beautiful "Tyrian rose", "amaranth purple", or red-purple to maroon colored blooms (Neese). Understanding the phylogenetic relationships of this taxon is valuable to assist in the development of cultivars derived from *P*. x *jonesii* for urban landscapes. In conflict with the claim of the natural hybridization of the two aforementioned *Penstemon* species, *P. x jonesii* exhibits phenotypic incongruencies with controlled experimental crosses of *P. eatonii* x *P. laevis*, which have bloomed in our greenhouse. Using ten *Penstemon* microsatellite markers we have been examining the allelic variations between *P.* x *jonesii*, *P. eatonii*, and *P. laevis.* Our preliminary results suggest that *P*. x *jonesii* is not a first generation (F1) hybrid of *P*. *eatonii* and *P*. *laevis.* These early SSR data suggest that *P*. x *jonesii* is more closely related to *P. eatonii*, than *P. laevis*. We now have reciprocal hybrid plants of the two parental species (*P. eatonii* and *P. laevis*); as well as hybrid plants growing where *P.* x *jonesii* was the male parent in crosses with *P. eatonii*. All of our preliminary data support our working hypothesis that *P.* x *jonesii* is more closely related to *P. eatonii* than *P. laevis*.

Specified Source(s) of Funding: Brigham Young University Department of Plant and Wildlife Sciences

Relative Salt Tolerance of Ornamental Grasses and Grass-like Plants (poster)

Alyssa Palmer*, *Utah State University* and Youping Sun, *Department of Plants, Soils, and Climate, Utah State University (Poster Board #360)*

Abstract: Ornamental grasses are popular in urban landscape in Utah and the Intermountain West, one of the driest and fastest growing regions in the United States. An estimated $158 million worth of ornamental grasses are sold annually in U.S. Alternative water sources such as graywater and reclaimed municipal water are becoming important resources for landscape irrigation. These water sources are known to carry relatively high levels of salts, which negatively affect plant growth and development. Therefore, understanding the salinity tolerance of different ornamental grasses can be beneficial for preventing salt damage to ornamental plants while maintaining appealing landscapes. Five ornamental grass species [*Bouteloua gracilis* (blue grama), *Chasmanthium latifolium* (inland sea oats), *Leymus arenarius* 'Blue Dune' (sand ryegrass), *Muhlenbergia capillaris* (pink muhlygrass), and *Pennisetum alopecuroides* 'Foxtrot' (foxtail fountain grass)] and two ornamental grass-like species [*Carex vulpinoidea* (fox sedge) and *Juncus effuses* (common rush)] were assessed for salinity tolerance in a greenhouse. Plants were irrigated weekly with a nutrient solution at an electrical conductivity (EC) of 1.2 $dS{\cdot}m^{-1}$ (control) or saline solution at EC of 5.0 $dS{\cdot}m^{-1}$ (EC 5) or 10.0 $dS{\cdot}m^{-1}$ (EC 10) for eight weeks. At nine weeks after the initiation of treatment, in EC 5, *L. arenarius*, *M. capillaris* and *P. alopecuroides* had no foliar damage with a visual score of 5 (0: dead; 5: excellent), while *J. effuses*, *B. gracilis*, *C. latifolium*, and *C. vulpinoidea* showed some foliar damage with an averaged visual score of 4.5, 3.8, 3.7, and 3.0, respectively. In EC 10, *L. arenarius*, *M. capillaris*, *P. alopecuroides*, *J. effuses*, and *B. gracilis* exhibited no or minimum foliar damage with an averaged visual score of 4 or greater. However, *C. latifolium* and *C. vulpinoidea* had slight foliar damage with averaged visual scores of 3. Compared to control, shoot dry weight (DW) of *C. vulpinoidea* in both EC 5 and EC 10 was decreased by 16%, whereas shoot DW was reduced by 24% and 54% for *P. alopecuroides* in EC 5 and EC 10, respectively. The

reduction in shoot DW in other species was no significant. This experiment is still underway to select the most salt tolerant ornamental grasses for aesthetically appealing landscape that is irrigated with alternative waters.

Specified Source(s) of Funding: New Faculty Start-up Funding from Plants, Soils & Climate, Center for Water-Efficient Landscaping, Utah Agriculture Experiment Station, and The Office of Research and Graduate Studies, Utah State University

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***2:30 PM – 4:15 PM** Jefferson East*

Growth Chambers and Controlled Environments 3

Moderator: Brandon M Huber, *NC State University*

2:30 PM Hydroponic Systems for Small-Scale Indoor-Food Production

Elisa M. Solis*; Celina Gomez and Paul R. Fisher, *University of Florida*

Abstract: Technology can help overcome some of the issues associated with urban farming, such as the lack of knowledge for indoor-plant production in a non-controlled home environment. Because indoor-home growers are producing plants on a much smaller scale compared to commercial growers, research in this area has been largely neglected over the years. However, indoor-home growers face significant production challenges that cannot be addressed with research focused on large-scale commercial production. The lack of information available regarding the production capabilities of 'indoor hydroponic gardens', especially with regard to the minimum inputs required to effectively operate a productive system that can provide a continuous supply of high-quality fresh produce, is affecting our ability to provide consumer-oriented guidance regarding techniques and requirements to produce edibles (e.g., herbs, vegetables) indoors. A 12-week experiment (6 Feb. through 30 Apr. 2018) is being conducted inside a poly-carbonate greenhouse located in Gainesville, FL. The objective of the study is to determine the minimum number of intervals required to change a nutrient solution without sacrificing harvestable yield for tomato (*Solanum lycopersicum*) and basil (*Ocimum basilicum*). Eight treatments are being evaluated using either a water-soluble or a pre-mixed liquid nutrient solution were nutrients are being added every 2 weeks to all treatments to a pre-set volume of water. Regardless of nutrient formula, water and nutrients are completely replaced every two, four, or eight weeks; a control treatment is also included were no water is replaced. Results from this experiment will be presented.

2:45 PM Recycled Nutrient Solution Effects on Hydroponic Lettuce Growth in Deep Water Culture and Nutrient Film Technique

Alexander Miller*; Yuyao Kong and Krishna Nemali, *Purdue University*

Abstract: Nutrient solution is constantly recycled by maintaining electrical conductivity (EC) in commercial hydroponic production. In recycled solutions, nutrients taken slowly by plants (ex Ca, Mg, and S) tend to accumulate and affect EC. Thus, for a given EC measured in the solution, recycled solution is relatively low in quality compared to fresh solution. Our hypothesis was that recycled nutrient solution can reduce nutrient availability to roots in Nutrient Film Technique (NFT, a thin film of solution) compared to Deep Water Culture (DWC, roots submerged in nutrient solution), due to higher volume of nutrient solution available to roots for nutrient uptake in DWC than NFT. A second hypothesis was that the portion of root system not exposed to nutrient solution under NFT may experience mild to moderate drought stress and affect crop growth. Lettuce (*Lactuca sativa L.*) was grown under hydroponic conditions in a greenhouse maintained at 22/20 °C (day/night) temperature and daily light integral of 15 $mol \cdot m^{-2} \cdot d^{-1}$ in three separate experiments. In experiment I, three varieties of lettuce (Black Seeded Simpson, Rex, and Redina) were grown under NFT and DWC using recycled nutrient solution. When data from three varieties were pooled, a significant decrease in shoot dry weight and increase in root dry weight were observed under NFT compared to DWC. These results could be due to nutrient or drought stress or combined effect of both stresses under NFT than DWC. Experiment II grew lettuce (var. Rex) in fresh and recycled solutions, each with NFT and DWC systems. No differences in crop growth between DWC and NFT were observed when fresh solution was used but a lower growth in NFT than DWC was observed when recycled solution was used. This data suggests the decreased plant growth in NFT with recycled solution was likely due to lower nutrient availability. However, plants in NFT compared to DWC did not experience drought stress, as there were no differences between NFT and DWC when fresh solution was used. A third experiment using leaf lettuce (var. Black Seeded Simpson) tested fresh and recycled solution in an NFT system. There was a significant increase in shoot dry weight of plants under fresh than recycled conditions. Tissue nutrient analysis indicated suboptimal concentration of N, P, and K in the recycled compared to the fresh solution treatment. These results confirm that reduced growth in NFT system under recycling conditions is due to low nutrient availability to plants.

Specified Source(s) of Funding: Purdue Univeristy

3:00 PM Optimizing Production of Tomato Transplants for Grafting Using Lower DLI and Supplemental CO_2.

Brandon M Huber* and Ricardo Hernández, *NC State University*

Abstract: Grafted plants offer several advantages for tomato growers including resistance/tolerance to soil borne pathogens and increase in yields. In the US, the demand for grafted vegetable seedlings has increased in the last few years. Precision Indoor Productions (PIP) systems offer advantages for the propagation of grafted seedlings such as control of the environment and increase in spatial and temporal plant uniformity. However, these systems are energy intensive due to the use of electrical lighting as the energy source for plants. CO_2 supplementation is inexpensive for closed systems and has shown to improve yield for many crops. The objective of this experiment is to decrease the light requirements and increase CO_2 levels to produce a high-quality tomato seedling while reducing energy consumption. Two tomato cultivars were grown scion 'Rebelski', and rootstock 'Maxifort'. Plants were subject to three different light treatments 100PPF (103 ± 7.4), 150PPF (152 ± 5.8), and 200PPF (200 ± 11) photosynthetic photon flux (mmol m^{-2} s^{-1}) (18 h) with a percent photon flux ratio of 60Red:40Blue. Furthermore, plants were also exposed to End-of-day far-red light at 5 mmol $m^{-2} \cdot d^{-1}$. Plants were also subjected to three different CO_2 treatments of 400CO_2 (439 ± 23) (ambient), 1000CO_2 (1018 ± 42), and 1600CO_2 (1589 ± 10) µmol mol^{-1}. The room air temperature was 24.3°C ± 0.5/16.7°C ± 1.1(day/dark) (22.4°C average), and 51.9 ± 8.2% RH. Tomato seedlings were grown until the grafting stage (1.8-2.0 mm stem diameter). Daily morphological measurements were taken to observe the growth response over time. In addition, dry mass and other morphological and physiological data was collected to quantify the effects of each treatment. Preliminary results show that under 200PPF-1600CO_2, 'Rebelski' reached grafting stage at day 14, 12% earlier than the control (200PPF-400CO_2). 'Maxifort' grown at 200PPF-1600CO_2 reached grafting stage at day 17, 6% earlier than the control (200PPF-400CO_2). In addition, the same plant growth was obtained under 25% less PPF and elevated CO_2 (1000-1600 µmol mol^{-1}) as with standard growing conditions (ambient CO_2 at 200 mmol m^{-2} s^{-1}).

Specified Source(s) of Funding: Award number 2016-51181-25404

3:15 PM Gas Exchange and Leaf Anatomy of Lettuce in Response to Red and Blue Sole-Source Lighting from LEDs

Luigi Gennaro Izzo*[1]; Matthew Mickens[2]; Giovanna Aronne[1] and Celina Gomez[3], *(1)University of Naples Federico II, (2)NASA Utilization and Life Sciences Office, (3)University of Florida*

Abstract: The sustainability of long-duration manned missions in space relies on plant-based Bioregenerative Life Support Systems (BLSSs). Providing optimal light conditions in closed environments is crucial for proper design and optimization of space-based plant growth chambers. Light-emitting diodes (LEDs) are a promising electric light source for BLSSs research because of their inherent capability to provide accurate spectral control as a function of specific crop requirements. In addition, the capability they offer to modulate light quality allows for plant photoreceptors to perceive light cues that can improve yield and nutritional attributes of food crops. The objective of this study was to quantify the effects of

blue light on growth and morphology, photosynthesis (*A*), stomatal conductance (g_s), transpiration (*E*), chlorophyll estimation (SPAD index), and anatomical features of 'Waldmann's Green' and 'Outredgeous' lettuce (*Lactuca sativa*) grown under different red-to-blue-light ratios. Five treatments were evaluated in the study: 100% red; 7% blue + 93% red; 26% blue + 74% red; 66% blue + 34% red; 100% blue. All treatments provided an average daily light integral (DLI) of 11.5 mol·m^{-2}·d^{-1} (200 ± 2 µmol·m^{-2}·s^{-1} over a 16-h photoperiod). The effect of light treatments on leaf structure was measured comparing anatomical traits by using light and fluorescence microscopes equipped with camera and software for digital image analysis. The experiment was replicated four times; each experimental replication was terminated 22 d after treatment initiation. Preliminary findings suggest that regardless of treatment, *A*, g_s, *E*, SPAD index, and biomass production are higher for 'Waldmann's Green' compared to 'Outredgeous' plants. Treatment comparisons indicate that except for 100% blue, the increasing percentages of blue light increased *A*, g_s, *E*, and SPAD index, but decreased leaf area and edible biomass production. Final results from this experiment, including a discussion on the function of leaf anatomy in response to light-quality, will be presented.

Specified Source(s) of Funding: University of Naples Federico II

3:30 PM Optimum Light Intensity for the Production of 'Albion' Strawberry Tips in Precision Indoor Propagation Systems

Xiangnan Xu* and Ricardo Hernández, *NC State University*

Abstract: The current open field strawberry propagation method in the US has intrinsic problems such as seasonal scarcity, low productivity, and plants have a high risk for contamination with soil borne pathogens. A potential alternative is precision indoor propagation (PIP). The overall objective of this project is to maximize strawberry tip production (reduce flower initiation) by precisely controlling all the environmental factors to provide affordable and clean propagation material. The objective of the present experiment is to find the optimal light intensity to maximize strawberry propagation efficiency (tips per mother plant). 'Albion' (day-neutral) strawberry plugs (27) with two expanded leaves and crown diameter of 7.3 ± 0.8 mm were transplanted in one-gallon pots filled with a substrate mixed of 50% perlite, 25% peat moss and 25% coconut coir. Potted plants were placed in a custom designed indoor strawberry propagation system. Plants were subject to three different light intensity treatments: 250PPF (251 ± 11), 350PPF (345 ± 13), and 450PPF (446 ± 14) photosynthetic photon flux (mmol m^{-2} s^{-1}) at 12 h photoperiod provided by cool white fluorescent lamps. The canopy air temperature was maintained at 27.6 ± 0.3°C / 23.9 ± 0.2°C during the day/dark period, relative humidity of 63.1 ± 4.4 % and ambient CO_2. The plants were watered through electronic irrigation system with modified Yamazaki recipe. Preliminary data shows that after three weeks of growth, there is no significant difference between the three treatments in leaf count and flower development, treatments have produced 5.7 ± 1.6 flowers and the canopy has 5.4 ± 0.6 leaves. Plants under 450PPF have 16% and 12% greater crown diameter (14.3 ± 1.2 mm) than plants under 250PPF and 350PPF treatments, respectively. Runners will be harvested when the first tip has two expanded leaves, and the third tip starts developing. Number of tips per mother plant and tip growth rate and morphology will be recorded. In addition, mother plant growth rate and morphology will also be recorded.

3:45 PM Performance and Yield of Vegetable Crops Are Affected By Water Flow-Rate in Aquaponics Systems

Teng Yang* and Hye-Ji Kim, *Purdue University*

Abstract: Aquaponics is a rapidly emerging agricultural production system, which recycles effluent from aquaculture to feed crops with nutrients, creating a symbiotic ecosystem for fish, microbes, and plants production in a closed system. Water and nutrients added into aquaponics system are recycled for fish and crop production, and therefore, water flow rate in an aquaponics system may be associated with water environment such as water quality and nutrient availability, consequently affecting the performance and growth of crops grown in the system. In addition, since different crop species have different production periods and nutrient requirement, their performance and yield may be also varied by water environment in an aquaponics system. This study was conducted to investigate the performance and growth of crop species in an aquaponics system with different water flow rates. Six vegetable crops varying in their production period were cultured in tilapia-based aquaponics systems, which include basil (*Ocimum basilicum*), chia (*Salvia hispanica*), Tokyo Bekana (*Brassica rapa*), lettuce (*Lactuca sativa*), mustard (*Brassica juncea*) and Swiss chard (*Beta vulgaris*). Water flow rates were set at low (1000 L/day, LFR), medium (2000 L/day, MFR), and high (3000 L/day, HFR). Fish were fed once a day with fish feed by 1% fish fresh weight. Water quality parameters (dissolved oxygen (DO), mg·L^{-1}; temperature, °C; pH; electrical conductivity (EC), µS·cm^{-1}) were measured daily. The pH was adjusted by using a mixture of potassium hydroxide and calcium hydroxide (v:v=1:1) at around 7.0. Water was sampled for total ammonium nitrogen (TAN), nitrite, nitrate, and phosphate measurements every three days. Photosynthetic rate (Pn) and leaf temperature were measured at the third week when crops showed highest growth rate. At harvest, crop growth parameters were measured, including plant height, leaf length, leaf number, chlorophyll content (SPAD value), and leaf area. Initial and final fresh and dry weights of fish and vegetable crops were measured. Data showed that HFR significantly lowered the pH, EC, water temperature, TAN, nitrate and phosphorus. During the second and third week, the pH in HFR was significantly lower than LFR. EC in HFR was significantly lower than that of LFR from the second week. Particularly, TAN and nitrate concentration was significantly lower in HFR in the first week compared to LFR. Such water environment in HFR improved crop growth in aquaponics. The SPAD and Pn values of crops in HFR/MFR were significantly higher than LFR. Crops in HFR showed significantly higher total dry weight from increased shoot and root dry weights. HFR improved crop performance and yield in aquaponics possibly through enhancing environment for microbial nitrification activities, which might have led to better environment for crops to uptake nitrate and phosphate demonstrated by lower EC and nitrate and phosphate in the effluent. Interestingly, crops in different production periods also showed different growth performance during the study. Fast-growing crops showed significant higher total fresh weight, shoot fresh weight, leaf area, Pn than slow-growing crops. In summary, we concluded that high water flow rate at 3000 L/day improved performance and yield of fast-growing crops in an aquaponics system.

Specified Source(s) of Funding: USDA-AFRI

4:00 PM Effect of Substrate Volumetric Water Contents on Growth and Secondary Metabolite Contents of *Lysimachia Mauritiana* Lam.

Suyun Nam*[1]; Seonghwan Kang[1]; Hyun Jin Kim[2]; Soo-Young Kim[2] and Jongyun Kim[1], *(1)Korea University, (2)National Institute of Biological Resources*

Abstract: Plants of genus *Lysimachia* including *L. mauritiana* L. inhabit in the relatively desiccate environment such as crevice of coast rock, and they are known to have antioxidant, anti-inflammatory, anticancer, and antimicrobial activities due to their flavonol glucosides. This study was conducted to investigate the effect of substrate volumetric water contents on growth and secondary metabolites of *L. mauritiana* which are one of the native plants in Korea. The seeds of *L. mauritiana* provided by Korean National Institute of Biological Resources (NIBRGR0000175023) were sown on 128 plug tray in a greenhouse in May 2017, and the germination rate and days to germinate were 74.2% and 14.8 days. The seedlings were transplanted into 4-inch pots with a soilless substrate (Sunshine Mix4, Sun Gro Horticulture, Agawam, MA, USA) mixed with a controlled released fertilizer (Multicote 6, Haifa Chemicals, Israel) at a ratio of 4g·L^{-1} at 45 days after sowing. After a month of the acclimation period, soil moisture sensor-based automated irrigation system maintained the substrate volumetric water contents at four different levels (0.3, 0.4, 0.5, or 0.6 m^3·m^{-3}) using capacitance sensors and a datalogger. Plant height, number of leaves, leaf area, leaf water potential, chlorophyll content, fresh weight, dry weight, and photosynthetic rate were measured at 0, 5, 11, 18 days after treatment. At 5 days after treatment, there were no significant differences in vegetative growth among all the treatments, but leaf water potential, photosynthetic rate, transpiration rate and stomatal conductance were the lowest in 0.3 m^3·m^{-3} treatment, indicating physiological drought stress. On the contrary, at 11 days after treatment, there were no significant differences in leaf water potential and photosynthetic rate, but all vegetative growth parameters except root dry weight were lower in 0.3 m^3·m^{-3} treatment than those in other treatments. As

substrate volumetric water content decreases, root fresh weight decreases, indicating root water content was affected by substrate volumetric water content. The results at 18 days after treatment was similar to those at 11 days after treatment, which showed significant differences in physiological responses but no significant differences in vegetative growth in most parameters. However, photosynthetic rate was lower in 0.3 $m^3 \cdot m^{-3}$ treatment than other treatments, although there were no differences in stomatal conductance and transpiration rate. It was likely due to severe and continuous drought stress, possibly imposing disorders of certain enzymes related to photosynthesis such as Rubisco. Although there was a slightly increasing tendency in antioxidant capacity under drought at 5 days after treatment, there were no significant differences in total phenolic content and antioxidant capacity among the treatments. When cultivating *L. mauritiana*, the growth and secondary metabolites would be affected by the substrate volumetric water contents, and they could be changed by the duration of drought. To optimize the growth and secondary metabolite contents in plants, further experiments with controlled drought at various levels, imposing times, and the duration of drought may be required.

Specified Source(s) of Funding: This work was supported by grants from Korea University and the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR201820101).

2:30 PM – 4:30 PM *Lincoln East*

Water Utilization and Management 1

Moderator: Damon Abdi, *Michigan State University*

2:30 PM The Change in Photosynthetic Activity and Leaf Water Content of Squash Plants Treated with Bacteria and Methylamine Under Drought Conditions

Ertan Yildirim[1]; Selda Ors[*1]; Melek Ekinci[1]; Metin Turan[2]; Ustun Sahin[1]; Atilla Dursun[1]; Recep Kotan[1] and İbrahim Demir[3], *(1)Atatürk University, (2)Yeditepe Üniversity, (3)Ankara University*

Abstract: In some parts of the world droughts are threatening the supply of fresh vegetable production and currently a major limiting factor in agricultural productivity especially in developing regions. Some prospective strategies for improving drought tolerance may become increasingly more effective if the complex mechanism in the plant could be understood. For this reason, we investigated the change of photosynthetic activity, leaf water content and electrolyte leakage of squash (*Cucurbita pepo* L. cv. Sakız) under different irrigation levels with three different bacteria strains (*Bacillus megaterium* TV-91C, *Bacillus megaterium* TV-6D, *Bacillus subtilis* RK-1900*)* and product of methylamine (MA). Four irrigations levels (Full-irrigation; 100%, irrigation with 85% of the full-irrigation (mild), irrigation with 70% of the full-irrigation and irrigation with 55% of the full-irrigation (severe)) were followed in field. The effects of the applications on photosynthesis (Pn), stomatal conductance (gs), transpiration rate (Tr), concentration of intercellular CO_2 (Ci), electrolyte leakage (EL) and leaf relative water content (LRWC) of squash under water stress were observed.

In full irrigation, the highest gs and Tr were obtained at RK1900+MA application, while the highest Pn and LRWC were recorded at of TV91C+MA application. All the measured parameters were improved by the application of used bacteria and MA application at different drought levels. Also LRWC were increased under different level of droughts as compared to control treatment. In the severe drought level, the highest Ci, Tr and LRWC were obtained at the RK1900+MA application, while the highest Pn were recorded at TV91C+MA application. We found that TV91C was the most effective bacteria on photosynthesis activity that caused 20% increase under full irrigation and 28% increase under severe drought conditions.

Specified Source(s) of Funding: TUBİTAK

2:45 PM Overcoming Barriers to Use of Nursery Run-Off Water: Understanding Plant Sensitivity to Residual Pesticides

Shital Poudyal[*1]; Bert Cregg[2] and Rodney Thomas Fernandez[2], *(1)Michigan State Univ, (2)Michigan State University*

Abstract: Nursery uses a significant amount of water, fertilizers, and pesticides. In the year 2013, nurseries in the U.S. used around 775 million cubic meters of water. The number of the nurseries in the U.S. is increasing which has led to the production of the significant amount of runoff water. Isoxaben, chlorpyrifos, and oxyfluorfen are common pesticides found on nursery run-off water, which if present at a higher level may have adverse effects on nursery plants. Nursery growers are often hesitant to use of runoff water due to concerns about adverse impacts of residual pesticides. Hence our research focused on determining the damage threshold of those pesticides to common container-grown nursery plants. Hydrangea, Cornus, and Hosta are popular nursery plants and vary in the degree of sensitivity to common pesticides. Hence *Hydrangea paniculata* 'Limelight', *Cornus obliqua* 'Powell Gardens', and *Hosta* 'Gold Standard' were used for the study. Levels of pesticide were chosen based on their reported level in runoff water. Application rates for each pesticide were 0, 0.15, 0.35, 0.7 and 1.4 mg L^{-1} of isoxaben, 0, 0.05, 0.1, 0.2 and 0.4 mg L^{-1} of chlorpyrifos and 0, 0.005, 0.01, 0.015 and 0.02 mg L^{-1} of oxyfluorfen. The experiment was conducted in the plastic greenhouse where the temperature was regulated at 20-25°C and 16 hours of photo-period was maintained. The different doses of pesticide were mixed with irrigation water and applied as overhead irrigation. After 3 months of pesticide application plants were compared for their growth by measuring growth index and biomass, and physical damage by visual scoring. Physiological differences were also compared by measuring gas exchange, light and dark-adapted chlorophyll fluorescence and chlorophyll content of leaves. The result shows, the damages to the plants were pesticide and species-specific. Oxyfluorfen had the greatest damage and the hydrangea was the most susceptible species. Chlorpyrifos and isoxaben never had any growth differences or visual deformities.

Specified Source(s) of Funding: PROJECT GREEN, MDARD

3:00 PM Quantification of Paclobutrazol in Recirculated Water in Commercial Greenhouses

Rosa E. Raudales[*], *University of Connecticut*; Jennifer Boldt, *USDA-ARS*; James Altland, *USDA-ARS, MWA ATRU* and Paul R. Fisher, *University of Florida*

Abstract: Recirculation of irrigation water bears the risk of introducing residual concentrations of chemicals from overspray, runoff, and substrate leaching into water, which can reduce commercial quality of subsequent crops. Paclobutrazol is commonly used in the ornamental industry to regulate plant growth. Label concentrations for paclobutrazol application are lower for drench applications than foliar applications mainly because paclobutrazol moves in the plant through the xylem (bottom-up) and not through the phloem. Low concentrations of paclobutrazol in water applied via sub-irrigation systems can significantly reduce crop size. The objective of this project was to quantify residual concentrations of paclobutrazol in recirculated water in commercial greenhouses and determine potential risks of recirculating irrigation water. We collected water samples from irrigation catchment tanks or ponds in commercial greenhouses dedicated to ornamental plant production and measured paclobutrazol using gas chromatography-mass spectrometry. Paclobutrazol levels were 30% higher in spring compared with autumn. Paclobutrazol levels in recirculated water across operations reached up to 77.2 ppb and 4.3 ppb in spring and autumn, respectively. Only one sampling time and location exceeded these values in spring (841 ppb). Our results suggest that there is a risk of undesired and uncontrolled growth reduction caused by residual concentrations of paclobutrazol in recirculated water in ornamental greenhouses.

Specified Source(s) of Funding: The Fred C. Gloeckner Foundation, Inc.

3:15 PM Pesticide and Water Movement in Nursery Container Production: Managing Irrigation to Reduce Agrichemical Losses

Damon Edward Abdi[*1]; Bert Cregg[1]; Jim Owen[2]; Francisca O Hinz[3]; Patrick Christopher Wilson[3] and Rodney Thomas Fernandez[1], *(1)Michigan State University, (2)Virginia Tech, (3)University of Florida*

Abstract: Nursery production is input intensive, demanding frequent irrigation and oftentimes multiple applications of pesticides throughout the season. Irrigation water lost to runoff

or groundwater infiltration can move pesticides from production sites and contribute to non-point source pollution. Irrigation can be applied in ways which reduce runoff, such as incorporating micro-irrigation and sensor based technology. In this study, an experimental nursery was created with two 12 m (east to west) by 100 m (north to south) beds raised 60 cm above grade and divided into 8 sections each. The first 25 cm of the beds was backfilled with native soil and graded to the center and to the north or south side, covered with a pond liner, filled with 25 cm washed sand, graded as was the native soil, then covered with a landscape fabric as a production surface. Drainage ports were installed at the low points at the surface and at the subsurface pond liner and piped to collection tanks to collect water from runoff or infiltration. In 2017, three daily irrigation treatments, overhead at 19 mm, spray stake at 2 L per plant, or a set-point between 35% volumetric water content and container capacity, were use to determine water movement via runoff or infiltration. Three tank-mix pesticide applications were made at label rate and using industry standard practices. On 27 June acephate, bifenthrin, isoxaben and mefenoxam were applied; 8 August chlorpyrifos, triflumazole, oxyfluorfen and glyphosate were applied; 29 August prodiamine, glyphosate and thiophanate methyl were applied. The water collected in each tank over a 24 h period was measured to determine concentration and load for nitrogen and phosphorus approximately every 2 weeks and on 0, 1, 2, 4, 8 and 16 days after pesticide application. The movement of each compound in water as a result of irrigation method yielded differences in concentration and load exported from production. Spray stake irrigation reduced total runoff and infiltration water quantity relative to overhead irrigation. Pesticides were detected primarily in runoff water but also occurred in infiltration water. Dynamics of water, pesticide and nutrient movement will be discussed during the presentation.

Specified Source(s) of Funding: SCRI WateR3

3:30 PM Efficacy of Biofungicides to Control Pythium Root Rot and Damping-Off in Hydroponically-Grown Arugula (*Eruca sativa*)

Cora S. McGehee* and Rosa E. Raudales, *University of Connecticut*

Abstract: *Pythium* spp. are the causal agents of Pythium root rot and damping-off in arugula (*Eruca sativa*) in hydroponic systems. Synthetic chemical fungicides are not registered for application in hydroponic solutions and few are registered for application on edibles in greenhouses. The objective of this project was to assess the efficacy of microbial biofungicides on Pythium root rot caused by *Pythium* spp. on arugula in hydroponic systems. Companion (*Bacillus subtilis* GB03), Triathlon BA (*Bacillus amyloliquefaciens* D747), or RootShield Plus (*Trichoderma harzianum* T-22 and *Trichoderma virens* G-41) were applied at label rate to germinated sprouts. One day after treatment, the plants were inoculated with *Pythium* spp. at 1 x 10^5 zoospores per mL. After seven days, we measured root necrosis, disease incidence and severity, fresh and dry shoot, and root weight. All plants inoculated with *Pythium* spp. were smaller by 40.1% or more compared with non-inoculated plants. All plants treated with microbial biofungicides with or without *Pythium* spp. were smaller than the untreated control. Plants inoculated with *Pythium* spp. and treated with microbial biofungicides had lower disease incidence compared with the control. Root necrosis was lower in plants treated with Companion and RootShield Plus. Results from this experiment suggest that beneficial microbes can be introduced in nutrient solutions and reduce the negative effects of Pythium infection. Disease incidence and severity were reduced in most cases. However, plant growth was also reduced when microbial biofungicides were applied. Further research will be conducted to identify if lower microbial biofungicides rates or combined applications can reduce the negative effects of microbial biofungicides in plant growth.

Specified Source(s) of Funding: USDA via the Connecticut Department of Agriculture – Specialty Crop Block Grant #AG151260

3:45 PM Poinsettia (*Euphorbia pulcherrima*) Growth and Root Rot Incidence in the Presence of Biofilm on Irrigation Pipes

Juan Carlos Cabrera* and Rosa E. Raudales, *University of Connecticut*

Abstract: Biofilms are ubiquitous on the inside surface of irrigation pipes. Biofilm in biological filters remove plant pathogens and nutrients from recirculated and wastewater. The objective of this project was to determine if biofilms in irrigation pipes could affect plant pathogens and nutrients from the nutrient solution and therefore affect plant health or quality of poinsettia (*Euphorbia pulcherrima* cv. Classic Red). The experimental design was a blocked split-plot design in which the initial presence or absence of biofilm in pipes was the main factor, and inoculation with *Pythium aphanidermatum* was the sub-factor. The experimental unit consisted of a drip irrigation line with 5 and 6 plants for experimental run 1 (R1) and 2 (R2), respectively. Each block had two polyvinylchloride (PVC) main lines of which one had a pre-established biofilm and the other was made of new unused pipes. The main lines were split in two lines of which one was inoculated with a 5-day old *P. aphanidermatum* and the other had no pathogen. Bacteria attached to the surface, disease incidence, solution and media pH and electrical conductivity, relative chlorophyll content (SPAD), and plant height were measured weekly. Plant height, SPAD, total bract area, total leaf area, and shoot dry weight were measured at harvest. The amount of bacteria attached to the pipe was used as indicator of biofilm presence in the pipes. Interaction between biofilm and Pythium was observed only for disease incidence by week, and SPAD at harvest in the first experimental run. Disease incidence was 58% and 23% in plants inoculated with Pythium compared with 0% in the controls for R1 and R2, respectively. The plants that grew with solution coming from pipes with the pre-established biofilm were 2.7 cm taller, had 4.1 higher SPAD units, and weighed 7.6 g (dry mass) more than the plants irrigated with pipes with no initial biofilm in R1. Overall plants with *P. aphanidermatum* were smaller and had higher disease incidence compared with the control. Plants with *P. aphanidermatum* were 6.7 cm shorter, had 8.8 lower SPAD units, 2,352 cm^{-2} smaller bract area, 2,263 cm^{-2} smaller leaf area, and weighed 26.4 g (dry mass) less than plants without *P. aphanidermatum*. These results suggest that irrigating plants with pipes that contain biofilm may slightly benefit overall plant health.

Specified Source(s) of Funding: This work is supported by Critical Agricultural Research and Extension grant no. GRANT11947449 and Hatch Multistate Accession Number 1004968, project number #CONS00944 from the USDA National Institute of Food and Agriculture.

4:00 PM Quantifying the Stormwater Ecosystem Services of an Urban Plaza with Mature *Taxodium Distichum and Zoysia japonica*

John D. Lea-Cox*[1]; Bruk E. Belayneh[1]; Olyssa Starry[2] and Darren DeStefano[3], *(1)University of Maryland, (2)Portland State University, (3)General Services Administration*

Abstract: We are monitoring green roof and urban tree systems in Washington, DC using wireless sensor networks for the continuous assessment of stormwater performance. One of these systems is at the U.S. Tax Court, where mature bald Cypress trees (*Taxodium distichum*) surrounded by zoysia grass (*Zoysia japonica*), are irrigated using runoff water collected from the roof and a hardscape plaza**.** The objectives of the study were provide daily and seasonal transpiration data for these two plant components, to understand how efficient this urban landscape is in mitigating the cost of potable water for irrigation, and additionally reducing stormwater drainage (impervious) fees, by quantifying the total runoff applied to this landscape on an annual basis. The tree/grass system is planted in a concrete overpass over the US 295 highway that passes underground at that location. Ten replicate Cypress trees and approximately 75m^2 of zoysia are monitored using a combination of soil moisture sensors, flow meters and a number of environmental (weather station) sensors. Data are logged using EM50R radio dataloggers (Meter-Group, Inc, Pullman, WA) on a 5-minute basis, and transmitted to a computer and radio basestation on site. Data are then assimilated into a database and charted graphically using Sensorweb™ software (Mayim, LLC, Pittsburgh, PA). Real-time data are available to irrigation managers over the internet through a password-protected site. Sensor data provide daily rainfall and irrigation inputs, reference evapotranspiration (ETo), and estimated daily crop water use (ETc), from soil moisture (Kc) data at three depths, integrated using the Penman monteith and a water balance model. During 2015, the water use of the cypress

trees totaled 127,213 L compared to 47,438 L for zoysia. During 2016, the water use for cypress vs. zoysia was 152,496 and 61,737 L, respectively and 66,806 and 76,482 L from April through July, 2017. The total value of Stormwater Retention Credits based on the variable contract price in Washington, DC was $20,924, $46,285 and $128,757 for 2015, 2016 and 2017 respectively.

4:15 PM **Remediating Pesticides from Water through Biological Degradation and Adsorptive Mechanisms**

Damon Edward Abdi[*1]; Bert Cregg[1]; Jim Owen[2]; Francisca O Hinz[3]; Patrick Christopher Wilson[3] and Rodney Thomas Fernandez[1], *(1)Michigan State University, (2)Virginia Tech, (3)University of Florida*

Abstract: Pesticides subject to runoff from agricultural production contribute to non-point source pollution, where the effects on human and ecosystem health are of concern. Treating agricultural effluent prior to off-site discharge, or for recycling as irrigation, stands to benefit the environment and increase the sustainability of plant production. Agrichemicals can be remediated from water through microbially-mediated breakdown, as well as through sorption. In this study, a two-stage treatment system was constructed combining both processes, with water being provided at a consistent flow-through rate of 1.3 Liters per minute for a total of 625 Liters per day. Woodchips served as a carbon substrate in the first stage to allow the proliferation of denitrifying and pesticide degrading microbial communities, while a calcined shale product was used in the second stage as the sorptive medium. Simulated runoff containing representative amounts of fertilizer and pesticides were supplied to the treatment systems, with influent and effluent concentrations measured at each stage. Initially an incubation period with influent containing only nutrients (20 ppm nitrate, 3 ppm phosphate) was provided to allow development of microbial populations prior to incorporation of three pesticides, oxyfluorfen, chlorpyrifos, and bifenthrin at rates between 1 and 2 ppb. At critical stages throughout the study, the microbial communities in the treatment systems were isolated and comparisons were made between the consortiums found in the nutrient only and the nutrient and pesticide treatments. Throughout the course of the study, effluent contents were monitored to determine the effects on the microbial communities and the saturation point of the sorptive materials. The remediation potential of nutrients and pesticides by these treatments will be presented, as well as population shifts in microbial communities throughout the study.

Specified Source(s) of Funding: WateR3, Project GREEEN, MDARD (Michigan Department of Agriculture and Rural Development)

3:00 PM – 3:45 PM

B.Y. Morrison Memorial Lecture: Professor Sir Peter Crane

International Ballroom West

Coordinator: Kim Kaplan, *U.S. Department of Agriculture*

Moderator: Chavonda Jacobs Young, *ARS*

3:00 PM **The Future of Plants**

Peter Crane[*], *Oak Spring Garden Foundation*

Abstract: Plants are indispensible for human survival, and the diversity of plants on our planet is an extraordinary gift bequeathed to us by 450 million years of plant evolution. However, the fundamental importance of plants remains insufficiently recognized and in the face of rapid global change the variety of plant life, both at the level of species and populations, is steadily being eroded. In this lecture I will review the diversity of plant life, its current status, the threats it faces, and ongoing patterns of change. I will also offer a personal perspective on some current attempts to conserve and use plant diversity in sustainable ways, including efforts by botanic gardens and arboreta around the world. On a planet dominated by people the future of plants is in our hands. It remains to be seen whether we have the wisdom and will for meaningful action that will secure the future for plants, and for ourselves.

3:00 PM – 4:00 PM *Oak Lawn (Lobby Level)*

Tropical Horticultural Crops (TROP) Meeting - Open to All Attendees

Chair: Alan H Chambers, *UNIVERSITY OF FLORIDA*

Objectives:

To discuss the culture, postharvest physiology, and processing of tropical fruits, vegetables, herbs, spices, condiments, pharmaceuticals, flavors, fragrances, latex, nuts, oils, beverages, and underutilized horticultural plants.

3:30 PM – 4:30 PM *Boundary (Terrace Level)*

Horticulture Hall of Fame Selection Committee Meeting

Chair: Mary Peet, *USDA-NIFA*

Members: Mary Albrecht, *University of Tennessee*; Michael Arnold, *Texas A&M University*; John Dole, *North Carolina State University*; Mary Meyer, *University of Minnesota*; Thomas Ranney, *North Carolina State University, Dept. of Horticultural Science*; Paul Read, *University of Nebraska*; William Lamont, *Pennsylvania State Univ*; Carl Sams, *The University of Tennessee* and Dewayne Ingram, *University of Kentucky*

3:30 PM – 4:30 PM *Jay (Lobby Level)*

Media Communications Committee Meeting

Chair: Kent Kobayashi, *University of Hawaii at Manoa*

Members: Christopher J. Currey, *Iowa State University*; Alicain Carlson, *North Carolina State University*; Sam E. Wortman, *University of Nebraska - Lincoln*; Christine H. Coker, *Mississippi State University Coastal Research and Extension Center*; Marc van Iersel, *University of Georgia*; David Kopsell, *Illinois State University*; Hunter Hammock, *University of Tennessee*; Anne Plotto, *USDA-ARS* and Casey Barickman, *Mississippi State University*

3:45 PM – 4:15 PM

B.Y. Morrison Reception

International Ballroom West

Coordinator: Kim Kaplan, *U.S. Department of Agriculture*

4:00 PM – 4:30 PM *Lincoln West*

Consumer Horticulture and Master Gardeners (CHMG) Meeting - Open to All Attendees

Chair: Sheri Dorn, *University of Georgia*

Chair-elect: Natalie Bumgarner, *University of Tennessee*

Secretary: Esther E. McGinnis, *North Dakota State University*

Objectives:

To become familiar with cooperative extension home horticulture programs within the United States, to identify and develop the ability to respond to home horticulture information needs, and to improve methods of information delivery to home horticulture audiences.

4:00 PM – 4:30 PM *Jefferson West*

International Horticultural Issues & Networking (IHIN) Meeting - Open to All Attendees

Chair-elects: John Griffis, *Florida Gulf Coast University* and E. Vanessa Campoverde, *University of Florida Extension, Miami-Dade County*

Secretary: Sofia Carvalho, *University of Florida*

Objectives:

To provide a forum for the exploration, discussion, and exchange of information on global issues of vital concern to horticulturists in all divisions and disciplines; to provide a potential mechanism through concerted action for input into decision and policy making processes at the national and international levels.

4:00 PM – 5:30 PM

Project Leaders — National Strawberry Sustainability Initiative Program

Piscataway (Lobby Level)

Objectives:

Presiding: Curt Rom

4:00 PM – 5:45 PM *Georgetown West*

Fruit Breeding 1

Moderator: Sujeet Verma, *University of Florida*

4:00 PM Analysis of Main Quantitative Characters and Study on Breeding Index of *Camellia Oleifera* Abel. Fruits

Yongzhong Chen*; Yanming Xu; Li Ma; Xiangnan Wang; Shaofeng Peng; Rui Wang; Yinghe Peng; Zhen Zhang; Zhigang Li; Wei Tang and Meiqun Li, *Hunan Academy of Forestry, National Engineering Research Center for Oil-tea Camellia*

Abstract: The size, weight, seed rate and oil content of fruit are great value to the breeding in *Camellia oleifera*. In the study, 12 main quantitative characters of 1361 *Camellia oleifera* fruits were studied through variation analysis, probability grading, and the correlation analysis. The 12 main quantitative characters included seed number per fruit, single fresh fruit weight, fruit diameter, fruit height, pericarp thickness, the number of 500g fresh seed, water content of dry seed, seed rate in fresh fruit, dry seed rate in fresh fruit, oil content of dry seed, oil content of fresh fruit, oil content of dry kernel. The results showed that variation was observed in the quantitative characters of fruit obviously, coefficients of variation of the 12 quantitative characters were all between 12.70% and 40.97%. Among them, the coefficients of variation were high in the number of 500g fresh seed (40.97%), single fresh fruit weight (40.04%), seed number in a fruit (37.61%) and oil content of fresh fruit (36.67%). The coefficients of variation were low in the fruit diameter (14.88%), fruit height (14.10%) and oil rate of dry kernel (12.70%). According to the K-S test, fruit diameter, fruit height, pericarp thickness, oil content of dry seed, seed rate in fresh fruit, water content of dry seed and oil content of dry kernel all conformed to the normal distribution (Sig. Value>0.05). Dry seed rate in fresh fruit conformed to the chi-square distribution (Sig. Value>0.05). Seed number in a fruit, single fresh fruit weight, the number of 500g fresh seed and oil content of fresh fruit did not conform to the normal distribution (Sig. Value<0.05). Seven quantitative characters that obeyed to the normal distribution could be divided into 5 grades by 4 dividing points (X-1.2818S), (X-0.5246S), (X+0.5246S), (X+1.2818S), while other four characters could be divided into 5 grades according to the actual distribution. There was highly significant positive correlation between oil content of fresh fruit with seed rate in fresh fruit and dry seed rate in fresh fruit (P<0.01), and negative correlation between the number of 500g fresh seed and pericarp thickness. According to the probability grading, the breeding targets were divided into five categories including high oil content, high seed, big seed, thin pericarp and large fruit shape, and these targets were also divided into the excellent level and superior level these breeding indicators could be divided into two levels.

Specified Source(s) of Funding: State Forest Administration of the People's Republic of China, Forestry industry research special funds for public welfare projects (201404702)

4:15 PM Genomic Selection for Complex Traits in Strawberry Breeding at the University of Florida

Sujeet Verma*; Luis Osorio; Salvador A. Gezan and Vance M Whitaker, *University of Florida*

Abstract: Genomic selection (GS) has been demonstrated as an effective method for increasing genetic gains for traits with complex genetics in animals and plants. However, its application in horticultural crops has been limited. The application of GS in the University of Florida strawberry breeding program was evaluated in a series of annual trials established from the 2013-2014 season until the 2017-2018 season at the Gulf Coast Research and Education Center in Balm, Florida. These trials comprised more than 2200 field-tested seedlings and selections, which were genotyped using Affymetrix SNP Axiom® arrays. Differences among GS methods were found, and on average the predictive ability (PA) of genomic breeding values (GBV) for true validations, across methods and across years, was moderate to high ranging from 0.3 for total marketable yield to 0.5 for average fruit weight. As data were aggregated from multiple breeding cycles in the training population, the PA increased for all traits in test populations. Between 500 and 1000 randomly selected markers resulted in more than 85% of the PA obtained with 8000 markers. In addition, within-family selection of seedlings generated gains from 4% to 16% above the family mean by selecting the top 10% of predicted individuals within families. Genomic selection has been effectively integrated into the UF strawberry breeding program for parental selection, decreasing the length of the breeding cycle, with strong potential for additional gains via seedling selection if cost-effective, low-density, genotyping can be obtained.

4:30 PM An Overview of Recent QTL Discovery for Disease Resistance and Flavor in the UF Strawberry Breeding Program

Sujeet Verma*; Natalia Salinas; Jonathan Nelson; Chris Barbey; Natalia Peres; Kevin M Folta and Vance M Whitaker, *University of Florida*

Abstract: Variable temperature and humidity in central Florida provide challenges for maintaining fruit quality and disease-free conditions in strawberry (*Fragaria ×ananassa*) production. The present study investigates the genetic architecture of resistance to charcoal rot (CR) caused by *Macrophomina phaseolina*, anthracnose fruit rot (AFR) caused by *Colletotrichum acutatum*, and fruit volatile compounds in the University of Florida (UF) strawberry breeding program. Clonal replicates of more than 1100 seedlings from 73 full-sib families were control-inoculated with *M. phaseolina* during two consecutive growing seasons in Florida, and clonal replicates of more than 700 seedlings from 38 full-sib families were controlled inoculated with three isolates of *C. acutatum*. In addition, five crosses were evaluated for fruit volatile compounds. Phenotyping of disease resistance was conducted weekly, rating plant collapse for CR and fruit incidence for AFR. Population-wide volatile metabolomics were generated via SPME-GC/MC with statistical alignment via Metaling software for flavor compounds. Genotyping was performed using Axiom® IStraw90 and IStraw35 SNP arrays. A pedigree-based analysis was performed for genome-wide QTL detection using FlexQTL™. Two major-effect loci, *FaRMp1* and *FaRMp2*, on linkage groups (LG) 2AII and LG 4B, together explained 58% of the phenotypic variation in mortality due to CR; a single large-effect locus, *FaRCa1*, for AFR on LG 6B explained 51% of phenotypic variation for AFR incidence; and a major QTL for Linalool along with several other moderate-effect QTLs for other flavor compounds were detected. Validation of these loci may facilitate development of marker-assisted breeding tools and techniques for these traits.

4:45 PM Identification of QTLs for Phenological Traits in Peaches

Zena Rawandoozi*[1]; Timothy Patrick Hartmann[2]; Ksenija Gasic[3]; Lichun Cai[4]; Nahla V. Bassil[5] and David H. Byrne[1], *(1)Texas A&M University, (2)Texas A&M AgriLife Extension, (3)Clemson University, (4)Michigan State University, (5)USDA-ARS Corvallis*

Abstract: Phenological traits of peaches (*Prunus persica* L. Batsch)are important for breeders to evaluate the adaptability in various environments and for the grower to efficiently manage their commercial orchards. Pedigree-based analysis (PBA) using Visual FlexQTL software was conducted on a total 162 individuals (143 F_1 seedlings and 19 founders and parents) grown in four environments (CA 2011, CA 2012, TX 2012, and TX 2013). A 9K SNP Illumina array was used for the genotyping. The objective of this study was to identify and compare quantitative trait loci (QTL) for three phenological traits including days to bloom (DTB), ripe date (RD), and fruit development period (FDP). The results showed that twenty-one QTLs were mapped for the three traits with strong [2*ln*(BF)>5] to decisive [2*ln*(BF)>10] evidence across the four

environments of phenotypic evaluations. Four QTLs were located on linkage group (LG) 1, and two QTLs were on each LG4, and LG7 for DTB. Six QTLs were identified on LG4 for RD. Lastly, six QTLs were found on LG4 and one on LG6 for FDP. QTLs on LG4 for FDP in TX 2012 and CA 2012 were co-localized, and both overlapped with RD in TX 2013 and CA 2012. The proportion of phenotypic variance explained (PVE) by a QTL for the three traits ranged from 18.5 to 95.4%. These results of identifying QTLs for these traits have validated QTLs that were previously reported in other breeding programs. This study would help peach breeders to develop DNA marker test and enable implementing marker-assisted breeding for developing new peach cultivars.

5:00 PM Mapping QTLs for Peach (*Prunus persica*) Leaf Resistance to Bacterial Spot [*Xanthomonas Arboricola* pv *Pruni* (*Xap*)] and Determining the Diversity and Virulence of a United States *Xap* Collection

Maxwell W. Vonkreuzhof*, *University of Arkansas*

Abstract: Bacterial spot, caused by the bacterium *Xanthomonas arboricola* pv. *pruni* (*Xap*), is a threat to the plum (*Prunus domestica* L), cherry (*P. avium* L.), and peach (*P. persica* L.) industries. This disease causes premature defoliation, reduced vigor and productivity, and yield loss due to unmarketable fruit in peaches grown in humid regions around the world, including the Eastern U.S. Recommended cultural practices to control *Xap* include removal of infected tissue and application of bactericides containing a mix of copper and oxytetracycline. The development of bacterial spot resistant peach cultivars could help to mitigate the environmental and health risks of bactericides while reducing input costs for growers. Because *Xap* pressure varies from year to year depending on environmental conditions and disease incidence is low in some important breeding sites, molecular markers associated with bacterial spot resistance can help breeders to develop resistant cultivars efficiently. Markers for fruit resistance to bacterial spot have been developed from quantitative trait loci (QTL) discovered on linkage groups (LG) 1 and 6 as part of the RosBREED project and are currently used in the University of Arkansas System Division of Agriculture (UA) and Clemson University peach breeding programs. However, no markers associated with foliar resistance to bacterial spot have been developed. Seven populations and their parents (n = 210), were evaluated for fruit and foliar resistance in 2017 as part of a genomewide association study (GWAS). Phenotypic data included visual ratings of fruit and leaves infected with natural inoculum at the UA Fruit Research Station in Clarksville, AR and a detached leaf bioassay performed in the lab under sterile conditions. All individuals were genotyped with 16K peach genotyping array and GWAS was performed using a Q+K model. Foliar resistance was quantitatively inherited and controlled by several small-effect QTL located on chromosomes 1, 3, 4, 6, and 8, each explaining 5-15% of observed phenotypic variation. Only one QTL for fruit resistance was found on chromosome 5 in a position overlapping with the IndelG locus controlling fruit pubescence. Several of the populations evaluated contained both peaches and nectarines, and nectarines had more severe fruit symptoms on average. This experiment will be repeated for a second year during 2018.

Specified Source(s) of Funding: RosBREED

5:15 PM Fruit Quality Trait Locus Genotypes in Apple from Rosbreed's SNP Array Data

Alexander Schaller*; Stijn Vanderzande and Cameron Peace, *Washington State University*

Abstract: Breeding done by today's apple breeders has been greatly improved by DNA-informed breeding techniques, such as marker-assisted selection. Marker-assisted selection uses DNA-based markers to identify parents and seedlings that have favorable allelic combinations. DNA-based markers are locus-specific tags that reveal polymorphism in DNA sequences. Markers are available for a range of traits including biotic stress resistances, productivity, and fruit quality. For efficiency in marker-assisted seedling selection, trait-predictive markers are usually run a few at a time on families as "DNA tests", but genetic information about parents is needed first. SNP arrays have become a preferred platform for elite germplasm (cultivars, collection accessions, parents and selections). SNP arrays can provide much more genetic information on germplasm individuals than each DNA test is able to. Currently, SNP data in apple do not automatically provide trait locus genotypes, thus translation of SNP data into haplotypes that are associated with each trait locus allele is needed. This study aimed to associate SNP haplotypes with alleles of fruit quality trait loci of apple, as part of the RosBREED project. Haplotypes spanning trait loci in cultivars from 8K SNP array data were compared with alleles for these cultivars known from previous use of DNA tests or from characterized QTLs. Expected inheritance was confirmed across numerous generations and families. Allelic combinations of each germplasm individual were determined. This information enables breeders to understand the sources of jewels in their germplasm and efficiently reveals the genetic value of each breeding individual.

Specified Source(s) of Funding: RosBREED

5:30 PM Quantitative Trait Loci for Fruit Quality Attributes and Cold Hardiness in Muscadine Grape (*Vitis rotundifolia*)

Margaret Worthington*; Jennifer Lewter and John R. Clark, *University of Arkansas*

Abstract: Muscadine grapes, *Vitis rotundifolia* Michx. subgenus *Muscadinia* Planch. (2n=40), are a disease-resistant specialty crop native to the southern United States. Large berries, balanced fruity flavor, dry picking scar, and cold hardiness are important breeding objectives of the University of Arkansas fresh-market muscadine breeding program. The development of predictive molecular markers for these traits would assist breeders in planning crosses and selecting promising seedlings early in the breeding pipeline. The objective of this study was to identify quantitative trait loci (QTL) for fruit quality attributes in two F_1 muscadine populations ('Supreme' x 'Nesbitt' and 'Black Beauty x 'Nesbitt') segregating for many important traits. Ten mature berries were harvested from 172 progeny in each mapping population and evaluated for berry weight, soluble solids content, pH, and titratable acidity at the University of Arkansas Fruit Research Station during 2011 and 2012. The proportion of berries in each sample with a dry picking scar was recorded during the 2011 season. The severity of winter injury to each vine was visually assessed on a 1-5 scale during June 2017, after low temperatures dipped below -10° C on four nights during December 2016 and January 2017. A high-density consensus linkage map consisting of 2346 markers in 20 linkage groups (LG) with a total length of 2164 cM was created using genotyping-by-sequencing (GBS) data from both populations. Quantitative trait loci were identified by analysis of traits combined over populations based on the consensus map. A large effect QTL explaining 15 to 30% of variation for berry weight in each population during 2011 and 2012 was mapped to LG 2. This QTL co-localized with the muscadine sex locus, with pistillate progeny producing larger fruit on average than perfect-flowered progeny. Overlapping QTL explaining 9 to 16% of variation for soluble solids content, titratable acidity, and pH measured in 2011 were mapped to LG 6. Separate overlapping QTL identified for SSC, TA, and pH in the 2012 season were mapped to LG 17 and explained 10 to 16% of trait variation. Three QTL for dry picking scar were found on LGs 3, 6, and 11, with the largest effect QTL on LG 6 accounting for 22% of trait variation in the 'Supreme' x 'Nesbitt' population. A QTL explaining 10 to 16% of variance in cold hardiness was also mapped to LG 6. The saturated linkage maps and QTL reported here lay the groundwork for marker-assisted breeding in muscadine grapes.

Specified Source(s) of Funding: Southern Region Small Fruit Consortium, SRSFC Project # 2012-02.

4:00 PM – 5:45 PM *Georgetown East*

Nursery Crops and Floriculture: Diseases, Insects, Breeding and Taxonomy

Moderator: Michael Schnelle, *Oklahoma State University*

4:00 PM Neonicotinoid and Pymetrozine Residues and Affects on Bees

Vera Krischik*, *University of Minnesota*

Abstract: Neonicotinoid residue in greenhouse plants may alter bee behavior. Imidacloprid residues in pollen of *Ruellia* at 5 wks (267 ppb) decreased 50% by 10 wks (125 ppb); *Calibrochoa* at 5 wks (492 ppb) decreased 80% by 10 wks (96 ppb); and dinotefuran residue at 5 wks (748 ppb) decreased 88% by 10 wks (96 ppb).

These levels may alter survival or behavior in bees. Pymetrozine (Endeavor) residue at 5 wks (126 ppb; 1/9) decreased 100 % by 10 wks and its use use will reduce insecticide exposure to bees. These data support the FOE Gardeners Beware reports that showed 62% of purchased plants can contain neonicotinoid residue (2 to 879 ppb).

Specified Source(s) of Funding: MNLA MN nursery landscape association + MN sate funds

4:15 PM Battling Rose Rosette Disease in the Great Plains

Michael A Schnelle*[1]; Jennifer D Olson[1]; Jason J. Griffin[2] and Lynda Carrier[3], *(1)Oklahoma State University, (2)Kansas State University, (3)oklahoma state university*

Abstract: Michael A. Schnelle*[1], Jennifer Olson[2], Jason Griffin[3] and Lynda Carrier[1]

[1]358 Agriculture Hall, Department of Horticulture and Landscape Architecture, Oklahoma State University, Stillwater, OK 74078, [2]127 Noble Research Center, Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater, OK 74078 and [3]1901 East 95th Street South, John C. Pair Horticultural Center, Kansas State University, Haysville, KS 67060

Rose rosette disease (RRD) was first reported in the United States in 1940. Since then, the disease has become widespread east of the Rocky Mountains particularly with the advent of free-blooming cultivars that landscapers utilize in virtually every project. Even though the causal agent was identified in 2011 and a better understanding now exists of the eriophyid mite that transmits the rose rosette virus, RRD is still rampant and thus responsible for thousands of dollars in losses to producers, landscapers and ultimately, end consumers. The disease is readily spread through movement of the mite by crawling, wind, or through human-induced physical movement of the mite. Consequently, rose trials were initiated at Oklahoma State University and Kansas State University in 2016. Researchers hope to find commercially available rose cultivars that possess RRD resistance. These selections will be presented to rose breeders for consideration in future breeding programs. In addition to cultivar trials, best management practices are being studied in order to slow progression of this disease. Third year results of rose rosette disease incidence will be reported.

Specified Source(s) of Funding: not applicable

4:30 PM Floral and Plant Growth Characteristics of Zinnia Peruviana Germplasm As a Potential Source of New Zinnias Varieties for Home Gardens

David Denton*[1]; Alexa Wright[2]; Alexander Krings[3] and Julia Kornegay[1], *(1)North Carolina State University, (2)Bayer CropScience, (3)NC State University*

Abstract: The only variety of *Zinnia peruviana L.* that is available commercially is 'Red Spider'. To determine whether other germplasm of potential commercial interest exists within this species, we evaluated 12 accessions of *Z. peruviana* obtained from the USDA Ornamental Plant Germplasm Center and compared them to 'Red Spider'. Six plants of each accession were grown in the greenhouse and evaluated for plant height, internode length, and leaf shape. The flowers were evaluated for floret ray shape, size and color, and number of ray florets per flower. A subset of the accessions were also evaluated in the field for disease resistance compared to 'Red Spider' and other commercial zinnia varieties. Although the *Z. peruviana* accessions evaluated in this study had similar plant and flower characteristics typical of the species, significant differences were found among accessions for plant height, flower size, and floret color. No significant differences were found among *Z. peruviana* accessions for powdery mildew and bacterial leaf and flower spot disease ratings in the field, although their overall scores for disease development were lower than that of other commercial *Zinnia violacea* varieties. Some accessions of *Z. peruviana* showed potential as new zinnia varieties and it is recommended that further studies be done on their commercial value as cut flower and home garden types.

4:45 PM Industry Typos in Plant Nomenclature: The Case of *Zinnia Tenuifolia*

David Denton*[1]; Alexa Wright[2]; Yu Gu[3]; Alexander Krings[3] and Julia Kornegay[1], *(1)North Carolina State University, (2)Bayer CropScience, (3)NC State University*

Abstract: *Zinnia peruviana* L. is a flowering annual native to Central America. An interesting characteristic about this species is that it is the only member of the genus *Zinnia* that is self-compatible except for a popular cultivated Zinnia known as *Zinnia tenuifolia* 'Red Spider'. Curiously, there is no published literature of the discovery of *Zinnia tenuifolia* even though it is listed as a species in seed catalogs. *Zinnia peruviana* was first introduced into cultivation by Phillip Miller, who brought seeds back to England in 1753. It was subsequently described as *Chrysogonum peruvianum* by Carl Linnaeus. Linnaeus later changed the name to *Zinnia pauciflora* L.*,* but this name has since been reduced to a synonym of *Zinnia peruviana*. In 1755, the director of the botanical garden in Vienna, Nikolaus Joseph von Jacquin, was commissioned by Francis I of Austria to undertake a plant expedition to Central America. He returned in 1759, with a number of plant species, including seeds of a wild *Zinnia* species that he described as *Zinnia tenuiflora* Jacq. This name was later reduced to synonymy beneath *Zinnia peruviana*. Today, many seed companies employ various scientific names for *Zinnia* 'Red Spider', including *Zinnia tenuiflora*, *Zinnia tenuifolia*, and *Zinnia peruviana* syn. *tenuifolia,* but the most common name used in seed catalogs is *Zinnia tenuifolia* 'Red Spider'. Considering the lack of a published protologue, the most likely origin of this name is a repeated industry typo of *Zinnia tenuiflora*, where 'flora' was changed to 'folia' to produce *Zinnia tenuifolia*. To test this hypothesis, we compared accessions of *Zinnia peruviana* obtained from the USDA Ornamental Plant Germplasm Center to commercially obtained seed of *Zinnia tenuifolia* 'Red Spider' for leaf dimensions, floret size and color, plant height, and internode length. 'Red Spider' had similar plant and flower morphology to the *Z. peruviana* accessions, and all were self-fertile. A cDNA analysis also revealed a great degree of similarity between *Zinnia peruviana* and *Zinnia tenuifolia* 'Red Spider'. Based on these results, *Zinnia tenuifolia* 'Red Spider' should be considered a selection of *Z. peruviana* and not a distinct species.

5:00 PM Impact of Acibenzolar S-Methyl, a Systemic Acquired Resistance Inducer on Roses and Rose Rosette Disease Severity

Charles B. Riddle; Binoy Babu; Laura Ritchie; Nghi Nguyen; Xavier Martini; Mathews Paret and Gary W. Knox*, *University of Florida*

Abstract: Commercial roses are susceptible to many viral diseases including rose rosette disease and rose mosaic virus disease. Between these two diseases, rose rosette disease is currently a major issue in the U.S rose industry. Rose rosette disease symptoms often appear as leaf distortion, rapid elongation of the branches, severe thorn proliferation, flower mutation, decreased vigor, and death of the plant. Currently, there are no effective methods for reducing the severity of rose rosette disease. Improving host resistance using a plant systemic acquired resistance (SAR) inducer is a potential management strategy, but needs to be evaluated against rose rosette disease. Acibenzolar S-methyl (ASM, Actigard) is a SAR inducer that activates the host plant's salicylic acid pathway that stimulates plant immune defense mechanisms. The objectives of the study were to evaluate the effect of ASM on plant growth and development under commercial field nursery conditions, and to assess the effect of ASM in reducing rose rosette disease severity under greenhouse conditions in the absence of the insect vector (eriophyid mite). In 2016, two cultivars of *Rosa* L., 'Radtkopink' (Pink Double Knock Out®) and 'Meijocos' (Pink Drift®) (N=160), were treated weekly for 12 consecutive weeks with foliar applications of ASM at three rates (0.5, 0.75 and 1.0 oz/A). Continuous weekly applications of ASM at even the highest rates were never fatal to any individual of either rose cultivar. Flowering of either rose cultivar was unaffected by ASM treatment (P=0.05). Other plant parameters were also studied and will be reported. In general, this study has shown ASM is safe for use on roses undergoing containerized nursery production. Foliar application of ASM at 50 mg/L and 100 mg/L significantly reduced rose rosette disease severity compared to the untreated control in two of the three greenhouse trials (SNK, P=0.05). Based on this information, field studies on the impact of ASM to reduce rose rosette disease severity will be a top priority for ongoing research.

Specified Source(s) of Funding: Southern Region IPM

5:15 PM Long-Lasting Protection: Preventing Ambrosia Beetle Attacks Using Insecticidal Netting

Chris Werle[*1]; K. M. Addesso[2]; J.H. (J.C.) Chong[3]; Jason Oliver[2]; C. M. Ranger[1]; Blair Sampson[1] and P. B. Schultz[4], *(1)USDA-ARS, (2)Tennessee State University, (3)Clemson University, (4)Virginia Tech*

Abstract: Exotic ambrosia beetles have been an important problem in ornamental and fruit tree production for decades. Due to their small size, wide host range and season-long period of activity, chemical control measures can be costly and unreliable. Alternate measures of control are needed to protect tree crops. Field trials were conducted in Mississippi, Virginia, Tennessee, Ohio and South Carolina to determine how well a wrap of deltamethrin-treated net can protect flood-stressed trees from ambrosia beetle attacks. Treatments in 2017 included 1) an unflooded negative control tree with no net, 2) flooded positive control tree with no net, 3) flooded tree with an untreated net and 4) flooded tree with a treated net. In 2018, an additional treatment using a finer mesh size was tested with the aim of achieving greater control. In each year, trees were left along the edge of infested forests for ~1 mo, after which counts of completed and abandoned beetle galleries were made along the length of the tree trunks. In 2017, while attacks were significantly lower on trees with treated net as compared with the other flooded trees, some beetles were able to crawl through the treated netting and complete gallery excavations. However, counts of abandoned galleries were significantly higher on the treated-net trees, representing beetles dying from insecticide exposure before they could complete galleries. New data from 2018 trials will be presented.

5:30 PM **Enhancing the Salt Tolerance By Zinc Application in Gladiolus**

Malik Fiaz Hussain Ferdosi[*1]; Hina sarwar[2]; Amna Shoaib[2] and M Kashif[2], *(1)University of the Punjab, (2)Institute of Agricultural Sciences University of the Punjab Lahore Pakistan*

Abstract: The aim of this study was to investigate the response of Gladiolus grandiflorus to zinc (2, 4 and 6 mg kg-1) application and various salinity levels (2, 4 and 4 dS m-1) of irrigation water. The analysis results of morphological and growth attributes of Gladiolus indicated significant reduction in the investigated attributes with increased in salinity, while zinc application alleviated the stress by increasing morphological and growth parameters. Furthermore, the study demonstrated that the continuous irrigation of saline water lead to a decrease in membrane stability index and relative water content, these were well-linked with reduction in the enzyme activity. Although soil application of zinc levels decreased the salinity stress, but the most pronounced results were obtained at low level of salinity (2 dS m-1) provided with different zinc doses (2-6 mg kg-1). It is concluded that soil application with zinc may have a potential role for increasing Gladiolus tolerance to salinity stress.

4:00 PM – 6:00 PM *Monroe*

Speed Dating - Industry Careers Explained by Industry Scientists

Speakers: Jeffrey Norrie, *Acadian Seaplants Limited*; Peter Petracek, *Valent BioSciences Corp* and Steven McArtney, *Valent BioSciences Corporation*

Coordinator: Peter Petracek, *Valent BioSciences Corp*

Moderator: Peter Petracek, *Valent BioSciences Corp*

Objectives:

Graduate Students and Young Scientists are invited to this participatory session with Industry Representatives. The presentations will cover the paths to different industry careers and working within the field of science differs in Industry. The session will consist of one hour of talks followed by a reception where students can network with Industry members.Speakers:Dr. Peter Petracek (Valent BioSciences LLC) will present on how to improve your chances of getting an industry job.Dr. Jeff Norrie (Breathing Green Solutions) will discuss his switch of industry positions.Dr. Steve McArtney (Valent BioSciences LLC) will discuss his move from academia to industry.The presentations will be followed by a free reception for graduate students and postdocs sponsored by Industry.

4:15 PM – 5:00 PM *International Ballroom West*

USDA-ARS All-Employee Meeting

4:30 PM – 5:30 PM *Jay (Lobby Level)*

Collegiate Activities Committee (CAC) Meeting

Chair: Stephanie Burnett, *University of Maine*

Members: Kimberly Moore, *University of Florida/IFAS*; Adam F. Newby, *Auburn University*; Katherine Warpeha, *University of Illinois at Chicago*; David Kopsell, *Illinois State University*; Kent Kobayashi, *University of Hawaii at Manoa*; Dennis Ray, *University of Arizona*; Martha Glenn, *University of Florida IFAS Extension* and Andrew King, *Texas A&M University*

4:30 PM – 5:30 PM *Boundary (Terrace Level)*

International Advisory Council Meeting - Open to All Interested Members

Chair: Elizabeth Mitcham, *University of California Davis*

Member: Mathieu Ngouajio, *USDA-NIFA*

4:30 PM – 5:30 PM *Oak Lawn (Lobby Level)*

Water Utilization and Management (WUM) Meeting - Open to All Attendees

Chair: John Majsztrik, *Clemson University*

Objectives:

To gather and disseminate information on water conservation, crop water requirements, irrigation methods, and efficient and effective water management.

4:30 PM – 6:00 PM *Jefferson East*

Herbs, Spices, and Medicinal Plants

Moderator: Christopher J. Currey, *Iowa State University*

4:30 PM **Growth and Strobile Yield Among 20 Hop (*Humulus lupulus*) Cultivars Utilizing a Traditional Tall-Trellis Production System in Florida**

Brian Pearson[*], *University of Florida, Mid-Florida Research and Education Center*

Abstract: Hops are a perennial, herbaceous climbing specialty crop cultivated for their strobiles or cones for use in food, tea, and craft beer products. Hops function as an antimicrobial preservative in beer and food due to the unique compounds they contain. Hops also impart unique flavors and aromas that are important to production of craft beer. Although hop production in the United States (U.S.) is centered within the Pacific Northwest with greater than 12,000 ha in production, increased demand has generated a need for expanded commercial production in non-traditional areas. The objective of this research was to quantify the influence of hop variety on growth and strobile yield when cultivated in the southeastern U.S. state of Florida utilizing a traditional tall-trellis production system. Three hundred sixty hops comprised of 20 cultivars were transplanted on 18 July 2016 into native deep sand soil (Tavares-Millhopper soil series) and trained onto a 6 m tall-trellis production system located in Apopka, Florida. Bine length, strobile yield, and hop oil content were recorded during 2016 (Year 1) and 2017 (Year 2). Significant differences (P<0.001) in hop bine length was observed among cultivars for both years. Dry strobile mass ranged from 1.2 to 12.8 and 5.7 to 44.0 g plant^{-1} for Year 1 and 2, respectively. Oil content was generally lower than reference values for hops grown in the Pacific Northwestern U.S. Despite demonstrated cultivation of hops in Florida, yields were significantly lower than values observed for those cultivated in the Pacific Northwest or other northern U.S. hop producing states. Low cone yields are likely a result of the insufficient day length and warm winters

experienced in Florida that result in premature flowering of hops. Breeding efforts to produce a day neutral hop variety that can tolerate low-chilling hours is likely necessary to provide a commercially viable, economically feasible solution to low yields observed for hops cultivated in Florida.

Specified Source(s) of Funding: Florida Department of Agricultural & Consumer Services

4:45 PM Restricting Irrigation Controls Containerized Culinary Herb Growth

Christopher J. Currey*; Nicholas J. Flax; Alexander G. Litvin and Vincent C. Metz, *Iowa State University*

Abstract: Containerized culinary herbs should be proportional to the container they are produced in so they are aesthetically balanced for marketing and sales. While anti-gibberellin plant growth retardants are commonly used to control containerized-plant growth, they are not labeled for use on containerized herbs and non-chemical growth-control strategies must be used. The objectives of our research were to quantify the impact of restricting irrigation on the growth and tissue nutrient concentration of basil (*Ocimum basilicum* L.), dill (*Anethum graveolens* L.), and parsley [*Petroselinum crispum* (Mill.) Fuss.], and common sage (*Salvia officinalis* L.). Seedlings were individually transplanted into 4.5-inch diameter round containers filled with a substrate comprised of (by vol.) 75% ground sphagnum peat moss and 25% coarse perlite and amended with 5 $lb \cdot yd^{-3}$ controlled-release fertilizer. Plants were watered to container capacity at transplant, allowed to dry down to volumetric water content (VWC) thresholds of 0.15, 0.23, 0.30, 0.38 or 0.45 $m^3 \cdot m^{-3}$ and subsequently maintained at desired setpoints by using a precision irrigation system controlled by soil moisture sensors. Four weeks after seedlings after seedlings were transplanted and irrigation treatments began, data were collected on plant height and width, node number, leaf area, internode and branch length, chlorophyll fluorescence, photosynthesis, transpiration, and conductance. Shoots were harvested and dried for 3 d, after which mass was recorded. For all four species, plant was positively correlated with substrate VWC. However, magnitude of change in response to VWC varied with species. For example, height of basil increased from 24.6 to 29.2 cm (19% increase) as substrate VWC increased from 0.15 to 0.45, respectively. Alternatively, as substrate VWC increased from 0.15 to 0.45, height of parsley increased from 14.9 to 27.1 cm (82% increase), respectively. Other growth responses followed a similar trend. While conductance and transpiration were unaffected by substrate VWC, photosynthesis of basil and parley increased as substrate VWC increased. Similarly, chlorophyll fluorescence of basil, parsley, and sage were indicative of plants that were not stressed, regardless of substrate VWC. Based on the results of our research, restricting irrigation can suppress growth of containerized herbs. However, the magnitude of growth control varies with species and for some species, such as basil, restricting irrigation may not be sufficient as the sole approach to controlling growth.

Specified Source(s) of Funding: Fred C. Gloeckner Foundation

5:00 PM Goji Root Bark Quality Grown in Central Washington State

Kevin Li[1]; Xiaozhong Liu*[2]; Phil Hintz[3]; Robert Li[1]; Maneesh Sharma[2]; Teric Li[1]; Darwin Hintz[3] and Franklin Johnson[3], *(1)Amway Botanical Research Center, (2)Amway Corporation, (3)Trout Lake Farm*

Abstract: *Lycium barbarum* L. and *Lycium chinense* Mill. are two species of goji used to supply root bark (Di GU Pi, mainly Epidermis) for use in Traditional Chinese Medicine (TCM). In China, goji root bark is typically harvested from plants after it has had multiple years of berry production. Therefore, the supply of goji root bark is limited and considered not favorable for traditional supplement industries. In this study, we evaluated goji root bark quality at Trout Lake Farm (TLF), an organic farm located in Central Washington, over a 3-year period (2015-2017). One type of *L. chinense* (sourced locally) and two types of *L. barbarum* ('Guandong' and 'Ningxia') were established in the open-field in June 2015. Roots were harvested at the end of each growing season in October 2015, 2016, and 2017. Root bark was separated from the root cortex, and then milled into powder. Kukoamine B content was measured by HPLC-MS, and was used as a marker to determine the quality of goji root bark. Results showed that among the three goji types grown at TLF, kukoamine B content was the highest in *L. chinensis*, followed by 'Ningxia' and was lowest in 'Guangdong'. Furthermore, the kukoamine B concentrations in each goji root bark type were relatively stable among the three years, suggesting that its biosynthesis was proportional to growth over time. We also measured kukoamine B in 12 commercially-available goji root bark samples purchased in China and compared these results with the TLF results. Among all 15 samples tested, kukoamine B content was consistently higher in the TLF goji root bark, thus indicating that goji root bark produced in Central Washington could be a reliable high-quality supplier of organic goji root bark in high in Kukoamine B for TCM industries around the world.

5:15 PM Restricting Phosphorous Suppresses Growth of Containerized Culinary Herbs

Christopher J. Currey*[1]; Vincent C. Metz[1]; Nicholas J. Flax[1] and Brian E. Whipker[2], *(1)Iowa State University, (2)North Carolina State University*

Abstract: Chemical plant growth regulators (PGRs) are commonly used to control growth of containerized plants. However, commercial PGRs are not labeled for containerized culinary herbs and alternatively growth control strategies must be used. The objectives of our research were to quantify the impact of restricting P on the growth and tissue nutrient concentration of basil (*Ocimum basilicum* L.), dill (*Anethum graveolens* L.), and parsley [*Petroselinum crispum* (Mill.) Fuss.], and common sage (*Salvia officinalis* L.). Seedlings were individually transplanted into 4.5-inch diameter round containers filled with a substrate comprised of (by vol.) 80% ground sphagnum peat moss and 20% coarse perlite and adjusted to a pH of ~6.0 using calcitic limestone. Beginning at transplanting, plants were irrigated with nutrient solutions providing 0, 5, 10, 20, or 40 $mg \cdot L^{-1}$ P formulated from technical-grade compounds. the N concentration was 150 $mg \cdot L^{-1}$ and, along with all other macro- and micronutrients except for P, was consistent across all solutions. Four weeks after seedlings after seedlings were transplanted and P treatments began, data were collected on plant height and width, node number, leaf area and internode and branch length. Shoots were harvested and dried for 3 d, after which mass was recorded and shoots were submitted to a commercial laboratory for tissue analyses. For all four species, plant height and width increased as P increased. However, the relationship between P concentrations and plant height was non-linear. As P concentration increased above 0 plant height increased until a maximum height was achieved height increases plateaued. Height increased for basil, dill parsley, and sage as phosphorous increased from 0 to 20 $mg \cdot L^{-1}$, but did not increase as concentration further increased to 40 $mg \cdot L^{-1}$. Restricting P applications to 5 $mg \cdot L^{-1}$ resulted in plants that were 12.0 cm (29%), 9.0 cm (32%), 4.6 cm (20%), and 6.7 cm (27%) for basil, dill, parsley, and sage, respectively. The effect of P on width followed a similar trend. In addition to height and width, restricting phosphorous also restricted branching and leaf expansion. While P concentrations that produced compact plants also resulted in tissue P concentrations that were below recommendation tissue concentration minimum values, visible P deficiency symptoms were not manifested. The results of this study illustrate that restricting P can suppress plant growth of containerized herbs, resulting in plants that are proportional to their containers and lack visible deficiency symptoms that may diminish retail marketability.

Specified Source(s) of Funding: Fred C. Gloeckner Foundation

5:30 PM Phenylalanine Boosts Brassica Production of Polyphenols for Medicinal Production.

Katherine Warpeha*; Nayfah Thnaibat; Chun-Tao Che and Thomas Park, *University of Illinois at Chicago*

Abstract: Chronic pain caused by injuries or disease impedes performance, and also leads to anxiety, depression and disability. non-opiate, antiinflammatory painkillers need to be developed. Phenotypes of high polyphenol plants in the Brassicaceae have been developed from abiotic stimuli experiments. Vegetatively propagated lines of three plant species used in medicinal or nutraceutical treatments were screened for polyphenol production in specific cell types. Analytical chemistry has permitted identification of polyphenol and other constituents in vegetative material. Polyphenols administered to mice reduce inflammatory pain responses. Analysis of chemical stability indicate specific solvents and concentrations affect shelf life and

mode of administration. Analysis of seeds and seedlings indicate selection criteria based on polyphenols may speed production of useful pharmaceuticals.

5:45 PM Influence of Saline Water Irrigation on Cilantro (Coriandrum Sativum L.) Under Drought Stress

Selda Ors[*1]; Melek Ekinci[1]; Ertan Yildirim[1]; Marc W. van Iersel[2] and Metin Turan[3], *(1)Atatürk University, (2)University of Georgia, (3)Yeditepe Üniversity*

Abstract: Cilantro (Coriandrum sativum L.) is a medicinal and aromatic plant that is widely used around the world. However, little research has focused on cilantro's responses to abiotic stress. Our objective was to quantify interactive effects of drought and salinity on growth, photosynthesis, and mineral content of cilantro. Plants were irrigated with water with four salinity levels (0, 50, 75, 100 mM NaCl) and exposed to three levels of drought (100% (control), 80% (mild drought) and 40% (severe drought) of the water required to reach container capacity). The study was conducted inside a greenhouse. The water content of the growing media was measured before each irrigation event (WET-2 sensor) and the applied water amounts were recorded to determine irrigation water use efficiency (IWUE, fresh weight/irrigation water use).

Increasing salinity levels reduced yield and decreased all gas exchange and vegetative growth parameters. Although the highest yield was obtained from the control treatment, the highest IWUE was found under severe combined stress conditions. Severe drought stress reduced yield by ~30% and 100 mM NaCl reduced yield by ~60% compared to the control treatment, while their combination decreased yield by ~70%. Drought and salinity treatments affected fresh weight more strongly than dry weight, suggesting that yield effects were partly due to differences in plant water content among treatments.

4:45 PM – 6:00 PM Jefferson West

Commercial Horticulture 1

Moderator: Stephen S Deschamps, *University of Florida*

4:45 PM Nitrogen Affects the Growth and Yield of Day-Neutral Strawberry 'Albion' in Low Tunnels

Josh Mays[*], *North Carolina Agricultural & Technical State University* and Sanjun Gu, *North Carolina Agricultural and Technical State University*

Abstract: Strawberry (*Fragaria ananassa*) is a major component of North Carolina agriculture. Strawberry production in the state ranks fourth in the United States, with a total of 2,000 acres in production. Traditionally, the North Carolina strawberry season only has a five to seven-week harvest period that begins in April. Most of the berries produced are grown in an annual plasticulture system with several June-bearing cultivars. Strawberries have proven to be economically sustainable in North Carolina and are popular with consumers year-round. The objective of this study was to investigate if growth and yield will be enhanced by increased nitrogen levels for day-neutral cultivars, paired with low tunnels targeting both fall and spring harvests. In the fall of 2017, research was conducted at the Sandhills Research Station (Jackson Springs, NC) with the day-neutral cultivar Albion. Plugs were planted in standard plasticulture system with low tunnels installed over the beds. The experimental design was a completely randomized design with three replications. Treatments included a single broadcast pre-plant dry application (60 lbs/acre) and eight weekly drip-applied applications (0, 3.5, 7, and 10 lbs/acre). There were substantial interactions in both plant growth and yield with increased nitrogen rates. Market yields were maximized with total nitrogen at 140 lbs/acre with 60 lbs/acre applied pre-plant as a broadcast granular and 80 lbs/acre applied through fertigation for eight weeks, beginning at first bloom. Yield ranges were 0.092, 0.131, 0.137, and 0.168 lbs/plant, yield increase was consistent with increased nitrogen; however, tissue analyses with leaf petioles showed that there was no significant difference in terms of NO_3-N between treatments. Biomass of crowns, leaves, and roots increased with nitrogen rate similar to the market yield. Our preliminary results suggest that growers can get a reasonable fall yield from day-neutral cultivars grown under low tunnels and fed at a relatively higher nitrogen rate.

5:00 PM Strip Planting Cover Crops to Improve Performance of Zone Tilled Organic Vegetables

Anusuya Rangarajan[*1]; Daniel C. Brainard[2]; Ryan Maher[1]; Brian Caldwell[1]; Margaret McGrath[1] and Zachary Sexton[1], *(1)Cornell University, (2)Michigan State University*

Abstract: Reduced tillage systems for vegetables must provide good crop establishment, soil temperatures, moisture and fertility to support desired quality, yields and timeliness of harvest. In more northern climates, zone tillage vegetable systems have shown to balance some of the soil improving benefits of no-till with the well-known advantages of tillage. However, zone tillage must overcome multiple barriers to grower adoption, including high weed pressure, interference from surface residue, and low soil nitrogen (N) availability. Strip planting legumes (in-row) and winter rye (between-row) could advance zone tillage systems for summer transplants by concentrating low residue, high nitrogen in the tilled zone while maintaining high-residue, weed suppressive mulch between-row. Over 4 site-years, we have investigated the effects of overwintering legume cover crops (none, hairy vetch or crimson clover) grown in mixture with cereal rye on N availability, weed suppression, and crop yield in an organic strip-tilled cabbage system. Cover crops were planted in the fall at two locations (NY and MI) in both mixes and alternating strips of legume and rye. In spring, cover crops were then managed by flail mowing, retained on soil surface and zone tilled. We measured cover crop biomass and total N and C:N ratio, weed biomass prior to planting, soil inorganic nitrogen at planting and during crop growth, and weed biomass at harvest and crop yield. Supplemental sidedress N was applied to subplots for each treatment. Winter rye – vetch mixtures had similar total cover crop biomass and total N compared to crimson clover but significantly lower C:N ratio. Optimizing cover crop termination with mowing was challenged by differences in species maturity; crimson clover was terminated later than ideal, since mowing had to match cereal rye anthesis. Strip planted cover crops facilitated zone-tillage by minimizing residue in the zone. Strip planting did not, however, result in yield improvements compared to mixed cover crop planting. Sidedress N provided slight improvement in yield within each cover crop treatment, but did not change ranking of the cover crops.

5:15 PM Developing Adzuki Bean and Quinoa in Irrigated Fields of Eastern Oregon

Ruijun Qin[*], *Oregon State University* and Chengci Chen, *Montana State University*

Abstract: In Eastern Oregon, potatoes and onions are the main high-value crops, which can only be planted every 2-3 years in rotation. Other rotational crops, such as wheat and corn, have endured low commodity prices for the past several years, thus growers' profits are marginal. Therefore, there is a need to increase the rotational crop choices, especially with higher value crops, to increase growers' profits. In fields with Adkins fine sandy loam at Hermiston, Oregon, we conducted field trials to evaluate the possibility of developing adzuki beans and quinoa, which have great marketing potential. One adzuki bean variety and two quinoa varieties were tested. All the crops were grown under two irrigation systems, i.e. central pivot and drip irrigation. For adzuki beans, four fertilization treatments including low-nitrogen rate, high nitrogen rate, manure, and no-fertilizer control with four replicates were studied as in-season fertilization. The first-year results showed that adzuki bean could be a suitable crop for the region, while quinoa failed to produce seeds. The drip irrigation showed great advantages in promoting the crop growth and/or production. The impact of fertilizer was not apparent for the adzuki bean. Further studies are needed towards selecting proper varieties and developing best crop management practices in order to realize the successful crops and ideal production in this region.

5:30 PM Characterization of Microenvironment Optimization By Multi-Colored Plastic Mulch for Winter Strawberry Production in Florida

Stephen S Deschamps[*]; Kevin M Folta; Vance M Whitaker and Shinsuke Agehara, *University of Florida*

Abstract: The strawberry production season in Florida and many other winter production regions is characterized by excessive heat during fall establishment and cool, sometimes freezing, temperatures during peak production. To mitigate seasonal

temperature extremes, new plastic mulch films that are white or metalized in the center and black on the shoulders have been recently developed. Our previous studies demonstrated that these striped plastic mulches improve fruit earliness, allowing growers to advance planting dates from October to September by reducing heat stress during transplant establishment. To characterize microenvironment modification by striped plastic mulches, we monitored several soil and canopy microenvironment variables during the 2017–18 winter strawberry growing season in Balm, FL. We evaluated entirely black plastic mulch (black mulch) against black plastic mulch with either a 51-cm wide white or aluminum center stripe (white-striped and metalized-striped mulch, respectively), using the short-day cultivar 'Florida Radiance'. Bare-root transplants were established in raised beds on 28 Sept. 2017. Thirty harvests were performed from mid-November through February. White-striped and metalized-striped mulches increased the early-season marketable yield by 40% and 52%, respectively, and the total season marketable yield by 26% and 34%, respectively, confirming the beneficial effects of these mulches on strawberry yield and earliness. Root-zone temperatures measured at a 10-cm depth under both striped mulches were reduced by 3°C compared to black mulch throughout the hot afternoons of October and November. For the same time periods, crown tissue temperatures monitored over the striped mulches via a fine-wire thermistor showed a reduction of up to 2 °C compared to black mulch. Spectroradiometric measurements in the late season showed that even within a well-shaded canopy, photosynthetically active radiation reflected by the mulch surface increased by 349% for white-striped mulch and 302% for metalized-striped mulch compared to black mulch. Spectroradiometric measurements also showed that, compared to black mulch, white-striped mulch decreased the ratio of red to far-red light within the canopy, which may play a role in floral bud induction for short-day strawberry cultivars. In summary, the changes in microenvironments with striped mulches can be characterized by cooler soil and crown temperatures during establishment, increased potential light capture, and far-red light enrichment. These results demonstrate that striped mulches optimize microenvironments to a comparable extent and serve as a feasible strategy to improve yield and earliness for winter and spring strawberry producers.

Specified Source(s) of Funding: Florida Strawberry Research and Education Foundation; Imaflex, Inc.

5:45 PM Improving Establishment, Earliness, and Yield of 'Florida Beauty' Day-Neutral Strawberry for Winter Production By Optimization of Early-Season Nitrogen Fertilization and Plant Spacing

Shinsuke Agehara[*1]; Tiare Silvasy[1] and Sana Shahzad[2], *(1)University of Florida, (2)University of Agriculture, Faisalabad*

Abstract: Strawberry growers in Florida generally apply 168–224 kg of nitrogen (N) per hectare during the growing season, starting with 1.96–2.24 kg/ha/d during establishment followed by lower rates at 0.56–1.12 kg/ha/d. The initial high-dose fertilization is beneficial for improving the establishment of strawberry transplants, but this practice must be tailored for each cultivar based on its growth characteristics and nutrient requirements. The objective of this study was to determine the optimal early-season fertilization program for 'Florida Beauty' strawberry, which is a newly developed early-yielding cultivar. Treatments were different durations of the high N fertilization at 2.24 kg/ha/d during the early season: 0, 3, 6, and 9 weeks. After these treatment durations, all treatments were subjected to the lower rate at 1.12 kg/ha/d, providing 149 to 243 kg of N in the growing season. Transplants were planted in the field on Sep. 28, 2017, and harvests were performed 30 times between Nov. 2, 2017 and Feb. 26, 2018. Extending the high N fertilization duration from 0 to 9 weeks accelerated initial canopy development and increased leaf N concentration by up to 8% until late Jan. It also increased the early yield (Nov.–Jan.) by 33% and the total season yield by 28%, while reducing the thrip-damaged fruit by up to 53% in the entire season. These results suggest that extending the durations of the high N fertilization for up to 9 weeks is effective in developing healthy and productive canopy, thereby improving fruit yield and earliness of 'Florida Beauty'.

Specified Source(s) of Funding: Florida Strawberry Research and Education Foundation

4:45 PM – 6:00 PM *Lincoln West*

Plant Biotechnology 1

Moderator: Manjul Dutt, *University of Florida*

4:45 PM Genetic Diversity of M*ortiño* (*Vaccinium floribundum* Kunth) in the Ecuadorian Highlands

María de Lourdes Torres[*]; Pamela Vega; María Mercedes Cobo; Andrea D. Argudo; Andrea Pinos and Dario Ramirez, *Universidad San Francisco de Quito*

Abstract: *Vaccinium floribundum* Kunth, known as Andean blueberry or *mortiño*, is a member of the Ericaceae family and is an endemic shrub of the high Andes in South America. In Ecuador, it is found in tundra-like ecosystems known as *páramos*, between 1600 and 4200m above sea level. This species produces edible berries with ethnobotanic properties for indigenous and rural communities. The uses reported for this species include food purposes, ceremonial beverages and the treatment of disease. *Mortiño* berries are considered an exotic fruit with a high potential of consumption due to their content of anthocyanins, proanthocyanidins and polyphenolic compounds, which have shown to possess antioxidant and anti-inflammatory properties. *Mortiño* is classified as a vulnerable species by the IUCN due to the fragmentation of its habitat. This species has not been domesticated, and its limited propagation capacity has been reported. Probably because of this feature, no attempts to cultivate this plant have been successful. Therefore, biological and ecological studies are needed to implement conservation and cultivation strategies. Furthermore, understanding the interaction of the plant with the bacterial communities of the rhizosphere could contribute to its establishment and subsequent cultivation.

In a previous study, we reported the genetic diversity of *mortiño* using 14 homologous microsatellites markers (SSRs) in nine localities from the provinces of Imbabura, Pichincha and Cotopaxi. For the present study, we have expanded the study area to 22 localities across 10 provinces of the Ecuadorian highlands, using 16 homologous SSRs markers in 85 individuals. Our results revealed a moderately high global genetic diversity (He = 0.75), with most of the diversity (71%) harbored within localities. The analysis of population structure showed three well-defined clusters in the Ecuadorian highlands, each including samples from different localities, suggesting gene flow between them. One exception occurs in the samples from Azuay, which grouped separately—indicating that this grouping could represent a specific gene pool. These results are the basis for our future research related to the identification of the core microbiota in the most genetically diverse individuals from different localities. Understanding the possible interactions between the plant species and its associated rhizosphere microbiota, along with the data of the genetic diversity of *V.floribundum* in Ecuador, could allow us to design conservation plans for this valuable genetic resource in the wild and to design programs for the development of sustainable agronomic systems.

5:00 PM Photosynthetic Influence on Branch Angle-Related Genes

Jessica M Waite[*], *USDA-ARS Appalachian Fruit Research Station* and Chris Dardick, *Appalachian Fruit Research Station, USDA-ARS*

Abstract: Plant architecture is intimately tied to environmental signals. One example of this is the relationship between light and shoot organ orientation. Light is known to affect the angle at which branches grow, and growth angle of branches influences the amount of light to which the plant has access. A number of genetic factors are also known to influence branch angles. Among these are genes in the IGT gene family, which contain *TILLER ANGLE CONTROL1 (TAC1)* and *LAZY1*. Loss of *TAC1* gene expression results in narrow, upright branch angles, whereas loss of *LAZY1* leads to wider or sometimes downward angles. These phenotypes have been shown in a wide range of species, including rice, corn, Arabidopsis, and recently demonstrated by our group in plum (*Prunus domestica*). Here we demonstrate a connection between light and the genetic components underlying branch angle. Dark-grown plants exhibit a phenotype similar to that of *tac1* mutants, which led us to find a number of light-related motifs upstream of the *TAC1* gene. *TAC1* expression is light regulated, does not show a strong circadian rhythm, and is not strongly influenced by Red/Far-Red or Blue light signaling.

However, *TAC1* expression is highly responsive to photosynthetic inhibitors, suggesting that it functions as a target of photosynthetic signals to regulate branch angles in a light-dependent manner.

Specified Source(s) of Funding: AFRI NIFA

5:15 PM Transcriptional Regulation of Flower Senescence

Cai-Zhong Jiang*[1]; Hong Wang[2]; Xiaoxiao Chang[2]; Jing Lin[3]; Youhong Chang[3]; Jen-Chih Chen[2] and Michael Reid[4], *(1)USDA-ARS, (2)University of California, Davis, (3)Jiangsu Academy of Agricultural Sciences, (4)University of California Davis*

Abstract: **Transcriptional regulation of flower senescence**

Cai-Zhong Jiang[1,2], Hong Wang[2,3], XiaoXiao Chang[2], Jing Lin[3], Youhong Chang[3], Jen-Chih Chen[2], Michael S. Reid[2]

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Abstract

Genetic regulatory mechanisms that control natural flower senescence in petunia are not well understood. To identify key genes and pathways that regulate the process, we conducted a transcriptome analysis in petunia corolla at four developmental stages, including fully opened corolla without anther dehiscence (D0), two days after anthesis (2 DAA, fully expanded, D2), 4 DAA with initial signs of senescence (D4), and 7 DAA with wilting (D7). We identified large numbers of differentially expressed genes (DEGs), including 1116 between D2 and D4, a transition to the onset of flower senescence, and 327 between D4 and D7, a developmental stage representing flower senescence. KEGG analysis showed that the auxin- and ethylene-related hormone biosynthesis and signaling transduction pathways were highly upregulated at onset of flower senescence. Ethylene emission was detected at the D2 to D4 transition, followed by a large eruption at the D4 to D7 transition. Furthermore, large numbers of transcription factors (TFs) were activated over the course of senescence. Functional analysis by virus-induced gene silencing (VIGS) experiments demonstrated that inhibition of the expression of TFs, such as ethylene-related ERF, auxin-related ARF, bHLH, HB, and MADS-box, significantly extended or shortened flower longevity. Our data suggest that hormonal interaction between auxin and ethylene may play critical regulatory roles in the onset of natural corolla senescence in petunia.

5:30 PM The Citrus *Flowering Locus T* (*CiFT3*) Gene Results in Precocious Flowering When Overexpressed in the Carrizo Citrange Trifoliate Rootstock

Manjul Dutt*; Wenming Qiu; Kawther Aljasim and Jude W. Grosser, *University of Florida*

Abstract: The genus *Citrus* consists of a group of long lived perennial trees species that have a variable juvenile phase ranging from 3 to 15 years or more. Most commercially cultivated sweet oranges and mandarins have a juvenile phase of more than 5 years. The transition from juvenile to the adult stage is a complex process involving several genes of which the *FLOWERING LOCUS T* (*FT)* is crucial. The *Citrus clementina CiFT3* gene was constitutively expressed under the control of a strong 35s promoter or a weaker NOS promoter. In addition, phloem expression of *CiFT3* was controlled by the AtSUC2 promoter or the gene was induced under control of an *Arabidopsis* heat shock protein (AtHSP) promoter. Genetically transformed carrizo citrange explants expressing the 35S-CiFT3 resulted in precocious flowering in the apical meristems *in vitro* and subsequent death of the explant. Also, 25 transgenic lines expressing *CiFT3* gene under the control of the AtHSP (11 lines) and NOS (14 lines) promoters did not flower even after five years following transformation. Additionally, 14 transgenic plants overexpressing CiFT3 gene constructs under the control of the AtSUC2 promotor were produced, four of which had more lateral branches than wild type and flowered within 16 months following transformation. There were no morphological abnormalities observed in the flowers and they produced viable pollen grains that resulted in self-pollinated seeds. The expression patterns of floral meristem identity genes indicated that *AP1*, *FT*, *LFY* and *SOC1* were significantly upregulated in the transgenic lines that flowered. *TFL* was downregulated in the precocious transgenic lines. Propagation of the 4 transgenic lines either through tissue culture or through mistbed resulted in the production of a large clonal population. These transgenic plants exhibit normal vigor and do not have a problem of terminal dieback. Grafting with juvenile scions will be conducted to evaluate the suitability of these early flowering lines with the hope of enhancing flowering in juvenile citrus scions.

5:45 PM LsGA2ox2 Regulates Lettuce Seed Germination Under Darkness

Heqiang Huo*[1]; Mohan Niroula[2]; Theresa Hill[2]; Juncheng Li[1]; Chi Nguyen[3]; Maria Jose Truco[4]; Ivan Simko[5]; Richard Michelmore[4] and Kent J Bradford[6], *(1)University of Florida, (2)University of California-Davis, (3)University of Florida/IFAS, (4)University of California, Davis, (5)USDA-ARS, (6)University of California*

Abstract: Lettuce seed germination is promoted by light through activation of gibberellin (GA) biosynthesis. A quantitative trait locus for inhibition of lettuce seed germination by the darkness was mapped to chromosome 7 using a RIL population derived from a dark-germinating cultivar (Lactuca sativa cv. “Salinas”) and a light-requiring accession of L. serriola (US96UC23). The LsGA2ox2 gene encoding a GA-inactivation enzyme was located in this QTL region and exhibited distinct expression patterns in Salinas and US96UC23 seeds imbibed in the dark. Nine of twelve SNPs between Salinas and US96UC23 (UC) were within a 93 bp window in the promoter of LsGA2ox2, and the same 9 SNPs were conserved in light-requiring Grand Rapids (L. sativa) and dark-germinating W48 (L. serriola). Expression of ProUCGA2ox2::UCGA2ox2 in Salinas lines resulted in strong inhibition of seed germination in the dark. Site-directed mutagenesis of three SNPs associated with an abscisic acid-responsive motif in the UCGA2ox2 promoter resulted in failure to complement atga2ox2 mutants, suggesting that these SNPs are critical for upregulation of LsGA2ox2 in seeds imbibed in the dark. Knockout of LsGA2ox2 through CRISPR/Cas9 in Grand Rapids or RNAi silencing of LsGA2ox2 in US96UC23 resulted in stem elongation and enhanced seed germination in the dark that are associated GA upregulation. The combination of genetic mapping, mutant complementation, and conserved SNPs implicates degradation of GA by LsGA2ox2 in the inhibition of germination by darkness. Our results may facilitate breeding of lettuce varieties with more uniform germination of pelleted seeds and improve lettuce stand establishment and yield.

4:45 PM – 6:00 PM *Lincoln East*

Plasticulture

Moderator: Annette Wszelaki, *University of Tennessee*

4:45 PM Promoting Productivity and on-Farm Efficiencies in Tissue Culture Red Raspberry System through Biodegradable Plastic Mulches

Huan Zhang*[1]; Carol A. Miles[2]; Shuresh Ghimire[1]; Chris Benedict[1]; Inga A. Zasada[3] and Lisa Wasko DeVetter[1], *(1)Washington State University, (2)Washington State University, NWREC, (3)USDA-ARS*

Abstract: Floricane red raspberry (*Rubus ideaus*) in northwest Washington is traditionally grown in raised beds with weeds managed through a combination of herbicide applications and hand weeding. Tissue culture (TC) raspberry plantings are increasing in Washington due to the availability of new cultivars sold exclusively as TC transplants as well as traditional cultivars becoming available through TC. However, TC transplants are more difficult to establish and cost more than traditional root and cane planting materials; therefore practices that offset these higher establishment costs might be important for overall on-farm economics. The overall objective of this project is to develop knowledge and practical strategies to improve establishment of TC raspberry transplants through application of biodegradable plastic mulches (BDMs) prior to planting. Six treatments, including four BDMs, one non-degradable polyethylene (PE) mulch, and a bare ground (BG) control are being evaluated in a commercial ‘WakeField’ raspberry field planted May 2017 in northwest Washington. Crop growth, weed suppression, mulch performance

[as percent soil exposure (PSE)], soil temperature and moisture, and root lesion nematode (*Pratylenchus penetrans*; RLN) population dynamics were measured in the 2017 season. By the end of the growing season (Oct. 2017), average primocane height and numbers were 36 cm and 5 canes/hill greater, respectively, in all mulched treatments relative to the BG control. Weed incidence was reduced in mulched plots compared to the BG control. No post-plant herbicides or hand weeding were applied to mulched plots, but hand weeding occurred three times in the BG control. PSE at the end of the year was lowest for PE (2%) and ranged from 48% to 72% in the BDM treatments. Soil temperature was on average 1.2 °C higher in all mulched treatments relative to the BG control. When volumetric water content was considered, PE had the greatest soil volumetric water content, while Organix 0.5 (a BDM) had the lowest, and the remaining treatments were intermediate. Average RLN soil and root population densities were 65 RLN/100 g soil and 123 RLN/g root in mulched treatments, and 5 RLN/100 g soil and 44 RLN/g root in the BG control; differences were not significant and plant growth was not decreased. Overall, BDMs and PE mulch performed well for commercial raspberry established as TC transplants. These data indicate that BDMs and PE mulch provide conditions that improve crop growth and weed management compared to the standard practice of herbicide application and hand weeding.

Specified Source(s) of Funding: Washington Red Raspberry Commission and Washington Commission on Pesticide Registration

5:00 PM Impact of Flowable Liquid Lime on Soil pH When Injected through Drip Irrigation

Timothy W. Coolong*, *The University of Georgia*

Abstract: In the southeastern U.S. many vegetable growers produce multiple crops over several years on plastic mulch in order to reduce input costs for the crops grown. Typically a high value crop such as bell pepper (*Capsicum annuum*) or tomato (*Solanum lycopersicum*) will be grown first, followed by lower valued crops such as squash (*Cucurbita pepo*) and even cabbage (*Brassica oleracea var. capitata*). One problem encountered is that there is no practical way to increase the soil pH in the planted bed for second or third crops. Generally limestone-based products are insoluble and not appropriate for injection through drip irrigation. Recently, a finely ground (<0.5 micron) liquid limestone based product (Top Flow 130; Omya, Oftringen, Switzerland) was developed for agriculture use to be injected through drip irrigation tubing. To test the efficacy of Top Flow 130, 0, 94, and 187 $L{\cdot}ha^{-1}$ of product were injected through drip irrigation and soil pH and nutrient content evaluated 7, 17, and 28 d after injection. Soils tests were conducted using the Mehlich 3 extraction method. The study was arranged in a completely randomized design with four replications. Each plot was a plastic mulched bed approximately 24 m-long. Flow rates measured before and after injection were not affected by treatment, suggesting that the liquid lime product did not clog emitters. There were significant interactions between application rate, sampling time, and distance from the emitter for change in soil pH and calcium level. In general, both application rates led to a significant increase in soil pH and calcium concentration at the emitter location and a distance of 10 cm from the emitter. Soil pH and calcium concentrations did not significantly change when measured at 20 cm from emitters. The increase in pH and calcium concentrations at a distance of 10 cm from the emitter were greater in those plots receiving 187 $kg{\cdot}ha^{-1}$ compared to those getting 94 $kg{\cdot}ha^{-1}$ of Top Flow 130. The effects on soil pH and calcium concentrations occurred within 7 d after injection the product, with no significant differences occurring between the 7, 17, and 28 day sampling periods at each sampling location (0, 10 and 20 cm from the emitter). These results suggest that Top Flow 130 could be used to adjust pH in a plasticulture system, but that the effects would occur within a zone of 10 cm on each side of the drip irrigation tubing.

5:15 PM Pepper Production on Biodegradable Mulches in the Southeast

Jennifer Moore and Annette Wszelaki*, *University of Tennessee*

Abstract: Plastic mulch has many benefits (e.g. weed and disease management, increased yield and quality, moisture conservation), but also several drawbacks (e.g. disposal cost, environmental concerns). Biodegradable plastic mulches (BDMs) offer a potential alternative if they can provide similar advantages to polyethylene plastic mulch without the disadvantages of additional labor costs for removal and disposal, contributing to landfill waste and polluting the environment. In a field experiment in 2017, we tested five potentially biodegradable plastic mulches (Experimental PLA/PHA, Organix A.G.: Black, Organix A.G.: White-on-black (WOB), Naturecycle and BioAgri), a creped cellulose mulch (WeedGuardPlus), polyethylene plastic mulch (non-biodegradable) and a no-mulch treatment for their effects on pepper (cv. Aristotle) petiole sap nitrate status, and fruit yield and quality. Additionally, weed assessments were conducted three times during the season (early, mid and late-season), and mulch degradation or percent soil exposure (PSE)- a visual rating of the amount of soil exposed due to mulch degradation- was measured twice monthly over the growing season. Petiole sap nitrate was lower in the white-on-black and paper mulches and bare ground plots at first flower and second harvest (range of 205-281 NO_3N ppm for bare ground, paper and WOB, range of 577-775 NO_3N ppm for the black mulches at first flower). Total season yields for marketable number of fruit per plot ranged from 35.4 to 38.5 in bare ground, BioAgri, PE, WeedGuardPlus and WOB, but were lower in Exp. PLA/PHA, Naturecycle and Organix (27, 18.2, and 27.1 respectively), likely due to severe nutsedge pressure. Nutsedge penetrated all of the mulches, except WeedGuardPlus. The number of weeds per m^2 at the late season weed rating was only 12.1 for WeedGuardPlus and ranged from 37.1-84.2 for all other treatments. The quality parameters of color and soluble solids did not differ among mulch treatments. The paper mulch degraded more quickly than the other mulches and very little, if any, of the mulch could be seen by the end of the season (PSE 100% for WeedGuardPlus, other treatments ranged from PSE of 15% for PE up to 69% for Naturecycle). In spite of this degradation, WeedGuardPlus generally stays intact during the critical weed period (first 4-6 weeks after planting) until the plant canopy fills in, providing nearly season long weed control. With this in mind, it is important to consider the most important benefits to be gained from the BDM before choosing a product.

5:30 PM Life Under Plastic; It's Fantastic: Wavelength-Selective High Tunnel Plastic for Controlling Two Insect Pests in Primocane Fruiting Red Raspberry.

Maria E. Cramer*[1]; R P. Marini[2]; K Demchak[2] and Tracy Leskey[3], *(1)The Pennsylvania State University, (2)Pennsylvania State University, (3)USDA ARS*

Abstract: High tunnels are an increasingly important technology in raspberry production. They protect the crop from rain and low temperatures, lengthening the growing season and improving fruit quality. As high tunnels have become more common, the number of materials available for covering tunnels is increasing. New plastics which block or alter natural sunlight provide growers with options. Some plastics block wavelengths in the ultraviolet and infrared ranges while others diffuse light, scattering it as it enters the tunnel. Polarized and ultraviolet light are used by many insects in navigation. Previous research showed that insect pest populations of several different orders are reduced when greenhouses are covered with UV-blocking plastics. Meanwhile, anecdotal observations indicate that Japanese beetles (*Popillia japonica*) are less problematic in high tunnels than in field-grown raspberries. For these reasons, we investigated the effects of various plastics on two key pests of red raspberries, Japanese beetle and Spotted Wing Drosophila (*Drosophila suzukii,* SWD). Research was conducted in 2016 and 2017. We grew two cultivars of primocane red raspberries, 'Polka' and 'Josephine' in high tunnels with five different plastic coverings plus an uncovered control. All plastics blocked some portion of the ultraviolet and visible range, and one also blocked infrared light. Japanese beetles were removed by hand and counted every day in 2016, and every 5 days in 2017. SWD were monitored with vinegar traps and harvested fruit were incubated to observe emergence of the flies. Foliage temperatures were measured with an infrared thermometer twice during the summer in each tunnel on the east and west sides of the rows. Fruit was harvested three times per week. Mean and cumulative beetle counts were compared for the different plastics, dates, and cultivars. Mean and cumulative trap counts and infestation rates for SWD were compared for the different plastics, dates, and cultivars. Weekly yield, and temperatures were compared between treatments and used as covariates. All plastics significantly reduced Japanese beetles. UV-blocking plastics had the lowest numbers, while the partially UV-blocking plastic which blocked some IR, was not significantly

different from the non UV-blocking plastics in 2017. In contrast, SWD trap numbers were lowest in tunnels that transmitted UV-light in 2017, and highest in those that blocked it. This suggests that SWD do not need UV in order to navigate, and may favor environments without it.

5:45 PM **Plasticulture Equipment Rental/Cash Back Program for N.C. Small Farmers**

Randy A. Fulk* and Sanjun Gu, *North Carolina Agricultural and Technical State University*

Abstract: Growing crops on plastic mulch has been proven to increase yield, reduce chemical weed control inputs, and increase profitability of small farms. Cooperative Extension at North Carolina Agricultural and Technical State University (NC A&T) trains farmers and agents in plasticulture (plastic mulch and drip irrigation) as a production method. To expand the adoption of plasticulture among North Carolina's small scale farmers, NC A&T transformed an existing plasticulture program to increase opportunities for farmers to try plasticulture. Previously an Extension Associate traveled the state, training farmers in plasticulture and assisting with laying plastic mulch. This took vast amounts of the Associate's time and generated a culture of dependency among farmers who relied on NC A&T to provide them with free labor. NC A&T sought improvements to the program and created the Plasticulture Equipment Rental/Cash Back Program for N.C. Small Farmers. Six plasticulture equipment rental locations were established around the state, placing plasticulture equipment within two hours' drive of most NC small farmers. Locations were equipped with a plastic layer small enough for high tunnel use, a larger plastic layer for field use, and a plastic mulch lifter to facilitate removal at the end of the growing season. A rental fee of $50 per day was established, of which 50% is refundable to the farmer upon the return of the equipment clean and undamaged. These fees will serve to generate a dedicated pool of funds at each location for maintenance and repair of the equipment. The anticipated result of this program will be increased adoption of plasticulture as a production method among small farmers. The resulting increases in yield and profits will lead many small farmers to eventually purchase their own plasticulture equipment.

5:15 PM – 5:30 PM

Colorado State University Gathering
Northwest (Lobby Level)

Objectives:

Meet up with Colorado State Alumni, Students and Faculty as we head out for a group happy hour! We will leave at 5:30 PM for a local establishment (walkable from the hotel).

6:00 PM – 7:30 PM

Graduate Student Poster Competition
International Ballroom East/Center

8:30 PM – 10:00 PM

Cornell Alumni Gathering
Northwest (Lobby Level)

7:00 AM – 6:00 PM

Speaker Ready Room - Thursday
Cabinet

7:30 AM – 9:00 AM

ASHS Past Presidents' Breakfast - *by invitation only*
Jay (Lobby Level)

7:30 AM – 5:00 PM

Registration Open - Thursday
Concourse Level Foyer

8:00 AM – 9:00 AM *Oak Lawn (Lobby Level)*

American Pomological Society (APS) Annual Business Meeting

Chair: Michele Warmund, *University of Missouri*

8:00 AM – 9:00 AM *Boundary (Terrace Level)*

Certified Professional Horticulturist Board (CPH) Meeting

Chair: Chad T. Miller, *Kansas State University*

Members: Kerrie Badertscher, *Otoke Horticulture LLC*; Leslie Halleck, *Halleck Horticultural LLC*; Robert Mikkelsen, *International Plant Nutrition Inst*; Richelle Stafne, *USDA-ARS Southern Horticultural Research*; Larry Knerr, *Tanimura & Antle*; David Zlesak, *University of Wisconsin, River Falls* and Dilip Nandwani, *Tennessee State University*

8:00 AM – 9:00 AM

How to Prepare for Your Visit to Capitol Hill - Thursday

Piscataway (Lobby Level)

Coordinator: Thomas Björkman, *Cornell University*

Objectives:

A training session to prepare members who are going to do meetings with legislators and staff on Capitol Hill. The session will include the basic protocol of a successful office visit, some tailoring of your pitch, and a review of where legislation of interest to ASHS members stands at that time. You will be able to have a productive and effective visit. The session will be led by ASHS members who have done many visits, as well as our expert, ASHS legislative affairs consultant Jonathan Moore.

8:00 AM – 9:30 AM

Application of New Breeding Technologies for Improving Horticultural Crops *CEU Approved*

Jefferson West

Coordinator: Guo-qing Song, *Michigan State University*

Moderators: Sanjun Gu, *North Carolina Agricultural and Technical State University* and Youping Sun, *Department of Plants, Soils, and Climate, Utah State University*

Objectives:

Horticultural plant breeding is a process of genetic improvement for meeting various needs of growers and consumers. While traditional breeding technologies continue to be the foundation for crop improvement, advances in marker assisted breeding, next-generation sequencing, and genetic transformation in the recent past have revolutionized plant breeding and offered new and effective ways for plant breeders to manipulate traits at the levels of individual gene(s) or gene blocks. With the help of some of these technologies, virus-resistant papaya and squash have been widely commercialized and virus-resistant plum and non-browning apples, already deregulated by the USDA, are on the horizon to be released. More recently, a new generation of breeding technologies emerges, such as transgrafting, MAB and fast-track breeding, cisgenesis/intragenesis, and genome editing technologies; and several of them have proven very effective for solving problems that are otherwise difficult to combat with the existing breeding tools and technologies. This workshop invites experts to discuss recent progresses and future perspectives of these and other new breeding technologies for the improvement of horticultural plants, with an emphasis on commercial fruit crops.

Description: Genetic engineering (GE) provides powerful tools to improve fruit quality and productivity. This workshop, co-sponsored by Working Group of Asian Horticulture (WGAH) and Plant Biotechnology Group (BTCH), focuses on potential strategies that can be used to increase “fruit productivity”. Five invited speakers will lead the following discussions:

- **Genome editing technologies:** How can genome editing technologies be used to effectively manipulate fruit development process?
- **Cell engineering for fruit breeding:** What are new findings on using somatic hybrids for non-GE fruit breeding?
- **Tree architecture manipulation:** How can genetic manipulation of fruit tree architecture be achieved?
- **Genomics:** What has been revealed about the mechanism of self-incompatibility by genome sequencing?
- **New strategies for high yield:** What is the potential for yield increase by manipulating flowering pathway genes?

These discussions will highlight the potential and practicalities of utilizing new biotechnology strategies for the improvement of horticultural plants.

8:00 AM **Efficient Genome-Editing of Wild Strawberry Genes for Fruit Development**

Zhongchi Liu*, *University of Maryland*

Abstract: **Efficient Genome-Editing of Wild Strawberry Genes for Fruit Development**

Junhui Zhou and Zhongchi Liu, Dept. of Cell Biology and Molecular Genetics, University of Maryland, College Park, MD 20742

The clustered regularly interspaced short palindromic repeats (CRISPR)-Cas9 system is an effective genome editing tool for plant and animal genomes. However, there are still few reports on the successful application of CRISPR-Cas9 to horticultural plants, especially with regard to germline transmission of targeted mutations. We will describe our efforts in developing CRISPR-Cas9 vectors and its high efficiency genome editing in the wild strawberry *Fragaria vesca.* Specifically, we will show results of successful application of CRISPR-Cas9 to mutate the auxin biosynthesis gene *TAA1* and *Auxin Response Factor 8 (ARF8)* and the resulting phenotype. To test germline transmission of the edited mutations and new mutations induced in the next generation, we also analyzed the progeny of the primary (T0) transgenic plants carrying the CRISPR construct. We found normal germline transmission of the mutations induced in the parent generation as well as high efficiency induction of new mutations, including large deletions between the two PAM sites within the same gene. The results indicate that our CRISPR vectors can be used to edit the wild strawberry genome at a high efficiency and open up exciting opportunities for engineering strawberry and related horticultural crops to improve traits of economic importance.

8:20 AM **Recent Advances in Our Understanding of Self-Incompatibility Mechanism in Prunus from a Genome-Wide Analysis**

Takuya Morimoto*, *Kyoto University*

Abstract: Most rosaceous fruit tree species, such as plum, cherry, apple, and etc, show self-incompatibility (SI). SI hinders efficient breeding and cultivation in these fruit tree species. Three plant

families Rosaceae, Solanaceae and Plantaginaceae share the common SI system called the S-RNase-based gametophytic SI, which uses S-RNase and F-box protein as the specificity determinants in pistil and pollen, respectively. Although similar molecules are involved in specificity determination in SI recognition reaction across different taxa, accumulated data suggests the presence of distinct SI recognition mechanisms. While the pistil *S* determinant S-RNase is considered to have a cytotoxic effect against pollen tube RNA in the Rosaceae, Solanaceae and Plantaginaceae, the pollen *S* determinant F-box proteins are suggested to have different functions in genus *Prunus* and in the other taxa that show the S-RNase based SI. Pollen *S* in *Prunus* is assumed to release cytotoxicity of self S-RNase, while in the other taxa, pollen *S* is considered to be involved in S-RNase detoxification. Since the genome sequence information from various plant taxa has been available, we are now able to utilize new approaches such as evolutionary analysis and genome re-sequencing to uncover molecular mechanism of SI. Here, we summarize recent advances in our understanding of SI mechanism in *Prunus* based on the genome-wide analyses.

8:40 AM Biotechnological Approaches to Increase Fruit Productivity--a Case Study on Blueberries

Guo-qing Song*, *Michigan State University*

Abstract: **Biotechnological Approaches to Increase Fruit Productivity--A Case Study on Blueberries**

Guo-qing Song

Plant Biotechnology Resource and Outreach Center, Department of Horticulture, Michigan State University, East Lansing, MI 48824, USA. (E-mail: *songg@msu.edu)*

Blueberries contain high amounts of antioxidants known to be important for human health. Developing new cultivars with different chilling requirement, high cold/heat tolerance, and high yield are the top priorities in blueberry breeding due particularly to the anticipation of climate changes. This presentation will focus on biotechnological approaches to increase productivity of blueberry. Overexpression of a blueberry *DWARF AND DELAYED FLOWERING 1* increased freezing tolerance without a trade-off impact on plant growth. Transgenic blueberries overexpressing a blueberry *FLOWERING LOCUS T* (*VcFT*) were produced and will facilitate FAST-TRACK blueberry breeding. Transgrafting on *VcFT*-overexpressing blueberry plants promoted floral bud formation in nontransgenic scions, and it provides a new approach to increase blueberry yield. Overexpression of the K-domain of a blueberry *SUPPRESSOR of Overexpression of Constans 1* gene increased berry productivity through the interaction of MIKC MADS-box genes. Transcriptome analyses in transgenic and non-transgenic blueberries revealed cold-regulated genes and flowering pathway genes. These studies suggest that manipulation of flowering pathway gene(s) is powerful to increase blueberry productivity.

9:00 AM Cell Engineering and Citrus Genetic Improvement in China

Wen-Wu Guo*, *Huazhong Agricultural University*

Abstract:

ABSTRACT

Citrus is the most important fruit crop in the world and in southern China. Cell engineering holds great potential for citrus genetic improvement. In our program, somatic hybrids from over 50 interspecific and intergeneric fusion combinations were produced which efficiently circumvented the reproductive barriers such as nucellar polyembryony, male/ female sterility encountered in citrus conventional breeding. Numerous autotetraploids, haploids and dihaploids were also produced and identified by SSR markers. Metabolic adaptation following genome doubling in citrus doubled diploids was revealed by non-targeted metabolomics. Some somatic hybrids / autotetraploids already flowered and set fruits, and served as pollen parents for seedless triploid production resulting in thousands of triploid plants from over 50 ploidy crosses being recovered and identified by embryo rescue, flow cytometry and SSR analysis. Facilitated by molecular marker analysis of numerous citrus somatic hybrids and cybrids, a strategy of male sterile cybrid production by symmetric fusion between embryogenic callus protoplasts of Satsuma mandarin (CMS type with sterile cytoplasm) and mesophyll protoplasts of elite seedy cultivars were put forward, and diploid cybrid plants containing sterile cytoplasm from Satsuma were regenerated, some cybrids already showed male sterility and seedless traits. The mechanism of male sterility in a citrus somatic cybrid is being conducted. Cell engineering combined with application of molecular marker and omics technology greatly enhanced the efficiency and targeted breeding of citrus cell engineering research.

9:20 AM Genetic Manipulation of Fruit Tree Architecture to Enable High-Density Production Systems

Courtney A. Hollender*, *Michigan State University*

Abstract: Genetic Manipulation of Fruit Tree Architecture to enable High-Density Production Systems

Courtney Hollender, Chinnithambi Srinivasan, Ralph Scorza, and Chris Dardick

Tree fruit production has been increasingly moving towards high density orchards. This is change is being driven by a need to increase production with limited resources, including labor. Most fruit trees, however, aren't naturally amenable to high density growth. The use of dwarfing rootstocks has been essential for the success of high density apple plantings. However, many fruit tree species lack size-controlling and dwarfing rootstock. In addition, time consuming branch training, scoring, and growth regulator applications are also needed for high density production. This amount of labor isn't practical for some species. Fortunately, fruit tree germplasm collections contain trees with more amenable architectures, including smaller statures and growth habits with potentially beneficial shoot orientations. Technological advances, such as high throughput sequencing, have enabled the genetic causes for these traits to be identified. Coupling this ability with improvements in tree transformation and gene editing can enable generation of newer cultivars and cultural practices that could make high density orchards a reality for more fruit species. The recent identification of genes associated with non-standard peach architectures exemplify this advancement. Mutations in the *TAC1* gene were found to be the cause pillar or columnar growth habits in peach. The repression of this gene in plum led to slender pillar plums, which can be planted closer together than standard plums. In addition, the overexpression of *TAC1* also resulted in plums with wide branch angles. Wide angles can cause plagiotropic growth, which is desirable for trellis-based high density systems. The identification of *TAC1* also led to the identification and manipulation of a related plum gene, *LAZY1*. Reduction in *LAZY1* expression in plum resulted in trees also produced trees wider branch angles. Other examples of the utility of gene identification and manipulation include the modulation of *GID1c* expression. A mutation in *GID1c* is the cause of dwarf peach phenotype, and reducing the expression level of this gene in plum produced dwarf and semi dwarf trees. Taken together, these results illustrate the possibility for rapidly breeding trees specific for high density stand alone and trellis-based plantings, which are needed for the tree fruit production sustainability in the future.

8:00 AM – 9:30 AM *Lincoln East*

Floriculture: Postharvest and Disease Management

Moderator: Melissa Munoz, *Clemson University*

8:00 AM Reducing Substrate Moisture Content during Greenhouse Production of Poinsettia Improves Postharvest Quality and Economic Value

Yanjun Guo*; Terri Woods Starman and Charles R. Hall, *Texas A&M University*

Abstract: The objective was to determine the effect of substrate moisture content (SMC) during poinsettia (*Euphorbia pulcherrima* 'Christmas Eve Red') greenhouse production on plant quality, postproduction longevity and economic value. Treatments included two SMC levels (20% or 40%) applied in four timing of application combinations. Total production (TP) time was 12 weeks in which vegetative production (VP) occurred from week 35 to 39 and reproductive production (RP) continued from week 40 to 47. Four timing of application treatments: 40/40 = TP at 40% SMC; 20/40 = VP at 20% + RP at 40%; 40/20 = VP at 40% + RP at 20%; 20/20 = TP at 20% SMC. After 12 h simulated shipping in the dark, plants were evaluated for two weeks in a simulated retail environment with two packaging treatments: no packaging or plastic perforated plant sleeves. Growth index (GI),

photosynthesis (Pn) and water potential were measured weekly. Bract and leaf surface area, bract and leaf number, internode length, leaf thickness, flower and bud number, petiole thickness and dry weight (DW) were measured at week 47. Light intensity within the plant canopy and ethylene concentration were measured during postproduction. Water potential was reduced in week 40 with 40/20 treatment only. At the end of greenhouse production, plants gown in 20% SMC during RP (20/20 and 40/20) had shorter bract internode length, stem length and smaller GI, and decreased shoot and root DW, and bract and leaf surface area compared to those in 40% SMC during RP (40/40 and 20/40). Poinsettias grown in 40% SMC had higher Pn than those in 20% SMC regardless of production stage. Leaf thickness, petiole thickness, bract and leaf number were not affected by SMC treatments. Plants in 20/20 or 40/20 had earlier bract coloring despite days to anthesis being the same for all SMC treatments. Compared to 40/40, 40/20 and 20/20 could save 44.2% or 43.6%, respectively, on irrigation and fertilizer usage, and 39.1% and 47.8%, respectively, on labor time. During postharvest, ethylene concentration was not affected by packaging method. Sleeved plants had lower light intensity in the plant canopy causing plants to have greater necrotic stem numbers and lower visual ratings at the end of postproduction. The 40/40 sleeved plants had increased yellow leaf and necrotic stem numbers. In summary, reducing SMC to 20% during total production or during the reproductive stage reduced water usage and produced more compact plants with greater postproduction quality.

Specified Source(s) of Funding: Floriculture/Nursery Research Alliance (FNRA) research grant

8:15 AM Effect of Production Fertilizer Concentration on Pretty Grand Red Petunia Growth and Postharvest Performance

Jiwoo Park* and James E. Faust, *Clemson University*

Abstract: Consumer performance is critical to the success of greenhouse businesses. In recent years, greenhouse growers have reduced the amount of fertilizer applied to their spring bedding plant crops. This has resulted in concern about the performance of these plants once the consumer has purchased them. An experiment was designed to determine the effect of fertilizer concentration and plant growth regulator during the production phase on the growth of petunias (*Petunia x hybrida*) in the consumer environment. Petunia 'Pretty Grand Red' plugs were transplanted into 6-pack containers (527 ml volume), grown at four concentrations of constant liquid fertilization (50, 100, 150 or 200 ppm N), and treated with four concentrations of paclobutrazol (0, 1, 2 or 3 ppm) in a 4x4 factorial arrangement. At flowering, the plants were placed into a simulated shipping and retail environment for 10 days. Then, the plants were transplanted into 1 L containers and grown for 5 weeks to observe consumer performance. No fertilizer was supplied in the post-production phases. Growth and flowering measurements were made following the consumer phase. Plant height increased linearly as the fertilizer concentration increased. Plant height increased by 34% as the fertilizer concentration increased from 50 to 200 ppm N. All three paclobutrazol treatments reduced plant height by ~15% compared to the untreated control. The number of flowers was highest in 150 and 200 ppm N treatments and there was 62% increase in flower number as the fertilizer concentration increased from 50 to 200 ppm N. Paclobutrazol application resulted in an 11% decrease in flower number. Shoot fresh weight per unit of plant height was used to assess plant quality. Using this measure, the plants grown with 150 and 200 ppm N displayed the highest quality during the consumer phase. Plant growth regulator had no effect on the shoot fresh weight per unit of plant height. The results of this study suggest that fertilizer and plant growth regulation play an important part in petunia growth during and after greenhouse production. In conclusion, low fertility and paclobutrazol applications during the production phase negatively impacted growth and flowering in the consumer phase.

8:30 AM The Effects of Dehydration Duration on Water Uptake and Postharvest Quality of Cut Lilies

Yen-Hua Chen* and William B. Miller, *Cornell University*

Abstract: We investigated the effects of dehydration duration on water uptake and postharvest quality of cut lilies. Stems of 'Nashville', 'Santander', and 'Sorbonne' were subjected to 0, 8, 24, or 48 h dehydration (at 20 ^{o}C) then put into test tubes containing 2% sucrose and biocide. Water uptake in the first 24 h of rehydration was significantly higher in dehydrated stems compared to controls . In 'Nashville', water uptake in the first 24 h of rehydration was similar for stems given 8, 24, and 48 h dehydration, ca. 33 ml to 34 ml, versus 27.7 ml in controls. Unlike 'Nashville', 'Santander' had dehydrated for 48h had 12.7 ml more uptake than controls, and 'Sorbonne' given 24 h dehydration had 9.9 ml more water uptake than the controls. While dehydration treatment increased water uptake in the first day after rehydration, the total uptake over a 9-10 day period was significantly less than in non-dehydrated controls. In 'Nashville', total water uptake was 117.1 ml in controls versus 85.5 ml in the 48 h dehydration treatment. In 'Sorbonne', total uptake was 60.3 ml more in controls versus the 48 h dehydration treatment. Although dehydration duration affected water uptake, individual flower life and vase life were not obviously different between dehydration treatments and controls. However, opened flowers of 24 and 48 h dehydrated 'Sorbonne' were smaller than controls and the 8 h dehydration treatment. In some cases, dehydration accelerated leaf yellowing. 'Nashville' stems dehydrated for 24 h showed visible leaf yellowing 3 days earlier than controls and 'Sorbonne' dehydrated 48 h showed leaf yellowing 2.4 days earlier. Cut lilies apparently have an ability to substantially recover from significant dehydration and restore uptake water, but dehydration reduces total water uptake and reduces postharvest performance.

8:45 AM An *in Vitro* Study Identifies Possible Bacteria Candidates for *Botrytis Cinerea* Biocontrol

Kaylee Anne South*[1]; Michelle L. Jones[2] and Christopher G. Taylor[2], *(1)The Ohio State University, OARDC, (2)The Ohio State University*

Abstract: The use of beneficial bacteria as a form of biological control in the greenhouse production of floriculture crops is a growing area of interest, but many questions still surround the potential use of bacteria to control plant pathogens. Interest in biological control is increasing because of a desire by both consumers and growers to reduce the use of chemical pesticides. This is particularly important for the control of *Botrytis cinerea*, which is a fungal plant pathogen that affects many crop species worldwide. This pathogen has become resistant to some fungicides, increasing the urgency to identify alternative control methods. In this study, a collection of 61 *Pseudomonas* bacteria were screened to identify bacteria that inhibited the growth of *Botrytis cinerea*. The objective of this study was to develop an *in vitro* assay that can be used to screen large collections of bacteria and identify those with the potential to control botrytis in floriculture crops. Identifying potential beneficial bacteria from large collections using only greenhouse trials is a difficult task because of the number of plants and greenhouse space required to evaluate large numbers of bacteria treatments. A dual plating assay was developed in which a single *Pseudomonas* strain was plated on PDA media with the *Botrytis cinerea* to directly quantify any effects that the bacteria had on the growth of the pathogen. The negative control plates contained botrytis and no bacteria, while cycloheximide was included on the positive control plates in place of the bacteria. When the fungal growth of the negative control plates reached a predetermined point, measurements were taken on all plates to quantify botrytis growth, and determine the zone of inhibition between the bacteria and botrytis. The experiment was designed to provide an initial screen for potential bacteria candidates. Based on the reduction of botrytis growth and the zone of inhibition, approximately twenty of the 61 strains tested were selected as potential biological control agents to use in the reduction of *Botrytis cinerea* in floriculture crops. This dual plating assay can be used in the future screening of large collections of bacteria, and the selected *Botrytis*-active pseudomonads will be used in future greenhouse validation trials.

Specified Source(s) of Funding: DC Kiplinger Floriculture Endowment and American Floral Endowment

9:00 AM Evaluation of Fungicide Resistance Development in *Botrytis Cinerea* from Cut Roses

Melissa Munoz*; James E. Faust and Guido Schnabel, *Clemson University*

Abstract: *Botrytis cinerea* causes the decaying of cut rose flowers in both production and post-harvest environments leading to

economic losses. Commercial growers typically address this problem with weekly preventative fungicide applications. However, *Botrytis* has the ability to quickly develop resistance to single-site. This study was performed to evaluate the fungicide resistance in a commercial cut rose crop over time. Six commercial shipments of Rose 'Orange Crush' were received from the same greenhouse harvested over a period on several months. Upon arrival, the roses were incubated for seven days in chambers maintained at 22 ^{O}C and 100% humidity. When sporulation occurred after the incubation time, *Botrytis* conidia were collected and placed on media containing discriminatory doses of fungicides to distinguish between resistant and sensitive isolates, then incubated at 22 ^{O}C in the darkness for 4 d. Resistance was determined based on an observational assessment of the mycelial growth in the media for each fungicide. A total of eleven fungicides (thiophanete-methyl, iprodione, cyprodinil, boscalid, fenhexamid, penthiopyrad, fluopyram, isofetamid, fludioxonil, pydiflumetofen and polyoxin-D) belonging to seven FRAC codes were tested. A high degree of resistance was determined across the shipments to thiophanete-methyl, iprodione, cyprodinil and boscalid. In the case of fenhexamid, penthiopyrad, fluopyram, isofetamid, and fludioxonil, there was considerable variation in the fungicide resistance profiles between shipments. No resistance was detected to pydiflumetofen and polyoxin-D fungicides which was likely due to the fact that they are not yet commercially available or relatively new to the industry. A second study following the same protocols was done to evaluate resistance profiles in four commercial shipments from Rose 'Freedom' from five different countries including Colombia, Ecuador, Guatemala, Kenya, and Mexico. A high proportion of the isolates evaluated were consistently resistant to thiophanete-methyl and cyprodinil. Resistance profiles for the other fungicides varied with locations. Once again, no resistance was observed at any of the locations to pydiflumetofen or polyoxin-D.

Specified Source(s) of Funding: American Floral Endowment

9:15 AM Floral Aromatics of *Ptelea*: Chemical Identification and Human Response

Anna J. Talcott*; William Richard Graves; Lester Wilson and Terri Boylston, *Iowa State University*

Abstract: North American shrubs in the genus *Ptelea* have untapped potential to add diversity to landscapes and to support populations of pollinators and swallowtail butterflies. Like other members of the Rutaceae, *Ptelea trifoliata* and *Ptelea crenulata* are notably aromatic, but intriguingly different descriptions of their floral fragrance led us to use gas chromatography and mass spectrometry to separate and identify the volatile chemicals emitted by flowers of these species. Chemicals identified include nonanal, 1- and 2-hexanol, benzyl acetate, limonene, linalool, bergamotene, bisabolol, bourbonene, farnescene, myrcene, and trans-ocimene. While these results are consistent with analyses of aromatics from flowers of other members of the Rutaceae, the status of *Ptelea* as dioecious species led us to question whether aromatic profiles of staminate and pistillate flowers differ. While similar compounds are present in both floral types, concentrations are different in ways that appear to affect how people perceive the fragrance. Human-subject assessments of floral volatiles of *Ptelea* confirm that pistillate flowers are considered to smell floral and citrusy, whereas pungent odors with vegetative undertones were additional scents that emanated from staminate flowers. This work helps to resolve conflicting reports of the floral fragrance of *Ptelea*, which range from hyacinth-like to skunk-like. Chromatography, spectrometry, and human responses indicate that the floral fragrance of *Ptelea* combines citrusy, spicy, floral, and pungently vegetative scents.

8:00 AM – 9:30 AM

Market Trends in Sustainability: What Is New in the Horticultural Industry? *CEU Approved*

Lincoln West

Coordinators: Chengyan Yue, *University of Minnesota* and Bridget Behe, *Michigan State University*

Moderator: Chengyan Yue, *University of Minnesota*

Objectives:

This workshop explores the issues related to sustainability in consumer horticulture. Presentations will feature an understanding of the issues surrounding various sustainable practices (aquaponics, recycling, sustainable irrigation systems, etc.) and consumer preferences for and attitudes toward sustainability.

Description: **Objective**: This workshop explore and discuss the issues related to sustainability in consumer horticulture. Presentations will feature an understanding of the issues surrounding various most recent sustainable trends and practices (aquaponics, recycling, sustainable irrigation systems, etc.) and the market potential and consumer preferences for sustainability.

Abstract: Consumer demand for sustainable products and business practices continues to rapidly rise. Many eco-consumers are profitable to companies that appeal to them with a record of environmentally friendly or sustainable production practices because eco-friendly products and practices can garner a higher price premium. Sustainable practices are being adopted by horticultural businesses such as using recycling water, aquaponics production system, sustainable irrigation systems, and etc., yet the communication of many products and practices is languishing. It is imperative to both study and communicate the market potential for eco-friendly products and practices. Consumers' attitudes towards sustainably-produced products or production practices may vary significantly due to a wide variety of factors. This workshop will explore the market potential for these recent practices in sustainability and compare consumer attitudes and preferences across different fields and products. Specifically, consumer preferences and willingness to pay for produce grown in aquaponics production system are explored; homeowners' preferences and willingness to pay for smart irrigation controllers are investigated; consumer acceptance of recycled water are assessed; and how information source affect consumer preferences for plants with environmental labeling are studied.

A discussion will follow each presentation. At the end of all the presentations, a more comprehensive group discussion will be facilitated to engage workshop participants, discuss what sustainability means for the horticultural industry, and explore future research ideas surrounding sustainability.

8:00 AM Consumer Preferences for Aquaponically-Grown Produce: Implications from Experimental Auctions and Market Segmentation Analysis

Chengyan Yue*; Neil O. Anderson; Marie Sorensen and Gianna Short, *University of Minnesota*

8:15 AM The Effect of Priming Messages on Consumer Perceptions of Recycled Water

Bridget K. Behe*[1]; Nikki McClaran[1]; Patricia Huddleston[1] and Charles R. Hall[2], *(1)Michigan State University, (2)Texas A&M University*

8:30 AM **Preferences and Willingness to Pay for Sustainable Landscape Irrigation Systems**
Hayk Khachatryan and Alicia Rihn*, *University of Florida*

8:45 AM **Information Source and Purchasing of Plants with Environmental Labeling**
Ben Campbell* and Julie Campbell, *University of Georgia*

8:00 AM – 9:45 AM *Monroe*

Growth Chambers and Controlled Environments 4

Moderator: Celina Gomez, *University of Florida*

8:00 AM **Effects of Light Quality on High-Wire Tomato Ion Uptake, Partitioning, and Fruit Quality**
Meng-Yang Lin* and Hye-Ji Kim, *Purdue University*

Abstract: Light-emitting diodes (LEDs) becomes popular supplemental lighting (SL) in greenhouse because of energy saving without compensating crop productivity. Accumulation of phytochemicals can be also induced by LEDs with specific spectrum in many crop species. However, recent study shows that phytochemical properties of greenhouse tomatoes remain unchanged in response to red (R, 600-700 nm), blue (B, 400-500 nm), and far-red (FR, 700-750 nm) SL from LEDs since the dynamic light environment in greenhouse nullifies the effects of wavelengths of light. Besides secondary metabolites, mineral nutrients are essential components for human nutrition and contribute to the quality and flavor of tomatoes. Ion uptake, translocation, and assimilation are also highly dependent on photosynthesis and photomorphogenesis, and therefore, responses of tomatoes to B, the signal of sunlight, and FR, the signal of shading, could be dramatically different in terms of ion utilization. The objectives of this study were to determine how different light quality affects ion accumulation, partitioning, and fruit quality of high-wire greenhouse tomato. 'Merlice' scions grafted onto 'Maxifort' rootstocks were supplemented with different combinations of B, R, and FR LED lighting: B + R (39%B:61%R), R + high FR (71%R:29%FR), or R only (100%R). Plants were fertigated with a commercial complete fertilizer mix (4.5N–14P–34K; CropKing, Lodi, OH) to maintain acceptable electrical conductivity and pH in the root zone, and irrigation duration and frequency were adjusted to provide a daily leaching fraction of 30%. The concentration of nitrate, nitrite, sulfate, phosphate, chloride, sodium, potassium, magnesium, and calcium in leaf, stem, root, and fruit were determined by ion chromatography. On a whole plant scale, B increased the accumulation of nitrite and calcium while FR reduced their accumulation. Particularly, B increased the partitioning of phosphate to stem while FR decreased it. B also increased the partitioning of calcium from stem to leaf; however, FR increased its partitioning from stem to fruit in association with higher dry mass allocation to fruit relative to stem. The concentrations of sulfate and sodium were increased by 300% and 27% by adding FR to R, suggesting that FR improves the quality and flavor of tomato. Our results suggest that FR light reverses the action of B light in the accumulation and partitioning of some ions and mineral composition of tomato can be manipulated by additional FR light.
Specified Source(s) of Funding: NE-1335 Resource Management in Commercial Greenhouse Production

8:15 AM **Preliminary Evaluation of Four Soilless Substrates and Supplemental Arbuscular Mycorrhizal Fungi for Greenhouse Strawberry Production**
Thomas W. McKean*[1]; Mark A. Kroggel[1]; Chieri Kubota[1] and Rémi Naasz[2], *(1)The Ohio State University, (2)Premier Tech Horticulture*

Abstract: Increasing demand for locally grown produce with high flavor quality has led to a significant increase in controlled environment strawberry production in recent years. Additionally, challenges in traditional open field production, including loss of methyl bromide and labor shortages, could lead to soilless systems dominating the future market. Soilless substrate mixes need to be optimized for plant productivity, plant health, and ultimately grower profit. This study investigates effects of four different substrate mixtures on 'Albion' strawberry plant vigor, fruit yield, and fruit quality. The four substrates tested were 1) a commercial mix developed for strawberry production, consisting of peat moss, perlite, chunk coco coir; and beneficial microbes (arbuscular mycorrhizal fungi (AMF) and biofungicide bacteria); 2) another commercial strawberry substrate mix composed of peat moss, tree bark fiber, coco coir fiber, and the same microbial supplement; 3) our standard lab substrate for strawberry containing perlite, coco coir, and peat moss; 4) the same lab substrate with supplemental AMF. Forty-eight 'Albion' plants were grown in each of the four substrates from September 2017 to April 2018 in a 103 m^2 glass greenhouse at The Ohio State University (Columbus, OH). Vegetative growth, fruit yield, and fruit quality (Brix and titratable acidity) were evaluated throughout the production period. At the transplant stage (September 12 – November 20, 2017), strawberry plants grown in Substrate 2 had the highest root-to-shoot dry mass ratio (1.10±0.36) followed by Substrate 1 (0.67±0.14), Substrate 4 (0.62±0.080), and Substrate 3 (0.54±0.070) indicating that use of commercial strawberry substrate mixtures or the addition of beneficial microbes to our standard substrate mix led to greater root development in early growth stages. Early fruit yield per plant (recorded from December 1, 2017 to February 7th, 2018) was significantly greater in Substrate 4 (187.3±4.6 g) and Substrate 2 (183.3±6.2 g) than in Substrate 3 (143.9±11.6 g) (Tukey HSD, P=0.05). However, no significant difference was observed between Substrate 1 (164.6±10.1 g) and any of the other three substrates. Furthermore, the average fruit size during the same early production season was the greatest in Substrate 2 (20.9±0.27 g) and there were no significant differences among the other three substrates (ranging between 17.2±0.84 and 18.6±0.27 g) (Tukey HSD, P=0.05). These results show increased productivity in plants grown when beneficial microbes were added in specific substrate mixes, suggesting the importance of chemical, physical and biological properties of substrate used in soilless strawberry production.
Specified Source(s) of Funding: Premier Tech Horticulture

8:30 AM **Higher Daily Light Integrals with Adaptive LED Lighting Control Speed up Ornamental Seedling Growth**
Theekshana C Jayalath* and Marc W. van Iersel, *University of Georgia*

Abstract: Supplemental lighting in greenhouse industry is often needed from late fall through early spring and can account for up to 30% of the value of crops produced. Reduction of this energy cost can be beneficial for profitable greenhouse crop production. Our study focused on quantifying the effect of daily light integral (DLI) on seedling production of bedding plants. We used an adaptive light-emitting diode (LED) control system to precisely control supplemental lighting by taking advantage of the dimmability of LED grow lights. The power of the LEDs was adjusted to provide only enough supplemental photosynthetic photon flux density (PPFD) to reach the threshold PPFD underneath the light bars. The threshold PPFD was recalculated every 2 seconds to assure that the crop received a specific DLI by the end of the 14-hour supplemental lighting period. This high-precision lighting control system provides supplemental light when plants can use it most efficiently, i.e., when there is little sunlight available. Therefore, we hypothesized that our adaptive LED control system stimulates plant growth more than ordinary lighting systems. We compared three adaptive lighting control treatments to achieve DLIs of 8, 12, and 16 $mol \cdot m^{-2} \cdot d^{-1}$ in 14 hours of supplemental lighting (10 am to midnight) to a treatment that supplied a PPFD of ~100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of supplemental light during the same 14 hours (average DLI was 8.6 $mol \cdot m^{-2} \cdot d^{-1}$), and a sunlight-only control treatment (average DLI was 5.4 $mol \cdot m^{-2} \cdot d^{-1}$). We used impatiens (*Impatiens walleriana*) 'Accent Premium Violet F1' and vinca (*Catharanthus roseus*) 'Jams 'n Jellies Blackberry' for the study. Seedlings were harvested 40 days after seeding. The number of leaves, shoot fresh and dry weight, root dry weight, and plant compactness (shoot dry weight/ plant height) of both species were greatest in the treatment receiving a DLI of 16 $mol \cdot m^{-2} \cdot d^{-1}$, followed by the treatment receiving a DLI of 12 $mol \cdot m^{-2} \cdot d^{-1}$. Seedlings in the treatment that received a supplemental PPFD of ~100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ had similar growth as those in the treatment with a DLI of 8 $mol \cdot m^{-2} \cdot d^{-1}$. The sunlight-only control treatment had the slowest seedling growth. These results suggest that our adaptive LED control system is capable of controlling LED's precisely while stimulating the plant growth more at higher DLIs. However, growers should determine

whether the better growth from more supplemental lighting is worth the cost of providing that light.

Specified Source(s) of Funding: American Floral Endowment, Georgia Research Alliance, USDA-NIFA-SBIR

8:45 AM Propagation of Herbaceous Perennials Under Sole-Source Light-Emitting Diodes or Greenhouse Supplemental Lighting from High-Pressure Sodium Lamps

W. Garrett Owen* and Roberto G. Lopez, *Michigan State University*

Abstract: Herbaceous perennials are propagated in early spring to late fall when outdoor daily temperatures and photosynthetic daily light integrals (DLIs) vary greatly. Inconsistent environmental conditions poses a challenge for propagators to consistently callus, root, and yield compact herbaceous perennial rooted liners. Research objectives were to evaluate and compare the effects of indoor sole-source lighting (SSL) delivered from red (R) and blue (B) light-emitting diodes (LEDs) to greenhouse supplemental lighting (SL) provided by high-pressure sodium (HPS) lamps during herbaceous perennial propagation. Cuttings of perennial sage (*Salvia nemorosa* L. 'Lyrical Blues') and wand flower (*Gaura lindheimeri* Engelm. and A. Gray 'Siskiyou Pink') were propagated in a walk-in growth chamber under multilayer SSL provided by LEDs with red [R; (660 nm)]: blue [B; (460 nm)] light ratios (%) of 100:0 (R_{100}:B_0), 75:25 (R_{75}:B_{25}), 50:50 (R_{50}:B_{50}), or 0:100 (R_0:B_{100}) delivering 60 μmol·m^{-2}·s^{-1} for 16 hours (DLI of 3.4 mol·m^{-2}·d^{-1}). In a glass-glazed greenhouse, cuttings were propagated under ambient light and SL provided by HPS lamps delivering 58 μmol·m^{-2}·s^{-1} for 16 hours (DLI of 3.3 mol·m^{-2}·d^{-1}). Ten days after sticking wand flower cuttings, callus diameter, a measure of growth, increased regardless of lighting treatments. At 10 d, stem length of perennial sage and wand flower propagated under SSL R_{50}:B_{50} LEDs were 21 and 30% shorter and accumulated 50 and 8% greater root biomass, respectively, compared to those under SL. Cuttings propagated under SSL R_{50}:B_{50} LEDs were similar or greater quality than cuttings under SL and thus, indicates that perennial sage and wand flower cuttings can be successfully propagated under LEDs in a multilayer SSL propagation system.

9:00 AM Production of Lettuce Increases By Utilizing a Longer Photoperiod with Consistent Daily Light Integral in Greenhouse Environments.

Jake Holley*[1]; Rachel Schuster[1]; Brian Poel[2] and Melanie Yelton[3], *(1)LumiGrow, (2)LumiGrow Inc., (3)LumiGrow, Inc.*

Abstract: In the study, we quantified the effect of photoperiod while maintaining equal DLI in two experiments. First in growth chambers we grew red-leaf lettuce, *Lactuca sativa* 'Red Sails' under five photoperiods. We found biomass increased linearly with longer photoperiods, with 24-h plants averaging 82% increase in dry biomass in comparison to the 12-h treatment plants. Second, in a greenhouse we grew red-leaf lettuce, *Lactuca sativa* 'Skyphos', and found biomass increased in the 21-h treatment by an average of 49% in comparison to the 12-h treatment. This report demonstrates that greater production of lettuce can be achieved through precise control of DLI and photoperiod in the greenhouse.

The benefits of extending photoperiod while maintaining daily light integral (DLI) have been demonstrated in the past to increase profitable production. Many significant horticultural crops, like lettuce, require a specific DLI that should be obtained, but not surpassed. To achieve lighting goals, a control algorithm using supplemental lighting must adjust light intensity to achieve the optimum photoperiod, without exceeding DLI, based on the variable daily sunlight conditions. Previously, due to the lighting technology at the time, lighting control algorithms could not utilize dimmability to achieve photoperiod and DLI simultaneously, therefore allowing for the most electrically efficient use of lighting. However, with the introduction of LEDs into horticultural environments, significant gains in the ability to control artificial light through rapid and instantaneous dimmability is now possible. Findings from this project have directed current research using a control algorithm to integrate the information from an ambient sunlight sensor with supplemental LED lighting in the greenhouse to maintain photoperiod while achieving the consistent DLI to optimize crop production utilizing supplemental LED lighting in greenhouses.

9:15 AM Quantifying Water-Use Efficiency of Two Lettuce Cultivars Grown Under Red and Blue LEDs

Celina Gomez* and Luis Jonathan Clavijo, *University of Florida*

Abstract: Blue light is known to affect leaf stomatal development and aperture and has been shown to play a role regulating plant-water relations. The objective of this study was to quantify the effects of blue light on growth and morphology, water-use efficiency (WUE), stomatal conductance (g_s), SPAD index, and shoot nitrogen uptake by 'Cherokee' and 'Waldmann's Green' lettuce (*Lactuca sativa*) grown under different red-to-blue-light ratios. Seven treatments were evaluated in the study: 100% red; 7% blue + 93% red; 26% blue + 74% red; 42% blue + 58% red; 66% blue + 34% red; 100% blue; and broad-band white light (containing 19% blue, control). All treatments provided an average daily light integral (DLI) of 17.5 mol·m^{-2}·d^{-1} (270 ± 5 μmol·m^{-2}·s^{-1} over an 18-h photoperiod). The experiment was replicated three times over time; each experimental replication was terminated 21 d after treatment initiation. Regardless of cultivar, no treatment differences were measured for leaf area and specific leaf area (SLA). In contrast, for every 10% increase in blue light, leaf number and shoot dry mass (DM) decreased by 0.02 leaves and 0.2 g, respectively. Water-use efficiency also decreased linearly in response to blue light. Conversely, g_s and SPAD index increased by 0.05 mmol·m^{-2}·s^{-1} and 0.02 units, respectively, for every 10% increase in blue light. Although tissue nitrogen content (mg·g^{-1}) increased with higher blue light, nitrogen uptake (mg) was unaffected by light quality. Our findings indicate that the significant decrease in WUE under higher blue light could be attributed to a reduction in plant growth (leaf number and DM) and an increase in g_s, which may be the result of higher stomatal aperture and leaf conductance, and could lead to higher water loss through transpiration.

9:30 AM Understanding Bases for Differences in Energy-Use-Efficiency Among LED Grow Lights Using Hydroponic Lettuce

Yuyao Kong and Krishna Nemali*, *Purdue University*

Abstract: Photosynthetic photon efficiency [PPE, mol. of light output per KWh of energy used; mol·(KWh)$^{-1}$] is one of the important characteristics used in marketing grow light fixtures for indoor production (vertical farms or plant factories). However, a more useful efficiency measurement for growers is energy-use efficiency [EUE, grams of dry weight produced per KWh of energy used, g·(KWh)$^{-1}$], which is a product of PPE and light use efficiency (LUE, grams of dry weight produced per mol. of incident light, g·mol^{-1}). While PPE is driven by engineering technology, LUE is influenced by physiological responses of plants to incident light intensity and composition. Information on PPE of a fixture is generally available from lighting companies, whereas LUE is species specific and limited information exist on LUE of a species under a specific fixture. This is the major reason why PPE is generally used for comparing light fixtures. Using hydroponically grown leaf lettuce, we studied differences in EUE, PPE and LUE among four commercially available light fixtures (Philips-Greenpower, Fluence-RazrX, TotalGrow-TG1A Bulb, and Lithonia-T8) which differed in the intensity and composition of incident light. Our results indicated that significant differences existed among light fixtures in EUE, PPE and LUE. More interestingly, when data from all fixtures were pooled in regression analysis, there was no relation between EUE and PPE among fixtures; whereas a strong linear relationship was found between EUE and LUE in hydroponically grown leaf lettuce. Further analysis indicated that LUE was linearly related to leaf growth rate (light interception), which decreased exponentially with increasing fraction of blue light (light composition) in the incident light. Leaf growth rate generally increased with increasing fraction of red light in the incident light. Fraction of red light decreased with increasing fraction of green light among fixtures. While acknowledging that observed responses are likely specific to leaf lettuce, we conclude that plant physiological responses to light (or LUE), can be an important characteristic in determining optimal lighting fixture for commercial indoor production.

Specified Source(s) of Funding: Purdue University

8:00 AM – 10:00 AM *Georgetown West*

Fruit Tree Architecture and Orchard Mechanization

Moderator: Chunxian Chen, *USDA, ARS, SEFTNRL*
Coordinator: Chunxian Chen, *USDA, ARS, SEFTNRL*

8:00 AM Orchard Mechanization and Tree Architecture in Pome Fruit

Stefano Musacchi*, *Washington State University*

Abstract: Europe is one of the most progressive areas where mechanization is applied. Orchard mechanization requires an adjustment of the tree architecture and the development of training systems that allow the use of equipment. Initially, innovation was influenced by increased production costs and the breeding of new varieties. In fact, increasing labor costs and difficulties to find qualified workers represent the main drivers to mechanize in the orchard worldwide. Higher density plantings, with the goal of developing a small spindle canopy or a fruiting wall, have become widespread worldwide to increase labor efficiency. These orchards are characterized by early bearing and short life span. The sustainability and the possibility to mechanize these specialized orchards are some of the major topics of research. Many investigators are interested in how to make the orchard more efficient and reduce the amount of sprays necessary for maintenance through the development of more efficient training systems and new cultivars resistant to disease. Training systems for apple and pear are chosen in relation to the cultivar and rootstock vigor, and the ability to deliver fruit with a high percentage of blush or over-color, especially for bi-colored cultivars. Several kinds of equipment have been developed to mechanize the full cycle of the orchards from planting to harvest.

8:20 AM Biology + Technology = Sustainable Orchard Systems

Matthew Whiting*, *Washington State University*

8:40 AM Fruit Tree Architecture Genomics and Breeding for Mechanization

Kenong Xu*, *Cornell University*

Abstract:

In commercial apple production, fruit harvesting and tree pruning are the two major contributors to the overall labor cost, which usually accounts for 60 percent of the total variable costs. The apple industry has long been seeking a viable means to mechanize such labor-intensive tasks in orchard operation. Several labor-aid platforms have been made available, and robotic prototypes for fully automated apple fruit harvesting have also been developed and tested recently. Although important progress has been achieved, it remains a long shot to adapt any of the robotic harvesting systems in orchard at a large scale. One of the major challenges has been the unpredictable fruit setting sites due to the complex canopy of apple trees. Attempting to provide genomic solutions that can simplify apple tree canopy and make the fruit setting locations predictable, we have been carrying out a research project to identify the genes and/or gene-networks responsible for varying tree architectural forms. Currently, we are focusing on the two extreme apple tree architectural forms, columnar and weeping, which are characterized by few upright and numerus downward branches, respectively. The latest results will be presented and discussed in the context of making apple trees friendlier for mechanized orchard management.

Specified Source(s) of Funding: NSF-Plant Genome Research Program grant IOS-1339211

9:00 AM Breeding Tree Architectures for Improve Orchard Productivity

Chris Dardick*, *Appalachian Fruit Research Station, USDA-ARS*

Abstract: Understanding tree architectures to improve orchard productivity.

Jessica M. Guseman, Kevin Webb, Courtney A Hollender, Doug Raines, Kenong Xu, Amy Tabb and Chris Dardick, Appalachian Fruit Research Station, USDA ARS, Kearneysville, WV

Tree management is the single most important factor that influences orchard productivity, starting with time of tree establishment and rootstock grafting followed by the continual pruning and training of the tree throughout its life. A broad range of management systems and strategies have been designed to maximize time to harvest, yield, and fruit quality while minimizing labor costs and chemical inputs. Currently, there is a sizeable knowledge gap in our understanding of the underlying growth and development mechanisms of trees which limits our ability to devise new solutions and/or genetically improve tree architectures. In particular, the growth patterns of branches including their growth dynamics and orientations as well as their interactions through apical dominance and apical control are poorly understood. Here we used gene expression profiling to compare shoot tips of apical and subtending 1st order lateral branches of young peach trees having different growth habits (standard, pillar, or weeping). Apical shoots in trees having a standard or pillar architecture displayed a cellular program that was clearly distinct from laterals, marked predominantly by down-regulation of a large set of genes. In contrast, very few significant differences were found when comparing lateral branches at different positions in the canopy or among shoot tips of weeping trees. Collectively, the data has important implications for understanding branch growth behavior and establishes a novel genetic program that is uniquely associated with apical shoots. Practical aspects of the work potentially related to management practices and/or breeding will be discussed.

9:20 AM Advances in Mechanized Tree Fruit Harvesting

Changki Mo*, *Washington State University Tri-Cities*

Abstract: Fresh market tree fruit harvesting is a difficult task that relies entirely on manual labor, but there exists a clear need for the technology in today's economy. Extensive research has been done on the development of mechanical harvesting techniques. Several selective harvesting robots have been developed for research studies, but there are no commercially available robotic systems.

This talk summarizes recent advances in mechanical tree fruit harvesting technologies. Because the fresh market apple industry is an agricultural sector with significant potential for the incorporation of robotic harvesting technologies, factors and considerations that are particularly applicable to apple picking are highlighted. In addition, it presents two studies of the design and field evaluation of robotic apple harvesters that have been conducted recently. In order to assess required functionality in modern orchard systems with ideal fruit distributions, an undersensed, low-cost system was developed. Based on local growers' willingness to modify the tree to optimize fruit distribution for robotic harvesting, apples adjacent to trellis wires and trunks were removed prior to field studies. The robotic system integrated a global camera set-up, seven DOF manipulator, and grasping end-effector of 3D printed tendon driven fingers to execute fruit picking with open-loop control.

The design and development of a novel 3D printed soft robotic end-effector to facilitate apple separation was also presented. In this study, the field test was conducted in an unmodified field environment. Additionally, a secondary robot was implemented to catch the harvested fruit to facilitate fruit collection as an approach to potentially reduce the overall cycle time of robotic tree fruit harvesting. The soft robotic end-effector performed very well in grasping apples and facilitating apple separation. The compliant actuators were unharmed in collisions with the tree canopy and trellis wires offering a significant improvement in grasping speed over the tendon driven fingers.

Results from field studies show that horticultural practices play a critical role in the selection of functionality requirements. Improved harvesting efficiency will require enhanced robustness, especially obstacle detection with increased visual sensing and force sensing on the end-effector for feedback on grasp status.

9:40 AM Tree Fruit Orchard of the Future: An Overview

Chunxian Chen*, *USDA, ARS, SEFTNRL*

Abstract: Mechanization has been prevailing in row crops over the past decades, and now gradually in some fruit crops, with integration of innovative computers, robotics, mechanics, and precision orchard management. This talk will give an overview of challenges facing commercial fruit industries and needs of new orchard systems for mechanization. Many fruit industries in recent years are encountering some tough headwinds:

uncertainty and cost of labors, rampancy of destructive diseases, frequent occurrence of unfavorable weathers, competition of imports and other fruit commodities, marginalized profits, etc. These challenges impose a great impact on farming from multiple facets. The trend of changes includes much larger orchards, higher planting densities, simpler plant architecture, more precise management, and more mechanization. In other words, fruit tree crops are towards being planted, managed, and mechanized, to some extent, like row crops. In this context, horticulturists, engineers, and breeders are striving to sustain tree fruit industries and ensure orchard operation with up-to-date horticultural knowledge, optimized management, innovative automation, and desired cultivars and rootstocks.

8:00 AM – 10:00 AM *International Ballroom West*

Minimizing Food Safety Risks While Maintaining Quality of Fresh and Fresh-Cut Produce

Coordinators: Yaguang Luo, *USDA-ARS* and Jeffrey Brecht, *University of Florida*

8:00 AM Fresh and Fresh-Cut Produce Food Safety - Meeting Technical Challenges with Advances

Patricia D. Millner*, *USDA-ARS*

Abstract: Fresh and fresh-cut horticultural food protection researchers along with supply chain partners have been actively engaged in a wide variety of technical studies and practices to improve food safety in the lead up to and since the enactment and implementation of the FDA Produce Safety Rule. This presentation will highlight key technical food safety challenges, data and technology gaps from farm to fork and feature how several major collaborative efforts, accomplishments, and lessons learned are continuing to advance technological improvements to meet the need for high quality and food safety of fresh produce.

8:15 AM Knows, Unknowns, and Unknown Unknowns Regarding the Potential Microbial Risks for Ready-to-Eat Produce

Eric C. Wilhelmsen*, *Alliance of Technical Professionals*

Abstract: A modeling approach to using the knowledge (Knowns) gained from industry bacterial testing programs to bound and limit the unknowns and unknown unknows regarding microbial risk. The overall incidence rates for positive results in these databases are very low (1 in 5000 to 10000 tests depending on the product, season and other factors) limiting the utility of individual tests. However, large testing databases can be mined to yield information regarding the overall system under study and also yield information about what would not be consistent with the data and therefore, is not of concern. This mining approach can be bolstered by targeted intensive testing to yield additional information. Having this “is“ and “is not” information about the system affords an approach to assessing and developing practical mitigation strategies in an environment where pasteurization is probably out of reach. This type of analysis should enable processors and their customers to make thoughtful decisions about their risk mitigation programs.

8:30 AM Opening Pandora’s Box of Sprouts

Andrea Ottesen*, *CFSAN FDA*

Abstract: In the past 20 years, FDA has been involved in over 48 outbreaks associated with sprouts. These events resulted in 179 hospitalizations and 3 deaths. Most outbreaks were attributed to alfalfa sprouts, although clove, mung bean and sprouted chia were also implicated. Salmonella was the most common pathogen identified, followed by E. coli and then Listeria monocytogenes. There has been substantial interest from commercial sprout growers to apply metagenomic methods to the description of the entire sprout production process to get an improved understanding of critical control points to ensure safe sprout production. To that end, shotgun metagenomics was used to study source water and water from each of the four days of growth in a typical alfalfa sprout production system to better understand the complete microbial ecology that sprouts are exposed to.
Viral, fungal, bacterial and protist taxa were described for each day.
Dominant bacterial species included: Klebsiella, Pseudomonas, Acinetobacter, Enterobacter, Curvibacter, Delftia, Flavobacterium, Escherichia and Pantoea. From the first day of growing to the last, there was an increase in the relative abundance of Curvibacter and Delftia. Escherichia was more prominent on days two and three and then appeared to be moderately suppressed by day four. Dominant protist taxa shifted from a majority on the first day of Pseudoperonospora to a balance of Endolimax and Pseudoperonospora by day four. Dominant fungal taxa included Enterocytozoon, Clavaria and Ongeneales. Dominant viral taxa observed were Lactococcus, Erwinia and Enterobacter phages.
A huge amount of data has now been amassed to better understand the agro-ecology of a single sprouts operation. Challenges remain however, in terms of understanding how well these data may represent a wider array of sprout production, and also with regard to how to use these data to improve safe stewardship of this crop.

8:45 AM Prevention of Salmonella Contamination on Tomatoes during Simulated Dump-Tank Washing

Xiangwu Nou*[1]; Samantha Bolten[2]; Ganyu Gu[3]; Sam Van Haute[1]; Bin Zhou[1]; Patricia D. Millner[1] and Yaguang Luo[1], *(1)USDA-ARS, (2)University of Maryland, (3)Virginia Tech*

Abstract: *Salmonella enterica* is the primary foodborne bacterial pathogen of concern, and the target of antimicrobial intervention, for the tomato industry in the United States. The typical commercial tomato dump tank washing practice is a concern as a potential means by which contamination by *S. enterica* and other harmful microorganisms may be disseminated. Current government regulations and industry performance standards require the presence of sufficient amount of antimicrobial agents in the wash water to mitigate this food safety risk. Presently, maintaining a minimal 150 mg/L of free chlorine in a commercial tomato dump tank is required by the Florida state regulation in the US. While the industry is updating the food safety performance standards, scientific studies are needed to support the development and implementation of science- and risk-based food safety policies. We used grape tomatoes as a model to examine the contamination by *Salmonella* during a simulated process of tomato washing. Freshly harvested tomatoes were directly obtained from a major US tomato packing operation, and used for generating simulated wash water that matched several key parameters (Turbidity, TDS, and COD) of water used for washing cherry tomatoes by a commercial processor. Tomatoes and field debris were differentially inoculated by strains of different *Salmonella* serovars distinguishable by their resistance to different antibiotics. Non-inoculated tomatoes were concurrently washed with inoculated tomatoes and debris in the simulated wash water of varying free chlorine levels, with or with pre-washing or post-washing comingling. When inoculated tomatoes and field debris were washed together with non-inoculated tomatoes at free chlorine levels ranging from 5 to 150 mg/L, *Salmonella* populations on both inoculated tomatoes and field debris were reduced by approximately 2 logs, or approximately 1.2 log higher than that of washing without chlorination. *Salmonella* was not recovered from the spent wash water at any free chlorine level. Sporadic contamination of non-inoculated tomatoes was observed at lower levels of free chlorine. The contaminating salmonellae originated from both inoculated tomatoes and field debris. These observations indicate that field debris is an important source of cross contamination and removal of field debris prior to washing will reduce the bioburden and source of contamination.

9:00 AM Controlled-Release Chlorine Dioxide Technology for Storage of Fruits and Vegetables: Sanitation Effects and Plant Physiological Responses

Jinhe Bai*[1]; Xiuxiu Sun[1]; Elizabeth A. Baldwin[1]; Anne Plotto[1]; Chris Ference[1]; Jan Narciso[1]; Yaguang Luo[1]; Bin Zhou[1] and Mark A. Ritenour[2], *(1)USDA-ARS, (2)University of Florida*

Abstract: Foodborne illnesses and decay loss caused by microorganisms are the main concerns for processors and marketers of postharvest fruits and vegetables. Like many water mediated sanitizers, ClO_2 solution has also been applied for a wide range of commodities. However, gaseous ClO_2 has many advantages over its aqueous formulations, including rapid diffusion, ease of mixing with air, and its ability to penetrate porous surfaces and biofilms. A controlled-release chlorine dioxide technology was used along with perforated packaging

systems for grapefruit, cherry tomato, blueberry and strawberry fruits to mimic storage and transportation conditions. Gaseous CO_2 enhanced decontamination of both foodborne and plant pathogens. Significant microbial reduction was confirmed for inoculated foodborne pathogens, such as *Escherichia coli*, *Salmonella*, and plant disease pathogens, such as *Alternaria alternata, Colletotrichum acutatum*, *penicillium digitatum,* and naturally infected *Xanthomonas citri* ssp. *citri* and *Lasiodiplodia theobromae* in different fruits. In addition, gaseous ClO_2 also influenced some fruit physiological responses in that ClO_2-treated fruits exhibited less weight loss compared to controls, and also retained higher firmness.

9:15 AM Food Quality and Safety Assessment of Packaged Leafy Greens after Storage in a Refrigerated Display Case with Doors

J. Atilio de Frias; Yaguang Luo*; Bin Zhou; Ellen Turner; Patricia D. Millner and Xiangwu Nou, *USDA-ARS*

Abstract: Retail display of packaged fresh-cut leafy greens is a critical stage of the cold chain management and is prone to temperature abuse when produce is displayed in open cases, due to infiltration of ambient air into the case. Previous studies using a research supermarket demonstrated that produce quality is improved, energy costs were less and temperatures are more uniform when products are displayed behind doors. In this study, we evaluated changes in quality attributes and populations of inoculated bacterial pathogens in packaged baby spinach, chopped romaine, and lettuce mix displayed in a case retrofitted with doors. Compared to our previously published work with open display case, the case retrofitted with glass doors showed significantly improved temperature uniformity and control, thus avoiding temperature abuse and product freezing. All the products after 4-days display in the doored case maintained high freshness and attractiveness which were comparable to those stored at a constant temperature in a 1^{o}C cold room. Growth of inoculated *E. coli* O157:H7, *Salmonella*, and *L. monocytogenes* was minimal for all the displayed products. These results indicate that retrofitting display cases with doors is a practical means of reducing temperature abuse and product damage for fresh-cut display.

9:30 AM Closed-Door Refrigerated Retail Display Cases for Whole and Fresh-Cut Produce: Are Temperature Management and Product Quality Improved?

Jeffrey K. Brecht*[1]; Yurui Xie[1]; Yaguang Luo[2]; Ellen R. Bornhorst[3]; Keith Vorst[4] and Wyatt Brown[5], *(1)University of Florida, (2)USDA-ARS, (3)ORISE, (4)Iowa State University, (5)California Polytechnic State University*

Abstract: We worked with a retailer in Florida to perform in-store measurements of temperature distributions in open and closed-door refrigerated display cases for whole and fresh-cut vegetables. Complementary projects were conducted with retailers in California, Iowa, and New York. The collaborating retailer selected two stores of the same size and identical floorplans, with comparable sales volumes and customer demographics. Refrigerated display cases in both stores were instrumented with eight temperature and humidity dataloggers per display case, placed in the front and back of the top, middle and bottom shelves. Doors were then retrofitted onto the display cases in one store and data were collected over 23 weeks from April to September 2017. Samples of bagged baby spinach were collected on a biweekly basis from the two stores and assessed for product quality and microbial growth. Temperature uniformity was improved in the closed-door display cases. Temperatures in the front were found to be 2.2°C and 1.2°C higher than in the back for open cases, but only 0.7°C and 0.5°C higher for closed cases in fresh-cut and whole vegetable displays, respectively. There was greater variation among temperatures at the back of the cases than the front, but that variation was reduced by half in the closed-door displays versus open displays. Use of doors decreased the temperatures inside the display cases by about 3.0°C for fresh-cuts and 1.8°C for whole vegetables, actually necessitating adjustment of temperature settings by +0.8°C after retrofitting to avoid sub-zero temperatures. Saturated relative humidity was continuously recorded due to presence of free water from misting plus evaporation. Reduced energy consumption was also validated for display cases with doors. Assessments of product quality and microbial growth revealed no significant differences between baby spinach from open and closed-door display cases, likely due to the relatively short residence time of the product on display (<12 hours).

9:45 AM Effect of Ginger Essential Oil on Citrus Fruit Pathogens and Fruit Decay When Applied in a Nano-Emulsion Coating

Elizabeth A. Baldwin*[1]; Marcela Miranda[2]; Marcos David Ferreira[3]; Odílio Benedito Garrido Assis[3]; Xiuxiu Sun[1]; Chris Ference[1]; Anne Plotto[1] and Jinhe Bai[1], *(1)USDA-ARS, (2)São Paulo State University, (3)Embrapa Instrumentação- Brazilian Agricultural Research Corporation*

Abstract: 'Nova' mandarin were coated with commercial carnauba and shellac microemulsions and an experimental carnauba nanoemulsion coating compared to an uncoated control. Fruit quality evaluation included weight loss, gloss, soluble solids (SS), titratable acidity (TA), pH, SS/TA ratio, internal CO_2 and O_2, internal ethanol, and a sensory shine rank test after storage at 20 °C for 7 days. Conventional and nanoemulsion carnauba wax resulted in the least weight loss compared to control and shellac. There were no differences for gloss measurements, but gloss decreased with time and shellac-coated fruit ranked highest for shine in the sensory test. There were no differences for SS, TA, pH and ratio among treatments, CO_2 and ethanol generally increased and O_2 decreased during storage while the highest levels of CO_2 and ethanol were found for the shellac treatment along with the lowest O_2, with no differences among the other treatments. Meanwhile, antimicrobial activity of ginger oil extracts (GOE) was evaluated using the poisoned food (PF) and inverted Petri-dishes test (IPD), minimum inhibitory concentration (MIC), minimum fungicide concentration (MFC) and percentage of spore germination for the citrus fruit pathogen, *Penicilium digitatium*. GOE significantly reduced mycelium growth of *P. digitatium* while spore germination was inhibited at 1% GOE, compared to 37.4% for controls after 24 h of incubation. GOE exhibited at a MIC between 0.4% and 0.8% (v/v). Now we will test the effect of 0.8% GOE in a nanoemulsion coating with *P. digitatum*-inoculated 'Unique' tangerines stored at 10 °C followed by a simulated marketing period for which results will be discussed.

8:00 AM – 10:00 AM *Jefferson East*

Water Utilization and Management 2

Moderator: Nastaran Basiri Jahromi, *University of Tennessee*

8:00 AM Comparison of on-Demand and Conventional Irrigation Regimes for 'Silver Dollar' Hydrangea Grown Outdoors in Biochar Amended Pine-Bark

Nastaran Basiri Jahromi*[1]; Amy Fulcher[1]; Forbes Walker[1]; James Altland[2] and Wesley Wright[1], *(1)University of Tennessee, (2)USDA-ARS, MWA ATRU*

Abstract: Controlling irrigation using timers, or manually operated systems are the most common irrigation scheduling methods in container production systems. Improving irrigation efficiency can be achieved by scheduling irrigation based on plant water needs and the appropriate use of sensors rather than relying on periodically adjusting irrigation volume based on perceived water needs. Substrate amendments such as biochar, a carbon-rich by-product of pyrolysis or gasification, can increase the amount of available water and improve irrigation efficiency and plant growth. Previous work examined two on-demand irrigation schedules in controlled environments. The objective of this research was to evaluate the impact of these on-demand irrigation schedules and hardwood biochar on water use and biomass gain of container-grown *Hydrangea paniculata* 'Silver Dollar' in a typical outdoor nursery production environment. Eighteen independently controlled irrigation zones were designed to test three irrigation schedules on 'Silver Dollar' hydrangea grown outdoors in pine bark amended with 0% or 25% hardwood biochar. The three irrigation schedules were conventional irrigation and two on-demand schedules, based on substrate physical properties and plant physiology. The conventional irrigation delivered 18 mm (0.7 inches) of water in one event each day. The substrate physical properties irrigation scheduling was based on the soilless substrate moisture characteristic curve. Irrigation was applied when the substrate water content decreased to the driest point at which there was plant available

water, -10 kPa. The plant physiology irrigation schedule was based on a specific substrate moisture content derived from the relationship between substrate moisture content and photosynthetic rate. This system maintained volumetric water content (VWC) to support photosynthesis at 90% of the maximum predicted photosynthetic rate. Total water use was unaffected or lower in the on-demand irrigation systems. However, plant dry weight was 22% and 15% greater, water use efficiency was 36% and 40% greater, and total leachate volume was 25% and 30% lower in the substrate physical properties-based and plant physiology-based irrigation scheduling systems, respectively, compared to the conventional irrigation. This research demonstrated that on-demand irrigation scheduling with a physiological-basis or substrate physical properties-basis could be an effective approach to increase water use efficiency for container-grown nursery crops without negatively affecting plant growth.

Specified Source(s) of Funding: This project was supported by Agriculture and Food Research Initiative Competitive Award No. #2015-68007-23212 from the USDA National Institute of Food and Agriculture.

8:15 AM Salt Risks Ultimately Become the Limit to Improved Irrigation Efficiency in Aridland Vegetable Cropping Systems

Charles A Sanchez*, *University of Arizona*

Abstract: In aridland cropping systems salts are most effectively managed by leaching. When irrigation efficiencies are poor, the leaching requirements (LR) of salts for agricultural sustainability are often incidental to these inefficiencies. However, as irrigation efficiencies are improved, caution must be exercised so that the seasonal leaching fraction (LF) achieved is not less than the leaching required for continued sustainability. This presentation evaluates the multiple cropping systems in the lower Colorado River region. Water application efficiencies for the salt sensitive vegetable crops (fall-winter-spring) widely produced in the region have improved dramatically over the past two decades. In fact, many field irrigation operations in the vegetable cropping system, while providing for the crop's water requirement, are net salt loading events (LF<LR). In contrast to the vegetable systems that are furrow irrigated, the spring-summer rotational field cropping systems are irrigated in basins, and due to slower irrigation advance resulting from increased soil and crop friction, net irrigation efficiencies are sometimes poor relative to crop consumptive use. Data we have collected suggests that these water application inefficiencies associated with the rotational crops, and associated leaching fractions, may sometimes be key to sustainability in the entire annual cropping system. Furthermore, pre-irrigation in the late summer before vegetables are planted is also important. Existing challenges to further improvements in irrigation efficiencies for the annual multi-cropping systems, in the context of salt management, will be discussed.

Specified Source(s) of Funding: Yume Center of Excellence in Desert Agriculture

8:30 AM Water Use of Drip-Irrigated Pistachio Orchards Grown on Saline Soils in the San Joaquin Valley of California

Giulia Marino*[1]; Richard Snyder[1]; Octavio Lagos[1]; Michael Whiting[1]; Blake Sanden[2]; Louise Ferguson[3]; Bruce D Lampinen[4]; Eric Kent[1]; Stephen Grattan[1]; Cayle Little[5]; Mae Culumber[2]; Kristen Shaphiro[2]; Octavio Robles Rovelo[6]; Khaled Bali[7] and Daniele Zaccaria[1], *(1)UC Davis, (2)University of California Cooperative Extension, (3)University of California, Davis, (4)UC Agriculture and Natural Resources, (5)California Department of Water Resources, (6)Consejo Superior de Investigaciones Científicas, (7)University of California*

Abstract: Pistachio acreage is rapidly expanding in California on salt-affected areas thanks to its economic profitability and salt tolerance. However, no information is currently available to growers on the actual water use of mature pistachio orchards grown on soils with high salinity. Our team of researchers from the University of California Cooperative Extension conducted a field study during the 2016 and 2017 crop seasons to determine the actual evapotranspiration (ETa) and crop coefficient (Ka) trends of one non-salt affected and two salt affected commercial pistachio orchards grown with drip irrigation in the San Joaquin Valley. We used the residual of energy balance method with a combination of eddy covariance and surface renewal to measure the sensible heat flux density. In addition, we collected the percentage of photosynthetically active radiation intercepted by the tree canopies (fPAR) and midday stem water potential (Ψ_{stem}) data to quantify tree canopy size and tree water status. The fPAR decreased from 75% for the non-salt affected orchard to 25% for the worst salt affected orchard, which had 10 to 30% lower seasonal ETa. The radiation interception was lower but the relative contribution of sensible heat flux to ETa increased to a maximum of 18% in the most salt impacted sites. The Ψ_{stem} values in the non-salt affected orchard were constantly above -1.5 MPa, whereas values Ψ_{stem} of around -3.0 MPa were reached in the salt affected orchards. The Kc of the salt affected orchards was 0.40 in April, between 0.60 and 0.80 from May to mid-July, and decreased to around 0.25 in October. Soil analysis highlighted that the electro conductivity (EC) did not explain the differences in ETa and fPAR among sites and suggested that the secondary effect of sodicity on soil physical properties (de-flocculation, crusting, compaction, reduced infiltration and aeration) may have a large effect on pistachio performance. Irrigation water volumes currently applied to salt affected orchards were as much as 33% higher than the measured seasonal ET values. This over application of "non beneficial" water not only decreases irrigation efficiency but also likely harms the trees as a result of reduced infiltration and water logging due to high sodicity and poor soil structure. Our results highlight the necessity to better understand the long term response of pistachio water use in salt affected soils to improve water management and orchard performance.

Specified Source(s) of Funding: California Department of food and Agriculture (CDFA)

8:45 AM Evapotranspiration and Crop Coefficients of Mature Pistachio Orchard Grown with Drip Irrigation in the San Joaquin Valley of California

Daniele Zaccaria*[1]; Giulia Marino[1]; Octavio Lagos[1]; Michael Whiting[1]; Blake Sanden[2]; Louise Ferguson[3]; Bruce D Lampinen[4]; Eric Kent[1]; Stephen Grattan[1]; Cayle Little[5]; Mae Culumber[2]; Kristen Shaphiro[2]; Octavio Robles Rovelo[6]; Khaled Bali[7] and Richard Snyder[1], *(1)UC Davis, (2)University of California Cooperative Extension, (3)University of California, Davis, (4)UC Agriculture and Natural Resources, (5)California Department of Water Resources, (6)Consejo Superior de Investigaciones Científicas, (7)University of California*

Abstract: Crop coefficient (Kc) values commonly used in California for irrigating pistachio were developed in an earlier study (1985) conducted in a commercial, sprinkler-irrigated orchard of Kerman cultivar grafted onto *P. Atlantica* rootstock. Nowadays, the majority of pistachio in the San Joaquin Valley of California is grown with drip-irrigation, which could reduce the evaporative water losses and increase irrigation efficiency and water productivity. Our team of researchers from the University of California Cooperative Extension conducted a three-year field study (2015-2017) to estimate the actual evapotranspiration (ETa) of a well-watered mature (30-year old, 75% canopy cover) commercial pistachio orchard (Kerman onto PGI) grown on a sandy clay loam soil with drip irrigation in the San Joaquin Valley. We used the residual of energy balance method to estimate the actual water use, with a combination of eddy covariance and surface renewal equipment to measure the sensible heat flux density. The collected field data confirm the ability of pistachio trees to use large water volumes when irrigated for full production, with average ETa of 7.5 mm day^{-1} during the hottest months (June and July) and daily peak water use reaching up to 10 mm in late June. The highest Kc values reached 0.90 during the period from mid-May to mid-July. Kc was 0.80 from mid-April to mid-May and during August. In September, a steep decrease of Kc was observed, reaching values around 0.50, most likely as a result of pre-harvest reduced water applications by the grower. The Kc values documented with the earlier study varied from 0.43 at the end of April to 1.19 in mid-July and decreased to 0.67 in October. The newly developed Kc trends should enable pistachio growers to achieve higher water productivity and improve the resource efficiency and pistachio production in the San Joaquin Valley.

Specified Source(s) of Funding: California Department of food and Agriculture (CDFA)

9:00 AM Assessing Soil Water Potential Thresholds for Optimum Irrigation Scheduling, Yield and Quality of Celery

Andre Biscaro[*1]; Jean Caron[2]; Nathan Bradford[3] and Kamille Garcia[3], *(1)University of California Cooperative Extension, (2)Université Laval, (3)University of California Cooperative Extension*

Abstract: Scientific evidence of soil water potential impact on yield and quality of celery (*Apium graveolens* L.) production is very limited. A better understanding of the subject could set actionable targets for irrigation scheduling and the use of soil water potential sensors. Celery yield and quality, water use, soil mineral nitrogen (N), plant total N, soil electrical conductivity, root depth and canopy cover were assessed under four irrigation treatments initiated at four different soil water potential targets in Oxnard, CA during Spring 2017. Soil water potential was monitored at 8 and 18 inch depth using Hortau®'s TX4 Field Monitoring Stations. The four treatments consisted of initiating irrigation when soil water potential readings at 8-inch depth reached -20, -30, -40 and -50 kPa, named T-20, T-30, T-40 and T-50, respectively. The amount of water applied at each irrigation was calculated based on the crop evapotranspiration since the last irrigation, with an additional leaching requirement of 30%. Treatments were replicated four times within a randomized complete block design. Each plot consisted of three side-by-side 40 inches-wide and 75 ft long beds, with two celery rows in each bed, and a drip tape on the top and center of the bed. Yield and quality data were collected in the center 20ft of the middle bed of each plot. Total and marketable yield and plant height linearly decreased from T-20 to T-50 ($P<0.050$). Total and marketable yield were 11.4% and 9.0% smaller, respectively, for T-50 compared to T-20. Whole plant weight and marketable plant weight also decreased from T-20 to to T-50, with significant differences ($P<0.05$) between T-20 and T-50. There were no trends nor significant differences ($P=0.596$) of pith among treatments. Water use was very similar, totaling 19.7, 18.9, 18.6 and 18.4 inches for T-20, T-30, T-40 and T-50, respectively. Soil mineral N, plant total N, soil electrical conductivity, rooting depth and canopy cover at harvest were very similar and not significantly different ($P>0.05$) among treatments. The averages of the highest soil water potential values at 8-inch depth prior to each irrigation were -25.9, -36.2, -43.7 and -52.0 kPa for T-20, T-30, T-40 and T-50, respectively. Overall, the results of this study suggest that initiating irrigation at soil water potential lower than -20 kPa decreases celery yield, plant height and plant weight in proportion with the decrease of soil water potential down to -50 kPa, but it didn't affect pith.

Specified Source(s) of Funding: California Celery Advisory Research Board

9:15 AM Applying Controlled-Release Fertilizer in Green Beans: May or May Not Work

Qingren Wang[*], *University of Florida/IFAS Extension Miami-Dade County*

Abstract: Application of controlled-release fertilizer (CRF) has shown great advantages in improving crop yield, reducing labor cost from farming operation, promoting fertilizer use efficiency, and protecting environment for a sustainable development in agriculture. However, a relatively higher price for CRF as compared to conventional fertilizer (CoF) is one of main obstacles for growers. In addition, a feasibility of the right source of fertilizers also depends on right crops associated with good management practices, especially with water management. To compare these two different fertilizers in vegetable crops, field demonstration trials were conducted on the Experimental Farm at UF/IFAS Tropical Research and Education Center in different years with various water supplies in green beans. The results showed that the yield of green beans was increased significantly in one year but not in the other year. Water supply seems play a critical role to improve the release of plant available nutrients from CRF and help increase the crop yield. A short life crop, such as green beans with only 56-58 days after sown, may not have enough time for the given CRF to function, especially when the water supply is limited. In conclusion, the application of CRF needs right type, right crop and with sufficient water supply to optimize the output.

Specified Source(s) of Funding: Florida Department of Agricultural and Consumer Services

9:30 AM Creation and Adoption of Smart Agriculture Innovations to Cope with Climatic Uncertainty

Clinton C. Shock[*], *Oregon State University*

Abstract: Human needs for nutrition and income in climatic uncertainty provide strong incentives for us to seek solutions to agriculture and community problems. The creation and adoption of innovative changes can result in the smart use of water, soil, and nutrients. Irrigation innovations are continually being created by scientists, agricultural industries, and growers. Irrigation efficiency is increased through more efficient systems and components, closer matching of irrigation to crop species needs, and better knowledge of each crop's physiology to understand the amounts of water stress tolerated in various phases of crop development. New options are creatively imagined to provide feasible solutions compatible with local production methods. These options must be winnowed with realistic field tests pertinent to local constraints. Examples of changes in irrigation systems, irrigation scheduling, crop physiology applications, and more efficient nutrient management will be presented.

Specified Source(s) of Funding: Oregon State University

9:45 AM Substrate Moisture Effects on Growth, Yield and Quality of Strawberry *(Fragaria X ananassa)*

Bruk E. Belayneh[*] and John D. Lea-Cox, *University of Maryland*

Abstract: We are investigating the effect of sustained substrate moisture levels on the growth, yield and fruit quality of the strawberry *(Fragaria X ananassa)* cv. 'Chandler' and 'Sweet Charlie'. The experiment was setup in a randomized complete block design with four replications in the Research Greenhouse at the University of Maryland, College Park. Plugs of the cultivars were transplanted to 3.8 L pots filled with a commercial substrate (Sunshine LC1 Mix, Sungro Horticulture, Agawam, MA) composed of 75-85% peat moss and 15-25% perlite on volume basis. The moisture release curve for the substrate mix was developed using Hyprop device (METER Group Inc., Pullman, WA) in order to correlate volumetric water contents with corresponding matric potential and four soil volumetric content levels were selected as treatment set-points. These VWC set-points were 40%, 30%, 20% and 15% and represented 67.7%, 50%, 33.3% and 25% of container capacity for the substrate mix, respectively. Corresponding matric potential values for the VWC set-points were -4.3, -13.8, -36.7 and -63 kPa. GS-1 Soil moisture sensors (METER Group Inc.,) were inserted in three plants per experimental unit and readings were recorded on a 5-minute basis using Em50R data loggers (METER Group Inc.,). Data was transmitted to Sensorweb^{TM} software (Mayim LLC., Pittsburgh, PA) and averaged on a 15-minute basis. Irrigation happened whenever averaged values were less than corresponding set-point for each treatment. In addition to VWC, substrate matric potential (MPS-6), electrical conductivity and temperature (GS-3), and irrigation volumes (Model 25, Badger Meter, Milwaukee, WI) were also recorded on a 5-min basis using the Em50R data loggers. For four weeks after transplant, all treatments were irrigated fully to allow establishment. Destructive harvest was done at the end of December in order to quantify growth effects. There were significant differences in branch crown number, leaf area, leaf fresh mass, stem fresh mass, leaf dry mass, stem dry mass and root dry mass for 'Sweet Charlie'. None of these parameters were significantly different for Chandler. While both cultivars are short day (June bearing), Sweet Charlie is an earlier cultivar compared to Chandler and is likely to have more rapid growth compared to Chandler. Additional destructive harvest will be done at the end of vegetative growth in the spring and after fruits harvest. Our understanding of how plant growth, yield and quality respond to varying soil moisture regimes is important to devise efficient irrigation practices for strawberry production in various soils as well as soilless substrates.

8:15 AM – 9:45 AM *Georgetown East*

Organic Horticulture 2

Moderator: Kathleen Delate, *Iowa State Univ*

8:15 AM Robotic Weeders in Organic Vegetable Cropping Systems

Kathleen Delate[*1]; Robert Turnbull[2]; Lie Tang[3] and Jingyao Gai[2], *(1)Iowa State Univ, (2)Iowa State University, (3)Iowa State Univeristy*

Abstract: Improved methods for weed management are considered some of the most pressing needs in organic crop production. Robotic weeding offers a possibility of controlling weeds precisely, particularly for weeds growing near or within crop rows. A study was conducted in 2016 and 2017 at an Iowa State University research farm near Gilbert, Iowa, to examine a machine vision system, based on a Kinect™ V2 sensor, to recognize and localize crop plants at different growth stages, through the fusion of two-dimensional textural data and three-dimensional spatial data, as the first step in constructing an autonomous weeder. Lettuce and broccoli were transplanted at a distance of 61 cm between plants and 91 cm between rows. Weeds at the site consisted of lambsquarter (*Chenopodium album*), bromegrass (*Bromus inermis*), pigweed (*Amaranthus* spp.), waterhemp (*Amaranthus rudis*), cockspur grass (*Echinochloa crus-galli*), bindweed (*Convolvulus arvensis*), purslane (*Portulaca oleracea*), and white clover (*Trifolium repens*). Weed populations were not adjusted until after sensor measurements were made. Several feature extraction algorithms were developed for broccoli and lettuce which were heavily infested by the aforementioned weed species. Crop plant recognition algorithms were developed to address the problems of canopy occlusion and leaf damage. With our proposed algorithms, different features in the 3D point cloud data of plants were extracted and used to train plant and background classifiers. For broccoli, the detection rate was 93.1%, and the average localization error was 10.1 mm. For lettuce, the detection rate was 93.7%, and the average localization error was 8.3 mm. The results have shown that 3D-imaging-based plant recognition algorithms are effective and reliable for crop/weed differentiation, which forms the basis for the next steps in developing a fully functioning robotic weeder.

Specified Source(s) of Funding: NIFA AFRI

8:30 AM Acetic Acid (Vinegar) - an Economical and Effective Diluent for Organic Herbicides

Ramdas Kanissery*, *University of Florida - IFAS* and Monica P. Ozores-Hampton, *University of Florida*

Abstract: Horticulture producers, as well as home gardeners, constantly ask about an economic at the same time effective substitute to expensive herbicides that can be used in organic production systems. A specific interest is in a cost-effective alternative to the herbicidal product, such as Axxe, an OMRI listed broad-spectrum herbicide that controls grasses and broadleaf weeds. The key ingredient in this herbicidal soap is a form of ammoniated pelargonic salts. They work by burning plant foliage that is contacted by the product. Lately, a great deal of interest has been conveyed in the use of acetic acid, commonly known as vinegar, as a broad-spectrum herbicide. While many subjective reports of the effectiveness of vinegar have been available, research to substantiate these claims is inadequate. The current study evaluated the herbicidal effectiveness of acetic acid when used as a diluent for the herbicide product Axxe, for row-middle weed management in organic plasticulture systems. The experiment was conducted in an herb (Rosemary), under organic production. When the standard use rate of herbicide Axxe was diluted to half rate with vinegar (5% acetic acid), the control of broad-leaved weeds and grasses was equivalent to the full use rate of Axxe. This study showed that acetic acid could be a viable and cost-effective diluent for herbicides like Axxe, from an economic perspective of broad-spectrum weed control in organic production.

8:45 AM Covering Ground: A Systems Evaluation of between-Row Management Strategies in Organic Plasticulture Vegetable Production

Alyssa R. Tarrant*; Zachary D. Hayden; Daniel C. Brainard and Lisa Tiemann, *Michigan State University*

Abstract: The use of plastic mulch (PM) is common for warm-season organic vegetable production in Michigan. While PM offers excellent weed control in-row, weed management between-row remains a challenge. Organic growers employ a variety of strategies to manage this area including cultivation, mowing, straw mulching, and less commonly, planting cover crops as living mulches. While these practices impact crop production and soil quality differently, information regarding the potential benefits and tradeoffs of each management strategy is lacking. The objective of this study is to clarify how between-row management affects both crop production and soil health indicators, allowing growers to make informed management decisions considering their unique farm context and goals. Strategies (treatments) evaluated in this study included weed-free wheel-hoe cultivation, rye cut and carry (dead) mulch, mowing weeds, rye living mulch, rye/white clover living mulch, and Italian ryegrass living mulch. These strategies were implemented between bell pepper (*Capsicum annuum cv. Paladin*) and summer squash (*Cucurbita pepo cv. Lioness*) grown on PM to allow for comparisons between a relatively short- and long-duration crop.

First year (2017) results demonstrate that competitive inhibition by living mulch and weeds is cash crop dependent. Summer squash yields were consistent across management strategies, but total pepper yields were reduced by an average of 453g per plant (~30%) in all treatments compared to weed-free cultivation. Cumulative biomass production in the between-row area was not significantly different between mowed weeds and living mulch treatments, averaging 490g m^{-2} biomass accumulated over the course of the growing season. Dead mulch reduced in-season weed biomass by 75% relative to the mowed weeds control, more than any living mulch species. Italian ryegrass was the only living mulch species to significantly decrease in-season weed biomass with a 52% reduction. Both mowed weeds and living mulch plots were able to scavenge between-row nitrogen, resulting in significantly less potentially leachable nitrogen in the fall (0-60 cm soil depth) compared to dead mulch and weed-free cultivated treatments. Significant differences in soil microbial biomass and shifts in soil microbial communities were not observed at any of four sampling dates during the first year of this study. However, this trial will be repeated in the same location in 2018 to evaluate cumulative impacts of between-row management on soil organic matter, microbial activity, and weed seedbanks.

Specified Source(s) of Funding: North Central SARE

9:00 AM Tomato Varieties for Organic High Tunnel and Field Systems: Are Separate Breeding Programs Needed?

Terry Hodge; Kitt Healy; Brian Emerson; Thomas Hickey and Julie C Dawson*, *University of Wisconsin-Madison*

Abstract: While tomato is important to global markets, it is also the iconic local vegetable, and consumers seek out the flavor of locally produced tomatoes. In Northern climates, production over a longer season is important to direct-market farmers. Farmers who have the first tomatoes at market can gain customers and keep them over the year. For this reason, many growers are using high tunnels to extend their season.

We compared a diverse set of varieties in high tunnel and field organic production environments. Our objectives were to determine if there was significant genotype by management system interaction for productivity, disease susceptibility and quality, in order to set breeding priorities for the two management systems. We also used data from the trials to compare different pricing scenarios for both early and late production for slicer and heirloom market classes. Labor hours were recorded to compare the cost of production for each system as well.

Management system had the largest effect on yield and disease, with the high tunnel producing 8.7 kg/plant compared to 5.1 kg/plant in the field, over all varieties and years. The incidence and severity of disease in the field was much greater than in the high tunnel. The average area under the disease progress curve was over four times greater in the field than in the high tunnel. Quality traits were more influenced by variety, although management also had an effect. Large slicers had the lowest ˚Brix value and flavor intensity, while heirlooms and small slicers had higher ˚Brix and flavor intensity. Flavor intensity was strongly correlated to preference.

While there was not significant genotype by management system interaction for yield or disease susceptibility, the traits required in each system were different enough to justify separate breeding projects. Breeding for early blight, septoria and bacterial speck resistance, combined with excellent flavor, is the top priority for field production. For high tunnels, pushing production even earlier while maintaining flavor is a top grower priority, and reducing susceptibility to blossom end rot and green shouldering is critical.

Some heirloom varieties would need to be priced considerably higher than slicers to have equivalent revenue, but we identified some very promising new varieties, selected to have the flavor of heirlooms with higher productivity. Labor hours were surprisingly

similar between the two systems, confirming what growers have been demonstrating, that high tunnel tomato production can quickly pay off the structure and be highly profitable.
Specified Source(s) of Funding: North Central SARE

9:15 AM **"Production Potential of Organically Managed June-Bearing Strawberry Varieties Grown Under High Tunnels and Low Tunnels."**

Amy Ballard[*1]; Sanjun Gu[1]; John Kimes[1]; John Evan Beck[2] and Tekan Rana[1], *(1)North Carolina Agricultural and Technical State University, (2)The Cooperative Extension Program at North Carolina Agricultural and Technical State University*

Abstract: The use of protected agriculture such as high tunnels and low tunnels have grown in popularity over the years, however not much research has been done on the actual potential of crop protection that can be offered from the use of low tunnels inside of high tunnels. This two-year study took place at the North Carolina Agriculture and Technical State University farm in Greensboro, NC (hardiness zone 7). The high tunnel was 30' (W) x 96' (L), managed organically and had a single layer 6mil polyplastic cover. Low tunnels consisted of metal wire hoops covered with 1-mil perforated plastic. The experimental design was a completely randomized design (CRD), conducted as a splitplot with three replications. The main plots were black plastic mulched beds combined with or without low tunnels; the split plots were cultivars Benicia, Camino Real, Florida Radiance and Winterstar. Strawberry plugs were planted on September 1st of 2016 and 2017. Marketable yields were not affected by low tunnel treatments. However, there were significant differences between the four varieties. Marketable yields were not affected by treatments, between low tunnel and no low tunnel, however there were significant differences between the four varieties. From the 2016/17 season, marketable yield totals were 386.18 g/plant with low tunnels and 433.84 without low tunnels. Cultivar Florida Radiance (475.14 g/plant) had the highest marketable yield, followed by Camino Real (428.06), Benicia (381.22) and Winterstar (355.6). From the 2017/18 season (up to February 28) the marketable yield was 39.1 g/plant with low tunnels and 32.7 without low tunnels. The marketable yields for cultivars are as follows: Winterstar (47.9 g/plant) had the highest marketable yield, followed by Florida Radiance (46.5), Benicia (32.8), and Camino Real (16.5). Overall, using low tunnels inside high tunnels may not be more effective than using high tunnels alone, but choosing more productive varieties may be a more beneficial option. This study will continue until May 2018 for complete evaluations of the low/high tunnel systems and cultivars.

9:30 AM **Meta-Analysis of Organic Research Results**

Diana Jerkins, *Organic Farming Research Foundation (OFRF)* and Michael Stein[*], *Organic Farming Research Foundation*

Abstract: There is a growing body of organic research that is available to researchers, extension, and farmers. Learn about current research topics and results that is adoptable for farmers and ranchers and furthering next generation of research. In this session, highlighted results on production practices, breeding, and economic trends from USDA-funded and OFRF–funded research from the past decade will be presented. Special focus will be on soil health and organic production. Participants will learn who funds major organic research and where funds have been spent. An interactive discussion will be done to gather input about future organic research needs.

9:00 AM – 10:00 AM *Boundary (Terrace Level)*

Education Advisory Council Meeting - Open to All Interested Members

Chairs: Cynthia McKenney, *Texas Tech Univ* and Amy Wright, *Auburn University*

9:00 AM – 10:00 AM *Oak Lawn (Lobby Level)*

Ornamental Plant Breeding (OPB) Meeting - Open to All Attendees

Chair: Amir Khoddamzadeh, *Florida International University*

Chair-elect: Lyn A Gettys, *University of Florida Ft Lauderdale Research and Education Center*

Secretary: Kimberly Shearer, *N/A*

Objectives:

To promote ornamental plant breeding, to serve as a forum for exchange of information among breeders, and to coordinate the communication of results to industry and academia.

9:00 AM – 10:00 AM *Piscataway (Lobby Level)*

Root Growth and Rhizosphere Dynamics (RHIZ) Meeting - Open to All Attendees

Chair: Gerardo H. Nunez, *University of Florida*

Secretary: Wenjing Guan, *Purdue University, Southwest Purdue Agricultural Center*

Speaker: Susan Miyasaka, *University of Hawaii at Manoa*

Objectives:

To provide a forum to promote and exchange information on basic and applied research about the plant rhizosphere, soil microorganisms, root growth and development, and root modeling, which apply to horticultural (fruit, vegetable, ornamentals), forest, and agronomic crops grown in synthetic or field soils.

9:00 AM – 2:30 PM *T Street Entrance - Terrace Level*

National Repositories of Tropical Crop Germplasm Tour

9:30 AM – 10:00 AM *Jefferson West*

Asian Horticulture Meeting - Open to All Attendees

Chair: Guo-qing Song, *Michigan State University*

Chair-elect: Sanjun Gu, *North Carolina Agricultural and Technical State University*

Secretary: Youping Sun, *Department of Plants, Soils, and Climate, Utah State University*

Objectives:

To promote dialogue and information and germplasm exchanges between horticulturists residing in America and Asia and to assist them in developing horticultural education, research, and extension programs to better preserve and utilize their rich horticultural resources.

9:30 AM – 10:00 AM *Lincoln West*

Marketing and Economics (MKEC) Meeting - Open to All Attendees

Chair: Bridget Behe, *Michigan State University*

Secretary: Chengyan Yue, *University of Minnesota*

Objectives:

To bring together workers having horticultural and economic interests in the marketing of horticultural crops and to expand markets and improve marketing techniques for horticultural crops.

9:30 AM – 7:00 PM *T Street Entrance - Terrace Level*

Undergraduate Student Tour of the Smithsonian Gardens

9:45 AM – 10:15 AM

Coffee Break (Thursday Morning)
International Ballroom East/Center

9:45 AM – 11:00 AM *Lincoln East*

Produce Quality, Safety, and Health Properties

Moderator: Austin Espe, *North Dakota State University*

9:45 AM Identity, Prevalence, and Chlorine Demand of Major Organic Compounds in Fresh Produce Wash Water

Zi Teng[*1]; Sam Van Haute[2]; Yaguang Luo[2]; Bin Zhou[2]; Patricia Millner[3] and Qin Wang[1], *(1)University of Maryland, (2)USDA-ARS, (3)USDA-ARS-BARC*

Abstract: ***Background:*** Fresh-cut produce washing generates significant amount of spent water loaded heavily with organic compounds. The associated large chemical oxygen demand (COD) and chlorine demand (CLD) lowers the sanitization efficacy during washing, and they complicate safe reuse or treatment of the water after washing. Identification of the major chemicals contributing to COD/CLD provides valuable information for improving food and water safety.

Purpose: To identify the chief source of CLD and COD occurring during fresh produce washing by systematic chemical analyses.

Methods: Samples were prepared by washing diced cabbage and measured for total COD and CLD. The samples were then fractionated through centrifugation, ultrafiltration, and solid phase extraction. Sugars, organic acids, and phenolic acids were profiled by HPLC, and peptides were extracted directly from the wash water. Regression equations were established to predict the time-dependent chlorine demand of each identified compound at their respective concentrations.

Results: Contribution to COD ranked as sugars (81.6%)>proteins/peptides (5.3%)>organic acids (3.6%)>phenolics (0.5%). Proteins accounted for over 50% of the total CLD in cabbage wash water in 2 hr. CLD of each compound increased linearly with concentration and logarithmically with time. Phenols reacted rapidly with chlorine, contributing to 21% of the total CLD at 5 min, but this percentage diminished over time. Organic acids (citric, malic, oxalic, and ascorbic) and sugars (fructose and glucose) reacted continuously, making up for 22% and 16% respectively of the total CLD after 2 hr. Collectively, the identified compounds explained for 94% of the total CLD in 2 hr.

Significance: This is the first systematic report on the source of COD and CLD occurring in produce washing. It emphasizes on the difference between them and thus suggests different treatments for their maximal removal. The findings shed some light on the development and deployment of effective water treatment strategies for fresh produce industry.

Specified Source(s) of Funding: This research was supported by USDA-NIFA (Specialty Crop Research Initiative Award No. 2016-51181-25403).

10:00 AM Screening of Serviceberry Cultivars for Phenolic Antioxidant-Linked Anti-Diabetic Properties Using Rapid *in Vitro* Assay Models.

Austin Espe[*]; Dipayan Sarkar; Harlene Hatterman-Valenti and Kalidas Shetty, *North Dakota State University*

Abstract: Serviceberry (*Amelanchier* spp.), a native temperate berry from North America, is a rich source of cold and other abiotic stress adaptation relevant protective bioactives such as phenolic metabolites. These same abiotic stress-related phenolic bioactives of serviceberry also have human health relevant protective functions and can be targeted for dietary and therapeutic support against diet and oxidative stress-linked chronic diseases such as early stages of type 2 diabetes and associated health risks. However, human health relevant phenolic bioactive profiles and associated health benefits of serviceberry vary between cultivars, environment, maturity and post-harvest storage conditions. Based on this biochemical and physiological rationale, the objective of this study was to screen and determine phenolic bioactive-linked antioxidant and anti-hyperglycemic properties of 20 serviceberry cultivars targeting dietary and therapeutic support against early stages of type 2 diabetes using rapid *in vitro* assay models. Cold water extracts (food grade) of 20 serviceberry cultivars from North America were evaluated for total soluble phenolic (TSP) content, phenolic acid profiles, total antioxidant activity (DPPH and ABTS radical scavenging activity), α−amylase, α-glucosidase, and angiotensin-I-converting enzyme (ACE) inhibitory activities using *in vitro* assay models. Significant differences in TSP content, antioxidant activity, and *in vitro* glucose metabolism relevant (α-amylase, and α-glucosidase) enzyme inhibitory activities were observed among serviceberry cultivars. High TSP content (2.8-3.2 mg/g FW) was observed in 12-1, 41-1, Parkhill, Smoky, and Buffalo cultivars, while high DPPH and ABTS radical scavenging assay based antioxidant activity (80-100% inhibition) was observed in 14-2, Thiessen, 1-4, 1-2, and 18-1 cultivars. Furthermore, very high *in vitro* α-amylase and α-glucosidase enzyme inhibitory activities (>90%) and significant dose responses were also observed in all serviceberry cultivars. The result of this study provides biochemical rationale to select and target high phenolic and high antioxidant serviceberry cultivars for further animal model based *in vivo* and clinical studies targeting dietary and therapeutic applications against early stages type 2 diabetes and associated macro and micro-vascular complications.

Specified Source(s) of Funding: North Dakota Specialty Block Grant funded part of the research associated with this abstract

10:15 AM Food Pathogen Attachment on Different Level of Epicuticular Wax Surface of Vegetables

Kang-Mo Ku[*1]; Yu-Chun Chiu[1]; Mark W. Farnham[2] and Cangliang Shen[1], *(1)West Virginia University, (2)USDA-ARS U.S. Vegetable Laboratory*

Abstract: Although understanding attachment mechanism of *Salmonella to produce surface is crucial information for reducing food pathogen outbreak, the bacterial attachment to different surface properties of leaves is not fully understood. Epicuticular wax is the most outer layer on the leaf surface that directly interact with food pathogen attachment. The hydrophobic nature of epicuticular wax has been found to have positive attributes to pathogen resistance due to the prevention of spore germination, however, there is limited study on if the amount of epicuticular wax layer on the leaf is correlated with the attachment ability of Salmonella. The goal of this study is to examine attachment strength of Salmonella on various leafy vegetable surface including collard green cultivars ('Green glaze' as glossy leaf type and 'Top Bunch' as waxy leaf type (Brassica oleraceae L. Acephala group), two sets of broccoli isogenic (USDA115 glossy and waxy; USDA188 glossy and waxy), and flowering lettuce. The leaf surface image of all vegetables examined by scanning electron micrographs (SEM) showed the topographical difference; net-like waxy crystals were deposited on 'Top Bunch' and waxy broccoli (USDA188 and USDA115) leaf surface and the waxy layer made less visible stomata compared to glossy collard 'Green Glaze' and glossy broccoli (USDA188 and USDA115). Characteristic of crystalline wax structures on lettuce leaf epidermis was platelets with few needles. Total wax content of waxy collard was 94.85±7.41 µg/cm^2 with total fatty acids concentration 24.1 µg/cm^2, total alkanes 776.6 µg/cm2, total alcohol 96.1 µg/cm2 and total ketone 394.3 µg/cm^2. By contrast, total wax content of glossy collard was 2.31±0.39 µg/cm2 with total fatty acid concentration 22.6 24.1 µg/mL, total alkanes 2.8 µg/mL, total alcohol 6.1 µg/mL and non-detectable ketone concentration. The total amount of epicuticular wax on apical and middle attached leaves of flowering stem in lettuce had about six fold higher than lower leaves (31 -39 µg/cm^2). The attachment of Salmonella was significantly stronger on the glossy collard (10^5 CFU/g) rather than the waxy collard (10^4 CFU/g). The different Salmonella attachment was maintained during postharvest storage. We also confirm the same trend using broccoli isogenic lines and flowering lettuce model. To confirm the epicuticular wax effect on Salmonella attachment, epicuticular waxes were removed by arabic gum treatment and test the Salmonella attachment. Salmonella attachment was significantly increased after epicuticular wax removal. These results suggest the presence of epicuticular wax has negatively influence on Salmonella attachment and the cultivar chosen for the salad leaves can potentially be considered to reduce the risk of foodborne contamination during pre-harvest and post-harvest condition.*

10:30 AM Effect of Boiling, Steaming, and Microwaving on Glucosinolate and Primary Metabolite Profile in Methyl Jasmonate Treated Broccoli

Yu-Chun Chiu* and Kang-Mo Ku, *West Virginia University*

Abstract: Many research have shown glucosinolate (GS) loss during cooking process in broccoli. While methyl jasmonate (MeJA) application significantly increases potential health-promoting GS) in broccoli (*Brassica oleracea* var. *Italica*) by mimicking insect damage, limited research looked at on how MeJA application affects GS retention after cooking. To fully utilize MeJA application, we aimed to measure how MeJA application affects GS retention after cooking. In this study, 250 µM MeJA was applied to 'Green Magic' broccoli four days before the harvest and we measured GS in broccoli, GS in cooking water, electrical conductance, and primary metabolites to evaluate the phytochemical profile change after three different cooking methods (boiling, steaming, and microwaving) and two cooking times (2 and 5 minutes) on control and MeJA-treated broccoli. In raw broccoli, MeJA treatment significantly (P<0.05) induced progoitrin (19%) and glucoerucin (43%), glucobrassicin (52%), neoglucobrassicin (488%), and 4-methoxy-glucobrassicin (21%) compare to the control. Among six cooking treatments (methods x times), 5 minutes boiling led to the most significant loss in total aliphatic (22%) and indole GS loss (62%) in control while it caused 47% total aliphatic and 54% indole GS loss in MeJA-treated broccoli. Even though GS loss rate were high in both control and MeJA-treated broccoli, only 5 minutes boiling cooking water from control broccoli consistently contained highest amount of glucoraphanin (0.04 µmole/g DW), total aliphatic GS (0.06 µmole/g DW), neoglucobrassicin (0.18 µmole/g DW), and total indole GS (0.2 µmole/g DW) at P<0.05; however, no significant difference was detected in MeJA-treated broccoli cooking water regardless of cooking treatments. In addition, the highest electrical conductance (EC) value was observed in control boiling 5 minutes cooking water and then MeJA 5 minutes boiling water, followed by steaming water and then microwaving water. This indicated the higher cell membrane leakage in the boiling treatment was observed in control and MeJA-treated broccoli. Sucrose, fructose, glucose, proline, isoleucine, valine, serine, oxoproline, and glutamic acid were significantly reduced in MeJA treated raw broccoli compared to control. In cooked broccoli serine was the most discriminating metabolites among all treatments, and only microwaving did not lose serine during cooking. In control cooked broccoli, sucrose was the most significantly different biomarker from partial least squares discriminant analysis while fructose was the most important biomarker in MeJA-treated broccoli. Our results suggested MeJA application on broccoli can potentially retain higher GS to provide improved phytochemicals in broccoli after cooking.

10:45 AM Mungbean: A Potential Health-Food Sprouted Bean Crop in Alabama

Rao S Mentreddy*[1]; Rachid Ouazaz[1]; Xianyan Kuang[2]; Nahid Sistani[1]; Kamala Bhat[1]; Ying Wu[3] and Mathew Blair[2], *(1)Alabama A&M University, (2)Tennessee State University, (3)Tennesssee State University*

Abstract: Mungbean (*Vigna radiata*) is a short-season, drought tolerant crop that can be grown as a rain-fed crop on marginal soils in Alabama. Mungbean seed is rich in protein (24%), dietary fibers, vitamins A, C and B12 complex, but low in fats, sodium, and cholesterol. In the USA, mungbean is well known as bean sprouts used in salads and soups, and is gaining popularity as a health food for combating obesity and diabetes. Approximately 10 million kg of mungbean is consumed annually in the U.S. of which about 75% is imported from Asian countries because of limited production in the U.S. The objective of the study was to assess mungbean varieties for yield and sprouted bean nutritional quality for potential commercial production in Alabama. Five mungbean varieties, Chinese Organic (CH-O), Chinese Conventional (CH-2, CH-3), Indian (IN-1), and Tennessee, US (TN-1) were planted in single row plots and were assessed for growth, yield, and seed nutritional qualities. Seed yield was determined per plant by harvesting plants from one-m row length of each variety. Hundred g of mungbean seeds of each variety were sprouted. The dry seed and sprouted seed were analyzed for mineral content using the OEC ICP Spectrometer. The total phytic acid, total flavonoid content, crude protein, oil, and condensed tannins were determined using appropriate methods. The number of pods/plant and seed wt./plant ranged from 42 (CH-2&CH-3) to 79 (CH-O) and 26 (IN-1) and 78 (CH-O), respectively. Chinese Organic Mungbean (CH-O) with more and heavier pods per plant out-yielded other varieties by 56%. Sprouted beans of all varieties possessed lower levels of total phytic acid than dry seeds. Total flavonoid content of dry seed ranged from 0.109 (CH-2) to 0.235 ug/g (IN-1). The percentage oil and crude protein of sprouted beans ranged from 0.3 (CH-3) to 0.9 (TN-1) and from 21.8 (IN-1) to 23.2 (CH-2), respectively. There was a significant reduction in condensed tannin when the seeds were sprouted. Minerals K and Na were higher among sprouted beans. Fe level decreased in sprouted, while Mn and Ca were higher in sprouted than dry seed in IN-1, CH-2 and CH-3. The variation in seed yield and nutritional traits of the varieties indicates that mungbean offers potential for commercial production as a health-food crop in Alabama.

Specified Source(s) of Funding: NIFA-ALDI-16SCBGPAL0004-12

10:00 AM – 11:00 AM *Piscataway (Lobby Level)*

Ornamentals/Landscape and Turf (O/LT) Meeting - Open to All Attendees

Chair: Mengmeng Gu, *Texas A&M AgriLife Reseach & Extension*

Chair-elect: Tim Pannkuk, *Sam Houston State University*

Secretary: Charles Fontanier, *Oklahoma State University*

Objectives:

To study woody (ornamental and native) herbaceous and turf materials with emphasis on plant adaptability, selection, and maintenance requirements and to provide a vehicle for arboreta, botanic gardens, and the landscape industry (architects and contractors) to become more closely allied to ASHS.

10:00 AM – 11:00 AM *Oak Lawn (Lobby Level)*

Plasticulture (PLAST) Meeting - Open to All Attendees

Chair: Gordon Johnson, *University of Delaware*

Chair-elect: Xin Zhao, *University of Florida*

Secretary: Shuresh Ghimire, *Washington State University*

Objectives:

Heightened environmental awareness and recent advances in plasticulture technology are catalyzing all kinds of new approaches in horticultural production around the world. The purpose of the Working Group is to encourage and facilitate the mutual exchange of ideas and information concerning the use of plastics in various aspects of horticultural research, extension, education, and industry. This is accomplished by promoting plastics science and technology, by providing a forum for the exchange of plasticulture ideas and information, and by encouraging innovation.

10:00 AM – 12:00 PM *Monroe*

Pomology 2

Moderator: Clive Kaiser, *Oregon State University*

10:00 AM Establishment of an Apple Orchard: Year 1

Naveen Kumar*, *University of Maryland Eastern Shore*

Abstract: Historically the tri-county (Wicomico, Somerset, and Worcester) area was known for fruit cultivation on the Eastern Shore of Maryland (MD). A USDA census of agriculture in 1925 showed 6.0 million pounds (m lb) of apple production in this area, which was dominated by Worcester (4.3 m lb) and followed by Wicomico (0.9 m lb) and Somerset (0.7 m lb) county. However, currently there is no commercial apple production in these counties (USDA, NASS 2012). We recently established an apple orchard at University of Maryland Eastern Shore (UMES) to rejuvenate the lost commercial apple industry on the Eastern Shore of MD. This medium density, multi-variety and multi-rootstock (5)/scion (30) apple orchard is the site for hand-on training for growers, beginner farmers, farm managers, stakeholders, and extension associates to generate human resources to popularize the apple cultivation on the Eastern Shore of MD and adjoining urban areas. This orchard will be

commercially productive within the next 3-4 years, giving all interested parties multiple opportunities to see the progression of the apple orchard from planting through initial productivity and harvesting. Within a year, after planting in March, 2017 four workshops were conducted on establishment of apple orchard, basics of pruning, rootstock/scion selection, and overview of the tall spindle system. This project got wide media coverage and larger number of local growers, small farmers, home owner, and schools became the part of this project. With the help of SARE funding, an apple team was recruited in the Tri-County area comprises of 25 stakeholders, growers, and extension agents for a period of three years. In addition, another apple team was recruited in Virginia through Virginia State University, Cooperative Extension following a workshop in March, 2018. Thirteen growers came forward and showed interest to conduct workshops frequently to enrich the knowledge of apple cultivation. Our orchard is visited by more than 200 visitors since March, 2017. Recently, one of our apple team member planted a high density apple orchard in Crisfield, MD. This showed an increase in the apple acreage for the very first time in the Tri-county area. We are also planting a high density apple orchard in April, 2018 using the tall spindle system to accelerate apple production. Our small apple orchard generated mass awareness about the potential of fruit cultivation in the Tri-County area. This program will revolutionize the culture of fruit cultivation in coming years on the Eastern Shore of MD.

Specified Source(s) of Funding: SARE and 1890 Extension

10:15 AM Evaluation of Artificial Spur Extinction on 'Gala' Apple Yield and Fruit Quality in Pennsylvania

Rebecca J Wiepz*[1]; James R Schupp[2]; Melanie A. Schupp[2] and H. Edwin Winzeler[2], *(1)The Pennsylvania State University, (2)Pennsylvania State University*

Abstract: Decreasing crop load to maximize fruit size and quality is a common management strategy for apple (*Malus domestica)* production. Current thinning strategies are limited by high cost of labor, changes in chemical regulations, and variation in plant response due to unpredictable weather. Additionally, current chemical and manual thinning strategies postpone removal of fruit until post bloom. Thinning earlier in the season causes larger gains in fruit size and more effectively minimizes alternate bearing. Artificial spur extinction (ASE) is a pre-bloom method of manual thinning that minimizes a tree's potential crop load. Experimental trials in New Zealand and Australia showed ASE to maximize the impacts, reliability, and profitability of thinning treatments. Previous research in Pennsylvania has shown that the industry standard ASE level of 6 buds remaining per square centimeter limb cross sectional area does not reduce crop load to profitable levels in our climate. In 2017 a completely randomized trial was conducted at the Penn State Fruit Research and Extension Center in Biglerville, Pennsylvania on twenty mature 'Gala' apple trees divided into 5 treatments. Trees were thinned to 2, 4, or 6 buds cm^{-2} limb cross sectional area (ASE2, ASE4, and ASE6), and compared to an unthinned control. Following initial fruit set, all buds on one year old wood were removed, except one treatment which remained unaltered. Yield of fruit ≥6.35cm in diameter was not significantly altered by the thinning treatments($P>0.65$). However, the fruit produced by ASE4 showed a trend toward increased size, and had the highest soluble solids content ($P>0.0033$). In 2018 the study will be continued, repeating the evaluation of fruit quality and yield. The addition of an early season non-chemical thinning strategy that could set potential cropload before applying other thinning treatments would be a beneficial tool for many growers in PA.

Specified Source(s) of Funding: State Horticultural Association of Pennsylvania

10:30 AM Towards Ecologically-Based Fertilizer Recommendations That Improve Soil Quality in High-Density Apple Orchards

Gregory Michael Peck*, *Cornell University* and Mark Williams, *Virginia Tech*

Abstract: The profitability of high-density apple (*Malusxdomestica*) orchards is dependent upon obtaining sufficient vegetative growth and high fruit yields during the first three years after planting, a goal typically achieved through applying high rates of synthetically derived nitrogen fertilizer. The purpose of this project was to test the use of mulch and composts as alternative soil fertility management practices for Mid-Atlantic and Southern apple growers. Over three years, we sampled from study sites at Virginia Tech's Alson H. Smith, Jr. Agricultural Research and Extension Center (AREC), and at the orchards of grower cooperators in Virginia and Maryland. By the third year, the mulch treatments increased tree growth at all three sites. However, using compost either alone or in conjunction with calcium nitrate did not further increase tree growth at any of the sites. Additionally, the compost applications increased plant-available soil phosphorus at the AREC site and potassium at the Maryland site, but leaf tissue mineral concentration did not increase correspondingly to the soil mineral content. Soil microbiotic communities were analyzed using the Quantitative Insights Into Microbial Ecology software. Quality checking of the more than 1.5 million bacterial sequence reads and 0.25 million fungal reads showed that the greatest effect was due to location. The dominant Operational Taxonomic Units were most closely related to Proteobacteria, Acidobacteria, and Actinobacteria. Bacterial community changes that were consistent across locations were strongly associated with root-zone Proteobacteria, increasing by 26% due to the mulch application. Evidence for fertilizer-induced changes in the relative abundance of ammonia-oxidizing bacterial family were also apparent and suggest that there are functional differences in nitrogen cycling resulting from both the mulch and fertilizer treatments. The ability to alter the bacterial community has important ramifications for the bioavailability of plant nutrients, plant-root bacterial interactions, and overall orchard sustainability.

Specified Source(s) of Funding: USDA-SARE funded research project (LS13-258)

10:45 AM Post-Bloom Application of AVG Increases Fruit Set and Yield of European Pears Produced in Two Different Climates

Mateus Pasa*, *Oregon State University - Mid-Columbia Agricultural Research and Extension Center*; Todd C. Einhorn, *Michigan State University* and Bruno Carra, *Universidade Federal de Pelotas - UFPEL*

Abstract: Low fruit set is a major concern of pear orchards in warm-winter climates like Southern Brazil, often leading to poor yields. In major pear producing regions of the northern hemisphere, specific cultivars have a tendency for low fruit set, primarily during their early years, despite receiving adequate chill. Exogenous application of plant growth regulators (PGR) is one strategy employed to overcome this problem, though many compounds have been inconsistent. Aminoethoxyvinilglycine (AVG), an ethylene synthesis inhibitor, has shown promising results for several cultivars. The objective of this study was to evaluate different rates and timings of AVG on yield components of pear trees grown in two markedly different climates. In 2015, 20-year old 'Packham's Triumph' (2 x 5 m; 1000 trees ha^{-1}) were sprayed with AVG (60 mg L^{-1}) 7 days after bloom (DAFB). In 2016, 5-year old 'Rocha' (0.7 x 3.5 m; 4082 trees ha^{-1}) were sprayed with AVG (60, 80 and 100 mg L^{-1}) 7 and 14 DAFB. Both orchards were located in Southern Brazil and were grafted on *Pyrus calleryana* rootstock. In Hood River, Oregon, twelve experiments were conducted between 2012 and 2016 using variable AVG rates and application timings to the cultivars 'd'Anjou' and 'Comice'. Orchards varied in tree age and planting density. All experiments were arranged in randomized block designs generally comprising four to six single-tree replications. A nonionic surfactant [0.05% (v:v)] was used in all studies and solutions were sprayed to whole trees. Fruit set and yield components of 'Packhams's Triumph' were increased by AVG. Similarly, AVG significantly and linearly increased fruit set and yield components of 'Rocha' regardless application timing. However, a greater increase was observed when treatments were sprayed 7 DAFB. Fruit size was slightly reduced as AVG rate increased, probably as an indirect result of crop load. In Oregon, AVG-treated trees had significantly greater fruit set in 65% of the experiments. Full bloom applications were ineffective. Natural ethylene production rates of non-treated flowers and fruitlets peaked at 14 DAFB, irrespective of cultivar or year, and were reduced considerably by AVG. The effect of AVG on ethylene production persisted for 10 to 20 days after application and was rate-responsive. AVG applications between 7 and 14 DAFB were, generally, efficacious. Based on these results, AVG is a promising PGR to improve fruit set and yield of 'Packham's Triumph' and 'Rocha' pears grown in Southern Brazil, and 'd'Anjou' and 'Comice' pears in Northwest USA.

11:00 AM Fruit Development Period Is Related to Fruit Quality Traits across a Wide Variation of Genotypes in *Prunus persica*

Anders Vidstrand*, *University of California, Davis*; Ted M DeJong, *Univ of California*; Ksenija Gasic, *Clemson University* and John E Preece, *National Clonal Germplasm Repository USDA-ARS*

Abstract: This study examined the relationship between the length of the fruit development period and fruit quality traits in a phenotypic analysis of the *Prunus persica* collection of the USDA - ARS National Clonal Germplasm Repository. Previous studies have examined the influence of fruit maturity date on soluble solids concentration but had limited sample populations and neglected to account for the phenological variability and management effects on fruit quality traits. This study addressed these key issues and analyzed the relationship between fruit development period and fruit soluble solids concentrations, titratable acidity and soluble solids/titratable acidity ratios. The sample population consisted of 360 genotypes from diverse lineages (breeders' lines, Western cultivars, Asian cultivars, and wild collections) with large phenotypic variation. A growing degree hour model was used to analyze data from an on-site weather station to control for phenological variation due to temperature changes. Orchard management included standardized commercial practices including tree pruning, fruit thinning and consistent irrigation and nutrient applications. Fruit were harvested from 2 replicate trees for each genotype when mature, and analyzed at tree ripe stage. Composites of juice from 5 fruit were processed from each replicate and soluble solids concentrations and titratable acidity were calculated using standard postharvest procedures. The fruit development periods were compared against soluble solids concentration, titratable acidity, and soluble solids concentration/titratable acidity ratios at maturity, with mean values used for each genotype. Further analysis was completed by grouping these genotypes by parameters such as origin, acid type, flesh color, and endocarp adhesion. Statistical analysis was completed using R. Overall, there was a linear trend of increased soluble solids concentration with longer fruit development periods, with a significant source of the variation attributable to the interaction of fruit development period and soluble solids concentration. This indicated that fruit development period was a limiting factor for soluble solids concentration in *P. persica* and that there may be challenges in breeding genotypes with short fruit development periods and high soluble solids concentrations. Titratable acidity and soluble solids concentration/titratable acidity ratio showed no linear trends. Numerous other correlations were observable among groups including; wild collected genotypes, sub-acid types and other groups. These group interactions may provide insight as to the effect of fruit development period on important fruit quality traits.

11:15 AM Nutrient Balance and Bitter Pit Incidence of Honeycrisp Apple As Affected By Rootstock

Huifeng Li; Mario Miranda Sazo; Ben Orcheski; Terence Lee Robinson and Lailiang Cheng*, *Cornell University*

Abstract: 'Honeycrisp' apple is very susceptible to bitter pit, a physiological fruit disorder related to calcium deficiency. The main strategy for mitigating the problem has been increasing root Ca uptake and subsequent partitioning to fruit, but how rootstocks affect the balance of Ca with other nutrients and bitter pit incidence has not been examined in detail. The objectives of this work are 1) to compare fruit Ca level and its balance with other nutrients in flesh and peel tissues between 'Honeycrisp' and a bitter pit resistance cultivar 'Gala' across rootstocks; and 2) to determine rootstock effects on bitter pit incidence of 'Honeycrisp' in relation to tissue Ca level and its balance with other nutrients. By using mature trees of both 'Honeycrisp' and 'Gala' on four rootstocks (M.9, B.9, G.11 and G.41) in an existing field trial, we found that 'Honeycrisp' had much higher ratios of K/Ca, Mg/Ca, (K+Mg)/Ca and P/Ca than 'Gala' in both fruit flesh and peel tissues at harvest. The higher ratios in the flesh were primarily caused by lower Ca concentrations in 'Honeycrisp' but those in the peel also resulted from significantly higher concentrations of K and P in 'Honeycrisp'. Among the four rootstocks evaluated, 'Honeycrisp' trees on B.9 had the lowest bitter pit incidence whereas those on G.11 had the highest incidence, with trees on M.9 and G.41 being in the middle. The incidence of bitter pit in 'Honeycrisp' was not correlated with tissue nutrient concentrations, but corresponded well to the ratio of (K+Mg+P)/Ca in the peel. These findings indicate that the imbalance of Ca with K, Mg and P is closely associated with bitter development and rootstock has a significant impact on bitter pit incidence.

Specified Source(s) of Funding: USDA National Institute of Food and Agriculture - Specialty Crop Research Initiative Project 2016-51181-25406 and New York Apple Research and Development Program.

11:30 AM Consumer Preferences and Quality Characteristics of Peaches Grown in Georgia

Catherine Belisle; Uyen Phan; Koushik Adhikari and Dario J. Chavez*, *University of Georgia*

Abstract: Fruit quality characteristics and consumer acceptability can go hand in hand. Few studies in peaches have shown how both are associated or interrelated. To better characterize these associations, this study focused on evaluating 15 fresh peach cultivars that ripen from late-May to early-August in Georgia for quality characteristics and consumer acceptability. The overarching aim was to understand the quality characteristics that drive consumer likes and dislikes in the current peach varieties available in the market. For quality measurements, soluble solids content or SSC, titratable acidity (TTA) and firmness were measured. For consumer acceptability, eighty-nine peach consumers (31 male, 58 female) evaluated 15 peach varieties for their liking of appearance, aroma, overall flavor, sweetness, texture, sourness, as along with the overall liking on a 9-point hedonic scale (1 – dislike extremely; 9 – like extremely). The consumers evaluated the appearance and aroma of the whole fruit, while rest of the attributes (overall flavor, sweetness, texture, sourness and overall liking) were done on sliced fruit. Results indicated that 'O'Henry' and 'Blazeprince' followed by 'August Lady' were liked the most for appearance and aroma of whole fruits. 'O'Henry', followed by 'Sierra Rich' were rated highest overall for liking, flavor, sweetness and texture. In general, an SSC/TTA ratio of 15-18 was acceptable to the consumers. 'O'Henry' and 'Sierra Rich' had a ratio of 15.0 and 16.4, respectively. All varieties' titratable acidity ranged from 0.5 to 0.7. 'Spring Prince', which was the least liked sample had the highest firmness (3.2 kgf). The results of this study indicate that relationships among consumers' liking and quality characteristics can provide growers and researchers candidates of major drivers of consumption and targets for future improvement.

Specified Source(s) of Funding: Georgia Commodity Commission for Peaches

11:45 AM Impacts of Hydroshield, a Novel Plant Cuticle Supplement, on Irrigation Water Reductions in Apples, Sweet Cherries and Wine Grapes

Clive Kaiser*[1]; Vaughn Walton[1]; Gabriella Tait[2] and James Harbertson[3], *(1)Oregon State University, (2)Fondazione E. Mach, (3)Washington State University*

Abstract: A novel hydrophobic plant cuticle supplement (HydroShield) was developed by the authors and patented by Oregon State University. HydroShield is at least 90 µm thick and simulates xerophytic plant cuticles, slowing the movement of water out of leaves and fruit. 'Sweetheart' sweet cherry trees in the Dalles were subjected to 0.61 gal per hour drippers (no HydroShield) as a check, 0.61 gal per hour plus 3 applications of 1% HydroShield, 0.53 gal per hour (13.1% reduction) plus 3 applications of 1% HydroShield, and 0.42 gal per hour (31% reduction) plus 3 applications of 1% HydroShield. Trees were sprayed to the point of run-off with a Rears mistblower applying 100 gal of water per acre at a maximum speed of 2 mph. Trees were irrigated daily for 4 hours from 05/12/17 till harvest. Soil moisture was monitored using a neutron probe. At harvest, fruit cracking, yield and quality were evaluated for the different treatments. No differences in fruit quality or yield were observed between the different treatments. In Milton-Freewater, 'Gala' apples were sprayed to the point of runoff with 1% HydroShield plus 1% Cuevo® at 'pink stage' of bloom and again two weeks later and other trees were sprayed on the same days with 1% Cuevo only as an check. Fruit size was measured 7 times on the same 5 fruit on 5 trees each for both treatments over the growing season and again at harvest. Fruit sprayed with 1% HydroShield plus 1% Cuevo were significantly larger by 10.6% ($P<0.001$) than those fruit sprayed only with 1% Cuevo. In addition, 'Braeburn'

apple trees were sprayed twice with 1% HydroShield at fruit set and again 2 weeks later. Trees were irrigated twice weekly for 15 hours total with four drippers per tree. Irrigation treatments included: - a check with drippers emitting 1 gal per hour, dripper emitting 0.75 gal per hour plus HydroShield and drippers emitting 0.5 gal per hour plus HydroShield. Soil moisture was monitored at depths of 10, 20, 30 and 40 cm in the soil profile. At harvest yield per tree was estimated and fruit size and quality were evaluated for all treatments. There were no significant differences observed in the yield or fruit quality between the different treatments. Soil moisture was not significantly impacted by either of the reduced irrigation regimes compared to the untreated check. A similar trial on wine grapes using own-rooted Clone 8 'Cabernet Sauvignon' was irrigated according to deficit irrigation practices and there were no differences in yield of fruit quality between those vines that received 1 gal per hour and those that received either 0.75 gal or 0.50 gal per hour plus 4 applications of 0.5% HydroShield. Soil moisture of the 1.0 gal and 0.75 plus HydroShield were similar at all depths in the soil profile. The 0.5 gal per hour soil moisture at 40 cm started drying up towards the end of the growing season. Whether or not this results in a problem in subsequent years remains to be seen. Precipitation in the Pacific Northwest occurs predominantly in the winter months and this is expected to recharge the water table but multiple years of testing are required to confirm this. Where wine grape fruit quality was concerned, only titratable acidity (TA) was significantly higher in grapes that received 0.75 gal per hour compared to the check and 0.5 gal per hour treatments. Results to date indicate that HydroShield has the ability to reduce water usage in apples, sweet cherries and wine grapes without negatively impacting yield or fruit quality. A 25% reduction in irrigation water plus HydroShield did not affect soil moisture content in 'Braeburn' apples, or 'Cabernet Sauvignon' wine grapes. A 13% reduction in irrigation water in 'Sweetheart' cherries also did not affect fruit quality or yield. A 50% irrigation reduction in 'Braeburn' apples and 31% irrigation reduction in 'Sweetheart' sweet cherries also did not affect yield, fruit quality or soil moisture content. A 50% reduction in irrigation water under deficit irrigation of 'Cabernet Sauvignon' did not affect yield or fruit quality in year one but may have an impact on the soil water table in subsequent years, which may result in lower yields and altered fruit quality. The research is ongoing.

Specified Source(s) of Funding: Oregon Best; Oregon Department of Environmental Quality

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10:00 AM – 12:00 PM *Georgetown East*

Viticulture and Small Fruits 2

Moderator: Elina Coneva, *Auburn University*

10:00 AM Yield of Day-Neutral Strawberries Grown Under Low Tunnels Is Affected By Planting Date

Courtney A Weber[*1]; Richard Gassier Jr.[2]; Kaspar Kuehn[2] and Marvin P. Pritts[1], *(1)Cornell Univ, (2)Cornell University*

Abstract: Day-neutral strawberry cultivars have expanded the potential strawberry season in cool climates from 6 weeks to 6 months. However, poor weather conditions typically experienced late in the season has made the use of protected agriculture critical for reaching this potential. Previous work has shown that the cultivars Albion and Seascape in an annual plasticulture system covered by low tunnels produce the best combination of yield and high quality fruit for local markets into the late fall season. The goal of this project was to examine the effect of spring planting date on the yield potential of these cultivars in this production system. Replicated plantings of 'Albion' and 'Seascape' were established in Ithaca and Geneva, NY in an annual plasticulture system utilizing low tunnels for weather protection. Bare root plants were installed at each site at approximately two week intervals starting April 15 in Geneva (5 total planting dates) and April 30 in Ithaca (4 total planting dates) and ending June 15. Fruit was harvested from mid-July to mid-November and evaluated for marketability and mean fruit weight. The highest yields were observed from the earliest planting dates with yields trending down at the latest dates. Overall the Ithaca site had higher mean yields at approximately 525 g·plant^{-1} for the April 30 planting and 300 g·plant^{-1} for the June 15 planting. At a planting density of 47,000 plants·ha^{-1}, this translates to a calculated yield of nearly 25,000 k·ha^{-1} at the early dates, which is considerably higher than typically achieved in June-bearing (short-day) production in the region. Marketable yield for 'Albion' and 'Seascape' at both locations reached a minimum of 75% and 65%, respectively, without the use of fungicides or insecticides. Higher total yield and percent marketable fruit was generally observed at the Ithaca site. Based on these trials, earlier planting is recommended for maximizing yield for day-neutral strawberry production in cool climate locations.

10:15 AM Biologically-Based Treatments for Strawberry Growth and Disease Control in High and Low Tunnel Production in the Mid-South

Russell W. Wallace[*], *Texas A&M University*; Peter A. Ampim, *Prairie View A&M University*; M. Elena Garcia, *Univ of Arkansas* and Karlee B. Pruitt, *University of Arkansas*

Abstract: Biologically-based (BB) treatments were evaluated for strawberry growth, berry yield and quality, and disease control in high tunnel (HT) and open field/low tunnel (OF/LT) strawberries (*Fragaria* x *ananassa*) in Texas (Lubbock and Prairie View); while in Arkansas, calcium + boron foliar applications were compared to chemical fungicides. Varieties included Camino Real (CR) and Strawberry Festival (F). Bio-based treatments in Texas included *Trichoderma* spp., *Bacillus* spp., *Streptomyces* spp., and the plant extract *Reynoutria sachalinensis*. Treatments for root diseases in Texas were applied at planting and selected timings throughout the season using drip irrigation; and bi-weekly foliar applications made for *Botrytis* control. Regardless of treatment, the number of *Rhizoctonia*-infected plants at Lubbock was significantly higher in CR compared to F, and *Rhizoctonia* was significantly higher in HT production compared to OF/LT. In both states, and regardless of treatment, CR had significantly higher *Botrytis*-infected berries compared to F. At Arkansas, calcium + boron foliar applications resulted in significantly fewer *Botrytis*-infected berries compared to the untreated and chemical fungicide treatments, but there was no difference in marketable yield. At Lubbock, CR had significantly higher *Botrytis*-infected berries in OF/LT plots compared to HT. Chemical fungicide-treated plants at Prairie View had significantly lower marketable yields compared to BB treatments, while at Lubbock, no differences in marketable yields were observed. Results indicate the potential for using bio-based products and calcium + boron applications for disease control in strawberries, though more research is needed.

Specified Source(s) of Funding: Southern SARE funded all or part of this research

10:30 AM A Strawberry Cropping System Design for Improving Early Yield and Water Conservation and Its Economic Effect

Prosanta K. Dash[*]; Carlene A. Chase; Shinsuke Agehara; Lincoln Zotarelli and Zhengfei Guan, *University of Florida*

Abstract: The majority of Florida strawberry production utilizes bare-root transplants that require large volumes of sprinkler irrigation for establishment. Although plug transplants can be established without sprinkler irrigation, they generally more than double the cost of bare-root transplants. We hypothesized that a combined use of plug transplants and heat stress management practices would be an effective strategy for water conservation and improving early yields for strawberry production. 'Florida Radiance' plugs were transplanted in September 2016 and 2017 in Citra and Wimauma, FL on beds mulched with white-on-black plastic mulch. This treatment (WPK) utilized plug transplants that were treated with foliar applications of kaolin at 56 kg/ha immediately after transplanting and at 7 days transplanting. Plant growth and yield were compared to those of bare-root transplants set in mid-October on beds mulched with black plastic mulch and established using either standard sprinkler irrigation (BBH) or micro-sprinkler (BBM) irrigation. Irrigation water use at both Citra and Wimauma was lower with plug transplants than bare-root transplants, even though the former were transplanted earlier, due to the elimination of sprinkler irrigation for plug transplant establishment. Flowering occurred 4 and 5 days earlier with the WPK treatment than with the BBM and BBH treatments, respectively. In both years an early yield of 7.8 t/ha was obtained with WPK, which was higher than those with BBM (1.9 and 5.3 t/ha) and BBH (1.8 and 4.1 t/ha). Total marketable yield with WPK was also significantly greater than with BBM and BBH. Partial budget analysis indicated that the WPK treatment at Citra increased the net return by $7,918/acre with a consistent result

obtained at Wimauma. These results will inform decision-making about cropping system modification that can be adopted by Florida strawberry growers to considerably reduce water use in an economically feasible manner.

Specified Source(s) of Funding: Southwest Florida Water Management District and Borlaug Higher Education for Agricultural Research and Development

10:45 AM Seasonal Patterns of Root Growth in Cranberries

Amaya Atucha* and Beth A Workmaster, *University of Wisconsin-Madison*

Abstract: Timing of root growth is of foremost importance to adjust and target production practices (e.g., irrigation, fertilization, agrochemical applications, disease control, etc.) to periods of active root growth, when uptake rates are highest, thus increasing production efficiency and reducing environmental impacts. The main objective of this study was to characterize cranberry seasonal root growth dynamics and root morphological traits, and develop a root phenology model to increase production efficiency and sustainability. A total of sixteen minirhizotron root observation tubes were constructed and installed in an angled position in the root zones of selected beds of 'Stevens' and 'GH1' in central Wisconsin during the fall of 2014. Root images were recorded from April 2015 to January 2016, and from April 2016 to November 2016. During 2015 and 2016, new root production began during bloom time, and continued until after harvest. The highest rate of root production happened during and after harvest, which corresponds to the cessation of vegetative growth on the above ground portion of the plants. Root activity and production extends past harvest into mid-late fall, which might suggest that more attention should be paid to soil moisture levels during fall given that roots are still up taking water and nutrients.

11:00 AM Applied Water Amounts, Not Timing of Leaf Removal Alters Grapevine Berry Flavonoid Content in Cabernet Sauvignon Grapevine

Kaan Kurtural*[1]; Johann Martinez-Luscher[2] and Luca Brillante[2], *(1)University of California, (2)University of California Davis*

Abstract: Majority of viticultural areas in California are characterized by non-limiting source of solar radiation during the growing season. A consequence of such solar radiation coupled with less than crop demand precipitation received result in water deficits during ripening. There is lack of information on determining appropriate balances of canopy management and applied water amounts to produce suitable yields without compromising berry chemistry. In response, a study designed to test the interactive effects of leaf removal timing (pre-bloom and post-fruit set, compared to an untreated control) and applied water amounts (1.0, 0.5 and 0.25 crop evapotranspiration replacement (ETc)) on Cabernet Sauvignon/110R in Oakville, CA. Stem water potential was lower in the 0.25 ETc regardless of leaf removal that led to a 40% reduction in net carbon assimilation This was mediated by a lower stomatal conductance with 0.25ETc. There was no effect of leaf removal timing on components of yield, including number of berries set. The 0.25 ETc treatment reduced berry mass and yield, but 0.5 and 1.0 ETc treatments were not different from each other. There was a significant interaction of leaf removal and irrigation on pruning mass and Ravaz Index. Reducing the applied water amounts resulted in significant effect on anthocyanin and proanthocyanidin content only when normalized dried skin mass (DSM) suggesting a concentration effect as opposed to an increase in biosynthesis. Leaf removal affected flavonol content, specifically kaempferol-*3-o*-glucoside both on DSM as well as a per berry basis which conformed to existing light exposure literature. Clear skies and long periods with minimal precipitation paired with severe reduction in irrigation will have a stronger influence on berry chemistry than leaf removal practices. Our results indicated that cluster microclimate without leaf removal was already optimized. Although not as impactful, there still appears to be potential for understanding leaf removal influence on berry physiology and its effect on vine balance in premium regions.

11:15 AM Pierce's Disease Resistant Vitis Vinifera L. Selections - an Innovation for Viticultural Sustainability in Alabama and the Southeast

Elina D. Coneva*; Andrej Svyantek and Edgar L. Vinson III, *Auburn University*

Abstract: Pierce's Disease (PD), caused by the bacterium Xylella fastidiosa, is the major limiting factor for production of Vitis vinifera grapes in the southeastern United States. Three 'Dog Ridge' grafted PD resistant V. vinifera selections developed at the UC Davis, namely '501-12', '502-01', and '502-10' were planted at the Chilton Research and Extension Center, Clanton, in 2010 to study their resistance to PD and overall performance in high PD pressure environment. The experimental vineyard is a RCBD with 6 replications and 5 vines/replication. Studies on vines' phenology, vegetative development, cropping potential, and fruit quality were conducted during 2012-2017 seasons. All selections initiated bud break stage at the end of March and had fully developed canopies by late April. Selection '502-01' had the earliest flowering season. Our results suggest all selections grew vigorously through the years of vineyard establishment. Results for dormant pruning weights revealed high vigor for all selections. Fruit of selection '502-10' matures early in the season, and is harvested in mid- August, followed by '502-01' harvested end of September to early-October. '501-12' ripens late and is usually harvested in the second half of October. Studied selections differed in total yield per vine, but were highly productive. Cumulative yield per vine for the period 2012-2017 was the highest for the late season '501-12'. Early-season selection '502-10' had the largest cluster size among the group with an average cluster weight of 467 g on average in 2015. Based on six years of observations, the study results are encouraging. No PD infection was detected during the period of plant establishment. The newly introduced PD resistant grape selections have the potential to improve the grape production sustainability in the southeastern region and enhance the agriculture and food systems.

Specified Source(s) of Funding: HATCH Alabama Agricultural Experiment Station (AAES)

11:30 AM Harvest Date Estimation for Hybrid Grape Cultivars in Nebraska

Paul E. Read*; Stephen J. Gamet and Benjamin A. Loseke, *University of Nebraska*

Abstract: Assessing grape fruit maturity, potential wine quality at harvest, and the estimated optimal timing for harvest, can benefit both the grape grower and the winery to which the grapes may be sold. We have studied the timing of harvest over a period of 15 years for a large number of hybrid grape cultivars and correlated these times with growing degree days (GDD, base 50 Fahrenheit). These results will be reported for 16 cultivars for which GDD were recorded over a period of up to 15 years. The mean GDD will be reported, in addition to the range of extremes for earliest and latest harvest. For example, the mean GDD for 'Marquette' was 2757, with extremes of 2322 (an outlier?) and 2887. If the unusual extreme low is removed from the data set, the mean GDD is 2806 and nearly 80% of harvests fell between 2803 and 2887 GDD. Similarly, mean GDD for 'Frontenac' was 2878, with a range of 2676 to 3281, while for 'Vignoles', the mean was 3014, with a range of 2710 to 3374. Although harvest parameters (soluble solids, pH, TA) influenced harvest timing in several years, the data accumulated over 15 years have enabled a rough estimation of suggested harvest times for these and other hybrid grape cultivars grown in Nebraska vineyards.

11:45 AM Source–Sink Ratio Manipulations Affect Greatly Wine Grape Ripening and Composition at Harvest

Johann Martínez-Lüscher*[1]; Kaan Kurtural[1] and Luca Brillante[2], *(1)University of California, (2)University of California, Davis*

Abstract: Canopy management and fruit load control aim to keep a balance between vine's sources and sinks. In fact, balanced vines may produce more consistent yields and have a more even ripening. This study aims to study the relationship between source–sink ratios and important parameters for production logistics and grape quality, such as progress of ripening and grape composition at harvest. After homogenizing all vines by removing laterals and adjusting the number of shoots to 20, we tested three levels of canopy density and fruit load combined in a factorial design (3 by 3). This is, 3 canopy levels, 100%, 66% and 33% of the leaves combined with 3 fruit loads, 100%, 66% and 33% of the fruit corresponding to 30, 20 and 10 clusters per vine, respectively. Onset of ripening was sequentially delayed in 66% and 33% canopy treatments. The progress of ripening,

accumulation of soluble solids and loss of acidity (increase in pH and decrease in total acidity), also occurred slower in 66% and 33% canopy treatments compared to 100% of the canopy. In fact, the time to reach commercial maturity (>25°Brix) was delayed 6 weeks for the 33% canopy level. Surprisingly, fruit load did not have a significant effect on the progress of ripening. When comparing all treatments at commercial maturity, the treatment maintaining 100% of the canopy had the highest total acidity and lowest pH. Berry flavonoids at harvest were similar in the case of anthocyanins and flavonols. Contrarily, proanthocyanidins in both skins and seeds were lower in treatments keeping 33% of the canopy and 33% of the fruit. These results provide the basis for the control of the speed of ripening, and the understanding of flavonoid profile development in the different yielding strategies in wine grape production.

10:15 AM – 11:45 AM

Plant Nutrition Diagnostics *CEU Approved*

Lincoln West

Coordinators: Robert Mikkelsen, *International Plant Nutrition Inst* and Kent Kobayashi, *University of Hawaii at Manoa*

Moderator: Robert Mikkelsen, *International Plant Nutrition Inst*

Objectives:

Proper management of plant nutrients has economic, environmental, and social impacts. New diagnostic tools are continually being developed to allow horticulturists to improve their use of both inorganic and organic nutrient sources. This workshop demonstrates new approaches and techniques for predicting plant nutrient requirements, assessing nutritional adequacy, and diagnosing nutritional problems that arise during the growing season. Tools and methods for field evaluation and for laboratory diagnosis will be demonstrated. Participation and hands-on demonstrations will be available during the workshop. Attendees will learn about the latest science in predicting and measuring nutrient adequacy.

Description: Predicting and assessing the adequacy of mineral nutrition for plants has important economic and environmental implications. New tools and modern approaches assist growers to appropriately use both inorganic and organic nutrient sources. This workshop reviews and demonstrates modern equipment and techniques for making in-field and laboratory assessments plant nutrient status.

10:15 AM The Importance of Proper Plant Nutrition

Robert Mikkelsen*, *International Plant Nutrition Inst*

Abstract: OVERVIEW: This presentation will cover the economic, environmental, and social needs for proper plant nutrient management. This introductory session will provide global context to plant nutrition for maintaining high yields and quality of horticultural crops. The final abstract will be submitted upon approval of the workshop.

10:30 AM Assessing Plant Nutrient Status during the Growing Season: Laboratory Tools

TBD*

Abstract: OVERVIEW:

Monitoring the nutrient status of horticultural crops during the growing season provides valuable information regarding plant health. A hands-on demonstration will be made of proper tissue sampling, petiole extraction and analysis, and destructive sampling techniques. The analytical process of working through a certified laboratory to achieve reliable results will be demonstrated by showing inter-lab variation. A virtual tour of a working plant analysis laboratory will be presented as part of the workshop.

The final abstract will be submitted upon approval of the workshop.

10:50 AM Predicting Nutrient Adequacy with Soil Testing: New Approaches

Bruce Dunn*, *Oklahoma State University*

Abstract: OVERVIEW: Soil testing can provide a valuable prediction of the nutrient requirement of horticultural crops. Although soil testing has been used for many years, there are still many spatial and temporal issues related to soil sampling. Laboratory analysis of the samples should be done by organizations participating in a certification program. Interpretation of the analytical results that result in fertilizer recommendations are also weak for many important horticultural crops. Demonstration of various tools for soil/media sampling, new resin-based root simulators, and a virtual tour of a modern soil testing lab will be included in the workshop.

The final abstract will be submitted upon approval of the workshop.

11:10 AM Assessing Plant Nutrient Status during the Growing Season: In-Field Tools

Bruce Dunn*, *Oklahoma State University*

Abstract: OVERVIEW:

There are a variety of new non-destructive methods for assessing the nutrient status of horticultural crops. Destructive methods are expensive, relatively time consuming, and rely on laboratory analysis. Non-destructive methods are rapid and less expensive, but may be less accurate. There are many field and remote sensing techniques that are now available for assessing plant nutrient status. A variety of commercially sensors will be discussed and demonstrated during the workshop. Attendees will have hands-on demonstrations with several of these sensors and learn how they operate.

11:30 AM Tools for Visual Diagnosis of Nutrient Sufficiency

Dharma Pitchay*, *Tennessee State University*

Abstract: OVERVIEW:

Visual diagnosis of plant nutrient deficiency symptoms can provide valuable information on crop health. Many of the essential plant nutrients have distinct deficiency symptoms that can be used as a guide for correcting nutrient shortages. However, when symptoms become visible, the crop has already been subject to hidden nutrient deficiency. Symptoms can also be caused by biotic and abiotic issues, making diagnosis frequently challenging. A variety of modern guides are now available to empower farmers to conduct field diagnosis of nutrient deficiency. Demonstration of modern tools for visual diagnosis of plant nutrient deficiency symptoms will be provided in the workshop.

A final abstract will be submitted when the workshop proposal is accepted.

10:15 AM – 11:45 AM Jefferson East

Postharvest 2

Moderator: Christopher Watkins, *Cornell Univerity*

10:15 AM Managing Stem-End Flesh Browning, a Physiological Disorder of 'Gala' Apples

Jacqueline Nock[1]; Franziska Doerflinger[1]; Gilang Sutano[1]; Yosef Al Shoffe[1]; Nurdan Gunes[2]; Yiyi Zhang[1]; John DeLong[3]; Harrison Wright[3] and Christopher B. Watkins*[4], *(1)Cornell University, (2)Ankara University Faculty of Agriculture, (3)Kentville Research and Development Centre, Agriculture & Agri-Food Canada, (4)Cornell Univerity*

Abstract: A physiological disorder known as 'stem-end flesh browning' has recently been found in 'Gala' apples in the USA, Canada, Europe and Brazil. The browning originates at the stem end but can extend throughout the fruit as severity increases . The effects of harvest date, plant growth regulators (PGRs) [aminoethoxyvinylglycine (AVG) (ReTain) and 1-methylcyclopropene (1-MCP) (Harvista)], postharvest 1-MCP (SmartFresh), storage temperature (0.5 and 3 ^{o}C), and storage method (standard controlled atmosphere (CA) and dynamic controlled atmosphere – chlorophyll fluorescence (DCA-CF)) have been investigated. A Harvista spray was more effective at reducing disorder incidence than a ReTain. SmartFresh treatment had little effect. DCA-CF also delayed disorder development, but did not prevent it. Disorder incidence was slightly lower at 3 ^{o}C than 0.5 ^{o}C, indicating an advantage to using a slightly warmer storage temperature, but quality factors such as flesh firmness were reduced. The occurrence of stem-end flesh browning can be reduced by pre- and post-harvest management through the use of Harvista and DCA-CF, respectively.

Specified Source(s) of Funding: The NY Apple Research and Development Program, AgroFresh Inc., and the USDA National Institute of Food and Agriculture, Hatch project 2013-14-483, Improving Quality and Reducing Losses in Specialty Fruit Crops through Storage Technologies (NE-1336).

10:30 AM Prediction of Bitter Pit in 'Honeycrisp' Apples By Inducing Symptoms before Storage

Yosef Al Shoffe*[1]; Jacqueline F. Nock[1]; Lailiang Cheng[1] and Christopher B. Watkins[2], *(1)Cornell University, (2)Cornell Univerity*

Abstract: The prediction of bitter pit in 'Honeycrisp' apples using non-chemical methods has been investigated. Fruit from 6 different blocks in each of Hudson Valley and Western NY regions were used. Fruit were harvested at three weeks before anticipated harvest and at commercial harvest. Mineral analysis of peel tissues from the calyx-end was carried out. Replicates of fruit were either dipped or not with 2000 ppm ethephon, (2-chloroethylphosphonic acid) and bitter pit assessed at weekly intervals for 3 weeks Another set of fruit were stored at 3 °C with and without one week conditioning at 10 °C, and stored for 4 months at 3 ^{o}C + 7 d at 20 °C. Multivariate analysis shows that the passive method and ethephon dipping for fruit harvested 3 weeks before the anticipated harvest had higher correlation with the actual bitter pit after cold storage than those from minerals. The passive method is being further evaluated as a non-chemical predictor of bitter pit in 'Honeycrisp' apples.

Specified Source(s) of Funding: New York Apple Research and Development Program

10:45 AM Enhancing Postharvest Tree Fruit Quality with Functional Genomics

Loren A. Honaas*[1]; Heidi Hargarten[1]; Stephen P. Ficklin[2]; John Hadish[2]; Eric Wafula[3]; Claude W dePamphilis[3]; James P. Mattheis[4] and David R. Rudell[4], *(1)USDA, ARS, Tree Fruit Research Laboratory, (2)Washington State University, (3)Penn State, (4)Tree Fruit Research Laboratory, USDA-ARS*

Abstract: Functional genomics is an emerging technological frontier in postharvest crop management. This is driven in part by exponential growth of genomics resources for specialty crops, which include genomes and transcriptomes. These global-scale technologies are allowing insights into responses of Rosaceous tree fruit to modified atmospheres, various storage temperature regimes, and crop protectants in the postharvest period. These insights will allow researchers and producers to maximize favorable outcomes, especially with regard to crop protectant-limited production strategies. Here we report transcriptional fluxes of Granny Smith apple fruit in the early phases of long term storage in response to intermittent warming, an ostensibly organic compliant strategy that effectively reduces the incidence of superficial scald. We observed two temporally distinct classes of gene expression, which were discovered with high granularity sampling and novel analytics. This suggests that long term outcomes on the scale of months may be influenced by gene expression changes on the scale of hours.

Specified Source(s) of Funding: USDA-ARS and The Washington Tree Fruit Research Commission

11:00 AM Utilizing Nontargeted Metabolomics to Characterize Delayed Sunscald Development on Apple

Christine McTavish*[1]; David R. Rudell[2]; Nathanael Sullivan[1]; Carolina Torres[3] and James P. Mattheis[2], *(1)USDA-ARS, (2)Tree Fruit Research Laboratory, USDA-ARS, (3)POMACEAS, University of Talca*

Abstract: Intense sun stress in the apple-growing region of eastern Washington state can cause delayed sunscald, a superficial postharvest peel browning disorder occurring on the sun-exposed side of apples. There is no known treatment for delayed sunscald once it occurs, so early detection of this disorder is key to avoiding losses. Polar, non-polar, and volatile metabolite extractions were performed to identify changes in peel chemistry associated with sun-induced injury prior to and during cold storage. Samples were collected from the sun-exposed and unexposed sides of the apple at harvest and at multiple timepoints throughout cold storage: 2 weeks, 1, 2, 4, 5, and 6 months. In addition, severely sunscalded peel was also collected for comparison. A principle component analysis and 2-way ANOVA was performed using Metaboanalyst, and a pairwise correlation network was generated using WGCNA, Cytoscape, and Allegro to visualize the multidimensional metabolome. Results indicated that *p*-coumaryl esters were higher on the sun-exposed side, indicating changes in cuticle consistency. Vinyl aldehydes and quercetin glycosides were more abundant on the sun-exposed side of the apple, consistent with their previously reported roles in sun stress, making these metabolites potential targets for early detection of delayed sunscald. Now that we have selected potential metabolic targets for delayed sunscald, a next step would be to utilize properties of these metabolites to more easily and economically detect delayed sunscald prior to symptom development.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission project AP-16-102

11:15 AM Alterations in Peel Secondary Metabolism Are Associated with Superficial Scald in Apples

Brenton C. Poirier*[1]; David A. Buchanan[2]; David R. Rudell[1] and James P. Mattheis[1], *(1)Tree Fruit Research Laboratory, USDA-ARS, (2)Tree Fruit Research Laboratory, USDA-ARS (retired)*

Abstract: Superficial scald is a peel browning of susceptible cultivars, such as 'Granny Smith' developing during prolonged cold storage. The ethylene perception inhibitor 1-methylcyclopropene (1-MCP) and the antioxidant diphenylamine (DPA) are used to effectively manage the disorder. The current study identifies changes in peel metabolism that are associated with the development of superficial scald throughout storage. Postharvest applications of 1-MCP and DPA were performed on 'Granny Smith' apples, and peel tissue was collected following harvest and throughout six months of storage. Nonpolar metabolites were extracted and analyzed using LC-MS and GC-MS to characterize metabolic divergence between control and treated fruit. Sesquiterpenes, α-farnesene oxidation products (conjugated trienols), sesquiterpene esters, and *p*-coumaryl esters differentially accumulated among control, DPA, and 1-MCP treated apples. Conjugated trienols were produced in high levels in control fruit prior to the development of visible scald symptoms as compared with DPA and 1-MCP treated fruit; this trend was also reflected in two compounds identified as fatty acyl esters of conjugated trienols. Levels of fatty acyl esters of *p*-coumaryl alcohol increased throughout storage; accumulation was greater in DPA treated peel and diminished in 1-MCP treated peel as compared with controls. Compounds tentatively identified as *p*-coumaryl conjugates of triterpenoic alcohols displayed the opposite trend, accumulating at higher levels in 1-MCP treated peel. Widespread changes in the metabolic profile of epidermal and wax layers indicate that changes in cellular dynamics and cuticle properties may both play a role in the development of superficial scald.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

11:30 AM Using the Delta Absorbance™ Meter to Measure Harvest Maturity in 'Honeycrisp' and 'Mcintosh' Apples

Renae E. Moran*, *University of Maine*

Abstract: Fruit maturity at harvest impacts quality and occurrence of storage disorders, but most maturity indicators are inaccurate for 'Honeycrisp' apples. The DA meter measures fruit peel absorbance at 670 and 720 nm and calculates the ratio as IAD units. Fruit were randomly harvested from 3-5 trees of 'Honeycrisp' at two harvest dates in 2015, and three in 2016, and 2017. Each harvest was replicated 3 times. 'McIntosh' was included in 2016. IAD was measured on two sides of each apple at harvest and ater 1.5 months cold storage at 1 °C, along with storage disorders. Starch index, SSC and flesh firmness was measured on 5-10 fruit from each IAD group (0 – 0.19, 0.20 – 0.39, 0.40 – 0.59, etc.).
IAD in 'Honeycrisp' decreased with advancing maturity in all 3 years. By the third harvest, IAD had decreased to zero in some apples. IAD was lower in 2016 than in 2015 and 2017. Mean IAD ranged from 0.6 to 0.8 during the 2nd harvest which corresponded with peak commercial harvest. Mean IAD of 'McIntosh' at peak harvest was 1.8. Within a harvest date, IAD in Honeycrisp varied substantially, as much as 1.4 IAD units, compared with 'McIntosh' which varied by 0.8 IAD units within a harvest date. Starch index was not related to IAD in 'McIntosh'. Starch index in Honeycrisp was negatively related to IAD during both harvest dates in 2015, during the 1st and 2nd harvests in

2016, and during the 2nd in 2017.
Bitter pit did not occur in Honeycrisp in 2015 nor in McIntosh in 2016. Bitter pit incidence did not vary with IAD in 2016 or 2017. In 2015, soft scald was severe in fruit from the 2nd harvest, and incidence decreased with decrease in IAD. In 2016, soft scald incidence was severe in fruit from the 2nd and 3rd harvest. In fruit from the 2nd harvest, soft scald decreased with decrease in IAD, but no relationship occurred with the other 2 harvests. However, when data from all 3 harvests were pooled, soft scald incidence was negatively related to IAD consistent with the effect of maturity. In 2017, soft scald incidence was not related to IAD in fruit from the 2nd or 3rd harvest, but in fruit from the 1st harvest, it increased as IAD decreased.

10:15 AM – 11:45 AM

The Important Role of Horticulture in Conservation of Threatened and Endangered Plants *CEU Approved*

Jefferson West

Coordinator: Matthew Taylor, *Longwood Gardens*

Moderator: Matthew Taylor, *Longwood Gardens*

Objectives:

The objectives of this workshop on the role of horticulture in conservation of threatened and endangered plants is to: 1) inform ASHS community on the important role horticulture plays in plant conservation programs around the globe and to improve synergy among researchers focused on plant conservation objectives and those focused on horticultural objectives. 2) Discuss where knowledge and resource gaps exist. 3) Determine methods to gain support and further engage ASHS members and the horticultural communities. 4) Create a list of action items to garner support for conservation from ASHS members. The workshop will also support key objectives of the worldwide initiative of the Global Strategy for Plant Conservation (GSPC).

Description: This Public Horticulture Public Interest Group sponsored workshop will showcase the ever-growing role of horticulture in plant conservation programs and work to develop action items to further connect horticulture and conservation programs. A high-level overview of global plant conservation followed by specific conversation efforts will showcase the important role of horticultural techniques and expertise. Seed germination, vegetative propagation, greenhouse and nursery production, ecosystem restoration, molecular analysis, tissue culture and cryopreservation are just some of the techniques that will be discussed as tools used for saving threatened and endangered plants. The first discussion will focus on identifying gaps between conservation efforts and the horticultural community. The second session will work towards developing action items to bridge gaps identified in the earlier discussion. Each discussion will begin with high level questions to promote an organic discussion, ultimately used to synthesize take-home points and action items.

10:15 AM Overview of the Importance of Horticulture for Saving the Worlds Endangered Flora

Matthew D. Taylor*, *Longwood Gardens*

Abstract: The 2017 assessment by the International Union for Conservation of Nature (IUCN) indicates there are over 24,000 threatened plant species worldwide, which represents an estimated 6% of plant species. In North America, 4,420 species are considered threatened. To confront the growing threat to plant biodiversity, Botanic Gardens Conservation International (BGCI) has established The Global Strategy for Plant Conservation (GSPC). The vision for the GSPC is to halt the continuing loss of plant diversity and to secure a positive, sustainable future where human activities support the diversity of plant life. Five objectives and 16 outcome-oriented targets have been implemented by GSPC and challenge humanity to participate. Particularly relevant to horticulture are the seven Targets of Objective II: Plant diversity is urgently and effectively conserved. This objective emphasizes *in situ* and *ex situ* conservation efforts, ecological restoration, and invasive plant management. In many cases, horticultural techniques and expertise are integral to the success of these efforts. Many public gardens, universities, non-profits, private organizations, and businesses are already working towards accomplishing these targets. However, much more work is needed. The all-important role horticulture in these outcome-oriented targets is the beckoning for horticulturist from around the world to do their part in preventing the loss of plant biodiversity.

10:20 AM Horticulture As a Necessary Partner to Land Preservation When Conserving Endangered Plants

David Remucal and Kimberly Drewiske*, *Minnesota Landscape Arboretum*

Abstract: Land preservation has been the primary means of endangered plant conservation for many years. As we continue to lose species there is an increasing recognition of the need for ex situ conservation techniques to complement these in situ techniques. Ex situ conservation is generally gene banking, which can take many forms, seed banking being the most common, but can also include techniques such as tissue culture preservation or living off-site populations. Whatever the form, ex situ conservation is ultimately only going to be successful as a form of conservation if genetically diverse and ecologically/genetically appropriate plants can be grown and moved back onto natural landscapes, which is where horticulture is important. Horticultural techniques will also be important as land preservation groups seek to connect the fragmented genetics of land preserve "islands". Both the techniques and the infrastructure of modern horticulture, especially those available at a public-forward institution like a botanic garden, would fit well with the ex situ conservation needs that land preservation alone does not meet. Of particular note are the technology and data tracking botanic gardens often have available, which are vital tools to help track and manage genetics. As climate change continues and static land preserves change to different ecotypes we will need to have a system in place to help plants migrate to new, and newly appropriate, locations. Horticulture and botanic gardens are the logical choice for these systems and are in many cases already preparing for this work.

10:30 AM Accelerated Ex Situ Conservation of Threatened Magnolia Spp. Using Commercial Nursery Propagation and Production Methods

Gary W. Knox*, *University of Florida*

Abstract: Of the 244 threatened (CR, EN, VU) or data deficient (DD) *Magnolia* species cited in *The Red List of Magnoliaceae, revised and extended*, (Rivers et al., 2016), only 104 (43%) can be found in *ex situ* collections. Most of these are present in five or fewer collections resulting in a greater risk of loss. Modern nursery propagation and production methods may be employed to propagate and rapidly grow endangered magnolias that can then be distributed for widespread *ex situ* conservation. *Magnolia sphaerantha* (C.Y.Wu ex Y.W.Law & Y.F.Wu) Sima (syn. *Magnolia elliptilimba*, syn. *Michelia sphaerantha*), ranked data deficient, is a rare species of evergreen magnolia that grows as a medium tree in broadleaved evergreen forests at elevations of about 2,000 m in central Yunnan Province, China. Until recently it was rarely found in botanical gardens outside China. In early 2014, the UF/IFAS NFREC received 66 seeds collected November 2013 from a grove of wild-collected *M. sphaerantha* in Kunming Botanical Garden, Yunnan, China. Twenty seeds germinated and seedlings were cultivated using production methods typical of North American container nurseries, including applications of slow release fertilizer and automatic irrigation to plants growing in containers containing soilless substrate. Rapid seedling growth resulted, allowing repeated collections of axillary cuttings for asexual propagation. Cuttings 12-14 cm in length were treated with a commercial talc-based rooting hormone and placed in a greenhouse under intermittent mist. Cuttings rooted in 9-11 weeks at percentages ranging up to 100% depending on seedling clone and rooting hormone concentration. In addition, rapid growth of newly propagated plants allowed additional cuttings to be collected from the initial set of propagules. Within 12 months of initial seed collection, parent seedlings exceeded 2 m in height and a total of 114 *M. sphaerantha* plants were available for distribution. As a result of these efforts, *M. sphaerantha* specimens are in *ex situ* cultivation at 32 botanical gardens and other institutions in 13 North American states and provinces. Similar nursery production and propagation practices are being applied to *M. garrettii*, *M. rajaniana*, and *M. sapaensis*. Preliminary research demonstrated feasibility of cutting propagation from seedlings of *M. fraseri* var. *pyramidata*, a taxon which cannot be propagated by cuttings from mature growth.

10:40 AM Strategies to Conserve Magnolia Ashei Based on Molecular Diversity Analysis

Christopher Von Kohn[1]; Kevin Conrad[1]; Matthew H. Kramer[2] and Margaret Pooler[*3], *(1)USDA-ARS U.S. National Arboretum, (2)USDA-ARS, (3)USDA-ARS, U.S. National Arboretum*

Abstract: The Ashe magnolia (*Magnolia ashei*) is a deciduous small tree most noted for its large leaves and fragrant white flowers. Although the species is adapted to and used in landscapes in many parts of the U.S., it is endemic only to Northwest Florida where it is limited to ten counties growing on undisturbed bluffs and ravine banks. The populations are highly fragmented and are threatened by degradation of habitat, leading the species to be listed as endangered in the state of Florida. SSR markers were developed to determine the genetic diversity of wild populations of M. ashei in order to guide long-term conservation strategies. 18 marker loci identified a total of 82 alleles that were used to characterize allelic diversity of *M. ashei* from 11 wild populations, 14 cultivated sources, five accessions *of M. macrophylla*, and three interspecific hybrids. Results indicated a higher than expected level of heterozygosity within populations, and a clear distinction between Eastern and Western populations; conservation efforts should therefore focus on maintaining these distinct groups in corresponding ex situ seed orchards to counteract pressures due to overcollection, pollution, and loss of habitat due to development. Clustering of individuals was similar using several analytical methods, indicating that despite relatively small sample sizes, our analysis is an accurate reflection of the diversity among and relationships between these populations.

10:50 AM Gap Analysis Discussion: What are the primary barriers that need to be overcome to garner support from more ASHS members and the horticultural community for plant conservation initiatives?

Matthew D. Taylor[*], *Longwood Gardens*

11:00 AM Plant Cryopreservation at the Huntington Botanical Gardens

Raquel Folgado[*], *The Huntington Library, Art Collections and Botanical Gardens*

Abstract: Besides the in situ conservation of plants, the development of efficient methods of ex situ conservation plays a crucial role in the maintenance of plant biodiversity. However, the traditional preservation methods, such as field clonal genebanks, are often costly and risky. Most of the plants are usually propagated through seeds, grafting, and rooting of stem cuttings. However, these methods are not always highly efficient for obtaining a significant amount of disease-free plant material (which might be used to re-introduce the plants in the natural environment if needed). An appropriate approach is the use of micropropagation (or tissue culture) to maintain additional ex situ collections besides the field collections at botanical gardens, such as The Huntington. Furthermore, we can take advantage of innovative techniques which allow long-term conservation of plants, such as cryopreservation or the storage of plant material from tissue culture at an ultra-low temperature (−196°C, in liquid nitrogen). The primary goal of the cryopreservation program at The Huntington Botanical Gardens is providing protocols to preserve plant germplasm in liquid nitrogen and freezers. This technology will help to ensure long-term conservation for threatened species that are part of living collections at botanical gardens, such as The Huntington. We are working with succulents, cacti, magnolias, avocado, oaks and other endangered species.

11:10 AM Native Orchids – Potential Uses in Horticulture in Support of Conservation

Dennis Whigham[*], *Smithsonian Environmental Research Center*

Abstract: The Orchidaceae is recognized as one of the most species-rich plant families on earth and it is also recognized that many native orchids are threatened, for example, by over-harvesting, climate change, and habitat destruction. The North American Orchid Conservation Center (NAOCC) has been established to conserve the genetic diversity of native orchids in the U.S. and Canada, with a long-term goal of using an ecological approach to conserve native orchids globally. A pillar of the NAOCC model for conservation is propagation of native orchids from seed using appropriate mycorrhizal fungi. Horticulture is envisioned to play an important role in the effort to conserve native orchids. Many native orchids have the potential to be used in horticulture and successful propagation in formal and informal garden settings will result in the establishment of native orchid populations in support of efforts to restore species across the U.S. and Canada. The application of ecological principles to orchid conservation will also raise awareness of the importance of orchid-fungal interactions – an essential component of native orchid ecology.

11:20 AM Determination of Asymbiotic, in Vitro Seed Germination, in Vitro Seedling Development and Greenhouse Acclimatization Protocols of Threatened Spiranthes Spp. for Ex Situ Conservation

Peter Zale[*], *Longwood Gardens*

Abstract: Reproducible propagation protocols are needed to develop genetically diverse ex situ collections of U.S. native orchids, but do not exist for many species of conservation concern. Approximately 45 species of the taxonomically difficult genus *Spiranthes* are found worldwide; 23 species occur primarily in the eastern United States and several are considered rare, threatened or endangered by federal and state agencies. Using the Pennsylvania endangered *Spiranthes casei* as a model species, a series of experiments were designed to determine optimal conditions for in vitro seed germination, in vitro seedling development and greenhouse acclimatization. Seeds were collected in November 2015 from 10 individual plants found in three subpopulations in Elk and McKean counties, Pennsylvania, cleaned and air-dried for six weeks. Seeds were surface sterilized and scarified for 10 and three minutes in 10% bleach solution, then plated on five replicates each of three different commercially available terrestrial orchid seed germination media: P723, M551 and K400 (*Phyto*technology Labs, Shawnee Mission, KS) with pH adjusted to 5.8. Seed germination ranged from 24 to 60 % and occurred on all three media only after the 3-minute treatment; none of the seeds germinated after the 10-minute treatment and visual inspection revealed badly damaged embryos. After shoot initiation, 150 seedlings were transferred to individual test tubes on one of two media (P723 and P658) and each was given one of the three photoperiod treatments for 10 months: 24/0 hour L/D, 18/6 hour L/D and 0/24 hour L/D. Seedling survival and growth occurred in all treatments, but incubated on P723 in the 24/0 and 16/8 treatments had a significantly greater fresh weight, leaf length, number of roots and root length than light treatments on P658 and dark treatments, indicating that light is essential for optimal seedling growth. Seedlings were removed from the test tubes and given a 100-day vernalization period at 2 °C. Seedlings were then randomly planted in one of four soilless media (Longwood Gardens research mix (LGRM), New Zealand sphagnum (NZ), Fafard 3b and Good Earth BC5). The survival rate (95%) and highest incidence of flowering (20%) occurred on NZ. The lowest survival rate (55%) and incidence of flowering (10%) was on LGRM. Results support anecdotal evidence that *Spiranthes* seeds are degraded by extended chemical scarification times. The propagation techniques described above are being applied to additional *Spiranthes* species to determine the efficacy of the protocol for propagating a greater range of taxa.

11:30 AM Using points identified during the gap analysis discussion, this session will be utilized to develop action items to bridge conservation programs, ASHS and the horticultural community.

Matthew D. Taylor[*], *Longwood Gardens*

10:15 AM – 12:15 PM *International Ballroom West*

Clean WateR^3 – Reduce, Remediate, Recycle

Moderator: Sarah White, *Clemson University*

10:15 AM Rate of Phosphorus Needed to Grow Seven Ornamental Taxa and Subsequent Fate within the Container System

Jacob H. Shreckhise[1]; Jim S. Owen[*1]; Alexander X. Niemiera[1] and James Altland[2], *(1)Virginia Tech, (2)USDA-ARS, MWA ATRU*

Abstract: The essential mineral nutrient phosphorus (P) must be supplied throughout production of containerized ornamental crops because of low anion exchange capacity of soilless substrate paralleled with frequent irrigation. The resulting crop P use efficiency can be as low as 20% resulting in wastefulness of a

finite resource that is increasing in price and under regulatory scrutiny because of its ability to degrade surface waters via eutrophication. Additionally, P fertility research is lacking two-fold: (1) reducing P below the recommended low rate in containerized woody taxa of 5 mg·L^{-1} and (2) P availability or fate in soilless substrates. This led to five-years of research focused on optimizing P fertility rates for seven taxa and laboratory experiments to determine the fate of P in substrate solution. Liquid fertilization studies with constantly applied 0.5 to 6 mg·L^{-1} P determined the minimum P concentration required to sustain maximal growth was 5 mg·L^{-1} for 'Limelight' hydrangea, 3 mg·L^{-1} for 'Karen' azalea, and 1 mg·L^{-1} for 'Helleri' holly. Studies using controlled release fertilizers (CRF) with varying rates of P in a zone 6 or 8 ecoregion determined maximal growth of Bloomstruck hydrangea could be attained with a 50% reduction in P compared to a conventional 15N-2.6P-10K CRF, regardless of hardiness zone, when produced with 18N-1.3P-10K. Growth of Knockout rose was equivalent when comparing two CRF, 18-1.7P-6.6K (conventional) versus 18N-1.3P-10K (low P), across zones 6 and 8. Green Giant' arborvitae, Encore azalea, 'Natchez' crape myrtle, and 'Annabelle' hydrangea required the 18-1.7P-6.6K (conventional) CRF to maximize growth. This may be in part because the conventional fertilizer formulation used in this specific trial had a higher N:P ratio (10:1) compared to the 6:1 ratio historically used in conventional fertilizer; however, this was not specifically investigated. In laboratory experiments we found that common substrate amendments reduced availability of the P inherent to the bark as well as that which is released by the CRF. The immediate availability and subsequent leaching of this initial P can be reduced 35% with lime, 54% with micronutrients, or 78% when amending pine bark with both dolomite and micronutrients. Once the CRF released (≈ 20 days), available or leachable P can be reduced by more than 50% for > 30 days when amending with dolomite with or without micronutrients. These data can be used to further refine P fertility when producing containerized woody nursery crops.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

10:35 AM Reducing Water and Pesticide Movement in Nursery Production

Rodney Thomas Fernandez*, *Michigan State University*

Abstract: Nurseries produce a large number of plants in a concentrated area and aesthetics are a key component of the product. In order to produce crops in this fashion, high inputs of water, nutrients and pesticides are typically used. Container nursery production further increases the inputs, especially water, since container substrates are designed to quickly drain and the most effective method to irrigate large numbers of plants in containers (up to a certain size) is with overhead irrigation. As irrigation and pesticides are broadcast over the crop and the crop is limited to the container, a large proportion of water or pesticide may land on non-target areas. Water is the primary means of pesticide movement in nursery production. This presentation will discuss water and pesticide dynamics and management strategies to conserve water and reduce pesticide and water movement in container nursery production.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

10:55 AM Effect of Plant Available Water Reduction on Two Yellow Garden Mum (Chrysanthemum morifolium) Cultivars

Andrew G. Ristvey*[1]; Bruk E. Belayneh[2]; Ian Howard[2] and John D. Lea-Cox[2], *(1)University of Maryland, WyeREC, (2)University of Maryland*

Abstract: The effect of reducing substrate moisture availability on the growth of two yellow garden mum (*Chrysanthemum morifolium*) cultivars (Chelsea and Ursula) was investigated in a greenhouse study. Seedling of both cultivars were transplanted and grown into 8-inch pots filled with two soilless substrates – Sunshine Gro mix- LC1 (70% peat moss:30% perlite) and a wood fiber (WF) substrate (60% peat moss:40% wood fiber). The experiment was laid out in randomized complete block design with four replications and consisted of three irrigation treatments. Moisture release curve for the substrates used in the study was developed using the Hyprop device (METER Group Inc., Pullman, WA). Based on the volumetric water content (VWC) vs. matric potential (MP) relationship observed, three VWC values (45% - Control, 35% - IT1 and 25%-IT2) were selected as set-points for treatments in order to apply progressively less irrigation water. VWC and MP measurements were obtained with GS-1 and MPS-6 sensors (METER Group Inc.) on a 5-min basis using Em50R data loggers (Meter Group Inc.,). Recorded data was transmitted through a basestation to Sensorweb^{TM} software (Mayim LLC., Pittsburgh, PA). For each substrate, VWC readings from two plants (one from each cultivar) in each experimental unit were averaged on a 15-min basis. Irrigation was applied for 15-sec durations whenever the average VWC sensed was below the corresponding set-point using PlantPoint^{TM} (METER Group Inc.) control data loggers that were connected to solenoid valves. The substrate VWC for each substrate was maintained within a very narrow range of the set-points throughout the study. Irrigation application was recorded with flowmeters (Model 25, Badger Meter Inc., Milwaukee, WI). Plants were destructively harvested at full maturity and data on growth index (GI), leaf area (LA), leaf fresh mass (LFM), leaf dry mass (LDM), flower number (FN), flower fresh mass (FFM), flower dry mass (FDM), stem fresh mass (SFM), stem dry mass (SDM), total shoot mass (TSM) and root dry mass (RDM) were obtained. Analysis of harvest data showed that there were no significant differences between irrigation treatments for all measured parameters for cv. Chelsea in the WF substrate. However, significant differences in the parameters GI, LA, LFM, FFM, FN, SFM, SDM, TSM and RDM were observed for cv. Ursula, with the IT1 and IT2 treatments resulting in plants with less vigor. Irrigation application volume was 16.6% and 41.1% less for the IT1 and IT2 treatments compared to the control. In the LC1 substrate, only GI and FN were significantly different between irrigation treatments for cv. Chelsea; whereas only GI was significantly different between irrigation treatments for cv. Ursula. Volume of irrigation water applied was 33.0% and 33.7% lower for the IT1 and IT2 treatments as compared to the control. The results observed indicate differences in the moisture release properties of the two substrates and possible differences in drought resistance of the two cultivars.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

11:15 AM Irrigation Practices and Pathogen Infection Potential: Balancing Reduced Water Use with Oomycete Disease Risk in Containerized Nursery Production

Cassandra Swett*[1]; Johanna Del Castillo-Múnera[1]; John D. Lea-Cox[2] and Bruk E. Belayneh[2], *(1)University of California Davis, (2)University of Maryland*

Abstract: The nursery crop production sector is a large agricultural consumer of fresh water. With rising concerns related to water insecurity, interest in precision irrigation scheduling to reduce water inputs is increasing, but adoption is hindered in part by perceived disease risks. The objectives of this study were to: (1) evaluate the effects of reducing soil volumetric water content (VWC) on oomycete pathogen colonization and root rot in a containerized crop, and (2) determine whether alteration of soil moisture at different host developmental stages influenced disease risk. All studies were conducted using the *Phytophthora capsici*-tomato model system. The effects of reducing soil VWC were evaluated for three soil moisture (SM) levels: well-watered (20% VWC), mid-range SM (15% VWC) and low-range SM (10% VWC). Plants were simultaneously inoculated and placed under irrigation regimes, with non-inoculated plants as pathogen controls. In inoculated plants, low-range SM increased the extent of root infection in asymptomatic plants (p< 0.05), as well as wilt progress (p = 0.006) and root rot severity (p = 0.03) compared to higher SM treatments. Low-range SM reduced stem water potential in inoculated plants to -0.94 ±0.04 MPa (p < 0.05), which corresponds to levels resulting in pathogen predisposition. In contrast, in inoculated plants mid-range soil moisture (15% VWC) did not alter pathogen colonization or plant health compared to well-watered controls, and reduced water use by 18%. To evaluate whether soil moisture effects vary by developmental stage of deployment, both 15% VWC and 10% VWC were initiated at vegetative (12 wks old), flowering (14 wks old) and fruit set (16 wks old). Irrigation treatments were applied until plants were 18 weeks old, and then returned to well-watered conditions and inoculated or left untreated (controls). Root rot was more severe and disease progress tended to be more rapid when 15% VWC

was initiated at the vegetative stage, compared to later time points (flowering, early fruit set) ($p < 0.05$); similar results were obtained for 10% VWC. These studies indicate that in containerized production systems, oomycete pathogen management must to be considered when deploying adaptive water use strategies which decrease soil moisture (and thus water inputs), but there is potential to effectively co-manage oomycete pathogens and water use by deploying moderate reductions in soil moisture and initiating reductions at later plant developmental stages.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

11:35 AM Slow Sand Filters Are Effective in Removing Water-Borne Plant Pathogens from Captured Irrigation Runoff

Lorence R. Oki*[1]; Eric Lee[2]; Mike Harris[3]; Deborah Matthews[4]; Bruno J. Pitton[1]; Sohrab Bodaghi[4]; Lloyd L. Nackley[5]; Grant Johnson[6]; Tammy Majcherek[6]; Jared Sisneroz[1] and Darren Haver[6], *(1)UC Davis, (2)Sustainable Conservation, (3)Cushman & Wakefield, (4)University of California, Riverside, (5)Oregon State University, (6)University of California*

Abstract: Slow sand filters (SSF) are an old technology used to produce drinking quality water, but there are few systems installed in the U.S. for horticultural purposes. Operational costs, other than pumping the water to the SSF, are low since chemical or energy inputs are not needed. Filters consist of a sand bed that serves as a substrate for a biofilm of microorganisms to develop. As water flows through the sand bed, these microorganisms degrade pathogens and other pollutants. We were interested in the capacity of these filters to remove different kinds of plant pathogens from captured irrigation run off and this report reviews our work on the capacity of these filters to remove *Phytophthora* ssp., *Fusarium oxysporum,* and *Tobacco mosaic virus*.

To determine if SSFs established against *Phytophthora capsici* were capable of removing other *Phytophthora* species, one set of SSFs was set up at University of California, Davis and exposed only to *P. capsici*. At the same time, another set of SSFs was set up in Santa Cruz County and provided water from Lompico Creek which was known to contain *P. ramorum*, the pathogen that causes Sudden Oak Death, in addition to other species of *Phytophthora*. After 30 days, all of the SSFs removed *Phytophthora* and the filters at UCD were moved to Santa Cruz Co. and provided creek water. *Phytophthora* was not recovered from water that flowed through the SSFs from UCD after relocation.

To see if SSFs can remove a newly introduced pathogen, a set of SSFs was exposed to *P. capsici* and a second set was exposed to *F. oxysporum*. After 7 weeks, the SSFs removed *P. capsici*, but the other set of SSFs did not remove *F. oxysporum*. Then, the SSFs exposed to *P. capsici* were now provided *F. oxysporum* and the SSFs previously provided *F. oxysporum* were supplied with *P. capsici*. *P. capsici* was immediately removed from the SSFs, but *F. oxysporum* was not removed from the other set of SSFs, which was expected. To simulate a pump failure, water was not provided to the filters for 7 days. After water flow was restarted, *P. capsici* removal resumed immediately, but there continued to be no removal of *F. oxysporum*. Another class of pathogens of concern are plant pathogenic viruses. In our tests, the SSFs were able to remove *Tobacco mosaic virus* from inoculated runoff water after 6 to 9 weeks of exposure.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

11:55 AM Nutrient and Pathogen Remediation Using Floating Treatment Wetlands

Lauren M. Garcia Chance*; Natasha L. Bell and Sarah A. White, *Clemson University*

Abstract: Floating treatment wetlands (FTWs) are a constructed wetland technology that directly exposes roots of plants to the water column. This exposure of water to the root system leads to an increase in nutrient uptake and remediation and a possible decrease in plant pathogen loading. Research at Clemson University was conducted between 2015 and 2018 to assess a variety of plant species for both their nutrient remediation efficacy, specifically nitrogen (N) and phosphorus (P), as well as their susceptibility to *Phytophthora* spp. Five species of plants were trialed for nutrient remediation and pathogen susceptibility (*Iris ensata, Pontederia cordata, Agrostis alba, Carex stricta*, and *Panicum virgatum*). An additional three species were assessed for nutrient remediation only (*Andropogon glomeratus, Canna* 'Firebird', *and Juncus effusus*) and an additional two species were assessed for pathogen susceptibility only (*Sagittaria latifolia* and *Typha latifolia*). Plants for nutrient remediation analyses were suspended using a floating mat and aerator cups in a mesocosm study, while plants for pathogen susceptibility analyses were floated in 2.5 L pots. Plants were exposed to either elevated levels of nutrients (5 ppm N or 12 ppm N) or one of five species of *Phytophthora* (*P. citrophthora, P. cinnamomi, P. cryptogea, P. nicotianae, P. palmivora*) in a 10 ppm N nutrient solution. While *C.* 'Firebird', *A. alba,* and *P. cordata* removed greater than 50% of nitrate from the system, maximum phosphorus removal was 28% and 12% with *P. virgatum* and *C.* 'Firebird', respectively. While there were no detected root infections by *Phytophthora* spp. during the 2016 pathogen trial, roots of *C. stricta*, *P. virgatum*, and *T. latifolia* were found to be infected in the 2017 trial. Both *I. ensata* and *P. cordata* show promise for FTW installations in nursery and greenhouse applications due to their nutrient remediation capabilities and apparent pathogen resistance. Further testing is needed to determine pathogen remediation efficacy of the trialed plants, as well as nutrient remediation efficacy and plant pathogen susceptibility of other aquatic plant species.

Specified Source(s) of Funding: USDA-NIFA-SCRI # 2014-51181-22372

10:15 AM – 12:15 PM *Georgetown West*

NIFA Grants - Strategies for Successful Applications

Coordinators: Mathieu Ngouajio, *USDA-NIFA*; Steve Smith, *NIFA* and Vanessa Lester, *NIFA*

Moderators: Mathieu Ngouajio, *USDA-NIFA* and Steve Smith, *NIFA*

Objectives:

The purpose of the Meeting is to provide an update of OREI (Organic Agriculture Research and Extension Initiative) and ORG (Organic Transitions) programs; discuss new opportunities with the 2018 Farm Bill, share output and outcome from previous awards; and discuss strategies for successful applications; and receive input on program improvement. The OREI and ORG programs are the flagship programs within the National Institute of Food and Agriculture (NIFA) that support organic agriculture research, education and extension in the USA. Grants are awarded on a competitive basis.We will discuss updates on the programs and strategies for successful applications. The format will be I) full presentations of successful projects, II) short flash talk presentations coupled, and III) open discussion. Additional information on OREI and ORG is available at: https://nifa.usda.gov/program/organic-agriculture-program

10:15 AM Opening and Welcome By NIFA Leadership

Jeff Steiner*, *NIFA*

10:20 AM Keys to Success for Large Multi-Regional Grants: Lessons from the Systems-Based Organic Management for Spotted Wing Drosophila Project

Ashfaq Ahmad*, *University of Georgia*

10:35 AM Vkeys to Success for Large Multi-Regional Grants: Building a National Coalition to Deliver Regionally Adapted Cover Crop Varieties to Organic Farmers

Steven Mirsky*, *USDA-ARS*

10:50 AM Keys to Success for Large Multi-Regional Grants: Organization, Goals and Successes of the Northern Organic Vegetable Improvement Collaborative (NOVIC)

James R. Myers*, *Oregon State University*

11:05 AM Evaluating the Effect of Muskmelon Cultivar and Cover Crops on Soil Biodiversity, and Plant and Human Disease Suppression during Organic Production

Shirley A. Micallef*, *University of Maryland*

11:10 AM **Blasting the Competition Away: Air-Propelled Abrasive Grits for Intra-Row Weed Management in Organic Grain and Vegetable Crops**
Sam E. Wortman*, *University of Nebraska - Lincoln*

11:15 AM **Research and Extension to Remove Barriers That Limit Transition from Conventional to Organic Maple Syrup Production**
Abby van den Berg*, *University of Vermont and State Agricultural College*

11:20 AM **A Natural Approach to Human-Pathogen Suppression: Can Biodiversity Fill the GAPs?**
William Snyder*, *Washington State University*

11:25 AM **Compost Carryover and Cover Crop Effects on Soil Quality, Profitability, and Cultivar Selection in Organic Dryland Wheat**
Ian Burke*, *Washington State University*

11:30 AM **Strategies to Enhance De Novo Biosynthesis of Methionine for Organic Poultry**
Samuel Aggrey*, *University of Georgia*

11:35 AM **Sustainable Organic Strawberry (SOS) Cropping Systems for the Southeast**
Sanjun Gu*, *North Carolina Agricultural and Technical State University*

11:40 AM **Sustainable and Profitable Strategies for Integrated Pest Management in Southern Organic Rice**
Xin-Gen (Shane) Zhou*, *TAMU*

11:45 AM **Evaluation of Paper Bags for Pest and Disease Management in Organic Peach Production**
Juan Carlos Melgar*, *Clemson University*

11:50 AM **Question & Answer**

12:00 PM **Lessons from 2018 Panels and Inputs for Future programs**

10:30 AM – 12:00 PM *Boundary (Terrace Level)*

Journal of the American Society for Horticultural Science Board Meeting

Chair: Neal De Vos, *De Vos & Associates*

Members: Rebecca Darnell, *University of Florida*; John Juvik, *University of Illinois*; Brent Pemberton, *Texas A&M AgriLife Research and Extension Center, Texas A&M University* and Marisa Wall, *USDA ARS*

11:00 AM – 12:00 PM *Oak Lawn (Lobby Level)*

Seed and Stand Establishment (SSEST) Meeting - Open to All Attendees

Chair: Amir Khoddamzadeh, *Florida International University*

Chair-elect: Shinsuke Agehara, *Gulf Coast Research and Education Center, University of Florida*

Secretary: Xianming Duan,

Objectives:

To bring together those interested in seed technology, seed storage, seed production, seed physiology, seed pathology, plant breeding, and all other phases of research, education, or extension related to horticultural seeds and seed quality, to discuss problems, new methods, technologies, and other aspects related to these areas, and to promote a strong union of public- and private-sector workers interested in seeds and seed crops. To promote activities related to the establishment of a uniform and vigorous crop from seed, transplant material, or vegetative propagules, with emphasis on seed treatments, soil amendments, transplanting techniques, and other practices that might lead to stand enhancement in the field or greenhouse.

11:30 AM – 12:15 PM *Lincoln East*

Plant Growth Regulation 2

Moderator: Franz Niederholzer, *University of California Cooperative Extension*

11:30 AM **Effect of Ethephon, Abscisic Acid and Methyl Jasmonate on Fruit Ripening in Rabbiteye Blueberry**
Savithri U. Nambeesan*; Yi-Wen Wang; Anish Malladi; John W. Doyle and Harald Scherm, *University of Georgia*

Abstract: Ripening in blueberry fruit occurs over an extended period requiring multiple harvests thereby increasing the costs of production. Several phytohormones contribute to the regulation of fruit ripening. Certain plant growth regulators (PGRs) can alter the content, perception or action of these phytohormones, potentially accelerating fruit ripening and concentrating the ripening period. The effects of three such PGRs on fruit ripening were evaluated in rabbiteye blueberry (*Vaccinium virgatum*) cultivars 'Premier' and 'Powderblue'. Application of ethephon, an ethylene-releasing PGR, at 250 mg L^{-1} when 30-40% of fruit on the plant were ripe, accelerated ripening by increasing the proportion of blue (ripe) fruit within 4 -7 d after treatment in both cultivars. Ethephon applications did not generally alter fruit quality characteristics at harvest or during postharvest storage, except for a slight increase in 'Powderblue' fruit firmness and titratable acidity after 15 d of postharvest storage. Abscisic acid (600 - 1000 mg L^{-1}) and methyl jasmonate (0.5 mM – 1 mM) applications generally did not alter ripening characteristics in either cultivar. These applications also had little effect on fruit quality characteristics at harvest and during postharvest storage. None of the above PGR applications affected the development of naturally occurring postharvest pathogens that developed during storage. Together, data from this study indicate that ethephon has the potential to accelerate ripening in rabbiteye blueberry fruit allowing for a potential decrease in the number of fruit harvests.
Specified Source(s) of Funding: Southern Region Small Fruit Consortium

11:45 AM **Spray Thinning at Bloom Increased Large Fruit Yield of 'Improved French' Prune.**
Franz Niederholzer*, *University of California Cooperative Extension* and Luke Milliron, *University of Califiornia Cooperative Extension*

Abstract: Prunes (*Prunus domestica* L. Batch) production in California is limited to a single cultivar, 'Improved French'. The crop is grown for the processed (dried) market with larger fruit, suitable for pitting, delivering higher grower return per pound than small fruit, which is used only for juice or concentrate production. Prune thinning is done by modified harvester more than a month after full bloom, when the fruit reach sufficient mass for mechanical removal. However, shaker thinning is not practiced by all growers and excessive production per acre of mostly small, lower value fruit is not uncommon. Return bloom can be limited in years following heavy crops, producing inconsistent production from year to year, harming grower income and industry marketing strategies. In 2015, a field study was begun in a mature, high yielding prune orchard in Sutter County, California, to test the hypothesis that bloom thinning with a caustic spray material would deliver more consistent production of large 'Improved French' prunes than unsprayed trees. For three seasons, 2015-17, potassium thiosulfate (KTS) at 1.0 v/v or 2.0 v/v was applied at 25% and again at 80% full bloom in a volume equivalent to 1871 l/ha to four (2015) or five (2016-17) trees per treatment. The experiment followed a randomized complete block design with blocking by trunk cross-sectional area and using a single tree per treatment per block. At commercial harvest, fresh fruit weight per tree was measured and a 2 kg subsample taken for drying at a commercial dehydrator. Whole tree dry (18% moisture) fruit yield per each treatment tree was determined using the dry to fresh weight ratio of the subsample. Dry fruit count per kg was determined for each subsample and then scaled up to determine large (<36 dry fruit/kg) fruit size yield for each tree. Conditions at bloom in 2016 resulted in crop failure, but large commercial crops were produced in 2015 and 2017. In both of those years, KTS bloom spray treatments did not significantly affect dry fruit yield (kg/tree), but 2% KTS bloom sprays significantly (p=0.05) increased yield of large fruit per tree over

that of unthinned trees. Bloom sprays of 1% KTS significantly (p=0.05) increased large fruit production in 2015 compared to control trees, but not in 2017. These results indicate a potential application for caustic spray thinning in 'Improved French' prune and encourage further research.

Specified Source(s) of Funding: California Dried Plum Board

12:00 PM **Effects of ABA or Abz Application on Anthocyanin and Sugar Biosyntheses in Grapes**

Sorawee Thunyamada*; Takanori Saito; Katsuya Okawa; Hitoshi Ohara and Satoru Kondo, *Chiba University*

Abstract: We examined the effects of ABA or abscinazole (Abz) application, which is ABA 8'-hydroxylase inhibitor, on anthocyanin and sugar biosyntheses in 'Kyoho' (*Vitis labrusca* × *V. vinifera*) grapes. Three groups were created in this study. ABA (first group) was applied to grapevines and Abz (second group) was applied to grapevines at véraison and 7 days after véraison. The third group was the untreated control. Grape berry skin was sampled at 15, 30, 45, 60 days after treatment (DAT). The anthocyanin and glucose, fructose, and sucrose concentration, anthocyanin biosynthetic genes, and sucrose transporter gene expression levels were analyzed. ABA application significantly increased anthocyanin concentrations but Abz application increased those concentrations significantly only at 15 DAT. Abz application increased glucose, fructose, and sucrose concentrations in the skin higher than the untreated control and ABA treated group. Moreover, Abz application up-regulated *VvSUT* expression levels. From these results, ABA application may induce anthocyanin accumulation in 'Kyoho' grape berries, and Abz application may enhance sucrose transportation and increase sugar concentrations.

11:45 AM – 12:15 PM *Lincoln West*

Plant Nutrient Management (PNM) Meeting - Open to All Attendees

Chair: Kent Kobayashi, *University of Hawaii at Manoa*

Chair-elect: Monica Ozores-Hampton, *University of Florida*

Secretary: Joseph Albano, *USDA-ARS*

Objectives:

To exchange ideas and information on mineral nutrition and to provide interaction between industry and public institutions interested in mineral nutrition of horticultural crops.

11:45 AM – 12:15 PM *Jefferson West*

Public Horticulture (PUBHORT) Meeting - Open to All Attendees

Chair: Matthew Taylor, *Longwood Gardens*

Chair-elect: Margaret Pooler, *USDA-ARS, U.S. National Arboretum*

Objectives:

To provide a forum for professional networking and discussion about matters related to botanic gardens, arboreta, and other institutions of public horticulture. Of particular interest are issues germane to public horticulture research, education, and outreach activities conducted within a higher education environment.

12:00 PM – 2:00 PM *Van Ness*

Featured Speaker Luncheon: Saharah Moon Chapotin, Trees, Gardens and Food Security – International Connections and Local Impact

12:00 PM **Trees, Gardens and Food Security – International Connections and Local Impact**

Saharah Moon Chapotin*, *U.S. Botanic Garden*

12:00 PM – 2:00 PM *Jay (Lobby Level)*

Pi Alpha Xi Luncheon

12:05 PM – 1:55 PM *Monroe*

Early Career Competition

Chair: Brian Trader, *Longwood Gardens*

Objectives:

The Early Career Competition has been developed for new faculty and professionals to communicate the impact of their extension, research, teaching, and other scholarly activities. The purpose of this competition is to provide a platform for new scholars to advance their work and, reputation in addition to helping facilitate peer-reviewed extension, teaching, and/or research from a wide range of horticultural professionals.

12:05 PM **Building a Research, Education and Extension Program for Blueberry and Other Small Fruits at NC State**

Hamid Ashrafi*, *North Carolina State University*

Abstract: **Building an integrated research, education and extension program for blueberry breeding**

Background

North Carolina State University has a long history in blueberry cultivar development. Cooperative breeding efforts between NC State and the USDA began in the 1930s following the loss of plants of the early blueberry cultivars developed by the USDA in New Jersey that were resistant to blueberry stem canker. Stem canker is a fungal disease caused by *Botryosphaeria corticis*. The first stem canker resistant cultivars were released in the 1950s, with 'Wolcott' being the most widely planted initially, but in a few years it lost its resistance and was replaced by 'Croatan'. Two significant events played an important role in the NC State blueberry breeding program in the 1970s. The first was the increasing incidence of stem blight, caused by *Botyosphaeria dothidea*, which devastated two large-fruited NC State cultivars, 'Harrison' and 'Bluechip'. The impact of this disease prevented either cultivar from becoming economically important. The second significant event was the introduction of "southern highbush blueberry" (SHB) cultivars into breeding programs throughout the southeastern US. SHB has been developed by interspecific crossing between Northern highbush blueberries and wild FL diploid *Vaccinium darrowii*; this combination allowed wider adaptation of blueberry to the southern US. The first SHB cultivars released from NC State were 'O'Neal', 'Blue Ridge' and 'Cape Fear', of which 'O'Neal' has been most important to the NC industry, the southeastern US and helped to establish some of the first international plantings in most of the low chill production areas around the world. The second most significant SHB cultivar from NC State University has been 'Reveille', which had the distinction of being the first cultivar adapted to mechanical harvest for the fresh market. The improved adaptation and superior fruit quality of SHB continues to dominate our breeding efforts today. Altogether 11 standard highbush, 16 southern highbush, 11 rabbiteye, 2 pentaploids and 4 ornamental blueberry cultivars have been introduced by the NCSU breeding program over the years.

Drs. E. B. Marrow, G. Galletta and J. R. Ballington have played an important role in releasing of all NC State blueberry cultivars. I joined the Department of Horticultural Science in April 2015 with two important missions: the continued success of the traditional breeding program and incorporation of new technologies in our conventional breeding program. Breeding blueberries via traditional methods is a long-term process that usually takes 15-20 years to release one cultivar. However, this period can be shortened by using marker-assisted breeding. I will address three components of my program, which mirror my formal responsibilities at NC State University in which I am assigned 70% research, 20% education and 10% extension and service.

Research

First, there is a wealth of germplasm that has been collected from around the world during the past 75 years by my predecessors. Second, blueberry does not have adequate genomic resources available, despite advances in molecular biology during the past 50 years. The genomic resources include bi-parental or association mapping populations, genetic maps, DNA based markers, transcriptome and genome sequences, databases, and genome browsers. As of April 2015, there were only two low-

density genetic maps and one fragmented reference genome sequence available. Tasks involved: first, preserving the germplasm and to use them to develop new mapping populations, and second, building genomic resources for our current breeding program, that will also be available to other blueberry researchers. In addition I am involved in developing genomic resources for other fruit crops including such as blackberry, red raspberry and muscadine grape.

With the advent of next generation sequencing (NGS), we have reached to new stage of molecular breeding that requires training a new generation breeders. Breeders who not only understand the art and science of traditional breeding, but also understand the implications of working with large datasets and making sense out of a tremendous amount of data that is generated by NGS technologies every day. In addition, to a lesser extent now and continuing to grow in the near future, another challenge is to work with phenomics data and processing image files. These emerging technologies will require the training another group of students who are interested in image processing, engineering and data science. I have built a collaborative project with the University of Georgia to explore these technologies in phenotyping blueberry breeding populations.

Training and Education

Breeding will continue to be an important component of agriculture progress as we are continually challenged by changing environmental, pest and cultural demands. My goal in my current position is to train and educate the next generation of breeders who are ready to fill the very competitive positions of the current job market. Also, to Keep myself and my students informed about the fast changing DNA sequencing technologies. Students who are applying for graduate studies in Horticultural Science at NC State often do not have a background in bioinformatics or next generation sequencing. By introducing these new concepts to the students in our department, I have implemented an interdisciplinary course of study in which students will learn the important aspects of NGS. In the lab they learn how to construct sequencing libraries, how to interpret the sequencing data and how to run bioinformatics pipelines to analyze the large datasets on servers and computer clusters. In addition, in the field and greenhouses, we will see the results of our screening as we evaluate seedlings and selections.

Outreach and Extension

I have been fortunate that North Carolina blueberry growers are proactive in supporting my program. The NC Blueberry Council are excited about the new opportunities and prospects that we have provided at NC State for the current and future blueberry growers. Translating the genomics research outcomes to a simple and understandable language to the public is an art. I teach my students to communicate their research results with blueberry growers during blueberry farm days or growers meetings in a grower friendly, yet scientifically appropriate level. My lab is actively involved in communicating their findings with public through websites, social media and weblogs which can be accessed via *https://blueberry.cals.ncsu.edu/*.

12:25 PM A Changing or Controlled Environment? Developing a Greenhouse Program for an Evolving Industry

Christopher J. Currey*, *Iowa State University*

Abstract: The greenhouse industry is traditionally synonymous with floriculture. This is for good reason: the wholesale value of floriculture crops for the 15 top producing states was $4.37 billion USD in 2015. However, the interest in non-floriculture greenhouse crops is increasing. For example, the wholesale value of food crops grown in protected culture (including greenhouse and hydroponically-grown crops) increased by 47% between 2009 and 2014. Furthermore, the demand for ecological and native plants for use in sustainable landscaping and supporting pollinators is increasing. I strive to create and maintain a synergistic program that addresses the changing nature of the greenhouse industry by integrating all areas of my appointment (60% teaching, 20% research, and 20% Extension) along with service to deliver impactful results.

I have designed the greenhouse curriculum at Iowa State University to provide a modernized curriculum for students by incorporating most up-to-date horticultural science to produce aesthetic, edible, or environmental plants and prepare students for a changing greenhouse industry. Floriculture crop production is thoroughly covered over two courses, Fall and Spring Greenhouse Crop Production, reflecting the value and prominence of floriculture crops in the industry. In response to the rapidly expanding popularity in controlled-environment agriculture and hydroponic food crops, Hydroponic Food Crop Production was created in 2014 to focus on solely on producing food crops in the greenhouse. Finally, production of ecological and native plants has been incorporated into Spring Greenhouse Crop Production, as it is complementary to the production of container-grown annuals and perennials. While I use my greenhouse crop production courses to teach the technical aspects about producing plants in the greenhouse, I also utilize my courses as a vehicle for teaching how greenhouse crop production can positively impact society. I incorporate service learning activities in to demonstrate the value of crops that are aesthetic, edible, and environmental through activities that also positively impact our community and reinforce that value of service to students. When surveyed about their experiences, across all three production courses report they see value in connecting technical skills in class with a service project and that completing the service project enhance the technical skills learned in class. Additionally, students believe their effort in producing crops in lab increase as a result of the projects, while the amount of service learning in the class is appropriate.

In order to respond to the current needs of greenhouse producers, as well as undergraduate and graduate students training to be future leaders in the industry, I have a research program focused on challenges faced in producing both flowers and food. My controlled-environment and greenhouse crop research provides research-based, best-management practices to support commercial producers of floriculture and food crops to improve productivity, profitability, and sustainability. This is achieved by researching the use, management, and manipulation of light, temperature, mineral nutrition, and plant growth regulators to improve plant quality and predictability and reduce or improve efficacy of inputs. To achieve the aims of my research program and to extend my mentorship beyond the classroom, I regularly collaborate with undergraduates students interested in conducting applied research through University research mentorship programs. However, my research ultimately returns to the classroom, as I also conduct scholarship on my approaches to teaching and learning.

Just as the greenhouse industry is changing, so is our approach to Extension, and I disseminate information to the industry using different approaches with the aim of enhancing the support I provide. While I started the Iowa State University Greenhouse Short Course to provide in-person educational experiences to the region (including Iowa, Illinois, Wisconsin, Minnesota, Nebraska, and Missouri), remote Extension allows me to provide more support to growers across the country and internationally. I am a member of Electronic Grower Resources Online, or e-GRO. As a group we provide weekly email blasts during the spring greenhouse season, webinars, research reports and podcasts at no cost to users. Additionally, I was one of the co-organizers of e-GRO Edible Alerts, focusing on providing information on challenges greenhouse and hydroponic food crop producers face in the same timely and electronic format as the other Alerts. I also strive to serve audiences of both floriculture and hydroponic food crop producers remotely by writing monthly columns for trade magazines, including Greenhouse Management ('Production Pointers') and Produce Grower ('Hydroponic Production Primer').

I believe strongly in the in the value of service to our communities and prioritize this as a horticultural scientist, regularly participating in roles that support not only horticultural science in general, but also the greenhouse industry. As a member of the American Floral Endowment's Vic and Margaret Ball Internship Scholarship Selection Committee, we work together with industry partners to place recipients of this scholarship into experiences that immerse them in the greenhouses across the country. I also am an advocate for supporting graduate students. As president of the Floriculture (FLOR) Professional Interest Group (PIG) last year, I initiated the Floriculture Graduate Student Oral Competition to provide more opportunities and support for future floriculturists. I currently serve as the Chair of the Growth Chamber and Controlled-Environment PIG, Chair-Elect of the Plant Growth Regulation Working Group, and as a member on the Communications Committee. Previously I was a member of the Membership and Member Services Task Force, as well as one of the co-organizers of the Colloquia "Farms of the Future:

Controlled-Environment Agriculture" at the 2016 Annual Meeting. As a Consulting Editor for all three of the ASHS journals in the areas of Urban Horticulture and Controlled Environments (HortTechnology), Plant Growth Regulators (HortScience), and Photosynthesis/Source-sink Physiology (Journal of the American Society for Horticultural Science), I support the process of publishing research relevant to greenhouse crop production that ranges from fundamental to readily applicable.

As with all of horticulture, the greenhouse industry has an important role economically and societally. I believe my program positively impacts the greenhouse industry by providing students with a broad background in greenhouse crop production, generating science-based solutions to challenges the industry faces, supporting the industry with innovative and accessible information delivery, and proactively engaging its primary professional and academic societies.

12:45 PM Enhancement of Florida Strawberries Using Advanced Molecular Breeding Technologies

Seonghee Lee*, *University of Florida*

Abstract: Strawberry is one of the most important crops in Florida agriculture. The University of Florida (UF) strawberry program has been active since about 1950, and currently over 80% of Florida's 11,000 acres are planted in UF varieties. Recently, the continued and rapid increase of fresh strawberry imported from Mexico is threatening the Florida strawberry, and superior cultivar development is a critical way to stay ahead of competitors. In addition, soil-borne diseases such as Phytophthora crown rot (PhCR) and charcoal rot of Florida strawberries are an increasingly critical economic burden since the loss of methyl bromide. The Florida Strawberry Growers Association (FSGA) estimates that yield losses due to soil-borne diseases cost Florida growers $15 million in revenue each year. Improved disease resistant varieties offer the most sustainable and economical solution to this problem. In the last three years, the UF strawberry breeding program has sought to implement molecular-assisted breeding to speed up new variety development with market-enhancing quality traits and diseases resistances.

For effective molecular marker-assisted breeding to screening large seedling populations, the method to amplify DNA directly from strawberry leaf tissue is critical. My program developed a high-throughput genotyping system through SNP-based high-resolution melting analysis (HRM). Using this method, we are capable to quickly and cheaply screen molecular markers in tens of thousands of seedlings, allowing us to "stack the deck" for desirable traits prior to field evaluation. Until 2014, no molecular markers had been applied in the UF strawberry breeding program for parent and seedling selections though markers had been utilized for identify verification of specific varieties and advanced selection. In 2015, high-throughput molecular markers for fruity aroma and PhCR were developed for the effective MAS. By screening with this DNA test, approximately half were discarded prior to establishment of the summer nursery. A total of 13,000 seedlings were retained for evaluation in the 2016-17 season; thus, the effective size of the breeding program was increased to ~25,000, counting the ~12,000 seedlings that were discarded after marker screening. In the spring of 2018, two additional markers will be added: HRM assays for fruit anthracnose resistance and day-neutrality. These markers can predict parental phenotypes/haplotypes with greater than 95% accuracy. With this high-throughput MAS, we are now able to combine many important traits for fruit quality and disease resistance together to achieve successful new cultivars.

Most of the recent varieties released from our breeding program have been susceptible to major diseases in strawberry. We have the genetic resources to develop new varieties with better resistance. But to efficiently combine disease resistance with all the other desired fruit and plant traits is quite a challenge due to the high levels of heterozygosity and the octoploid nature of the genome. Currently, my program is using advanced genetic mapping and whole genome sequencing techniques to identify genes associated with Florida-relevant diseases like angular leaf spot, crown rots, fruit anthracnose, charcoal rot and powdery mildew. We are in the process of identifying candidate genes for disease resistance and flavor using whole-genome SNP genotyping, sequencing, and transcriptome analysis. A bacterial artificial libraries are developed to facilitate gene cloning in these candidate regions. Furthermore, by using CRISPR/Cas gene-editing technology, these genes or gene variants for disease resistance can be rapidly moved into desirable breeding selections and can be further moved via conventional crossing in later generations. This technology allows for the adjustment or removal of specific genes in already established cultivars or breeding parents without otherwise altering the genetic constitution of an elite genotype. This is particularly useful for cultivated strawberries because they are genetically complex, and it would be much easier to simply adjust a single trait than reshuffle the genetic deck and hope for a plant with all traits incorporated. Importantly, we can utilize established MAS tools to track the transmission of edited genes.

The FSGA has great interest and motivation to commercialize and promote varieties with resistant to multiple pathogens for the benefit of growers. The extension efforts from my program includes participation in cooperative extension and industry organized meetings and workshops to foster scientific exchange and the translation of genomic-enabled breeding approaches. My group has actively engaged in the training of extension agents and industry workers through formal programs, personal farm visits, FSGA sponsored field days and meetings, workshops, newsletter articles and extension reports. Graduate students from my program also have the opportunity to communicate results (oral or poster presentation) to the public and stakeholders through field days, cooperative extension meetings and FSGA-organized meetings. My program also successfully established outreach program with existing strawberry advisory committee for communicating the latest research results to the industry, and receive feedback. This is an excellent way to communicate information how our team can successfully developed better strawberries for growers, markets, and consumers using molecular breeding approaches. Looking to the future, the technologies developed in my research projects should contribute to breeding efforts for many years to come, far beyond the project period, and increase the sustainability and profitability of the Florida strawberry industry through better varieties.

My program is an active participant in RosBREED, the USDA/NIFA SCRI CAP project which focuses on developing DNA tests for routine use in Rosaceae crop breeding programs. Total 22 U.S. breeding programs are involved in this multi-state project focusing on eight fruit crops. The developed high-throughput genotyping platform and markers has been applied to the multi-state breeding programs. We have participated last three years and shown the great impact on this multi-state project. Work on the genetic basis of important strawberry disease resistance traits is being done in collaboration with the RosBREED members every year. From last year, my program has been involved in the USDA/NIFA SCRI project, "Next-generation disease resistance breeding and management". This research is for accelerating the development of disease resistant cultivars through the application of genomic technologies, and delivering cultivars with commercially viable levels of resistance to multiple pathogens through collaborative research with national wide strawberry teams of UF and University of California Davis researchers in the areas of breeding, genomics and pathology.

1:05 PM Developing Integrated Programs for the Emerging Hard Cider Industry

Gregory Michael Peck*, *Cornell University*

Abstract: My research, teaching, and outreach program has been providing the nascent hard cider industry with research-based information on specialized hard cider apple cultivars, orchard management practices, and cider apple processing and fermentation.The volume of hard cider (fermented apple juice) sold in the U.S. increased nearly ten-fold over the last decade and is now estimated to be a $1.3B industry supporting 800 cider producers across the U.S.Industry revenue is projected to grow at an annual average rate of at least 1.2% over the next five years.

Hard cider apples contain quality attributes that provide important and noteworthy characteristics to the finished cider, including bitterness and astringency, sharpness, sweetness, and aromatics. Specialty hard cider apples are unique in that they may contain exceptionally high levels of one or more of these components. There is a clear opportunity for apple growers to increase the production of specialized cider apples. However, tree-fruit producers need sound, research-based information.

While there are dozens of European and American specialized hard cider cultivars that can be used to make cider, most do not

perform as well as common culinary apples in commercial orchard situations. Specifically, many hard cider cultivars are not responsive to chemical fruit thinning, have an extremely biennial bearing habit, tend to be overly vegetative, and/or are highly susceptible to economically important apple diseases. Additionally, apples destined for hard cider production can be mechanically harvested and pruned and may require lower pesticide inputs than culinary apples because cosmetic defects and even some superficial damage are acceptable for fruit that will be processed soon after harvest.

To assist with identifying stakeholder needs, I collaborated with Dr. Carol Miles to survey hard cider producers at the national hard cider industry conference (Peck and Miles, 2015). We published the results from the first two years in the Journal of Extension, and continued the survey for two additional years. Averaged over the four surveyed years, we found that 88% of respondents indicated they need more research conducted on hard cider production by university scientists, 89% were willing to participate in research experiments in their orchard or cidery, and 55% were willing to fund research that targeted their needs.

Among the first hard cider research projects I conducted, I found that growers would need to receive a median return of $0.29 per pound and an average yield of 32,550 pounds per acre to justify planting a high-density hard cider apple orchard (Farris et al., 2013). For this project, I collaborated with agricultural economists to develop interactive and fully customizable partial and enterprise budget spreadsheets that can be downloaded for free. I have presented data from this project at more than 20 different meetings and workshops for commercial apple growers and cider makers. Currently, I am working with a Cornell Agribusiness Management graduate (Whit Knickerbocker) to update the budget spreadsheets and develop case studies for New York.

Next, I turned my attention to identifying the hard cider apples that are best suited for the Eastern U.S. by evaluating existing processing and culinary apples, establishing replicated cultivar trials, importing European hard cider cultivars, and conducting an exhaustive screening of accessions in the USDA-Plant Genetic Resource Unit's *Malus*germplasm collection. I coordinated a project that analyzed the chemical attributes of 20 culinary, processing, and ciderapple cultivars for their potential to make premium quality hard cider (Thompson-Witrick et al., 2014). I am currently in the third year of evaluating ten European hard cider apple cultivars planted in a replicated high-density orchard in Ithaca. In Spring 2018, I will be planting a replicated study of Spanish hard cider apple cultivars that have recently been released from USDA-APHIS quarantine. I also recently imported British hard cider cultivars, including17 new releasesfrom the Long Ashton Research Station that account for an estimated 20% of the cider apple acreage in the United Kingdom. The germplasm screening project is part of Nathan Wojtyna's Master's research project. In 2017, we phenotyped over 180 of these accessions, with additional evaluations planned for 2018. In conjunction with this project, Mr. Wojtyna has worked with Dr. Kenong Xu's lab to identify fruit acidity genes in these accessions. Additionally, Dr. Gayle Volk (USDA-ARS) and I have fingerprinted a large number of hard cider cultivars using simple sequence repeat microsatellites.

My research also investigates the pre- and post-harvest factors that affect cider quality. In one recent study, I found that higher crop loads produced smaller, less acidic fruit that were slightly more mature (Peck et al., 2016). Additionally, in juice made from fruit from these treatments, the total polyphenol content did not differ at harvest, but, after fermentation, the medium crop load had 27% and the high crop load had 37% greater total polyphenol content than the low crop load. With funding from the New York apple industry, I have expanded the crop load research and am currently evaluating eight European hard cider cultivars grown at a grower-cooperator's orchard. From 2015-2017, the Virginia Wine Board funded my Virginia Tech study on the impacts of apple harvest timing, and storage conditions and duration on hard cider quality. My lab is also investigating the effects that nitrogen fertilizers, sunlight, and temperature have on polyphenol development in cider apples (Ph.D. project for Adam Karl).

By collaborating on cost-of-production studies for growing hard cider apples and producing hard cider, evaluating the suitability of processing and culinary apple cultivars for hard cider production, and studying the ways in which pre-harvest orchard management can affect hard cider quality, I have begun to address the needs of this nascent industry along the complete supply chain. I have obtained more than $600,000 in funding support for my hard cider projects, including a 2014 USDA-NIFA-SCRI planning grant. My hard cider research has informed my additional faculty responsibilities. In 2017, I developed and co-taught an undergraduate hard cider course and laboratory which we offer on an annual basis. Over 60 students have taken this course over the past two years.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Consumer Horticulture and Master Gardeners (Poster)

Master Floral Designer: A New MSU Extension Certificate Program (poster)

James DelPrince*, *MSU-Coastal Research and Extension Center*; Patricia Knight, *Mississippi State University Coastal Research and Extension Center* and Susan Deblanc, *MSU-Coastal Research and Extension Center (Poster Board #080)*

Abstract: A series of two-hour, floral design workshops was developed beginning 2015 at the MSU Coastal Research and Extension Center, Biloxi, Mississippi. Workshop participants were surveyed from October 2015 to June 2016. Respondents agreed that they desired to achieve a certificate in floral design (77%), while 64% strongly agreed (n=106). A Master Floral Designer (MFD) category was planned and a pilot program was implemented in January 2017. Similar to the Master Gardener program in scope, the program consists of 42 hours studio (lecture, demonstration, and hands-on practice) and a volunteer segment requiring 40 hours of work. To date, 17 people have participated in the studio segment and seven have completed the volunteer segment.

Research Based Infographics Convey and Build Awareness of Plant Benefits (poster)

Bridget Behe*, *Michigan State University*; Debbie Hamrick, *North Carolina Farm Bureau*; Jennifer Gray, *AmericanHort* and Jill Calabro, *AmericanHort/HRI (Poster Board #081)*

Abstract: The Economic Committee of the National Initiative for Consumer Horticulture worked throughout 2017 to April 2018 to operationalize a peer-reviewed publication by Hall and Dickson (2011). Their publication, *Economic, Environmental, and Health/Well-Being Benefits Associated with Green Industry Products and Services: A Review* contained citations of 134 studies that extolled the benefits of plants. In order to gain widespread adoption and use of plant benefits, the committee developed the first Infographic entitled *The Power of Plants: Enriching Lives, Creating Jobs, Building Wealth, Saving Money* which was released in 2017. Given the tremendous number of plant benefits, the committee was encouraged to create four additional infographics in a series under the banner #PlantsDoThat Inside Where We Live, Learn, Heal, and Work. The free infographics are available on the NICH website for use by any company or enterprise to endorse the benefits of plants using research-based information. The goal is to facilitate the objectives of NICH to educate the public on the multiple benefits of plants and encourage more purchase and enjoyment of plants by the American public.

Taking the Trial to the People: Citizen Science Project for Tennessee Vegetable Gardeners (poster)

Natalie Bumgarner*, *University of Tennessee* and Virginia Sykes, *University of Tennessee (Poster Board #082)*

Abstract: Edible gardening is an important part of consumer horticulture because of its potential to improve human well-being through physical activity and food provision. Additionally, recent increases in food gardening participation have included younger generations and first-time gardeners across the rural to urban continuum. With participation in food gardening estimated to be one-third of households nationwide, the stakeholder audience is both wide and diverse. The selection of crops and care of home gardens are frequent questions for Extension educators. Questions related to variety selection for the home garden are particularly challenging to answer due to a lack of geographically pertinent data. The time and expense of managing cultivar trials, reduced funding for consumer horticulture research, and the wide range of growing conditions across the highly varied geographical regions of Tennessee create significant hurdles for

researchers trying to answer the question, "which variety should I grow in my home garden?" A collaborative approach between researchers and citizens may hold the key to addressing these challenges. In 2017, a home garden vegetable trial program was established to evaluate home vegetable crops and cultivars across the state. This trial took a citizen scientist approach and provided home gardeners the opportunity to evaluate variety performance at their own sites across the gardening environments represented in Tennessee. Participants were allowed to choose from a selection of paired variety comparisons in a number of different vegetable categories. Seeds and instructions were mailed to participants who then grew the trials and returned evaluation data on key characteristics such as germination, yield, appearance, and flavor. In the pilot year, participation was limited to 15 counties. From these 15 counties, 47 citizen scientists put out a total of 247 trials. In addition to producing previously unavailable information on variety performance in Tennessee, this project has provided an opportunity for Extension to directly engage citizens; increasing knowledge of vegetable gardening, encouraging physical activity and healthy eating, and expanding knowledge of the scientific process within the stakeholder audience.

Gardening and Art Activities: Comparing Health Outcomes in a Clinical Study of Healthy Women (poster)

Raymond Odeh*, *University of Florida* and Charles L. Guy, *University of Florida (Poster Board #083)*

Abstract: Health broadly encompasses well-being in physical, mental and social areas. Much of the extant literature in the area of horticultural therapy and people-plant interactions lacks experimental comparisons between gardening and other allied therapeutic modalities for any population. In this clinical study an active, concurrent control group was used to compare relative health outcomes associated with engaging in gardening and art activities. Treatment-based outcomes for perceived stress, mood disturbance, depression symptomatology, anxiety, quality of life, social satisfaction, cardiovascular and physical health factors were investigated using a battery of self-reported psychometric assessments and cardiovascular monitoring for a population of healthy women randomly assigned to gardening or art groups. Appraisal of the results from the four-week interventions provides evidence that tests treatment effect hypotheses associated within and between the gardening and art therapeutic modalities.

Specified Source(s) of Funding: Horticultural Research Institute; Gene and Barbara Batson Endowed Nursery Fund; Florida Nursery, Growers and Landscape Association; and Department of Environmental Horticulture

Evaluation of Alternatives to Glyphosate for Organic Gardening Systems (poster)

Jacob C. Domenghini*, *Eastern Kentucky University (Poster Board #084)*

Abstract: Interest in organic vegetable gardening has increased among homeowners in recent years. A growing number of people are searching for alternatives to glyphosate for weed suppression and control for establishing and maintaining vegetable gardens. In this study, weed control treatments were evaluated as well as the number of follow-up treatment applications needed for garden plot establishment. This study was conducted twice and each study lasted 131 days during the summer growing season of 2016 and 2017 in Richmond, KY. Treatments included a control and two application periods (fall and spring) of glyphosate, vinegar [5% acetic acid (AA)], 20% horticulture grade vinegar (20% AA), and 30% horticulture grade vinegar (30% AA). Following the treatments, each plot was evaluated using a quality rating (1-9 scale, 1=100% of the plot is dead and 9=100% of the plot is alive with weeds). After the initial treatment applications, quality ratings of the 5%, 20%, and 30% AA declined quickly to a rating of one within three days while the glyphosate required seven days to reach a rating of one. Treatments were reapplied to subplots in the spring when a plot received a quality rating of five (approximately 50% of the plot had regrown with weeds). Glyphosate performed the best requiring 71 to 80.8 days to reach 50% regrowth with both a fall and spring application of glyphosate (average of 78 days) achieving better results than a spring application only (average of 73.8 days). Control plots had the least number of days to full regrowth after the spring treatment application with 96 (2016) and 79.7 (2017) days after treatment (DAT) compared with glyphosate which took more than 105 DAT for full regrowth in 2017 and did not fully regrow in 2016 within the 131 days of the study. Five (2016) and nine (2017) retreatment applications to subplots were required in the 5% AA plots while glyphosate only required one retreatment application each year. The 20% and 30% AA both required approximately three (2016) and four (2017) retreatments. In this study, glyphosate has shown to be the more effective weed control method for vegetable gardens. In cucurbit gardens with reduced soil exposure, both 20% and 30% AA are viable alternatives to glyphosate.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Genetics and Germplasm 1 (Poster)

Two Unique Apple Hybrid Populations Segregating for Many Phenotypes of Horticultural Importance (poster)

Peter Hirst*, *Purdue University*; Khalil Jahed, *Purdue University* and Yuanzhi Yang, *Purdue University (Poster Board #264)*

Abstract: With a number of genomics approaches now being able to be applied to perennial tree fruits relatively easily and inexpensively, the availability of segregating hybrid populations is often a constraint. We have two hybrid populations, each derived from crosses of a large-fruited genotype ('20 Ounce' and 'Edward VII') and a very small-fruited crabapple genotype ('Prairie Fire'). These populations have a much wider genetic basis than commonly found in apple breeding populations since the parents represent different Malus species. Each population is comprised of approximately 100 fruiting seedlings. While our primary purpose is to use these populations to investigate fruit size regulation, the populations are segregating for many other traits of potential interest. Some of these include tree characteristics such as branch angle, leaf color, flower color, and flower number per tree and per cluster. Wide variation in fruit characteristics is also evident including fruit size, fruit skin and flesh color, soluble solids concentration, fruit acidity, maturity time, fruit abscission, and fruit surface characteristics. There is also likely segregation for pest and disease susceptibility. We are in the process of genotyping all the seedlings in both populations, however phenotyping has been limited to focusing on fruit size. We are inviting collaborators to phenotype these populations for traits of interest and we are willing to share genotype information.

RNA-Seq Analyses of a Late Maturing Somatic Mutation Identify a Co-Expressed Gene-Network Module Associated with Fruit Development in Apple. (poster)

SeungHyun Ban*, *Cornell University* and Kenong Xu, *Cornell University (Poster Board #265)*

Abstract: In tree fruit, somatic mutations may alter fruit color, size, shape, and maturation date. 'Autumn Gala' is a somatic mutation from a widely grown apple cultivar 'Gala'. The fruit of 'Autumn Gala' distinguish from those of 'Gala' by a 4-week delayed maturation date and a longer shelf life. Fruit maturation is a genetically programmed event involving numerous biochemical, physiological, and structural alterations. To understand the molecular mechanisms underlying the remarkable fruit maturation delay and shelf life extension, RNA-sequencing (RNA-Seq) analyses were conducted at various stages during fruit development and postharvest storage from 'Gala' and 'Autumn Gala'. A total of 102 RNA-Seq libraries, including 48 (24x2) for 'Gala' and 54 (27x2) for 'Autumn Gala' were sequenced using next-generation genome sequencer illumina HiSeq 2500. RNA-Seq data analysis was conducted using CLC Genomics Workbench and the software package R. To identify casual factors responsible for late maturation, gene expression profiles throughout the developmental stages were analyzed. In total 9,368 differentially expressed genes (DEGs) were identified between 'Gala' and 'Autumn Gala' at each developmental stages and between the adjacent stages. A weighted gene co-expression network analysis (WGCNA) of the DEGs uncovered a network module of 57 genes highly correlated (r=0.98, P=4e-21) with the suppressed expression in 'Autumn Gala'. Among the 57 genes, 49 were located within a 2.7Mb region on chromosome 6. Further analysis is underway to identify if there are any genomic structural changes in this region that might have impacted on fruit maturation.

Identification and Characterization of a Strong Candidate Gene for Weeping Growth Habit in *Malus* (poster)

Laura Dougherty*, *Cornell University*; Raksha Singh, *Cornell University*; Susan Brown, *Cornell University*; Chris Dardick, *Appalachian Fruit Research Station, USDA-ARS* and Kenong Xu, *Cornell University (Poster Board #266)*

Abstract: Downward branches characterize the weeping growth habit. In *Malus*, the weeping tree form is common in crabapples, such as 'Cheal's Weeping' and 'Red Jade', which are highly desired for ornamental use. Although most apple cultivars grow their branches upward with certain angles, a branch bending down practice is recommended in several modern orchard training systems, such as Solaxe and Tall Spindle. Term 'weeping' here distinguishes from the same term used for 'ideotype IV' that described the growth habit and fruit bearing type represented by apple cultivars 'Granny Smith' and 'Rome Beauty', where the weeping-like trait is caused by the bending of branches due to fruit bearing at tips. To determine the genetic cause of weeping growth habit in *Malus*, a pooled genome sequencing-based approach was taken using an F_1 population segregating for the weeping trait. Through a detailed analysis of segregation types of DNA variants, four genomic regions were revealed of a significant association with weeping, including a major locus *Weeping* (*W*) on chromosome 13 and others on chromosomes 10 (*W2*), 16 (*W3*) and 5 (*W4*). Examining the putative function and expression profile of the genes annotated under the *W* region, a strong candidate gene MDP0000254069 (MD13G1122400) encoding a LAZY1-like protein was identified, designated *MdLAZY1*. Apple transgenic lines under-expressing the *MdLAZY1* grow leaves downward while those over-expressing the gene grow leaves with normal angles at young stage. Currently, an extensive effort to characterize *MdLAZY1* is underway.

Specified Source(s) of Funding: NSF-Plant Genome Research Program grant (IOS-1339211)

Understanding *Armillaria* Root Rot Tolerance/Resistance in *Prunus* (poster)

Sarah B. Miller*, *Clemson University*; Goran Barac, *University of Novi Sad*; Ksenija Gasic, *Clemson University*; Christopher Saski, *Clemson University*; Guido Schnabel, *Clemson University* and Gregory Reighard, *Clemson University (Poster Board #267)*

Abstract: *Armillaria* root rot (ARR) disease is affecting stone fruit and nut crops throughout the U.S. and is the greatest threat to peach and cherry orchard sustainability in the southeastern U.S. and the Great Lakes Region, respectively. ARR has become a serious and widespread problem in the major tart and sweet cherry production regions of Michigan and is responsible for tens of millions of dollars in losses in historic peach production regions of Georgia and South Carolina. The causal soil-borne fungi, *Armillaria* spp., infect the root system, typically killing trees when they are reaching their maximum productivity, making orchards unprofitable, and the infected land unsuitable for continued stone fruit production. At present, there is no environmentally safe, clean management strategy for ARR in *Prunus spp*. tree fruits, and the few management options that are available are only marginally effective at best. The longer peach and cherry trees are cultivated at a single location, the more fungal inoculum in the form of infested root pieces builds up in the soil. Therefore, replant sites with a history of ARR are considered economically unfeasible for continued peach and cherry cultivation. At such locations, it is not uncommon for trees of only 3 and 4 years of age to succumb to ARR. Therefore, the most economical and potentially effective solution to combat *Armillaria* is through use of genetic resistance. To understand ARR tolerance/resistance in *Prunus* and uncover potential sources of tolerance/resistance that could be used in rootstock breeding, we used *in vitro* infection to screen 81 *Prunus* wild accessions from the National Clonal Germplasm Repository in Davis, CA. Preliminary results of the *in vitro* screen and root microscopy confirm tolerance to *A. mellea* in a few *P. cerasifera* accessions. Implications for breeding new resistant rootstocks via introgression of resistance genes from wild relatives into stone fruit-compatible rootstocks will be presented.

Specified Source(s) of Funding: USDA-AMS-SCMP-2015 "Short and Long-Term Solutions for Armillaria Rot Rot in Prunus (ME#44165761)

Comparing Acetogenin Activity in Ripe Fruit and Twig of Pawpaw [*Asimina Triloba* (L.) Dunal] Varieties Using the Brine Shrimp Test (poster)

Harry Momo*, *Kentucky State University*; Kirk Pomper, *Kentucky State University*; Jeremiah Lowe, *Kentucky State University* and Sheri Crabtree, *Kentucky State University (Poster Board #268)*

Abstract: Pawpaw [*Asimina triloba* (L.) Dunal] is a tree fruit native to Eastern North America in its initial stages of commercial production in the United States. Annonaceous acetogenins are long chained fatty acids contained in pawpaw fruit and vegetative tissues, which display pesticidal and anti-tumor properties. Kentucky State University (KSU) is the site of the USDA Repository for pawpaw species, and germplasm evaluation and collection are program priorities. Fruit is a major biomass source for acetogenin extraction; however, it takes 5 to 8 years for a tree to mature and produce fruit. Comparing annonaceous acetogenin activities can possibly allow breeding programs to focus directly on breeding a desired level of acetogenin activity in pawpaw trees. In this study we aim to determine if there is a correlation between annonaceous acetogenin activity in varieties of ripe pawpaw fruits and twigs. Pawpaw fruit and twigs were collected from individual trees of pawpaw varieties and advanced selections (Sunflower, Hi 7-5, Hi 4-1, Susquehanna, and PA Golden) with known and unknown fruit acetogenin activity. 2.5 grams of dried twig tissue were extracted with 25 ml of 95% ethanol and 10 grams of frozen fruit pulp were extracted with 25ml of 95% ethanol. Concentrated extract was transferred to vials to correspond to 5, 10, and 50 ppm concentrations for pulp extracts and vials containing 0, 1.0, 5.0, 10, and 15 ppm concentrations of twig extracts. There were replicates for each concentration. A brine shrimp test (BST) was used to compare mortality in both twig and pulp for each variety and they all showed varying degrees of mortality which indicate acetogenin activity in the varieties. Results suggest that twig extract activity can be used to identify pulp activity in pawpaw fruit of the same variety and high twig activity indicates high fruit activity.

Specified Source(s) of Funding: USDA Evans Allen Research

Apomictic and Sexual Seed Reproduction in *Aronia* and Implications for Breeding and Commercial Fruit Cultivars (poster)

Jonathan D. Mahoney*, *University of Connecticut*; Thao Hau, *University of Connecticut* and Mark Brand, *University of Connecticut (Poster Board #269)*

Abstract: Native to eastern regions in North America, the genus *Aronia* is a group of deciduous shrubs in the Rosaceae family, subtribe Pyrinae. The four commonly accepted species include *A. arbutifolia* (L.) Pers., red chokeberry; *A. melanocarpa* (Michx.) Elliott, black chokeberry; *A. prunifolia* (Marshall) Reheder, purple chokeberry; and *A. mitschurinii* (A.K. Skvortsov & Maitul), involving *A. melanocarpa* × *Sorbus aucuparia* hybridization. Very little has been accomplished with genetic improvement of polyploid *Aronia* genotypes due to the suspected apomictic reproductive mechanisms in this genus. The objectives of this study were: 1) elucidate the reproductive mechanisms of *Aronia* species and reveal the occurrence of apomixis within the genus and 2) determine the genetic diversity of commercial cultivars of *A. mitschurinii*. For experiment I, 20 *Aronia* accessions (five *A. melanocarpa* [2x], four *A. melanocarpa* [4x], three *A. prunifolia* [3x], four *A. prunifolia* [4x], three *A. arbutifolia* [4x], one *A. mitschurinii* [4x]) were used in this study. Intra-accession variability was evaluated by growing out progeny from an open-pollinated maternal accession and comparing Amplified Fragment Length Polymorphism (AFLP) profiles between the progeny and maternal accession. Diploid accessions produced a significant amount of genetic variation (0.6-0.8 Jaccard's similarity coefficient) in progeny which was indicative of sexual reproduction. Seedlings from tetraploid accessions had very little genetic variation (0.90-0.98 Jaccard's similarity coefficient) in comparison to their maternal accession. The very limited genetic variation observed in tetraploid progeny suggests that apomictic diplospory with one round of meiotic division is occurring. Triploid accessions appear to reproduce via sexual reproduction and apomictic diplospory. For experiment II, genetic similarities were determined for nine *A. mitschurinii* cultivars that are commonly used in commercial fruit production. All cultivars, except for 'Nero', were genetically identical, with 'Nero' producing a Jaccard's similarity coefficient of 0.97. We propose that the same genotype has been renamed

repeatedly by growers. Nero is likely a seedling of the primary clone in commerce, since it has a similarity coefficient that is equivalent to what we observed in tetraploid *Aronia* progeny.

Preliminary Results of a Genotyping By Sequencing Diversity Study of Big-Bracted Dogwood (*Cornus spp.*) Cultivars (poster)

Erin Pfarr*, *Rutgers University*; Jennifer Vaiciunas, *Rutgers University*; Christine Kubik, *Rutgers University*; John Michael Capik, *Rutgers University*; Josh Honig, *Rutgers University* and Thomas Molnar, *Rutgers University (Poster Board #270)*

Abstract: Big-bracted dogwoods (*Cornus spp.*) are small trees that are prized as ornamentals in managed landscapes because of their beautiful spring blooms with showy bracts, striking red fruits, and attractive fall color. Two of the most popular species are *C. florida* and *C. kousa*. *Cornus florida* is native to the eastern United States and blooms early in the spring before its leaves appear. *Cornus kousa*, from Asia, blooms later than *C. florida* and is more resistant to powdery mildew and dogwood anthracnose. Vigorous, disease-resistant hybrids between the two species can also be found in cultivation. A performance trial holding 96 different accessions of big-bracted dogwoods was established in 2016 at Rutgers University in New Jersey. In this study, we are using the genotype by sequencing (GBS) approach to discover single nucleotide polymorphisms (SNPs) within our *Cornus* accessions and use them to examine relationships, clonal identities, genetic diversity, and population structure. As a preliminary trial before including the entire collection, we focused on a subset of 48 accessions: 20 *C. florida*, 20 *C. kousa*, and 8 interspecific hybrids. DNA was extracted from dormant flower buds using Qiagen DNeasy Plant Kit, and quality and concentration was quantified with a spectrophotometer. DNA was double digested with PstI-HF and MspI, barcoded, multiplexed, and sent to Genewiz labs for sequencing. The raw data will be analyzed with Stacks, JoinMap, and STRUCTURE. Results, including the number of high quality SNPs as well as indices of diversity and relationships between the preliminary subset of *Cornus* cultivars, will be presented. These data will support a larger study and provide valuable insight into the genetic diversity and population structure of these important landscape plants, as well as guide future germplasm collection efforts for the development of improved cultivars.

Cytogenetics and Genome Size Evolution in *Illicium* (poster)

Thomas Ranney*, *North Carolina State University, Dept. of Horticultural Science*; Connor Ryan, *North Carolina State University*; Lauren Deans, *North Carolina State University* and Nathan Lynch, *North Carolina State University (Poster Board #271)*

Abstract: *Illicium* is an ancient genus and member of the earliest diverging angiosperms known as the ANA grade (Amborellales, Nymphaeales, and Austrobaileyales). These adaptable, broadleaf evergreen shrubs, including approximately 40 species distributed throughout Asia and North America, are valued for diverse culinary, medicinal, and ornamental applications. The study of cytogenetics of *Illicium* can clarify various discrepancies and further elucidate chromosome numbers, ploidy, and chromosome and genome size evolution in this basal angiosperm lineage and provide basic information to guide plant breeding and improvement programs. The objectives of this study were to use flow cytometry and traditional cytology to determine chromosome numbers, ploidy levels, and relative genome sizes of cultivated *Illicium*. Of the 29 taxa sampled, including approximately 11 species and one hybrid, 2C DNA contents ranged from 24.5 pg for *I. lanceolatum* to 27.9 pg for *I. aff. majus*. The genome sizes of *Illicium* species are considerably higher than other ANA grade lineages indicating that *Illicium* went through substantial genome expansion compared to sister lineages. The New World sect. *Cymbostemon* had a slightly lower mean 2C genome size of 25.1 pg compared to the Old World sect. *Illicium* at 25.9 pg, providing further support for recognizing these taxonomic sections. All taxa appeared to be diploid and 2n = 2x = 28 except for *I. floridanum* and *I. mexicanum* which were found to be 2n = 2x = 26, most likely resulting from dysploid reduction following divergence into North America. The base chromosome number of x = 14 for most *Illicium* species suggests that *Illicium* are ancient paleotetraploids that underwent a whole genome duplication derived from an ancestral base of x = 7. Information on cytogenetics, coupled with phylogenetic analyses, identifies some limitations, but also considerable potential for the development of plant breeding and improvement programs with this genus.

Chloroplast Sequence, Assembly, and Annotation of Six Penstemon Species (poster)

Jason M. Stettler*, *Brigham Young University*; Mikel R. Stevens, *Brigham Young University*; Jed Grow, *Brigham Young University* and William W. Crump, *Brigham Young University (Poster Board #272)*

Abstract: North American beardtongue (*Penstemon* Mitch.) species form a diverse group that occupies a wide variety of ecological habitats and niches. With approximately 270 species, the genus spans North America, from the Arctic to the tropics, and are organized into six monophyletic subgenera, *Dasanthera, Saccanthera, Cryptostemon, Dissecti, Habroanthus*, and *Penstemon*. Due to their diverse floral and vegetative traits, beardtongues have great horticultural value, and have been utilized in several breeding programs since the early 1800's. To assess genetic diversity of breeding stock, and to prioritize potential crosses in our breeding program, we sequenced representative species of each beard tongue subgenus, *Penstemon fruticosus* (*Dasanthera*), *P. rostriflorus* (*Saccanthera*), *P. personatus* (*Cryptostemon*), *P. dissectus* (*Dissecti*), *P. cyaneus* (*Habroanthus*), and *P. palmeri* (*Penstemon*), using the Illumina HiSeq platform (Illumina Inc., San Diego, CA). Our sequencing data, 2 x 250 pair-end reads, contained sufficient genome coverage to assemble and annotate the complete chloroplast genome (plastome) for each species. We evaluated the complete plastomes for SSRs and repetitive sequences using the programs MISA and REPuter. We also compared whole plastome Maximum Likelihood phylogeny to the *rbcL* gene phylogeny of 12 Lamailes species, with *Solanum lycopersicum* as an outgroup. Plastome lengths varied between 152,598 base pairs (bp) and 152,739 bp for *P. rostriflorus* and *P. cyaneus* respectively. The number of SSRs identified in each plastome varied between 16 and 23 for each species. The SSR nucleotide composition and location also varied between species. Repetitive sequence length for each species were also highly variable between 25 bp and 147 bp, with one repeat of over 7,000 bp in *P. rostriflorus*. All species had multiple palindrome and forward repeats except *P. cyaneus* and *P. palmeri*, which only had one and two forward repeats, respectively. While the phylogenetic topologies within the Plantaginaceae remained consistent, the relationships between the other species of the Lamailes order were not consistent between the plastome phylogeny and *rbcL* phylogeny. The complete plastome sequences have improved our understanding of the phylogenetic relations of the beardtongue subgenera over commonly used single gene phylogenies. This will help us to predict breeding success of crosses between closely related species, as well as potentially break reproductive barriers of distantly related species by first making crosses with intermediate species.

Analysis of Genetic Diversity of Piedmont Azalea By Genotyping-By-Sequencing (GBS) (poster)

Lav Kumar Yadav*, *University of Georgia*; Dayton Wilde, *University of Georgia* and Hanieh Hadizadeh, *Tarbiat Modares University (Poster Board #273)*

Abstract: Piedmont azalea (*Rhododendron canescens*) is the most common native azalea in the southeast US, ranging from Texas to North Carolina. It is of interest as a landscaping plant because of its adaptability, lace bug resistance, and early flowering. Piedmont azalea is one of the first native azalea species to bloom and could benefit early spring pollinators in urban landscapes. Information on the genetic diversity and population structure of Piedmont azalea would be useful for breeding and conservation biology. We used genotyping-by-sequencing (GBS) to examine 88 genotypes from Georgia and Florida. Bar-coded libraries of MspI/PstI-digested DNA samples were sequenced by Illumina Nextseq 500. Single nucleotide polymorphisms (SNPs) were identified using TASSEL and filtered at a minor allele frequency of 0.05. A total of 5186 SNPs were discovered by GBS, of which 1739 high quality SNPs were retained by TASSEL for further analysis. Since no reference genome was available for alignment, one of the genotypes from the population was selected to create a mock reference genome and all other genotypes were aligned to it. Analysis of population structure using STRUCTURE software showed that the Piedmont azalea genotypes could be grouped in three distinct populations based on delta K=3. Principle

component analysis corroborated the STRUCTURE results showing three different population clusters. A neighbor-joining tree was constructed based on the SNP data to determine genetic relationships of the Piedmont azalea genotypes. Information derived from GBS analysis will benefit the breeding of Piedmont azaleas for urban landscapes.

Specified Source(s) of Funding: Specialty Crop Block Grant

DNA Vs. Morphology: The Two Sides of Every Plumeria "Species" (poster)

Kauahi Perez*, *University of Hawaii at Manoa (Poster Board #274)*

Abstract: The genus *Plumeria* L. is a member of the family Apocynaceae that is valued in many parts of the world for religious, ornamental, ethnobotanical and cosmetic purposes. However, the taxonomy of *Plumeria* species (spp.) is not well-understood, which has huge implications in the realms of bioprospecting and plant breeding. Identification of a spp. can be achieved through morphological and molecular means, but phenotypic plasticity may hinder accurate identification of a spp. and molecular markers must be tested prior to commercializing their use. Thus, a combined approach using morphological and molecular markers will help to identify *Plumeria* spp. and determine genetic relationships within this genus. The objectives of this research are to 1) identify a combination of morphological markers that will distinguish among *Plumeria* spp., and 2) identify molecular markers will also identify *Plumeria* spp. Seventy-five samples of 13 putative *Plumeria* spp. were collected from germplasms of Hawaii and Florida, and analyzed for the presence or absence of 52 morphological characters, in addition to evaluating five DNA barcodes (partial matK, psbJ-petA, rpl32-trnL, trnH-psbA, and ITS2). Based on three principal components of the morphological data, only five groups were identified out of the 13 putative spp. No single DNA barcode was able to distinguish any more than four spp. Even the combination of all five DNA barcodes was insufficient to identify more than 40% of putative *Plumeria* spp. tested. It is thus recommended to identify other morphological characters and molecular regions to accurately identify *Plumeria* spp.

Specified Source(s) of Funding: Southern California Plumeria Society and Plumeria Society of America

Identification of Two New Races of *Diplocarpon Rosae* Wolf, the Causal Agent of Rose Black Spot Disease (poster)

David Zlesak, *University of Wisconsin, River Falls*; Matthew Holen, *University of Minnesota*; Jason Zurn, *USDA-ARS, NCGR*; James M. Bradeen, *University of Minnesota*; Nahla V. Bassil, *USDA-ARS Corvallis* and Stan Hokanson*, *University of Minnesota (Poster Board #275)*

Abstract: The fungal pathogen, *Diplocarpon rosae* Wolf, infects only roses (*Rosa* spp.) and leads to rose black spot disease. Rose black spot is the most problematic disease of outdoor grown roses worldwide, due to the potential for rapid leaf yellowing and defoliation. Plants repeatedly defoliated from black spot become weakened and may eventually die from lack of energy reserves. Eleven races of the pathogen have been characterized previously from isolates collected in North America and Europe. Isolates of *D. rosae* obtained from infected leaves of Brite Eyes™ ('RADbrite'; isolate BEP; collected in West Grove, PA) and Paprika™ ('CHEwmaytime'; isolate PAP; collected in Minneapolis, MN) proved to have unique infection patterns using the established host differential and Lemon Fizz™ ('KORlem'). The new races are designated race 12 (BEP) and 13 (PAP), respectively. A differential infection pattern on Lemon Fizz™ is what distinguished race 7 from 12. Expanding the collection of *D. rosae* races provides an ever more valuable resource to support ongoing efforts to identify and characterize unique race specific resistance genes in *Rosa* and subsequently utilize them in breeding efforts.

Specified Source(s) of Funding: USDA-NIFA SCRI

Cioa 2 - Carrot Improvement for Organic Agriculture with Added Grower and Consumer Value (poster)

Phillipp Simon*, *USDA-ARS Vegetable Crops Research Unit*; Micaela Colley, *Organic Seed Alliance*; Laurie McKenzie, *Organic Seed Alliance*; Jared Zystro, *Organic Seed Alliance*; Cathleen McCluskey, *Organic Seed Alliance*; Lori Hoagland, *Purdue University*; Erin Silva, *University of Wisconsin-Madison*; Philip Roberts, *University of California*; Julie C Dawson, *University of Wisconsin-Madison*; Lindsey du Toit, *Washington State University*; Timothy D. Waters, *Washington State University* and Joe Nunez, *University of California Cooperative Extension, Farm and Home (Poster Board #276)*

Abstract: Carrot Improvement for Organic Agriculture 2 (CIOA 2) builds upon accomplishments of the CIOA 1 project funded by the USDA OREI. Plant breeding is long-term work and the proposed project will maximize impacts of the CIOA 1 research by delivering new, improved carrot cultivars and breeding lines to the organic seed trade; developing new breeding populations that combine critical traits identified during CIOA 1; expanding the screening of diverse carrot germplasm and field testing of finished cultivars and advanced materials in diverse organic environments; and advancing our understanding of positive genetic-soil microbial interactions, thereby expanding the potential to breed for nutrient use efficiency, disease resistance, and drought tolerance. The long-term goals are to: 1) deliver carrot cultivars with improved disease and nematode resistance, improved nutrient acquisition, seedling vigor and weed competitive traits, increased marketable yield, superior nutritional value, flavor and other culinary qualities, and storage quality for organic production; 2) determine how carrot genotypes interact with, or influence, the root microbiome to access key nutrients under limiting environments, and limit heavy metal uptake; 3) inform growers about cultivar performance to maximize organic carrot production, markets, and organic seed usage; 4) inform consumers about the positive environmental impacts of organic production systems and about carrot nutritional quality, flavor and culinary attributes; and 5) train undergraduate, graduate, and post-doctorate students in critical organic agriculture issues. A timeline for project activities was developed and on-farm field trials have been initiated in six states to identify promising carrot breeding stocks with stakeholder involvement. New genetic sources of improved flavor, nutritional value and novel colors with promising production characteristics have been identified, and major differences in susceptibility to foliar diseases such as carrot red leaf, Cercospora leaf spot, and bacterial blight have been identified. Fine mapping of resistance genes conditioning root-knot nematode resistance is underway to accelerate the incorporation of resistance into new breeding stocks. In addition, marker-assisted selection was initiated for major pigmentation genes.

Specified Source(s) of Funding: USDA-NIFA-OREI 2016-51300-25721

Utilization of Carrot Cwrs for Carrot Pre-Breeding in Bangladesh and Pakistan (poster)

Phillipp Simon*, *USDA-ARS Vegetable Crops Research Unit*; M.a. Rahim, *Bangladesh Agricultural University* and A. Ali, *University of Sargodha (Poster Board #277)*

Abstract: Carrot is a very widely grown vegetable that is not only a valuable cash crop, but also an excellent source of Vitamin A derived from the orange pigments familiar to consumers. Carrot production has historically been in cooler climates, but with the development of carrot cultivars for subtropical regions of Brazil in the last 40 years, carrot production has expanded dramatically in warmer climates around the world. For example, carrot production in Bangladesh has risen significantly in recent years. Since most of the global incidence of Vitamin A deficiency is in warmer regions of the world, the development of carrot cultivars adapted to subtropical climates takes on even greater potential importance. Cultivated carrot germplasm is genetically and phenotypically diverse, and crossable wild relatives are a reservoir of even more genetic diversity. Wild carrot germplasm has been collected in very warm, dry, and, in some cases, very saline sites, and this germplasm is available in the USDA carrot germplasm collection. This project evaluated carrot wild relatives and cultivated carrots in warm, dry, saline field conditions, intercrossed climate-tolerance from wild relatives to adapted, nutritious cultivated germplasm, and evaluated intercrosses among carrots and their derivatives in hot, dry, saline field sites in Bangladesh and Pakistan. Exposure to heat and salinity in field trials was effective in limiting growth for most of the germplasm entries evaluated, whereas exposure to drought did not limit carrot growth as dramatically as heat or salt. Of particular interest, a few entries demonstrated heat, drought, and salinity tolerance in both Bangladesh and Pakistan. Intercrosses involving plants with novel abiotic stress resilience traits of carrot crop wild

relatives (CWRs) with highly nutritious, good flavor, widely-grown carrot types were initiated in both Bangladesh and Pakistan, and seed production was successful in subsequent generations. Tolerance for heat, salinity, and drought was discovered among carrot germplasm accessions evaluated and, for selected entries, was reliably demonstrated across both locations and across several years. Interestingly, among tolerant germplasm accessions, many were cultivated carrot. While wild carrot relatives also demonstrated repeatable tolerance, the incidence of tolerant cultivated carrots suggests that genes in cultivated background can be tapped to develop breeding populations with good horticultural quality favorable to both farmers and consumers. The inheritance of tolerance is being evaluated and germplasm is being developed.

Specified Source(s) of Funding: Global Crop Diversity Trust 58-3655-4-055F

12:15 PM – 1:00 PM *International Ballroom East/Center*

Growth Chambers and Controlled Environments 2 (Poster)

High Tunnel Systems for Producing Annual Cut Flowers in the Intermountain West (poster)

Maegen Lewis*, *Utah State University*; Larry Rupp, *Utah State University*; Brent Black, *Utah State University* and Daniel Drost, *Utah State University (Poster Board #151)*

Abstract: Small farms in the Intermountain West are using high tunnels to expand their production season for high value crops such as fruits and vegetables. Cut flowers are one potential high value crop that hasn't been fully explored, partly due to a lack of region-specific information. A research project is underway at the Utah State University research farm in North Logan, Utah to develop appropriate management strategies for two representative cool-season annual cut flower crops (snapdragon and sweet pea). Replicated plots of 'Rocket' snapdragon, and the sweet pea cultivars 'Mammoth', 'Elegance', 'Royal', and 'Spencer' were planted in high tunnels in early April-May of 2017, with comparison field plantings in late May. Stems were harvested 3 days per week and evaluated for yield (stem number), marketable stems, and length of harvest season. Results from 2017 indicate an increase in quality and stem length of snapdragons grown in high tunnels, compared to the field. Sweet peas showed increased quality during cooler months in high tunnels. For 2018, earlier planting dates were included for both sweet pea and snapdragon, and the snapdragon cultivars 'Potomac', 'Animation' and 'Chantilly' were tested. Cool season annual cut flowers are showing promise as a high-tunnel crop for local markets in the high-elevation Intermountain West.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant

Effect of Nitrogen Dioxide on Physiological Reaction in 41 Garden Plants (poster)

Sheng Qianqian*, *Nanjing Forestry University (Poster Board #152)*

Abstract: Nitrogen dioxide (NO_2) is one of the most common and harmful air pollutants. To analyze the response of plants to NO_2 stress, the current study aimed to explore the physiological response of plants to NO_2.

In this study, we investigated the physiological parameters (chlorophyll content, peroxidase activity, dissolved protein and malondialdehyde concentration) and leaf mineral ion contents (N^+, P^+, K^+, Ca^{2+}, Mg^{2+}, Mn^{2+} and Zn^{2+}) of 41 garden plants which are classified into 13 plant functional groups according to the Angiosperm Phylogeny Group when plants exposed to 6 μl/L concentration of NO_2 in the open-top glass chamber and then placed these 41 plants in the natural environment for natural recover to observe if plants could recover to normal growth.

Our results imply that NO_2 caused pollution risk to plant system. During the progress, NO_2 exposure affected leaf chlorophyll content of most functional groups. Increase of the levels of POD, dissolved protein and MDA and change of the mineral ion content could act as a signal to induce a defense response, and antioxidant status played an important role in plant protection against NO_2-caused oxidative damage, especially perform better in evergreen than other functional groups, and this damage could be recovered to normal level.

Specified Source(s) of Funding: The National Natural Science Foundation of China (31770752)

Performance of Crop Species with Different Thermal Requirements in Aquaponics Systems (poster)

Teng Yang*, *Purdue University*; Yi-Ju Wang, *Purdue University* and Hye-Ji Kim, *Purdue University (Poster Board #154)*

Abstract: Aquaponics is a new emerging agricultural production system that recycles residual nutrients resulted from fish waste for crop production. The culture environment in aquaponics is different from traditional farming, and a good aquaponics system should be designed to meet the growth requirements for fish, microbes, and plants production at the same time. Due to the excellent adaptability to a fluctuating water environment, tilapia (*Oreochromis niloticus*), a warm-water fish species, is the most popularly grown in commercial and scientific aquaponics systems in the U.S. The temperature environment of warm-water aquaponics system does not match with many vegetables popularly grown in aquaponic systems, most of which are cool-season crop species; however, there is no relevant information regarding this aspect. In order to compare the performance of crop species with different thermal requirements in warm-water aquaponics systems, two warm-season crops, cherry tomato (*Solanum lycopersicum*) and basil (*Ocimum basilicum*) and one cool-season crop lettuce (*Lactuca sativa*), were grown with tilapia for 2 months. Fish were fed once a day by 1% fish fresh weight. Water quality parameters were measured daily. The pH was adjusted by using a mixture of potassium hydroxide and calcium hydroxide (v:v=1:1) at around 7.0. Water was sampled for total ammonium nitrogen (TAN), nitrite, nitrate, and phosphate measurement every three days. At the beginning and harvest, crop growth parameters were measured. Bio-filter mediums were sampled for bacteria DNA extraction by qPCR with amoB as a molecular marker to check the population of ammonia-oxidizing bacteria (AOB) weekly during study period. Data showed that cherry tomato showed significantly higher SPAD than basil and lettuce, while both cherry tomato and basil showed significantly higher photosynthesis rate (Pn) values than lettuce. In addition, there was significant linear correlation between leaf temperature and net photosynthesis in cherry tomato and basil-based aquaponics systems, while no correlation was found in lettuce-based aquaponics systems between the two variables. Further, the results showed that higher leaf temperature increased net photosynthesis rate in cherry tomato and basil-based aquaponics systems, which may be partly explained by their higher thermal requirements. However, there was no significant difference in weekly AOB population density among the treatments, indicating that AOB did not play a critical role in plant growth variations. In summary, warm-season crops showed better growth performance in tilapia-based warm-water aquaponics systems.

Specified Source(s) of Funding: USDA-AFRI

Effects of Plant-Derived Protein Hydrolysate Biostimulant on Adventitious Rooting in Cuttings of Basil, Tomato, and Chrysanthemum (poster)

Seunghyun Choi*, *Purdue Univeristy*; Hye Su Lee, *Purdue Univeristy* and Hye-Ji Kim, *Purdue University (Poster Board #155)*

Abstract: Biostimulants, formulated products of various biological origins, have been considered as innovative tools to improve plant productivity by enhancing nutrition efficiency, abiotic stress tolerance, and quality parameters for crop production. Among all biostimulant groups, plant-derived protein hydrolysate group have gained in popularity due to its effectiveness. Plant propagation by stem cuttings is a general method for the commercial production of many greenhouse crops, with auxin being the main rooting hormone. The aims of this study were to identify the biostimualant action (hormone like activity) on adventitious rooting of cuttings and to determine its ideal concentration for the maximum rooting responses of cuttings. A biostimulatnt 'Quik-Link' containing lignosulphonate and protein hydrolysates derived from legume seeds was utilized in the cuttings of three different plant species, basil, tomato, and chrysanthemum. Unrooted cuttings of the plant species were either purchased from a commercial source or taken from stock plants grown in the greenhouse. 10-20 replicates of each plant species were treated with either biostimulant at five different

concentrations (0, 0.1, 1, 5, and 10 g/L), or rooting hormone 'Dip'N Grow' at five different concentrations (0ppm, 100ppm, 200ppm, 300ppm, and 500ppm) for comparison. The cuttings were then planted in a propagation tray filled with soilless media and placed under intermittent mist where optimum temperature, humidity, and lighting were provided for rooting. Maximum rooting occurred in 3 weeks and percentage of rooting, root growth, and shoot growth were measured. The results demonstrated that the biostimulant showed auxin-like and gibberellin-like activities, noticeably increasing both root and shoot growth. It significantly enhanced the number of root and volume, and root dry weight, as well as stem length and shoot dry weight. Overall, plant cuttings treated with 5 g/L of the biostimulant showed the maximum effectiveness in adventitious rooting. The findings suggest that the treatment of unrooted cuttings with the biostimulant can significantly improve adventitious rooting in basil, tomato, and chrysanthemum. Interestingly, it was also found that the biostimulant can perceptibly enhance the number of roots in a different way unlike auxin.

Specified Source(s) of Funding: NE-1335

Effects of Plant-Derived Protein Hydrolysate Biostimulant on the Productivity and Quality of Lettuce and Tomato (poster)

Seunghyun Choi*, *Purdue Univeristy*; Gaotian Zhu, *Purdue Univeristy* and Hye-Ji Kim, *Purdue University (Poster Board #156)*

Abstract: The use of biostimulants has been proposed as an innovative and promising approach to improve crop quality and yield. Among all biostimulant groups, plant-derived protein hydrolysate are gaining interest globally due to their remarkable agronomic value compared to other groups. In general, greenhouse production system is known as a high input system where high levels of fertilizers were consumed for intensive plants growth. In this study, a type of biostimulant, legume-derived protein hydrolysate, was used to improve crop quality and yield, while reducing fertilizer inputs for crop production. A series of experiments were conducted in the greenhouse to identify the effects of biostimulant on romaine lettuce 'Sarah' and dwarf tomato 'Micro-tom' on plant performance, which includes leaf/stem/root length, leaf number/area, root diameter, photosynthetic gas exchange, chlorophyll content, and crop yield. Treatments consisted of two levels of biostimulant (0 and 3 g/L biostimulant), which were combined with either nitrogen (N) treatments (low, medium, and high) or electrical conductivity (EC) treatments (low, medium, and high) with commercial fertilizer (4.5N-14P-34K). A solution of 50 mL containing biostimulant was applied to romaine lettuce and micro-tom as soil drenching once every week during production period. The results showed that leaf area and head fresh weight of romaine lettuce were increased by 11 % and 15 %, respectively, when 3 g/L biostimulant was applied with low nitrogen or low EC treatment. Even though the micro-tom experiment is currently ongoing, we observed similar results as romaine lettuce and the tomato plants applied with biostimulants have already shown better performance, particularly under low nitrogen and low EC treatments. Based on our findings, it is concluded that biostimulant improves productivity and quality of both romaine lettuce and tomato under low nutrition conditions. This suggests that the plant-derived protein hydrolysate application may contribute to the reduction of fertilizer inputs in greenhouse production systems.

Specified Source(s) of Funding: NE-1335

The Effect of Wavelength Specific Lighting on Whole Plant CO_2 and H_2o Gas Exchanges (poster)

Jason Lanoue*, *University of Guelph*; Evangelos D. Leonardos, *University of Guelph*; Xiuming Hao, *Agriculture and Agri-Food Canada* and Bernard Grodzinski, *University of Guelph (Poster Board #157)*

Abstract: Advancements in light-emitting diode (LED) technology have made them a viable alternative to current lighting systems for both sole and supplemental lighting requirements. Much research is available on the wavelength specific responses of leaves from multiple crops when exposed to long-term wavelength specific lighting. However, leaf responses to environmental stimuli do not always extrapolate linearly to whole plant responses due to the complexities of the plant canopy, namely mutual shading and leaves of different ages. For these reasons, we measured the diurnal whole plant CO_2 and H_2O gas exchange of vegetative tomato plants under both long-term and short-term exposure to various spectral qualities as well as ambient and elevated CO_2 conditions. It was determined that within each environmental stimulus provided to the plant, biomass gain throughout the day was similar when plants were measured under high-pressure sodium (HPS), red-blue LED, or red-white LED. Under all luminary systems, tomato plants showed a similar diurnal pattern of transpiration, rising to a maximum around mid-day and declining during the remainder of the photoperiod. However, plants measured under the LED lighting systems produced higher transpiration rates than plants measured under HPS lights. This conversely lead to decreased water-use-efficiency (WUE) rates throughout the day. The decrease in WUE from plants exposed to both LED systems was ubiquitous within all lighting and CO_2 conditions tested. The understanding of the effects of wavelength specific lighting on both CO_2 and H_2O canopy gas exchanges have significant implications for both academic research where plants are cultivated in controlled research environments and commercial greenhouse production.

Specified Source(s) of Funding: Agriculture & Agri-Food Canada

Image Analysis Technique for Remotely Estimating Light Absorption Efficiency in Plants Grown in Controlled Environment Agriculture (CEA) (poster)

Ranjeeta Adhikari*, *Purdue University*; Alexander Miller, *Purdue University* and Krishna Nemali, *Purdue University (Poster Board #158)*

Abstract: Artificial lighting is required in indoor production while it improves crop quality for year-round greenhouse production. Artificial light provided to plants is intercepted and transmitted by the canopy. The intercepted light is absorbed and a portion of the light is reflected back. Reflected light is wasted if plants do not reabsorb it. Extent of light reflection can further increase under stress conditions. Artificial light provided to plants can be significantly high, therefore it is important to minimize any wastage of provided light. Continuous monitoring of light absorption efficiency of plants can aid in reducing artificial light wastage. Currently available sensors (e.g., quantum sensors, spectral reflectance sensors) are not designed to measure light absorption efficiency of whole-plants. There is an urgent need to develop simple, accurate and affordable sensing techniques to estimate light absorption efficiency of plants. The objective of this study is to test the efficacy of image analysis technique for estimating light absorption efficiency of plants in CEA. For testing this technology, petunia (*Petunia* × *hybrida* L. 'Easy Wave Red Velour') seedlings were transplanted in a greenhouse maintained at 26/20°C (day/night) temperature and daily light integral (DLI) of 10-20 $mol \cdot m^{-2} \cdot d^{-1}$. Plants were subjected to optimum and stresses treatments including water stress, nitrogen stress and low light stress. Direct measurements such as, light absorption efficiency (ratio of absorbed to incident light intensity, $PPF_{a/i}$), photosynthesis rate (A) and shoot dry weight (SDW) were taken. A multi-spectral imaging station with image analysis software was used for image acquisition, plant pixel segmentation and plant reflectance measurement at different visible (450, 523, 591, 625, 660 nm) and near infrared (*nir*, 870 nm) wavebands. Mean reflectance of visible wavebands (R_{VIS}) from groups of plants was calculated and expressed as relative reflectance of light in visible wavebands (R_{VIS}/R_{870}). Results showed $R_{VIS/870}$ was inversely related to $PPF_{a/i}$ and SDW. Petunia plants subjected to stress showed increased light reflectance (or absorbed less light) likely due to A under stress. These results indicate that image-based measurements (R_{VIS}/R_{870}) can be used to indirectly estimate light absorption efficiency in plants.

Automated and Non-Destructive Measurement of Plant Growth Characteristics Using a Multispectral Image Based Technique in Controlled Environment Agriculture (CEA) (poster)

Alexander Miller*, *Purdue University*; Ranjeeta Adhikari, *Purdue University* and Krishna Nemali, *Purdue University (Poster Board #159)*

Abstract: Intensive farming, high plant densities, and multi-level production makes it challenging to monitor plant growth and input use in controlled environment agriculture (CEA, greenhouses and vertical farms). With the advancements of imaging technology, remote observations using drones is already

used in outdoor agriculture systems. Image based measurements using cameras in CEA can make monitoring crops more efficient. Our objective was to test whether a multi-spectral image analysis technique can be used to remotely and automatically measure plant growth characteristics in CEA. Experiments were conducted in a greenhouse maintained at 26/20 ºC (day/night) temperature and daily light integral (DLI) of 10-20 $mol \cdot m^{-2} \cdot d^{-1}$. Leaf lettuce (*Lactuca sativa L.* var. Black Seeded Simpson) and tomato (*Solanum lycopersicum* var. Early Girl) were grown in a peat-based substrate (Sungro Professional Mix) and supplied with a liquid fertilizer comprised of 15-5-15 and 21-5-20 mixes in 3:1 ratio. Leaf lettuce and tomato plants were grown under non-stress conditions in the experiment. A multi-spectral imaging station with image analysis software was used for image acquisition, plant pixel segmentation, and canopy area estimation. Image based canopy area (LA_{image}) was measured for groups of plants on different days. Immediately after imaging, direct measurements included total leaf area (LAa_{ctual}), shoot dry weight (SDW_{actual}), and relative growth rate (RGR_{actual}). There was a linear relation between LA_{actual} / SDW_{actual} and LA_{image}, and RGR_{actual} and image derived RGR (RGR_{image}) in leaf lettuce and tomato. These results indicate that image-based measurements can non-destructively measure plant growth characteristics. Automated non-destructive growth measurements using camera based image systems can be mounted on moving systems (ex: booms) or placed at stationary locations in CEA. These systems can aid in early detection of production related issues affecting growth, thereby leading to increased productivity in CEA.

Specified Source(s) of Funding: Purdue Univeristy

Low Tunnel and Planting Dates Affected Yield and Growth of Organically Managed, Field Grown Day-Neutral Strawberries. (poster)

Tekan Rana*, *North Carolina Agricultural and Technical State University*; Sanjun Gu, *North Carolina Agricultural and Technical State University*; John Beck, *The Cooperative Extension Program at North Carolina Agricultural and Technical State University*; John Kimes, *North Carolina Agricultural and Technical State University* and Amy Ballard, *North Carolina Agricultural and Technical State University (Poster Board #160)*

Abstract: Planting date and low tunnel could play important roles in the annual plasticulture strawberry system. The objective of this study was to determine the effect of low tunnel and planting dates on the growth and early and total yield of day-neutral strawberries in North Carolina. Cultivars Albion and San Andreas were planted on September 1 (D1) & 29 (D2) in raised beds with low tunnels (LT) and without low tunnels (NLT) on NC A&T State University farm in Greensboro, NC (hardiness zone 7b). LT was used from October through May of both 2016/17 and 2017/18 seasons. Yield and bloom data were taken twice/week, while canopy and biomass data were taken monthly from October to May. In the 2016/17 season, no significant difference in total yield occurred between D1 & D2 and between LT & NLT. LT and D2 had numerically higher marketable yield (57% and 53%) compared to NLT and D1 (45% and 48%). The marketable and total yield from October to January, in April or May were not affected by LT and PD. However, LT significantly increased the total and marketable yield compared to NLT in period from January to March, and D2 plants had significantly higher yield than D1 plants (total yield of 24.56 vs 13.28 g/plant and marketable yield of 18.10 vs 8.04g/plant). LT and D2 plants had smaller canopy size and biomass, and LT also delayed the days to 1st bloom and 1st harvest by 13 and 29 days, respectively, compared to NLT. In the 2017/18 season, LT numerically increased the total and marketable yield than NLT for D1 plants (total yield of 51.13 vs. 35.39 g/plant and marketable yield of 49.47 vs 23.8 g/plant) before winter. LT shortened days to 50% bloom by 20 or seven days compared to NLT for D2 or D1 plants, respectively. The 2017/18 research is still ongoing, but based on the results so far, LT and D2 should be recommended for higher marketable yield before winter.

Rapid Light Response Curves As a High-Throughput Screening Method for Photochemical Responses of Bedding Plants. (poster)

Geoffrey Weaver*, *University of Georgia* and Marc van Iersel, *University of Georgia (Poster Board #161)*

Abstract: Understanding plant photochemical responses to photosynthetic photon flux density (*PPFD*) is important for developing energy-efficient supplemental lighting strategies. However, the photochemical light response varies greatly among species and cultivars, and a rapid, reliable method to describe species- and variety-specific photochemical responses is needed. Chlorophyll fluorescence measurements were used to determine the electron transport rate (ETR) of six bedding plant species: *Begonia semperflorens* 'Ambassador Scarlet' (begonia), *Catharanthus roseus* 'Jams N Jellies Blackberry' (vinca), *Impatiens walleriana* 'Super Elfin Violet' (impatiens), *Pelargonium* x *hortorum* 'Maverick Violet'(geranium), *Petunia* x *hybrida* 'Daddy blue'(petunia), and *Salvia splendens* 'Mojave' (salvia). Diurnal measurements were conducted in a greenhouse with fluorescence measurements taken every 15 min during the day and hourly at night with 5 measurement days per species. Additional measurements were taken in a growth chamber using a hyperbolic series of *PPFD*s (0, 50, 150, 300, 500, 750, 1050, 1400 $\mu mol \cdot m^{-2} \cdot s^{-1}$), with 20 min acclimation at each intensity, and 5 replications per species. For 4 species, the data collected in the growth chamber was similar to the greenhouse data, but for impatiens and petunia observed ETR was generally lower in the greenhouse. This may have been due to physical damage to the leaves induced by the fluorometer leaf clip. In all cases, an asymptotic rise to a maximum function fit the data well. This function uses only two variables: the initial slope and the asymptote of the ETR response curve: ETR= [asymptote of ETR] x [1- *e*^[-(initial slope of ETR/asymptote of ETR) x PPFD]. Accordingly, it was hypothesized that the photochemical light response could be adequately described by determining only the initial slope and asymptote: a rapid light response curve. This was tested in a growth chamber by measuring the ETR of each species at a very low (≈3 $\mu mol \cdot m^{-2} \cdot s^{-1}$) and very high (≈2100 $\mu mol \cdot m^{-2} \cdot s^{-1}$) light intensity for 5 min. The equation generated from this data fit the greenhouse ETRs with a mean R^2=0.93 and slope of 0.89; the estimated values were generally 11% higher than the observed ETRs. Similarly, it fit the previous growth chamber data with mean R^2=0.96 and slope of 0.94 (estimated ≈6% higher than observed) for all species except for impatiens, which had a much higher slope (m=1.5, R^2=0.94), suggesting that the high PPFD used to determine the asymptote was photoinhibitory for impatiens. This high-throughput method accurately describes the ETR response for 5 of the 6 species.

Response of Tomato 'Merlice' to the Interaction of Daily Light Integral and Carbon Dioxide Concentration (poster)

Dylan C. Kovach*, *Cornell University* and Neil Scott Mattson, *Cornell University (Poster Board #162)*

Abstract: Of all tomatoes consumed in New York State less than 10% are grown within state, creating a void in the availability of locally produced tomatoes. Greenhouse tomatoes are the largest greenhouse vegetable crop produced in the U.S. with over $400 million annual wholesale value. One of the challenges associated with growing tomatoes in upstate New York is the energy demands for heating and lighting. Use of supplemental CO_2 can reduce the need for supplemental lighting and increase crop yield in off-season. While CO_2 enrichment is known to increase crop yields, scientific literature is lacking on the interaction between CO_2 concentration and daily light integral (DLI) and subsequent photosynthetic and yield response of tomatoes.

The objective of this research is to study the interaction of supplemental CO_2 and lighting on tomatoes at different developmental stages. Phase 1 of this experiment uses climate controlled mini-chambers with 16 different treatment combinations conducted using four different CO2 concentrations (400, 600, 800, 1000 ppm) and light intensities (10, 15, 20, 25 $mol \cdot m^{-2} \cdot day^{-1}$ PAR) on juvenile 'Merlice" tomato plants. After 10 days of exposure, plants are assessed for biomass, photosynthetic parameters, and morphological differences. An equation relating plant biomass and net photosynethic assimilation based on CO_2 and DLI is under development. In Phase 2, CO_2 and DLI will be controlled in a greenhouse to determine responses at the tomato fruiting stage.

Specified Source(s) of Funding: NYSERDA GLASE

Effects of Temperature and Potassium on Lettuce Biomass, Quality, and Phytonutrient Concentrations in a Controlled Environment (poster)

Will Sublett*, *Mississippi State University*; T. Casey Barickman, *Mississippi State University* and Carl Sams, *The University of Tennessee (Poster Board #163)*

Abstract: Lettuce is an economically important crop that generates sizeable income for small and medium-sized growers in the southeastern United States. When produced in adverse environmental conditions, lettuce is vulnerable to yield losses and deterioration of quality. Previous research has indicated that elevated levels of potassium (K) positively affects the quality of several fruits and vegetables, including strawberry, melon, pepper, and tomato. However, research concerning the impact of elevated K levels on leafy vegetables, such as lettuce, is lacking. Therefore, seeds of dark-red 'Lollo' lettuce were sown in a soilless medium and germinated under greenhouse conditions at 25/20 °C (day/night). Upon emergence of the first true leaf, plantlets were transferred into 11-L Rubbermaid© plastic containers and placed into growth chambers at 25 and 33 °C. Plants were produced with increasing K treatments of 117.3 (control), 234.6 (2x), 469.2 (4x), and 4) 938.4 (8x) mg·L^{-1}. Plants were harvested 30 days after seeding. Increasing K treatments resulted in a negative quadratic response on lettuce dry mass and generated 14% more leaf calcium at 234.6 mg·L^{-1} compared to the control treatment. Increasing temperature from 25 to 33 °C resulted in the increased leaf dry matter and biomass by 40% and 43%, respectively. Conversely, leaf water content increased by 3% from 25 to 33 °C. Increasing nutrient solution K alone did not affect lettuce quality (phenolics and mineral content). However, plants produced at 33 °C showed a greater accumulation of quercetin glycosides compared to plants produced at 25 °C. Additionally, interactions between temperature and K treatment influenced leaf concentrations of phosphorous, sulfur, and copper. The results from this study suggest that temperature is a stronger regulatory factor than increasing K in the determination of lettuce yield and quality; however, increasing K concentration to 234.6 mg·L^{-1} results in greater concentrations of leaf mineral content without compromising plant yield.

Specified Source(s) of Funding: This study was a contribution of the Mississippi Agriculture and Forestry Experiment Station and USDA-NIFA Hatch S294 project MIS 146030

The Effects of Environment and Nutrient Solution Concentrations on Hydroponic Lettuce Yield, Quality, and Phytonutrients (poster)

Will Sublett*, *Mississippi State University*; T. Casey Barickman, *Mississippi State University* and Carl Sams, *The University of Tennessee (Poster Board #164)*

Abstract: In response to increasing interest in greenhouse production and difficulties imposed by adverse environmental conditions in the southeastern United States, a study was conducted with green and red-leaf lettuce cultivars grown in a deep-water culture production system. Plants were seeded in Rockwool and germinated under greenhouse conditions (Verona, MS; 34° N Lat.) at 25/20 °C (day/night) for 21 days before transplanting. The experimental design was a randomized complete block with a 2 x 3 factorial arrangement of cultivar and nutrient treatments that consisted of six replications, with individual tubs representing an experimental unit. Treatments consisted of two lettuce genotypes 1) green (Winter Density) and 2) red (Rhazes) and three nutrient treatments containing electroconductivity (EC) levels of 1) 1.0, 2) 2.0, and 3) 4.0 mS·cm^{-1}. After 50 days, plants were harvested, processed, and analyzed to determine marketable yield, biomass, plant height, and stem width. Additionally, nutritional quality was assessed by determining flavonoid and phenolic content and leaf elemental nutrient concentrations. Project results demonstrated that the interaction between growing season and lettuce cultivar was the predominant factor influencing yield, biomass, and plant quality. Nutrient solution EC treatment significantly affected shoot dry mass, biomass, and water content. EC treatment also significantly impacted the concentration of 3-O-glucoside and uptake of phosphorous, potassium, iron, boron, zinc, and molybdenum. Results from this study indicate that the effects growing season and cultivar on leafy lettuce performance (yield and quality) was more pronounced than the effect of nutrient solution EC treatment. However, despite statistical insignificance, all elemental nutrients increased with increasing solution EC. Thus, greenhouse production of green and red-leaf lettuce cultivars in the southeastern, United States should be conducted in the spring and fall growing seasons with elevated nutrient solution EC of ≈4.0 mS·cm^{-1} to maximize yield and quality. The current study may spur research into the performance outcomes of increasing individual solution nutrients in conjunction with production season and green and red-leaf lettuce cultivars.

Specified Source(s) of Funding: This study was a contribution of the Mississippi Agriculture and Forestry Experiment Station and USDA-NIFA Hatch S294 project MIS 146030

Applied Effect of a Modified Open-Top Chamber Simulated at Elevated CO_2 Concentration in Goji Berry (*Lycium barbarum* L.) (poster)

Yaping Ma*, *School of Agriculture, Ningxia University*; Rong Ha, *School of Agriculture, Ningxia University*; Hao Jia, *School of Agriculture, Ningxia University*; Lihua Song, *School of Agriculture, Ningxia University* and Bing Cao, *School of Agriculture, Ningxia University (Poster Board #165)*

Abstract: Enhancement of carbon dioxide (CO_2) in the atmosphere has received great attention due to its potential repercussion on global warming and direct effects on the vegetation, especially with a potential increase in atmospheric CO_2 level from 400 μmol·mol^{-1} to 1000 μmol·mol^{-1} by the end of the 21st century according to the currents environmental studies. Therefore, development of new technologies on controlled environment conditions are needed to investigate plant response to CO_2 enhancements and its possible repercussion on world food security. In the present study, we aimed to evaluate a modified open-top chamber (OTC), designed and constructed based on previous OTC experiences, which provides precise control of CO_2 under different concentrations, with excellent control of air temperature and humidity. To test the functionality of the modified OTC, Goji berry (*Lycium barbarum* L.) plants were grown from May to October on 2017 inside the chambers. Real-time data of CO_2 concentration, temperature, and air relative humidity of the chambers were collected. As a result, the average CO_2 levels obtained in the chamber during the study period was 369.33 μmol·mol^{-1} for ambient conditions, while elevated group 1 and group 2 showed concentrations of 558.35 μmol·mol^{-1}and 772.71 μmol·mol^{-1} respectively. The fluctuation for elevated group 1 ranged from 551.82 to 572.40 μmol·mol^{-1} with a variation amplitude of 20.57 μmol·mol^{-1}. In the elevated group 2, the range of CO2 concentration was from 756.71 to 779.79 μmol·mol^{-1} with variation amplitude of 23.09 μmol·mol^{-1}. In addition, no significant differences were found in temperature and air relative humidity among the chambers treatments ($P > 0.05$). Meanwhile, the measured amounts of fructose, glucose, sucrose and starch contents of Goji berry fruits revealed that the sugar content of the fruit was significantly reduced under elevated group 2 CO_2 concentration, there was a significant increase ($P<0.05$) in the activity of sucrose cleavage enzyme and a decrease in the sucrose synthetic enzyme. These results demonstrated precise control of CO_2 concentration, temperature, and humidity inside the modified OTC chambers, showing an excellent development of CO_2 effect improvement on Goji berry, and it can be used to test climate change response in other plant species.

Specified Source(s) of Funding: The National Natural Science Foundation of China (No. 31660199，31160172)

Controlled Temperature Treatments with Low-Cost, Off-the-Shelf Equipment for Bud or Seed Forcing Experiments. (poster)

Douglas Bielenberg*, *Clemson University*; Rosa Kome, *Clemson University*; Tyler McIntosh, *Clemson University*; Marcellus Washington, *Clemson University* and Ksenija Gasic, *Clemson University (Poster Board #166)*

Abstract: Characterizing the regulation of development by temperature requires controlled exposure of replicate plants (whole or in part) to multiple temperature environments simultaneously. Inexpensive access to the number of environmental chambers needed for the parameterizing temperature response curves for development is not common and can limit the scope of experiments. Similarly, these experiments are often also not included in teaching labs to demonstrate the effects of temperature on plant development. We found an inexpensive (<$40) temperature controller designed for use by homebrewers which allows a chest freezer to be tightly regulated to a desired set point across a range biologically

relevant temperatures. Set up can be completed in a few minutes. We included a desktop fan for circulation and water ballast to stabilize temperature responses to opening the lid for observations. Temperature data loggers within the chambers recorded standard deviations of approximately 0.25 °C around temperature set points from 3 to 20 degrees °C. To demonstrate the potential of the chambers we performed two different experiments. First, we used these chambers evaluate temperature effects on 'time to event' data for different stages of germination as a laboratory exercise in an undergraduate plant physiology course. Second, we warm forced buds of a woody perennial (peach) at multiple temperatures for the calculation of base temperature and growing degree hour requirement for bud break. For our applications we added flexible strip LED lighting for photoperiod signaling. However, use of the chambers for photosynthetically driven growth may be limited by the lack of CO_2 or humidity control. Measures must also be taken to limit fungal growth due to high humidity.

Specified Source(s) of Funding: USDA-AMS-TM-Specialty Crop Block Grant Program, South Carolina Department of Agriculture

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12:15 PM – 1:00 PM *International Ballroom East/Center*

Ornamentals/Landscape and Turf 1 (Poster)

Evaluation of Ornamental Species (Order: Lamiales) for Phytotoxic Response to Various Pesticides in Southeastern U.S. for Interregional Research Project #4 (IR-4) (poster)

B.A. Fraelich*, *USDA-ARS*; B.T. Scully, *United States Horticultural Research Laboratory* and C.L. Palmer, *IR-4 Headquarters (Poster Board #110)*

Abstract: The Interregional Research Project #4 (IR-4) is a national program which provides pest management solutions for specialty crop growers and was started at the Tifton GA location in 1977. In the last ten years, the IR-4 Project on the U.S. southeastern coastal plain has completed 18 phytotoxicity experiments on six ornamental Lamiales genera including *Buddleia, Lantana, Ligustrum, Salvia, Torenia,* and *Verbena*. Four herbicides were applied at label rates as either a broadcast granular or as "over-the-top" foliar sprays. Over this same period, six fungicides and two insecticides were applied using foliar sprays. Field experiments were designed as randomized complete blocks with application method and pesticide treatments assigned to a specific Lamiales species. Phytotoxicity was recorded on a 0 to 10 scale (0 = no injury; 10 = dead) at intervals required by the protocol which differed for each species and chemical combination. Plant height and width were also measured at initial and final evaluations to assess any adverse chemical impact on plant growth and marketability. Data were analyzed in ARM (Agricultural Research Manager) using ANOVA, with means separated using Fisher's Protected LSD at a level of 0.05. Results indicated no injury among any of the fungicide or insecticide treatments, but significant differences in phytotoxicity between the nontreated controls and some of the herbicide treatments. IR-4 research data have contributed to the registration of Actigard, Alibi Flora, Dimension, Echelon, Freehand, Kontos, Orkestra Intrinsic, QRD 416, Tourney, Tower, and Trinity on these Lamiales ornamental horticulture specialty crops.

Evaluation of Twenty-One *Kalmia Latifolia* L. Cultivars for Container and Landscape Performance in Georgia (poster)

He Li, *University of Georgia*; Matthew Chappell, *University of Georgia* and Donglin Zhang*, *University of Georgia (Poster Board #111)*

Abstract: Mountain laurel (*Kalmia latifolia* L.) is a valuable ornamental shrub due to its attractive foliage and showy flowers. Breeding efforts have led to improved selections that had been developed, evaluated, and distributed in the northeastern United States, but being ignored by nursery people and consumers in the southeastern US. We conducted a four-year trial to evaluate 21 popular mountain laurel cultivars, primarily developed in the northeastern US, for container and field performance in Georgia. All container grown cultivars yielded considerable growth in the first year, indicating growing mountain laurel as one-year container plants was feasible for nurseries. Cultivars displayed significantly different growth index throughout the container trial. Fast-growing cultivars, 'Bullseye' and 'Ostbo Red', grew to over 100 cm, 150 cm, and 250 cm while slower growers like 'Firecracker' and 'Tinkerbell' had less than 80 cm, 115 cm, and 180 cm in one, two, and four years, respectively. Cultivars were classified into five groups, which were dwarf habit with pink flower, dwarf habit with non-pink flower, non-dwarf habit with green stem and white flower, non-dwarf habit with pigment-patterned flower, and non-dwarf habit with pink flower. This information provided growers on how to select various cultivars for their production among groups. In the field study, performance rating of 21 cultivars ranged from 2.0 to 4.8 (out of 5.0) in 2014 and from 2.0 to 5.0 in 2015 and significant differences were observed in 2014. Ten cultivars received the highest ratings over the two years were selected for the subsequent field trial in 2016. Cultivars showed overall decreased ratings (1.0-3.3) from the previous two years because of late spring planting and relatively unfavorable soil conditions. 'Ostbo Red', 'Pristine', and "Tinkerbell' had higher performance rating, more net growth, and less decrease in maximum quantum yield, which indicated their adaptation to the southeastern environmental conditions. Nursery growers and consumers should benefit from our regional cultivar trial information and we recommend 'Ostbo Red', 'Pristine', and 'Tinkerbell' for the southeastern landscapes based on their superior container and field performance, leaf spot resistance, and morphological variations.

Colocasia Trials at Stephen F. Austin State University (poster)

Jared Barnes*, *Stephen F. Austin State University*; John Dilday, *Stephen F. Austin State University*; Chanelle Angeny, *Louisiana State University*; Seukmin Hong, *Stephen F. Austin State University* and Michael Maurer, *Stephen F. Austin State University (Poster Board #112)*

Abstract: Diversity amongst and within species is a cornerstone of horticulture. However, with such great diversity comes the need for academics, breeders, growers, landscapers, retailers, public gardens, and home gardeners to know how plants are going to perform in their region. Plant trials and trial gardens help to provide that information to these various entities so that wise decisions can be made about plant choice. In July 2016 a new genera trial garden was started at Stephen F. Austin State University in east Texas to evaluate 46 Colocasia cultivars over a three year period. To reduce bias, data was collected by two trained undergraduate students and included plant performance on a 1 (poor) to 5 (outstanding) scale, plant height, and plant width. Based on two years of data, 'Madiera', 'Red Eyed Gecko', and 'Ruffles' were three of the best cultivars who averaged a performance over 3.5. Our data on height and width will be beneficial for those who grow and install Colocasia in ornamental landscapes.

Specified Source(s) of Funding: Fred C. Gloeckner Foundation

Effects of High pH Substrate on Growth and Foliar Chlorosis of Iowa Grown River Birch Provenances (poster)

Braden Hoch*, *Kansas State University*; Jason Griffin, *Kansas State University* and Chad T. Miller, *Kansas State University (Poster Board #113)*

Abstract: River birch (*Betula nigra* L.) is a common landscape shade tree known to develop iron deficiency interveinal leaf chlorosis (IFC) when grown in high pH and $CaCO_3$ soils. While variation in symptomology has been observed, provenances endemic to high pH soils may not always display chlorosis. The increased interest for environmentally sustainable landscape selections could be made if additional screening was conducted to determine their potential adaptability to high pH and $CaCO_3$ soils. The first study (Expt. 1) evaluated open-pollinated (OP) seedlings of Iowa provenances and 'BNMTF' OP in an elevated pH substrate. A second study (Expt. 2) evaluated clones from selected Iowa provenances, 'BNMTF', 'Cully', and 'BNMTF' OP. Twice-weekly 120 mL drenches of 4.8% $CaCO_3$ were used to maintain an elevated substrate pH. In Expt. 1, leaf chlorophyll was reduced by 36% in elevated pH substrate (pH = 7.57) compared to the control (pH = 5.57): (16.95 and 26.39 $\mu g \cdot cm^{-2}$, respectively) with differences in seed sources observed. A seed source from Bearbower Sand Prairie, Buchanan Co., IA (BSP3) had the greatest leaf chlorophyll content (25.86 $\mu g \cdot cm^{-2}$) but was not statistically

greater than two sources from Clemons Creek WMA, Washington Co., IA (23.90 µg·cm^{-2}, CCWMA1 and 22.76 µg·cm^{-2}, CCWMA2). Total leaf iron (Fe) concentrations were reduced by 61% for sources growing in the elevated pH substrate. In Expt. 2, leaf chlorophyll was reduced by 32% in elevated pH substrate (pH = 7.00) compared to the control (pH = 5.29); (19.40 and 28.73 µg·cm^{-2}, respectively). An Iowa clone, CCWMA3, had greater chlorophyll content than some other sources (26.78 µg·cm^{-2}) but no greater leaf chlorophyll content than 'BNMTF' (25.70 µg·cm^{-2}), a source from Ciha Fen, Johnson Co., IA (24.95 µg·cm^{-2}, CF3), and a source from Princeton WMA, Scott Co., IA (24.13 µg·cm^{-2}, PWMA2). 'Cully' had lower leaf chlorophyll (21.87 µg·cm^{-2}) than CCWMA3 and 'BNMTF'. Total leaf Fe content was also reduced in elevated pH substrate for all sources compared to their controls. Based on our studies, these Iowa provenances did not sequester more substrate Fe in their leaves than the industry standards, but two selections (BSP3 and CCWMA3) were perhaps more Fe efficient, because they were considerably less chlorotic than 'BNMTF' OP and 'Cully'. These Iowa seed sources and clones should be further evaluated in field studies to determine their extent of Fe-use efficiency in high pH soils compared to popular industry cultivars.

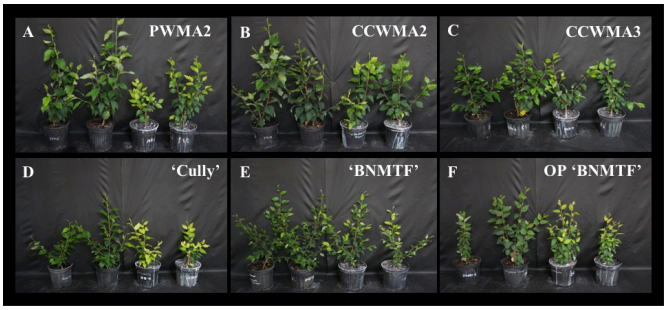

Figure 3.3 Expt. 2: each pane represents two replications per source x substrate treatment [control; pH = 5.29 (left) and elevated; pH = 7.00 (right)] Photos were taken after 101 d. Notice severe stunted plants upper yellow foliage on plants in the elevated pH substrate in panes A, B, D, and F. Furthermore, notice pane C (CCWMA3): plants in the elevated substrate pH were less stunted and less chlorotic.

Anthocyanins in Flowers of Redbud (*Cercis* spp) As Potential Natural Colorants (poster)

Penelope Perkins-Veazie*, *North Carolina State University*; Dennis Werner, *North Carolina State Univ* and Guoying Ma, *North Carolina State University (Poster Board #114)*

Abstract: Redbud (Cercis spp.) is used globally as a spring flowering ornamental tree or shrub. Interest in colorants from plants to replace synthetic dyes used in foods has greatly increased in the last 10 years. Redbud flowers are of interest as a natural pigment source as they do not brown with senescence and all parts of the flower contain pigment. In this study, redbud flowers of 12 cultivars and lines, primarily from *Cercis canadensis*, were collected and anthocyanin pigments determined by high performance liquid chromatography and diode array detector. The anthocyanins cyanidin-3-glucoside, petunidin-3-glucoside, peonidin-3-glucoside, malvidin-3-glucoside, and 3,5- diglucosides of delphinidin, cyanidin, and petunidin were found in purple, rose, and red-purple redbud flowers. An acylated malvidin 3-glucoside was also present. Malvidin 3,5 diglucoside was the dominant pigment (60%) in the red-purple 'Appalachian Red' and 'Crosswick's Red' while cyanidin 3-glucoside was dominant (60%) in flowers from the purple type cultivars such as 'Oklahoma', 'Forest Pansy' and 'Traveller'. 'Ruby Falls' was intermediate (50%) in both cyanidin-3-glucoside and malvidin-3,5-diglucoside. Total amounts of anthocyanin were highest in 'Oklahoma', 'Appalachian Red', and 'Ruby Falls' and were 2-3 g cyanidin 3-glucoside or malvidin 3,5 diglucoside/kg dry weight. In comparison, blackberries contain 15-25 g cyanidin 3-glucoside/kg dry wt and 'Concord' grape juice contains about 5 g malvidin 3,5 diglucoside/kg dry weight.

Evaluating Pollinator Visitation of Native Shrubs and Nativars (poster)

Jacob Ricker*, *University of Connecticut* and Jessica Lubell, *University of Connecticut (Poster Board #115)*

Abstract: There is increased interest in native plants for landscaping to support pollinators. The majority of native plants sold by nurseries are cultivars. Some consumer and conservation groups question the suitability of native cultivars (nativars) to support pollinators. This work evaluated insect pollinator visitation for five native shrub species, and one or more cultivars of each species. The following species were installed in a full sun field behind the University of Connecticut Floriculture Greenhouse Facility in a randomized complete block design with three replicates: *Aronia melanocarpa*, *A. melanocarpa* 'UCONNAM012' Low Scape® Rug, *A. melanocarpa* 'UCONNAM165' Low Scape® Mound, *Clethra alnifolia*, *C. alnifolia* 'Hummingbird', *C. alnifolia* 'Ruby Spice', *Dasiphora fruticosa*, *D. fruticosa* 'Goldfinger', *D. fruticosa* 'Pink Beauty', *Hydrangea arborescens*, *H. arborescens* 'Annabelle', *Physocarpus opulifolius*, and *P. opulifolius* 'Monlo' Diablo®. During the bloom period for each plant, insect visitation was measured on ten different occasions using visual observation with each observation period lasting 5 minutes. There was no significant difference in insect visitation between *A. melanocarpa* and its cultivars and *C. alnifolia* and its cultivars. Eighty percent of insect pollinators visiting *Clethra* species were bumblebees (Bombus sp.). Overall, *D. fruticosa* and its cultivar 'Goldfinger', both of which have yellow flowers, attracted more insects than *D. fruticosa* 'Pink Beauty', which has pink flowers. *H. arborescens* and *P. opulifolius* attracted more total insect pollinators than their respective cultivars. *H. arborescens* attracted 4 times as many bumblebees, 2 times as many other bees (clade Anthophila), and 2½ times as many wasps (suborder Apocrita) than did its cultivar, 'Annabelle'. *P. opulifolius* attracted more honeybees (*Apis mellifera*) and mining bees (family Andrenidae) than its cultivar 'Monlo', but 'Monlo' attracted more hoverflies (family Syrphidae) than the straight species.

Specified Source(s) of Funding: USDA Hatch

Microscopy Studies of Eriophyid Mites on Roses in the US (poster)

Gary R. Bauchan, *USDA/ARS*; Gabriel Otero-Colina, *Colegio de Postgraduados*; Ronald Ochoa, *Beltsville Agricultural Research Center*; James Amrine, *West Virginia University*; John Hammond, *U.S .National Arboretum*; Ramon Jordan, *U.S. National Arboretum, USDA-ARS* and David Byrne*, *Texas A&M University (Poster Board #116)*

Abstract: A survey of roses from several states within the US was conducted to identify eriophyoid mite species associated with Rosa spp. Various microscopy techniques including bright field, phase contrast, differential interference contrast light microscopy, table top scanning electron microscopy and low temperature scanning electron microscopy were used. Three species of eriophyid mites were discovered, P. fructiphilus, Eriophyes eremus, and Callyntrotus schlechtendali. Phyllocoptes fructiphilus is the mite vector for an Emaravirus, Rose rosette virus (RRV), the causal agent of rose rosette disease (RRD). This mite was found primarily under the petioles (stipules), inside the flower sepals appressed to the ovary/seeds and on open leaves during the growing season. This mite often hides amongst dense simple and bulbous, glandular hairs (trichomes) or under stipules/petioles. Eriophyes eremus has been found under the stipules and is now recorded for the first time on the American continent. Callyntrotus schlechtendali was found on the open leaf surface. The latter two species were not associated to obvious plant injury. In addition, predatory mites that were found associated with these eriophyid mites may be useful as biological control agents.

Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches" 2014-51181-22644/SCRI

A Cost-Effective Technique for Counting Phyllocoptes Fructiphilus, an Eriophyid Mite Vector of the Rose Rosette Virus (poster)

Sara Collins, *University of Tennessee*; Katherine Solo, *University of Tennessee*; David Byrne*, *Texas A&M University*; Alan Windham, *University of Tennessee*; Frank Hale, *University of Tennessee*; Qunkang Cheng, *University of Tennessee* and Mark Windham, *University of Tennessee (Poster Board #117)*

Abstract: Rose rosette disease is vectored by the eriophyid mite, Phyllocoptes fructiphilus. Due to its small size, detecting and evaluating management strategies for P. fructiphilus on roses in nursery, commercial, public, and private settings is difficult. Methodology has been published for counting eriophyid mites in laboratory settings, but equipment costs (excess of $9,000 U.S. in some cases) prohibits many individuals from counting eriophyid mites on their roses. The objective of this study was to develop a simplified technique for eriophyid mite counts with readily

available materials and a combined cost $100 or less. An eriophyid mite counting kit was developed, that achieves this goal. Main kit components include: containers for sample transport, pollen sieves for mite isolation, and an inexpensive microscope for mite detection and population estimation. Also included is a handbook containing equipment descriptions, costs, and protocols for mite collection, extraction, and population estimation. Nineteen kits have been distributed to nursery owners, professionals who maintain rose gardens, and private garden owners. Each kit recipient was asked to fill out a survey on kit ease-of-use and results satisfaction for kit improvement. Distinguishing eriophyid mite population increases on rose plantings will aid nursery and landscape professionals as well as homeowners in scheduling miticide applications.

Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches" 2014-51181-22644/SCRI

A Survey of the Deep South for Rose Rosette Virus and Its Eriophyid Mite Vector (poster)

Katherine Solo, *University of Tennessee*; Sara Collins, *University of Tennessee*; Ronald Ochoa, *Beltsville Agricultural Research Center*; Gary R. Bauchan, *USDA/ARS*; Alan Henn, *Mississippi State University*; James Jacobi, *Alabama Cooperative Extension System*; Jean Williams-Woodward, *University of Georgia*; Reza Hajimorad, *University of Tennessee*; Frank Hale, *University of Tennessee*; John Wilkerson, *University of Tennessee*; Alan Windham, *University of Tennessee*; David Byrne*, *Texas A&M University* and Mark Windham, *University of Tennessee (Poster Board #118)*

Abstract: Across the United States, rose rosette disease has killed thousands of roses. The eriophyid mite, Phyllocoptes fructiphilus, vectors the causal agent, Rose Rosette Virus (RRV), for this disease. Parts of the southeastern United States have remained free of the disease, except for disease introductions that were eradicated. A survey of Alabama, Georgia, and Mississippi plots (n = 204) have revealed the southeastern border of RRV. The presence of RRV in symptomatic samples was confirmed by RT-PCR. Samples were also collected at each plot for detection of eriophyid mites, specifically for P. fructiphilus. These mites were identified through isolation, staining, and light microscopy. Mites were found to be generally distributed throughout the Deep South, however many of these sites contained eriophyid mites that were not P. fructiphilus. The reasons for the lack of RRV and low populations of P. fructiphilus in the southern regions are unknown.

Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches" 2014-51181-22644/SCRI

Effect of Iba, Number of Leaves per Node, and Number of Nodes per Cutting on the Propagation of *Abelia* 'Raspberry Profusion' (poster)

Leynar Leyton Naranjo*, *University of Georgia* and Carol Robacker, *University of Georgia, Georgia Campus (Poster Board #119)*

Abstract: *Abelia* is a woody shrub with outstanding landscape characteristics including rapid growth, adaptation to different types of soils, long flowering period, and disease, pest, and drought tolerance. Abelia has a wide variety of flower, sepal, and foliage colors. Despite the diversity of the genus, only a few species and cultivars are available commercially and these are mostly sports of *Abelia* x*grandiflora*. Abelia has always been described as an easy to propagate plant by cuttings, but low propagation rates from cuttings has been reported from growers in *A*. 'Raspberry Profusion', a hybrid of *A. '*Edward Goucher' x *A. chinensis*.

Three-node cuttings – with either two leaves per node or three leaves per nodes – were rooted in Fafard® 3B mix and dipped in 1000 or 3000 $mg \cdot L^{-1}$ powder Indole-3-butyric acid (IBA). Cuttings were placed under mist and evaluated after three weeks. Effect of leaf number, IBA concentration and the interaction between leaf number and IBA concentration were significant for root number and root length. The highest rooting percentage (100%), root number (37.3) and root length (8.7 mm) were obtained with 3000 $mg \cdot L^{-1}$ IBA on cuttings with three leaves per node.

The effect of leaf number per node was also evaluated on one-node and three-node cuttings dipped in 3000 $mg \cdot L^{-1}$ IBA. Leaf number per node and number of nodes per cutting significantly affected root number (*p*-values <0.001 and 0.020 respectively) and root length (*p*-values 0.013 and 0.026 respectively), but no interaction between number of leaves per node and number of nodes per cutting was observed. Root number was higher on three-nodes cuttings (28.2) and in three leaves per node cuttings (31.9). Root length was higher in one-node cuttings (10.3 mm) and in 3 leaves per node cuttings (10.5 mm), but one-node cuttings produced no shoots.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Plant Biotechnology 1 (Poster)

Gramene's Reference Genomes and Comparative Resource for Horticultural Species (poster)

Marcela Karey Tello-Ruiz*, *Cold Spring Harbor Laboratory*; Sharon Wei, *Cold Spring Harbor Laboratory*; Andrew Olson, *Cold Spring Harbor Laboratory*; Justin Preece, *Oregon State University*; Parul Gupta, *Oregon State University*; Joshua Stein, *Cold Spring Harbor Laboratory*; Sushma Naithani, *Oregon State University*; Yinping Jiao, *Cold Spring Harbor Laboratory*; Bo Wang, *Cold Spring Harbor Laboratory*; Sunita Kumari, *Cold Spring Harbor Laboratory*; Young Koung Lee, *Cold Spring Harbor Laboratory*; Vivek Kumar, *Cold Spring Harbor Laboratory*; Demitri Muna, *Cold Spring Harbor Laboratory*; Daniel Bolser, *Cold Spring Harbor Laboratory*; Peter D'Eustachio, *New York University School of Medicine*; Irene Papatheodorou, *EMBL-European Bioinformatics Institute*; Paul Kersey, *EMBL-European Bioinformatics Institute*; Pankaj Jaiswal, *Oregon State University* and Doreen Ware, *USDA ARS NEA Plant (Poster Board #290)*

Abstract: Gramene (http://www.gramene.org) is an integrated plant resource for reference genomes and comparative functional analysis in plants. Does your species have a reference assembly, transcript data or genetic variation data for entire populations? If so, these data sets may already be part of Gramene. The current Gramene release contains provides researchers with access to reference assemblies and annotation for 53 genomes (including peach, grape, banana, cocoa, cucumber, sugar beet, common bean, tomato, potato, cassava, yam, and Brassica crops) in a genome browser. In addition, we provide pathways views for 75 plants species including strawberry, orange, chili pepper, peas, and coffee, as well as the species listed above. Have you ever needed to know the function of the gene, and wanted to see the function of the ortholog in rice, maize or Arabidopsis? Does the gene you are working on belong to a large or small gene family. Did the gene family associated with expansion or contractions, in species that are evolutionary close? Is the biochemical pathway you work on conserved in sorghum and soybean? If so, Gramene can help you explore these questions in the Gramene. Gramene provides powerful phylogenetic approaches, including protein-based gene trees with stable IDs and whole-genome DNA alignments, enable traversing between plant species. We provide integrated search capabilities and interactive views to visualize gene features, gene neighborhoods, phylogenetic trees, genetic variation, gene expression profiles, pathways, and cross-references and host curated rice pathways, and uses these curated pathways to generate orthology-based projections for other species. Gramene builds upon Ensembl and Reactome software, and is committed to open accesses and reproducible science based on the FAIR principles, providing both human and machine access to the data. Gramene is supported by an NSF grant IOS-1127112, and from USDA-ARS (1907-21000-030-00D).

Specified Source(s) of Funding: NSF

Phloem Specific mRNA Isolation Using Translating Ribosome Affinity Purification (TRAP) in *Prunus Domestica* L. (poster)

Tamara D. Collum*, *University of Maryland*; Elizabeth Lutton, *Appalachian Fruit Research Station, USDA-ARS*; Doug Raines, *Appalachian Fruit Research Station, USDA-ARS*; Chris Dardick, *Appalachian Fruit Research Station, USDA-ARS* and James N. Culver, *University of Maryland (Poster Board #291)*

Abstract: In plants, the long-distance movement of photosynthates, defense compounds, and signals essential for plant growth and development occurs via the phloem vascular tissue. The phloem is also a key route for the spread of plant

pathogens. However, how phloem transport functions at the cellular and molecular levels has been a challenging question to address in part due to the technical difficulty of sampling phloem tissues. The phloem is a pressurized system, and disruption of this pressurized system as is done in many phloem sampling techniques can lead to damage and the introduction of components from neighboring cells. In this study, we adapted a new phloem specific sampling method, called translating ribosome affinity purification (TRAP), for use in plum trees (*Prunus domestica* L). An advantage of this approach is that it does not require disruption of the pressurized phloem system prior to mRNA harvesting. Using this method, we identified 1100 genes that were specifically active in the phloem and characterized their activities over the course of leaf development. We found that up regulated genes were involved in nutrient metabolism, defense responses, and reproduction. While down regulated genes were largely associated with DNA replication. The results reveal new insights into leaf and phloem development and establish TRAP as a powerful tool for studying tissue specific functions and responses in trees.

Specified Source(s) of Funding: USDA National Institute of Food and Agriculture, Plant-Associated Microbes and Plant-Microbe Interactions Program (2015–67013-23004) and the NSF Division of Integrative Organismal Systems (ISO-1644713)

Identification of Citrus Phloem Protoplasts By a Combination of Brightfield and Fluorescent Microscopy (poster)

Prabhjot Kaur, *University of Florida*; Pedro Gonzalez, *University of Florida*; Manjul Dutt, *University of Florida* and Ed Etxeberria*, *University of Florida (Poster Board #292)*

Abstract: Phloem-limited diseases, such as citrus greening (Hunaglongbing; HLB), are becoming increasingly pervasive, threatening the existence of crops around the world. Studies of phloem diseases are complicated by the inaccessibility of the phloem tissue. Phloem cells are located buried inside the plant body and are interspersed with other cell types. In addition, phloem cells are amongst the smallest cells in a plant kingdom and make up a small percent of the total cell population within a plant. Together these properties create a complex research challenge. Protoplasts should provide an alternative approach to the study of phloem cells in isolation, especially HLB studies, where the causing agent *Candidatus* Liberibacter asiaticus remains unculturable. However, crucial to this hypothesis is the ability to distinguish sieve elements (SE) and companion cells (CC) within a population of protoplasts. For this purpose, we aimed at developing a system to allow the distinction of SE and CC from the remaining cells. We present evidence that using a combination of Neutral Red (acidic compartments), Mito Tracker Green (mitochondria), Hoechst 3342 (nucleus) and chloroplast autofluorescence, allows for the identification of SE and CC protoplasts from citrus leaf tissue. Isolated SE and CC offer an additional approach to advance studies on HLB.

Recombinant Antibodies Targeting Key Bacterial Genes Significantly Reduces Titer of *Ca. Liberibacter Asiaticus* in ACP-Inoculated Carrizo Citrus Rootstock (poster)

Joseph A. Krystel*, *USDA-ARS*; Qingchun Shi, *USDA-ARS*; John Hartung, *USDA-ARS*; Huawei Liu, *USDA-ARS*; Ed Stover, *USDA-ARS* and David Hall, *USDA, ARS (Poster Board #293)*

Abstract: *Candidatus Liberibacter asiaticus* (CLas) is the associated agent of Huanglongbing (HLB), the most serious and impactful disease of citrus worldwide. In previous work, we identified a population of antigen-binding fragments that interact with two CLas proteins that were predicted to play a vital role in the infection process. These proteins are homologs of the virulence gene InvA facilitating bacterial invasion of tissue layers and TolC which mediates removal of toxins from the bacterial cell. These antigen-binding fragments were transformed into Carrizo citrange under control of a modified 2x35s promoter. Confirmed transgenic plants were subjected to infestation and subsequent bacterial infection by CLas carrying Asian Citrus Psyllids (ACP), the insect vector of HLB. Bacterial titer was measured over a nine month period. Transgenic plants showed significantly reduced bacterial titers as measured by quantitative PCR analysis. Expression of the antigen-binding fragments resulted in average reductions in bacterial titer by 8.5 Ct (99.8 %) for InvA and 6 Ct (99%) for TolC targets. Transgenic populations also showed a much higher proportion of plants with non-detected CLas when compared to wild type controls, and these were not included in the statistical analysis. Transgenic plants expressing five additional antigen-binding fragments are currently undergoing ACP inoculation. Transgenic rootstocks are also being grafted with wild type scions for greenhouse and field testing of HLB-resistance.

Specified Source(s) of Funding: Citrus Research and Development Foundation

Metabolic Variations between Grapefruit Cybrid Plants and Their Respective Parents (poster)

Ahmad A. Omar*, *University of Florida*; Mayara M. Murata, *University of Florida*; James H. Graham, *University of Florida* and Jude Grosser, *University of Florida (Poster Board #294)*

Abstract: Several grapefruit cybrid plants were developed through the fusion of protoplast from cell suspension of citrus canker highly resistant 'Meiwa' kumquat and mesophyll protoplast of three selections of highly susceptible grapefruit. Plants recovered from all three combinations displayed the typical grapefruit phenotype and were all validated to be somatic cybrids. For disease resistance screening, most of the regenerated cybrid clones were evaluated by pressure infiltration inoculation of *Xanthomonas citri* subsp. citri (Xcc) suspension of attached leaves. Quantification of Xcc bacterial populations *in planta* was assessed. Cybrid clones showed a range of citrus canker resistance, but all grapefruit cybrids with a kumquat chloroplast had a significantly lower number of lesions and Xcc population compared to grapefruit controls. However, cybrid clones with grapefruit chloroplast had a significantly higher number of lesions compared to clones with kumquat chloroplast. These cybrids have the potential to provide a high level of citrus canker resistance in commercial grapefruit orchards, as well as, act as a valuable model for understanding the contribution of chloroplast to plant disease resistance. To understand the cytoplasmic/nuclear interaction in the regenerated grapefruit plants, the preliminary metabolic comparison between 'Marsh; grapefruit cybrid and parents plants was initiated. ^{1}H NMR spectroscopy approaches are used to provide snapshots of the plant sample composition, and to evaluate the metabolic profile in cybrid and parents plants. Metabolite concentrations from leaves of 'Marsh' grapefruit plant were higher than 'Meiwa' kumquat and cybrid plant, including many amino acids such as isoleucine, tyrosine, alanine, proline, proline betaine, and leucine. The cybrid plant seems to contain an intermediate concentration of all the measured components compared to the parent plants. Proline, Proline betaine, carbohydrates, glutamine, and unidentified glucose product seems to present in a high amount in all the tested plants. Except for proline betaine, most of the top significant chemical shifts that give differences between the three plants are present in carbohydrate regions. These preliminary results about the metabolic profile of grapefruit cybrid plants and their respective parents provides a very useful information for designing a large-scale experiment to understand the natural mechanism of plant defense to create new varieties and/or genetically modified genotypes for tolerance/resistance against citrus canker and/or HLB (Huanglongbing or citrus greening).

Regeneration of *Cornus Florida* (Flowering Dogwood) Plants from Somatic Embryos (poster)

Heather Gladfelter*, *Univ of Georgia* and Dayton Wilde, *University of Georgia (Poster Board #295)*

Abstract: *Cornus florida* (flowering dogwood) is a small tree native to eastern North America that is commonly planted as an ornamental because of its showy bracts and fall color. Its genome has been sequenced, providing information that could be useful for improving horticultural traits like disease resistance. We investigated somatic embryogenesis (SE) as a potential platform for *C. florida* transformation and gene editing. The induction of SE cultures from immature zygotic embryos of *C. florida* was reported by Trigiano et al. (1989), but plants beyond the first true leaf stage were not recovered. In prior studies in our lab, we identified the *C. florida* genotypes and basal medium (WPM) that gave the best SE response from immature zygotic embryos. In the current study, 160 zygotic embryos from the most responsive parent tree were cultured on WPM containing either an auxin analog or no auxin. Zygotic embryos were exposed to eight media treatments (5 embryos/treatment) at four timepoints (globular to

early cotyledon stage). We obtained embryogenic lines from explants exposed to IBA (0.1 mg/L), picloram (0.1 mg/L), 2,4-D (2 mg/L), or no auxin. Overall, the SE response rate was 6.9%, with over half of the embryogenic lines originating, surprisingly, on auxin-free medium. For plant development, somatic embryos were transferred to G-7 boxes containing auxin-free WPM supplemented with 0.25 mg/L activated charcoal. To date, 65.4% of the somatic embryos have germinated and 26.9% have developed beyond the first true leaf stage. The effect of a four-week cold treatment (4C) on somatic embryo conversion is being evaluated. Regenerated *C. florida* plants will be transferred to soil and acclimated to greenhouse conditions.

In Vitro Plant Regeneration of Red Raspberry (*Rubus idaeus*) Cultivar 'Joan J' (poster)

Changhyeon Kim*, *North Dakota State University* and Wenhao Dai, *North Dakota State University (Poster Board #296)*

Abstract: Plants were regenerated from in vitro tissues of red raspberry cultivar 'Joan J'. The effects of plant growth regulator (PGR), explant type, and explant age on shoot regeneration were investigated. In vitro leaf segments and petioles were inoculated in woody plant medium (WPM) with 200 mg/l *polyvinylpyrrolidone* (PVP) and various combinations of 6-*Benzylaminopurine* (BA) and/or thidiazuron (TDZ). Results showed that the highest regeneration rates were 70% and 38% when the 7-day-old leaf segment and petiole were inoculated on WPM with 2.5 µM BA and 1.0 µM TDZ, respectively. The explant at the age of 7-day-old showed higher ability to shoot regeneration than that of the 14 or 28-day-old explants. Regenerated shoots are being rooted both in vitro and ex vitro. The in vitro rooting will be carried out in 1/2 Murashige and Skoog (MS) medium with 5 µM 1-naphthaleneacetic acid (NAA), 10 µM NAA, 5 µM indole-3-butyric acid (IBA), 10 µM IBA, and the no-auxin control. The ex vitro rooting will be conducted by dipping cuttings in a solution of 500 µM NAA, 500 µM IBA or water, then inserted to potting mix. The rooting percentage, the root number, root length per responsive cutting, survival rate in greenhouse will be determined.

Elevated Auxin Content in Rootstock Improves the Rooting Performance and Graft Success Rate in Micro-Grafting (poster)

Longmei Zhai*, *University of Connecticut*; Wei Li, *University of Connecticut*; Richard McAvoy, *University of Connecticut* and Yi Li, *University of Connecticut (Poster Board #297)*

Abstract: Micro-grafting, an increasingly popular method, involves grafting an aseptic scion onto an in vitro-grown rootstock. Success of micro-grafting is largely depended on firm contact between rootstock and scion at the graft junction, which will assist the callus formation. Micro-grafting procedures are difficult due to the fact of handling difficulties associated with preserving the delicate graft unions. In this study, we used a root-predominant gene promoter (SbUGT) to drive the expression of a tryptophan-2-mono oxygenase gene (iaaM) from Agrobacterium tumafaciens to increase auxin levels in tobacco rootstock. Our results have showed that over-expression of the iaaM gene in rootstock enhance vascular formation in stem tissues. In our micro-grafting experiments, we have observed that grafting joints using the SbUGT::iaaM rootstock are tighter in junctions than the wild type plant rootstock, and therefore higher success rate of micro-grafting are observed. Also, compared with wild type plant rootstock, we have observed that the stem cuttings of SbUGT::iaaM rootstock plants can root quicker. Furthermore, the expression of iaaM gene in rootstock suppresses their lateral bud releases while growth of scions is not affected. Thus, the SbUGT::iaaM gene may be a useful tool for improving rootstock and subsequently enhancing success rates of micro-grafting for many crop plant species.

Specified Source(s) of Funding: USDA-NIFA BRAG (2010-33522-21697), CRDF (Project 16-001) and USDA Hatch Grant to YL

Molecular Characterization Based on RNA-Seq of Ovaries at Different Developing Stages after Self-Pollination in Chinese Chestnut (*Castanea mollissima*) (poster)

Feng Zou, *Central South University of Forestry and Technology*; Huan Xiong, *Central South University of Forestry and Technology*; De-yi Yuan, *Central South University of Forestry and Technology*; Lin Zhang, *Central South University of Forestry and Technology*; Genhua Niu*, *Texas A&M AgriLife Research Center at El Paso, Texas A&M University* and Su-juan Guo, *Beijing Forestry University (Poster Board #298)*

Abstract: Chinese chestnut (*Castanea mollissima* Blume.), native to China, has been cultivated as an economically important fruit tree species for thousands of years. Chinese chestnut was found to display late-acting self-incompatibility (LSI), resulting in low fruit bearing percentage and yield. During the LSI process in chestnut, self pollen tubes are hampered in the ovaries instead of styles. To understand molecular character on LSI, transcriptome analysis were conducted on ovaries at four different stages after pollination. A total of 75,554 unigenes were assembled, of which 11,677 unigenes were annotated KOG database covering 26 categories. Genen Ontology (GO) enrichment analysis revealed that many genes involved in metabolic processes, cell part, binding, and catalytic activity. Among them, a number of self-incompatibility-related genes were identified including S-locus-specific glycoprotein S13 precursor, S-locus lectin protein kinase family protein, S-locus-specific glycoprotein S6, calcium-binding protein CML17, and 24 calcium-dependent protein kinase. Compared to 15 days and 30 days after pollination, we screened a total of 285 differentially expressed genes, of which there were 175 genes showed up-regulated and 110 genes down-regulated. Most of the genes participated in catalytic activity, transferase activity, hydrolase activity and nucleotide−sugar metabolic process. The results of study will help fully understand the mechanism of the chestnut LSI and provide useful information for breeding projects.

Specified Source(s) of Funding: the National Natural Science Foundation of China (No.31500554).

Single Molecule Real Time Transcript Sequencing Unveiled Flowering Regulatory Genes in *Crocus sativus* (poster)

Liqin Li, *Huzhou Central Hospital, Zhejiang University*; Xiaodong Qian, *Huzhou Central Hospital, Zhejiang University*; Guifang Zhou, *Zhejiang University of Traditional Chinese Medicine*; Chong Yao, *Huzhou Central Hospital, Zhejiang University* and Youping Sun*, *Department of Plants, Soils, and Climate, Utah State University (Poster Board #299)*

Abstract: *Crocus sativus* (saffron) is prized for purple flower that is well-known for producing spice saffron, a most valuable spice with medicinal uses in gynaecopathia and nervous system diseases. Single molecule real time (SMRT) sequencing is a newly developed technology that can generate kilobase-sized sequence reads. Unveiling flowering regulatory genes using SMRT sequencing is important to breed superior cultivars with increase flower numbers, thus resulting in high saffron yield. Two full length transcriptomes of flowering saffron and non-flowering saffron were established using SMRT sequencing separately. The bulb buds, pistils, stamens, petals and leaves of flowering saffron and terminal buds, lateral buds, leaves of non-flowering saffron were used. Meanwhile, higher-accuracy short-read sequencing of terminal and lateral buds of both flowering and non-flowering saffron and small terminal buds (< 6 g) of non-flowering saffron was obtained separately using next generation sequencing (NGS) method.

Sixteen SMRT cells were detected, and 22.85 G data was acquired from the PacBio RS II panel. Flowering and non-flowering saffron had 394,653 and 252,850 high quality full-length transcripts, respectively. A total of 75,351 full-length saffron unigenes were generated. Function annotation showed that 64,562 (85.7%) full-length unigenes were annotated against databases of Cluster of Orthologous Group(COG), Swiss Prot, Non redundant(NR), Gene Ontology (GO) and Kyoto Encyclopedia of Genes and Genomes (KEGG), and 50,197 coding DNA sequences (CDS) were predicted with an average length of 1081 bp. Alternative splicing (AS) was detected in 72,148 unigenes with 1 to 217 AS events, among which 42 and 28 AS events existed in flowering and non-flowering saffron gene pool, respectively. In addition to long noncoding RNAs (lncRNAs), single-nucleotide polymorphism (SNP) and simple sequence repeats (SSR) in flowering or non-flowering saffron were obtained. A total of 478 full-length differentially expressed genes between flowering terminal buds and non-flowering terminal buds, 74 genes between flowering lateral buds and non-flowering lateral buds, and 1,247 genes between non-flowering small terminal buds and flowering terminal buds was acquired. At least 14 genes were closely related with flowering

phenotype using real-time RT-PCR method. Further validation of AS, lncRNAs, SNP, and SSR is needed for flowering and non-flowering saffron.

Specified Source(s) of Funding: National Natural Science foundation of China (No.31600255)

12:15 PM – 1:00 PM *International Ballroom East/Center*

Pomology 2 (Poster)

Physiological Response of 'honeycrisp' Apple to Water Deficit (poster)

Michelle Reid*, *Washington State University* and Lee Kalcsits, *Washington State University (Poster Board #425)*

Abstract: 'Honeycrisp' has rapidly increased in production in Washington State over the last 20 years. This cultivar is predisposed to develop bitter pit during storage and produces oversized fruit. Previous work has identified a link between plant water status, fruit size, and bitter pit when crop load was controlled indicating that irrigation could be used as a tool to control fruit size and bitter pit. However, accurate indicators of the physiological water status of 'Honeycrisp' need to be developed. Currently, there is little known about how 'Honeycrisp' responds to developmentally-timed water limitations. Here, three-year-old 'Honeycrisp' were subject to four different irrigation treatments where soil moisture was reduced to approximately 30-40% of field capacity for 30-day increments. Early water limitations were imposed from 15-45 days after full bloom (DAFB), mid-season water limitations were imposed from 45-75 DAFB, and late-season water limitations were imposed from 75-105 DAFB. The well-watered control was maintained at 80-90% of field capacity for the entire season. Physiological measurements were made every 15 days from 30 to 105 DAFB. Measurements included leaf gas exchange, plant water status, stomatal conductance, chlorophyll fluorescence, and leaf reflectance to assess how 'Honeycrisp' apple responded to water limitations. At the end of the season, vegetative growth and return bloom was measured to assess the impact of water deficits on growth and productivity. Stomatal conductance was significantly influenced by irrigation deficit. During the early water limitation, stomatal conductance was nearly 40% and 70% lower during middle and late-season water limitations compared to the control. Photosynthesis was approximately 50% lower during all water limited periods compared to the control. Stem water potential was also influenced by deficit irrigation and decreased by 30-50% throughout the growing season and were -1.69 MPa, -2.33 MPa, and -2.70 MPa at the end of the early, middle, and late-season water limitations, respectively, compared to -1.23 MPa for the well-watered control. Stem water potential and stomatal conductance were the most responsive during water limitations carried out later during the growing season when temperatures and vapor pressure deficit (VPD) were greater. Early season water limitations have a lower impact on plant response to abiotic stress compared to late-season deficits. Stem water potential, an integrator of soil moisture availability and water demand, and stomatal conductance measurements have the potential to guide in the making of irrigation decisions for fruit size control in 'Honeycrisp' apple to better meet market targets and reduce bitter pit.

Specified Source(s) of Funding: Washington State Tree Fruit Research Commission

Analysis of the Diversity of Flavor Compounds Present in a Collection of Appalachian Cider Apple Varieties (poster)

Michael Gutensohn*, *West Virginia University*; Mirjana Bulatovic-Danilovich, *West Virginia University* and Matthew A. Jenks, *West Virginia University (Poster Board #426)*

Abstract: **The cultivation and production of apples has a long history and significant economic impact in West Virginia and the Appalachian region. However, it is notable that total apple production in West Virginia, in particular of table and sauce apples, has declined steadily in the last decades. In contrast, the hard cider industry is growing rapidly nationally as well as in West Virginia and its neighboring states. Although hard ciders were among the most popular and common alcoholic beverages in colonial America, the recent renaissance in craft cider in the US has led to a dramatic increase in the demand for cider apples, and also revealed a lack of information available to assist cider apple growers and the cider industry. Cider apple varieties are distinctively different from table and sauce apples, typically possessing high polyphenol and/or acid content, as well as other unique flavors. The supply of locally grown cider apples is momentarily often quite limited, and the selection of the best blend of cider apple varieties and a sufficient supply of these cider apples is one of the biggest challenges to expanding the cider industry in West Virginia and the Appalachian region, as well as nationally. The formation and different content of malic acid (responsible for sharpness) and polyphenols (responsible for bitterness), two important sensory characteristics of cider, have been analyzed extensively in an array of cider apple varieties. However, the blend and diversity of flavor compounds, also know as volatile organic compounds, found in apple varieties with potential for hard cider production has not been studied in detail yet. We will present first results from our analysis of flavor compounds in fruits and juice from a collection of cider apple varieties found in the Appalachian region.**

Ecophysiological Adaptation of *Malus Domestica* Borkh Cv. 'Honeycrisp' Grown Under Photoselective Protective Netting (poster)

Giverson Mupambi*, *Washington State University* and Lee Kalcsits, *Washington State University (Poster Board #427)*

Abstract: Apple production in Washington State (WA) occurs under semi-arid climate characterized by high temperatures and solar radiation. As a result, apple growers in WA are increasingly turning towards photoselective protective netting (PN) to reduce the occurrence of sunburn in apple fruit and reduce tree stress. Previous studies on the ecophysiological response of apple tree under netting have just looked at response under PN on short time scales, but not the entire growing season. Our goal was to understand the ecophysiological response of apple tree under PN over the growing season. The experiment was carried out in a fourth leaf 'Honeycrisp' apple commercial orchard on B9 rootstock at Quincy, WA. Measurements were done at 32, 66, 100 and 132 days after full bloom (DAFB). Four treatments were evaluated; an uncovered control, 22% blue, 22% red and 19% pearl PN. Leaf gas exchange measurements were done between 08:00 and 11:00 Pacific Standard Time (PST) before midday depression, whilst leaf spectral reflectance, chlorophyll fluorescence and plant water status were measured between 12:00 and 14:00 PST. Data was analyzed using a two-way analysis of variance with PN treatments and time (DAFB) as factors. There was a signification interaction between PN treatments and time for maximum photochemical efficiency of PSII (F_v/F_m). There were no significant differences between treatments in F_v/F_m at 32, 66 and 100 DAFB. Later in the season at 132 DAFB, F_v/F_m was significantly lower for uncovered trees (0.68) compared to PN treatments and had fallen below the threshold of a healthy leaf (0.79). Quantum photosynthetic yield of PSII had significant effects for PN treatments, it was higher under PN treatments compared to the uncovered control. PN treatment also affected leaf gas exchange. Net carbon assimilation was greater under 22% blue and 19% pearl PN compared to the control. The 22% red PN was not significantly different from the control. Stomatal conductance and leaf transpiration followed the same trend as net carbon assimilation. Midday stem water potentials showed a significant effect for time, it was more negative at 66 and 100 DAFB compared to 32 and 132 DAFB. The reduction in solar radiation stress under protective netting increased light-use efficiency over the growing season. This resulted in improved leaf gas exchange under 22% blue and 19% pearl PN. PN is as a potential tool to alleviate tree stress in apple under high light conditions in WA.

Specified Source(s) of Funding: Washington State Department of Agriculture Specialty Crop Block Grant (K1771) and the Washington Tree Fruit Research Commission

S-Genotyping in *Malus* to Determine Cross-Compatibility of New Candidate Pollinizers (poster)

Ryan Sheick*, *Washington State University*; Sara Serra, *Washington State University* and Stefano Musacchi, *Washington State University (Poster Board #428)*

Abstract: Apple (*Malus* × *domestica* Borkh.) exhibits gametophytic self-incompatibility (GSI), which necessitates cross-pollination to achieve desired fruit and seed set in commercial orchards. The GSI mechanism is controlled by the multi-allelic *S* locus which harbors genes encoding pollen- and pistil-part determinants. In the pistil, S-RNases are expressed and are cytotoxic to incompatible pollen carrying *S* alleles identical to the seed parent, whereas pollen carrying *S* alleles differing from a seed parent are able to detoxify the S-RNases and inhibit degradation. Because the apple industry relies on consistent pollen viability it is imperative that pollinizer varieties produce cross-compatible pollen. In this study, the *S-RNase* gene was used as a target to determine the *S*-genotypes of over 30 crabapple varieties currently under evaluation for use as apple pollinizers. Polymerase chain reaction (PCR) methods using allele-specific primers in combination with consensus PCR and restriction fragment length polymorphism (RFLP) methods were used to determine *S*-haplotypes. Novel *S-RNase* sequences were characterized and submitted to the National Center for Biotechnology Information GenBank database, and molecular identification methods were developed. The results of this work serve to inform pollinizer-cultivar compatibility, and the methods developed aim to supplement future *S*-genotyping work.

Specified Source(s) of Funding: United States Department of Agriculture Technical Assistance for Specialty Crops program, Agreement # 2014-17 activity code: T14RXTSC01

Utilizing UV-Vis Spectroscopy to Estimate Pollen Density in Suspensions (poster)

Stefan Roeder*, *Washington State University*; Sara Serra, *Washington State University* and Stefano Musacchi, *Washington State University (Poster Board #429)*

Abstract: *In vitro* pollen germination and viability assays are commonly used to assess pollen quality. Two of the most frequently used germination methods are the hanging drop technique and the use of agar plates. Different authors have reported a significant effect of pollen density on pollen germination. Therefore, the pollen concentration must be standardized between different samples when performing germination tests. A fast, reliable and possibly non-destructive method is needed, since pollen grains can start germination as soon as five minutes after being mixed with germination media.

Stored pollen (-20 °C) from five apple cultivars ('Gala', 'Granny Smith', 'Honeycrisp', 'Red Delicious' and 'Rome Beauty') were used for this experiment. A stock solution for each cultivar was created by suspending 0.5 grams of pollen in 20 ml pollen germination media (10 g L^{-1} sucrose, 40 mg L^{-1} boric acid). A serial dilution with three replicates for each cultivar stock was created (0, 25, 50, 75, 100 %). The absorbance (optical density) between 400 and 700 nm (1 nm intervals, scan speed 600 nm min^{-1}) was measured using a spectrophotometer (Cary 60 UV-Vis, Agilent Technologies). A hemocytometer was used to count the number of pollen grains of the dilutions.

The cultivar specific regression models showed a coefficient of determination of 0.98, 0.98, 0.96, 0.98, 0.98 for 'Gala', 'Granny Smith', 'Honeycrisp', 'Red Delicious' and 'Rome Beauty', respectively. The R-squared value decreased slightly when using a general regression model that includes all five cultivars (R^2 = 0.89). The decreases could be explained by variations in pollen grain size between cultivars. Every tested wavelength was suitable to estimate the optical density of pollen solutions.

There are two applications for the described method. Optical Density ($OD_{400 - 700}$) can be used to adjust pollen concentration in suspension. Using a spectrophotometer is a fast, reliable and non-destructive approach that can be integrated with *in vitro* germination and viability assays. Furthermore, this method would allow for estimation of the pollen yield of different pollinizers. A standard method for quantifying pollen yield is the use of a hemocytometer. However, this method can be time consuming when screening large populations. Cultivar specific OD models are necessary when the variation in pollen grain size becomes too large.

Specified Source(s) of Funding: United States Department of Agriculture Technical Assistance for Specialty Crops program, Agreement # 2014-17 activity code: T14RXTSC01

Air Root Pruning Containers Alter Root Architecture and Increase Canopy and Root Growth of Apple Trees Compared to Field Grown Liners (poster)

Mokhles ELsysy*, *Michigan State University* and Todd Einhorn, *Michigan State University (Poster Board #430)*

Abstract: Trees account for the majority of expenses when establishing high-density plantings. The vast proportion of nursery trees are produced in the field and shipped bare-root. These trees are prone to transplant-shock and may require additional time to fill orchard space. The objectives of this project were to 1) compare two nursery production systems (air root-pruning containers and field-produced liners [i.e., bare-root trees]) on the growth and development of above-ground and below-ground organs of apple trees during the formative 'nursery' year and, 2) correlate these parameters with canopy growth and fruiting during the establishment years in the orchard. We hypothesized that container-produced trees would possess higher-quality root systems that mitigate transplant-shock and result in rapid canopy infill to expedite orchard return on investment.

This experiment was conducted in 2017 at the Michigan State University Horticulture Teaching and Research Center. Three apple cultivars 'Gala', 'Fuji', and 'Honeycrisp' were bench-grafted to M9 Nic29 rootstock and divided into two production systems: Ellepot containers and field liners. Entire plants were carefully harvested from each production system several times throughout the season. Leaf area, average leaf size, trunk cross-sectional and total above-ground dry matter were quantified. Whole root systems were scanned to determine root growth and architecture (size classes) then dried (dry matter). Growth of Ellepot-produced trees was more uniform and total leaf area, average leaf size, and seasonal above ground dry matter were significantly ($P < 0.05$) greater than field grown trees, irrespective of scion. Root morphology differed drastically between the two systems. Ellepot-produced trees had markedly higher fine root production and greater root length density compared to field liners. In spring 2018, container and bare-root trees were established in an orchard. Root and canopy development are being monitored throughout the season.

Effects of Leader Bagging, 6-Benzyladenine (6-BA), and GA_{4+7} Plus 6-BA on Lateral Branching of 3rd Leaf 'Gala' Apple (poster)

Thomas M. Kon*, *North Carolina State University* and Christopher D. Clavet, *NC State University (Poster Board #431)*

Abstract: Inadequate lateral branch development can have negative consequences on apple orchard productivity and profitability, particularly in high-density orchard systems. While plant growth regulator applications are generally utilized to increase lateral branching on leaders of young apple trees (1st and 2nd leaf), inconsistent responses were observed on older trees in the southeastern United States. In 2017, an experiment was initiated to identify effective leader management strategies on 3rd leaf 'Gala'/'M.9' apple trees at a commercial orchard in Edneyville, NC. Ninety-six uniform trees were selected and treatments were assigned to single-tree plots in a completely randomized design. The experiment had a factorial treatment structure with eight replicates. Effects of leader bagging (bagged or unbagged), 6-benzyladenine (6-BA; applied at green tip, silver tip, or untreated), and 6-BA + GA_{4+7} (treated or untreated) on lateral branch development of one year-old leaders were evaluated. Leader bagging occurred at the silver tip stage of bud development. Bagged leaders were enclosed in a 96.5 x 15.2 cm section of 4-mil polyethylene tubing and secured using clothespins. Bags were removed once lateral branches were ~ 3 cm long. Where appropriate, 6-BA was applied at 500 $mg \cdot L^{-1}$ and 6-BA + GA_{4+7} was applied at 250 $mg \cdot L^{-1}$ + 0.2% (v:v) non-ionic surfactant when lateral branches were 3 to 5 cm long. During dormancy, the number and length of lateral branches on the treated section of leader and terminal shoot length was determined. Analysis of variance was used to test main effects and interactions. When compared to unbagged trees, leader bagging increased lateral branch number (17%), average branch length (25%), and total linear bearing surface (43%) of the treated section of leader. 6-BA + GA_{4+7} increased average branch length (17%), but had no effect on branch number or total linear bearing surface. Measured responses were not influenced by 6-BA or interactions between factors. Terminal shoot length was not

influenced by any factor. Leader bagging was effective in increasing lateral branch number, length, and total linear bearing surface, but this procedure was labor intensive. 6-BA did not influence lateral branch number or length at the application timings evaluated, but 6-BA + GA_{4+7} increased average branch length. Future efforts will focus on productivity and profitability of leader management strategies and characterizing the localized environment of bagged leaders.

Climate Cues of Alternate Bearing in Commercial Apple Orchards across South Korea (poster)

Jung Gun Cho, *Colorado State University*; Arne Buechling, *University of Denver*; Patrick H. Martin, *University of Denver*; Hyun-Hee Han, *Rural Development Administration* and Hee Ju Lee*, *Vegetable Science Division, National Institute Horticultrual & Herbal Science (Poster Board #432)*

Abstract: The causes of alternate bearing (AB) in apple (*Malus domestica* Borkh.) trees has been widely studied because stable production is a priority for commercial orchards. Although individual orchards are intensively managed, we still observe irregular, inter-annual flowering and harvest. At a national scale, irregular bearing or variation in year to year crop sizes leads to price instability in markets in South Korea. High and low yields are geographically and temporally synchronized across the country. Thus, we hypothesized AB in apple trees is related to climate even though orchards are intensively managed by growers. To evaluate our assumption, we used a large industrial data set collected across the country for natural disaster insurance by the NongHyup Property & Casualty Insurance from 2007 to 2014 in South Korea. We evaluated the relationships between the number of fruit set and seasonal climate over a 3 year period, including the current fruiting year and the previous 2 years. Annual fruit count per tree was recorded between late June and July after fruit thinning and natural June drop. A total of 3990, 884, and 665 orchard blocks were sampled for the country's main cultivars, 'Fuji', 'Hongro', and 'Tsugaru', respectively. Seasonal temperatures and precipitations were generated for each orchard using spatial interpolation of 88 weather stations managed by the Korea Meteorological Administration. We used nonlinear regression models in a likelihood framework to evaluate relationships between fruit production and seasonal climate effects. We controlled for management effects first. Models with only orchard planting system explained about 44%, 38%, and 31% of the fruit count per tree in 'Fuji', 'Hongro', and 'Tsugaru', respectively, and best models including climate variables and tree age improved up to approximately 48%, 42%, and 36% respectively. High spring temperature in the bud initiation season, a year prior to the fruiting year, was associated with high fruit production in all cultivars. Effects of winter temperature during bud dormancy varied depending on cultivar; low winter temperature was positively related to fruit output in 'Fuji' and 'Hongro', but negatively associated with crop size in 'Tsugaru'. Precipitation in the growing season of the previous year constrained fruit output in 'Fuji' and 'Tsugaru'. Low fall precipitation two years prior to the fruiting year increased fruit production in 'Fuji', but did not influence 'Hongro' and 'Tsugaru'. We anticipate that apple production in the future may be altered in the face of changing climate regimes.

Specified Source(s) of Funding: RDA

Use a Natural Mutant Yeast Strain and Transcriptomics Analysis Reveal Genes That Influence Occurrence of Hydrogen Sulfite in Cider Fermentation Under Different Levels of Yeast Assimilable Nitrogen (poster)

Yangbo Song*, *Cornell University*; Gregory Peck, *Cornell University*; Lailiang Cheng, *Cornell University* and Shuwen Liu, *Northwest A&F University (Poster Board #433)*

Abstract: Apple (*Malus xdomestica* Borkh.) juice typically contains low concentrations of yeast assimilible nitrogen (YAN). During fermentation, this can cause yeast (*Saccharomyces cerevisiae*) cells to produce the sulfur containing amino acids, methionine and cysteine, a reaction that reduces sulfate to hydrogen sulfide (H_2S). When H_2S is produced in excess, it is considered a sensory fault as this compound is associated with a "rotten egg" smell. The goal of this research was to determine the effect of YAN concentration, as adjusted with diammonium phosphate to low (86 mg·L^{-1}), intermediate (208 mg·L^{-1}), and high (433 mg·L^{-1}) concentrations, on yeast H_2S production and yeast gene expression during apple cider fermentation. Each YAN treatment was fermented in quadruplicate with UCD932 (a strain with a natural mutation in the *MET10* gene and therefore produces no H_2S) and UCD522 (a commercially available strain known to produce relatively high H_2S concentrations). The same base apple juice was used for all treatments and all other fermentation conditions [e.g., temperature, physical agitation, and potassium metabisulphite (160 mg·L^{-1}) additions] were kept constant. All fermentations fully metabolized the available sugar. For both UCD932 and UCD522, the intermediate YAN concentration resulted in faster fermentation rates than the low or high YAN concentrations. Under the intermediate YAN concentration, the fermentation rate of UCD932 was 34% greater than that of UCD522. The fermentation rates showed the maximum difference at a YAN concentration of 208 mg/L. The fermentation rates showed the minimum difference at 86mg/L. The fermentation rates of UCD522 and UCD932 were similar. At these three different YAN concentrations, there were significant differences in H_2S production with UCD522. Under the medium YAN concentration, UCD522 produced 2 and 6 times greater H_2S than those under the low and high YAN concentration, respectively. Total RNA was extracted from yeast cells sampled at the initial phase of fermentation and at the peak of H_2S production using a hot phenol method. RNA samples were prepared as biological triplicates and for RNA-Seq Library sequencing using standard Illumina protocols. Further data analyses will include RNA-Seq, HPLC, and microarrays, as well as bioinformatics data analyses (Tophat v2.0.8b, PCA, MFA). Our results will identify the yeast genes associated with H_2S production in cider fermentation and ultimately reduce the production of ciders with a rotten egg smell.

Specified Source(s) of Funding: Cornell SIPS-Horticulture Section & Chinese Scholar Council Fellowship & National Natural Science Fund Program of China

Chemical Blossom Thinning of Apple in New York Utilizing the Pollen Tube Growth Model (poster)

Peter C. Herzeelle*, *Cornell University*; Gregory Peck, *Cornell University* and Terence Robinson, *Cornell University (Poster Board #434)*

Abstract: The Pollen Tube Growth Model (PTGM) developed at Virginia Tech is a more precise method of monitoring the time required for 'king' bloom fertilization of apple (*Malus xdomesitca* Borkh.) cultivars to occur, providing growers with greater precision in chemical thinning applications for crop load management. In New York, the PTGM can be integrated into management practices to facilitate earlier crop load reduction, which has been shown to increase fruit size and return bloom for biennial varieties, resulting in consistent, high quality production. Commercially available bloom thinning chemicals were tested in 2017 with applications occurring in accordance with the PTGM. Our objective was to determine the optimum application materials that provide an effective reduction in crop load comparable to the industry standard in New York, while attempting to minimize adverse side effects. Treatments included two caustic materials: the biofungicide Regalia (Marrone Bio Innovations, Davis, CA), liquid lime-sulfur (Miller Chemical & Fertilizer, Hanover, PA), two plant growth regulators: naphthalene acetamide (AMVAC Chemical Corporation, Los Angeles, CA), 6-benzyladenine (Valent Biosciences, Libertyville, IL), a hand-thinned treatment, and an untreated control (UTC). Average style length was determined for 'Smoothee' Golden Delicious and 'Rising Sun' Fuji on M9-Nic29 rootstock by collecting 50 king flowers from each cultivar. The PTGM was started once the desired number of king blossoms were open. Pollen tube growth rates were calculated using weather data from a nearby weather station. The first treatments were applied once pollen tube growth reached 75% of the style length, eight days after initiating the model. The second treatments were applied when pollen tube growth reached 85% of style length in order to prevent the setting of fruit in lateral blossoms. The Regalia, LLS, and hand-thinned treatments significantly reduced crop load in both cultivars compared with the UTC. The same treatments in Fuji yielded significant increases in fruit weight, size, length, and percent red color compared with the UTC, but only fruit length was increased in Golden. There were no differences in fruit finish (russetting) with any of the treatments, which is a main risk with bloom thinning of apple. Return bloom will be assessed in Spring 2018. This experiment will be repeated in 2018 to assess year-to-year variability.

Specified Source(s) of Funding: Apple Research and Development Program

Cost-Benefit Analysis of DNA-Informed Apple Breeding (poster)

Seth Wannemuehler*, *University of Minnesota*; Chengyan Yue, *University of Minnesota*; James Luby, *University of Minnesota*; R. Karina Gallardo, *WSU - Puyallup Research and Extension Center* and Vicki A. McCracken, *Washington State University (Poster Board #435)*

Abstract: DNA-informed breeding techniques allow breeders to more quickly select and breed crops with desired traits and genes as compared to conventional breeding methods. Incorporation of this technology requires additional costs for reagents, machinery, and labor. In order to elucidate cost-effectiveness of DNA-informed breeding in perennial crops with multi-year generations; we conducted a cost-benefit analysis examining incorporation of marker-assisted selection (MAS), a type of DNA-informed breeding, in an apple breeding program. Annual production costs for a Midwest apple breeding program were used to construct a simulation using itemized costs and per unit costs for each procedure in the program. Simulations using these costs compared MAS at the greenhouse growth stage with cull rates of high (50%), medium (25%), and low (10%) to conventional breeding methods without MAS. The break-even point where cost-savings associated with MAS equals the additional costs incurred was then calculated. Additional sensitivity analyses were conducted exploring decreases in MAS laboratory costs, seedling maintenance costs, and seedling evaluation costs. These results have important implications for breeding programs of perennial crops considering incorporation of DNA-informed breeding.

Establishing a Cider Apple Orchard for Mechanized Management (poster)

Travis Robert Alexander*, *Washington State University, NWREC*; Carol Miles, *Washington State University, NWREC*; Stefano Musacchi, *Washington State University*; Ed Scheenstra, *Washington State University, NWREC* and Jacky King, *Washington State University, NWREC (Poster Board #436)*

Abstract: Washington State, like many other states, has been dealing with labor shortages across the agricultural sector for many years. Short-term strategies for managing labor shortages have included adjusting growing practices, increasing off-season activities, and increasing wages. Long-term strategies have included shifting to less labor-intensive cropping systems and increasing investment in mechanization. For cider apple production, mechanization of pruning, thinning, and harvest requires a high-density orchard training system that is characterized by a planar canopy that is about 2 feet in width, and includes long continuous rows that are suitable for equipment. We have developed a guide to provide commercial cider apple growers with orchard management options that will reduce the need for hand labor. Specific objectives are to establish a high-density fruiting wall that will allow for mechanized pruning, thinning, and harvesting, and to mechanically manage the fruiting wall such that fruit yield and quality are optimized. The first objective will be achieved by methodically training and pruning in response to the growth and bearing habit of the cultivar selected for production. The second objective will be achieved by focusing wall maintenance on the removal of wood that is damaged, shading, diseased, or dead. Equipment that will be used is dependent on the scale of the orchard and available financial resources, and includes hand-held pruners, loppers, and a mechanical hedger. It is important to note that for small-scale growers who may find mechanical harvest equipment unaffordable, mechanized thinning and pruning followed by hand harvest will still significantly reduce labor needs. As discussed in the guide, the experiences at Washington State University Mount Vernon Northwestern Washington Research and Extension Center where we have established such an orchard may be especially applicable for small-scale growers, as a lower cost hand-held hedger was used for mechanical pruning rather than a tractor-mounted hedger.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Root Growth and Rhizosphere Dynamics (Poster)

A Novel Sensor and Technique to Quantify Root Respiration. (poster)

George Guenthner*, *University of Minnesota*; Paul Kusuma, *Utah State University*; John Erwin, *University of Minnesota* and Bruce Bugbee, *Utah State University (Poster Board #331)*

Abstract: Oxygen consumption, measured by galvanic cell oxygen sensors (Apogee Instruments, Logan UT) connected to an automated data acquisition system were used to quantify post-harvest root respiration in multiple closed chambers. Individual sensors were mounted in sealed glass jars (240 cm^3) containing roots and media harvested from plants grown in '128-plug trays' (individual cell volume = 22 cm^3). Separate sensors were mounted in jars containing media only (empty cells adjacent to those with plants) to quantify background microbial respiration. After stabilizing for 15 minutes, oxygen depletion was measured from 15 to 30 minutes (data collected every second) after closure and the root respiration rate was calculated from linear regression. Respiration per unit mass was calculated by dividing CO_2 evolution rate by root fresh and dry mass (after washing media from roots). This technique was used to quantify differences between ornamental and vegetable species root respiration rate, and in a separate experiment, conduct temperature response curves on several tomato cultivars that vary in heat tolerance. The benefits and limitations of this technique for rapid quantification of root respiration rate resulting from our experimentation will be discussed.

Specified Source(s) of Funding: USDA-ARS, MN-DRIVE

Variation in Root Respiration Rate Among Herbaceous Ornamental Plant Species. (poster)

George Guenthner*, *University of Minnesota* and John Erwin, *University of Minnesota (Poster Board #332)*

Abstract: ±1^oC using a new galvanic cell oxygen sensor. Seedlings were grown at the same time in a '288 plug trays' (individual cell volume = 40 cm^3) in a soilless media until plants unfolded 3-10 leaves (species specific). Thirty root masses (including media) from each species were harvested (separated from the stem) and five masses were placed in each of six sealed (metal top) glass jars (240 cm^3 volume) with an oxygen sensor mounted vertically through the top of each jar. A separate sensor was mounted in a jar with five media-only masses (taken from empty cells adjacent to plants) to quantify potential background microbial respiration in each cell. After closing jars, and a 1 hr stabilization period, absolute oxygen concentration was measured for two additional hours (data collected every 10 sec) and root respiration rate was calculated from a linear regression fit to kPa oxygen depletion over time. Respiration rate was calculated on a root fresh and dry mass (after washing media from roots) for each jar (5 masses). Respiration rate varied from -0.0000239 to -0.0000126 kPa 10 sec^{-1} per gram fresh weight for *Angelonia* and *Coleus*, respectively. Respiration rate varied from to -0.000340 to -0.000184 kPa 10 sec^{-1} per gram dry weight for *Petunia* and *Tagetes*, respectively.

Specified Source(s) of Funding: USDA-ARS; FRA; Minnesota Agriculture Experiment Station

Using a Split-Root Hydroponic System to Study Rhizosphere Acidification in Southern Highbush Blueberry (poster)

Christopher S. Imler*, *University of Florida* and Gerardo H. Nunez, *University of Florida (Poster Board #333)*

Abstract: Hydroponic growing systems are an effective tool for studying plant nutritional physiology because nutrient concentrations can be easily controlled. Typically, these studies entail exposing the entire root system to the same nutrient solution. This design fails to account for soil heterogeneity. Moreover, it poses a challenge for plant nutritional physiology experiments where local and systemic responses need to be isolated. Previous studies suggest that southern highbush blueberry (SHB, *Vaccinium corymbosum* interspecific hybrids) and other *Vaccinium* spp. do not acidify their rhizosphere. However, these studies used single-reservoir hydroponic systems, which confound direct and nutrient uptake-dependent rhizosphere acidification. We designed a split-root hydroponic system to distinguish between nutrient-uptake dependent rhizosphere acidification (local response) and direct, H+-ATPase-mediated rhizosphere acidification (systemic response) in hydroponically-grown SHB. One-year old rooted cuttings of 'Emerald' SHB were

transplanted to a hydroponic growth system where each half of the root system was in a different reservoir. One reservoir was supplied with a buffered, complete nutrient solution containing 2.5 mM NH4+. The other reservoir was supplied with a non-buffered nutrient solution containing either 2.5 mM NH4+ (treatment NH4+ /NH4+) or no nitrogen (treatment NH4+ /None). All nutrient solutions were continuously aerated. Fresh nutrient solutions were supplied every 7 days. Hydroponic solution pH was measured periodically. Root relative electrolyte leakage (REL), and tissue N content were measured destructively after 35 days of treatment. Plants in both treatments exhibited similar, adequate leaf N levels ($P > 0.05$) and similar root REL ($P > 0.05$), suggesting that the split root design and treatments did not cause N deficiency or root stress. Both NH4+ uptake-dependent rhizosphere acidification and direct rhizosphere acidification were observed. NH4+ uptake-dependent rhizosphere acidification occured at a higher rate than direct rhizosphere acidification. These findings suggest that SHB exhibits both systemic and localized rhizosphere acidification. Using a split-root hydroponic growth system helped distinguish between these two responses.

Specified Source(s) of Funding: Thad Cochran Southern Horticultural Laboratory, U. S. Department of Agriculture Agricultural Research Service, under award number 58–6062–5-004

Comparing Saturation and Particle Density Methods to Derive Substrate Porosity (poster)

Paul C. Bartley*, *North Carolina State University*; Brian Jackson, *North Carolina State University* and William Fonteno, *North Carolina State University (Poster Board #334)*

Abstract: The total porosity of substrate components can be derived from indirect measurements such as the North Carolina State University Porometer Method (PM), a saturation method, or calculated from its bulk volume divided by its particle density (ρ_S). In order to calculate substrate total porosity from ρ_S, coir, peat, pine bark, perlite, and wood fiber components were analyzed using a helium gas pycnometer. Porometer Method data was collected from the NCSU Horticultural Substrates Lab's database on single component substrates and compared to the calculated total porosity derived from ρ_S. The PM's measured total porosities were consistently lower than the derived total porosity determined by ρ_S. However, it was observed that the initial moisture content of the substrate prior to being subjected to the PM affected the agreement between the two methods. Assuming the ρ_S derived total porosity provides the true value, the optimal moisture content to achieve the most accurate results from the PM could be determined for each material.

Total Porosity of Horticultural Substrates Derived from Particle Density (poster)

Paul C. Bartley*, *North Carolina State University*; Brian Jackson, *North Carolina State University* and William Fonteno, *North Carolina State University (Poster Board #335)*

Abstract: The particle density (ρ_S) of a porous medium represents one of its basic physical properties. The ρ_S of coir, peat, perlite, pine bark, and wood fiber were analyzed by gas pycnometer using helium (He), nitrogen (N), and purified air. Gas significantly affected the measured ρ_S of organic substrate components. For example, gas containing high concentrations of N resulted in a lower pine bark ρ_S, 1.08 g/cm^3, than He, 1.20 g/cm^3. The measured ρ_S of wood, peat, and coir with He were 1.40 g/cm^3, 1.44 g/cm^3, and 1.49 g/cm^3, respectively. Grinding each component increased the measured ρ_S for perlite and pine bark. An increase in ρ_S after grinding suggest that inaccessible voids were present within perlite and pine bark particles. For both perlite and pine bark, the effective ρ_S could be correlated to its particle size distribution. These measurements coupled with the understanding of the potential variability in ρ_S of organic/inorganic substrate components could generate more accurate values of calculated parameters including total porosity and volumetric water content.

Utilizing Image Analysis to Obtain Particle Size Distributions of Substrate Components (poster)

Paul C. Bartley*, *North Carolina State University*; Brian Jackson, *North Carolina State University* and William Fonteno, *North Carolina State University (Poster Board #336)*

Abstract: Particle size analysis is conducted to better understand the physical characteristics of a material or to ensure a product remains within a predetermined range of sizes for quality control. Previously in substrate research, particle size analysis has been conducted by sieving as the principles of sieving are easy to understand and the equipment is relatively cheap. However, sieving provides very little data about the shape characteristics of the material. Additionally, the equipment would be difficult to incorporate into a streamlined production system. Image analysis is capable of obtaining similar particle size distribution data and the equipment could be easily incorporated into a streamlined production system. Substrates were analyzed using a computerized particle analyzer (CPA) to explore the potential of image analysis for substrate characterization. Tyler's CPA analyzes each individual particle greater than 33 microns as the particle passes between a light source and camera. Each particle is instantly analyzed according to any one of many operator-selected parameters, such as equivalent diameter, minimum Feret, maximum Feret, length, skeletal length, or geodetic length. The thorough analysis of the CPA includes distributions of a sample's particle count, length, area, volume, or length to width ratio. Although the equipment was hindered by touching or dust-sized particles, image analysis provides a plethora of information to characterize a material beyond that of sieving's capabilities.

Infection By Reniform Nematode (*Rotylenchulus reniformis*) Alters Root Growth, Architecture, and Gene Expression in Upland Cotton (*Gossypium hirsutum*) (poster)

Wei Li, *Clemson University*; Paula Agudelo, *Clemson University* and Christina Wells*, *Clemson University (Poster Board #337)*

Abstract: Reniform nematode (*Rotylenchus reniformis*, RN) is a sedentary plant-parasitic nematode that infects over 300 species from numerous plant families in tropical, subtropical, and warm-temperate regions. Among its hosts are multiple economically-important crops, including pineapple, soybean, and cotton. Belowground parasitism by RN involves anatomical and metabolic changes in root pericycle cells, the same cells from which lateral roots emerge. We investigated the effect of RN parasitism on root growth, architecture and histology in upland cotton (*Gossypium hirsutum*) and documented the expression of multiple genes related to lateral root development and auxin dynamics in parasitized roots. Nematode-induced changes in root growth were measured in three plant culture systems: split-root pots, foam cups, and germination pouches. Gene expression of infected and uninfected roots was measured using Illumina-based RNA sequencing, followed by Trinity *de novo* transcriptome assembly and transcript quantification with rsem and DESeq2.

At 3 days after inoculation (DAI), RNs had penetrated cotton roots intracellularly; some nematodes had arrived at the endodermis. At this stage, the pericycle cells surrounding the nematode head were not visibly modified. By 9 DAI, expanding feeding sites (syncytia) were clearly visible as regions of hypertrophied, interconnected pericycle cells filled with dense cytoplasm, enlarged nuclei and nucleoli, and an increased number and size of organelles. Across multiple plant culture systems, nematode parasitism increased total root length, weight, branching, and fractal dimension. Simultaneously, the expression of multiple genes associated with lateral root development and with auxin metabolism, transport, and response were altered in parasitized roots. Of particular note was the up-regulation at 3 DAI of Lateral Root Primordium 1, an auxin-regulated transcription factor whose Arabidopsis homolog is expressed in developing lateral root primordia. Also strongly induced in early parasitism were genes encoding the auxin biosynthetic enzyme YUCCA10 and an auxin polar transporter from the ABC family. Later stages of parasitism were characterized by the differential expression of additional auxin transporters, auxin response factors, and lateral root-associated genes. The increased production of lateral roots in parasitized plants may result from nematode manipulation of the plant's own hormonal pathways. Alternately it may reflect increased allocation of carbon to root growth in response to the strong sink produced by nematode feeding. A larger root system may ultimately benefit the parasite by increasing the root surface area available for feeding by its offspring.

Specified Source(s) of Funding: Cotton, Inc.

12:15 PM – 1:00 PM *International Ballroom East/Center*

Temperate Tree Nut Crops (Poster)

Visual Injury of Selected Fruit and Nut Plants to Driftable Fractions of Dicamba, 2-4D, and Glyphosate (poster)

Michele Warmund*, *University of Missouri*; Brian Dintelmann, *University of Missouri*; Kevin Bradley, *University of Missouri* and Mandy Bish, *University of Missouri (Poster Board #409)*

Abstract: The reformulation of low-drift dicamba (Xtendimax +Vapor Guard Technology®) and 2,4-D (Enlist One + Colex-D Technology®) and their subsequent use alone or in combination with glyphosate on herbicide-resistant row crops have resulted in numerous cases of off-target movement and injury to horticultural plants. A study was conducted to evaluate the sensitivity of one-year-old apple, elderberry, grape, peach, pecan, eastern black walnut, raspberry, and strawberry plants following the application of three driftable fractions (1/2X, 1/20X, and 1/200X) of the labeled rate of dicamba (0.56 kg ae·ha^{-1}) or 2,4-D choline (1.09 kg ae·ha^{-1}), with or without glyphosate (1.12 kg ae·ha^{-1}). By 28 days after treatment, dicamba-treated plants had symptoms of chlorosis and inward cupping of young foliage and 2,4-D-treated plants generally expressed symptoms of epinasty or leaf distortion. At the 1/2X rate, visual injury was more severe for apple, peach, pecan, and elderberry plants treated with dicamba compared with 2,4-D. In contrast, injury to walnut and grape plants treated with 2,4-D was more severe than that of dicamba at the 1/2X rate, but raspberry and strawberry injury was similar for both herbicides. The addition of glyphosate to either herbicide increased injury of all plants except grape.

Pistachio Precocity: Choose a Cultivar That Makes Money Sooner (poster)

Craig Kallsen*, *Univ of California Cooperative Extension/kern County* and Dan Parfitt, *University of California (Poster Board #410)*

Abstract: Compared to many fruit and nut crops grown in California, pistachio (*Pistacia vera* L.) is relatively slow to provide an economic return to growers. Typically, the first harvest does not occur in the San Joaquin Valley of California until the trees are five or six years old. Precocity, the ability of a cultivar or variety to produce nuts in a reduced time interval after planting, is a desirable characteristic in that producers can begin recouping their initial investment earlier. However, many of the cultivars grown in California, have not been compared in replicated and randomized scientific trials with the objective of evaluating differences in precocity, bloom timing, and nut quality characteristics. The objective of this research was to address this deficiency by comparing cultivars that are currently grown or were grown in California and variety selections that appear to have commercial potential from the U.C. breeding program or from farmer collections. In this single trial, planted in 2010 on clonal rootstock and located within the pistachio growing area of the southern San Joaquin Valley, we compared the following cultivars: Golden Hills, Joley, Kalehghouchi, Kerman, Lost Hills, Pete 1, Red Aleppo, Ruehle, and Sirora; and the varieties KB25-78, KA22-80 and Velez. Differences were found in precocity, bloom timing, nut weight, shell splitting and other nut quality characteristics, which should be of interest to commercial pistachio producers, processors and breeders.

Specified Source(s) of Funding: The California Pistachio Research Board and the University of California

Determining the Effect of Acadian LSC Seaweed Extract, Maxcel PGR, and Low-Biuret Urea on Pistachio Inflorescence Bud Abscission (poster)

Leigh F Archer*, *University of California, Davis*; Narges Mahvelati, *University of California, Davis*; Lu Zhang, *University of California, Davis*; Emre Billen, *University of California, Davis*; Gureet Brar, *California State University Fresno*; Eden Lange, *University of California, Davis*; Muhammad Hammad Raza, *University of California, Davis*; Mateen Sajid, *University of California, Davis*; Abdollatif Sheikhi, *University of California, Davis*; Daniel YP Syverson, *California State University Fresno*; Ahmad Tajabadipour, *University of California, Davis*; Holly Little, *Acadian SeaPlants* and Louise Ferguson, *University of California, Davis (Poster Board #411)*

Abstract: This trial examined the potential of *Ascophyllum nodosum* based biostimulants, produced by Acadian Seaplants LLC, the currently registered growth regulator, MaxCel® (6-benzyladenine (6BA) 1.9% AI), and low-biuret urea (Total Nitrogen Analysis 46.0% minimum), to mitigate floral bud abscission in pistachios, the visible mechanism of alternate bearing. The Acadian products are formulated to alleviate alternate bearing by increasing shoot nitrogen levels to enhance photosynthesis and carbohydrate status of the shoot. MaxCel is a growth regulator used to increase bud sink strength, and low-biuret urea is used as a nitrogen fertilizer. 8 different treatment combinations were applied to 8 replicate rows over two growing seasons. Treatment applications at 1085 and 1380 accumulated temperature units were selected to correlate with the initiation and midpoint of embryo growth respectively. Average percent bud abscission ranged from 86-95% across all treatments with no significant differences in abscission or yield between treatments at α=.05.

Specified Source(s) of Funding: California Pistachio Research Board; Acadian Seaplants LLC

Performance of Seven Pecan Cultivars in South Georgia. (poster)

Patrick Conner*, *University of Georgia, Tifton Campus (Poster Board #412)*

Abstract: Seven pecan (*Carya illinoinensis*) genotypes were evaluated over 15 years in a yield trial at Tifton, Georgia, USA. Genotypes included five cultivars; Cherryle, Excel, McMillan, Nacono, and Zinner, and 'Desirable' and 'Stuart' as check cultivars. Actual yields were measured for each tree in the test and a 50 nut sample was taken to determine nut quality. Trees were evaluated for leaf and nut scab infection (*Venturia effusa*) and black aphid (*Melanocallis caryaefoliae*) damage. Significant differences were found for yield with all cultivars performing better than 'Desirable'. Cultivars also varied widely in alternate bearing intensity. 'McMillan' and 'Excel' had exceptional pest resistance, but mediocre nut quality. 'Zinner' produced consistent yields of high-quality nuts and had adequate pest resistance for this region. 'Nacono' and 'Cherryle' both produced large high-quality nuts and had moderately irregular bearing. 'Stuart' is an older cultivar that produces a low-quality nut and is no longer recommended to be planted. 'Desirable' is the most common cultivar in Georgia, but extreme scab susceptibility make it a poor choice for new plantings.

Specified Source(s) of Funding: Georgia Agricultural Commodity Commission for Pecan

Performance of New Pecan Cultivar 'Avalon' in South Georgia. (poster)

Patrick Conner*, *University of Georgia, Tifton Campus (Poster Board #413)*

Abstract: 'Avalon' is a new pecan cultivar that was released by the University of Georgia in 2016. 'Avalon' was topworked into a Tifton, GA yield trial in 2009 and its performance was monitored for nine years. Actual yields were measured for each tree in the test and a 50 nut sample was taken to determine nut quality. Trees were evaluated for leaf and nut scab infection (*Venturia effusa*) and black aphid (*Melanocallis caryaefoliae*) damage. 'Avalon' trees were also placed into unsprayed scab resistance trials at three locations in south Georgia. 'Avalon' is a productive cultivars with significantly greater yields than the check cultivar 'Desirable' and similar yields to 'Byrd' and 'Pawnee'. 'Avalon' produced nuts of good size (9.7 g) and quality (53.5 % kernel). Harvest date is about 1 wk before 'Desirable' in Tifton, Ga. Spring bud break was later than all cultivars except 'Gafford' indicating low frost susceptibility. No scab infection was observed in sprayed yield trials, and only incidental scab infection was observed in unsprayed scab resistance trials. 'Avalon' is a high yielding cultivar with commercially acceptable nut size and quality and has excellent levels of resistance to pecan scab. 'Avalon' is thus recommended for trial in commercial orchards in Georgia and should be useful throughout the humid southeastern U.S. where pecan scab infection is common.

Specified Source(s) of Funding: Georgia Agricultural Commodity Commission for Pecan

Long-Term Observation of Resistance Sources to Eastern Filbert Blight in New Jersey (poster)

Michael P. Gandler*, *Rutgers University*; Emil Milan, *Rutgers University*; John Michael Capik, *Rutgers University* and Thomas Molnar, *Rutgers University (Poster Board #414)*

Abstract: Three hundred and eighty-three clonal accessions of *Corylus* were assessed for their response when exposed to eastern filbert blight (EFB, *Anisogramma anomala*) in New Jersey. The plants were deemed resistant or tolerant to EFB in previous studies and acquired from the U.S. Department of Agriculture Agricultural Research Service National Clonal Germplasm Repository, the University of Nebraska-Lincoln, the National Arbor Day Foundation, and Oregon State University. Further, clonal accessions derived from multiple seed introductions from across the native range of *C. avellana* in Europe and the Caucuses were included. The trees were planted in the field from 2004 to 2012 and subsequently exposed to EFB on a yearly basis. This study expands upon earlier work published in 2012 by examining disease progression over a longer time-period using additional genotypes. In January 2018, all trees were evaluated for presence of EFB. It was found that 207 of 383 accessions remained free of the disease. The 148 accessions with EFB present had their cankers measured and proportion of diseased wood calculated. Most noteworthy, 'Ratoli', a Spanish cultivar that carries a dominant *R*-gene, and all six of its selected offspring remained free of EFB across the span of this study. Further, all eight offspring of Yoder #5, a *C. americana* x *C. avellana* hybrid, also remained free of EFB, as did OSU 541.147, a *C. americana* x *C. avellana* hybrid related to *C. americana* 'Rush'. Fifty-three of 65 new germplasm introductions selected at Rutgers and deemed resistant in earlier studies still remain free of EFB. In contrast, most accessions protected by the 'Gasaway' *R*-gene deteriorated with time. For instance, all 'Zimmerman' trees planted in 2005 were free of disease in 2012, whereas today five of the remaining six trees are infected. In addition, 'Jefferson' had its proportion of diseased wood increase from 4% to 31% and expresses larger individual cankers than recorded in 2012. Similarly, EFB increased on 'Yamhill' from 2% to 20%. Overall, most accessions from Oregon remained at least tolerant in New Jersey (proportion of diseased wood less than 25%), but only about a third remained free of EFB. Fortunately, more than 80% of the of the new introductions and nearly all *C. fargesii*, *C. chinensis, C. heterophylla*, and *C. americana* accessions continued to remain free of EFB. Generally, these results convey that a wide diversity of *Corylus* germplasm exists to support breeding efforts to combat this devastating disease.

Inadequate Chill Influences Carbohydrate Resources and Flower Development in Pistachio (*Pistacia vera* L.) (poster)

Lu Zhang, *University of California, Davis*; Leigh F Archer, *University of California, Davis*; Eden Lange, *University of California, Davis*; Emre Bilen, *Atatürk Horticultural Central Research Institute*; Mateen Sajid, *University of California, Davis* and Louise Ferguson*, *University of California, Davis (Poster Board #415)*

Abstract: Premature flowers, uneven bud break and poor bloom synchrony were observed in pistachio due to the lack of chill in warm winters. Previous research demonstrated warm temperatures (>45 ^{O}F) during dormancy increased shoot respiration and consumption of carbohydrates. To understand this better, we compared the flower bud development and carbohydrates levels of 'Kerman' and 'Peters' pistachio trees under low (400 chilling hours) and high (800 chilling hours) winter temperatures. The buds, and shoot sections that 5cm beneath the individual buds were collected biweekly from February through April in 2016 and 2017. The soluble sugar and starch content of the shoot's phloem and xylem were tested. Results demonstrated that with low chill both male and female flowers bloomed more slowly than flowers that experienced high chill. Consistently, the carbohydrate contents of shoots receiving low chill were significantly lower than the carbohydrate contents of shoots that had received more chilling. At bloom flower buds with high chill had a higher sugar content and produced better bloom than buds with low chill. This data suggests warmer temperatures promoted respiration that exhausted the shoots' carbohydrates that support bloom.

Specified Source(s) of Funding: California Pistachio Research Board

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1:00 PM – 1:45 PM *International Ballroom East/Center*

Computer Applications in Horticulture (Poster)

Ifarmer's Bookshelf—High Technology in Agriculture (poster)

Kent Kobayashi*, *University of Hawaii at Manoa* and Harry Bittenbender, *University of Hawaii (Poster Board #338)*

Abstract: The Farmer's Bookshelf information system was created in 1987 on a Macintosh computer using the application software HyperCard. Initially covering fruit crops in Hawaii, it was later expanded to other crops and cost of analysis spreadsheets. A version was created to run on PC (IBM compatible) computers using the application software Spinnaker PLUS. The Farmer's Bookshelf was later modified to run on the World Wide Web. Recently, an extension agent in Hawaii expressed interest in updating the Farmer's Bookshelf. It was decided that the updating and management of this information system would be taken over by this agent and another extension agent. We then saw the potential for creating another version of the Farmer's Bookshelf that went beyond just crops. The iFarmer's Bookshelf is a mobile version of the Farmer's Bookshelf. Rather than crops, it covers a diverse range of topics related to high technology in agriculture. We used Google Sites to develop the iFarmer's Bookshelf. Google Sites was chosen because the iFarmer's Bookshelf could be stored on the University of Hawaii server and the ease of having the iFarmer's Bookshelf formatted especially for use on mobile devices. Unlike the original Farmer's Bookshelf, which covered various crops, the iFarmer's Bookshelf covers various topics related to high technology in agriculture. These topics were chosen from the latest technological fields in agriculture. The topics and pages include What's New Today, Things to Do, Innovative Agriculture, High Technology, Hydroponics, Unmanned Aerial Vehicles, Precision Agriculture, Space Farming, Robotics, Nanotechnology, Augmented Reality, Artificial Intelligence, and Science Conferences. RSS feeds and news aggregators were used to find and retrieve cutting-edge information. In conclusion, the iFarmer's Bookshelf goes beyond the original Farmer's Bookshelf by keeping users up-to-date with innovative high technology in the ever-changing fields of agriculture.

Specified Source(s) of Funding: Smith Lever Funds

Remote Detection of Growth Dynamics in Red Lettuce (poster)

Matthew R. Urschel*, *Rensselaer Polytechnic Institute* and Tessa Pocock, *Rensselaer Polytechnic Institute (Poster Board #339)*

Abstract: Chlorophyll fluorescence (ChlF) is used as a tool to measure photochemical efficiency, health status, stress and photosynthesis in plants. Remote tracking of the overall health and growth status of plants by ChlF detection can reduce energy requirements for growers by allowing light output to be synchronized with plant needs. However, current ChlF measurement systems are expensive, labor intensive, and invasive, making them impractical for use in controlled environment agriculture (CEA). Here, real time growth dynamics of red lettuce was monitored using a new, custom-made, cost effective and simple to operate ChlF detector. The device remotely measures canopy ChlF in the light-adapted state immediately after an excitation pulse from a blue (470 nm) LED excitation light. The LESA detector requires no physical contact with plants and automated ChlF measurements are taken at user-defined intervals throughout the growth period and stored in a cloud database for easy manual or automated access and analysis. The ChlF system successfully provided automated, real time tracking of growth dynamics in red lettuce over a 17-day period with no observed effect on plant growth. The rate of change in the ChlF signal was closely correlated with changes in biomass and plant area in the growing plants. Polynomial regression modeling from observed values enabled biomass and plant area to be estimated from observed ChlF. Relative growth rate (RGR) and leaf area ratio (LAR) calculated from these estimates were within 10% of those calculated from observed values, demonstrating that ChlF measured by this device can

serve as a reasonably-accurate proxy for physical growth dynamics in red lettuce. To our knowledge, the chlorophyll fluorescence detection system described here is the first device of its kind designed for the purpose of remotely monitoring crop health and growth dynamics in real time.

Specified Source(s) of Funding: NSF

Dynamic Lighting Control Programs: Intensity Modulation Vs. Binary Control (poster)

Schuyler W. Duffy*, *Cornell University (Poster Board #340)*

Abstract: Electricity for supplemental lighting is a major cost of year-round crop production, so increasing efficacy of lighting is of primary concern to growers. Market opportunities may support projects with high energy use intensity, which again highlights the need for energy efficient technologies. In greenhouse production, where electric light is supplemented against a broad-spectrum background, only supplemental wavelengths with the highest photosynthetic efficiency justify the cost of electric lighting, and plant growth is largely correlated to the overall quantity of light received. Intensity of photosynthetically active radiation (PAR) is expressed in quantum units, or photosynthetic photon flux density (PPFD), which is the number of photons occurring per square meter per second (umols m-2 s-1). The daily light integral (DLI) (mols m-2 d-1) is the sum of PPFD occurring in a day and is commonly used to express crop specific light requirements. Any reduction in the quantity of supplemental light, while maintaining minimum instantaneous and integrated lighting targets, will coincide with reduced electricity costs for growers. Modulating the intensity of supplemental light can be accomplished at high temporal resolution using computational control mechanisms and LED fixtures. The current research compares the efficiency of two lighting control strategies, intensity modulation and binary off/on. Intensity modulation varies supplemental PPFD, balancing supplemental against ambient light to meet an instantaneous threshold, while binary control switches lights on at full power. Each strategy is combined with the Lighting & Shade System Implementation (LASSI), developed at Cornell University (Albright et al., 2000). The LASSI algorithm strives to meet a target daily light integral, making lighting decisions based on expected solar DLI, the potential for supplemental lighting, the season and the time of day. The algorithm takes effect by delaying supplemental lighting each day for a number of hours determined by the season and the insolation occurring to the current time. Binary control is expected to accurately provide a target DLI, with some overshoot on cloudy days that become sunny. Modulation control is expected to precisely meet a minimum threshold DLI while minimizing overshoot of supplemental lighting. Networked microcontrollers manage LumiGrow 650e LED fixtures, and the project lays the groundwork for incorporation of additional software into dynamic greenhouse lighting systems.

1:00 PM – 1:45 PM *International Ballroom East/Center*

Marketing and Economics (Poster)

Consumers Willingess to Pay for the "Local" Attribute of a Familiar Vegetable, Broccoli. (poster)

Jiayi Carol Dong, *Cornell University*; Miguel Gómez, *Cornell University* and Thomas Björkman*, *Cornell University (Poster Board #361)*

Abstract: Broccoli is a major fresh vegetable crops with supply concentrated in California. There is a benefit to diversifying the sources of supply to meet a stated increase in demand for local produce, as well as improving resource use efficiency and shelf life. The “Developing an Eastern Broccoli Industry” project is underway to support the production and marketing of East Coast grown broccoli as an alternative to West Coast supplies.

Plant breeders have recently released several new varieties adapted to eastern growing conditions. We selected two varieties adapted to, and grown in New York State and benchmarked them with the California variety. An auction experiment measured the consumer perception of the different varieties and the price premium they are willing to pay for local broccoli. This study also measured the effect of information about product origin on consumer quality perception and willingness-to-pay (WTP).

We conducted a series of broccoli auction experiments in Ithaca and Geneva, NY in September 2017. Over 150 subjects revealed their willingness to pay for one pound of broccoli crowns of the three varieties based on their appearance and taste. We used a reduced-form econometric model to estimate the effect of the information treatment on consumers’ product perception and willingness to pay.

We found that the appearance of eastern-adapted varieties was not as well-received as the California variety, but the taste was equally accepted. Consumers who were given product-origin information rated the appearance of the eastern varieties higher than those who were not given the information, showing that consumers became more forgiving after knowing the products are “local”. Consumer willingness-to-pay for the local varieties were not significant different from the California variety despite the lower ratings on appearance. Overall, the two eastern-adapted varieties showed a potential to compete with the California variety at a similar price level. Further improvement on the product appearance is likely to create a competitive advantage that could lead to a price premium.

Promoting Native Grass Benefits for Lepidoptera through Point of Sale Displays at Garden Centers (poster)

Diane Mary Narem, *University of Minnesota* and Mary Meyer*, *University of Minnesota (Poster Board #362)*

Abstract: Native grasses provide numerous benefits to the environment, including food and shelter for numerous species of Lepidoptera (butterfly and moth) larvae. However, this is not typically known to many horticulturists or consumers. Many Lepidoptera are incidental pollinators, hunting for nectar and transferring pollen in the process. The public values pollinators, but their valuation of pollinators depends upon their awareness and knowledge on pollinator issues and the wording of advertising materials. Consumer education can be an important tool to influence consumer preference and buying decisions. One way to influence and educate consumers is through point of sale marketing. To understand if consumer awareness of native grass benefits affected purchases, a point of sale (POS) marketing study was conducted over the course of two years at five garden centers in Minnesota, U. S. Point of sale (POS) materials included a poster and plant tags that listed four benefits of native grasses, including the benefits grasses provided to Lepidoptera. The POS displays were used at the garden centers for two years. We developed a one-page consumer survey to understand the influence of the POS display. The questions assessed whether a consumer saw the display, reaction to the display, their current and past purchases, awareness, attitude and knowledge of native grasses and general demographic questions. The survey was given to customers at each garden center during the gardening seasons of 2016 and 2017. A total of 341 surveys were collected over two years of which 336 were suitable for the analysis. We found consumers were less aware of the benefits that native grasses provide to butterflies and moths in comparison to three other benefits. The results were inconclusive regarding whether consumer knowledge level increased after seeing the POS display. We found that consumers that saw the POS display were more likely to purchase a native grass. The level of consumer knowledge on the benefits of native grasses was not found to influence native grass purchases. Because consumer knowledge did not influence consumer decisions to purchase a grass, we cannot confirm that an increase in awareness of benefits caused consumers to buy more grasses. Further research is needed to clarify whether consumers internalize information from POS displays, causing them to make informed decisions or whether POS displays simply draw the attention of consumers, making purchases more likely.

Specified Source(s) of Funding: Minnesota Department of Agriculture Specialty Crop Block Grant

Landscape Importance Components Related to Consumer Active Interest and Passive Disinterest in Water Conservation (poster)

Melinda Knuth*, *Texas A&M University*; Bridget Behe, *Michigan State University*; Charles Hall, *Texas A&M University*; Patricia Huddleston, *Michigan State University* and Tom Fernandez, *(Poster Board #363)*

Abstract: Competition for water resource in urban, suburban, rural, and agricultural areas will likely intensify in the coming decades as competition for potable water supplies increases.

While water for irrigation meets a physical need for the plants, the water indirectly meets a psychological need by elevating homeowners' perceived social status through aesthetically pleasing landscapes. Thus, homeowner perceptions about water use and conservation may be related to their perceptions about the importance of plants and landscapes. Education about and adoption of sustainable water use practices may help ensure an adequate supply of irrigation water while conserving water sources for human and ecosystem services. We hypothesized that water conservation involvement and expertise may be negatively related to the importance of landscaping since individuals with high aesthetic and recreational priorities use more water outdoors.

We conducted an online survey with 1,543 respondents in 2016 to ascertain their water conservation and plant expertise and involvement and horticultural importance. A principal component analysis was used to describe the strength and direction of correlated variables in terms of their potential to quantify unobservable constructs. The values that emerge show the interdependencies between observed variables which can be collapsed to a smaller set of components. In the analysis, we retained items with loadings ≥ 0.500. Five components emerged: Landscape Beautification, Active Landscape Enjoyment, Passive Landscape Enjoyment, Low Maintenance Landscape Desire, and Response in Drought. The components identified in those analyses are useful in segregating a sample into smaller clusters or market segments. We conducted a K-means cluster procedure using the five components that emerged. Cluster analysis results identified two key market segments comprising ~50% of the sample each: those who are Actively Interested in Water Conservation and those who are Passively Disinterested in Water Conservation. The Actively Interested segment scored higher on selected components relating to horticultural importance including aesthetically beautiful landscapes, active landscape enjoyment, desire for a low maintenance landscape, and response in drought compared to the Passively Disinterested segment. The latter segment scored higher on a component labeled inactive with no landscape enjoyment. Findings suggest that pro-water conserving attitudes are found among consumers who value outdoor landscapes and those individuals who spent more on plants. Results suggest that producers and retailers should focus marketing and communication efforts on low-water use cultivar selection and operationalizing water conserving behaviors more than convincing consumers that plant purchases and landscaping are important.

Specified Source(s) of Funding: USDA SCRI Clean WateR3 – Reduce, Remediate, Recycle Grant Number 2014-51181-22372; USDA NIFA Hatch Projects MICL 02085 and 02473, and TEX0-1-7051; Michigan State University AgBioResearch, and MSU Project GREEN and Texas A&M AgriLife Research.

Economic Feasibility of Cover Crops for Organic Strawberry Production (poster)

James E Rentz*, *University of Florida*; Zhifeng Gao, *University of Florida*; Xin Zhao, *University of Florida*; Carlene Chase, *University of Florida*; Zack Black, *University of Florida*; Oscar Emanuel Liburd, *University of Florida* and Marilyn E. Swisher, *University of Florida (Poster Board #364)*

Abstract: Cover crops can be used in an organic farming system to enhance soil quality and reduce weed pressure, potentially leading to higher yields and revenue that may offset their cost. Partial budgets were developed for three different cover crop treatments in an organic strawberry cropping system study. The treatments were sunn hemp (*Crotalaria juncea L.*), hairy indigo (*Indigofera hirsuta L.*), and a mix of these two with slender leaf rattlebox (*C. ochroleuca G. Don*) and American jointvetch (*Aeschynomene americanca L.*). The study aimed to determine how the treatments affected profits relative to a no-cover-crop, weedy control system in the context of a Florida winter organic strawberry production season. A trial was conducted at the Plant Science Research and Education Unit in Citra, FL to obtain yield and cost data. Cover crops were established in July 2016 and terminated that September. Four strawberry cultivars were transplanted into plastic-mulched, raised beds in October and harvested from November 2016 through April 2017. Horticultural researcher interviews, previously developed budgets, and Agricultural Marketing Service data were integrated with the experimental data to produce partial budgets for each treatment. Yield and cost data were averaged over the four strawberry cultivars and four replications. The sunn hemp and mix treatments both increased profits relative to the no-cover-crop control while the hairy indigo treatment decreased yield and thus decreased profits relative to the control. A sensitivity analysis was performed to determine hypothetical profit outcomes under differing yield and price scenarios. In all scenarios, hairy indigo reduced profits relative to the control while sunn hemp and the mix increased profits. Compared to the control, the additional profit of sunn hemp was greatest in low-yield scenarios while that of the mix's was greatest in high-yield scenarios. Impacts on profit relative to the control across all scenarios ranged from ($5347) per acre for hairy indigo to $6287 per acre for the mix. A breakeven analysis showed that the seed cost of sunn hemp would need to increase 9.31 times for it to have the same profit as the control. The seed cost of the mix would need to increase 16.67 times to break even with the control. Hairy indigo does not break even at any seed cost. Further research into less visible effects such as accrued soil quality benefits and reduced weed management costs is warranted to fully capture the economic benefit of various cover crops.

Economic Analysis of Anaerobic Soil Disinfestation Treatments for Tomato Production in Southwest and North Florida (poster)

Lijia Shi, *University of Florida*; Zhifeng Gao*, *University of Florida*; Monica Ozores-Hampton, *University of Florida*; Bodh R. Paudel, *University of Florida*; Zack Black, *University of Florida*; Francesco Di Gioia, *University of Florida*; Jason C. Hong, *USDA-ARS* and Erin N. Rosskopf, *USDA-ARS (Poster Board #365)*

Abstract: The main approach of anaerobic soil disinfestation (ASD) in Florida, a method for pre-plant soil treatment, consists of combining the application of the molasses (C source) with the application of composted poultry litter (CPL) as an organic amendment. However, CPL is not always available locally and is rich in phosphorous. Conventional growers are reluctant to use CPL to avoid any potential food safety issue. In this study, alternative organic amendments, such as composted yard waste (CYW) which poses no food safety issue and is inexpensive and available locally, was used as a substitute for CPL. The main purpose was to evaluate the economic profitability of treatments using alternative organic amendments. Two open-field tomato production trials were conducted at two research stations during the fall 2016 season in Immokalee and Citra, FL. Different application rates of alternative organic amendments (e.g., CYW) were compared to chemical soil fumigation (CSF) as a control. Economic profitability analysis of all eight soil treatment methods was conducted. The results showed that ASD treatment with CPL 11 Mg ha^{-1} and molasses 7 m^3 ha^{-1} achieved the highest gross return among all treatments tested. Compared with CSF, most of the relative net returns of ASD treatments with CYW were negative. ASD treatments with CYW had lower land preparation cost than ASD with CPL, but the marketable tomato yields were lower. The relative net return of all ASD treatments with CYW compared with CSF decreased with tomato prices but increased with tomato yield. The breakeven molasses prices for ASD treatment with CPL to be comparable with CSF were lower than the current agronomic molasses market price ($6/gallon). Higher price of tomatoes gave higher breakeven molasses price. At the current high cost of using molasses as the carbon source, ASD treatments cannot surpass CSF in economic profitability. Alternative carbon inputs that reduce pre-treatment costs while maintaining the high tomato yield achieved using ASD are needed in order to increase the adoption rate of this promising non-chemical soil disinfestation practice.

Economic Analysis of Breeding Program Procedures in Peach (poster)

Seth Wannemuehler*, *University of Minnesota*; Chengyan Yue, *University of Minnesota*; William Shane, *MSU - Southwest Michigan Research and Extension Center*; R. Karina Gallardo, *WSU - Puyallup Research and Extension Center* and Vicki A. McCracken, *Washington State University (Poster Board #366)*

Abstract: Conventional breeding in tree crops requires multiple years of field growth before evaluation resulting in decreased revenue. DNA-informed breeding techniques provides breeders the ability of reducing numbers of individuals before significant field costs occur. However, incorporation of this technology

introduces additional costs for machinery, chemicals, and labor. Previous simulations in apple have shown DNA-informed breeding may be cost-effective yet breeding programs in different crops require different inputs. In order to further evaluate DNA-informed effectiveness in perennial crops, we conducted a cost-benefit analysis examining marker-assisted selection (MAS) in an upper Midwest peach breeding program. Itemized costs and per unit costs were based on annual production costs from the program. Using these costs, simulations were conducted comparing MAS at the end of seedling test orchards with cull rates of low (40%), medium (60%), and high (80%) to conventional breeding methods. Additional simulations were then used to explore impacts of using MAS at an earlier stage prior to planting in seedling test orchards with cull rates of low (10%), medium (25%), and high (50%). To further investigate the relationship between labor cost and MAS utilization, sensitivity analyses were conducted examining decreases in seedling maintenance costs and MAS laboratory costs. These results serve to inform breeders of the cost-effectiveness and viability of DNA-informed breeding.
Specified Source(s) of Funding: Specialty Crop Research Initiative projects, "RosBREED: Enabling marker-assisted breeding in Rosaceae" (2009-51181-05808) and "RosBREED: Combining disease resistance with horticultural quality in new rosaceous cultivars" (2014-51181-22378)

1:00 PM – 1:45 PM *International Ballroom East/Center*

Ornamental Plant Breeding (Poster)

A New Landscaping Garden Chrysanthemum Cultivar 'Cushion Ball' with Bicolor Petals, Spreading Type and Decorative Flower (poster)

DongChan Kim*, *Chungcheongnam-do A.R.E.S.*; HaSeung Park, *Chungcheongnam-do A.R.E.S.*; Kuksong Son, *Flower Research Institute*; JongJin Choi, *Chungcheongnam-do A.R.E.S.* and Neil Anderson, *University of Minnesota (Poster Board #068)*

Abstract: Abstract. The garden chrysanthemum is one of the most beloved flowers in Korea. It has become increasingly being sold as pot and landscaping plants in Korea. The objective of the breeding of garden mum is to make a spreading type that can be planted on landscape area with a short plant height. 'Cushion Ball' is the newest garden chrysanthemum (*Dendranthema grandiflorum)* releases from the Flower Research Institute in Chungcheongnam-do ARES. 'Cushion Ball' is the result of a cross pollination between '09-04-73' and '09-78-10'. The characteristics were investigated from 2014 to 2016 for the evaluation and selection of this variety in natural culture condition. It is a vigorous and uniform plant that usually begins blooming in the early of October. It has decorative type flowers, bicolor with white and yellow color petals and plant shape of spreading type. The diameter of flower is 6.3cm, the plant height is 15.5cm, and the number of flowers is 685. These were checked local adaptability about the characteristics of growth and flowering at Yesan-gun and Suwon city. Abstract. The garden chrysanthemum is one of the most beloved flowers in Korea. It has become increasingly being sold as pot and landscaping plants in Korea. The objective of the breeding of garden mum is to make a spreading type that can be planted on landscape area with a short plant height. 'Cushion Ball' is the newest garden chrysanthemum (*Dendranthema grandiflorum)* releases from the Flower Research Institute in Chungcheongnam-do ARES. 'Cushion Ball' is the result of a cross pollination between '09-04-73' and '09-78-10'. The characteristics were investigated from 2014 to 2016 for the evaluation and selection of this variety in natural culture condition. It is a vigorous and uniform plant that usually begins blooming in the early of October. It has decorative type flowers, bicolor with white and yellow color petals and plant shape of spreading type. The diameter of flower is 6.3cm, the plant height is 15.5cm, and the number of flowers is 685. These were checked local adaptability about the characteristics of growth and flowering at Yesan-gun and Suwon city.

Effects of a Floral Cut on the Retention of Eriophyid Mites on Rose Cuttings (poster)

Katherine Solo, *University of Tennessee*; Sara Collins, *University of Tennessee*; Reza Hajimorad, *University of Tennessee*; Frank Hale, *University of Tennessee*; John Wilkerson, *University of Tennessee*; Alan Windham, *University of Tennessee*; David Byrne*, *Texas A&M University* and Mark Windham, *University of Tennessee (Poster Board #069)*

Abstract: Rose cuttings from the field are treated with floral cuts to reduce the number of eriophyid mites that drop off in transit to the laboratory. The theory is that the change in osmotic pressure within the cane can trigger a mite to abandon its host. To streamline the collection process and reduce sampling time, an experiment was developed to determine the necessity of floral cuts for the retention of eriophyid mites. Four groups of plants (healthy Knock Outs, RRV infected Knock Outs, healthy multiflora, and RRV infected multiflora) were evaluated at different time intervals (0.5, 2, 4, 8, 24, 48, 72, 96 hours post-harvest) to assess the number of mites per gram of tissue that were present. Cut type and rose species were not found to have a significant effect on the number of mites per gram of tissue found. Floral cuts are not needed for accurate recovery of eriophyid mites. RRV infected rose cuttings were found to have 42 times as many mites per gram as healthy rose cuttings.
Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches" 2014-51181-22644/SCRI

Ploidy Determination of Rose Cultivars and Progeny of Interploidy Crossses (poster)

Ellen L. Young*, *Texas A&M University*; Jeekin Lau, *Texas A&M University*; Jinrong Bai, *Key Lab of Beam Technology and Material Modification of Ministry of Education, College of Nuclear Science and Technology, Beijing Normal University*; Wenji Xu, *Shenyang Agricultural University*; Jonathan Corser, *Texas A&M University* and David Byrne, *Texas A&M University (Poster Board #070)*

Abstract: Roses (x=7) can have a range of ploidy levels from diploid to decaploid, though most garden rose cultivars are tetraploid, triploid, or diploid. For the purposes of genetic studies, it is useful to distinguish between ploidy levels; however, there are not consistent, reliable morphological differences between roses of different ploidy levels, making direct ploidy determination necessary. In our program, we have found root squashes to be most useful for ploidy determination in roses, as flow cytometry results can be challenging for roses and pollen assessment is not always reliable. Using this technique, we have determined or confirmed the ploidy of 58 cultivars and species, and have tentatively determined the ploidy of 12 more. Among those definitely identified, we found 16 diploids, 7 triploids, and 34 tetraploids. Some of these results were surprising based on pedigree; for example, 'Himmelsauge', allegedly the progeny of diploid *Rosa setigera* and diploid *Rosa rugosa,* was shown to be either triploid or tetraploid. Furthermore, as roses can be successfully bred between ploidy levels, we also determined the ploidy of seedlings from crosses between the triploid cultivar 'Home Run' and various diploids and tetraploids. These interploidy crosses were found to produce both triploids and tetraploids, confirming that triploids likely produce mostly diploid pollen. Interestingly, a diploid by triploid cross was found to produce one tetraploid. This information will be used to inform breeding efforts as well as identify diploids for a potential genome-wide association study (GWAS).
Specified Source(s) of Funding: USDA-SCRI "Combating Rose Rosette Disease: Short Term and Long Term Approaches" (2014-51181-22644/SCRI)

Improved Gerbera Transcriptome Assembly Using a Combination of Four Assemblers (poster)

Krishna Bhattarai*, *Gulf Coast Research and Education Center, University of Florida* and Zhanao Deng, *University of Florida (Poster Board #071)*

Abstract: Gerbera daisy is popular for its attractive flowers available in a wide array of colors. It is also used as a model plant to study flower development and secondary metabolites. Genomic and transcriptomic information and resources are very limited in gerbera, due to a number of factors including a large genome size (5.5 Gb) and a high level of heterozygosity. In this study, we sequenced and assembled the leaf transcriptomes of two gerbera breeding lines with a contrasting phenotype in flower color, flower form, peduncle length, and powdery mildew resistance. We used four different *de novo* transcriptome assembly pipelines: SOAP, Trinity, Velvet, and TransAbyss and

produced a composite assembly of the gerbera daisy leaf transcriptome consisting of 145,348 contigs with a N50 value of 1124 nucleotides and a mean contig length of 761 nucleotides. Our experience showed that the use of multiple assemblers significantly improved the quality of the gerbera daisy leaf transcriptome compared to the assembly produced with Trinity alone. When Trinity was used alone, the assembly consisted of 528,630 contigs with a N50 value of 708 nucleotides. Gerbera daisy leaf transcripts showed highest similarities with *Helianthus annus* and *Cynara cardunculus* var. *scolmus* (both belonging to Asteraceae family), with 13,888 and 13,406 gerbera transcripts similar to the genes of the latter two species, respectively. The high quality gerbera daisy leaf transcriptome assembly should facilitate downstream analyses of gerbera transcriptome including transcript quantification, identification of differentially expressed genes, and identification of candidate genes in gerbera resistance to powdery mildew.

Identification and Characterization of Rust Resistant Lines from Dwarf Mutants of Perennial Ryegrass (poster)

Rahul Kumar*, *University of Connecticut*; Huseyin Yer, *University of Connecticut*; Rania EL-Tanbouly, *University of Connecticut, Storrs, USA* and Yi Li, *Nanjing Agricultural University (Poster Board #072)*

Abstract: Perennial ryegrass (*Lolium perenne,* L.*)* is an important cool-season turfgrass species which is widely cultivated around the world. Perennial ryegrass is very fast to establish, which makes it very favorable for ornamental use. Crown rust (*Puccinia coronata Corda f. sp. lolii*) is one of the most devastating fungal diseases of perennial ryegrass, causing significant economic losses worldwide. Rust infections can be controlled by fungicide chemicals, but the approach is pollutive and expensive. However, breeding rust resistance cultivars of perennial ryegrass may provide a better solution. We have isolated 16 dwarf mutants from an ethyl methanesulfonate (EMS)- and gamma-treated population of "Fiesta 4" cultivar of perennial ryegrass. Under a field condition, we have observed that the wildtype "Fiesta 4" plants were severely infected by rust with an average score of 4.9 (a score of "5" indicates all leaves were infected by rust while "0" is indicative of no infection). Meanwhile, under the same condition, some mutant plant lines scored 0 on average, and the others had an average score of 1-3. It appears that the rust resistance is related to the degrees of dwarfness of the mutant lines. We are currently further evaluating a small number of the rust resistant mutant lines under growth chamber conditions. The mutants identified from this study may provide valuable resources for understanding of the mechanism of rust resistance observed in our dwarf mutants and also for breeding of novel rust resistant perennial ryegrass cultivars.

Specified Source(s) of Funding: UConn College of Agriculture

Discovery of Quantitative Trait Loci for Plant Architecture in Diploid *Rosa* (poster)

Ellen L. Young*, *Texas A&M University*; Xuan Wu, *Texas A&M University*; Shuyin Liang, *Texas A&M University*; Muqing Yan, *Texas A&M University*; Eric van de Weg, *Wageningen University & Research*; Patricia Klein, *Texas A&M University* and David Byrne, *Texas A&M University (Poster Board #073)*

Abstract: Plant architecture, which is the result of both the plant organization and the interaction between the plant and the environment, affects the ornamental value and flower productivity of roses. Thus, it is helpful to understand the genetic basis of plant architecture so that breeding efforts can be directed towards improved architecture. To this end, six rose architectural traits (plant height, number and length of primary shoots, number of nodes on primary shoot, number of secondary/tertiary shoots per primary shoot) were evaluated in May and December of 2015 in College Station, TX in 13 interrelated diploid rose populations segregating for plant architecture types. Number of primary shoots, length of primary shoots, and number of nodes on primary shoots were found to have low to moderate narrow sense heritability and moderately high to high broad sense heritability, making them of particular interest for breeding. These populations were also genotyped for single nucleotide polymorphisms (SNPs) by digital genotyping, a genotyping by sequencing technique and a consensus map was developed using JoinMap 4.1. The software FlexQTL, a pedigree-based approach which uses a Bayesian analysis, was used to detect quantitative trait loci (QTLs) for these plant architecture traits. Future work will involve identifying specific markers for these traits to enable efficient breeding for superior rose architecture.

Specified Source(s) of Funding: USDA-SCRI, "Combating Rose Rosette Disease: Short Term and Long Term Approaches" (2014-51181-22644/SCRI) and "RosBREED: Combining Disease Resistance with Horticultural Quality in New Rosaceous Cultivars" (2014-51181-22378)

Heritability of Flower Size and Heat Stress in Diploid Roses (poster)

Jeekin Lau*, *Texas A&M University*; Shuyin Liang, *Texas A&M University*; Xuan Wu, *Texas A&M University*; Muqing Yan, *Texas A&M University*; Patricia Klein, *Texas A&M University*; Ellen L. Young, *Texas A&M University*; Eric van de Weg, *Wageningen University & Research* and David Byrne, *Texas A&M University (Poster Board #074)*

Abstract: Heat stress on roses (*Rosa x hybrida*) negatively affects rose performance and reduces the market value of the crop. The effect of heat on flower size was assessed with a heat shock treatment (44°C for 1 hour) and in the field during the cool (~20°C) and warm (~30°C) seasons of the year for 10 and 9 interrelated diploid rose populations respectively. The elevated temperature caused a decrease in flower size under both conditions for flower diameter (~16-18%), petal number (~23-17%), and flower weight (~17-32%). Flower size showed low to moderate (flower diameter, 0.24-0.38; petal number, 0.12-0.26; flower weight, 0.34-0.53) narrow and moderate (flower diameter, 0.62-0.70; petal number, 0.74-0.91; flower weight, 0.76-0.88) broad sense heritability inferring a major non additive genetic component for flower size. Differences in heat tolerance would indicate that roses respond differentially to the environment (heat stress). Thus in a genetic variance analysis, a high GxE variance would indicate genetic differences in heat stress. Among the three size parameters, flower diameter showed the largest GxE genetic variance. The populations were genotyped using genotyping by sequencing and the SNPs were used to create a consensus map with JoinMap 5. Using the consensus map in FlexQTL, a pedigree based QTL analysis software, for flower petal number, flower diameter, and flower dry weight was done.

Specified Source(s) of Funding: "RosBREED: Combining Disease Resistance with Horticultural Quality in New Rosaceous Cultivars" (2014-51181-22378/SCRI) and "Combating Rose Rosette Disease: Short Term and Long Term Approaches" (2014-51181-22644/SCRI).

The Search for Resistance to Rose Rosette Disease (poster)

David Byrne*, *Texas A&M University*; Ellen L. Young, *Texas A&M University*; Jeekin Lau, *Texas A&M University*; Tom Evans, *University of Delaware*; Daniele Novick, *University of Delaware*; Kevin Ong, *Texas A&M AgriLife Extension Service*; Madalyn Shires, *Texas A&M University*; Jennifer Olson, *Oklahoma State University* and Mark Windham, *University of Tennessee (Poster Board #075)*

Abstract: Rose rosette disease is caused by the Rose Rosette Virus (Emaravirus) and transmitted by the eriophyid mite Phyllocoptes fructiphilus. Since 2015, the Combating Rose Rosette Disease SCRI project has been evaluating a wide range of rose germplasm for its resistance to RRD in replicated plots in Tennessee, Delaware, Oklahoma, and Texas. In addition, observational data was collected from a number of gardens. Thus far, about 900 rose accessions have been observed. Of these 900 accessions, 850 have developed typical symptoms of RRD although most have not been tested to verify that the virus is present in the plant. The first replicated trials were planted in Tennessee and Delaware and contained 227 unique rose accessions with 68% planted at both sites. The disease pressure in these sites was augmented by attaching symptomatic shoots with mites from infected plants to the test plants. After 2 years in the field, there are still 34 rose accessions that have not yet shown symptoms nor have been detected with the virus. This includes 12 garden roses, 7 rugosa hybrids, 8 Rosa species accessions, and 8 selections from the TAMU breeding program. These will be tested for one more season to confirm their resistance to the disease.

Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches"

2014-51181-22644/SCRI

Confirmation of *Hibiscus Syriacus* Allotetraploid Genome and Disomic Segregation Patterns Using rDNA Fluorescent *in Situ* Hybridization. (poster)

Hsuan Chen*, *Oregon State University*; Jason D. Lattier, *US National Arboretum - USDA* and Ryan Contreras, *Oregon State University (Poster Board #076)*

Abstract: *Hibiscus syriacus* is a woody ornamental shrub in the Malvaceae family and is commonly found throughout much of the U.S. due to its broad adaptability and variability of ornamental characteristics. Although *H. syriacus* is a very popular ornamental plant, little is known about its pattern of inheritance of ornamental traits such as flower color and petaloid stamens. *Hibiscus syriacus* has been identified as tetraploid based on its chromosome number (2*n* = 4*x* = 80); however, relatively little additional cytology or genetics information is available. In this study, a hexaploid (6*x* = 120) cultivar 'Pink Giant' was used to cross with tetraploid (4*x*) cultivars, and to create putative pentaploids (5*x*). Fluorescent *in situ* hybridization (FISH) was used to determine 45S and 5S rDNA loci numbers of 4*x*, 6*x*, and putative pentaploids. For the 4*x* and 6*x* cultivars, 4 and 6 signals of 45S rDNA were observed; however, only 2 and 3 signals of 5S rDNA were detected. Furthermore, the signal numbers of these putative pentaploids varied among siblings. The segregation patterns of rDNA signals in *H. syriacus* appeared to be random among the putative pentaploids and signals for each rDNA site ranged between the values of the two parents. Both the 5S rDNA loci numbers and the random segregation loci of putative pentaploids indicated that the *H. syriacus* genome presented with disomic segregation. In addition, the variation in rDNA loci number indicated that the putative pentaploids were actually aneuploids. This information is valuable for targeted *H. syriacus* breeding in that it will allow prediction of segregation patterns of ornamental traits.

Specified Source(s) of Funding: Oregon Department of Agriculture

Evaluation of Garden Rose Species, Cultivars, and Breeding Populations for Disease Resistance and Landscape Performance in Texas (poster)

Brent Pemberton*, *Texas A&M AgriLife Research and Extension Center, Texas A&M University*; Ellen L. Young, *Texas A&M University*; Jeekin Lau, *Texas A&M University*; Stella Kang, *Texas A&M University*; David Zlesak, *University of Wisconsin, River Falls*; Cody Bishop, *Texas A&M AgriLife Research and Extension Center, Texas A&M University*; Natalie Anderson, *Texas A&M University* and David Byrne, *Texas A&M University (Poster Board #077)*

Abstract: In 2015 and 2016, plants of almost 300 garden rose entries were field planted in Overton, Texas for evaluation of disease development and landscape characteristics. The entries included species and modern roses including hybrid tea, hybrid rugosa, and traditional and modern shrub type roses. Plants were planted in a randomized complete block design and evaluated monthly during the 2017 growing season for disease incidence of black spot (*Diplocarpon rosae*) and landscape performance. During the growing season at Overton, overall black spot incidence varied from 4.1 in June and July to 5.1 in November using a rating scale of 0 to 9 with 0 representing a total lack of disease and 9 denoting all foliage infected with heavy defoliation and reduced plant vigor. Many species roses such as *Rosa bracteata* and hybrids such as John Davis and Oso Happy Candy Oh exhibited the lowest black spot ratings. Highest ratings were given to mainly commercial cultivars such as Intrigue and Linda Campbell. Also, in 2017 a breeding population was planted to evaluate disease incidence. Rust was seen for the first time in the Overton plantings in this population and was only present in the *R. setigera* crosses. Forty percent of the seedlings of *R. setigera* x Bayse's Thornless, 20% of the seedlings of *R. setigera* (or *R. s. serena*) x Pink Gnome, and a seedling of *R. setigera* x X566-81 were rust free. All crosses involving Driveway Red with *R. setigera* or *R. s. serena* were rust free. This information will be valuable for genetic studies and for determining entries useful for future breeding.

Characterizing and Identifying Black Spot Resistance Genes in Polyploid Roses (poster)

Jason Zurn, *USDA-ARS, NCGR*; David Zlesak, *University of Wisconsin, River Falls*; Matthew Holen, *University of Minnesota*; James M. Bradeen, *University of Minnesota*; Stan Hokanson, *University of Minnesota* and Nahla V. Bassil*, *USDA-ARS Corvallis (Poster Board #078)*

Abstract: The ornamental quality of outdoor grown roses (*Rosa hybrida*) is under constant threat from foliar diseases, such as black spot caused by *Diplocarpon rosae*. Fungicides are primarily used to manage black spot; however, there is a high consumer demand for disease resistant roses which eliminate the need for chemical inputs. Phenotyping with 12 *D. rosae* races was conducted to better characterize resistance in four popular polyploid rose cultivars (Brite Eyes™, High Voltage™, Lemon Fizz™, and Morden Blush). Subsequently, two populations ('Morden Blush' × Brite Eyes™ and High Voltage™ × Lemon Fizz™) were developed to study resistance segregation and map the genes mediating black spot resistance using the rose Axiom array. 'Morden Blush' was susceptible to all races while the remaining three cultivars displayed differing disease responses. A 1:1 segregation ratio was observed for the two populations where each individual was either resistant or susceptible to all races tested to date, suggesting resistance is conferred by a single resistance gene in Brite Eyes™ and Lemon Fizz™. High Voltage™ is expected to have a different resistance gene than Brite Eyes™ and Lemon Fizz™ based on observed disease responses. Linkage mapping in the 'Morden Blush' × Brite Eyes™ population identified a single resistance gene that mapped to a chromosome 5 homeolog (*Rdr4*). To date, three black spot resistance genes, *Rdr1, Rdr2*, and *Rdr3*, have been identified. *Rdr1* and *Rdr2* both map to chromosome 1 indicating they are not allelic to *Rdr4* and the location of *Rdr3* is currently unknown. *D. rosae* races 3 and 9 are virulent on *Rdr3* but avirulent on *Rdr4.* As such, we cannot confirm if *Rdr4* is a unique gene or an allele of *Rdr3*. Future work will focus on developing tools for marker assisted breeding and pyramiding the identified resistance genes into new cultivars.

Specified Source(s) of Funding: USDA-ARS-NIFA project 'RosBREED: Combining Disease Resistance and Horticultural Quality in New Rosaceous Cultivars' (2014-51181-22378)

Combatting Rose Rosette Disease(RRD) with the Use of Web-Based Outreach Tools to Engage Volunteers for Research. (poster)

Kevin Ong*, *Texas A&M AgriLife Extension Service*; Madalyn Shires, *Texas A&M University* and Joseph LaForest, *University of Georgia (Poster Board #079)*

Abstract: In 2014, the project entitled "Combating Rose Rosette Disease: Short-term and Long-term Approaches", was funded by a NIFA Specialty Crop Research Initiative grant to address the growing impact of this disease on the rose industry. Rose breeders are searching for resistant germplasm that could be used to develop roses with resistance to RRD. To date, no cultivated rose has been confirmed resistant to the virus that causes this disease. An effort to reach out and seek public involvement to help accelerate the research was executed. A website (*http://roserosette.org*) was developed to serve as a clearinghouse of RRD information for the general public, but also to engage and recruit the public to assist in monitoring for RRD. This reporting tool that was launched in the 4th quarter of 2017, aims to encourage the report of suspected RRD and the rose cultivars where these symptoms were observed. To date (3/15/2018), this reporting system has registered 197 reports submitted. 13 have been verified via visual (photograph), 143 are credible or plausible reports and 30 had been confirmed by PCR. This website and the reporting tool is being actively marketed at current time. We anticipate a continued increase in usage and recovery of valuable information that would inform and help to accelerate our efforts to discover current cultivars with resistance to RRD.

Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches" 2014-51181-22644/SCRI

1:00 PM – 1:45 PM *International Ballroom East/Center*

Plant Growth Regulation (Poster)

Ethanol Treatment Induces Compact Growth in *Euphorbia Pulcherrima* (poster)

Margrethe Serek*, *Leibniz University Hannover (Poster Board #325)*

Abstract: One of the most important characteristics of ornamental potted plants is their proper compact growth habit. The most common way to achieve compactness during plant production is usage of chemical growth retardants. However, some of these chemicals have a hazardous character and have been prohibited in a range of European countries due to their toxicity to humans and negative impact on environment.

In our studies we investigated the influence of ethanol treatment on a growth habit of a popular ornamental potted plant *Euphorbia pulcherrima* cv. Premium Ice Christal. During vegetative growth the plants were watered with ethanol solution in concentrations: 0, 0.5, 1, 2, 4 or 8%. All concentrations of ethanol, except 0.5%, resulted in more compact growth than control plants, however, the concentrations of 4% or 8% caused chlorotic and necrotic spots, or in some cases even death of the plant. Fresh and dry weight, and plant diameter decreased when concentration of ethanol increased. No delay in coloration of bracts was observed.

Ethanol treatment used in appropriate concentrations appears to be an excellent alternative to chemical growth retardants for induction of compact growth. Ethanol is inexpensive, biodegradable material, non-toxic in proper concentrations, which can easily be integrated into a commercial production.

Influence of Paclobutrazol on Growth, Compositon and Number of Different Shoots in High Density Pecan Orchard (poster)

Haijun Zhu*, *Jiangsu Acedamy of Agricultural Sciences* and Guangqin Liu, *Jiangsu Acedamy of Agricultural Sciences (Poster Board #326)*

Abstract: Close spacing is the fastest way to generate a lot of pecans in early years. With the application of much better precocious cultivars and improved horticultural technologies, high density pecan production could be achieved. Like some other fruit trees, most of the fruits bear only on the shoots with terminal growth less than 30 cm. However, young pecan trees always have vigorous vegetative growth with the terminal growth greater than 50 cm. It's difficult to generate pecans on young trees. This experiment was carried out to: (1) evaluate the effects of paclobutrazol on inhibiting pecan vegetative growth and increasing the number of bearing branches. (2) investigate composition of different kinds of branches.

The study was conducted from 2012 through 2014 in a 6-year-old pecan orchard in Nanjing, Jiangsu, China. 'Mahan' trees were spaced 5×7.5 m apart. Trees appeared to be crowding as limbs began to intermesh within rows. Most newly branches grew much than 30 cm which couldn't form flower buds. Paclobutrazol (15% a.i.) was applied to trees via soil drench (rates of 0, 30, 90, and 150 mg/cm^2 trunk cross-sectional area). The four treatments initially were applied in a randomized complete block design to three replications. Terminal shoot growth was measured in April 2013 and 2014, and 10 terminal shoots were selected on each of four sides of the tree at the height of maximum limbspread.

Compared with the control, the application of PBZ treatments significantly increased the number of branches (less than 30 cm) by 76.4%, 141.0%, 54.0% respectively, and decreased branches (greater than 30 cm) by 48.3%, 64.2%, 60.3% respectively. The cumulative growth of current-season shoots was significantly inhibited in comparison with the control. The chlorophyll content of leaves was significantly increased in response to paclobutrazol application.

Unravelling Cadmium Toxicity and Nitric Oxide Induced Tolerance in *Cucumis sativus*: Insight into Regulatory Mechanisms Using Proteomics (poster)

Biao Gong*, *Shandong Agricultural University* and Yanyan Yan, *Shandong Agricultural University (Poster Board #327)*

Abstract: Nitric oxide (NO) is a signal molecule that can mediate a wide range of physiological processes against cadmium (Cd) toxicity in plants. However, little information can be used to reveal the global and systematic mitigative mechanism of NO in improving Cd stress tolerance of cucumber plants. In the present study, we used Isobaric Tag for Relative and Absolute Quantification (iTRAQ) analysis to identify 1,691 proteins, which can be used to determine the role of NO in regulating the molecular changes of proteome in cucumber leaves exposed to Cd stress. Several dysregulated key proteins indicated that Cd-induced physiological deterioration of cucumber leaves were mainly involved in metabolic process, cellular process, response to stimulus and so on. Metabolic pathway analysis indicated that several Cd-disruptive pathways were markedly reversed by NO treatments, including Cd transport and localization, photosynthesis, chlorophyll metabolism, redox homeostasis, glutathione-mediated Cd detoxification and Ca^{2+} signaling transduction. Taken together, this iTRAQ analysis provides more comprehensive insights into the physiological and molecular mechanisms of NO against Cd toxicity in cucumber plants.

Specified Source(s) of Funding: National Natural Science Foundation of China (31501779)

Molecular Characterization of the Role of Weep in Directing Branch Orientation in Peach Trees (poster)

Joseph L. Hill*, *Michigan State University*; Jameel Al-Haddad, *Michigan State University*; Frank Telewski, *Michigan State University* and Courtney A. Hollender, *Michigan State University (Poster Board #328)*

Abstract: Control of shoot architecture is a fundamental aspect of plant growth and development. The dissection of molecular mechanisms controlling architecture is important for understanding the basic biological question of 'how plants grow' while also having potential agro-economic impacts. Manipulation of shoot architecture allows plants to acquire sufficient levels and quality of light. Variation in the architecture of fruit trees can improve fruit quality and size as well as potentially reducing the cost of training, production, and orchard maintenance. Recently, a mutation in the uncharacterized and highly conserved *WEEP* gene was identified as the cause of a downward growing (weeping) growth habit in peach, implicating *WEEP* in the control of lateral shoot growth in trees. Here, we begin to elucidate the molecular mechanism of WEEP and its effect on branch growth. *weep* branches were subjected to a 4-point bending test, which demonstrated similar structural properties as standard peach branches, rejecting the hypothesis that the downward-growing weeping growth habit results from weak or 'floppy' branches. Histological and wood chemistry analyses were conducted to determine how changes in the cell wall could lead to alteration of branch growth habit. However, no obvious differences between *weep* and standard peach in the quantity or distribution of cell wall polymers were observed. Fiber cells of *weep* were found to be slightly shorter than those of standard peach, suggesting a role for WEEP in cell elongation. To investigate biochemical roles of WEEP, we have developed a specific antibody to this protein and are currently investigating its subcellular localization, expression pattern, and are using co-immunoprecipitation to discover interacting protein partners. This characterization will aid in understanding molecular function and pathways of WEEP and how this protein contributes to the control of lateral shoot architecture in trees.

Specified Source(s) of Funding: USDA NIFA Award #2018-67013-27457

The Impacts of Altering Source-Sink Dynamics on Non-Climacteric Pepper Ripening On- and Off-Plant (poster)

Sijia Guo*, *The University of Adelaide*; Jason A. Able, *The University of Adelaide* and Amanda J. Able, *The University of Adelaide (Poster Board #329)*

Abstract: Bell pepper, *Capsicum annuum* L., is one of several, highly-valued greenhouse crops. However, because they are non-climacteric, if bell peppers are harvested green, they stay green. For green peppers to turn red, the ripening process requires an extra 20 to 30 days on the plant. The aim of this study was to investigate source-sink dynamics during pepper ripening on- and off-plant. To examine the impacts on on-plant ripening, source-sink dynamics were altered by various levels of leaf removal and complete removal of the phloem when fruit were at either green or breaker. Physiological parameters such as fresh weight, firmness, colour, total carotenoids and chlorophylls were then measured at 0, 5, 10, 15 and 20 days after treatment (DAT). Compared with breaker-treated fruit, green fruit from plants where leaves and phloem had been removed showed a delay in the on-plant ripening process until 15 DAT. Furthermore, the greater the leaf removal rate, when fruit were green, the greater the delay to colour development and carotenoid content.

Interestingly, phloem removal from plants when fruit were green not only significantly delayed the ripening process but also resulted in significantly higher fresh weight between 5 DAT and 15 DAT when compared to control fruit. Together, these results suggest important roles for sugar availability in on-plant pepper ripening. With 80% leaf removal having the greatest impact, this treatment was then selected to examine the effects on the behaviour of fruit during storage at 0, 6, 12 and 20 days after harvest. However, there was no effect of the preharvest leaf removal on any physiological parameter related to ripening during postharvest storage. Therefore, although source-sink dynamics appear to be important for pepper ripening on the plant, there may be other triggers for induction off the plant that require investigation.

Specified Source(s) of Funding: Not yet decided

Micropropagation of *Epidendrum nocturnum,* an Endangered Native Orchid Using Organic Media (poster)

Douglas De Stefano, *Florida International university*; Amir Khoddamzadeh*, *Florida International University* and Jason Downing, *Fairchild Tropical Botanic Garden (Poster Board #330)*

Abstract: Overharvesting and deforestation has led to the critical endangerment of many native South Florida orchid species. Conservation efforts of these rare orchids has, in the past, proven difficult, as the propagation of orchids in nature is uncommon. Due to their tiny, dust-like seeds, which lack an endosperm, orchids require assistance from species-specific mycorrhizal fungi that form a symbiotic relationship with the orchids, in which the fungi provides nutrients for germination and embryo development. Because of this complex specialized relationship, germination rates in nature are exceedingly low. Using *in-vitro* micropropagation methods, in which artificial growth mediums provide the necessary nutrients, thus, eliminating the need for the fungi symbiont, germination rates can reach nearly 100%. *Epidendrum nocturnum* is an imperiled (IRC) native south Florida orchid species and the focus of this study. *E. nocturnum* is epiphytic with fragrant yellowish and white flowers ranging from 3-5 inches. Traditionally, the orchid grows on a variety of trees throughout the swamps and hammocks of south Florida. The aim of this study was to use biotechnological conservation methods to develop a protocol for the micropropagation of *E. nocturnum* using organic amendments in the growth medium.

Specified Source(s) of Funding: USDA-NIFA Hispanic Serving Institutions Higher Education Grants Program (2016-03476-2009)

1:00 PM – 1:45 PM *International Ballroom East/Center*

Plant Nutrient Management (Poster)

Investigating Silicon As a Beneficial Nutrient for Leafy Green Crops (poster)

Yuan Li*, *Rutgers University (Poster Board #195)*

Abstract: Silicon (Si) accumulator species such as rice, wheat and cucurbits can absorb and accumulate soluble silicate under normal growing conditions and gain beneficial effects from the Si deposit under the cuticle. However, Si non-accumulator species such as leafy green vegetables have not been investigated very much. Recent studies have found that some Silicon non-accumulator species can start uptake Si and obtain benefits when under biotic or abiotic stresses. We investigated different levels of silicon amendments to the nutrient solutions of several hydroponically grown leafy green crops (lettuce, basil and bok choy, representing the common leafy green vegetable families *Asteraceae*, *Lamiaceae* and *Brassicaceae*), and observed the Si uptake and plant growth characteristics under heat & cold stress or physical damage. Basil with Si amendment showed significantly increased cold tolerance. Si amended lettuce and bok choy showed moderate increase in heat tolerance. The Si levels in basil, lettuce and bok choy plant tissue were increased after cut and grow back treatment. Our results indicate Si is an overall beneficial nutrient to the non-accumulator species.

Effect of Turfgrass Species on Water Extractable Inorganic N and P (poster)

Emily Hyde, *Oklahoma State University*; Charles Fontanier*, *Oklahoma State University* and Becky Cheary, *Oklahoma State University (Poster Board #196)*

Abstract: Eutrophication of urban surface waters is a significant problem associated with excess nutrient pollution. Historically, regulatory agencies have attributed urban eutrophication to fertilizer use in lawns and golf courses. Scientific evidence suggests nutrient pollution from turfgrasses can be minimal if fertilizer is applied according to best management practices. Specifically, numerous reports have shown that applied fertilizer is quickly taken up by turfgrass roots and made unavailable to environmental losses. Whether N and P content of turfgrass plants influences the nutrient content of runoff is undocumented. The objective of this study was to directly assess the leachability of N and P from turfgrass above-ground tissues in order to simulate the effects of runoff moving through a turfgrass field.

Bermudagrass (*Cynodon dactylon*) and perennial ryegrass (*Lolium perenne*) were established in 5 cm diameter pots containing a calcined clay (Turface MVP) rootzone. Treatments consisted of four N (urea) rates (0, 100, 200, 300 kg N ha^{-1}) and three P (triple superphosphate) rates (0, 10, 100 kg P ha^{-1}). Other plant essential nutrients were applied to prevent deficiencies using a commercial fertilizer. After six weeks of treatments, above-ground plant tissue was harvested and clipped to a uniform size before being subjected to a water extraction procedure. The extractant was filtered and analyzed for nitrate-N, ammonium-N, and orthophosphate-P concentration. Plant tissue N and P concentration were measured using reserved above-ground tissue. Relationships between application rates, plant tissue nutrient concentration, and extractable nutrient concentration varied between turfgrass species. In bermudagrass, N tissue content increased with increasing N rate while extractable dissolved inorganic N decreased. A similar pattern was seen for P rates in bermudagrass. In ryegrass, P tissue content decreased with increasing P rate suggesting faster growth under higher P rates led to nutrient dilution in plant tissues. These findings suggest healthy turfgrass tissue (lacking in nutrient deficiency) would not likely be a direct source of inorganic nutrients in an urban watershed.

Mineral Content of Cilantro (*Coriandrum sativum* L.) in the Condition of Combined Drought and Salt Stress (poster)

Selda Ors*, *Atatürk University*; Melek Ekinci, *Atatürk University*; Ertan Yildirim, *Atatürk University*; Metin Turan, *Yeditepe Üniversity*; Ustun Sahin, *Atatürk University*; Hilal Yildiz, *Nevşehir Hacı Bektaş Veli Üniversity* and Atilla Dursun, *Atatürk University (Poster Board #197)*

Abstract: Salinity and drought are the main and common abiotic stresses that reduce crop growth and the productivity in addition to plant nutrient uptake is very sensitive to environmental stress factors. In this study we focused on the cilantro (*Coriandrum sativum* L.) mineral content and their transformations under abiotic stress conditions. For this aim we conduct a greenhouse experiment with different level of salinity and drought treatments. Four different salt doses (A0: 0 mM NaCl, A1: 50 mM NaCl, A2: 100 mM NaCl, and A3: 150 mM NaCl) and three different irrigation levels (I0: 100%, I1: 75% and I2: 50% of the water required to reach the field capacity) were applied and individual and combined effects of two stresses were evaluated.

Both drought and salinity altered the mineral-nutrient relations by decreasing N, P, K, Ca, Mg, Cu, Mn, Fe and Z of the coriander plants in general but Na, and B content of the plants were increased. The decrease in the content of N, P, K, Ca, Mg, Fe, Cu, Mn, and Zn were 27%, 29%, 15%, 17%, 13%, 7%, 22%, 20%, and 15% respectively in severe drought stress treatment (I2) and were 56%, 57%, 48%, 56%, 33%, 46%, 35%, 32%, and 27% in severe salt stress (A3) compared to control. The combined stress treatments (I2A3) caused more reduction in the content of N, P, K, Ca, Mg, Fe, Cu, Mn, and Zn (70%, 67%, 61%, 65%, 56%, 65%, 58%, 58% and 50% respectively). On the other hand increase of Na and B were 45% and 24% in I2, 51% and 35% in A3 and 118% and 78% in I2A3. The results of this study state that the effect of salt stress on cilantro was more destructive compared to drought stress. Besides, coexistence of the drought and salinity stress was deteriorated and the results demonstrate their roughly additive effects on the plant mineral content.

Using Sprinkler Irrigation and Fertigation to Save Water and Nutrients for Potato Production in Florida (poster)

Xiangju Fu, *University of Florida*; Crystal Snodgrass*, *University of Florida/IFAS Cooperative Extension*; Guodong David Liu, *University of Florida*; Lincoln Zotarelli, *University of Florida*; Steven Sargent, *University of Florida*; Yuqi Cui, *University of Florida* and Xiaolin Liao, *University of Florida (Poster Board #198)*

Abstract: Sustainable management of water and fertilizers is imperative for Florida's vegetable production. To save irrigation water and increase nutrient use efficiency for commercial potato production, we conducted a fertigation trial to explore the feasibility of adopting fertigation in Florida potato. The objectives were to: (1) evaluate water savings for commercial potato production using a sprinkler irrigation system and (2) determine the most efficient application method for fertigation in potato production. The effect of the sprinkler irrigation and hybrid irrigation systems on potato growth and development, whole plant physiology, and tuber yield and quality was assessed. Subsequently, two fertigation trials were completed in Hastings and Parrish, Florida. The trial in Parrish in Manatee County had two treatments including fertigation and dry granular fertilization. The results showed that the tuber yield of the chipping cultivar 'Atlantic' (season 2015~2016) had a 19% increase and the table cultivar 'Red LaSoda' (season 2016~2017) had a 24% increase compared with the fertigation treatment than with the other treatment. Also, another trial was conducted at UF/IFAS Hastings Agricultural Extension Center (HAEC) research farm to explore the best approach to fertigate potato plants. Eight fertigation treatments and four dry granular fertilization treatments were completed with different fertigation times and nitrogen rates. The results showed that five fertigation events each with total 10 lbs N/acre was the best combination for Florida potato. The fertigation treatments had greater tuber yield than the dry granular fertilization treatments. Fertigation may become an effective BMP tool for potato production in Florida.

Specified Source(s) of Funding: SWFWMD

Determining the Effect of Aluminum Sulfate Application on Red Hydrangea Sepals (poster)

Hunter Landis*, *North Carolina Department of Agriculture & Consumer Services*; Kristin Hicks, *North Carolina Department of Agriculture & Consumer Services*; Josh Henry, *North Carolina State University*; Ingram McCall, *North Carolina State University* and Brian Whipker, *North Carolina State University (Poster Board #199)*

Abstract: Hydrangeas (*Hydrangea macrophylla*) contain an anthocyanin pigment within the sepal that naturally produces a pink or red color. In the presence of aluminum (Al) the pigment will bind with the Al producing a blue or purple color. While most hydrangeas are marketed as a pink or blue there are some red cultivars. Red cultivars are managed similar to pink varieties in order to express their true red coloring. The purpose of this study was to determine if applications aluminum sulfate ($Al_2(SO_4)_3$) would change the color of the true red sepal. We treated 'Hot Red' hydrangeas with 0, 1.2, 1.8, 2.4, and 3.0 g/L of $Al_2(SO_4)_3$ applied during weekly irrigations. We measured the Al levels in the sepals, leaf tissue, and substrate leachate by ICP analysis at full bloom. Sepal colors were evaluated by visual analysis and measured using a handheld colorimeter. There was a positive correlation between the concentration of $Al_2(SO_4)_3$ applied and the level of Al in the sepal, leaf tissue, and substrate leachate. Regression models illustrated that each tissue continued to accumulate higher concentrations of Al as the $Al_2(SO_4)_3$ concentration increased. There was a noticeable change in sepal color with increasing concentrations of $Al_2(SO_4)_3$. Color data indicated that higher $Al_2(SO_4)_3$ concentrations resulted in darker sepals with more blue and less red coloration. Based on the findings, growers producing 'Hot Red' hydrangeas have the ability to manipulate the sepal coloration by applying $Al_2(SO_4)_3$.

Specified Source(s) of Funding: North Carolina Department of Agriculture and Consumer Services (Agronomic Division), North Carolina State University Floriculture, The Fred C. Gloeckner Foundation Inc.

Effects of Long-Term Application of Organic Fertilizer on Growth and Soil Microbial Properties of 'Huangguan' Pears (poster)

YC Xu*, *Nanjing Agricultural University* and Caixia Dong, *Nanjing Agric Univ (Poster Board #200)*

Abstract: Fertilizer input plays an important role in the production of pear trees, and rational fertilization is not only related to the improvement of pear orchard yield and quality, but also affects the soil fertility and economic benefits of pear orchard. 15-year-old 'Huangguan' pear trees were selected to study the influence of different organic fertilizers on pear tree growth, yield, fruit quality and soil biological properties. Four organic fertilizers were bio-organic fertilizer with PGPB (BOF1), bio-organic with phosphorus-solubilizing bacteria (BOF2), chicken manure(CM) and organic-inorganic compound fertilizer(CF), compared with no fertilizer (CK) and local traditional chemical fertilizers (TF). The results were as followed: Organic fertilizers improved the tree growth and promoted fruit yield and quality, especially bio-organic fertilizer with PGPB (BOF1). Compared with CK and local traditional chemical fertilizers (TF), organic fertilizers increased soil microorganism quantity, soil mineral nitrogen and promoted soil enzyme activity during the whole growth period of pear trees in different degrees. In addition, soil microorganism quantity and soil enzyme activity increased first and then declined during the growth period, and the quantity of soil microbial, sucrase activity and urease activity of BOF1 were highest of all. But the activity of acid phosphatase in soil was the highest under Bio-organic with phosphorus-solubilizing bacteria (BOF2). Nitrate nitrogen (NO_3^--N) was the main composition of the mineral nitrogen in soil. The content of mineral nitrogen under different fertilizer treatments decreased firstly and then increased gradually. In addition, the content of mineral nitrogen at young fruit stage and the second expansion stage reduced significantly. What's more, the content of mineral nitrogen under Bio-organic fertilizer with PGPB (BOF1) treatment was the highest during the whole growth stages.

Key words: 'Huangguan'pear；organic fertilizer；fruit；soil microbes

Specified Source(s) of Funding: This research was supported by the fund of China Agriculture Research System (CARS-28-10)

Spinach Response to Zn Fertilizers in the Desert (poster)

Charles Sanchez*, *University of Arizona (Poster Board #201)*

Abstract: Vegetable crops produced in the Arizona desert have always shown large yield and quality responses to N and P fertilization. Soil test based fertilizer recommendation of N and P have been developed by the Universities and N and P fertilizers are commonly used to optimize production. Because our irrigation water has K, and our soils have abundant K-bearing minerals, response to K fertilizers are very infrequent and K fertilizers are rarely used. This desert region in Arizona has been classified as an area prone to Zn deficiency. This is due to soil pH values greater than 7.5, and the presence of carbonate that ties up plant available Zn. However, measured crop responses to Zn had been lacking and the routine application of Zn fertilizer could not be economically justified. More recently, we have found spinach produced in this region often showed yield responses to low levels of Zn fertilization. In fact, we observed spinach yield responses in about 50% of the field studies we conducted. Interestingly, in a follow-up survey we found about 50% of the soils used for spinach production had DTPA soil-test Zn levels less the 1 ppm indicating a response to Zn was possible.

Specified Source(s) of Funding: SCBG

Nitrate and Phosphate Losses from Organic versus Inorganic Soilless Root Support Substrates during Nonrecirculating Hydroponic Culture of Swiss Chard (Beta vulgaris L.) (poster)

Jonathan Egilla*, *Lincoln University of Missouri*; Isabelle Nyirakabibi, *Lincoln University of Missouri*; Abua Ikem, *Lincoln University of Missouri*; Jimmie Garth, *Lincoln University of Missouri* and Marian Dolan-Timpe, *Lincoln University of Missouri (Poster Board #202)*

Abstract: Abstract.

This study compares the relative rate of nitrate and phosphate losses, and crop yield from 100% Coconut Coir (organic) or Perlite (inorganic) soilless root support substrates (SRSS) during the culture of Swiss chard (Beta vulgaris L.) cv. Acelga in a nonrecirculating hydroponic system (NRHS). Excess nutrient solution (15N–2.2P–12.5K plus micronutrients, supplied at 200 mg nitrogen/liter, pH 6.5 – 7.2) delivered by drip emitters to the SRSS

during each cropping cycle, flowed to drainage via 2-inch PVC pipes. Mean ambient day/night temperature and relative humidity during the cropping cycle were 22.9/8.5 C and 86.5/54.0%, respectively. We grew Swiss chard seedlings from the third true-leaf stage until the second harvesting at 103 days after transfer into hydroponic culture (DAT). Weekly leachate sampling from the NRHS for determination of nitrate and phosphate concentration started when the seedlings were fully established and capable of active mineral nutrient absorption. We analyzed the samples for nitrate and phosphate using the Dionex™ ICS-5000+ Capillary High Performance Ion Chromatograph System equipped with conductivity detector. Compared with the inorganic, the organic SRSS significantly reduced leachate nitrate and phosphate concentration by ~78% ($p = 0.0130$) and ~66.5% ($p = 0.0001$), respectively, compared with Perlite over a 103-day sampling period. The organic and inorganic SRSS reduced nitrate leaching losses by 77.8% ($p = 0.0004$) and 51.4%, ($p = 0.0113$), respectively, compared with the source nutrient solution (SNS) collected from the emitter. Although the phosphate concentration of the leachate were 56.2% and 38.0% less than that of the SNS in the organic and inorganic SRSS, respectively, overall differences averaged over the cropping cycle were not significant ($p = 0.05$), due to variability between batches of samples. Crop grown in the organic SRSS had significantly greater marketable leaf yield and leaf dry weight (LDW) ($p < 0.05$), but there were no differences in leaf count. Crop grown in the organic SRSS had higher leaf water content (LWC) ($p < 0.0047$) compared with the inorganic in one of the two replicates of the experiment. Reductions in nitrate and phosphate losses by both organic and inorganic SRSS over the cropping period can amount to significant savings in fertilizer cost at the percentages observed in this study. However, the organic SRSS shows a greater capacity to minimize potential environmental pollution by nitrate or phosphate discharge from small-scale nonrecirculating hydroponic operations, without limiting the growth and leaf yield of Swiss chard.

Specified Source(s) of Funding: USDA-NIFA Grants: MOLU-HYDROPONICS-05 & 06 funded all of the research associated this abstract.

Effect of Phosphorus Fertilizer Placement on Growth and Yield of Tomato in a Calcareous Soil (poster)

Qiang Zhu*, *University of Florida*; Monica Ozores-Hampton, *University of Florida* and Yuncong Li, *University of Florida (Poster Board #203)*

Abstract: The right placement of phosphorous (P) fertilizer can help overcome P fixation in calcareous soils. Banding application, including surface and deep banding, concentrates P fertilizer in narrow zone to provide higher nutrient concentration and less P fixation than broadcast application. The surface banding is preferred in vegetable production since it is a simple field application method. However, the movement of P to the root zone becomes a major concern when P is applied as surface banding. Thus, the objective of this experiment was to compare surface banding with deep banding based on the growth and yield of tomato (*Solanum lycopersicum,* cultivar Ridgerunner) grown on a calcareous soil. One field trial was conducted during the winter growing season of 2015 in Homestead, FL using plasticulture system with drip irrigation. Treatments included control (without any P addition), deep banding (78 kg ha^{-1} of P, incorporated into 4-inch deep soils after surface banding), and surface banding (78 kg ha^{-1} of P, applied in two bands with 2-inch width and 6 inches away from the bed center). Data collection consisted of leaf tissue P concentration (LTPC), total dry-weight biomass (TDB), total P uptake (TPU), fruit yield, and postharvest qualities. There were no significant differences in LTPC between deep and surface banding and both methods resulted in optimum LTPC during the season. Neither TDB nor TPU were significantly affected by the treatments. Deep and surface banding resulted in significantly higher total season extra-large fruit yield than the control, however, there were no significant differences between the two methods. Tomato postharvest qualities, including exterior color, pH, and total soluble solids content, were not significantly affected by the treatments. Consequently, surface banding can be an viable option to apply P fertilizers for drip irrigated tomato on the calcareous soils.

Specified Source(s) of Funding: Florida Department of Agriculture and Consumer Services

Altered Chemical and Physical Properties of Aging Coir Dust Root Substrate and Their Influence on Growth of Tomato and Pepper Seedlings (poster)

Jong-Myung Choi*, *Chungnam National University*; Myong Sun Park, *Chungnam National University*; Yun Seob Kim, *Chungnam National University* and Chiwon Lee, *North Dakota State University (Poster Board #204)*

Abstract: This study was conducted to investigate influences of the aging of coir dust used as a root substrate for growing tomato and hot pepper seedlings in plug trays. The raw coir dust was placed in the greenhouse and moistened with ground water and turned over once in every two weeks. At each time of moistening and mixing, the aging coir dust was characterized for its physical and chemical properties while being used as root substrate for seedling culture. The percentage of substrate particles in 0.355 mm to 1.4 mm sizes increased as they become aged in comparison to the raw coir dust. The total porosity and air-filled porosity of aging coir dust decreased until week 12 and then increased until week 24 of aging, showing a quadratic response curve. However, container capacity of the root substrate increased until week 12 and then remained unchanged. The pH of the root substrate changed from 5.04 at week 0 to 6.0 at week 4 and remained in the range of 5.6 to 6.0. The electrical conductance (EC) changed from 9.19 $dS \cdot m^{-1}$ for non-aged coir dust to 1.8 $dS \cdot m^{-1}$ for aged coir dust after 4 weeks. The root substrate concentrations of major cations (K^+, Ca^{2+}, Mg^{2+}) and anions (Cl^-, PO_4^{-3}, SO_4^{2-}) decreased until week 4 of coir dust aging treatment. Although ammonium form of nitrogen (NH_4^+-N) and nitrate form of nitrogen (NO_3^--N) decreased during the early stages of coir dust aging, NH_4^+-N concentrations stayed in the range of 30 to 60 mgL^{-1} after week 4, while NO_3^--N started to increase after week 8. When grown for 4 weeks, the fresh weight of tomato seedlings increased linearly as the aging time for coir dust used in the root substrate increased. The relationship between the fresh weight of hot pepper seedlings and the coir dust aging period showed a quadratic response when determined for 5 weeks of culture.

Influence of Different Nutrient Solution NH_4^+ to NO_3^- Ratios on Photosystem II Photochemistry and Thermal Energy Dissipation in Hydroponically Grown Lettuce (poster)

Tae Seok Ko, *North Dakota Stae University*; Jae-Bom Ohm, *USDA-ARS, Red River Valley Ag. Res. Center* and Chiwon W. Lee*, *North Dakota State University (Poster Board #205)*

Abstract: The objective this experiment was to study the influence of various ammonium (NH_4^+) to nitrate (NO_3^-) ratios on growth, photosynthetic pigment composition, and photosynthetic apparatus associated with photosystem II (PSII) photochemistry and thermal energy dissipation in hydroponically grown lettuce (*Lactuca sativa* L.). Two lettuce cultivars (Rex RZ, Black Seeded Simpson) were grown with hydroponic nutrient solutions containing 5 different NH_4^+:NO_3^- ratios (100:0, 75:25, 50:50, 25:75, 0:100, adjusted to total 12 meq L^{-1} N) and evaluated during the first (T1) and second (T2) week of culture. Plants grown under higher NH_4^+/NO_3^- ratios exhibited significantly suppressed shoot growth with a poorly developed root system, dark-green leaves, and less water and nitrate uptake. On the other hand, plants grown under higher NO_3^-/ NH_4^+ ratios exhibited vigorous shoot growth with well-developed root systems and high water and nitrate uptake. There were strong correlations between growth parameters and photosynthetic pigment stoichiometry as well as ratios. Total chlorophyll content increased, but the ratios of Chl a/b and carotenoid x+c/Chl a+b decreased progressively with increasing NH_4^+/NO_3^- ratios which are associated with a greater increase in Chl b. There were significant changes in PSII efficiency under different NH_4^+/NO_3^- ratios for cultivar Rex RZ during T1 period, however these changes are likely to be temporal and cultivar-dependent. In this study, the steady-state chlorophyll fluorescence (Fs) was directly correlated with total biomass and maximum efficiency of PSII photochemistry (F'_v/F'_m) and inversely correlated with non-photochemical quenching (NPQ) under different NH_4^+/NO_3^- ratios, but no clear correlation with quantum yield of PSII electron transport (F_{PSII}) and photochemical quenching coefficient (q_P). Values of parameters F_{PSII} and q_P were strongly influenced by Fs, leading these values to peak at 25% NO_3^- ratio and then decrease with increasing NO_3^- ratios. Leaves under high NH_4^+/NO_3^- ratios exhibited increases in F_{PSII} (actual

PSII efficiency) but maintained F_{NPQ} and F_{NO} unchanged. However, leaves under high NO_3^-/NH_4^+ ratios kept F_{PSII} and F_{NPQ} unchanged but significantly increased F_{NO}, enhancing thermal dissipation of the light absorbed by PSII within the antenna bed.
Specified Source(s) of Funding: NDDA Specialty Crop Block Grant

Nitrogen Level Influences Root Growth Dynamic and Shoot Components of Young 'Arbequina' Olives (poster)

Yahia A. Othman, *The University of Jordan* and Daniel Leskovar*, *Texas A&M AgriLife Research & Extension Center, Texas A&M University (Poster Board #206)*

Abstract: Olive (*Olea europaea* L.) is considered one of the most important agricultural crops worldwide with an olive oil production of about 2.8 million tons in 2016. The influence of nitrogen (N) levels and sources on olive growth have been commonly researched in established orchards, but is limited in young olive plants, especially on the effects of root dynamic and physiological traits. The objective of this two-years field study was to evaluate the effects of N levels and sources on root growth dynamics, leaf-level gas exchange [photosynthesis (*Pn*), transpiration (*E*), and stomatal conductance (*gs*)] and leaf nutrient content of young 'Arbequina' olives. Nitrogen treatments were, control (no N), nitrate (NO_3^-) form applied as calcium nitrate (CN) at 20, 40 and 60 kg ha^{-1}, and ammonium (NH_4^+) applied as urea at 20, 40 and 60 kg ha^{-1}. Root analysis derived from minirhizotron images revealed that the application of N significantly reduced root length intensity (L_a, mm cm^{-2}) compared to control olives in both years. In addition, no significant difference was noticed between N forms for L_a in 2015. In fact, leaf N% in control olives was above the N deficiency thresholds; i.e. 2.1% in 2015 and 2.57% in 2016. In both years, control-untreated seedlings had higher plant height, stem diameter and branch number than olives that received 40 or 60 kg ha^{-1}-N. We attributed the high performance of control (no N) seedlings to adequate N level in the soil (NO_3^-~ 25 mg kg^{-1}) from previous year application and the extra N supply from irrigation water and rainfall. However, leaf mineral concentrations were inconsistent (P, Ca^{+2}, Na, Zn, Fe, Cu) or not significant (Mn, S and B). In addition, no significant difference was noticed between treatments in gas exchange (*Pn*, *gs* and *E*). Overall, N applied to reach the sufficiency leaf N threshold level (2%) in olive reduced L_a. In addition, N application may not be required if pre-plant soil NO_3 levels are normal (~ 25 mg kg^{-1}).
Specified Source(s) of Funding: Texas Department of Agriculture, Specialty Crop Block Program

Onion (*Allium cepa* L.) Response to Stabilized Municipal Solid Waste Compost and Suphur Amendments (poster)

Samuel K. Asiedu*, *Dalhousie University Faculty of Agriculture*; Lord Abbey, *Dalhousie University Faculty of Agriculture* and Zhujun Qiu, *Dalhousie University Faculty of Agriculture (Poster Board #207)*

Abstract: Plant growth and bulb quality of onion (*Allium cepa* L.) are responsive to sulphur (S) and nitrogen (N) interaction, but compost and S interaction is understudied. This study was performed to assess the response of onion cv. Safran to stabilized municipal solid waste compost (MSWC) and sulphur (Magnesium sulphate) amendments in a greenhouse container-experiment. The treatments were MSWC at 0, 25, 50 and 75% w/w; and sulphur at 0, 10 and 20 mg pot^{-1} mixed in Promix-BX peat moss soilless substrate. An increase in the rate of MSWC increased SPAD value for onion plant leaf greenness, anthocyanin content (up to 50%) and photosynthetic activity. Unlike the MSWC, S application and the interaction between S and MSWC had no significant (P>0.05) effect on onion plant growth and bulb yield components. Consistently, the 25% MSWC treatment significantly (P<0.01) increased plant height, bulb diameter, number of fresh scale leaves and bulb fresh and dry weights. MSWC at ≥50% significantly (P<0.01) reduced these growth and yield parameters. Total soluble solids (TSS) content of the onion bulb was significantly (P<0.01) influenced by the applications of S and MSWC, and their interaction. The 25% MSWC and the 10 mg S pot^{-1} treatments gave the highest onion bulb tissue TSS content. The MSWC and the S applications increased the nutrients contents of the onion bulb tissue at harvest. In conclusion, MSWC amendment can be adopted to increase onion plant growth and plant tissue quality. Future studies should increase S rate and evaluate onion bulb flavor indices.

Keywords: onion, organic amendment, compost, sulphur, onion plant growth, onion quality

Seaweed Extract and Humic Acid Biostimulants Improve Growth and Post-Harvest Quality of Lettuce and Spinach (poster)

Monica Sandepogu, *Dalhousie University Faculty of Agriculture*; Samuel Asiedu*, *Dalhousie University Faculty of Agriculture* and Balakrishnan Prithiviraj, *Dalhousie University Faculty of Agriculture (Poster Board #208)*

Abstract: **The leafy greens are highly perishable vegetables that are affected by pre-harvest and post-harvest conditions. These vegetables generally have short shelf-life. Biostimulants can be utilized to enhance germination, growth, yield and quality of the crops. In this study, the effect of two plant biostimulants, *Ascophyllum nodosum* extract (ANE) and humic acid (HA) and their combinations (ANE+ HA) were evaluated for their potential to improve growth and minimize post-harvest losses in lettuce and spinach. Thirteen combinations of ANE and humic acids were assessed for seed germination and early growth of lettuce and spinach. Among these, most effective treatments were used to analyze post-harvest quality of lettuce and spinach. In the laboratory, the application of ANE, HA, and ANE+HA significantly ($p \leq 0.05$) improved germination and early growth parameters of lettuce and spinach. The combination treatment, 0.25 % ANE and 0.2 % HA (T_{12}) showed 103.2% and 13.1% increase in the radicle length of lettuce and spinach, respectively. Similarly, plumule length was also higher in the presence of ANE, HA, and ANE+HA. Under the greenhouse conditions the weekly application the biostimulants improved biomass in all treatments but fresh and dry biomass in lettuce treated with 0.25 % ANE and 0.2 % HA (T_{12}) were 103.1% and 113.9% respectively, compared with control. Whereas in spinach T_{12} had increased fresh and dry biomass by 62.9% and 103.3%, respectively. Pre-harvest treatment of lettuce and spinach with the combined ANE and HA significantly reduced fresh biomass loss during storage at 4ºC for up to 21days. Further visual appearance quality (color, turgor and reduced softening of tissue) was also maintained while the nutritional quality of total antioxidants and phenolics were 1.7 and 1.5 folds, respectively, higher than the control. The preliminary results suggest ANE, HA and combination ANE + HA would enhance seed germination, plant growth and retain post-harvest quality of lettuce and spinach.**

Keywords: Spinach, Lettuce, plant biostimulant, Ascophyllum nodosum extract, Humic acid,

Effect of Sulfur Fertility on Proteins and Carbohydrates in Beans of Edamame Soybean [*Glycine max* (L.) Merrill] (poster)

Theoneste Nzaranyimana, *Purdue University*; David Kopsell*, *Illinois State University*; Dean Kopsell, *University of Florida* and Robert Rhykerd, *Illinois State University (Poster Board #209)*

Abstract: Edamame, a vegetable soybean [*Glycine max* (L.) Merr.] known for larger seeds or beans and sweet flavor, is harvested and consumed in the R6 growth stage prior to reaching full maturity. Consumers in the U.S. have increasing interest in edamame because of its protein content and beneficial health properties; however, the buttery flavor and crispy texture is responsible for the desirability with American consumers. Sulfur (S) is a component of the amino acids cysteine and methionine which are the building blocks of proteins, but also contributes to bitter flavors in many vegetable crops. Little is known about how S fertility influences protein and carbohydrate content in the beans of edamame. As result, a solution culture experiment was conducted to evaluate the effect of S fertility levels on protein and carbohydrate content in edamame beans. Seeds of 'Chiba' edamame were germinated under greenhouse conditions at 22°C day/14°C night in the fall of 2016. Fifteen days after germination, seedlings were transferred to twenty 30 L tubs holding five plants each and filled with a modified Hoagland's nutrient solution containing S treatment levels of 4, 8, 16, 32, and 64 mg S L^{-1}. Sulfur treatments were delivered as magnesium sulfate ($MgSO_4$) and sodium sulfate (Na_2SO_4) to balance the other essential

nutrients. Treatments were arranged in a randomized complete block design with four replications. Nutrient solutions were replaced to their original nutrient concentrations every 2 weeks and the photoperiod was reduced to 10 h on 8 Nov 2016 to induce flowering. Plants were harvested approximately 60 days after planting when they reached the R6 maturity stage and weighed for fresh biomass. Fresh samples were either frozen at -20°C for carbohydrate analysis or oven dried at 60°C for protein content analysis. Elemental S concentrations were measured in oven-dried bean tissue using ICP-MS. Manipulating S fertility concentrations showed no significant effect on bean accumulation of crude protein (P=0.171), adjusted protein (P=0.171), acid detergent fiber-neutral protein (P=0.409), acid detergent fiber dry matter (P=0.707), or amylase neutral detergent fiber (P=0.271). Edamame bean sucrose (P=0.009) and fructose (P=0.001) increased linearly in response to decreasing S fertility, but bean glucose (P=0.416) levels were not affected. The results showed that increasing the S concentration from 4 to 64 mg S L^{-1} in nutrient solution culture did not affect the protein composition in beans of 'Chiba' edamame, but did significantly affect bean carbohydrate levels.

Specified Source(s) of Funding: Illinois Soybean Association

1:00 PM – 1:45 PM *International Ballroom East/Center*

Pomology 3 (Poster)

Effect of Ripening Seasons on Nutrient Requirements of Peach Trees (poster)

Qi Zhou*, *Clemson University* and Juan Carlos Melgar, *Clemson University (Poster Board #437)*

Abstract: Peach trees from different ripening seasons may have distinct nutrient concentrations in the removed organs so they might lose different amounts of nutrients through nutrient removal events. The objective of this research was to determine the nutrient concentrations in organs removed from the tree (either as a consequence of orchard management practices or naturally).We used peach trees from different ripening seasons, and calculated the amount of removed nutrients among different cultivars. We selected 18 peach trees of six cultivars from three different ripening seasons (early-season: 'Desiree' and 'Spring Snow'; middle-season: 'Sweet N Up' and 'Coralstar'; late-season: 'Snow Gem' and 'Snow King'), and measured the nutrient concentrations in all the removed organs, including pruned wood, thinned fruitlets, harvested fruits and leaves fallen during autumn. Nutrient analyses showed that early-season cultivars accumulated i) more nitrogen in thinned fruitlets and mature fruits, ii) more potassium in pruned wood, mature fruits and fallen leaves, and iii) more phosphorus in mature fruits and fallen leaves compared to mid- and late-season cultivars. Early-season cultivars lost more nutrients through pruning and leaf fall but lost less nutrients through harvesting compared to mid and late-season cultivars. These results suggest that ripening season can affect peach tree nutrient requirements and fertilization with different levels of nutrients should be applied to the orchards instead of one uniform fertilization program. These findings are expected to help farmers to optimize fertilization plans that are specific to the ripening season of their peach trees.

Specified Source(s) of Funding: South Carolina peach council, Southern Region of SARE

Seasonal Nitrogen Dynamics in Young Peach Tree. Where Does the Nitrogen Go? (poster)

Bruno Casamali*, *University of Georgia*; Marc van Iersel, *University of Georgia* and Dario J. Chavez, *University of Georgia (Poster Board #438)*

Abstract: Nitrogen fertilization and irrigation are two essential management practices to achieve adequate plant growth and yield. For many years, the peach industry in the southeastern U.S. has been using fertilizer recommendations for young plants that are believed to be outdated and not well-suited to modern production practices. On the other hand, irrigation recommendations for young plants are non-existent, and irrigation is typically not used until three years after planting. We tested different fertilizer and irrigation rates from field planting, at the University of Georgia, with the objective of improving current recommendations for young plants. To complement that research and to improve our understanding of the seasonal nitrogen dynamics in orchards, we determined how different nitrogen rates and irrigation availability influence the amount of nitrogen being utilized by young peach plans. The amount of nitrogen removed by plant material during major management practices that affect plant growth (pruning, thinning, harvest, and defoliation) was quantified for the 2016 and 2017 seasons. 'Julyprince' plants grafted onto 'Guardian' rootstock were planted in 2015, at a density of 358 plants/hectare. Two irrigation rates (sensor-based irrigation at volumetric water content of 15-25% versus non-irrigated), two irrigation systems (drip versus micro-sprinkler), and four fertilizer rates (16, 33, 65, and 129 kg of N per hectare for one-year-old plants; and 23, 48, 95, and 191 kg of N per hectare for two-year-old plants) were tested. Plants growing in the highest fertilizer rate had 230 g of nitrogen removed by the management practices compared with ~205 g with the lowest fertilizer rates. Fall defoliation was where most of the nitrogen was allocated and removed from the system. Irrigated plants had more nitrogen removed through the management practices than non-irrigated plants (248 g vs. 174 g per plant), with most of the nitrogen removed by defoliation and pruning. When comparing the irrigation systems, drip irrigation induced greater nitrogen removal than sprinkler irrigation (231 g vs. 191 g per plant), mainly through defoliation. The results of this research are important indicators that when more nitrogen is applied, plants primarily allocated resources to produce vegetative structures, not affecting fruit yield if plant's needs are met. Irrigation induces greater nitrogen absorption by the plant, resulting in greater vegetative and reproductive structures. Even with all these variations in nutrient allocations and removal, no nutritional deficiency was found across treatments.

Specified Source(s) of Funding: Peach Commodity Commission

High Tunnel Apricot Production in Frost Prone Northern New Mexico (poster)

Shengrui Yao*, *New Mexico State University Sustainable Agriculture Sciences Center*; Steve Guldan, *New Mexico State University Sustainable Agriculture Sciences Center* and Robert Heyduck, *New Mexico State University Sustainable Agriculture Sciences Center (Poster Board #439)*

Abstract: Late frosts are the number one issue challenging fruit production in northern New Mexico. The NMSU Alcalde Center had apricot trees for 15 years and no fruit was produced due to late frosts. There are native apricot trees in the communities with sporadic crops. Since 2012, we planted apricots in two 16x40 ft (9.5 ft high-point) high tunnels with spindle and upright fruiting offshoot (UFO) systems. There were five cultivars planted in each high tunnel at 4x8 ft spacing in a randomized complete block design with two replications and two trees per cultivar in each plot. In 2015, Puget Gold had the highest yield (29.0 lb/tree) in spindle system while Golden Amber had the highest yield (18.6 lb/tree) for the UFO system. On average, UFO produced 60% of the yield of the spindle system in 2015. There were more lessons learned than success in this study. A heating device is mandatory in high tunnel apricot fruit production in northern New Mexico since trees normally bloom in early to late March depending on year while the frosts can continue until mid-May. Heaters should also have the auto-on and off function regulated by a thermostat. In years like 2017 and 2018 with temperature <-10 °C in late February or early March, the expanded flower buds were killed before bloom. On those cold nights, one 100 lb tank of propane may or may not be enough for one night's frost protection. Economically, it was not feasible. Only in years of cool spring and late blooming trees with mild April and May, the high tunnel apricot production can make positive revenue. High tunnel apricot production with heating device is still very risky and cannot guarantee a reliable crop each year in northern New Mexico.

Specified Source(s) of Funding: NIFA Hatch Grants

New Sweet Cherry Canopy Architectures Differ in Leaf Area at Maturity (poster)

Gregory Lang*, *Michigan State University*; Dilek Soysal, *Ondokuz Mayıs University* and Husnu Demirsoy, *Ondokuz Mayis University (Poster Board #440)*

Abstract: Sweet cherry orchards have changed with the availability of precocious, highly productive, and vigor-controlling rootstocks such as the Gisela (Gi) series from Germany. These

rootstocks have led to new ideas about the applicability of high density production systems to cherry orchards, resulting in new canopy training systems such as Tall Spindle Axe (TSA), Super Slender Axe (SSA), Upright Fruiting Offshoots (UFO) and Kym Green Bush (KGB). Leaf area is particularly important for cherry trees on highly-productive dwarfing or semi-dwarfing rootstocks at high densities. High quality fruit reguires an optimum leaf area to fruit ratio. This study characterized the differences in leaf area at canopy maturity for several new sweet cherry training systems as part of a visiting international doctoral research fellowship project funded by TUBITAK/BIDEB. The study was conducted with seven-year-old 'RadiancePearl/Gi5' and 'RadiancePearl/Gi6' scion/rootstock combinations trained as SSA, UFO, and TSA at Michigan State University's campus Horticulture Teaching and Research Center. Planting distances were: TSA 1.2 x 2.5 m (tree x row spacing), UFO 1.1 x 2.5 m, and SSA 0.7 x 2.5 m. The site has a sandy soil, is drip-irrigated, and the orchard is covered from spring through summer with high tunnels. Fertility has been managed organically, weed control is managed organically with weed barrier fabric, and pest control has been semi-organic (minimal pesticide applications). Leaf area was calculated using a formula for measured leaf length and width values (Demirsoy, 2009) and leaf area per orchard area used 17.5 m^2 as the total orchard area occupied by each plot of training system trees. The highest values for total leaf area per orchard area for both 'RadiancePearl/Gi5' and 'RadiancePearl/Gi6' were obtained with the SSA canopy architecture, followed by the UFO, and finally the TSA. The SSA values were 58 to 113% higher than TSA values and 19 to 88% higher than UFO values. The high LA values for the SSA training system are due to a higher proportion of one-year-old new shoots, which have large individual leaves that result from the annual renewal of every fruiting branch, compared to the other systems that have a higher proportion of smaller spur leaves on older sections of fruiting wood. Leaf area per fruit measurements resulted in no significant differences due to high variability and low replication (due to spring frost damage to part of the orchard). However, with both scion/rootstock combinations, the UFO trees had the largest fruit.

Specified Source(s) of Funding: TUBITAK/BIDEB and USDA-National Institute of Food and Agriculture Hatch project #MICL02002

Salt Tolerance of *Punica Granatum* 'Wonderful' (poster)

Youping Sun*, *Department of Plants, Soils, and Climate, Utah State University*; Genhua Niu, *Texas A&M AgriLife Research Center at El Paso, Texas A&M University*; Joseph Masabni, *Texas A&M AgriLife Research & Extension Center* and Girisha Ganjegunte, *Texas A&M AgriLife Research Center at El Paso, Texas A&M University (Poster Board #441)*

Abstract: *Punica granatum* 'Wonderful' (pomegranate) is currently the industry standard cultivar that accounts for over 90% of all commercial trees planted. Little research based information is available on its salt tolerance. Plants were pruned uniformly prior to treatments: irrigation with nutrient solution at an electrical conductivity (EC) at 1.2 dS m^{-1} (control), saline solutions at EC of 5.0 dS m^{-1} (EC 5) or 10.0 dS m^{-1} (EC 10). New growth, which was identifiable visually, was harvested eight weeks after treatment (first harvest). One week later, the same plants were received the same treatments for another eight weeks. The new shoot growth during the 2nd eight-week treatment and roots were harvested (second harvest). Dry leaves, stems, and roots were ground, and samples were used for mineral nutrient analysis. At both harvest dates, all pomegranate plants had no or minimal foliar salt damage. At the first harvest, treatment EC 10 decreased the pomegranate shoot dry weight by 15%, but EC 5 did not. At the second harvest, treatment EC 5 and EC 10 reduced shoot dry weight by 13% and 31%, respectively. The sodium (Na) concentration in the leaf and stem tissue of 'Wonderful' pomegranate in all treatments was less than 1 mg g^{-1} on a dry weight basis, while that in the root tissue was 0.8, 3.7, and 4.5 mg g^{-1} in control, EC 5, and EC 10, respectively. The Cl content in leaf, stem, and root tissue increased by 36-90%, 101-156%, and 254-299%, respectively. These results indicate that 'Wonderful' pomegranate is very tolerant to the saline water irrgation in this study and has a strong capability to exclude Na and Cl accumulation in the leaf tissue to avoid salt damage.

Specified Source(s) of Funding: Hatch project TEX090450

Despite a General Warming Trend, Erratic Temperatures during Late Winter Eliminates Successive Peach Crops in North Florida (poster)

Peter Andersen*, *University of Florida* and Brent Brodbeck, *University of Florida North Florida Research and Education Center (Poster Board #442)*

Abstract: A 0.50 ha peach orchard was established during March 2015 at the NFREC-Quincy. The cultivars and chilling units were as follows: Gulfking (350), Suncoast (375), Flordacrest (400), Flordaking (400), Gulfcrimson (400), GulfPrince (400), Gulfsnow (400), GulfAtlas (400) and Gulfcrest (525). Flordaking and Flordaking are melting flesh peaches, Suncoast is a melting flesh nectarine, and the remainder Gulf series are non-melting flesh peaches. The chill units recorded for 2016, 2017 and 2018 were 550, 350 and 625, respectively. Trees were 2.5 – 3.0 m tall and 2.3 – 2.8 m wide by the second leaf. Yield varied from 2 to 24 kg, and fruit weight varied from 60 – 118 g depending upon the cultivar. Freeze events occurred on 15 March 2017, and on 9 and 15 March 2018, virtually eliminating the entire peach crops. Trees were well passed full bloom, (with the exception of Gulfcrest in 2017) when the freeze events occurred. Thus, despite a general warming trend for winters during the last two decades, erratic winter temperatures remain a potential problem for the culture of peaches in north Florida.

Specified Source(s) of Funding: Florida Department of Food and Agriculture Specialty Crop Grant

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1:00 PM – 1:45 PM *International Ballroom East/Center*

Postharvest 1: Vegetables and Ornamentals (Poster)

Yield and Storability of Open-Pollinated and Hybrid Onions in Chile (poster)

Samuel Contreras*, *Pontificia Universidad Católica de Chile* and Christian Krarup, *Pontificia Universidad Católica de Chile (Poster Board #241)*

Abstract: Onion is the second most important vegetable in Chile. Production for export or storage is based in a small number of long-day open-pollinated (OP) cultivars. During the last decade many hybrid cultivars asserting to have superior yield and bulb quality have been introduced. The lack of objective information regarding the performance of these new hybrid cultivars under Chilean conditions, posed the main objectives of these studies: to compare yield and storability of available onion cultivars in Chile. During the season 2014/15 two trials were conducted in different locations: Malloa (34°27' S, 70°57' W) and Chépica (34°44' S, 70°15' W). In each location, 16 cultivars were produced; 10 of them were hybrid and 6 of them were OP, including the most used OP cultivar, Cobra, as control. For each cultivar, harvest was performed when around 50% of the plants foliage lodged. After bulbs weight and diameter were registered, they were cured and stored in well ventilated rooms (12,5ºC average temperature; 77,5% average relative humidity). Bulb losses due to sprouting or rotting were determined every two weeks. In Malloa yield ranged between 9,9 and 1,7 kg/m^2, while in Chépica ranged between 9,0 and 3,2 kg/m^2. In Malloa, Cobra out performed most of cultivars but there were two hybrids that had higher yields (non-significant difference). In Chépica, two hybrids had higher yields than 'Cobra' ($p<0.05$). In addition to their good yield, some of the hybrids stood out for their high bulb quality (uniformity, size and high percentage of single centers). When stored, Cobra and three other OP cultivars had greater resistance to sprouting than most of hybrids. In bulbs produced in Malloa, after 245 days of storage 'Cobra' presented 14% of bulbs sprouted while most of hybrids had over 40% sprouting. In onions produced in Chépica, after 223 days of storage, 'Cobra' presented 30% sprouting and most of hybrids had over 50% sprouting. In summary, results highlight the importance of cultivar evaluation and selection in onion productivity. Some of the new hybrid cultivars that are been introduced in Chile presented competitive yields and quality, however it lower resistance to sprouting during storage should be considered.

Use of Maleic Hydrazide for Sprouting Inhibition during Storage of Open-Pollinated and Hybrid Onions (poster)

Samuel Contreras*, *Pontificia Universidad Católica de Chile* and Christian Krarup, *Pontificia Universidad Católica de Chile (Poster Board #242)*

Abstract: In Chile, onion production is mostly based on long-day cultivars, which are harvested during summer, stored, and marketed from autumn to early spring. The open-pollinated (OP) cultivars that have been traditionally used have good resistance to bulb sprouting; hybrids with competitive yields and high quality bulbs but lower resistance to sprouting have been introduced in recent years. The objectives of these experiments were to determine the timing and outcome of maleic hydrazide (MH) treatments to inhibit bulb sprouting. Two experiments were conducted, in 2015 (Exp. 1) and 2016 (Exp. 2). In Exp. 1, MH was applied to cultivars Cobra (OP) and Pandero (hybrid) 2, 9, 16 and 23 days before harvest (DBH). Effects of MH treatments were compared with a non-treated control of each cultivar. In Exp. 2, the effect of HM applied 15 DBH was compared with non-treated bulbs of cultivars Cobra and Titan (hybrid). Storage of bulbs in both experiments was carried out in similar conditions to those traditionally used by local growers (ambient temperature, 12,5ºC average, and 77,5% average relative humidity). Results from Exp. 1 showed that HM treatments did not have any effect on bulb yield or size. Non-treated bulbs of 'Cobra' presented 11 and 53% sprouting after 204 and 245 days of storage, while non-treated bulbs of 'Pandero' had 39 and 94% sprouting after the same period of storage. In both cultivars, sprouting of bulbs treated with HM 2 DBH was similar with non-treated bulbs, while the use of HM 16 or 23 DBH reduced sprouting around 50% compared to non-treated bulbs; bulbs treated with HM 9 DBH had an intermediate response. In Exp. 2, after 199 and 245 days of storage, non-treated bulbs of 'Cobra' had 22 and 58% sprouting, and non-treated bulbs of 'Titan' had 63 and 86% sprouting. The HM treatment had a positive effect in 'Cobra', reducing sprouting in around 60% compared with non-treated bulbs; in 'Titan' the effect was even greater, reducing sprouting more than 90%. In conclusion, HM treatment of plants two weeks before bulb harvest had a positive effect in reducing the sprouting of bulbs during storage. For Chilean growers, the use of HM would be specially recommended when using new hybrid onion cultivars, which have shown to have higher susceptibility to bulb sprouting during storage than traditional OP cultivars.

Genome-Wide Association Mapping of Deterioration in Fresh-Cut Lettuce (poster)

Jinita Sthapit Kandel, *USDA-ARS*; Beiquan Mou, *USDA-ARS*; Ryan Hayes, *USDA-ARS* and Ivan Simko*, *USDA-ARS (Poster Board #243)*

Abstract: Fresh-cut lettuce is widely used in packaged leafy vegetable salads. While there are no current estimates of the retail value of fresh-cut lettuce, the segment represents 25-35% of raw product production in Monterey county of California, which has a farm gate value of approximately 1.5 billion dollars. Most fresh-cut products involve harvesting whole mature heads of romaine or iceberg type lettuce, cutting the leaves to a specified size, and packaging the salad in clear specialized films with modified atmospheres (modified atmosphere packaging, MAP). However, even in MAP, fresh-cut lettuce can have short shelf life and deterioration can occur within a week after processing. Deteriorated lettuce is not marketable, must be disposed, and results in the need for more lettuce to be grown, processed, and transported. Lettuce cultivars with extended shelf life will help reduce waste and increase efficiency. Genome-wide association studies (GWAS) were performed on a set of 498 lettuce accessions. The accessions were genotyped, and 4,615 high-quality, polymorphic, single-nucleotide polymorphism (SNP) markers were used for analyses. For shelf life assessment, four field experiments were performed in three locations in Salinas Valley during 2016 and 2017. Lettuce heads were harvested, processed into fresh-cut salad, and stored at 4°C for evaluations. Salad bags were visually evaluated weekly and deterioration assessed using the scale of 0 through 10, where the rating corresponds to $1/10^{th}$ of the estimated percentage of deteriorated tissue. Mean area under deterioration progress stairs (AUDePS) was calculated for each accession. GWAS of shelf life data was performed by mixed linear model analyses; the genetic relationships among the individuals were incorporated into statistical models using principal component analysis and kinship matrix. Significant marker-trait associations (SMTA) were detected on Linkage Group 4 (LG4) in all experiments. The most significant P-value was 8.44E-14 that explained 15% of the total phenotypic variation (R^2 = 0.15) of the trait. Major quantitative trait loci (QTL) for deterioration of fresh-cut lettuce were reported previously in LG4 in a recombinant inbred line population of Salinas 88 x La Brillante. Molecular markers closely linked with the trait QTL can be applied for selecting lettuce genotypes with a slow rate of deterioration and for identification of gene(s) responsible for extended shelf life of fresh-cut lettuce.

Influence of Artificial Bacterial Inoculation on Enzymatic Browning of Fresh-Cut Potatoes and Apples (poster)

Hidemi Izumi*, *Kindai University*; Natsuki Takebe, *Kindai University*; Kotoha Inui, *Kindai University* and Ayano Inoue, *Kindai University (Poster Board #244)*

Abstract: We have found higher bacterial counts on fresh-cut potatoes and apples with wound-induced enzymatic browning tissues than non-browning tissues. Bacterial species isolated only from the browning tissues were identified as *Pseudomonas fluorescence* on potatoes and *Herbaspirillum huttiense* on apples. In this study, we investigated the influence of inoculation with *P. fluorescence* and *H. huttiense* on the browning response of fresh-cut potatoes and apples, respectively. Surface color, enzymatic activities of polyphenol oxidase (PPO) and peroxidase (POD), amounts of phenolic compounds and lignin, and bacterial counts were determined in sliced potatoes inoculated with *P. fluorescence* and sliced apples inoculated with *H. huttiense* (approximately 3 and 6 log CFU/ml) during storage for 3 days at 5°C. Non-inoculated fresh-cuts were used as the controls. When fresh-cut potatoes were initially inoculated with either 3 or 6 log CFU/ml of *P. fluorescence* and then stored, bacterial counts increased from an initial 3.0 log CFU/g or 5.3 log CFU/g to 5.7 log CFU/g or 8.2 log CFU/g, respectively, after 3 days of storage. However, no differences were found in the surface color, activities of PPO and POD, amounts of phenolics and lignin between non-inoculated and inoculated fresh-cut potatoes regardless of the inoculum levels. With fresh-cut apples, bacterial counts increased to 5.1 log CFU/g following inoculation with 6 log CFU/ml of *H. huttiense* and the counts were constant during storage for 3 days. In comparison, the bacterial counts of fresh-cut apples either uninoculated or inoculated with 3 log CFU/ml were below the detection level (2.4 log CFU/g) throughout the storage period. Inoculation did not affect surface browning, activities of the enzymes, and amounts of the components during storage, except that the polyphenol content was higher in non-inoculated samples than inoculated samples. These results indicated that artificial inoculation with *P. fluorescence* and *H. huttiense* did not enhance browning of fresh-cut potatoes and apples with the accumulation of phenolic compounds and lignification, although we have hypothesized that the bacteria could synthesize bacterial PPO or POD resulting in the browning enhancement.

Specified Source(s) of Funding: This work was supported by JSPS KAKENHI Grant Number 16K07606.

Pre-Harvest UV-B Irradiation Elevates Glucosinolate Contents and Improves Postharvest Quality of Broccoli Microgreen (poster)

Yingjian Lu*, *USDA-ARS* and Tianbao Yang, *USDA-ARS (Poster Board #245)*

Abstract: Many recent studies report that broccoli has great anti-cancer activities because of high glucosinolates (GLs) contents, such as glucoraphanin (GLR) and glucoerucin (GLE). Previously we showed that broccoli microgreen contains high GLs than broccoli florets and mature leaves, indicating that microgreens is a richer source of GLs than mature broccoli. Preharvest calcium spray could significantly increase the total aliphatic GLS levels, while postharvest UV-B radiation only had limited effects on GLs enrichment. Here we report the impact of preharvest UV-B treatment on GLs levels in broccoli microgreens. Our results showed that preharvest UV-B treatments with 10 mM $CaCl_2$ spray could significantly increase the GLE, GLR, and total aliphatic GLs levels by around 70% in broccoli microgreens as compared to the control. Additionally, the nutritional qualities of two UV-B treated microgreens were quite stable during 21-day storage, with only small changes in their GLS levels. The UV 0.27 Wh/m^2 with 10 mM $CaCl_2$ spray treated broccoli microgreen maintained their overall quality, and had the lowest TEL and off-odor values during the storage. Furthermore, UV-B 0.27 Wh/m^2 treated microgreens significantly upregulated the level of GLs synthetic genes such as CYP79F1 during storage. Thus, the preharvest UVB is more

effective on enriching the GLs levels than postharvest UVB. Overall, preharvest UV treatment together with calcium spray can enhance the health-beneficial compounds and improve the postharvest quality of broccoli microgreen.

Storage Temperature and Time Impacts Glucosinolates and Flavor Volatiles of Broccoli Grown on the East Coast (poster)

Jennifer Wheeler*, *University of Tennessee, Knoxville*; Hunter Hammock, *University of Tennessee*; Carl Sams, *The University of Tennessee*; Curtis R. Luckett, *University of Tennessee*; Thomas Björkman, *Cornell University*; Jeanine Davis, *North Carolina State University* and Miguel Gómez, *Cornell University (Poster Board #246)*

Abstract: East Coast broccoli production decreases the time between harvest and purchase for East coast consumers. The objective of this experiment was to monitor the effect of storage temperature and time on broccoli grown on the East coast. A randomized complete block design was conducted using two broccoli varieties (Emerald Crown and Diplomat) obtained from a local grower. At harvest, broccoli was sorted into containers to establish four replications each of two storage conditions: 0°C (iced at harvest) and 5°C (cooled in storage). Broccoli heads of each variety were sampled weekly for seven weeks during postharvest storage, including the day of harvest. Florets were freeze-dried, ground, and analyzed for 13 glucosinolates, which included glucoprogoitrin (detrimental to health), glucoerucin, glucoraphanin and glucoiberin (anti-carcinogenic properties), and total glucosinolate content. A complete volatile profile was analyzed using the fresh frozen tissue. Volatiles reported are dimethylsulfide as an indicator of off-flavor volatiles, and 2-ethyl-furan, benzeneacetaldehyde, and 2-pentyl-furan as indicators of desirable flavor volatiles. Data were analyzed using mixed model analysis of variance (Glimmix procedure, SAS Institute, Cary, NC). Glucoprogoitrin was essentially undetectable in Diplomat broccoli and was greater in Emerald Crown broccoli stored at 0°C ($P<0.05$). Glucoiberin, glucoerucin, and glucoraphanin were found in significantly greater quantities in both cultivars stored at 0°C ($P<0.05$) compared to storage at 5°C. Glucoiberin was 59% greater in Emerald Crown than Diplomat broccoli ($P<0.0001$). Overall, broccoli stored at 0°C had greater total glucosinolate content ($P=0.0001$). Dimethylsulfide was greater in Diplomat broccoli ($P=0.0007$), broccoli stored at 5°C ($P<0.0001$), and at 42 days postharvest ($P<0.0001$). 2-ethyl-furan and 2-pentyl-furan were both greater in broccoli stored at 0°C ($P<0.01$) and at the day of harvest compared to all other days ($P<0.0001$). However, Emerald crown had greater concentrations of 2-ethyl-furan ($P=0.0003$), while Diplomat had greater concentrations of 2-pentyl-furan ($P=0.0006$). Benzeneacetaldehyde was greater in broccoli stored at 0°C for both varieties ($P=0.012$). Neither storage temperature nor time greatly affected nutritionally harmful glucosinolates. However, both cultivars of broccoli stored at 0°C had a higher concentration of anti-carcinogenic glucosinolates. As time and temperature increased, undesirable flavor volatiles increased and desirable volatiles decreased. This study indicates that storing broccoli at 0°C for no longer than 21 days is optimum to maintain the quality of desirable volatiles and anti-carcinogenic glucosinolates. Future experiments are needed to evaluate a broader range of postharvest temperatures for impact on these and other quality parameters.

Specified Source(s) of Funding: National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2016-51181-25402

Microencapsulation and Antimicrobial Activity of Carvacrol in a Pectin-Alginate Matrix (poster)

Xiuxiu Sun*, *USDA-ARS*; Randall Cameron, *USDA-ARS*; Elizabeth Baldwin, *USDA-ARS* and Jinhe Bai, *USDA-ARS (Poster Board #247)*

Abstract: Carvacrol is a natural phenolic compound that has received great attention due to its high antimicrobial activity. However, the applications of this compound are limited for its high volatility and low water solubility. In this research, the use of food grade polymers for microencapsulation of carvacrol in a pectin-alginate matrix using spray drying method was studied. The physical properties, encapsulation efficiency, stability, and the microstructure of the microcapsules were analyzed as well as the products' antimicrobial and antioxidant properties.

The microcapsules were regularly spherical particles with 4.51% moisture content, 0.33 g/cm^3 bulk density, 4.55 min wettability, and a hygroscopicity at 34.44 g water absorbed/100 g powder. The microcapsules also showed high encapsulation efficiency (76.98%) and stability. The microencapsulation process did not significantly affect the antimicrobial activity against *Escherichia coli* K12 (minimum inhibitory concentration (MIC) = 0.25 mg/mL) and antioxidant activity (DPPH percentage inhibition (PI) = 89.96%) of carvacrol. The results indicated that the microcapsules may have important applications in postharvest for the protection of fruit and vegetables from microbial contamination. It may also be suitable for the application in foods and nutraceuticals processing industry.

Catechin and Volatile Compounds in Oolong Tea Under Vibrating Stimulus (poster)

Zhilong Hao, *Fujian A&F University*; Zhongying Liao, *Fujian A&F University*; Xingyan Xu, *Fujian A&F University*; Hongzheng Lin, *Fujian A&F University*; Xinlei Li, *Fujian A&F University*; Xiaoming Yu, *Fujian A&F University*; Donglin Zhang*, *University of Georgia* and Xinyi Jin, *Fujian A&F University (Poster Board #248)*

Abstract: Tea (*Camellia sinensi*s (L.) Kuntze) offers great benefit to human health and it is the second most popular drink, only eclipsed by water. Oolong tea is popular to consumers because of its unique flavor. The formation of Oolong tea flavor derived from its special processing, especially the shaking procedure that induced the flavor of Oolong tea by mechanical force. We applied the same *Tieguanyin* withered leaves as material, provided continuous vibrating stimulus to tea leaves as treatment with natural spreading as control, and collected samples continuously during the vibrating. Catechin composition and content were analyzed by LC-MS and the content of volatiles by GC-MS. The results indicated that catechin composition in the vibrating tea leaves were lower than natural spreading. There were significant differences among vibrating time. For volatiles, the relative percentage of alcohols, aldehydes and esters was at 14.75%, 5.29%, and 4.34% respectively, higher than that of the control after 5min vibrating. The ketone was higher in the period of 30~90min, up to 20.41%. The hydrocarbon was up to the peak of 12.95% at 120 min. The phenylacetone was higher in 30~90min with the highest of 20.20%. Linalool and salicylate were higher after 5min, up to 1.82% and 2.22%. Both nerolidol and indole were higher at 120min, up to 1.06% and 2.81%. With decreasing of catechin content by vibrating stimulus, the bitterness of tea soup reduced and the Oolong tea had a much smooth and pleasant taste. Vibrating stimulus increased volatiles at the important stages, which provided basic material for the flavor formation of Oolong tea and eventually resulted the unique quality of Oolong tea.

Specified Source(s) of Funding: National "20th 5-year" S&T project (2014BAD06B06); National modern agri (tea) industry tech system (CARS-19);Fujian modern agri tea industry system(NYT2017001);Fujian "2011 collaborative innovation center" (2013-51).

Seasonal Changes in Polar Lipids Linked to Needle Abscission in Four Genotypes of Balsam Fir Post-Harvest (poster)

Rajasekaran R. Lada*, *Dalhousie University Faculty of Agriculture*; Gaye MacDonald, *Dalhousie University, Faculty of Agriculture*; Claude Caldwell, *Dalhousie University Faculty of Agriculture* and Chibuike Udenigwe, *University of Ottawa (Poster Board #249)*

Abstract: Several studies have suggested that postharvest needle retention in balsam fir, *Abies balsamea*, L increases in autumn due to cold acclimation, and that this is more evident in genotypes with lower postharvest needle retention prior to cold acclimation. It has been found that many changes occur in balsam fir during autumn months, such as accumulation of ABA, raffinose, and galactose. However, the possible roles of lipids and fatty acids (FA) in postharvest needle abscission have not been confirmed. The objective of this study was to identify if changes in polar lipids occur and if these changes are related to postharvest needle abscission in balsam fir. An additional objective was to identify any genotypic differences.

Four genotypes of balsam fir, AB-NSD-016, AB-NSD-005, AB-NSD-140, and AB-NSD-124, were sampled (x5) in the clonal orchard owned by the Department of Natural Resources, Debert, Nova Scotia, Canada at 5 time periods between September and February. Onsite testing was performed for capacitance,

fluorescence, and membrane injury (MII). Samples were frozen in liquid nitrogen to store in a -80 °C freezer for later polar lipid and fatty acid analysis. The weather and photoperiod parameters were collected from the Environment Canada Weather Station located within a 2 km radius of the orchard. In addition, "sister" branches (x5) were collected at each sampling interval, transferred to the lab and hydrated to determine the mean needle abscission commencement (NAC), and average daily water usage (ADWU). The experiment was designed as a 4 x 5 factorial and analyzed using repeated measures.

AB-NSD-016, AB-NSD-005, AB-NSD-140, and AB-NSD-124 had a mean NAC of 42, 52, 32, and 75 days, respectively. AB-NSD-124 had significantly better needle retention than all other genotypes in each of the sampling periods (p = 0.000). The poorest needle abscission resistance (NAR) was the genotype AB-NSD-124. All genotypes commenced needle abscission significantly earlier when collected in February than when collected in September through December (p = 0.000), possibly related to a January thaw. Fluorescence was significantly (p < 0.05) linked with $T_{min,}$ (r = .881), a typical response to winter stress and reduced photosynthesis. With respect to polar lipids, there was no loss of lipids, but a redistribution of lipids as a result of exposure to decreasing temperatures and photoperiod. There was a significant (p < 0.05) decrease in the monogalactosyldiacylglycerol to digalactosyldiacylglycerol ratio (MGDG:DGDG). There were significant changes (p < 0.05) in four lipid species causing the change in the ratio: DGDG 36:6, MGDG 36:5; MGDG 36:6, and MGDG 36:7, the first two increasing and the latter two decreasing. There was an increase in the % of phosphatidylcholine (PC) and phosphatidyl ethanolamine (PE). These changes provide evidence that cold acclimation linked to lipid changes is occurring in these genotypes of balsam fir. However, there is not enough evidence to link these changes to postharvest needle abscission.

Specified Source(s) of Funding: Atlantic Innovation Fund, NSERC, SMART Christmas tree Research Coop., CTCNS, NSDNR, AgriFutures NS, Dalhousie University

Physiological and Molecular Characterization of Ethylene Binding and Biosynthesis Inhibition in *Rosa Hybrida* L. (poster)

Suong T. T. Ha, *Sejong University*; Jin Hee Lim, *Sejong University* and Byung-Chun In*, *Andong National University (Poster Board #250)*

Abstract: In cut roses, the primary factors determining the longevity vary depending on flower sensitivity to ethylene. While the vase life of ethylene-sensitive cultivars is shortened by water stress, that of ethylene-insensitive cultivars is strongly related to ethylene synthesis. In this study, we characterized the nature of the ethylene sensitivity changes in four rose cultivars, which have different sensitivities to the hormone. In addition, we determined the impacts of ethylene binding and synthesis inhibition on flower senescence and gene expression using 1-methylcyclopropene (1-MCP) and aminoethoxyvinylglycine (AVG). Cut roses were treated either singly with 1 $\mu L \cdot L^{-1}$ 1-MCP (+M) or simultaneously with 1 mM AVG and 1-MCP (A+M) for 12 h. After +M or A+M treatments, the flowers were subsequently exposed to ethylene. The relationship between the mRNA levels of ethylene biosynthesis, receptor, and signaling genes and the degree of ethylene sensitivity were determined during flower development and senescence. The results showed that A+M effectively maintained chlorophyll fluorescence emission (Fv/Fm) levels and water balance, and consequently prolonged the vase life of cut flowers in both ethylene-sensitive and -insensitive cultivars. In contrast, the cut flowers treated only with ethylene showed an early failure of water relations and shorter vase life. Both +M and A+M suppressed the expression of ethylene biosynthesis (*RhACS2* and *RhACO1*) and receptor genes (*RhETR1-5*) in cut roses, although A+M was more efficient than +M. The expression of *RhCTR1* and *RhCTR2* was not consistently influenced by ethylene, however, was enhanced by +M and A+M. We also observed that the mRNA levels of *RhEIN3-1*, *RhEIN3-2*, and *RhEIN3-3* were highly reduced by +M and A+M in ethylene-sensitive cultivars. These results contribute to better understanding about the relation between flower senescence and ethylene sensitivity as well as postharvest treatments of the ethylene antagonists.

Specified Source(s) of Funding: Young Researcher Grant (PJ012295) from the Rural Development Administration of Korea (RDA)

1:00 PM – 1:45 PM *International Ballroom East/Center*

Vegetable Crops Management 2 (Poster)

Management of Intercropped Strawberry, Pepper, Eggplant, and Cantaloupe to Maximize Yield and Economic Return. (poster)

Ravneet K Sandhu*, *GCREC-University of Florida (Poster Board #015)*

Abstract: Strawberry growers in the Southeast face rising production costs combined with competition from foreign markets and low commodity prices. These issues are especially important for growers that rely solely on the strawberry crop. Planting a vegetable crop on the same bed before strawberry crop termination enables continued berry harvest while the new vegetable transplants become established. This practice helps growers diversify, reduce risk, and increase profits. A study on relay cropping of strawberry with peppers, eggplants, and cantaloupes was done in fall 2016 and spring 2017 at GCREC, Balm, FL. The strawberries were planted in September, and the vegetables were transplanted on the beds with strawberry plants and as sole crops at five different dates (Jan 4, Jan 18, Feb 1, Feb 15, and Mar 1). The objective of the research was to determine the competition between two crops and to optimize the efficient planting date of vegetables so as there will be a minimum effect on yield of both the crops. Data on yield and heights were collected. Strawberry yields did not differ between treatments regarding weight and counts. Pepper yield varied with transplant date but not the date of strawberry removal. The early planting dates (Jan 4, Jan 21, and Feb 1) had significantly higher yields than later planting dates. The eggplant yields were not affected when planted with or without strawberries. The highest yields were obtained at the earliest planting dates (Jan 1 and 21). The cantaloupes exhibited the same results as peppers; mid planting dates were higher yielding than others. In conclusion, the intercropping did not affect the yield of the vegetables. However, it differs with canopy structure and stature of the plant. The mid planting dates are better to transplant vegetables in strawberries to get high total yields. The strawberry yields were not affected by the vegetable intercropping which implies that the relay cropping could be the best practice to maximize the returns and minimize the yield losses.

Specified Source(s) of Funding: self

Effect of Antitranspirant Application on the Survival of Splice Grafted Watermelon (poster)

Pinki Devi*, *Washington State University* and Carol Miles, *Washington State University, NWREC (Poster Board #016)*

Abstract: The production of grafted watermelon seedlings is labor-intensive and more costly to the propagator and grower than non-grafted seedlings. Rootstock regrowth, sometimes referred to as 'suckering', is a major concern for grafted watermelon as the commonly used grafting methods, one-cotyledon and hole insertion, often leave rootstock bud meristem tissue intact. Rootstock regrowth can result in scion abortion, graft failure, or a decrease in yield by robbing the scion of water and nutrients. Another challenge facing the watermelon grafting industry is grafting efficiency, especially the speed at which grafting occurs. Further, desiccation of the grafted seedling occurs because of water stress of the scion during healing and hardening after grafting, causing death of grafted seedlings. In this study, the splice grafting method was used where both rootstock cotyledons were removed to eliminate meristem tissue and rootstock regrowth. Antitranspirant products, which can increase stomatal resistance and mitigate water stress, were tested to determine if they could increase the survival of splice-grafted watermelon as compared to water control. Antitranspirant products Chitosan (0.08% solution), Root-Drench (2% solution), Moisture-Loc (10% solution) and Glycerin (4% solution) were applied as a drench or foliar spray to rootstock and scion seedlings 1 day before grafting. Survival (%) of splice-grafted watermelon seedlings 16 days after grafting was the greatest for plants that received Root drench and Glycerin treatment (70% and 57%, respectively), and was lowest for plants that received water (8%) (P = 0.0005). These results indicate that antitranspirant applications to rootstock and scion seedlings before grafting can increase grafting success, but further research is needed to

optimize the environmental conditions for the survival of grafted plants.

Keywords. grafting efficacy, rootstock regrowth, transpiration, stomatal resistance

Hydrogen-Rich Water Improves Cold Tolerance of Cucumber By Alleviating Membrane Lipid Peroxidation and Photoinhibition (poster)

Fengjiao Liu, *Shandong Agricultural University*; Xiang Shen, *Shandong Agricultural University*; Huangai Bi, *Shandong Agricultural University* and Xizhen Ai*, *Shandong Agricultural University (Poster Board #017)*

Abstract: In northern China, low temperature is the most common abiotic stress for cucumber plants cultivated in a solar-greenhouse in winter. Hydrogen (H_2) is a new signal molecule that plays an important role in responses to various abiotic stress. However, the mechanism of H_2 in improving the chilling tolerance of cucumber in solar-greenhouse remains unclear. Here, we investigated the changes of lipid peroxidation and antioxidant system, gas exchange parameters, chlorophyll fluorescence parameters, and activity and mRNA expression of key enzymes in Calvin-cycle for cucumber (*Cucumis sativus* L.) plants in solar-greenhouse. Cucumber plants were either treated with foliar spray of saturated hydrogen-rich water (HRW, H_2 donor) or distilled water (control) once for 10 d, in Oct. 25 to Dec. 25 (7 times total). We found that the temperature is lower (day/night average temperature 12.5 ℃~18.2 ℃/8.6 ℃~12.5 ℃) for cucumber in solar-greenhouse during Oct. to Dec., and the chilling injury symptoms appeared in some leaves. We also noticed that the electrolyte leakage (EL), superoxide anion production rate, hydrogen peroxide (H_2O_2) and malondialdehyde (MDA) contents in cucumber leaves increased as the temperature decreased. HRW-treated plants showed significant decrease in EL, H_2O_2 and MDA contents, but a distinct increase in the activities of superoxide dismutase (SOD), peroxidase (POD), catalase (CAT), ascorbate peroxidase (APX) and glutathione reductase (GR), compared with the control during chilling days. HRW also led to a significant increase in photosynthetic rate (P_n), stomatal conductance (G_s), transpiration rate (T_r), and the activities of ribulose bisphosphate carboxylic (RuBPCase), Rubisco activase (RCA), sedoheptulose-1,7-bisphosphatase (SBPase) and transketolase (TK), and an obvious increase in the intercellular CO_2 concentration (*C*i). The maximum photochemical efficiency of PSII (F_v/F_m), actual photochemical efficiency of PSII (Φ_{PSII}) and the maximum photochemical efficiency of PSII in light (F_v'/F_m') were enhanced by HRW as well in cucumber plants during chilling days, whereas the initial fluorescence (F_0) was on the contrary. The yield of HRW-treated cucumber increased by 10.6%, in comparison with the control. These data demonstrate that HRW can enhance the chilling tolerance by improving the ROS scavenging activity and alleviating the injury of photosynthetic apparatus due to photoinhibition in cucumber.

Specified Source(s) of Funding: National Natural Science Foundation of China (31572170)

The Effect of Number of Lateral Shoots on Growth and Fruit Yield in Winter-Planted Cultivation of Paprika (Capsicum annum L. 'Redwing') (poster)

Dong-Cheol Jang*, *Department of Horticulture, Kangwon National University*; Il-Seop Kim, *Kangwon National University* and Ki-Young Choi, *Kangwon National University (Poster Board #018)*

Abstract: This experiment was carried out to investigate the effect of number of lateral shoots on growth and yield according to the external weather conditions during the growing stage. The test group was divided into zero, one, two and three leaves of lateral shoots based on one leaf on main branch from March 31 to November 15, 2014 for 36 weeks. As a result of this experiment, the total LAI difference between zero leaf and three leaves was about three times. The plant height was the largest at 286.86cm on zero leaf, and the smallest at 259.14cm on two leaves. In the period 1, the average fruit weight was 258.97g, 260.65g, 271.86g and 255.43g, respectively. However, as the growth progressed, it decreased to 110.73g, 104.21g, 95.1g and 72.04g, respectively, in Period 5, reversing to 148.24g 156.44g, 176.76g and 183.39g. The total production of zero leaf was 58.8kg, the smallest. And the largest yield 73.6kg of two leaves. In conclusion, by the fact that total yield increased to two leaves from zero leaf but decreased over two leaves, two leaves are considered to be the best number of lateral shoots in winter-plant cultivation of paprika.

2017 Muskmelon Variety Trial at Highmoor Farm, Monmouth, Maine (poster)

Nicholas Rowley, *University of Maine*; Mark G. Hutton*, *University of Maine* and David Handley, *University of Maine (Poster Board #019)*

Abstract: Melons were among the crops requested for trialing by members of the Maine Vegetable and Small Fruit Growers Association at the 2017 Maine Agricultural Tradeshow. A variety trial was designed at the University of Maine Agricultural and Forestry Experiment Station: Highmoor Farm in Monmouth Maine for the 2017 growing season. Thirty-two cultivars of muskmelon including cantaloupe, honeydew, galia, canary, crenshaw, and butterscotch types were planted in a random complete block design with four replications. Melons were seeded on 17 May and 25 May into 2" peat pots and grown in a greenhouse until they were moved into a high tunnel to harden off prior to transplanting. On 7 June the melons were planted through black plastic in rows 8' on center with an in-row plant spacing of 18". Melon yields were good at Highmoor farm in the 2017 growing season despite low rainfall amounts. For season yields, medium sized 'Majus' and 'Wrangler' (both Tuscan type cantaloupes) had high fruit numbers, high total plot weights and good flavor. Larger cantaloupes 'Afterglow', 'Grand Slam', 'Athena' and 'Avatar' had high fruit numbers and plot yields and had a harvest window of over 2 weeks. 'Sarah's Choice' produced poorly, exhibited poor netting and worse flavor compared to the other cantaloupes trialed.

'Minerva' while having good flavor and a high brix reading, was very large. Melons with larger sizes may be unappealing to consumers who want a more manageable size fruit; or hard to package if shipping. Furthermore, melons that are small compared to their bigger counterparts may have similar edible flesh amounts. Honey dews are typically later than other melons and cooler late summer night time temperatures slowed the ripening process. This trial was terminated before all the honey dews ripened.

Evaluating USDA NPGS Cucurbit Germplasm Accessions for Resistance to Verticillium Wilt (poster)

Abigail Attavar*, *Washington State University* and Carol Miles, *Washington State University, NWREC (Poster Board #020)*

Abstract: *Verticillium dahliae* is a soil-borne fungal pathogen that causes Verticillium wilt. Grafting has been widely used as part of an integrated disease management strategy for Verticillium wilt in cucurbits. Cucurbit rootstock seeds can be expensive and seeds of most rootstock cultivars are imported into the U.S. from seed companies that breed them. Verticillium resistant germplasm accessions from the USDA National Plant Germplasm System (NPGS) could potentially be used by researchers and seed companies as rootstocks or as parents in rootstock breeding programs to develop domestic rootstocks. NPGS accessions could thus reduce the cost of development and availability of rootstock seed. This study evaluated 56 NPGS cucurbit accessions from four species – *Benincasa hispida*, *Cucurbita maxima, Cucurbita moschata* and *Lagenaria siceraria*- for their resistance to Verticillium wilt. These four species are commonly used as rootstocks for watermelon. The evaluation was done at WSU Mount Vernon NWREC, in a certified organic field naturally infested with *V. dahliae* (10 cfu g-1 of soil). Seedlings were raised in the greenhouse and inoculated with *V. dahliae* microsclerotia (sand inoculum was adjusted to deliver 1.5 cfu per planting hole) at transplanting. Disease development was noted over five weeks, and AUDPC values were calculated for all accessions. Mean AUDPC values for germplasm accessions ranged from 9 to 297 and was 275 for 'Sugar Baby' (Verticillium susceptible control). Thirteen accessions with the lowest AUDPC values and no detectable *V. dahliae* colonies in a subsequent stem sap assays were identified. The selected accessions included *L. siceraria* (seven accessions) *Lagenaria* sp. (one accession) and *Cucurbita* (five accessions). These accessions will be used in a follow-up study, during which they will be used as rootstock for grafting watermelon and evaluated again for resistance to *V. dahliae* and grafting compatibility.

Summer Production of Broccoli in Western North Carolina (poster)

Jeanine Davis*, *North Carolina State University*; Margaret Bloomquist, *North Carolina State University*; Thomas Björkman, *Cornell University* and Phillip Griffiths, *Cornell University NYSAES (Poster Board #021)*

Abstract: The Eastern Broccoli Project, a multi-state federally funded project led by Cornell University, includes researchers, extension personnel, public and private breeders, and farmers from Maine to Florida in its efforts to create a broccoli (*Brassica oleracea* var *botrytis*) industry in the eastern United States. An important aspect of the project is to try to extend the production season up and down the east coast across as many months of the year as possible. Producing this cool season vegetable in the summer is difficult for much of the East Coast. It can be done successfully in the New England region to satisfy market demand in the Northeast, but it is desirable to identify a more southern location to supply the Southeast. The high elevations in western North Carolina experience cooler temperatures during the late spring and summer than are commonly found in the Southeast. Our role in this project is to evaluate varieties, breeding lines, and cultural practices for summer production in the mountains of western North Carolina. Early in the project (2010-2014), broccoli yields and quality from our research station and on-farm trials were low compared to those produced by our project colleagues in Maine, New York, Virginia, and South Carolina. Identification of heat tolerant varieties and breeding lines, use of raised beds and drip-irrigation, use of black plastic mulch in the early spring and white on black plastic mulch in late spring, increased plant populations, and improved transplant production have resulted in increased yields and quality. In the first five years of the project, five new varieties were released or remarketed to the East, and improved selections particular for our region were identified. In our 2017 on-farm trials an industry standard, Emerald Crown, and an advanced breeding line provided favorable marketing potential (approx. 49,421 heads/ha) over a good harvest window. *Specified Source(s) of Funding: NIFA/USDA SCRI 2016-51181-25402*

Optimum Plant Spacing for New Mexico Green Chile (*Capsicum annuum*) Mechanical Harvest Efficiency (poster)

Charles D Havlik*, *New Mexico State University*; Stephanie Walker, *New Mexico State University*; Paul Funk, *USDA Agricultural Research Service Southwestern Cotton Ginning Research Lab* and Mark A Marsalis, *New Mexico State University (Poster Board #022)*

Abstract: Closer plant spacing influences the plant growth habit of New Mexico chile by creating taller plants with fewer basal branches and higher fruit set. These traits are beneficial to mechanical harvest efficiency. Experiments conducted in 2015 and 2016 at New Mexico State University's Los Lunas Agricultural Science Center investigated the impact of thinning NM green chile plants to 4 and 8 inch spacing on mechanical harvest efficiency, and if closer plant spacing would adversely affect green chile fruit size. Two commercial New Mexico green chile cultivars, 'NuMex Joe E. Parker' (Biad Chili Company, Las Cruces, NM) and 'AZ-1904' (Curry Chile and Seed Company, Pearce, AZ), were direct seeded on 17 Apr. 2015 and 14 Apr. 2016. Three thinning treatments (4, 8 and 12 inch plant spacing) were established in a randomized complete block design with five replications. Plots were thinned on 11 Jun. 2015 and 14 Jun. 2016. The field was flood irrigated, fertilized and cultivated as needed. Plant measurements including height and width, height to main bifurcation, stem diameter, and number of basal branches were recorded immediately before harvest. An Etgar Series MOSES 1010 (Bet-Lehem-Haglilit, Israel) was used to mechanically harvest the plots on 2 Sept. 2015 and 31 Aug. 2016. Harvested material was sorted and weighed by marketable green fruit, broken fruit, and non-fruit plant material. Weight of fruit dropped on the ground and fruit left on the plants following harvest was also measured. Fruit dimensions (weight, width, length, and wall thickness) from a subsample of the harvested pods were recorded. Results were similar in both years. Overall, 'NuMex Joe E. Parker' provided higher mechanically harvested green chile fruit yield than 'AZ-1904'. 'NuMex Joe E. Parker' with the 4 inch thinning had the most marketable green yield of 28,160 lb/acre, 101.4% more than the lowest yielding 'AZ-1904' with the 12 inch thinning. 'AZ-1904' fruit from the 4 inch thinning was significantly longer (22.6 cm) and heavier (112.6 gm) when compared to all 'NuMex Joe E. Parker' and 'AZ-1904' 8 and 12 inch thinning treatments. Fruit width and number of locules were not affected by thinning treatments. 'NuMex Joe E. Parker' at the 4 inch thinning had the tallest plants (73.9 cm) and also had the highest height to bifurcation at the 4 and 8 inch thinning treatments, 23.3 cm and 23.6 cm respectively. Both cultivars had a higher bifurcation value as the spacing between plants decreased.

Southeastern U.S. Brussels Sprout Variety Trial (poster)

Kathryn Fontenot*, *LSU AgCenter*; Brian Ward, *Clemson University CREC*; Mary Sexton, *LSU AgCenter*; Matthew Horry, *Clemson* and Christopher Simmons, *Clemson (Poster Board #023)*

Abstract: The Brussel sprout (*Brassica oleracea* var. gemmifera) is a cool season Cole crop in the mustard family. Sprouts, resembling small cabbage heads, develop along the leaf axil, maturing from ground level upwards. The majority of U.S. Brussels sprouts are produced in California. However, Brussels sprout popularity continues to rise in the Southeastern United States. In Louisiana and South Carolina, small scale vegetable producers are planting small plots of Brussels sprouts (less than 0.25 acres) for high end restaurants, grocery stores and farmers market consumers. A replicated variety trial was conducted in Husser, LA and Charleston, SC to determine if particular varieties would perform well in the fall season in warm humid states. Twenty-one varieties were initially selected, but because of low seed germination and poor performance in the field, the study was narrowed to 12 varieties. Total number of buds per plant, average bud diameter and total bud weight per plant were measured. Combining data from both states, 'Hestia' produced heavier total bud weight than all tested varieties. 'Hestia' also produced higher number of buds than 'Dagan', 'Franklin' and 'Colbus', and had wider bud diameter than 'Colbus', 'Nautic', and Diablo'. Separating variety performance by state, 'Hestia' grown in Louisiana produced the least number of total buds, ranked average in bud weight, and was among the top varieties for bud diameter. South Carolina grown 'Hestia' ranked in the top two varieties for bud number, bud weight and bud diameter.

Effects of Planting Date and Grafting with Interspecific *Cucurbita* Rootstocks on Seedless Watermelon Production (poster)

Sylvia Willis*, *University of Florida*; Dustin Huff, *University of Florida*; Zack Black, *University of Florida* and Xin Zhao, *University of Florida (Poster Board #024)*

Abstract: In addition to Fusarium wilt resistance, the interspecific hybrid squash rootstock (*Cucurbita maxima* × *C. moschata*) is also known for its tolerance to low temperatures. This field experiment was conducted at the Suwannee Valley Agricultural Extension Center in Live Oak, FL to explore the impacts of grafting with interspecific *Cucurbita* rootstocks on seedless watermelon yield and fruit quality at two planting dates during the spring 2017 season. Seedless watermelon 'Melody' was grafted onto two interspecific *Cucurbita* rootstocks 'Carnivor' and 'Super Shintosa', respectively, with non-grafted 'Melody' as the control. Two types of grafted plants were also included, i.e., plants with original rootstock roots and plants with rootstock root excision and regeneration, as both are currently provided by commercial nurseries. Plants were transplanted into the fumigated field on 20 Mar. (early) and 6 Apr. (late), respectively. Destructive plant sampling before the first harvest showed that all the grafted plants had more female flowers compared with the non-grafted plants, while similar numbers of female flowers were found between the two types of grafted plants. However, the full-season yield components including marketable and total fruit numbers and yields as well as the average fruit weight did not differ significantly between grafted and non-grafted plants. In contrast, early planting led to significantly higher marketable and total fruit yields primarily due to increased averaged fruit weight, in comparison with late planting. No significant interactions between planting date and grafting were observed. With respect to each harvest, early planting significantly improved marketable fruit yield compared with late planting at the first harvest. Although statistical significance was not observed ($P = 0.068$), grafted plants especially those with 'Super Shintosa' rootstock tended to have higher marketable fruit yield than non-grafted plants at the first harvest. At the second harvest, non-grafted plants showed the highest marketable fruit yield, while no significant effect of planting date was observed. Average fruit weight was significantly higher at early planting than late planting for both harvests, while it did not differ significantly between

grafted and non-grafted plants. Planting date and grafting did not show any significant impacts on fruit yield from the third harvest. Fruit quality assessment showed similar levels of soluble solids content, pH, and titratable acidity between grafted and non-grafted plants regardless of root excision and regeneration. However, early planting resulted in a significant increase in fruit pH with lower titratable acidity compared to late planting.
Specified Source(s) of Funding: Florida Specialty Crop Block Grant Program

Soil Fertility Drives Yield Gains and Losses of Grafted Heirloom Tomatoes in Nebraska (poster)

Ashley A. Thompson*, *University of Nebraska - Lincoln* and Sam E. Wortman, *University of Nebraska - Lincoln (Poster Board #025)*

Abstract: Grafting heirloom tomato (*Solanum lycopersicum*) cultivars onto hybrid tomato rootstocks can increase yield, mineral nutrition, drought tolerance and disease resistance. In 2017, the determinant heirloom tomato 'Nebraska Wedding' was grafted onto two rootstocks, 'Estamino' and 'Maxifort'. Non-grafted and self-grafted 'Nebraska Wedding' plants were controls. Plants were grown in a high fertility soil in Lincoln, NE (residual NO_3-N = 10.7 ppm; P = 90 ppm, and K = 410 ppm), and in a low fertility soil near Mead, NE (residual NO_3-N = 3.2 ppm; P = 5.5 ppm, and K = 296 ppm). Plants received no nitrogen fertilizer (control) or 168 kg N ha^{-1} from yardwaste compost, calcium nitrate [$Ca(NO_3)_2$] fertigation, or both (84 kg N ha^{-1} from each source). In the high fertility soil, grafting tomatoes with 'Estamino' or 'Maxifort' reduced yield by 41% and 48% relative to non-grafted plants. Fertilizer and compost did not affect tomato yield in the high fertility soil, but did increase leaf nutrition. In the low fertility soil, tomatoes grafted to 'Estamino' had 20% greater yield than non-grafted plants. Fertilizing with $Ca(NO_3)_2$ alone and in combination with compost also increased tomato yield in the low fertility soil, and plants grafted to 'Maxifort' and fertilized with $Ca(NO_3)_2$ and compost had greater leaf tissue nitrogen, phosphorus, and potassium. Results suggest that grafting and integrated nitrogen management can increase tomato yield and leaf nutrition, especially in a low fertility soil. However, grafted tomatoes grown in a high fertility soil may have excessive vigor and reduced harvest index.
Specified Source(s) of Funding: USDA AMS Specialty Crop Block Grant Program

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1:00 PM – 2:00 PM *Oak Lawn (Lobby Level)*

History of Horticultural Science (HIST) Meeting - Open to All Attendees

Chair: David Karp, *University of California - Riverside*

Objectives:

To exchange information and promote interest in the history of horticultural technology and science.

1:00 PM – 2:00 PM

Resume Review Session II

Concourse Level Foyer

Objectives:

Schedule a time to go over your CV and ask career questions with a professional mentor. These will be scheduled in 20 minute sessions.

1:00 PM – 2:00 PM *Boundary (Terrace Level)*

Scholarship Awards Committee Meeting

Chair: Diane Beckles, *University of California Davis*

Members: Michela Centinari, *N/A*; Jacob Domenghini, *Illinois Central College*; Joan Davenport, *WSU Prosser*; Rosanna Freyre, *Univ of Florida*; Juan Carlos Melgar, *Clemson University* and Gary R. Bachman, *Mississippi State University Coastal Research and Extension Center*

1:45 PM – 3:00 PM *Georgetown East*

Genetics and Germplasm 4

Moderator: Stan Hokanson, *University of Minnesota*

1:45 PM **First Clear Evidence of Population Structure in *Cornus Kousa* (Asian Dogwood)**

Marcin Nowicki*[1]; Logan C. Houston[1]; Sarah L. Boggess[1]; Denita Hadziabdic[1]; Anthony S. Aiello[2]; Masahiro Yamanaka[3]; Mitsuhiro Hayasida[4] and Robert N. Trigiano[1], *(1)University of Tennessee - Knoxville, (2)University of Pennsylvania, (3)International University of Health and Welfare, (4)Yamagata University*

Abstract: Asian dogwood (*Cornus kousa*), closely related to North America-native flowering dogwood (*C. florida*), is an economically important ornamental understory tree. Many *C. kousa*-based cultivars, breeding lines, and hybrids with *C. florida* have been developed and commercially released in the U.S.A. due to their attractive features and desirable (a)biotic stress tolerance. To assess the species genetic diversity, samples of *C. kousa* gDNA from 130 plants of non-cultivated Asian origin (China, Japan, Korea) were collected. Both living trees and herbarium specimens dated as early as 1950s were sampled. The collection was analyzed with PCR using 18 *C. kousa*-specific microsatellite markers and automated capillary gel electrophoresis. The dataset was then subjected to the population genetics analysis using R with several relevant packages. The majority of our dataset (locus- and population-wise) remained under the Hardy-Weinberg Equilibrium assumptions and showed high gene flow as expected from an obligate outcrossing species. Only negligible linkage disequilibrium was detected among the markers. Analysis of molecular variance indicated the overwhelming majority of variance partitioned among subpopulations and individuals. Among the five subpopulations (China current and old, Japan current and old, Korea old), the genetic variation accounted for 8.5% of total variation, yet demonstrated clear population structure according to the country of origin. Population structure was analyzed with both Bayesian and Discriminant Analysis of Principal Components approaches and indicated the presence of three population clusters matching the country of origin. Low genetic differentiation of our collection was attributed to the mutations accrued over time. The Neighbor-Joining tree of population distances indicated the samples from Japan as the most ancestral. This is to our knowledge the first detailed report on *C. kousa* population structure. Our results have important implications for future cultivar development, indicating that multiple sources of diversity may be used for breeding.
Specified Source(s) of Funding: USDA/ARS for the dogwood research in the Trigiano lab (58-6062-6)

2:00 PM **Population Analysis of *Erysiphe Pulchra*, Pathogen of *Cornus Florida***

Christopher Wyman[1]; Denita Hadziabdic[2]; Sarah L. Boggess*[2]; Timothy A. Rinehart[3]; Alan Windham[1]; Phillip A. Wadl[4] and Robert N. Trigiano[2], *(1)University of Tennessee, (2)University of Tennessee - Knoxville, (3)USDA-ARS, SHL, (4)USDA-ARS, U.S. Vegetable Laboratory*

Abstract: *Cornus florida* (flowering dogwood) is an understory tree native to eastern hardwood forests of the United States (U.S.) and utilized as a popular ornamental landscape tree. In the mid-1990s, dogwood powdery mildew (*Erysiphe pulchra*) reached epidemic levels throughout the *C. florida* native range causing a drastic rise in production costs. Dogwood powdery mildew is an obligate biotrophic fungus of some big-bracted dogwoods (*C. kousa, C. florida,* and *C. nuttallii*). The pathogen exhibits with the white mycelium, conidiophores, and conidia on the adaxial surface of leaves. Disease symptoms include stunted growth of trees, necrosis of young leaves, red pigmentation near infected areas, and decreased flower and fruit production. During the late 1990s, both sexual and asexual stages of *E. pulchra* were regularly observed, but in recent years, chasmothecia have been rarely detected. Utilizing 15 microsatellite loci, we analyzed 174 *E. pulchra* samples collected from symptomatic *C. florida* leaves to assess genetic diversity and population structure of the pathogen. After clone correction, which removed 77 *E. pulchra* individuals, a total of 97 multilocus haplotypes (MLH) were used for further population analyses. Data were grouped and analyzed as either two sub-populations or eight sub-populations based on

geographical sampling. Our study indicated low genetic diversity and a lack of population structure of *E. pulchra* in the eastern U.S. The index of association differed significantly from 0, signifying asexual or clonal reproduction. Our demographic history data indicated a population bottleneck among the sampling locations. These findings strongly suggest that *E. pulchra* has become almost exclusively clonal since 1995, which lends support to the hypothesis that *E. pulchra* is an exotic pathogen introduced to North America.

Specified Source(s) of Funding: USDA/MOA number 58-6062-6-002

2:15 PM Genetic Diversity of Minnesota's Most Endangered Tree Species, Eastern Hemlock (*Tsuga canadensis* (L.) Carr)

Emily K. Ellingson[1]; Steven McNamara[2]; Matthew D. Clark[1]; James M. Bradeen[1] and Stan C. Hokanson[*1], *(1)University of Minnesota, (2)Minnesota Landscape Arboretum*

Abstract: Eastern hemlock (*Tsuga canadensis* (L.) Carr), a common conifer in the eastern United States, exists on the northwestern extent of its native range in Minnesota. The species has always been rare in the state, possibly due to the cold, dry climate, but it has declined in the last century due to pressures from fire and logging. Eastern hemlock is currently considered to be the most endangered tree species in Minnesota, with less than 40 mature trees left in native stands in the northeastern region of the state. Additionally, there are trees of known native origin at the Minnesota Landscape Arboretum and trees of unknown, but possibly native origin at various municipal and state parks across the state. We used eight previously described microsatellite markers derived from *Tsuga canadensis* to investigate the genetic diversity and differentiation of disjunct native populations and cultivated trees in Minnesota and to determine the origin of cultivated trees of unknown provenance. We collected foliage samples for DNA extraction from all known native trees and select cultivated trees in Minnesota, trees in the Great Lakes region and trees from North Carolina, the center of species diversity. Additionally, over the course of two years we collected and grew seed from 17 Minnesota native trees and 4 trees of wild provenance from the Minnesota Landscape Arboretum. Considering only native adult trees, population differentiation and inbreeding as measured by Slatkin's were relatively high (R_{st} = 0.123; R_{IS} = 0.219). Structure and Principal Component Analysis revealed Minnesota native populations to be genetically distinct from main range populations in Michigan and North Carolina. Paternity analysis of seedlings revealed few statistically significant mother-father pairs, although likely pollen parents often included non-native trees. Results from this research are being used to inform decisions about the conservation and management of existing native and cultivated trees. This includes using select native trees as seed sources for restoring populations and supplying the region's landscape nursery industry with native sourced plant material. Although these disjunct populations are subject to potential genetic risks posed by inbreeding, they may prove useful as a source of genetic resources for problems such as the hemlock wooly adelgid (*Adelges tsugae* Anaand.) currently killing large numbers of trees in eastern U.S. populations.

Specified Source(s) of Funding: MN Ag Expt. Station

2:30 PM Evaluation of Genetic Diversity and Stability of *Colocasia* Cultivars Using ISSR

Jared Barnes[*]; Seukmin Hong; Bea Clack; Yuhui Weng and Michael Maurer, *Stephen F. Austin State University*

Abstract: Using 44 ornamental *Colocasia* cultivars planted at Stephen F. Austin State University (Nacogdoches, TX), cultivar assessment, genetic diversity, stability, and relationship were examined with banding patterns produced from Inter-simple sequence repeat (ISSR) markers. Comparing banding patterns of vegetatively propagated clones of each cultivar, genetic stability was examined. Unweighted pair group method with arithmetic mean (UPGMA) and principal coordinate analysis (PCO) were performed to examine genetic relationship that can explain a need for the new classification *Colocasia gigantea* and recent movement of re-classifying *Colocasia antiquorum*. Average Shannon's diversity index for all loci was found to quantify genetic diversity. The genetic stability analysis confirmed all 44 cultivars commonly found in market have identical genetic characteristics. The genetic relationship analysis supports the new classification of *Colocasia antiquorum* but does not strongly support the need for re-classification of *Colocasia gigantea* based on our results. Shannon's diversity index suggested that 44 ornamental *Colocasia* cultivars have high gene pool.

2:45 PM Molecular Basis Underpinning Leaf Coloration and Defoliation in Transgenic *Ficus Lyrata* Plants

Xiayu Guan, *Fujian Agriculture and Forestry University*; Qingxi Chen, *Fujian Agriculture & Forestry University* and Jianjun Chen[*], *University of Florida, Mid-Florida Research and Education Center*

Abstract: *VvmybA1* is a gene derived from grape (*Vitis vinifera*) and belongs to the *MYB* gene family. Our previous study demonstrated that overexpression of *VvmybA1* caused accumulation of anthocyanin in leaves of transgenic *Ficus lyrata*, a popular woody ornamental plant. The purple-leaved *F. lyrata* was also prone to leaf defoliation in greenhouse. This study was undertaken to analyze molecular mechanisms underpinning the leaf coloration and leaf defoliation. Transcriptome profiling derived from purple-leaved *F. lyrata* overexpressing *VvmybA1* was compared to that of non-transformed, green-leaved plants. The results showed that the accumulation anthocyanin was caused by the upregulation of genes encoding UDP glucose flavonoid 3-O-glucosyl transferase, UDP rhamnose-anthocyanidin-3-glucoside rhamnosyltransferase, chalcone synthase and chalcone isomerase, which are key to anthocyanin biosynthesis. However, genes associated with photosynthesis and energy supply were downregulated. Furthermore, genes involved in defoliation, including beta-glucosidase, shikimate O-hydroxy cinnamoyl transferase and anthocyanidin reductase were all downregulated. The downregulation of these genes may explain why purple leaves are more prone to defoliation. The defoliation is undesirable as *F. lyrata* has been widely used as a house plant for interiorscaping. This study indicates that overexpression of a particular gene can significantly affect other valuable traits in ornamental plants. Thus, subsequent selection should retain the novel phenotype without compromising other traits.

1:45 PM – 3:15 PM *Georgetown West*

Commercial Horticulture 2

Moderator: Vanessa Gordon, *USDA-ARS SEA Sugarcane Field Station*

1:45 PM Improving Establishment of Hops By Optimal Selection of Cultivars, Plant Materials, Nitrogen Fertilization and Plant Spacing in Florida

Shinsuke Agehara[*1]; Tiare Silvasy[1]; Zhanao Deng[1] and Simon Bollin[2], *(1)University of Florida, (2)Hillsborough County Economic Development*

Abstract: Hops (*Humulus lupulus* L.) have been gaining interests as a specialty crop for Florida's rapidly growing craft beer industry. Although hops are adapted to temperate climates, previous studies demonstrated that some hop cultivars have potential for viable production even under Florida's subtropical climate. Field experiments were conducted over the two seasons (2016–2017) to determine the optimal cultivar, planting material, nitrogen (N) fertilization rate, and in-row plant spacing for improving the establishment of hops in Florida. In the first season, rhizomes were planted in April on native, deep sand soil in a 6-m high trellis system. Treatments were factorial combinations of two cultivars ('Cascade' and 'Chinook'), two nitrogen (N) rates (0.84 and 1.1 kg/ha/day), and three in-row plant distances (76, 91, and 107 cm). Harvests were performed 10 times between June 1 and Dec. 2, 2016. The maximal bine length was similar regardless of cultivars and other treatments (282 to 321 cm). By contrast, bine number recorded during the mid-harvest was 186% greater for 'Cascade' than 'Chinook' (4.1 vs. 1.4 bines/plant). Cone yield showed significant cultivar × N rate interaction effects: 'Cascade' increased yield with increasing N rate by 33% (333 vs. 442 kg/ha on a fresh-weight basis), whereas yield of 'Chinook' was very small regardless of N rates (40 kg/ha). In both cultivars, in-row plant spacing did not have significant effects on both bine growth and yield. Major drawbacks associated with rhizomes included low emergence rates (57% to 67%) and the infection of apple mosaic virus confirmed immediately after planting. Because of these drawbacks, the hop yard was reestablished using tissue culture seedlings of 'Cascade' in the second season. Compared with the plant growth in the first season, tissue culture plants had a

relatively high survival rate (97%), but less vigorous growth with up to 176 cm in bine height and 3.7 in bine number. Cone yield was 322 kg/ha on a fresh-weight basis. The results suggest that 'Cascade' has a much higher yield potential than 'Chinook' in Florida, and that bine number is an important yield-related trait. Furthermore, the first season yield of 'Cascade' can be maximized by optimizing N fertilization rate. To establish a virus free ho yard with uniform stands, tissue culture seedlings are recommended than rhizomes.

Specified Source(s) of Funding: 2017 Florida Specialty Crop Block Grant # USDA-AMS-SCBGP-2017

2:00 PM Identifying Bulb Fennel Cultivars Suitable for Production in Northwest Washington

Yao Mu*[1]; Patti Kreider[2] and Carol A. Miles[2], *(1)Washington State University, (2)Washington State University, NWREC*

Abstract: Farmers in northwest Washington are searching for new crops that are well suited to the region's moderately cool environment, have good market value, and fill a crop rotation niche that supports the production of the primary high-value specialty crops grown in the region. Bulb fennel (*Foeniculum vulgare*) fits these criteria. Bulb fennel is a cool-weather crop that is produced predominantly in Sicily, which has a climate similar to northwest Washington during the fennel production season. The average temperature in Sicily during bulb fennel seeding/transplanting (Nov.-Dec.) is 13°C, and during harvest (Mar.-May) is 17°C, which is similar to the growing climate of Mount Vernon, Washington during the spring (11°C) and summer (16°C). This study tested the yield and quality of 11 bulb fennel cultivars in northwest Washington in summer 2017. The experimental design was a randomized complete block with 4 replications and 20 plants per plot, and the planting design was a double row on a raised bed with drip irrigation covered with black plastic mulch. All cultivars were seeded in the greenhouse on 2 May and transplanted to the field 14 June. The average emergence was 91%, with Orazio, Solaris and Zefa Fino with the lowest emergence (85% on average). The days from seeding to first harvest was 148 to 150 days for all cultivars except Bronze, which did not form bulbs. All cultivars except Florence and Zefa Fino reached marketable bulb size (bulb circumference ≥ 16 cm). Solaris and Tauro produced the largest bulbs, with average bulb weight of 400 g. Finale and Tenace produced more marketable bulbs (80%) than other cultivars. There were no significant differences among cultivars in total soluble solids (TSS), tenderness and branching; and internal cracking was also similarly minimal for all cultivars. Perfection had the lowest basal cracking level than other cultivars, but all bulbs were considered marketable. These preliminary results indicate northwest Washington has the potential to produce high-quality bulb fennel. This study will be repeated in 2018 and will also include a second seeding/transplant date of 2 weeks later than the current study.

2:15 PM Increasing Artichoke Yields By Cultivar Selection and Optimization of Nitrogen Fertilization Rates and in-Row Spacing in Florida

Shinsuke Agehara and Tiare Silvasy*, *University of Florida*

Abstract: Globe artichoke (*Cynara cardunculus* var. *scolymus*) is emerging as a new specialty crop in Florida because of its high potential production value. However, suitable cultivars and production guidelines have not been established. Two field experiments were conducted under a subtropical climate in West Central Florida. To overcome chilling requirements of artichoke, plants were treated with gibberellic acid at 49 g·ha^{-1} three times during the vegetative growth stage. First, we evaluated six cultivars and identified that marketable yield was highest in the order: 'Imperial Star' (7.25 t·ha^{-1}) > 'Opal' (4.30 t·ha^{-1}) > 'Green Globe' (3.85 t·ha^{-1}) > 'Colorado Red Star' (0.99 t·ha^{-1}) > 'Purple Romagna' (0.64 t·ha^{-1}) > Madrigal' (0 t·ha^{-1}). Marketable yield of 'Imperial Star' was significantly higher than that of three lowest-yielding cultivars. The yield variation was due mainly to bud number per plant, with 'Imperial Star' producing the highest number of buds (3.9/plant) among all cultivars. Using 'Imperial Star', factorial combinations of five nitrogen (N) fertilization rates (106, 157, 206, 257, and 307 kg·ha^{-1}) and three in-row plant distances (76, 91, and 107 cm) were tested. Overall, N rates had stronger significant effects than plant spacing. For all in-row plant distances, plant width and leaf N concentration increased linearly with N rates. Marketable yield also increased linearly with N rates (1.73 to 5.13 t·ha^{-1}), averaging across in-row plant distances. Although area-based yield was unaffected by plant spacing, yield on a plant basis increased with increasing plant spacing. In addition, the linear trends of measured variables became generally stronger with increasing plant spacing, indicating more intense plant competition at narrow plant spacing. In the two trials, seedlings were transplanted on Oct. 2 to 16, 2017, and harvests were performed 8 to 12 times between Jan. 31 and Mar. 22, 2018, when market prices of artichoke are generally highest because of the low domestic supply. These results suggest that 'Imperial Star' is the most suitable cultivar to the subtropical growing conditions of Florida. Marketable yield of this cultivar can be maximized by adopting high N fertilization rates. Importantly, the enhanced earliness may support viable artichoke production in Florida.

Specified Source(s) of Funding: 2016 Florida Specialty Crop Block Grant # USDA-AMS-SCBGP-2016

2:30 PM Field Measurement and Qualitative Inquiry Indicates Need for Reevaluation of on-Farm Food Loss Estimates in North America

Lisa K Johnson*; Rebecca D. Dunning; Chris Gunter; J. Dara Bloom; Mike D. Boyette and Nancy G. Creamer, *North Carolina State University*

Abstract: Estimates of food loss and waste in developed countries including the U.S. suggest the most impact to the triple bottom line of society, environment, and economy occurs at the consumer level. Hence, research and other initiatives have emphasized consumer campaigns, aiming to reach national and global targets. Food loss at the origin of the supply chain, however, is considered low volume or low value, not garnering much attention, even as approximations that inform these estimates are decades old and not rooted in field measurement. Several projects centered on the farm level aimed to understand whether the available estimates are accurate emphasized field sampling focused on modern vegetable production systems over grower estimates collected through interviews. The method used is similar to determining harvest potential at the start of the season, but has been applied after the growers' primary harvest. Considering edible vegetable crops alongside what is considered acceptable in the marketplace, an evaluation of eight crops in seventy North Carolina fields determined the average loss is equivalent to 36% of the marketed yield, much higher than the 10% used in global calculations. Qualitative inquiry with vegetable growers confirmed no measurement of losses is routine, and the confidence they have in estimates they have provided is low. Solutions that aim to reduce losses in the field have been explored, with mixed success. Results from these studies using field measurement indicated there is a need for reevaluation of the estimates used to report farm level losses in the U.S. supply chain.

Specified Source(s) of Funding: USDA-SARE

2:45 PM Exciting Youth about Careers in Agriculture and STEM

Martha Glenn*, *University of Florida IFAS Extension* and Crystal Snodgrass, *University of Florida/IFAS Cooperative Extension*

Abstract: Manatee County has over 313,000 acres of production agriculture and ranks 7th in Florida in agricultural sales. However, an aging workforce threatens the future viability of these enterprises. Therefore, it is vital to inspire our youth to consider careers in agriculture. An annual youth field day was held to help inspire youth interested in agriculture. The objectives of the field day were to provide the opportunities for youth to experience science, technology, engineering, and math (STEM) programs while exposing them to different facets of agriculture. The methods used for the field day included tours of plant nurseries/farms/research centers, presentations, hands-on activities, and educational games. Seventy-two youth of diverse backgrounds participated. A survey was used to evaluate the day and a six month follow-up was utilized to measure behavior change. There was a 39% increase in knowledge about agricultural science, a 36% increase in knowledge pertaining to commercial agriculture, and a 28% increase in an interest in pursuing a career in agriculture. Eighty-eight percent felt that buying food locally was a good idea and had convinced their parents to do so. Sixty percent realized that many insects are beneficial and now try to preserve them in their homes and

gardens. This annual program has been a success preparing today's youth towards becoming an integral member of agriculture in Manatee County and elsewhere.

3:00 PM **Optimizing Return on Investment: Maintaining Scientific Integrity While Balancing the Strategic Relationship Shared between the USDA Agricultural Research Service and Its Stakeholders - a Case Study**

Vanessa S. Gordon*, *USDA-ARS SEA Sugarcane Field Station*; R. Wayne Davidson, *Sugar Cane Growers Cooperative* and Hardev S. Sandhu, *University of Florida*

Abstract: The Canal Point Cultivar Development Program incorporates five phases through which clones of sugarcane (complex hybrids of *Saccharum* spp.) are progressed. Each stage (i.e. seedlings, Stages 1, 2, 3, and 4) offers an added level of selection stringency designed to focus on the ultimate release of superior cultivars with both agronomically desirable traits (e.g. tonnage and/or sucrose, etc.) and abiotic/biotic tolerances to growth pressures experienced in the Everglades Agricultural Area. The sampling and trialing of these stages, however, is tied directly to the harvesting season of the commercial processes occurring concurrently in the October through March timeframe. Trial clones are typically sampled earlier (i.e. September) than what would occur in production, and subsequent selection for advancement to the next developmental stage based upon this premature data. A study was conducted over a 3-year span to investigate the ramifications of this early sampling on the Stage 2 developmental trial stage of the muck-soil program. The study included annual sugar sampling at both early (i.e. normal trial sampling; September) and late (i.e. optimal harvest sampling; late February – early March) harvesting dates; and comparing these BRIX and sugar data against those taken for the clones in the previous Stage 1 and succeeding Stage 3 stages. The results indicate: (a) That the majority of elite clones are continually overlooked for advancement based on this premature data; (b) Only ~ 12% of the clones selected in the autumn maintain their performance over the harvest season; and, (c) That a maximum return on investment for the costs of trialing throughout the Canal Point Cultivar Development Program could be achieved by sampling the clones at a later date during the harvest season.

1:45 PM – 3:15 PM

Grafting Vegetable Crops: Status and Challenges of an Expanding Industry *CEU Approved*

Lincoln West

Coordinators: Ramon Arancibia, *Virginia Tech*; Richard Hassell, *Clemson University*; Matthew Kleinhenz, *The Ohio State University-OARDC*; Chieri Kubota, *Ohio State University*; Penelope Perkins-Veazie, *North Carolina State University*; Brian Ward, *Clemson University CREC* and Xin Zhao, *University of Florida*

Moderator: Ramon Arancibia, *Virginia Tech*

Objectives:

To define the role, management, and challenges of grafting in the vegetable crops industry

Description: Grafting is an innovative technique used in vegetable crops to improve plant performance by reducing the effects of biotic and abiotic stresses and inducing responses that favor growth and production. This workshop will discuss the current status of the grafting industry and the major challenges associated with the use of grafted plants in production of solanaceous and cucurbitaceous vegetables. A grafting and automation demonstration will also be included for interested parties. The workshop participants will then be fully engaged in a structured discussion session following the presentations and demonstrations to explore future application of vegetable grafting and research needs towards enhancing the long-term sustainability of vegetable industry. This workshop is also in collaboration with a USDA-SCRI funded project team working on vegetable grafting technology development and improvement.

1:45 PM **Vegetable Grafting Science, Commercial and Consumer Practice, and Education in the U.S. Now and Later**

Ramon A Arancibia*, *Virginia Tech*; Xin Zhao, *University of Florida*; Brian Ward, *Clemson University CREC*; Penelope Perkins-Veazie, *North Carolina State University*; Richard L Hassell, *Clemson University*; Chieri Kubota, *Ohio State University* and Matthew D. Kleinhenz, *The Ohio State University-OARDC*

Abstract: **Purpose:** Tens of millions of grafted solanaceous and cucurbit vegetable plants are prepared by hand or with machine assistance each year in the U.S. and used in horticultural education, home production, or commercially (greenhouse, high tunnel, and field). For fruiting vegetable growers, grafting can speed the delivery of important root-based traits, especially disease and abiotic stress resistance/tolerance and vigor, to farms and gardens. Fruit produced by grafted plants may also have improved quality over fruit from the same ungrafted scion. For propagators and plant retailers, grafting is an opportunity to increase and/or diversify income. For scientists, grafting opens a large number of hypotheses collectively spanning the fundamental to applied spectrum. For grower-advisors, grafting offers a promising technology while still needing careful study. For educators, grafting can be useful in units focused on genetics, development, physiology, mineral nutrition and water relations, horticultural techniques, and other topics. This workshop is designed to: a) provide a comprehensive update on the state of vegetable grafting science and application in the U.S., and b) create an atmosphere where individuals and teams learn how vegetable grafting can provide additional value in horticultural research, practice (business), and education. **Approach**: This workshop is set up in 3 parts. First, 10-12 synopses, each three minutes long, containing one slide, and collectively covering grafted plant preparation (beginning with rootstock-scion selection), use, and evaluation, will be shared by researchers and educators. Next, a moderated group-wide discussion will demonstrate how participants can immediately gain and contribute to the science and practice of vegetable grafting. Finally, a supplementary, interactive, multimedia, and hands-on session will demonstrate and portray hand and machine assisted vegetable grafting techniques. **Outcomes**: Workshop participants will gain: a) greater familiarity with the U.S.-based vegetable grafting-related scientific and industry community; b) a shared understanding of the current application of vegetable grafting in commercial and consumer horticulture and education; c) up-to-date information on current and emerging vegetable grafting-related hypotheses, experiments, recommendations, resources, and techniques; and d) foundations for plans representing independent and collaborative efforts to follow up on insights gained during the workshop.

1:50 PM **Evaluating Desirable Root Traits for Chill-Tolerant Tomato Rootstocks for Early Plantings in Northern Nevada**

Felipe Barrios Masias*, *University of Nevada Reno*

1:55 PM **Addressing the Needs for Developing Management Programs Towards Optimizing Grafted Vegetable Performance and Cost Effectiveness**

Xin Zhao*, *University of Florida*

2:00 PM **Research and Outreach on Grafted Tomatoes Directed to Non-Commercial Producers in the Southeast**

Natalie Bumgarner*, *University of Tennessee*

2:05 PM **Increasing Organic Cucumber Yield By Grafting and Keeping Two Leading Vines in a High Tunnel**

Sanjun Gu*, *North Carolina Agricultural and Technical State University*

2:10 PM **Opportunities of Growing Grafted Seedless Cucumbers for Greenhouse and High Tunnel Production in the Midwest**

Wenjing Guan*, *Purdue University, Southwest Purdue Agricultural Center*

2:15 PM **Light and Temperature Requirements for Growing Consistent Rootstock and Scion Material for Cucurbit Grafting**

Richard L Hassell*, *Clemson University*

2:20 PM **Morphological Responses of Scion 'Florida 47' and Rootstock 'Shin Cheong Gang' Tomato Seedlings to Varied Light Intensity and CO2 Enrichment**

Brandon M Huber*, *NC State University*

2:25 PM **Vegetable Grafting from the Perspective of Tri-Hishtil**

Josh Kardos*, *N/A*

2:30 PM **Integration of Industrial and Systems Engineering Approach in Optimizing Nursery Operations for Vegetable Grafting**

Chieri Kubota*, *Ohio State University*

2:35 PM **Increasing Access to and Application of Vegetable Grafting**

Carol A. Miles*, *Washington State University, NWREC*

2:40 PM **Grafting As a Means to Improve Vegetable Fruit Quality and Storage Life**

Penelope Perkins-Veazie*, *North Carolina State University*

2:45 PM **Opportunities in Organic Watermelon Production Systems Utilizing Disease Resistant Scion and Rootstock Combinations**

Brian Ward*, *Clemson University CREC*

2:50 PM **Discussion**

1:45 PM – 3:45 PM *Jefferson East*

Floriculture: Culture Methods and Light

Moderator: Michael Maurer, *Stephen F. Austin State University*

1:45 PM **Investigating the Interactions between Blue and Far-Red Radiation in Growth of Ornamental Seedlings Under Sole-Source Lighting**

Yujin Park* and Erik S. Runkle, *Michigan State University*

Abstract: Blue (B, 400 to 500 nm) and far-red (FR, 700 to 800 nm) radiation have antagonistic effects on stem elongation; B typically suppresses extension growth while FR promotes it. Although the effects of B and FR radiation on plant growth have been investigated independently, little research has been published on how they interact to regulate extension growth and flowering. We grew seedlings of geranium (*Pelargonium ×hortorum*), petunia (*Petunia ×hybrida*), and coleus (*Solenostemon scutellariodes*) at 20 °C under six sole-source LED lighting treatments with an 18-h photoperiod. All treatments provided a photosynthetic photon flux density of 160 $\mu mol \cdot m^{-2} \cdot s^{-1}$ with the following intensities (subscript in $\mu mol \cdot m^{-2} \cdot s^{-1}$) of B (peak= 447 nm), red (peak= 660 nm), or/and FR radiation (peak= 731 nm): $B_{80}R_{80}$, $B_{80}R_{80}FR_{10}$, $B_{80}R_{80}FR_{80}$, R_{160}, $R_{160}FR_{20}$, and $R_{160}FR_{160}$. When seedlings were sufficiently large, they were transplanted into 10-cm pots and subsequently grown in a common greenhouse finishing environment at 20 °C with a 16-hour photoperiod. As expected, stem length of all species increased linearly with additions of FR [as the R:FR or estimated phytochrome photoequilibrium (PPE) decreased]. When R was partly substituted with B light ($B_{80}R_{80}$), stem length of shade-avoiding petunia and geranium also increased linearly with decreasing PPE, but substantially less (55-85%) than under R_{160}. In shade-tolerant coleus, there was little to no effect of PPE on stem elongation under $B_{80}R_{80}$. In geranium, shoot dry weight decreased linearly with increasing PPE similarly under R_{160} and $B_{80}R_{80}$, while in petunia, similar trends occurred only under R_{160}. In the long-day plant petunia, decreasing the PPE promoted subsequent flowering by 7 to 11 d under $B_{80}R_{80}$ and R_{160}. In day-neutral geranium, plants grown under $R_{160}FR_{160}$ flowered earlier (by 4 d) than those grown under $B_{80}R_{80}$. We conclude that a moderately high intensity of B attenuates the effects of FR radiation on extension growth but has no apparent effect on the FR-promotion of flowering promotion in at least some long-day plants.

2:00 PM **Influence of Propagation Daily Light Integral and Root-Zone Temperature on Rooting of Single-Internode *Pennisetum ×advena* Culm Cuttings**

W. Garrett Owen* and Roberto G. Lopez, *Michigan State University*

Abstract: Culm cuttings are an economically attractive method for propagating purple fountain grass [*Pennisetum ×advena* Wipff and Veldkamp (formerly known as *P. setaceum* Forsk. Chiov. 'Rubrum')] for quick liner production. Research objectives were to quantify the impact of propagation daily light integral (PDLI) and root-zone temperature (RZT) on rhizogenesis and culm development of single-internode purple fountain grass culm cuttings. Prior to culm cutting insertion, cuttings were treated with a basal dip rooting hormone solution containing 1000 $mg \cdot L^{-1}$ indole-3-butyric acid (IBA) + 500 $mg \cdot L^{-1}$ 1-naphthaleneacetic acid (NAA). Cuttings were placed in a glass-glazed greenhouse with an air temperature of 23 °C, benches with RZT set points of 21, 23, 25, or 27 °C, and under PDLIs of 4 and 10 $mol \cdot m^{-2} \cdot d^{-1}$ (Expt. 1) or 8 and 16 $mol \cdot m^{-2} \cdot d^{-1}$ (Expt. 2). At 28 d, greater root biomass accumulation occurred under a PDLI of 10 $mol \cdot m^{-2} \cdot d^{-1}$ than 4 $mol \cdot m^{-2} \cdot d^{-1}$. For example, as PDLI increased from 4 to 10 $mol \cdot m^{-2} \cdot d^{-1}$, root dry mass increased by 105, 152, and 183% at RZTs of 21, 25, and 27 °C, respectively. In Expt. 2, RZT increasing from 21 to 23 °C resulted in 70% more root dry mass for cuttings under a PDLI of 8 $mol \cdot m^{-2} \cdot d^{-1}$ while root dry mass was similar among all RZTs under 16 $mol \cdot m^{-2} \cdot d^{-1}$. When these results are taken together, single-internode culm cuttings of purple fountain grass can be most efficiently propagated under PDLIs of 8 to 10 $mol \cdot m^{-2} \cdot d^{-1}$ with RZT set points of 23 to 25 °C for quick liner production.

2:15 PM **Enhancing Herbaceous Perennial Stock Production through the Application of Three Plant Growth Regulators**

Sean Markovic*, *Colorado State University*

Abstract: Enhancing Perennial Stock Plant Production through the Use of Plant Growth Regulators

Sean Markovic, Graduate Student and Dr. Jim Klett, Colorado State University, Department of Horticulture and Landscape Architecture

Abstract

Commercial growers throughout the Rocky Mountain Region have an increased demand for sustainable herbaceous perennial plants. Production of these adaptable perennials has resulted in problems in stock plant management and propagation. The objective of this study was to determine the efficacy of plant growth regulators applied as foliar sprays on the vegetative growth of Heuchera sanguinea 'Snow Angel' and Zauschneria garrettii 'Orange Carpet' propagation stock plants in number one containers. Three chemical plant growth regulators were applied at two different rates: 1) Ethephon [250 and 500 mg·L–1 (ppm)] (Verve, Nufarm Americas, Inc., Alsip, IL), 2) 6-benzylaminopurine (200 and 400 mg·L –1) (Configure; Fine Agrochemicals Limited, Worcester, U.K.), and 3) Gibberellins A4A7 (GA) & N-(phenylmethyl)-1H-purine 6-amine (50 and 100 mg·L–1) (Fascination; Valent USA Corp., Fresno, CS). Twelve replications of the two taxa were evaluated once for four months for plant height, width, number of branches, number of cuttings, and fresh & dry weight of the cuttings. This study was replicated twice, the first experiment was performed from November 2016 to March 2017, and the second experiment was performed from August 2017 to December 2017. The two different seasons aided in indicating a better time of year for stock production of these two herbaceous perennials. Heuchera plants that received GA treatments at 50 and 100 mg·L–1 and 6-benzylaminopurine at 400 mg·L–1 concentrations resulted in 17%, 22%, and 20% more cuttings taken than control plants. All concentrations of Ethephon treated Heuchera plants were similar to the control plants, respectively. Zauschneria plants that received GA treatments at 50 and 100 mg·L–1and 6-benzylaminopurine at 200 mg·L–1 concentrations had 14%, 16%, and 10%, respectively. Zauschneria plants that received GA treatments at 50 and 100 mg·L–1had a decrease of 13% and 14% for the fresh weight of cuttings taken when compared to the control.

Specified Source(s) of Funding: USDA Colorado Specialty Crop Block Grant (2016), Colorado Horticulture Research and Education Foundation, Plant Select

2:30 PM **Successful Rooting of *Heuchera sanguinea* 'Snow Angel' Stem Cuttings Is Influenced By Greenhouse Temperature and Season of Propagation**

Shana Brown*, *Colorado State University*

Abstract: A greenhouse experiment was conducted at Colorado State University to determine the effect of stock plant container size and growth media on the rooting of vegetative cuttings from *Heuchera* 'Snow Angel'. Although stock plant treatment had little influence on the rooting capability of cuttings, it appears that temperature and time of year may play a key role in stock plant productivity and the rooting process. Stock plants grown between 18.3-22.8 °C (day) and 16.1-22.8 °C (night) produced more cuttings

per plant between October and March with 94.4-100% rooting success during April, May and June. Stock plants grown between July and November in a greenhouse kept between 16.7-20.0 °C (day) and 12.8-16.7 °C (night) produced fewer cuttings that were larger and cuttings rooted with 100% success during December, January and February. During the rooting process of the experiment, bottom heat was set to maintain the soil temperature at 18.3 °C (65 °F) and intermittent mist was applied to provide a humid environment. For most cuttings, roots began to form after one to two weeks and the number of visible roots exceeded 35 after 4 weeks under mist.

Specified Source(s) of Funding: USDA Colorado Specialty Crop Block Grant 2016, Colorado Horticulture Research and Education Foundation (CHREF), Plant Select

2:45 PM Pinching Specialty Cut Sunflowers to Increase Production.

Michael Maurer*; Bilawal Cheema; Rebecca Burnett and Jared Barnes, *Stephen F. Austin State University*

Abstract: Specialty cut sunflower (*Helianthus annuus* L.) cultivars response to pinching depends on time of planting and cultivar characteristics. Experiments evaluated five non-branching sunflower cultivars 'Pro Cut Gold', 'Sunbright Supreme', 'Sunrich Lemon', 'Superior Gold' and 'Vincent's Choice' pinched at nodes 0 (non-pinched), 1, 2, 3, or 4. Stem length, stem diameter, flower diameter, and disk diameter were measured at harvest along with days-to-harvest, number of stems and number of marketable stems. Pinched sunflowers produced significantly more stems than the non-pinched sunflowers, but also resulting in decreased stem length, stem diameter, flower diameter and disk diameter. Conversely, days-to-harvest increased with pinching. Spring planting increased the number of marketable sunflower stems pinched at nodes 1, 2, and 3, but Fall planting produced a similar number of marketable stems to the non-pinched treatment. The more vigorous cultivar 'Superior Gold' tended to performed better than less vigorous cultivar such as 'Sunrich Lemon'. These initial experiments indicate that pinching specialty cut sunflowers may not be an effective method for increasing sunflower production in Texas.

3:00 PM Effect of GA_3 Drenches and Duration of Chilling on Growth and Flowering of Containerized Peonies

Dongfang Zhou*[1]; Rachel Mack[1]; Daniel L. Jackson[1]; Holly L Scoggins[1] and Joyce Griffin Latimer[2], *(1)Virginia Tech, (2)Virginia Cooperative Extension*

Abstract: Herbaceous peony (*Paeonia lactiflora* Pall.) is a popular landscape plant in temperate regions because of its great ornamental value. Peony needs a chilling period to break dormancy and enhance flowering. The objective of this study was to evaluate gibberellic acid (GA_3) effects on replacing chilling requirement and increasing the number of flowering shoots of plants held under different controlled chilling durations. Two peony cultivars, 'Sarah Bernhardt' and 'Inspecteur Lavergne', from 3-5 eye crowns from Holland, were potted in 1.7-L pots. Plants were placed in a 5°C cooler for 6 weeks in a preliminary study, and 3, 4 or 5 weeks in a follow up study. GA_3 (Florgib, Fine Americas) was applied as a 0 or 100 mg/L drench (250 ml/pot) after moving plants from cooler to greenhouse. For the preliminary study of peonies chilled for 6 weeks, GA_3 did not shorten days to emergence (13 days for both with and without GA_3), but increased the number of shoots on both cultivars (3.7 shoots/pot without GA_3 to 4.9 shoots/pot with GA_3 drench in 'Inspecteur Lavergne', and 3.6 shoots/pot without GA_3 to 5.0 shoots/pot with GA_3 in 'Sarah Bernhardt') and the number of flowering shoots in 'Inspecteur Lavergne'. For the follow up study with 3, 4 or 5 weeks of chilling, GA_3 decreased the number of days to emergence (14 days without GA_3 to 10 days with GA_3 in 'Sarah Bernhardt', and 19 days without GA_3 to 14 days with GA_3 in 'Inspecteur Lavergne') while duration of chilling had no effect, and there was no interaction between GA_3 and duration of chilling. Neither GA_3 nor chilling duration affected the number of days to bud opening. The growth and flowering data are still being collected.

Specified Source(s) of Funding: Fine Americas Inc.

3:15 PM Identification of Plant Growth-Promoting Rhizobacteria with the Ability to Alleviate Drought Stress in Floriculture Crops

Nathan P. Nordstedt*; Michelle L. Jones and Christopher G. Taylor, *The Ohio State University*

Abstract: Drought stress is one of the most significant factors limiting crop quality; causing stunted growth, discolored tissue, and reduced flowering. This is particularly detrimental to floriculture crops that have a value largely dependent on aesthetics. In recent years, plant growth promoting rhizobacteria (PGPR) have emerged as a sustainable solution to alleviate abiotic stress in plants. Plant roots secrete proteins and metabolites that are utilized by PGPR, and in return, the bacteria assist in the acquisition of macro and micronutrients, production of plant growth-promoting hormones, and the reduction of stress hormones such as ethylene. Although research on PGPR has gained significant interest in recent years, much of this research has focused on agronomic crops, with little emphasis on floriculture crops. In this study, two high-throughput bioassays were developed to screen a core collection of 45 *Pseudomonas* strains for their potential to alleviate drought stress when applied to floriculture crop production systems. Polyethylene glycol (PEG) is a well-documented compound used in bioassays for the *in vitro* selection of osmotic stress tolerant bacteria. This property in bacteria is commonly correlated with the ability to alleviate drought stress in plants. A second bioassay was developed to identify bacteria that produce the enzyme 1-aminocyclopropane-1-carboxylic acid (ACC) deaminase. Bacterial ACC deaminase reduces the amount of stress ethylene produced by plants by degrading the ethylene precursor, ACC. Of the 45 strains individually tested in the PEG and ACC-deaminase bioassays, 14 and 6 were selected, respectively. One bacteria strain was selected in both bioassays, having the potential to alleviate drought stress through two unique modes-of-action. The development of these bioassays provides a high-throughput method to select bacteria with the potential to alleviate drought stress when applied to floriculture crops. Bacteria selected in the in-lab assays will be validated *in planta* in greenhouse trials.

Specified Source(s) of Funding: DC Kiplinger Floriculture Endowment and American Floral Endowment

3:30 PM Flower Bud Development of *Lycoris Radiata* (L'Hér.) Herb. and *L. Sprengeri* Comes Ex Baker

Junhuo Cai[1]; Donglin Zhang*[2]; Xuying Wei[1]; Jiajia Ren[1] and Lu Zhang[1], *(1)Jiangxi Agricultural University, (2)University of Georgia*

Abstract: Lycoris radiata (L'Hér.) Herb. and *L. sprengeri* Comes ex Baker are bulbous plants native to China. However, *L. radiata* leaved out after bloom in fall, while *L. sprengeri* sprouted out its foliage in next spring. To better understand their flower initiation and development, we conducted anatomical study of their buds from February to August. The flower bud formation stages could be divided into flower bud differentiation（from March to May）and flower bud development（from June to July）for both species. The flower-bud differentiation could be divided into 9 phases as flower bud initiation, flower primordium formation, perianth formation, formation of stamen, formation of ovary, formation of pistil, inflorescence formation, formation of pollen, and formation of flower bud. The flower bud initiation of *L. sprengeri* was from late February to early March, while *L. radiata* was during the middle or late March, about 20 days behind. Although *L. sprengeri* and *L. radiata* both had completed the process of flower bud formation in early June, *L. sprengeri* only needed one month for floral development and bloom and *L. radiata* required three months. Further studies should address why flowers of *L. sprengeri* developed much faster than that of *L. radiata*?

1:45 PM – 3:45 PM *International Ballroom West*

Food Insecurity

Sponsor: Human Issues in Horticulture

Moderator: Esther E. McGinnis, *North Dakota State University*

1:45 PM Understanding the Contributions of Extension Master Gardeners to the Food Insecurity Solution

R. Michael Maddox, *University of Wisconsin-Extension*; Sheri Dorn, *University of Georgia*; Susan DeBlieck, *Iowa State University*; Terri James, *University of Nebraska - Lincoln*; Mary A. Wilson*, *Michigan State University* and Lynda Garvin, *New Mexico State University Extension*

Abstract: Extension Master Gardener (EMG) volunteers are individuals trained and coordinated by Extension employees in 49 states. They are recruited and trained specifically to increase Extension's capacity to deliver horticulture and gardening information as well as to implement educational programming that meets local issues and needs, such as food insecurity. Community gardens are recognized as a means of increasing access to fresh food and are commonly listed as EMG projects in local and state reports. The number of pounds of produce grown annually under EMG leadership in these gardens is included as a metric in the EMG national program report. Contributions of EMG volunteers to the food security solution are not fully described by numbers alone. To understand the full meaning of these numbers and the activities that support them, the Impact Evaluation Task Force was appointed by the EMG National Committee. First-year efforts included development of evaluation tools and establishment of collection methods to set the stage for the first data collection. While it is apparent that EMG volunteers are changing local food streams, forming strategic collaborations, and making monumental efforts for addressing food insecurity, key process challenges, including decentralized EMG program management and burden of data collection, complicate the measurement of true impact. Realizing that the development of quality measures takes time, the task force team has reviewed the first round of data to improve data collection and is preparing state and local coordinators for the second data collection in late 2018.

Specified Source(s) of Funding: Lynn Khadiagala, of the National Institute of Food and Agriculture, U.S. Department of Agriculture, provided technical assistance.

2:00 PM Veggies for the Pantry: Fighting Food Insecurity in North Dakota

Esther E. McGinnis*, *North Dakota State University*

Abstract: Despite having a large and vibrant agricultural economy, ten percent of North Dakotans rely upon food pantries to alleviate hunger. Food pantries normally receive generous donations of canned and boxed goods. Donations of quality fresh fruits and vegetables are rare and especially prized. In 2016, North Dakota State University Extension Master Gardeners initiated a pilot project called Veggies for the Pantry to fight food waste and to increase access to fresh produce in the Fargo-Moorhead area. The purpose of this project was to collect surplus fruits and vegetables from home gardeners and from community gardens for delivery to local food pantries. Extension Master Gardeners staffed strategically located collection points across the metropolitan area on Monday evenings and then delivered the produce to local food pantries the following day. Produce collection points were advertised through traditional news media, social media, and by word of mouth. In 2017, the project expanded to other counties. In total, Extension Master Gardeners collected and delivered over 8,900 lbs. of produce to local food pantries.

2:15 PM Gardening Programs to Address Food Insecurity on Native American Reservations

Rhoda L Burrows*, *South Dakota State University*

Abstract: Gardens provide fresh healthy food for families and communities, helping alleviate the persistent food shortages of the very low-income areas of our northern plains indigenous peoples. Since the formation of the reservations, Native Americans in the Great Plains have been urged to garden, with mixed success. The culture of the tribes in the 1800's in South Dakota was based on hunting and gathering, well-suited to the short-grass prairies with sparse and unpredictable rainfall. However, many tribal members remember reservation-era grandparents growing vegetables to feed their families, a practice that few of their children continued. Interest in growing food has increased more recently, driven by a desire to increase control over the reservation food systems, as well as health issues. South Dakota reservation counties have high rates of obesity (>40%) and diabetes (up to 19%), partially due to the poor availability and/or high cost of healthy foods in remote areas.

Numerous gardening projects on SD reservations have been sponsored by many NGOs, as well as tribal organizations and universities. Many are discontinued after a few years because of changes in personnel, funding, or organizational focus. Those that persist usually have dedicated, paid gardeners. A few families have developed private large gardens providing vegetables for extended family and friends, and sometimes for sale.

South Dakota State University Extension offers gardening education to support these efforts. We have tried a number of approaches over the years. Because of the widely scattered population and the transportation challenges (poor roads and often unreliable vehicles), as well as competing demands of an extended family cultural base, it can be difficult for participants to attend a series of meetings. Therefore, we've evolved a more flexible approach of creating demonstration gardens, a series of workshops offered at different times/places for those who are "scaling up" from personal to larger-scale production, and cooking/preserving classes. This year, we will work with private and public partners to place high tunnels and root cellars at strategically selected sites, and provide training on growing food in high tunnels. Our methods must be applicable for very low resource growers, who may live hours away from the nearest hardware store, so local low-cost or free materials are used when possible. Projects are vetted by tribal members for cultural appropriateness and programs are designed in concert with tribal members to address needs that they have identified.

2:30 PM Feeding the Need through Community

Christine E. H. Coker[1]; Ronald Stephenson*[2]; Gary R. Bachman[1] and Scott A. Langlois[1], *(1)Mississippi State University Coastal Research and Extension Center, (2)Mississippi State Univ.*

Abstract: Community gardens have historically addressed educational, economic, environmental, and health needs within their communities, leading to financial benefits as well as increases to food security. In the United States, community gardens were initially promoted in urban centers to provide skill training to youth and the unemployed. Today community gardeners are focused on alleviating food insecurity and building a sense of cohesion in their neighborhoods. Mississippi consistently rates high among states where food insecurity is greatest. In coastal Mississippi, there are several proactive projects addressing the issue. The People's Garden program was initiated by the USDA to unite neighbors in a common effort and inspire locally led solutions to challenges facing our country - from hunger to climate change. This program is made up of a network of school community gardens across the United States. Cooperative efforts between the Harrison Co. Soil and Water Conservation District, Mississippi State University, and NRCS have supported several projects in Harrison County, MS. Additionally, in order to provide additional support for food security as well as educational programs directed at youth and adults, community garden and education projects were initiated in Hancock County, MS. These programs consist of two community gardens located within the Bay St. Louis and Waveland, MS communities as well as home gardening educational programs associated with the community in Lakeshore, MS. The primary community garden site in Bay St. Louis is focused on the production of fresh vegetables and fruits for donation to food pantries and community centers. Current amount of donations are approximately 275 kg of vegetables and fruit per season. The garden also serves as a demonstration garden to instruct community members in all aspect of home food production. In partnership with the Hancock County Youth Drug Court, educational programs directed toward at-risk youth were developed and a second community garden was created specifically targeted inclusion of these youth. Programs in financial management and nutrition were linked to garden activities. Lastly, in cooperation with church groups located in Lakeshore, MS, an area severely impacted by Hurricane Katrina, education programs were conducted addressing food insecurity through home production of fruits and vegetables. These programs focus on home production of high value produce.

2:45 PM Enabling Accessibility and Success to Address Food Insecurity

Gary R. Bachman[1]; Scott A. Langlois*[1]; Christine E. H. Coker[1] and Ronald Stephenson[2], *(1)Mississippi State University Coastal Research and Extension Center, (2)Mississippi State Univ.*

Abstract: Food insecurity is a real problem all across Mississippi and the interest in local/home grown food is increasing. Mississippi State University personnel have been promoting a couple of growing strategies to address these needs, especially focusing on garden accessibility. EarthBoxes are a sub-irrigated growing system that has been used with great success by new

gardeners growing their first garden to Master Gardeners. They are easily placed on tables, stands and benches to effectively raise the level of the garden to those with accessibility problems. Homeowner John Monroe is making a difference in his garden which contains 128 EarthBoxes, all of which are on raised benches. He has relied on MSU Extension for ideas and advice to help him grow various produce throughout the year according to season. Each year about 95% is donated to the local community, especially the elderly to which gardening has become too hard. Looking for a way to enable individuals with disabilities that may not allow them to participate in 'traditional' gardening, the Pine Belt Master Gardeners developed a raised shallow table that would allow gardeners with limited mobility to enjoy gardening from a wheelchair or walker. Five years and over 700 raised 'salad tables' later, these master gardeners continue to supply tables, at a small fee, to garden enthusiasts across South Mississippi. Money earned through these sales allows the Pine Belt Master Gardeners to donate a large percentage of the tables they construct to veteran groups, hospitals, universities, public schools, and scout troops. These salad tables have been used for vegetable and ornamental demonstrations at multiple Mississippi State University research locations across the state with excellent results. In addition to the accessibility quality these tables possess, anecdotal evidence from hundreds of users suggest that they may offer benefits which include reduced pest and weed pressure facilitated by the raised design. Recent modifications, based on user feedback, include options for varying leg heights (supporting specific needs of handicapped users), trellis supports for taller vegetable varieties and deeper tables allowing production of root crops and larger crops benefiting from an increased depth of soil.

3:00 PM Developing a Local Foods Program

Pamela J. Bennett*, *Ohio State University Extension*

Abstract: Clark County Ohio is predominantly rural with less than 1% of the county's 400 square miles consisting of urban areas and a population of 138,333. The largest city is Springfield with a population of 60,608. Larger urban communities in Ohio had been addressing the local foods issue for approximately four years prior to this with many of them having food councils already in existence. Rural communities were just beginning to look at this issue. Ohio State University had a Local Foods Signature Program that provided assistance in developing these programs. With the growing interest in Clark County, the Extension Educator provided leadership in developing a comprehensive local foods program for this rural community beginning in 2015.

Essential components of a local foods program for the county were identified by a steering committee consisting of Extension professionals, Extension Master Gardener Volunteers and community stakeholders. These components included organizing a local food council, public education on the concept of local foods and insecurity, a commercial kitchen that could be used as an incubator for new food-based startups, and a framework for food-based economic development opportunities.

Extension provided leadership for the steering committee and the overall program development by obtaining funding for a part-time staff member. The steering committee established goals and objectives which included a implementing a yearly Food Summit, the development of a local foods council and a commercial kitchen, and bringing stakeholders together to develop a site for a year round farmer's market.

This session discusses the challenges in developing a local foods program as well as the successes that assist the county in addressing food insecurity. The Food Council has been organized and is in its strategic planning phase; community stakeholders have plans and the financing to create a commercial kitchen; an historic building has been identified as a location for a year round market.

1:45 PM – 3:45 PM

NIFA National Research Support Project 10: Specialty Crop Database Resources for Genomics, Genetics and Breeding Research *CEU Approved*

Jefferson West

Coordinator: Doreen Main, *Washington State University*

Moderator: Mike Kahn, *Washington State University*

Objectives:

The objectives of this workshop are to (1) Update NRSP10 participants and other specialty crop researchers on new development of specialty crop genomic, genetic and breeding community database resources (2) Provide specialty crop researchers with outline of plans for the next 5 years of this project (3) Solicit feedback from the community on database and tool development needs and extension activities associated with this project.

Description: ***National Research Support Project 10*** (NRSP10, www.nrsp10.org) is a *USDA NIFA* funded, five year project (2014-2019) providing national crop database resources for under-served crops with a focus on specialty crops. It involves broad support and participation from US Land Grant Universities Experiment Stations and industry, many of who will present updates of project features or be participants in this follow up workshop to the one held at ASHS 2017. It will be will include a series of talks by scientists who use these r*osaceae* (www.rosaceae.org), *citrus* (www.citrusgenomedb.org), and *vaccinium* (www.vaccinium.org) database resources to enable their genomics, genetics and breeding research, highlight new data and functionality, present ideas for further work and solicit feedback from the workshop attendees. Each presentation will be 10-12 minutes with 3-5 minutes for discussion and each presentation will conclude with a slide containing one or more question to facilitate the discussion. The presenters will coordinate these questions ahead of time and reach out to known attendees through our mailing list to ensure the questions are pertinent and relevant to the goals of the workshop. This will be followed by a 30 minute general discussion session to solicit further feedback on community needs for the next five-years of this project.

Example questions for the participants might include:

Staton Presentation: Do you need help with setting up a project database using Tripal or do you see using your community database as able to meet your project data management and project data sharing and analysis needs?

Rife Presentation: What challenges or impediments do you have or forsee having in your ability to use the FieldBook App to collect phenotype data from the field

Peace Presentation: Do you see your program as being able to utilize global prediction functionality and if so what might be the challenged your would face in using it?

Jung Presentation: Is there any functionality you need in these databases that we don't have? If so, is that functionality available in other databases?

Gasic Presentation: Do you like the functionality of BIMS? What can we do or provide to help you be able to use it? Any limitations you can see with it?

Main Presentation: Do the planned activities for the next 5 years look appropriate? Are there other activities we should be including and if so what are they?

General Discussion:

Is it clear what these database resources and tools provide to you? What are we doing well in this project and where are we not doing well and could improve? Should NRSP10 have a larger role in educating young scientists on data management, data nomenclature, data submission to maximize possible re-use and impact of their research data and results?

1:45 PM Welcome and Goals of NRSP10 Workshop

Mike Kahn*, *Washington State University*

Abstract: In the introduction to the workshop, we will go over the aims of the workshop and briefly introduce NRSP10.

1:50 PM Tripal v3, the Collaborative Online Database Platform Supporting an International Community of

Plant Genome Databases

Margaret Staton*[1]; Abdullah Almsaeed[1]; Bradford Condon[2]; Ming Chen[2]; Jill Wegrzyn[3]; Emily Grau[3]; Nic Herndon[3]; Sook Jung[4]; Lisa Sanderson[5]; Kirsten Bett[5]; Dorrie Main[4] and Stephen P. Ficklin[4], *(1)University of Tennessee, Knoxville, (2)University of Tennessee, (3)University of Connecticut, (4)Washington State University, (5)University of Saskatchewan*

Abstract: Tripal is an open-source software platform for building online community or project databases that house genes, genomes, markers, germplasm, genotypes, phenotypes and other data types. A number of specialized community databases that use Tripal are tailored for horticultural and agricultural crops such as fruits, nuts, legumes, cotton, and forest trees. With active code contributors from 8 research groups in 3 countries, Tripal has emerged as a model of cooperative database development across specialty crops and as a mechanism for increased sustainability of community-level and community-built web resources. Based on the content management system Drupal, Tripal enables developers to easily write their own custom code and share with others. The community is building the primary infrastructure to support standardized biological data storage formats, intuitive data visualization, and commonly needed analysis tools. With increasing maturity of the software and a growing number of member databases, Tripal is now poised to take advantage of the shared code base across groups by building cross-site interfaces that unify data across various specialty crop communities. This is largely enabled by the latest version of Tripal v3, a fully ontology-driven design with data structures and RESTful web services. With the new major expansion of the Tripal module that leverages ElasticSearch, sites are able to provide comprehensive full text search to users and also incorporate search results from other public Tripal databases. For example, the Hardwood Genomics Project can return relevant search results from its own data stores as well as results from other sites with tree data such as TreeGenes, the Genome Database for Rosaceae and the Citrus Genome Database. The growth of the Tripal community demonstrates how to drive advances in large scale cyberinfrastructure development and data integration through collaborations among smaller, specialized research communities.

2:05 PM New Data and Functionality in NRSP10 Databases

Sook Jung*[1]; Taein Lee[1]; Chun-Huai Cheng[1]; Jodi Humann[1]; Jing Yu[1]; Katheryn Buble[1]; Morgan Frank[1]; Kristin Scott[1]; Deah McGaughey[2]; Heidi Hough[1]; Victor Unda[1]; Ksenija Gasic[3]; B. Todd Campbell[4]; Don Jones[5]; Sushan Ru[6]; James Crabb[1]; Kate M. Evans[7]; Lisa Wasko DeVetter[1]; James R. McFerson[8]; Cameron Peace[1]; Mike Kahn[1]; Margaret Staton[9]; Jill Wegrzyn[10]; Stephen P. Ficklin[1]; Albert Abbott[11] and Main Dorrie[1], *(1)Washington State University, (2)Washignton State University, (3)Clemson University, (4)USDA-ARS, (5)Cotton Incorporated, (6)University of Wisconsin-Madison, (7)Washington State University - Tree Fruit Research and Extension Center, (8)Washington State University, TFREC, (9)University of Tennessee, Knoxville, (10)University of Connecticut, (11)University of Kentucky*

Abstract: National Database Resources (NRSP10) for Crop Genomics, Genetics and Breeding Research is a USDA NIFA, industry and US Land Grant Universities funded project which provides standardized database and informatics resources for undeserved or specialty crops such as tree fruit, nuts, and berries. It builds on existing database resources developed for Rosaceae (Genome Database for Rosaceae, www.rosaceae.org), Citrus (Citrus Genome Database, www.citrusgenomedb.org), Vaccinium (Genome Database for Vaccinium, www.vaccinium.org), Cool Season Food Legumes (Cool Season Food Legume Genome Database, www.csfl.org) and Cotton (CottonGen, www.cottongen.org). Developed using Tripal, an open-source, resource-efficient, modular, well supported software platform, these community databases provide centralized access to integrated genomic, genetic and breeding data and analysis tools for 24 crops representing a combined annual production value of over $25 B. The latest data and functionality provided in these databases includes integrated genomic, genetic and breeding data made accessible through various search pages, JBrowse, and the new interactive visualization tools such as TripalMap for genetic maps and Tripal Synteny Module for browsing conserved syntenic blocks among genomes. We will also highlight access to available public data through the new Breeding Information Management System (BIMS), a resource being developed for breeders to manage, store, and analyze their private breeding data integrated with public data in these databases.

2:20 PM Integrating Free Mobile Apps into Specialty Crop Breeding and Horticultural Programs

Trevor Rife* and Jesse A. Poland, *Kansas State University*

Abstract: Plant breeding, horticultural, and genetics research are inherently data-driven enterprises. Typical experiments and breeding nurseries can contain thousands of unique entries and programs will often evaluate tens of thousands of plots or plants each year. Due to temporal and economic limitations, many phenotypes that could prove useful for selection are neglected or collected only on a subset of lines. To operate a modern breeding program efficiently, electronic data capture and management is essential. Many research programs, however, continue to operate by scribing and transcribing much, if not all, of their data. This creates a heavy burden on human resources, decreases data integrity, and limits future utilization of data. We have developed several open-source apps to increase the speed and robustness of data collection in plant breeding programs. All of our apps run on consumer-grade Android phones and tablets, thereby decreasing the cost to breeders and creating a viable solution for research programs around the world. In this presentation, we will briefly introduce our collection of apps that are relevant to specialty crop phenotype data collection but focus on Field Book, an app for field and greenhouse data collection and highlight improvements made following input from specialty crop breeders through the NRSP10 project.

2:35 PM Using the Tripal Breeding Information Management System to Improve Breeding Efficiency

Ksenija Gasic*[1]; Taein Lee[2]; Sook Jung[2]; Jodi Humann[2]; Jing Yu[2]; Heidi Hough[2]; B. Todd Campbell[3]; Cameron Peace[2]; Kate M. Evans[4] and Dorrie Main[2], *(1)Clemson University, (2)Washington State University, (3)USDA-ARS, (4)Washington State University - Tree Fruit Research and Extension Center*

Abstract: Advances in sequencing, sensor, drone and computational technology have led to increasing volumes of genotype and phenotype data being collected and tracked by modern breeding programs. To efficiently store, manage and integrate these large private and public research data sets, so breeders can use them efficiently in decision-making, we are developing the Tripal Breeding Information Management System (BIMS). BIMS is available in the rosaceae, citrus, cool season food legume, vaccinium and cotton NRSP10 Databases. It allows breeders to create and manage access to their breeding programs; upload phenotype data from the FieldBook App or Excel templates; upload genotype data; generate input files for the FieldBook App; archive their entire data to their own computers; search and filter by accessions/lines name, trial, location, cross, parent and trait values; and perform basic statistical analysis. BIMS is being developed in collaboration with public plant breeders. In this presentation we highlight current functionalities available in BIMS and demonstrate how it is being used to improve efficiency in a peach breeding program.

2:50 PM Extending the Tripal Breeding Information System to Combine International Data for Global Performance Predictions

Cameron Peace*[1]; Craig M. Hardner[2]; Sook Jung[1]; Taein Lee[1] and Dorrie Main[1], *(1)Washington State University, (2)University of Queensland*

Abstract: Breeders Toolbox, initially created as part of the RosBREED program, provided a system to manage pedigree, phenotypic, and genotypic data from a breeding program. As breeding programs have begun to use information on large-effect trait loci and genome-wide predictions for selection of parents, seedlings, and advanced selections, the breeders toolbox is being extended into the Tripal platform as Breeding Information Management System (BIMS) to incorporate new types and amounts of genetic data, as well as to allow breeders to manage their own data. Horticultural tree crop breeding programs tend to be locally focused and there has generally been limited evaluation of the suitability of advanced selections across a broad range of target commercial environments. We propose to extend functionality of this publicly funded Tripal BIMS to support the

evaluation of environmental stability of germplasm on a global scale, initially for horticultural crops. Our hypothesis is that a particular phenotype of an individual is a sample of its response to the environment to which it has been exposed, and SNP genotyping can track replicated genomic segments across otherwise unconnected germplasm trials. Our vision is that data from different sources can be compiled into an anonymous database that individual users can interact with to input genotype and phenotypic data and output performance predictions across the range of environments in the dataset.

3:05 PM NSRP10 - the Next Five Year Plan: Furthering Integration of Big Data, Tools and Analysis Capability to Enable Specialty Crop Research Discovery and Improvement

Doreen Main[*1]; Sook Jung[1]; Jodi Humann[1]; Cameron Peace[1]; Ksenija Gasic[2] and James R. McFerson[3], *(1)Washington State University, (2)Clemson University, (3)Washington State University, TFREC*

Abstract: *National Research Support Project 10* (NRSP10, *www.nrsp10.org*) is a *USDA NIFA*, US Land Grant Universities, and industry funded project which provides standardized database and informatics resources for undeserved or specialty crops such as tree fruit, nuts, and berries. It builds on existing database resources developed for Rosaceae (*Genome Database for Rosaceae*), Citrus (*Citrus Genome Database*), Vaccinium (*Genome Database for Vaccinium*), Cool Season Food Legumes (*Cool Season Food Legume Genome Database)* and Cotton (*CottonGen*). Developed using *Tripal*, an open-source, resource-efficient, modular, well supported platform, these community databases provide centralized access to integrated genomic, genetic and breeding data and analysis tools for 25 crops representing a combined annual production value of over $25 B. We highlight the broader impacts of the current projects and driven by the research community it serves, we highlight plans for the next 5-year project, which focuses on providing tools and analysis capability to manage and utilize big data for both discovery and crop improvement, whilst leveraging funding from multiple sources as we develop solution for sustainability of these research-enabling resources.

2:00 PM – 2:45 PM *Lincoln East*

Plant Biotechnology 2

Moderator: Changhyeon Kim, *North Dakota State University*

2:00 PM Optimization of *Malus* 'Spring Sensation' Floral Aroma Determination Using Electronic Nose

Junjun Fan[*1]; WangXiang Zhang[2]; Donglin Zhang[3]; Guibin Wang[2] and Ting Zhou[2], *(1)Nanjiang Forestry University, (2)Nanjing Forestry University, (3)University of Georgia*

Abstract: Floral aroma plays an important role in the reproductive processes of plants and the aesthetic implication of ornamental plants. Accurate determination of aroma components is limited by collection and analysis methods. Electronic nose (E-nose) can recognize single or complex odor quickly and completely and has been widely applied for food science. We analyzed floral aroma of *Malus* 'Spring Sensation' using Pen3 E-nose with the orthogonal design at various flowering stages, sample quantity, collecting time, headspace equilibrium temperature and duration. The results indicated that the impact of various factors on the sensors of E-nose was: collecting time > headspace equilibrium temperature > flowering stage > sample quantity > equilibration duration. The most important factor was collecting time and equilibrium duration had the less impact on the electronic nose.The optimal condition was $A_3B_4C_2D_2E_1$,which meant flowers in bloom (A_3), 4 g of flowers (B_4) collected during 10:00-12:00 am (C_2) and the flower sample could be analyzed after equilibrating at 20°C (D_2) for one hour (E_1). The sensor #7 and #9 of the E-nose had higher peak during the analysis processes of crabapple floral aroma, but the sensor #1, #3 and #4 had very lower detection. Our findings suggested that the sensor array should be optimized before handling the data of floral aroma. The E-nose could be applied for quick determination of *Malus* 'Spring Sensation' floral aroma, which could be further applied to distinguish crabapple taxa.

Specified Source(s) of Funding: Priority Academic Program Development of Jiangsu Higher Education Institution (PAPD) (164010189), the National Germplasm Center of Crabapple in China (164010065) and Jiangsu Provincial Science and Technology Department (Modern Agriculture) (BE2016388).

2:15 PM Genome-Wide Association Study and Genomic Selection for White Rust in Spinach

Ainong Shi[*1]; Jun Qin[1]; Jim Correll[1]; Wei Zhou[1]; Gehendra Bhattarai[1]; Bazgha Zia[1]; Waltram Ravelombola[1]; Yuejin Weng[1]; Chunda Feng[1]; Bo Liu[1]; Carlos A. A. Avila[2] and Beiquan Mou[3], *(1)University of Arkansas, (2)Texas A&M AgriLife Research, (3)USDA-ARS*

Abstract: White rust, caused by *Albugo occidentalis,* is a severe disease of economic importance that causes reduction in yield and quality in spinach (*Spinacia oleracea* L.). Because no major genes have been reported for resistance to white rust, quantitative resistance has been employed to manage white rust. Selecting for quantitative traits using classical breeding methods can be a challenge. However, the use of molecular markers linked to qualitative traits can be valuable. The objectives of this study are to evaluate and screen white rust resistance in a collection of world-wide spinach germplasm, to conduct genome-wide association study (GWAS) and identify SNP markers, and to do genomic selection (GS) for white rust resistance in spinach. A total of 910 spinach genotypes were evaluated in four seasons (the winter of 2014-15, 2015-16, 2016-17, and 2017-18) at the Del Monte White Rust Nursery in Crystal City, TX. Over 100 spinach genotypes have been identified with levels of quantitative resistance to white rust pathogen. SNPs identified from genotyping by sequencing (GBS) were used as genotypic data. Thus far, GWAS was conducted in 412 spinach genotypes using 648 SNPs and performed with compressed mixed linear model (cMLM) implemented in the GAPIT R package. Eight SNP markers were identified that were strongly associated with white rust resistance. Genomic estimated breeding values (GEBVs) were calculated using the best linear unbiased estimator (BLUE) plus best linear unbiased prediction (BLUP) in GAPIT with both genome-wide SNP set (648 SNPs) and the only associated SNP markers (8 SNPs). The GS was validated in the association panel with 250 spinach genotypes as s training set and 162 genotypes as validation set with high correlation coefficients (r) between the predicted breeding value and the phenotypic white rust resistant data: r=0.66 and 0.68 with 648 SNP set and 8 SNP set, respectively. The data from this study will provide breeders with a set of markers to select for white rust resistance in spinach breeding programs through marker-assisted selection (MAS) and GS.

2:30 PM Agrobacterium-Mediated Transformation of Raspberry Species (*Rubus spp.*)

Changhyeon Kim[*] and Wenhao Dai, *North Dakota State University*

Abstract: Raspberries (*Rubus spp.*) are a group of high-value woody species and their fruits are available in a variety of forms in grocery products. Due to the complicated genetic background and perennial nature, improvement of raspberry species, such as yield and fruit quality using conventional breeding is time-consuming. Plant biotechnology including genetic transformation can not only develop novel breeding materials, but also help speed up the breeding process. In this research, one purple raspberry (*R. occidentalis* × *R. idaeus*) 'Amethyst' and two red raspberry cultivars (*R. idaeus*) 'Polana' and 'Joan J' were used to develop an efficient genetic transformation system for raspberry species. *Agrobacterium tumefaciens* strain EHA105 harboring pBI121 or pCAMBIA S1300 with the selection gene *npt*II or *hpt* and the target gene *PtFIT* in response to iron deficiency in *Populus*. Young in vitro leaves and petioles (7-day-old) were infected by submerging in the bacterial solution for 10 min and then co-cultivated for 3-5 days. Transgenic cells were recovered and shoots were regenerated in the media with various concentrations of kanamycin or hygromycin. Transformation was confirmed using polymerase chain reaction (*PCR*). Expression of the *PtFIT* gene is being determined using real-time quantitative PCR. The genetic transformation system can be used for gene functional analysis and germplasm enhancement in raspberry or related species.

2:00 PM – 3:00 PM *Boundary (Terrace Level)*

ASHS Certified Horticulturist Board (CH) Meeting

Chair: Janet Cole, *Oklahoma State Univ*
Members: Kerrie Badertscher, *Otoke Horticulture LLC*; Robert Geneve, *University of Kentucky* and Karen Panter, *University of Wyoming*

2:00 PM – 3:00 PM *Piscataway (Lobby Level)*

Temperate Tree Nut Crops (NUTS) Meeting - Open to All Attendees

Chair: Joshua Sherman, *University of Arizona*
Chair-elect: Luke Milliron, *University of Califiornia Cooperative Extension*
Objectives:
To bridge the wide communications gap among nut tree researchers, to exchange ideas, results, and experiences in similar orchard crops, and to provide a forum to discuss various aspects of research unique to tree nut crops.

2:00 PM – 3:00 PM *Oak Lawn (Lobby Level)*

Viticulture and Small Fruits (VSF) Meeting - Open to All Attendees

Chair: Jill M. Bushakra, *USDA-ARS, NCGR*
Chair-elect: Elina Coneva, *Auburn University*
Secretary: Kaan Kurtural, *University of California*
Objectives:
To study the improvement, production, propagation, and culture of small fruit and grape crops, to perform services for the Society and the general public in the area of small fruits and grapes, and to exchange current information on recent research findings and educational and industry problems.

2:00 PM – 4:00 PM *Concourse Level Foyer*

New Innovations in Horticulture Technologies and Products

Objectives:
ASHS Exhibitors presentations on new technologies and/or products.

2:00 PM **The Internet of Things Arrives in Horticulture: Utilizing Advancements Both Online & in-the-Field to Bring Vital Harvest Data to Your Fingertips Today**
Dennis Fisher*, *CID*

2:20 PM **The LI-6800: Advancements in Gas Exchange and Fluorescence Measurements**
Elizabeth Gordon*, *Li-COR*

2:40 PM **NDVI, Red-Far Red, and PRI sensors from Apogee Instruments**
Schuyler Smith*, *Apogee Instruments*

3:00 PM **Passion for Partnership**
Mike Marett*, *Rimol Greenhouse Systems, Inc.*

3:20 PM **Future Farming: Substrate, Robotics, and Analytics in Berry Production**
Logan McCollum*, *Driscoll's*

2:00 PM – 4:00 PM *Monroe*

Pomology 3

Moderator: Travis Robert Alexander, *Washington State University, NWREC*

2:00 PM **Foliar Application of Plant Hormones and Nitrogen Have Differential Effects on Sweet Cherry Spur Leaf Development**
Feiran Li*, *Michigan State University*

Abstract: In spring, sweet cherry bloom, fruit set, and spur leaf development are dependent on storage carbohydrates. Subsequent fruit and new shoot development relies on photoassimilates supplied by new spur, and eventually shoot, leaves. Thus, horticultural techniques that increase spur leaf size would be expected to increase the carbohydrate supply capacity for the remainder of fruit development. Leaf photosynthetic capacity is determined by physical features, such as specific leaf area (the ratio of leaf area to leaf dry mass) and stomata density, and biochemical features (particularly nitrogen content per unit area). This study examined post-bud break foliar applications of cytokinin (6-benzylaminopurine, 6-BA), gibberellin (GA_3), the combination 6-BA plus GA_{4+7}, and several nitrogen fertilizers to improve spur leaf size. Foliar applications were made to individual spurs of 'Sam' sweet cherry trees before sunrise by hand-held trigger-pump sprayer as follows: T1: 0.5% urea; T2: 150 ppm 6-BA; T3: 30 ppm GA_3; T4: distilled water (control); T5: 2.0% $Ca[NO_3]_2$; T6: 1.7% KNO_3; and T7: 150 ppm 6-BA plus 30 ppm GA_{4+7}. Applications were made when the first spur leaf was large enough to measure, usually between full-bloom and the petal fall, with five replications. For each spur leaf, length and width was measured every ~60 growing degree days (GDD, base 7.2°C) from emergence to complete expansion. Small sections were cut from leaf margins to determine cell number and size. Statistical comparisons (Wilcox, 0.05) showed that all of the phytohormone treatments significantly increased final leaf area, while none of the nitrogen treatments differed from the control. $Ca[NO_3]_2$ (T5) caused young leaf marginal burning and cupping and was omitted from further data collection. To simplify the leaf growth curve analyses (173 curves total), mean growth curves were ranked for the five largest leaves for each spur and grouped by the largest to the smallest final leaf area. These mean growth curves revealed 6-BA plus GA_{4+7} (T7) increased overall spur leaf area by ~50%, and 6-BA (T2) and GA_3 (T3) increased overall spur leaf area by ~20%. Analysis of leaf cell number and size was highly variable, but treatments that increased spur leaf area appeared to largely increase cell elongation. The results are promising for developing horticultural treatments to increase spur leaf area in spring, though further research on timings and rates is needed.

2:15 PM **Comparison of the Polyphenol Profiles of Juice and Cider Derived from Machine- and Hand-Harvested 'Brown Snout' Specialty Cider Apple in Northwest Washington**
Travis Robert Alexander*[1]; Tom Collins[2] and Carol A. Miles[1], *(1)Washington State University, NWREC, (2)Washington State University, Wine Science Center*

Abstract: In this study, the polyphenol profiles of juice and cider derived from over-the-row machine- and hand-harvested 'Brown Snout that were ambient stored (56 °F) 0-4 weeks postharvest were compared utilizing analytical chemistry. Variation due to harvest method was found to be non-significant ($P > 0.05$) for all quality characteristics [specific gravity (SG), pH, titratable acidity (TA), and tannin content] measured on juice and cider samples. The SG, pH, and TA of juice samples significantly differed due to duration of ambient storage ($P = 0.01$, $P = 0.04$, and $P = 0.01$), fruit most likely underwent dehydration over time. The SG, pH, and TA of cider samples did not significantly differ due to duration of storage (0.999 ± 0.000, 3.52 ± 0.01, 0.63% ± 0.02%), which was expected as these three parameters were artificially adjusted for controlled fermentation. The tannin content of juice and cider samples did not differ due to harvest method or duration of storage (0.19% ± 0.01%). The ABV of cider samples differed due to duration of storage ($P = 0.02$). Fruit that was pressed immediately after harvest (0 weeks storage) on average had ABV of 5.39% ± 0.19%, whereas fruit that was stored under ambient conditions for 4 weeks had on average 6.14% ± 0.16% ABV; a higher sugar content in the stored fruit allowed for greater alcohol production by yeast. Total phenolics and total tannins [measured in catechin equivalents (CE)] of juice and cider samples did not significantly differ due to duration of ambient storage time. Total phenolics of juice samples did not significantly differ due to harvest method (1415 ± 98 $mg \cdot L^{-1}$ CE). Total tannins of juice samples did significantly differ due to harvest method ($P < 0.0001$). Machine-

harvested juice samples had lower levels (231 ± 36 mg·L^{-1} CE) of total tannins than hand-harvested juice samples (420 ± 14 mg·L^{-1} CE). Total phenolics and total tannins of cider samples did not significantly differ due to harvest method (1431 ± 73 mg·L-1 CE and 203 ± 22 mg·L-1 CE). The harvest cost savings provided by over-the-row machine-harvesting of 'Brown Snout' appears to come at the cost of lower polyphenol content in the final cider product. Modification of pressing methodology to maximize extraction of phenolic compounds from machine-harvested fruit or the addition of exogenous phenolic compounds to collected juice could serve to minimize the observed reduction in cider polyphenol content.

Specified Source(s) of Funding: Washington State University Emerging Research Issues Grant, the Washington State Department of Agriculture Specialty Block Grant Project No. K1270, the Northwest Agricultural Research Foundation, and State project WN00427 – Acc. # 1000194

2:30 PM The Effect of Fruit Removal and Rootstock on Stored Carbohydrates and Response to Chemical Thinning in Apple

Emily K. Lavely*[1]; Robert M Crassweller[2]; David Eissenstat[3] and R P. Marini[2], *(1)The Pennsylvania State University, (2)Pennsylvania State University, (3)The Pennsylvania State University*

Abstract: Total non-structural carbohydrate (TNC) availability in apple trees (*Malus domestica* Borkh.) is affected by light availability, temperature and other environmental factors as well as physiological processes such as respiration, tree growth, and crop load. These factors affect photosynthesis and starch accumulation (energy supply) and alter energy requirements for tree growth (demand). The balance between carbohydrate supply and demand is particularly important for apple development at thinning time when fruitlets are 10-12 mm in diameter and competition for carbohydrates is high. If current season carbohydrate supply to competing fruitlets is low, the application of chemical thinners may be more effective resulting in a lower crop density than if carbohydrate availability is high. However, if starch concentrations, accumulated in the previous year are high, more carbohydrates may be available for fruitlets which may limit the effect of a chemical thinner application and result in a higher crop density.

'Golden Delicious' trees on M.9, M.26, and G.16 rootstocks were used to investigate the effect of fruit removal treatments at 29, 125, 154 and 182 days after full bloom (DAFB) in 2013 on glucose and starch concentrations in current-season shoots and 1- and 2-yr-old branch sections the following season. The effect of fruit removal on thinning efficacy the following year was also investigated and trees were sprayed with water (control) or a mixture of 0.95L Carbaryl 4L and 5 ppm of NAA (Fruitone N) in 378.5L of water. We hypothesized that trees with fruit removal treatments at 29 and 125 DAFB would have higher glucose and starch concentrations and higher crop density after thinner application the following year while trees with fruit removal at 154 and 182 DAFB would have lower glucose and starch concentrations and lower crop density after thinner application. Trees with fruit removal at 29 DAFB had greater return bloom than trees with fruit removal later in the season. Fruit removal and application of chemical thinner enhanced available glucose and starch concentrations (mg·g^{-1} dry weight) in actively growing shoots and 1- and 2-year-old wood; however, this depended on time of year and rootstock.

Specified Source(s) of Funding: State Horticultural Association of Pennsylvania

2:45 PM Estimation of a Crop Coefficient for Low-Chill Peach Trees in Subtropical Humid Climates

Carlos A. Zambrano-Vaca*; Lincoln Zotarelli; Kati Migliaccio; Kelly T. Morgan; Richard C. Beeson Jr.; José X. Chaparro and Mercy A. Olmstead, *University of Florida*

Abstract: Florida's agricultural industry is moving to non-traditional crops such as peaches, which are common crops in northern latitudes. Low-chill peach cultivars allow Florida growers to market their crops before northern states, thereby obtaining premium prices. Irrigation is a common practice for peach production in Florida and is required to maximize yields. Current irrigation recommendations and peach crop coefficients were determined in arid climates which likely are inaccurate for humid climates. The objectives of this study were to estimate the daily crop evapotranspiration (ET_C) and the crop coefficient (Kc) of adult peach trees. Three trees were evaluated during 18 months in north-Florida for water uptake. Soil moisture sensors measured daily changes in soil volumetric water content every 10 minutes to calculate a daily water balance and estimate ET_C. Daily values of reference evapotranspiration (ET_O) were used to estimate Kc. Daily ET_C ranged from 0.71 mm·d^{-1} during dormancy, 3.39 mm·d^{-1} during fruit development and 2.47 mm·d^{-1} during vegetative growth. Daily estimated Kc ranged from 0.64 during dormancy, 0.8 during fruit development and 0.6 during vegetative growth. Daily peach Kc estimations provide a more accurate guideline to peach growers for irrigation practices in humid climates, compared with previous recommendations.

Specified Source(s) of Funding: FDACS

3:00 PM Characteristics of 180 Hard Cider Apple Genotypes in the USDA-PGRU Malus Germplasm Collection

Nathan Carey Wojtyna*[1]; Michael G Brown[1]; C. Thomas Chao[2] and Gregory Michael Peck[1], *(1)Cornell University, (2)PGRU USDA-ARS*

Abstract: In the United States, hard cider producers are increasingly interested in acquiring apple genotypes (*Malus ´domestica* Borkh. and other *Malus* species) that possess higher concentrations of tannins (polyphenols that taste bitter and/or astringent) and acidity (described as having a sharp taste) than what is typically found in culinary apples. The purpose of this research project was to phenotype a targeted population of genotypes in the United States Department of Agriculture-Plant Genetic Resources Unit (USDA-PGRU) *Malus* germplasm collection in Geneva, NY for desirable cider apple characteristics. Through a literature search for apples that were historically used in cider production and by the data-mining of the USDA Germplasm Resources Information Network Global (GRIN Global) database, we identified 308 potential candidates of which 180 were characterized in 2017. In the PGRU, each genotype is physically represented by a single-tree accession. Fruit weight (133; 1.34-599 g), diameter (65.6; 31.3-123.3 mm) red peel percent (49.9; 0-100%) or yellow-green background color (2.49; 1-4), flesh firmness (64; 4.5 – 140 N), peel chlorophyll-a (1.04; 0-2.1), and cortex starch pattern index, a 1-8 scale based on potassium iodine staining, (7.73; 3-8) was measured on three 15-apple subsamples from each accession (mean; range of measured values from the sample population is shown in parenthesis). Apple juice was evaluated for: soluble solid concentration (12.3; 2.8- 21.5 °Brix), titratable acidity (4.84; 0.26-22.9 g·L^{-1}), and polyphenol concentration (1.31; .092-5.14 g·L^{-1}) (as measured by the Folin-Ciocalteu assay). Sucrose (32.3; 0-107 g·L^{-1}), glucose (21.0; 3.8-74.4 g·L^{-1}), fructose (63.1; 11.5-123.0 g·L^{-1}) and sorbitol (10.4; .288-39.0 g·L^{-1}) have also been measured on a subset of apple juice samples. As per the Long Ashton Research Station cider apple classification system (> 0.2% (w/v) tannins bitter; > 0.45% (w/v) malic acid is sharp), 29% of the 180 accessions would be classified as bittersweet, 13% as bittersharp, 28% as sweet (neither bitter nor sharp), and 30% as sharp (Folin-Ciocalteu values were corrected to accurately reflect the Lowenthal Permangante Titration assay). These results confirm observations that apples with high polyphenol concentration, particularly those classified as bittersharp, are less common in the germplasm than sweet or sharp apples. Through this research, we hope to identify accessions within the USDA *Malus* germplasm collection that are of interest to the emerging hard cider industry. Future work will determine the seasonal variability in fruit and juice characteristics, as well as other important features, such as precocity, bearing habit, disease resistance, and overall compatibility with high-density apple orchard systems.

Specified Source(s) of Funding: USDA Hatch, United States Association of Cider Makers (USACM), Cornell-SIPS-Horticulture

3:15 PM Physiological Responses and Nutrient Uptake for 'gala' and 'honeycrisp' Apples Grafted on G41, M9-337, B9 and G890 Rootstocks

Nadia A Valverdi* and Lee Kalcsits, *Washington State University*

Abstract: 'Honeycrisp' and 'Gala' apple cultivars are two of the most commonly planted cultivars in Washington State. However, 'Honeycrisp' is susceptible to several nutrient-related physiological disorders and Gala is less susceptible. Rootstocks can affect scion growth and nutrient balance and are strongly

influenced by the soil environment. Washington State can experience periodic water limitations and elevated soil temperatures. Still, the contribution of rootstocks including rootstock-scion interactions regulating plant responses to soil abiotic stress are poorly understood. **The objective of this study was to evaluate the response of potted 'Gala' and 'Honeycrisp' apple trees grafted to four different rootstocks (G41, M9-337, B9, and G890) to soil abiotic stress (drought and heat).** At the WSU Tree Fruit Research and Extension Center, 72 trees (9 of each rootstock-scion combination) were grown in a greenhouse for 60 days. After this period, for three trees each, the water supply was reduced for the drought treatment (50% of field capacity), soil temperature was elevated by approximately 5°C using a thermostat-controlled heating cables for the heat treatment, and the remaining trees were left as an untreated control. Photosynthesis rate (A), transpiration (E), and midday stem water potential (SWP) were collected every two-weeks. After 60 days of treatment, all trees were destructively sampled to determine stem length, total leaf area, and root: shoot ratio. Stem water potential was greater for both cultivars with G890 as a rootstock. SWP was 0.75 MPa and 0.53 MPa higher than the control for Honeycrisp and Gala, respectively. Similarly, photosynthetic rates were 35% less for Gala trees grafted to G890 exposed to drought compared to the control trees while photosynthesis was 46% lower for Honeycrisp on the same rootstock. Stem length of Honeycrisp on B9 was 55% and 30% lower than the control for drought and heat, respectively. Drought reduced leaf area for all rootstock-scion combinations by 50% while the heat treatment moderately reduced leaf area for some scion-rootstock combinations. The root:shoot ratio for B9 rootstock was lower for both scions cultivar under drought compare to control. For G890 rootstock exposed to elevated soil temperatures, the root:shoot ratio was greater for both scions under heat stress compared to the control. We can conclude that the physiological performance and growth of Honeycrisp on G890 was the most affected by drought and M9-337 was the most sensitive to heat stress for both scions.

Specified Source(s) of Funding: USDA National Institute of Food and Agriculture - Specialty Crop Research Initiative project "AppleRoot2Fruit: Accelerating the development, evaluation and adoption of new apple rootstocks" (2016-51181-25406)

3:30 PM The Development of Free Amino Nitrogen in Crimson Crisp® Apple (*Malus domestica* Borkh.) Juice in the Growing Season and in Response to Foliar Urea Fertilization

Derek J. Plotkowski*, *University of Guelph* and John A. Cline, *Univ. of Guelph*

Abstract: Cider production relies primarily on the transformation of fresh apples. When the primary constituents are inadequate, producers often rely on additives to increase sugar, correct acid, or control the yeast assimilable nitrogen (YAN) in the pre-fermentation juice. Apple juice often has insufficient YAN for yeast, particularly *Saccharomyces cerevisiae*, to use for its own growth, which can prevent the completion of alcoholic fermentation and affect flavor development. In apple juice, YAN consists of individual amino acids (free amino nitrogen, or FAN) and ammonium. Nitrogenous compounds develop and change in apple fruits during fruit growth and development and in response to nitrogen fertilization, but it is unclear exactly which compounds in the juice are affected. This study investigated the concentration of 20 individual amino acids in apple juice in two ways: one looking at the development of amino acid concentrations throughout the growing season and one looking at this development in response to foliar fertilization. In the 2016 and 2017 seasons we applied weekly urea foliar sprays (5.1 g N/L solution) to Crimson Crisp® apple trees on M9 rootstock weekly after petal fall at three treatment levels: zero sprays, three sprays, and six sprays. The orchard was divided into eighteen units of ten trees. Each treatment was applied to six units in the orchard in a completely randomized design. Sprays began 7 days after full bloom ended. After the third spray was completed and every three weeks thereafter until maturity apples were collected from each unit and processed into juice. The juice was then analyzed for amino acid concentrations using high performance liquid chromatography. The results indicate that the greatest changes in amino acids within the growing season are the overall reduction in FAN concentration, the decline of asparagine concentration, and the increase in aspartic acid concentration as the fruit approaches maturity. The study found that the six-spray treatment increased the concentration of FAN in juice, but FAN concentrations in juices from the zero- and three-spray treatments were not significantly different from one another. The most notable differences in the amino acid concentrations in mature fruit were higher concentrations of aspartic acid, asparagine, methionine, and valine in the units that received six sprays. This information can be used by cider producers to better plan for their supplementation regimens during fermentation. Further research is required to investigate other forms of nitrogen fertilization as well as the effect of spray timing.

Specified Source(s) of Funding: University of Guelph, Growing Forward 2 Program, the Ontario Ministry of Agriculture, Food, and Rural Affairs, the Ontario Craft Cider Association, and the Norfolk Fruit Growers' Association

3:45 PM Development and Validation of a Pollen Tube Growth Model for Precise Thinning of Apple 'Red Delicious' Blossoms.

Sherif Sherif* and Keith Yoder, *Virginia Tech*

Abstract: The profitability of apple fruit producers is largely dependent upon consistent, high annual yield of quality fruit. In commercial apple production systems, this cannot be achieved without effective crop load management strategies that make a balance between vegetative and fruiting buds, reduce fruit-to-fruit competition, allow fruit enough room to grow, expose fruit to adequate sunlight and enhance return bloom. Winter pruning of dormant trees, chemical thinning of blossoms and fruitlets and hand thinning of fruit are the three common crop load management strategies. Chemical thinning can start at bloom stage and continue until fruits reach 25 mm in diameter. It is already well-established that crop thinning during bloom produces the largest fruit, the greatest return bloom and reduces biennial bearing. The application timing of bloom thinners has been subjective until a group of researchers at Virginia Tech has developed a model known as "the pollen tube growth model" (PTGM). This model predicts the time required for a pollen tube to reach the ovary and achieve fertilization to the fraction of king blooms needed for a crop, and the time for bloom thinners to be applied to prevent further set of later bloom. Over the last 13 years, models have been developed for six apple cultivars including Golden Delicious, Gala, Fuji, Cripps Pink, Honeycrisp and Granny Smith. In the present research, we describe the development of a PTGM for 'Red Delicious' and the validation of the model in commercial apple orchards in WA State. More than 100 WA Red Delicious beta-test blocks were bloom-thinned using the pollen tube growth model in 2016-17. From about 30 of those sites we received spray timing, yield data, and/or evaluated flower samples for evidence of fertilization. Microscopic evaluation of sampled flowers in the laboratory to determine the percentage of flowers that had been fertilized showed predictive effectiveness of Red Delicious model in the field. In addition, reported harvest data showed that the pollen tube growth model is helping growers to achieve their targeted crop loads.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

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3:00 PM – 3:30 PM *Boundary (Terrace Level)*

Awards Committee Meeting

Chair: Mary Meyer, *University of Minnesota*

Members: Michael Arnold, *Texas A&M University*; John Dole, *North Carolina State University*; Curt Rom, *University of Arkansas* and Carl Sams, *The University of Tennessee*

3:00 PM – 9:00 PM *T Street Entrance - Terrace Level*

Tour of the U.S. National Arboretum

3:15 PM – 3:45 PM *Lincoln West*

Vegetable Crops Management (VCM) Meeting - Open to All Attendees

Chair: Ramon Arancibia, *Virginia Tech, Eastern Shore AREC*
Chair-elect: Shinsuke Agehara, *Gulf Coast Research and Education Center, University of Florida*
Objectives:

To promote research and extension of a systems approach to production and utilization of vegetables.

3:15 PM – 4:15 PM *Georgetown East*

Consumer Horticulture and Master Gardeners

Moderator: Ellen Bauske, *University of Georgia*

3:15 PM **Delaware Master Gardeners: A Report on Volunteer Satisfaction, Perception of Training and Retention Intent**

Valann Budischak*[1]; Emily Barton[2] and Susan S. Barton[1], *(1)University of Delaware, (2)University of Virginia*

Abstract: Master Gardeners are a critical resource for Delaware (DE) Extension, and we conducted a survey in winter of 2017 to measure their demographics, perception of initial training, attribution of skills to learning experiences (initial training, advanced training, and volunteer experience), volunteer satisfaction, connection with sponsoring organizations (DE Extension, DE State University, and University of DE), and intent to remain with the organization. We distributed a survey via Qualtrics (Qualtrics, LLC, Provo, UT) to 282 current, active DE Master Gardeners, receiving 198 responses for a 70.2% response rate. The majority of the responding MGs are female (154; 87.20%), white (183; 91.92%), and college-educated (136; 70.10%), and the mean age is 70.45 years old. While not representative of the general population, these demographics are similar to those of other MG programs (Jeannette and Meyer, 2002; Schrock et al., 2000a). Delaware Master Gardeners had an average of ten years of service, gardened an average of four times per week, and participated in an average of seven volunteer activities. Master Gardener Volunteers highly rated their overall training experience (*M* = 6.31, *SD* = 0.99; scale of 1 to 7), and they felt general knowledge could be attributed most significantly to original training, whereas the confidence to teach practices and find answers to questions could be attributed most significantly to advanced training and volunteer experience. As measured by the Volunteer Satisfaction Index (VSI) (Galindo-Kuhn and Guzley, 2001), Master Gardeners highly rated their overall program satisfaction (*M* = 6.00, *SD* = 0.92; scale of 1 to 7), with empowerment as the highest sub-category (*M* = 6.18, *SD* = 0.95) and participation efficacy (volunteer's perception of their ability affect change with their volunteer work) as the lowest sub-category (*M* =5.83, *SD* = 0.91). Regardless of home county, Master Gardeners felt significantly stronger connections to DE Extension than either academic institution, University of DE, or DE State University. Finally, Master Gardeners reported that they intend to remain with the program, for the next year (*M*=6.44, SD=1.24; scale of 1 to 7), and for three years (M=5.91, SD=1.63). Overall, these data suggest DE Master Gardeners are satisfied with their work and learning opportunities. However, there are several areas for improvement. Long term goals include diversification of the volunteers to better match the constituent population (Bobbitt, 1997) and increasing volunteers connections to the sponsoring academic institutions at which they can find valuable resources. More attainable in the short term, volunteers need to see the impact of their own and others' volunteer work such that they can build participation efficacy, increasing their sense of ability to affect change.

Specified Source(s) of Funding: Delaware Cooperative Extension

3:30 PM **The Impact of Remote Training on Program Satisfaction and Retention Intent of Delaware Master Gardeners**

Emily Barton*, *University of Virginia* and Susan S. Barton, *University of Delaware*

Abstract: In 2015, Delaware Extension piloted Master Gardener remote delivery of training sessions via synchronous Zoom sessions. We evaluated trainees' ability to apply information after sessions and perception of the training in terms of approximating an in-person experience (Barton et al. 2016). While overall quality of information application was equivalent between in-person and remote sessions, several specific sessions with technical difficulties showed reduced application ability for remote trainees and trainees perceived the remote component poorly. Despite the trend towards no significant difference in knowledge when technical functionality is sufficient (Jeannette & Meyer, 2002; Stack, 1997; VanDerZanden, Rost & Eckel, 2002; Warmund & Schrock, 1999), Master Gardener researchers identify reduced tenure as a potential consequence of remote delivery or online training (Stack, 1997). To assess this in Delaware, we conducted a follow-up survey in winter 2017 to evaluate the 2015 Zoom trainees' satisfaction, intent to remain with Master Gardeners, and attribution of Master Gardener skill to various learning opportunities (original training, advanced training, or experience in role). We surveyed all current Delaware Master Gardeners (MGs) in order to compare 2015 Zoom trainees to their Delaware MG peers, with a 70.2% response rate. Using a series of robust multiple linear regressions, we identified that although MGs rate their training high overall, the subset of volunteers who participated in training via Zoom did express a statistically significantly lower rating (*M* = 5.83, *SD* = 1.09; scale of 1 to 7) than those who participated in previous trainings (*M* = 6.39, *SD* = 0.95). Similarly, we also found that Zoom trainees rated their satisfaction with the MG program (*M* = 5.63, *SD* =1.13; scale of 1 to 7) significantly lower than the rest of the Delaware MG volunteers. (*M* = 6.06, *SD* = 0.87). Encouragingly, we did not identify a significant difference in Zoom trainees' intent to remain with the organization. These results suggest that, while MG facilitators should plan use of remote MG training carefully, we do not expect it to impact their volunteer retention.

Specified Source(s) of Funding: Delaware Cooperative Extension

3:45 PM **A Model for Evaluating Consumer Horticulture Systems for Environmental Sustainability**

Ellen Bauske*; Bodie V. Pennisi; Velma Zahirovic-Herbert and Gentian Kostandini, *University of Georgia*

Abstract: Consumer horticulture (CH) systems (managed landscapes) serve as drivers of the agricultural economy, promoting the sale of specialty crops, goods, and services. They also provide environmental services that can promote sustainability. To gather on-site environmental data, a unique evaluation tool was developed. This tool protects the privacy of homeowners, is quick and efficient to apply, and creates accurate and reproducible results. Three areas of sustainability were selected because landscape characteristics associated with them have been fairly well defined. Shade trees impact home energy use. Landscapes that retain rainwater and reduce runoff promote improvement in water quality. Lastly, landscapes with flowers, sunshine, and greater plant variety provide pollinator habitat. A checklist with over 30 items was designed that could be used from the sidewalk or street to evaluate the extent of the three environmental services. Ten landscapes were selected in Decatur, GA (a city in the Atlanta Metropolitan area). The landscapes represented a range of summer and winter shade, ability to retain water on the property, and pollinator habitats. A 1.5-hour workshop was held at which 11 Extension Master Gardener (EMG) volunteers were trained to use the checklist. Two researchers and the EMG volunteers evaluated the houses in August of 2017. Participants were also asked to rank the curb appeal of each house on a scale of 0 (no appeal) to 10 (maximum appeal). Spearman Correlation Coefficients were calculated among participants for each variable, allowing for easy identification of individuals who needed additional training and variables with inconsistent evaluations. Volunteers appeared to have little difficulty assessing the level of shade provided by trees, the slope of the property, the nature of the vegetative coverage (e.g. turfgrass, herbaceous, woody ornamentals), the presence or absence of impervious surfaces, or the size and number of trees. Volunteers found it challenging to identify splash and rill erosion and to estimate the quantity of flowers on the property. This

suggests the need for additional training on the corresponding aspects of the check list. Interestingly, shrubs and morning shade had significant negative correlations with curb appeal, but many other characteristics that either support or hinder sustainability (as defined above) had significant, expected positive or negative correlation. These results indicate that this methodology could be used to quickly and inexpensively assess the combined environmental impact of residential landscapes in systematic studies of large scale.

4:00 PM A Characterization of Urban Agriculture in Kentucky

Leigh Whittinghill*, *Kentucky State University*

Abstract: Food insecurity and economic difficulties cause some people to turn to urban agriculture to supplement the household food supply or income. Others turn to urban agriculture as part of the local food movement and for community building. There are, however, barriers to urban agriculture that impact its form and growth. Both the motivations for participating in urban agriculture and the barriers to urban agriculture can result in a wide diversity of practices used. A survey was conducted to collect information on urban agriculture in central Kentucky. Survey questions included sections on farm/garden description, farming/gardening practices, and farmer/gardener demographics. Farm description data can include information about the farm itself, such as location, number of employees, goals, what growing strategies are used, such as permaculture or season extension, and soil testing. The farming practices section includes questions on crop selection, including both plants and livestock, nutrient management practices, irrigation systems, pest and disease management, and the tools and implements used on the farm. Phase one data were gathered through in-person interviews. Phase two data collection included both in person interviews and a web based survey. Both phases of the survey were reviewed and approved by the Institutional Review Board (IRB). Data were analyzed for descriptive statistics and correlations between variables using R.

The survey has provided a wealth of information about urban agriculture, urban farming and gardening practices, and the people who participate in these activities. Selected results from phase one reveal some interesting information. Most of the farms/gardens are not run for profit (77%), but only 22% are registered as 501(c)3 nonprofit businesses. Most farms reported that they do not keep records of either crop yields (66%), nutrient applications (77%), or irrigation applications (100%). Most farms (88% in both cases) use compost to supply nutrients and manual watering with either a hose or sprinkler, which can make record keeping more challenging. Urban farmers/gardeners are predominantly male (62%), white (75%), and non-Hispanic (100%). All respondents reported a bachelor's education or higher and 62% reported a field of study was related to sustainability and environmental science. The average number of years in farming is 28, with variation between new farmers and those with over 60 years of experience. The results of this survey will inform the direction of future research and extension projects especially in the areas of production practices, crop selection, and management choices, such as record keeping and nutrient management.

Specified Source(s) of Funding: USDA Evans-Allen Grant

3:15 PM – 4:15 PM *Lincoln East*

Ornamental Plant Breeding 2

Moderator: Lisa Alexander, *USDA-ARS*

3:15 PM Breeding and Genetic Research in Cut-Flower Gerberas

Zhanao Deng*, *University of Florida*

Abstract: Gerberas have become one of the top five most important cut flowers in the global floricultural trade. In 2010, as many as 938 million stems of cut gerbera flowers were sold at the Dutch auctions, generating 140 million euros a year. The annual wholesale values of cut-flower gerberas in the U.S. over the last several years have been between $32 million and $36 million. Commercial production of cut-flower gerberas also occurs in dozens of other countries. Gerbera breeding over the last 50 years has resulted in the development of numerous clonal cultivars with improved flower quality, increased flower yields, and extended vase life. A number of characteristics, including double, full-crested, and spider flowers, dark centers, and bi-coloration are now widely available in many gerbera cultivars. In recent years, *Botrytis* resistance, leafy stems, and twisted petals have been discovered in gerbera. Genetic, genomic and molecular studies over the last 20 years have led to the development of a number of new tools and resources for gerbera breeding, including molecular markers for *Botrytis* resistance, genetic linkage maps for local regions and the whole genome, candidate genes for flower types and disease resistance, cloned resident genes for anthocyanin synthesis and regulation, genomic and transcriptome sequences, and gene transfer technologies. It is expected that some of these new traits will be incorporated into new gerbera cultivars and new breeding tools will be adopted in cut-flower gerbera breeding.

3:30 PM Segregation of Floral Traits in Althea (*Hibiscus syriacus* L.)

Jason D. Lattier*, *US National Arboretum - USDA* and Ryan N. Contreras, *Oregon State University*

Abstract: Althea (*Hibiscus syriacus*) is an ornamental shrub prized for its winter hardiness and large, colorful flowers. Altheas are primarily tetraploids ($2n = 4x = 80$), although breeders have developed hexaploid and octoploid cytotypes. Although floral traits are most important for breeders of althea, little is known about their segregation patterns. The objectives of this study were to determine segregation patterns in eyespot presence, flower color, and flower form. Over four years, thousands of flowering seedlings were observed representing F_1, F_2, and backcross families. Based on our results, we propose that eyespot presence is controlled by a single locus and that a recessive allele called *spotless* results in a complete elimination of color. The gene controlling *spotless* is likely located upstream in the flavonoid biosynthetic pathway. We also propose that flowers with white to blush-pink petal body color and a red eyespot are controlled by a single recessive allele called *geisha*. This trait exhibits incomplete dominance and is under epistatic control by *spotless*. It is likely located downstream in the delphinidin biosynthetic pathway, responsible for lavender, dark pink, and blue pigments. In addition to color segregation, depth of color irrespective of hue (CIE L*) was also investigated (*spotless* and *geisha* seedlings removed). The deepest pigments were measured in crosses among hexaploid 'Pink Giant', taxa homozygous dominant for *geisha*, and taxa heterozygous for *geisha*. Conversely, the lightest pigments were observed in crosses between taxa homozygous recessive for *geisha* and taxa heterozygous for *geisha*. Future efforts at eliminating the *geisha* allele from a breeding population may allow for quantitative improvement in total anthocyanin production. Observations on petal number inheritance revealed that seedlings produced a continuous distribution of petal numbers between the petal numbers of the two parents, with occasional transgressive segregants. The highest average petal numbers were found in seedlings resulting from the cross of double-flowered taxa. Flower size (petal area), varied significantly among cross combinations and flower forms. The largest petals were observed in the seedlings of single-flowered by double-flowered crosses. Concomitant upregulation or expression of genes controlling laminar growth in stamen may not only result in petaloid stamen, but may also result in increased laminar growth in the true petals, resulting in wider, overlapping petals. However, further work must be undertaken to eliminate environmental effects on flower size estimates.

Specified Source(s) of Funding: Oregon Department of Agriculture and Oregon State University

3:45 PM Inheritance of Foliage and Flower Color of *Hibiscus Moscheutos* hybrids

Kaitlin Barrios* and John M. Ruter, *University of Georgia*

Abstract: Hardy hibiscus (*H. moscheutos*) is a perennial shrub with showy blooms and is hardy from USDA zones 4 to 9. Selections of hardy hibiscus were crossed with a Florida native, *H. moscheutos var. incanus* (swamp rose mallow), for introgressing various traits. F1 and F2 seedlings varied in phenotypic traits, particularly foliage and flower color. The objective of this study was to determine inheritance of these two traits. Two experimental lines of *Hibiscus moscheutos* were each crossed with swamp rose mallow and resulting F2 populations were evaluated Summer 2015. Seed for evaluating both traits was obtained from crosses and selfings

conducted Summer 2016. Seedlings were planted Spring 2017 and evaluated Summer 2017 in Watkinsville, GA. From the F2 populations, foliage color was observed to fit the Mendelian inheritance ratio of 3:1, where red foliage is dominant to green. To evaluate this observation, selfing of each original parent plant and a plant from each of the F2 populations was conducted and progeny were evaluated for foliage color. Results indicated the two parental experimental lines to be homozygous dominant (χ^2 = 0 for each) for a gene controlling foliage color, and the other parental line, *H. moscheutos var. incanus*, to be homozygous recessive, having all green foliage (χ^2 = 0.14). Progeny from selfing a red foliage plant from each of the F2 populations also fit the expected red:green foliage values (χ^2 = 0 and 0.03). To evaluate inheritance of flower color, two groups of crosses were conducted: one, using a red-flowered parent with white to blush-colored parents and the second, using two red-flowered parents. Reciprocal crosses of *Hibiscus xmoscheutos* 'Robert Fleming' USPP# 14,776 with three experimental lines of *H. moscheutos* indicate red flower to be maternally inherited from 'Robert Fleming.' When 'Robert Fleming' was pollinated with each of the three white/blush-flowered experimental lines, progeny displayed only red/dark pink flowers. Whereas, when 'Robert Fleming' was used as pollinator on the three experimental lines, progeny exhibited flowers ranging from white, pink to red. Additionally, selfing of *H. xmoscheutos* 'Robert Fleming' yielded only red-flowered progeny. Reciprocal crosses between two intraspecifc experimental lines of *H. moscheutos* bearing red flowers yielded progeny with flower color segregating out to red, pink, and white. Flower color ratios observed suggest the trait to be controlled by two genes. This information on inheritance of foliage and flower color can prove useful for further breeding work of hardy and swamp rose mallow hibiscus.

Specified Source(s) of Funding: Star Roses and Plants

4:00 PM Ploidy Level Influences Resistance to Powdery Mildew Disease in *Hydrangea Macrophylla*

Lisa Alexander*, *USDA-ARS* and Fulya Baysal-Gurel, *TSU*

Abstract: Polyploidy – also known as whole genome duplication – has long been associated with changes to ornamental traits in plants. Increasing the number of chromosome sets in plant cells often leads to thicker stems and leaves, a deeper green foliage color, larger and more textured flowers, and increased resistance to diseases and environmental stress. Ploidy level has been shown to influence morphological traits in *Hydrangea macrophylla*, with triploids having larger inflorescences, thicker stems, and increased stomatal area. The objective of this study was to determine if ploidy has an influence on resistance to powdery mildew, a common foliar disease of *Hydrangea*. Five diploid and five triploid *H. macrophylla* genotypes from related full-sibling families were placed in the greenhouse in a randomized complete block design with six replications. Data collection began one week after the first symptoms of natural powdery mildew infection occurred and continued for nine weeks. Powdery mildew disease severity was evaluated using a scale of 0-100% foliage. Area Under the Disease Progress Curves (AUDPC) was calculated using the formula AUDPC = $\sum[(Xi+1 + Xi)/2](ti+1–ti)$. Percent affected leaf tissue was measured using the Leaf Doctor plant image analysis application on the final week of data collection. Triploid plants had lower severity of powdery mildew infection in all weeks of observation. By week nine, AUDPC scores were significantly lower for triploids (7.7 ± 10.3) than diploids (19.5 ± 15.3). Triploids remained uninfected longer than diploids, with symptoms appearing an average of two and four weeks after the study onset, respectively. Triploids had significantly less leaf spot damage (2.5 ± 1.1%) than diploids (6.4 ± 1.2%). There were significant differences in powdery mildew resistance among genotypes within ploidy levels, with two genotypes remaining uninfected for the duration of the study. These data support the hypothesis that ploidy manipulation will be an effective breeding strategy to improve *H. macrophylla* for disease resistance traits.

3:30 PM – 4:30 PM *Georgetown West*

Citrus Crops 2

Moderator: Flavia Tabay Zambon, *University of Florida*

3:30 PM Effect of Growing Media pH on Nutrient Uptake in HLB-Affected Young Citrus Plants Grown in Hydroponics

Faisal Shahzad*, *Institute of Food and Agricultural Sciences*

Abstract: Huanglongbing (HLB aka citrus greening) is a serious endemic citrus disease presumed to be caused by *Candidatus Liberibacter* asiaticus (CLas) and is vectored by the Asian citrus psyllid. About 80 to 90% of citrus trees in Florida are estimated to be infected by CLas; resulting in >70% decline in citrus production over the last decade. HLB-affected plants showed blotchy mottling on leaves, twigs dieback, reduced fibrous root density, and stunted growth which leads to the shorter lifespan. Preliminary studies show that enhanced mineral nutrition helps in maintaining growth and productivity of CLas-infected plants. Mineral nutrition seems to overcome stress in HLB-affected plants; however, soil pH directly impacts on specific nutrients availability and uptake pattern. Therefore, a comparative greenhouse study was conducted to evaluate the nutrient uptake with different pH ranges in healthy and HLB-affected plants. This study was designed as a completely randomized block design with four replicates of each healthy and CLas-infected plants grown in hydroponic culture (with Hoagland solution). The pH range i.e. 6-6.5, 6.5-7, 7-7.5, 7.5-8 and 8-8.5 were maintained in Hoagland solution by adding acid/base on alternate days for five-week growing period. Under pH 6-6.5 range, CLas-infected plants showed increased chlorophyll content (%), leaf number and shoot growth (% increase), leaf nitrogen and zinc content; and, decreased calcium and manganese leaf contents compared to higher pH ranges. Hoagland nutrient analysis showed increase in nitrogen, potassium, calcium, magnesium, and boron uptake at pH 7-7.5 range in healthy and HLB-affected plants. Overall, HLB-affected plants showed better growth at pH 6-6.5 than healthy plants. In addition, the interaction of HLB and reactive oxygen species (ROS) and genes expression analysis related to nutrients will be determined. With this study, we expect to develop better understanding of HLB, pH of growing media, and nutrient absorption interaction with changing pH; these results will help in selection of favorable pH range for fertigated citrus to maintain optimal plant growth under HLB prevailing conditions for commercial groves.

3:45 PM Rehabilitation of HLB Infected Citrus Groves By Changes in Cultural Practices and Tree Nutrient Amendments

Frank Dean*, *LidoChem, Inc.* and C. Ramsey, *USDA-APHIS*

Abstract: The citrus disease Huanglongbing (HLB or citrus greening), is a bacterial disease that is widespread throughout Florida. Thus far, HLB has been difficult to manage due to the nonspecific disease symptoms, dissimilar environmental stresses, visible symptoms only revealed long after probable infection, differences in host - pathogen recognition and containment, and, host tolerance to the bacterium.

We hypothesized citrus greening is caused by induced nutritional deficiencies enhanced by environmental stresses, and, from cultural practices; these stresses induce changes in soil microbiota, microbial induced nutrient deficiencies, disruptive host metabolism, and, host immune system challenges.

Cultural practices and environmental stresses may induce metabolic disorders, changes in morphology, and disease susceptibility. When each of the stresses is addressed, metabolic disorders are corrected and morphology reverts to the norm.

Program changes made to cultural practices included reduced pesticide use and rates, lower fertilizer inputs, applications of soil amendments and foliar applications of selected nutrients. These changes reduced or eliminated symptoms of citrus greening, reduced or eliminated HLB rDNA titer, increased yield and quality, and, elimination of Post Bloom Fruit Drop.

4:00 PM Ground Applied Overdoses of Manganese Show a Therapeutic Effect Against HLB in Established 'Vernia' Sweet Orange Trees.

Flavia Tabay Zambon*; Davie Kadyampakeni and Jude W. Grosser, *University of Florida*

Abstract: The Florida citrus industry has been devastated by the bacteria *Candidatus* Liberibacter asiaticus (*C*Las), the probable causal agent of greening (HLB). Blotchy mottled leaves, phloem plugging, root depletion, misshapen fruit, severe defoliation and fruit drop are some of the HLB symptoms in infected trees. Micronutrients play an important role in conferring plant disease

tolerance. Manganese (Mn) protects the cells against the damaging effects of free radicals, and activates enzymes involved in: nitrogen metabolism, flavonoid, and indole acetic acid pathways. Boron (B) is required for sugar transport, carbohydrate metabolism, cell wall synthesis and cell structure. Our hypothesis is that manganese and boron applied in excess of current recommendations as controlled released fertilizer (CRF) can mitigate HLB symptoms in field established trees. Commercially established 'Vernia' grafted onto Rough Lemon trees were divided into eight (8) supplemental CRF nutrition treatments (two and four times the recommended doses) in a randomized complete block design in St. Cloud, FL. Treatments were composed of 6 trees in duplicate as follows: 1) No extra nutrition (control), 2) Harrell's – St. Helena Mix (H) 0.9 kg per tree; 3) Harrell's with 32g of Florikote Polymer Coated Sodium Borate (B) per tree; 4) Harrell's with 90g TigerSul® Manganese Sulfate (Mn) per tree; 5) Harrell's with 32g of B + 90g of Mn per tree; 6) 180 g of Mn per tree, 7) 64 g of B per tree, and 8) 180g of Mn + 64g of B per tree, applied every 6 months, for 5 years. Leaf nutritional analyses were done in March and September 2017, as well as qPCR for *C*Las in December. Low bacteria presence, meaning higher CT values were observed in trees that received four times the recommended dosage of manganese (180g Mn). No significant differences in juice characteristics, canopy volume and trunk section area were found between control and 180g Mn treated plants. Soil and leaf nutrients B, K, Mn and Zn were significantly different among treatments at various times in the study. We conclude that citrus trees supplied with excessive amounts of Mn bacteria populations are suppressed by its therapeutic effect. This response was not observed when Mn and B were combined in overdose, suggesting an antagonistic effect from B. When overdosed, Mn might restore biological functions and tree tolerance lost from nutritional imbalances caused by HLB. Further studies are needed to elucidate which pathways differ from overdosed and conventionally fertilized trees.

Specified Source(s) of Funding: The Lee Family and all fertilizers donated by Harrells and TigerSul.

4:15 PM **Citrus Resilience Under a CAT 4 Hurricane: Lessons from Irma in South West Florida.**

Fernando Alferez*, *University of Florida*

Abstract: Since the strike of four hurricanes in South West and Central Florida in 2004 (Charley, Frances, Ivan and Jeanne), and then Wilma in 2005, citrus growing areas in the state were hurricane-free for more than a decade. However, the disease known as citrus greening or HLB was first detected in Florida in 2005. Under HLB pressure, that has decreased production by 70% in 10 years, Florida Citrus Industry has adopted several strategies to survive while coping with the disease, since it is now endemic and there is no cure currently available. These strategies include, but are not limited to, developing and testing new varieties (rootstocks and scions) with tolerance to the disease. On September 10th, 2017 Irma made landfall as a cat 4 hurricane in South West Florida, severely affecting citrus groves aligned in her path. As a result, USDA Citrus Crop Forecast for this year has dropped from roughly 70 to about 45 million boxes. Being the situation dramatic for the Industry, still there was useful information during Irma's aftermath that we have been able to share with the rest of the citrus community in our state. In addition, these observations have seeded new research initiatives. Examples include rootstock behavior in response to winds and survival of new varieties after extensive flooding and wind damage. Trees from Hamlin and Valencia grafted on different rootstocks behaved differently in response to hurricane-force winds: Around 50% of trees grafted on the trifoliate dwarfing rootstock 'Flying dragon' were uprooted, whereas this only happened on less than 6 % of trees on Swingle citrumelo or Cleopatra mandarin, irrespective of the scion. The mandarin hybrid LB8-9, also known as SugarBelle [Clementine' mandarin (*Citrus reticulata*) × 'Minneola' tangelo] has shown tolerance to HLB and is now being adopted by many growers in Florida willing to produce high quality mandarins for the fresh market. In an experimental plot of 6-year old trees grafted on Carrizo rootstock, winds uprooted 70% of the trees. These trees were laying on the ground for up to three weeks before planted back. After winter, all the trees have survived, and spring flush, flowering, and fruit set was more abundant and occurred two weeks earlier as compared to standing trees. Taken together, these data increase our understanding and will lead to better management of stresses associated with hurricane conditions, allowing citrus growers to make better decisions in a timely manner.

3:30 PM – 4:30 PM *Boundary (Terrace Level)*

Nominations and Elections Committee Meeting

Chair: Robert L. Jarret, *ARS USDA*

4:00 PM – 5:00 PM *Jay (Lobby Level)*

Human Issues in Horticulture (HIH) Meeting - Open to All Attendees

Chair: Esther E. McGinnis, *North Dakota State University*

Chair-elect: Mun Wye Chng, *National Parks Board*

Objectives:

To stimulate discussion among those engaged in research and education programs in areas of horticulture that interact with the social sciences, such as economics, psychology, education, various forms of therapy, urban and rural sociology, and urban and rural development.

4:00 PM – 5:00 PM *Oak Lawn (Lobby Level)*

Postharvest (PH) Meeting - Open to All Attendees

Chair: Peter Petracek, *Valent BioSciences Corp*

Chair-elect: Steven Sargent, *University of Florida*

Secretary: Sastry Jayanty, *COLORADO STATE UNIVERSITY*

Objectives:

To exchange ideas and information relating to postharvest biology and technology of horticultural crops, to increase the awareness among other researchers, research administrators, legislators, and the public of the importance of the postharvest aspects of horticulture to the physical, economic, and psychological well-being of the population, and to integrate activities with those of associated Working Groups.

4:00 PM – 5:30 PM

"Improvement of Seed Technology Practices in Medicinal (Herbs & Spices) Plants and Horticultural Crops." *CEU Approved*

Jefferson West

Coordinator: Katherine Warpeha, *University of Illinois at Chicago*

Moderators: Changbin Chen, *University of Minnesota*; Amir Khoddamzadeh, *Florida International University* and Shinsuke Agehara, *University of Florida*

Objectives:

1. To explore the challenges in producing seed and advancing seed and horticultural technology with plants of medicinal importance. 2. To discuss the future for crops that are considered 'new' medicinal plants. 3. To build coalitions and collaboration among medicinal plant researchers and crop researchers.

Description: This workshop will bring together those ASHS members (including students) who are interested in many types of plants and the valuable seeds they produce. We will have discussion on how we can improve on the seed production, seed technology, seed storage, seed production, seed physiology, seed pathology, plant breeding / propagation of herbs, spices, and medicinal plants. We will have some short talks to lead into discussions on seeds and seed quality, to discuss problems, new methods and how they can help promote horticulture of plants with medicinal properties.

Rationale Groundwork: In 2016, Dr Gary Stutte published a Chapter in the American Chemical Society's eBook series about "Controlled Environment Production of Medicinal and Aromatic Plants" to express concern about the fact that Although controlled environments are widely used for the production of vegetables and ornamental species, there is limited published data on growth, production, and chemistry of medicinal herbs and plants. Due to

the increasing demand worldwide, we would like to discuss what technology is 1) required/needed in the opinion of the participants and what are 2) plants of interest to forge more inroads into increasing safe production of medicinal herbs and plants.

Speakers. Four brief talks which will be entry points for discussion:

1. Katherine Warpeha, University of Illinois at Chicago, Title, "Improvement of propagation technology of medicinal plants and crops".

2. Shengrui Yao, New Mexico State University, Title, "Jujube, a nutritious fruit and medicinal herb for its fruit and seeds".

3. Changbin Chen, University of Minnesota, St. Paul, Title, "Assessment of production and harvest potential of urban grown ginkgo biloba for economic and environmental benefit."

4. Shinsuke Agehara, University of Florida, Gainesville, Title, "Plant adaptation to water stress and its practical application for phytochemical production"

Kate Warpeha is Coordinator of workshop.

Kate Warpeha (University of Illinois at Chicago) is an assistant professor at University of Illinois. She teaches Cell Biology as well as specialty classes in medicinal herbs/plants for medicinal purposes. She has a patent in a chemical coating that boosts production of crops, herbs. She uses controlled environments and outside controlled areas to grow plants and would like to advance technology in chemical treatments.

Dr. Amir Khoddamzadeh - Florida International University. Dr. Khoddamzadeh has taught the courses such as Medicinal, Aromatic, and Poisonous Plants, Sustainable Agriculture, Introduction to Environmental Science, Modern Crop Production, Introduction to Horticulture Sciences, Sustainability in Action, Biotechnology Applications in Horticultural Crops, and also organized number of professional workshops throughout his career. His current research focuses are on: a) In-vitro propagation (tissue/cell culture) and gene-banking (cryopreservation) of the endangered Floridian native plants (mostly orchids), b) Optical non-destructive handheld sensor technology for sustainable fertilizer management in horticultural crops c) Anti-quorum sensing activity of medicinal plants.

Dr. Shinsuke Agehara (University of Florida, Gainesville) will also moderate the session. Research and extension program focuses on crop stress physiology, and most studies are performed on vegetable transplants or established crops. He will introduce discussion on crops that have medicinal properties, such as artichoke, blueberry, pomegranate, and hops and how stress management or production practices (indoors, outdoors) to promote the growth of those crops should be considered. Of particular interest are deficit irrigation strategies to improve water conservation and crop water productivity and nutrients uptake.

Dr Changbin Chen (University of Minnesota, St Paul) will also moderate the session, particularly focusing on student involvement. Dr. Chen focuses on ginko, which has been used for conditions that affect blood flow in the brain, asthma, allergies, bronchitis, and for disorders of the central nervous system. Dr Chen is an expert in Chinese medicinal plants and teaches their use and biotechnology advancement of plants of interest particularly by understanding cytogenetics and propagation, and teaches many horticultural topics at University of Minnesota Dept of Horticultural Sciences.

4:00 PM "Improvement of Propagation Technology of Medicinal Plants and Crops"

Katherine Warpeha*, *University of Illinois at Chicago*

Abstract: The interest in herbs and medicinal plants for health and treatment has grown significantly in the last 20 years. There are a number of root, shrub and annuals that can be difficult to grow or cultivate in a high throughput way, yet are high in demand. We introduce the workshop by doing an overview of current herbs and medicinal plants where supply does not meet demand, and may not be amenable to standard vegetative or breeding techniques. In addition, we will go over seed treatments that may be required for quality seedlings and stand establishment for greater yields of indoor and outdoor horticulture.

4:15 PM "Jujube, a Nutritious Fruit and Medicinal Herb for Its Fruit and Seeds"

Shengrui Yao*, *New Mexico State University Sustainable Agriculture Sciences Center*

Abstract: Jujube (*Ziziphus jujuba* Mill.), also called Chinese date, was imported into the US beginning in 1908. Its fruit is rich in vitamin C, cyclic adenosine monophosphate (cAMP), fiber, and antioxidants. Both its fruit and seeds together with seeds from wild jujubes (Z. spinosa) are traditional Chinese medicines. Jujubes grow and produce well in the U.S. especially the Southwest. At this time, the limited plant supply is a critical issue limiting the jujube industry. Hopefully, tissue cultured plants will solve the plant shortage problem. Jujube cultivars can be classified as fresh eating, drying, multipurpose and ornamentals. We will discuss the jujube cultivar collections in the U.S., cultivar classification and recommendations for growers. We will also discuss the jujube research progress, challenges and opportunities of jujube production.

4:30 PM "Assessment of Production and Harvest Potential of Urban Grown Ginkgo Biloba for Economic and Environmental Benefit."

Changbin Chen*, *University of Minnesota*

Abstract: *Ginkgo biloba* has been used for thousands of years in the oriental countries in medicine and food. For the North America, ginkgo is considered to be one of the best climatically adaptive species. The species is highly resistant to disease, stress and pests. However, female ginkgo trees may be considered undesirable due to the strong odor of the fleshy seed. In some cases mature female ginkgo trees have been removed for this reason alone. Fortunately, there is growing local interest in assessing ginkgo seed as a valuable new crop. The worldwide market for ginkgo products is approximately 3 billion dollars annually. The majority of the ginkgo market resides in Asian countries; however, there is considerable demand in the United States which is met by importing ginkgo products from overseas. Currently, there are no locally grown sources of ginkgo available in Minnesota. We work on assessing the potential production, harvest, and processing of urban produced ginkgo seeds for sale to local and regional markets. The outcome of which will generate new income in communities with existing ginkgo trees as well as help in preserving this valuable component of the urban forest. In addition, we report our findings regarding the safe uses of urban produced ginkgo nuts, especially the measurement results of heavy metal and ginkgotoxin levels in the ginkgo nuts collected from different locations in Twin-Cities of Minnesota.

4:45 PM "Plant Adaptation to Water Stress and Its Practical Application for Phytochemical Production"

Shinsuke Agehara*, *University of Florida*

Abstract: Plants respond to abiotic stress by inducing antioxidants as a defense mechanism. Such antioxidants include phytochemicals with health-promoting properties and essential oils with medicinal properties. Crop stress management strategies aim to maximize the production of these beneficial chemical compounds by achieving an optimal balance between crop stress and stress adaptation. Horticultural crops with high health-promoting and medicinal properties, plant stress responses, and, how crop stress management and production practices can be used to promote antioxidant production will be discussed. Particular emphasis will be on water stress and deficit irrigation strategies.

4:00 PM – 5:30 PM

Microclimate Modification Effects on Fruit Physiology and Production *CEU Approved*

Lincoln West

Coordinator: Stefano Musacchi, *Washington State University*

Moderator: Thomas M. Kon, *North Carolina State University*

Objectives:

The goal of this workshop is to provide an interactive forum to discuss ongoing projects related to microclimate modification in fruit crops, identify common challenges and future research needs, and foster future collaboration among professionals in academia and industry.

Description: Innovations in fruit production increasingly involve technologies that modify the plant's microclimate, often resulting in multiple impacts on developmental physiology (as well as related issues like pest management). Two such innovations in perennial fruit crop production are high tunnels and protective netting. Both technologies are usually employed to protect fruit crops from

specific climatic events, such as hail or rain, but secondary climatic components also are altered, such as light quantity and quality, wind, relative humidity, and air and soil temperatures. Optimization of protective production technologies requires consideration of the range of potential microclimatic modifications and the plant's reproductive and vegetative responses. High tunnels are plastic-covered steel arches that have been applied to a diversity of horticulture crops including vegetables, fruits, herbs and flowers. High tunnels can extend growing and harvest seasons, accelerate vegetative growth and fruit maturity, minimize impacts from unfavorable climatic events like low temperatures, wind, rain, hail, and high light intensity, and protect crops from some pests and diseases, all resulting in increased marketable yields and quality. Protective netting was originally used to protect horticultural crops from hail and bird damage. The net have a great impact on light quantity and quality, as well as temperature and wind. This expands the potential to optimize growing conditions for canopy and fruit development as well as potentially mitigate abiotic stresses associated with climate change (e.g., increased temperatures, less atmospheric haze resulting in higher light intensity, higher UV light with depletion of the ozone layer, etc.). In the past, net colors were primarily white, black or grey. In recent years, new dyes and types of plastic have provided a wider range of colors, more durability, and greater resistance to UV radiation. Photoselective protective netting represents a new frontier of light microclimate manipulation since net colors can be chosen to specifically modify components of the light spectrum that may alter distinct physiological responses, such as vegetative growth, flowering, and fruit development. We propose a 1.5 hour Workshop comprised of 6 presentations at 10 minutes each and 30 minutes of audience-interactive round table discussion. This Workshop will offer the opportunity to interact with the ASHS Professional Interest Groups of Viticulture and Small Fruits and Plasticulture (PLAST). They are secondary sponsors of the workshop.

Workshop topics include:

- Fruit microclimate modification with photoselective netting and plastic-covered high tunnels;
- Light spectrum modification using photoselective protective netting and photoselective plastic covers;
- Perennial fruit plant responses to altered light spectra.

Workshop speakers include:

- Greg Lang, MSU
- Kathy Demchak, Penn State University
- Stefano Musacchi, WSU
- Sara Serra, WSU
- Giverson Mupambi, WSU
- Sahap Kaan Kurtural, University of California Davis

SHORT BIO OF THE SPEAKERS AND ORGANIZERS

Stefano Musacchi

Dr. Stefano Musacchi, Associate Professor and Endowed Chair of Tree Fruit Physiology and Management in the Department of Horticulture at Washington State University. Musacchi was the National coordinator in Italy of a project on the effect of netting on tree physiology and how to mechanize the netting system. Dr. Musacchi is involved in two projects on photoselective netting funded by Washington State Department of Agriculture (WSDA) and Washington Tree Fruit Commission (WTFRC).

Tom Kon

Dr. Tom Kon joined the Department of Horticultural Science at North Carolina State University in 2016. His program seeks to improve orchard practices and enhance the economic and environmental sustainability of the southeastern apple industry (NC, SC, and GA). Tom's research program is focused on apple crop load and canopy management and developing new tools and technologies to maximize fruit quality and storage potential.

Greg Lang

Dr. Gregory Lang, Professor of Tree Fruit Physiology at Michigan State University, has been conducting research on tree fruit production in high tunnels and other orchard covering systems since 2005, including sweet cherries, tart cherries, apricots, nectarines, and plums. Greg's research teams have been instrumental in advancing space- and labor-efficient, high density canopy training systems for stone fruits that are particularly suitable for production under covering structures, utilizing both dwarfing and vigorous rootstocks.

Sara Serra

Dr. Sara Serra, Assistant Professor at the Department of Horticulture at Washington State University, joined WSU in 2013. She is involved in two projects on photoselective netting funded by WSDA and WTFRC. In recent years, she study the effects of netting on light quality.

Giverson Mupambi

Dr. Giverson Mupambi started work as a postdoctoral research associate at Washington State University in 2016. He has a PhD in Horticultural Science from Stellenbosch University in South Africa. Giverson's expertise is in apple ecophysiology. His current research focuses on the ecophysiological response of apple under photoselective shade netting.

Lee Kalcsits

Dr. Lee Kalcsits is an assistant professor of tree fruit physiology in the Department of Horticulture at the Washington State University Tree Fruit Research and Extension Center in Wenatchee, Washington, USA. Lee's research program works towards understanding the interactions between the environment, horticultural management and genetics of tree fruit.

Kathy Demchak

Kathy is a Senior Extension Associate in the Dept. of Plant Science at Penn State University. She's been growing a berry crops in high tunnels since 2000, most recently as part of the USDA-NIFA-SCRI project "Optimizing Protected Culture Environments for Berry Crops", led by Dr. Eric Hanson at Michigan State University. She and her colleagues are comparing the effects of plastic films with different UV and IR transmitting characteristics on raspberry and strawberry plant growth, insect pests, and the plant microclimate in high and low tunnel environments.

Sahap Kaan Kurtural

Dr. Kaan Kurtural is Professor and Associate Cooperative Extension Specialist in viticulture with the Department of Viticulture and Enology at University of California Davis and is the Director of Oakville Experiment Station, a 40-acre University of California research facility in the heart of Napa Valley. Dr. Kurtural's research has been instrumental in advancing vineyard mechanization and its related effects on flavonoid biosynthesis in wine grape cultivars. He has recently completed two projects in photoselective netting to mitigate the effects of climate change on the high-value wine grape crop in California's Napa Valley.

4:00 PM High-Tunnel Orchard Microclimate Modification

Gregory A Lang*, *Michigan State University*

Abstract: As fruit production becomes increasingly technology-driven, one orchard challenge remains a significant challenge – the weather. Every fruit grower has experienced potentially damaging climatic events that are difficult to predict, add production risk, and reduce or eliminate profits. Plastic-covered high tunnels can mitigate weather-related risks associated with spring frost, rain, hail, wind or other adverse conditions. However, tunnels also provide the potential to change (for better or worse) the production climate by altering temperatures, light quality and quantity, pest and beneficial insect populations, and diseases, all of which impact plant growth, fruit development, quality, yield, and marketing windows. Different covering strategies may be utilized in different climates to address the risks, or market opportunities, most critical for each region. This presentation will summarize the high tunnel operational parameters and management strategies that can alter orchard microclimatic conditions, and impact developmental and reproductive physiology during production of tree fruits, berries and wine grapes.

4:10 PM Plastic Film Light-Transmitting Characteristics As Related to Berry Crop Production

K Demchak*[1]; R P. Marini[2]; Maria Cramer[2] and Eric Hanson[3], *(1)Pennsylvania State University, (2)Pennstate University, (3)Michigan State Uiversity*

Abstract: Plastic films used to cover protective structures such as high tunnels and greenhouses vary in their light-transmitting characteristics. These films are manufactured to transmit a high proportion (often 90% or greater) of visible light (and thus PAR), but depending on the film, may block a significant portion of UV-A, UV-B, and/or infrared (IR) radiation entering or leaving the

structure. Different plastic films also diffuse light to varying degrees, affecting the extent to which light is scattered as it passes through the film. An ongoing multi-state project is testing three commonly used films with a wide range of light-transmitting characteristics, along with two experimental films. Among these commercially available films, transmission of UV-A and UV-B ranges from roughly 5 to 90% depending on plastic film type and wavelength, transmission of visible light ranges from 70 to 95%, and transmission of near IR radiation ranges from 50 to 95%. The experimental films either block nearly all UV, or allow about 80-90% transmission of UV, while allowing transmission of over 90% of wavelengths longer than UV. In an experiment on day-neutral strawberries in single-bay high tunnels in 2016 and 2017, yields with all films were greatly increased compared to no covering, but differences due to film type were minimal, perhaps because plants were at ground level and exposed to similar temperatures when tunnels were vented. With two cultivars of primocane-fruiting raspberries in PA in 2017, the first year in which effects were due primarily to plastics rather than previous growth in the nursery, there was an interaction between cultivar and film type. The film that transmitted high light levels across the spectrum, diffused light the least, and resulted in the highest foliage temperature produced the highest yields with one cultivar, and tended to produce the highest yields with the other one. When used on low tunnels for day-neutral strawberry production on raised beds covered with either white or black plastic mulch, films that transmitted higher amounts of UV tended to result in a brighter red color, presumably due to increased production of anthocyanins as reported in other research. Film type effects were noted for certain pests, especially Japanese beetles, whose numbers were reduced to the greatest extent by the films that most markedly reduced UV light transmission.

4:20 PM Overview of Netting Systems

Stefano Musacchi*, *Washington State University*

Abstract: Protective netting is becoming a widespread technique all around the world. Originally, netting was developed to protect high value perennial crops from hail damage. In some countries the hail risk is covered by insurance. Insurance can protect crop loss but there are other indirect damages that are very difficult to recover. In the case of perennial trees affected by a strong hail storm, not only the current crop can be lost but also the crop of the following year due to the damage of the flower buds. In addition, wounds can become a penetration point for disease like bacteria (Erwinia amylovora fire blight) or fungi. In Europe, netting was developed in the 1970s and there were different shapes of the protective structure. The utilization of netting is associated with the increase of planting density and the modification of the tree canopy related to the use of dwarfing rootstocks. The original structure was initially made of tall posts and a triangular structure to support the net on the top. The use of dwarfing rootstocks, like M9 for apple and Quince for pear, that reduced tree height allowed the structure to become more flat and less expensive by saving on the cost of posts and net. The increasing cost of HDP orchard establishment justify the use of protective netting. Additional advantages of netting are protection against bird, especially in cherry, insect and physiological stress. The Alt-carpo system developed in France in 2005 and validated in 2006 by Severac, is a physical barrier to reduce the damage of Codling moth by the net's mesh size. This system creates a completely closed net with only one gate to enter and can be applied for large areas or to single row (drop net). All these solutions to cover full orchards or a single row increases benefits for the growers to make production more sustainable. Nets modify physiological conditions of the tree because they induce microclimatic variation. Protective netting primarily modifies light quantity and quality by reducing light intensity by an approximately pre-determined percentage. Protective netting has also been reported to reduce wind speed and soil temperature with minimal impact on canopy temperature, relative humidity and with important effects on fruit quality.

4:30 PM Light Environmental Manipulation By Colored Nets in Washington State

Sara Serra* and Stefano Musacchi, *Washington State University*

Abstract: Apple production in Washington State is distributed in five growing regions characterized by a semi-arid climate. However, thanks to the abundance of waters from the Columbia River though the territory this area produces the majority of apples in North America. Crop production in WA is challenged by several environmental factors, such as high light intensity, temperature and wind, that can cause stress to the trees and fruit damage (i.e. sunburn). For those reasons, protective netting is becoming a choice embraced more and more every year by WA growers in order to minimize losses in apple orchards. Originally developed as anti-hail protection, now shading nets can be specifically employed to modify the light spectrum and intensity hitting the orchard canopies by the use of different colors. A commercial orchard of 'Cameron Select® Honeycrisp' on Bud-9 orchard was planted in 2013 in Quincy (WA) and trained to V-system (4485 trees/ha). In spring 2015 shade pearl, blue and red nets (approx. 20% shade factor) were installed horizontally over the top of the orchard and deployed after bloom. The goal of our trial was to characterize the light intensity and light quality under three different colored nets and compare the modified light environment to the full sun-no net. Spectra of total light and scattered light (diffuse) were measured monthly by a spectroradiometer outside and underneath the colored nets each summer for two consecutive years (2016-2017). Transmittance of total light (%) for each colored net and scattered light (%) were measured and light intensity parameters (PAR, UV, Blue, Red, Far Red) were calculated. PAR, UV, Blue, Red, Far Red light in total light measures were always significantly lower under the nets compared to the uncovered controls. The scattered light data showed a higher intensity in the PAR range for the Pearl net compared to the other colored nets in both years. The highest PAR/UV ratio in full light measure was reported under Red nets in 2017. These results confirmed the beneficial effect of Pearl and Red nets for improving light quality in orchards and further studies can address the effects of the modified light on the tree physiology.

4:40 PM Protective Netting Optimization of Light Conditions for Apple Production in Washington State

Giverson Mupambi* and Lee Kalcsits, *Washington State University*

Abstract: The major apple growing regions in WA are located in the semi-arid eastern half of the state which experiences harsh environmental conditions due to the rain shadow effect from the Cascade mountain range. Fruit sunburn results in substantial losses to the apple industry every year. To mitigate these losses, the adoption of protective netting to reduce fruit sunburn and trees stress is increasing in WA. The types of protective netting structures commonly used by commercial apple growers in WA are exclusion netting, horizontal over the top of the orchard only and louvered / partial overhead netting. Factors that influence a grower's decision on the netting structure include cost, amount of protection needed and tree row orientation. The primary benefits of protective netting is the reduction in solar radiation reaching the orchard environment underneath it. Protective netting primarily modifies light quantity and quality underneath by reducing light intensity by an approximately pre-determined percentage. Depending on the cultivar, apple growers in WA use protective netting that reduce the total amount of incoming solar radiation by 10–30% depending on the cultivar. This results in a reduction in photoinhibition and improved photosynthetic light use efficiency. In young orchards under protective netting, trees are able to fill-in the canopy earlier compared to an uncovered control. The reduction in incoming solar radiation under protective netting reduces the occurrence of sunburn by decreasing the amount of radiation reaching the fruit surface and reduces photooxidative damage to the fruit peel. Protective netting has been shown to consistently reduce the incidence of sunburn in apple under high light intensity growing conditions experienced in WA. Overall, protective netting provides is a resilient innovation to protect apple fruit from sunburn and reduce abiotic stress that limits tree establishment in WA.

4:50 PM Partial Solar Radiation Exclusion Increases Berry Flavonoid Content and Must Acidity in Winegrapes

Christoper Chen[1]; Johann Martinez-Luscher[1] and Kaan Kurtural*[2], *(1)University of California Davis Davis,CA USA, (2)University of California*

Abstract:

The increase in day time temperatures, particularly the intermittent heat spikes during engustment, is negatively affecting the biosynthesis, retention, and degradation of flavonoids content and organic acids in grapevine berry. There is lack of information on how to mitigate radiative damages and

degradation that may occur under these conditions. A field experiment was conducted with Cabernet Sauvignon/110R in Oakville, CA using one meter, black, polyethylene shade nets of 40% light transmissivity, to determine the effects of partial solar radiation exclusion and applied water amounts on productivity, primary and secondary metabolites of grapevine berry flavonoid profiles. One netting treatment, of 40% Black net (Black-40), and one untreated control, with no nets, were applied shortly after fruit-set at Eichhorn-Lorenz stage 29 and retained until harvest. Two applied water amounts of 0.65 crop evapotranspiration (0.65 ET_c, Control) and 1.3 ET_c, were applied. At harvest, there was no effect of treatments applied on juice pH or titratable acidity. However, individual berry mass was greater in controls than shade net treatments. Diurnal cluster temperature shifts were recorded on both sides of the canopy. During peak daytime temperatures, cluster temperatures were 3.9°C greater in plants without the Black-40 applied to the canopy; although no effect was attributed to applied water amounts. Cluster damage attributed to solar radiation exposure was quantified. Although yield was unchanged, damaged cluster count and mass were significantly greater in treatments without shade netting applied. Anthocyanins and flavonols of berry skins were measured using C18 revered-phase HPLC. At harvest, treatments without shade nets had greater flavonol content, but a lower tri/dihydroxylation ratio than Black-40 treatments. However, anthocyanin content was greatest in Black-40 berries. Our results provide evidence that, regardless of applied water amounts in a vineyard, shade netting may alleviate the stresses that excessive solar radiation exposure puts on grape berry. It may do so without greatly affecting yield at harvest, and instead mitigates the amount of visible radiation damage on the fruit itself.

5:00 PM **Panel Discussion**

4:00 PM – 6:00 PM *Jefferson East*

Vegetable Breeding 2

Moderator: Gehendra Bhattarai, *University of Arkansas*

4:00 PM Cucurbit Powdery Mildew Races on Melon: Current Status in the U.S.

James D. McCreight[*1]; Michael D. Coffey[2]; Kaori Ando[1] and Shaker S. Kousik[1], *(1)USDA-ARS, (2)University of California, Riverside*

Abstract: Cucurbit powdery mildew (CPM) is caused most frequently by two fungal species, *Golovinomyces orontii* and *Podosphaera xanthii* (Px), that are highly variable in virulence. The former organism has not been reported on melon in the U.S. since the 1960s, while the latter organism is consistently reported on melon across the country. Variability in CPM virulence, recorded as different physiological races, was first observed in the U.S. in 1938, when race 2 appeared shortly after the release of race 1-resistant 'PMR 45' for Imperial Valley, Calif. production. Px race 3 appeared in 1977 in Weslaco, Texas. Px race 1 was present on spring and fall season melons in Imperial Valley in 2001–02, but in 2003 a new race, designated S, was observed in a spring melon production field and race differential research plots. Race S infected all the CPM melon race differentials in common use at that time. Px races 1, 2, and S occurred on spring melons in Imperial Valley, 2004–17. In Yuma, Ariz., ~80 km distant from the Imperial Valley research plots, race S first appeared in Spring 2004, and recurred there during the spring seasons of 2005, 2007–08. Px race S has not been observed on fall melons in Yuma or Imperial Valley; only race 1 was observed in those areas in Fall 2002–07. Px races 2, 5, 3.5, and S were present at 3 locations in the Central Valley, Calif. in August and September 2003–17. Px race SD, which infects all known Px melon race differentials was first isolated via single spore transfers from race S in 2003, and has been present in a greenhouse at Salinas since 2012. Twelve California field isolates and their single-spore sub-strains collected 2014–15 revealed additional virulence variation, including one similar to race pxCh1, in controlled-inoculation greenhouse tests of 11 CPM race differentials. Such virulence variation has not been reported in other parts of the U.S., with the exception of one unconfirmed report of race S in Georgia. Px races 1 and 2 occur in Texas and New York. Px race 1 occurs along the Atlantic coast, though there was evidence of race 2 at a low level on fall melons in Charleston, S.C. Px race 2 consistently occurs in the Gulf of Mexico coastal areas of Florida.

4:15 PM Candidate Susceptibility Genes for Powdery and Downy Mildew in Watermelon and Squash

Geoffrey Meru[*] and Ryan Porterfield, *University of Florida-TREC*

Abstract: Genetic resistance is the most preferred management strategy for powdery mildew (*Podosphaera xanthii*) and downy mildew (*Pseudoperonospora cubensis*) in cucurbits. However, traditional breeding for resistance to the two diseases is resource intensive, often requiring decades' long phenotyping and selection processes. As an alternative, durable and broad-spectrum resistance to powdery and downy mildew can be obtained through loss-of-function of susceptibility genes in elite breeding material. Susceptibility genes for powdery mildew [Mildew-Locus-O (MLO) and Powdery Mildew Resistance (PMR)] and downy mildew [Downy Mildew Resistance (DMR)] have been functionally proven in model plant species. Previous studies have reported candidate MLO genes for *Citrullus lanatus* and *Cucurbita. pepo*, but none for *C. maxima* and *C. moschata*. However, no PMR or DMR candidate genes have been identified for *C. lanatus* or any of the *Cucurbita* species. The current study used bioinformatics approaches based on sequence similarity, phylogenetic relationships and presence of conserved domains to predict candidate MLO genes in *C. maxima* and *C. moschata* and PMR and DMR genes in *C. lanatus*, *C. pepo*, *C. maxima* and *C. moschata*. Four MLO homologs in *C. maxima* and five in *C. moschata* clustered within Clade V, a clade containing all MLO susceptibility genes in dicots, and had highly conserved transmembrane domains and C-terminal PM interaction motif. Sixty-three candidate PMR genes were identified among the four species, 16 of which had close similarity to functionally proven PMR homologs in model species. Similarly, 37 candidate DMR genes were identified 12 among which clustered with functionally proven DMR homologs in model species. Functional analysis of the genes identified in the current study will reveal their role in pathogenesis and assess their potential for manipulation through gene editing methods to generate novel resistant plant genotypes.

4:30 PM Field Phenotyping and Genome Wide Association Analysis for Downy Mildew Resistance in USDA Spinach Germplasm

Gehendra Bhattarai[*1]; Bazgha Zia[1]; Wei Zhou[1]; Chunda Feng[1]; Jun Qin[1]; Waltram Ravelombola[1]; Yuejin Weng[1]; Jim Correll[1]; Ainong Shi[1] and Beiquan Mou[2], *(1)University of Arkansas, (2)USDA-ARS*

Abstract: Spinach (*Spinacia oleracea*) is an important cool-season leafy vegetable crop. A significant increase in spinach consumption in last two decades in the U.S. is attributed to an increased consumer health-consciousness. Downy mildew (DM) caused by an obligate oomycete *Peronospora effusa,* is an economically important disease in spinach. Many new races (> 10) have been identified in last two decades and such a rapid increase in the number of races threatens the sustainable production of spinach. DM can be managed using a number of strategies, but disease resistance is the most practical and economical management practice. Disease resistance is particularly critical for organic spinach production, which makes up approximately 50% of the market. The development of durable resistance of the downy mildew pathogen is critical. A total of 400 spinach genotypes, collected from a wide geographical region and maintained at NCRPIS, were evaluated at the USDA research station, Salinas, CA in Oct. 2017. The purpose of the field evaluation was identify field resistance to the downy mildew pathogen under natural disease pressure under field conditions. Field screening for downy mildew resistance can potentially identify partial resistance governed by QTL. The selection for QTL resistance in spinach to the downy mildew pathogen can improve durability of resistance. The spinach accessions evaluated were originated from 37 countries and belong to five different species but most are *S. oleracea*. Disease severity was rated on a scale of 0-100% based on a percentage of leaf area showing signs or symptoms of downy mildew. A wide variation in downy mildew disease severity was observed among the evaluated spinach genotypes. A whole-genome resequencing of all evaluated spinach genotypes is underway, and the SNPs marker identified from the population-resequencing approach will be used to conduct genome-wide association analysis. Identification of markers associated with minor and major resistance alleles can be used for gene pyramiding to improve the durability of resistance of spinach cultivars to the spectrum of races of the downy mildew pathogen.

4:45 PM Evaluation of Resistance in *Capsicum* species to Powdery Mildew and Characterization of the *Camlo2* Locus

Jack McCoy* and Paul W. Bosland, *New Mexico State University*

Abstract: Since its introduction to New Mexico in the 1990s, powdery mildew, caused by *Leveillula taurica* (Lév), has been a major disease on chile peppers. Powdery mildew can lead to severe plant defoliation, resulting in significant quality and yield losses. Applications of fungicide can be effective in managing the disease; however, early detection and thorough coverage of the plant is required. The most economically and environmentally sustainable solution is breeding for resistance. The Chile Pepper Institute at New Mexico State University grows an annual Teaching Garden at the Fabian Garcia Science Center in Las Cruces, NM. During the 2017 growing season, environmental conditions were highly favorable for powdery mildew development, and severe infection was observed. Under natural infection, 152 accessions, including six *Capsicum* species, were evaluated for resistance. Of the 152 accession, 53 accessions would be considered resistant. When examining across species, 18 *C. annuum* accessions were resistant, as well as 11 *C. baccatum*, 16 *C. chinense*, 5 *C. frutescens*, 1 *C. chacoense*, and 1 *C. rhomboideum* accession. A disease index ranging from 0 to 5 was used to score individual leaves of the plant. Accessions were considered resistant if they scored a 0 or 1. In addition to the field study, characterization of a novel susceptibility gene, *CaMlo2*, was conducted in the resistant accession, HV-12, and the susceptible cultivar, 'Maor'. A single nucleotide polymorphism (SNP) was identified and a marker was developed. Select accessions from the field study were screened. The marker identified all evaluated resistant accessions; however, was not accurate for all susceptible accessions. This study provides the first multiple species evaluation for powdery mildew resistance among *Capsicum* species in New Mexico. It also provides preliminary evidence for genetic control of resistance in *Capsicum* populations. The identified SNP can be used for early screening of resistant material. This study provides a valuable base for continued breeding efforts, especially in the more commercially significant, *C. annuum.*

5:00 PM Rhizoctonia screening of the USDA-NPGS Table Beet Germplasm Collection and Commercial Cultivars

Katharina Wigg*, *University of Wisconsin-Madison* and Irwin L Goldman, *University of Wisconsin, Madison*

Abstract: *Rhizoctonia solani* is a fungal pathogen affecting many crop families. Anastomosis groups (AG) IIIB and IV affect table beet (*Beta vulgaris* subsp. *vulgaris*) and *Rhizoctonia* infections can cause severe yield losses. Resistance to this fungus is available in sugar beet lines, but has yet to be explored thoroughly in table beet. Table beet is an important crop in the state of Wisconsin with over 3,500 acres grown annually for processing.

In the fall of 2016 and spring of 2017 greenhouse screening techniques for *Rhizoctonia* in table beet were developed. Ten genotypes were screened: three open-pollinated cultivars, three hybrids, two publicly-available inbred lines, and resistant and susceptible sugar beet breeding lines (obtained from the USDA sugar beet breeding program, Ft. Collins, CO). Detroit Dark Red, Red Ace, Camaro, and W364 performed comparably to the resistant sugar beet (mean disease rating= 1.04) with mean disease ratings of 1.69, 1.47, 1.20, and 1.35, respectively. In the spring of 2018, two screens were conducted. The first evaluated 94 PI accessions obtained from the USDA-NPGS in Pullman, Washington. The second evaluated over fifty commercially available cultivars and publicly-available inbred lines. Resistant and susceptible sugar beet breeding lines and one inbred line were included as checks. Each screen was replicated over time. Plants were artificially inoculated at 8 weeks after planting. At 3 and 5 weeks post-inoculation, roots were given a disease score based on their internal and external characteristics. The results from these screens and future screens will be useful in identifying sources of resistance within *Beta vulgaris* which can be used in breeding for resistance to *Rhizoctonia*. The research described in this study will be helpful in developing table beet lines with resistance to *R. solani*.

Specified Source(s) of Funding: Midwest Food Products Association

5:15 PM Screening of *Solanum* Species for Resistance to Target Spot of Tomato

Samuel F. Hutton*; Gary E. Vallad; Reza Shekaste band and John Smeda, *University of Florida*

Abstract: Target spot, caused by *Corynespora cassiicola* (Berk. & Curt) Wei, has become a significant threat to tomato production in Florida in recent years. The disease infects tomato foliage and fruits and can result in dramatic yield losses under conditions favorable for disease development. Recent studies have demonstrated increased aggressiveness and fungicide resistance in *C. cassiicola* populations in the state. In an effort to identify potential sources of host resistance, 83 tomato accessions representing nine different *Solanum* spp. were screened for resistance to *C. cassiicola* using a newly developed seedling assay. Initial results identified seven of these accessions as resistant and 22 as moderately-resistant. Assays were subsequently repeated for 12 of the better accessions, and resistance relative to susceptible *S. lycopersicum* controls was confirmed in each of the 12 accessions. Resistance was identified among *S. lycopersicum*, *S. habrochaites*, *S. cheesmaniae*, and *S. pimpinellifolium* species. Two *S. cheesmaniae* accessions (LA1042 and LA0932) and two *S. pimpinellifolium* accessions (LA1043 and LA2093) demonstrated the highest levels of resistance among the 12 accessions. Ongoing research efforts seek to further validate resistance levels among these accessions using seedling disease screens and field trialing of mature plants. Crosses between resistant accessions and elite germplasm are also underway and will be used to characterize gene action and to begin introgression of resistance into cultivated tomato.

Specified Source(s) of Funding: Florida Specialty Crop Block Grant

5:30 PM Developing Methods to Screen for Heat Stress Tolerance in Lima Bean (*Phaseolus lunatus)* based on Effects of High Night Temperature Stress on Reproductive Structures

Emmalea Garver Ernest*; Gordon C Johnson and Randall Wisser, *University of Delaware*

Abstract: Heat stress reduces yields of May and early June-planted lima bean (*Phaseolus lunatus*) in the Mid-Atlantic Region of the US. High night temperatures during flowering and seed development can reduce or delay pod set, resulting in delayed harvest, lower yield and split pod sets. Breeding heat tolerant baby and Fordhook type lima beans is one goal of the University of Delaware lima bean breeding program. Greenhouse experiments were used to characterize the response of several lima bean genotypes to high versus ideal nighttime temperatures in order to better understand the mechanism by which high night temperatures reduce yield.

Higher amounts of pollen shed onto the stigma and style under heat stress are correlated with higher yield under heat stress, and that there is genotypic variation for this trait. Additionally, some heat sensitive genotypes exhibited a number of physiological changes to reproductive structures while under heat stress, some of which may interfere with reproduction and affect yield: lower in vitro germination of pollen collected from the pistil, extrusion of the stigmatic pad from the keel and anther indehiscence. Other aspects of reproduction, such as stigma receptivity, are affected in some heat sensitive genotypes, but not others.

Vegetative growth was not reduced by high night temperatures. Plants grown under stressed and unstressed conditions produced similar shoot dry weights. Heat sensitive plants produce more leaves and stems under high temperature conditions, compensating for the reduction in seed weight.

In the University of Delaware lima breeding program, characterization of some of the physiological changes to reproductive structures that are associated with heat sensitivity is being used to screen diverse germplasm and breeding lines in order to select for heat tolerance.

Specified Source(s) of Funding: Delaware Specialty Crop Block Grant

5:45 PM Short Day Onion Germplasm Evaluation in Southern Texas.

Subas Malla*, *Texas A&M AgriLife Research*

Abstract: Disease and insect are one of the limiting factors for short day onion in Texas. The objective of the study was to evaluate Texas A&M onion germplasm for disease and insect prevalent in southern Texas. A total of 25 elite onion lines were evaluated at Uvalde and Weslaco, TX in 2016-17 and 2017-18 field season. Data were collected on yield and its components, disease and insect and quality traits. Association among traits was tested using correlation and path coefficient. Genotype, GenotypeXEnvironment (GGE) biplot was used to analyze multi-environment data. Results indicated that bulb height had the highest positive direct effect on bulb weight. A positive and high correlation was observed between foliar disease and root disease. Germplasm showed variation for diseases and insect. Texas A&M experimental lines 34154 and 34114 had higher yield and also tolerant to diseases in the first year. Second year field data are being collected in the field to validate first year data.

Specified Source(s) of Funding: Texas A&M AgriLife Research Seed Grant

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4:15 PM – 6:00 PM *Monroe*

Plant Nutrient Management 2

Moderator: Ryan Dickson, *University of New Hampshire*

4:15 PM Higher Accumulation of Nutrients and Sugar in Pear Fruit Might be Closely Related to the Vascular Development of Petiole and Peduncle

Caixia Dong[*1]; CW Shen[2] and YC Xu[2], *(1)Nanjing Agric Univ, (2)Nanjing Agricultural University*

Abstract: Potassium (K) is one of the most important mineral nutrients limiting fruit growth and development and is known as a 'quality element'. The results from the study showed K fertilization improved the development of the vascular bundles in pear petioles and fruit peduncles and enhanced the synergistic effect of the genes involved in nutrients and sugar transport. Magnesium (Mg) concentrations in the leaves, petioles and fruit peduncles were significantly lower under the K treatments than under the control treatment, but the concentrations of K, calcium (Ca), and Mg in the fruit gradually increased as the K application rate increased. Leaf Mg and Ca were antagonistic to K, and this phenomenon may be related to the up-regulated expression of Mg transporters (MRS2-1 and MRS2-3) under low K treatment. The concentrations of sorbitol, sucrose and total sugar in the leaves and fruit at maturity significantly increased in response to K supply. The improvement of sugar concentration was closely related to the up-regulation of the expression of sucrose transporter (SUT) and sorbitol transporter (SOT) genes. In turn, these effects promoted the transport of nutrients and sugar from sources (leaves) to sinks (fruit) to increase the accumulation of sugar in the fruit.

Specified Source(s) of Funding: This research was supported by the fund of China Agriculture Research System (CARS-28-10)

4:30 PM Determining Early Season Aluminum Tissue Values in Hydrangea Leaves to Predict Blue Sepal Color

Hunter Landis[*1]; Kristin Hicks[1]; Josh Brady Henry[2]; Ingram McCall[2] and Brian E. Whipker[2], *(1)North Carolina Department of Agriculture & Consumer Services, (2)North Carolina State University*

Abstract: Hydrangeas (*Hydrangea macrophylla*) contain an anthocyanin pigment within the sepal that naturally produces a pink or red color. In the presence of aluminum (Al) the pigment will bind with the Al producing a blue or purple color. The current method for producing blue hydrangeas is to apply 3-4 weekly drench applications of aluminum sulfate ($Al_2(SO_4)_3$). Growers lack a way to verify if sufficient Al applications were made. The purpose of this study was to determine if early season Al leaf tissue values could be used to predict blue sepal color. We treated 'Early Blue' hydrangeas with 0, 6, 8, 9, 10, 12, and 15g of $Al_2(SO_4)_3$ per pot applied as a drench beginning two weeks after transplanting. The 6, 8, and 10g rates were split over 2 applications and the 9, 12, and 15g were split over 3 applications. We measured Al levels in the leaf tissue and substrate leachate by ICP analysis beginning one week after final drench application and continued weekly until bloom. Sepal colors were evaluated by visual analysis and measured using a handheld colorimeter. The plants receiving 0, 6, 8, and 9g $Al_2(SO_4)_3$ produced the least blue sepals ranging in color from blueish pink to purple. Plants receiving 12 and 15g $Al_2(SO_4)_3$ produced the most blue sepals. Plants treated with 15g of $Al_2(SO_4)_3$ were stunted in growth and displayed leaf scorch symptoms. Leaf symptoms were likely due to stunted root systems caused by higher Al application rates. The Al leaf tissue values were consistently higher in the 12g and 15g treated which produced the bluest sepals. At week 6 the plants treated with 12g (4g $Al_2(SO_4)_3$ at 3 applications) had Al tissue values of 1724 ppm which was significantly higher than the plants treated with 8g (4g $Al_2(SO_4)_3$ at 2 applications) which had 867 ppm. At week 7 the plants treated with 15g (5g $Al_2(SO_4)_3$ at 3 applications) had Al tissue values of 2152 ppm which was significantly higher than the plants treated with 10g (5g $Al_2(SO_4)_3$ at 2 applications) which had 1454 ppm Al. Based on these findings growers producing 'Early Blue' hydrangeas should target leaf tissue values between 1300-2000 ppm Al by weeks 6 to 8 of forcing in order to produce blue hydrangeas.

Specified Source(s) of Funding: North Carolina Department of Agriculture and Consumer Services (Agronomic Division), North State University Floriculture, The Fred C. Gloeckner Foundation Inc.

4:45 PM Quantifying the Acidic and Basic Effects of Vegetable and Herb Species in Peat-Based Substrate and Hydroponics

Ryan Dickson[*], *University of New Hampshire* and Paul R. Fisher, *University of Florida*

Abstract: Greenhouse crop species differ in their effects on root zone pH in soilless and hydroponic production. Objectives of this study were to (1) quantify acidic and basic effects on the root zone pH for eight vegetable and herb species grown in peat-based substrate and hydroponic nutrient solution and (2) determine NH_4^+:NO_3^- nitrogen ratios expected to have a neutral pH reaction for each species during their vegetative growth phase. In one experiment, plants were grown for 33 days in substrate containing 70% peat:30% perlite by volume and were fertilized with a nutrient solution containing 7.14 mEq·L^{-1} N and NH_4^+:NO_3^- ratios ranging from 0:100 to 40:60. In the second experiment, the same species were grown for six days in hydroponic nutrient solutions at 7.14 milli-equivalents (mEq)·L^{-1} N with NH_4^+:NO_3^- ratios ranging from 0:100 to 30:70. Acid and base produced in the root zone and cation versus anion uptake were quantified in both experiments. Species produced from 2.18 mEq of acid (lettuce) to 2.65 mEq of base (arugula) in substrate and from 2.82 mEq (lettuce) to 3.86 mEq (eggplant) in the hydroponic solution. Acid and base per gram of dry mass gain (plant growth) ranged from 0.60 mEq·g^{-1} acid (lettuce) to 1.74 mEq·g^{-1} base (arugula) in substrate and from 1.35 mEq·g^{-1} acid (lettuce) to 1.32 mEq·g^{-1} base (arugula) in solution. Plants produced acid when there was a greater net uptake of cations over anions, and produced base with a net uptake of anions. Overall, arugula had the greatest uptake of anions compared with other species. Percent NH_4^+-N of total N expected for a neutral pH ranged from 0% (cucumber) to 55% (arugula) in substrate and from 6% (lettuce) to 32% (arugula) in hydroponic solution. Evaluating the effects of vegetable and herb species on root zone acidity and basicity can be used to select a neutral NH_4^+:NO_3^- fertilizer ratio for substrate and hydroponic production.

5:00 PM How Should We Help Growers Follow the Fertilizer Recommendations for Chip Potato Production in Florida?

Guodong David Liu[*]; Lincoln Zotarelli; Steven A. Sargent; Yuqi Cui and Dario Racano, *University of Florida*

Abstract: Phosphorus is relatively immobile in soil under moderate soil pH. As a result of long-term P applications in potato production area, the soils are high in P on average of 351 mg/kg Mehlich-3 P (range 81 to 599). This average P level is almost 8 times greater than the UF/IFAS recommendation for zero P application. However, potato growers keep applying 112 kg/ha every growing season because they can have 5% to 10% tuber yield response which is just their profit margins. To help growers optimize their phosphate management, on-farm trials with six P levels (0, 45, 90, 135, 179, and 224 kg/ha P2O5) were conducted at HAEC, Hastings, FL from 2015 thru 2017. Plot size was 49.55 square meters (12.2 m × 4.1 m). Randomized Complete Block

Design was used with four replicates. Potato cultivar was 'Atlantic'. The results showed that zero P application had significantly lower tuber yield than 45 kg/ha P application. The yield difference was 7% or 17%. The soil pH was as low as 4.8 in the growing season. The soil had 563 kg/ha aluminum and 131 kg/ha iron. The P in soil was tied up with active aluminum and iron. Phosphate fractionation showed that approximately two thirds of P were locked out by the metal ions. The data show that 45 kg/ha P is sufficient for potato production in the Hastings area in Florida.
Specified Source(s) of Funding: SWFWMD

5:15 PM Biochar As a Soil Amendment and Nutrient Regulator

Amjad Ahmad; Arnoldus K. Berek; Theodore J.K. Radovich and Hue Nguyen*, *University of Hawaii at Manoa*

Abstract: Biochar, a product of biomass that is heated in an oxygen limited environment (pyrolysis), has been reported to improve soil quality and increase plant growth. To quantify and further characterize such effects of biochar, three experiments were conducted: (1) a greenhouse trial on an acidic tropical Ultisol, which evaluated the aluminum (Al) detoxifying potential of biochar, using *Desmodium intortum*, an Al sensitive forage legume as the test plant; (2) a greenhouse trial using nitrogen (N) fertilizer sources, both organic and synthetic, with and without biochar, which measured the capacity of biochar to regulate/release N to Chinese cabbage (*Brassica rapa* Chinenesis group) growth; and (3) a field trial on a highly weathered Oxisol, which documented the long-term, field-condition effects of biochar on a variety of crops [sweet corn (*Zea mays*), okra (*Abelmoschus esculentus*), and soybean (*Glycine max*)]. Our results show: (1) At an application rate of 2.5% (approximately 25 tons/ha), a kiawe-wood biochar could reduce Al toxicity and increase *D. intortum* growth as much as lime ($CaCO_3$) applied at 3 cmolc/kg (1.5 tons/ha). $CaCO_3$ equivalent (represented by ash content) and COOH, OH functional groups on the biochar surface were likely responsible for these effects. (2) At a same total N rate of 200 mg/kg, cabbage yield was much higher in the presence of a wood-based biochar (at 2%) than when urea or organic N fertilizer was applied alone, and yield increased became even more pronounced in the 2nd harvest than in the 1st. This increased N use efficiency could be attributed to biochar properties, such as large surface area and numerous tiny pores. (3) Under field conditions, corn yield (first season) was nearly doubled in the presence of 2% biochar (derived from macadamia shells) when N was applied as urea or blood meal (10% total N) at 150 or 300 kg N/ha rate. Interestingly, the effect of biochar on plant growth seemed to extend beyond N nutrition because the treatments receiving biochar but no N input also out-yielded those having N input but no biochar. The prolonged/aging effect of biochar will be further studied in future time.
Specified Source(s) of Funding: Western SARE

5:30 PM Foliar Application of Biostimulant As a BMP Tool to Improve Tomato Production in Florida

Muhammad Adnan Shahid* and Guodong David Liu, *University of Florida*

Abstract: A pot study was conducted to investigate the effects of individual biostimulants on tomato (cv. 'Phoenix') growth and yield in greenhouse in fall 2017. Six different biostimulants: CP_1, CP_2, BS, CP_2+BS, Competitor, and Water (control) were respectively foliar-applied at three different stages: pre-bloom, fruit setting and color change. A control (only water sprayed) was paralleled. The contents of different nutrients like Ca, K, Mg and P in leaves and roots were also determined. Plants treated with biostimulants had improved levels of Ca, K, Mg and P compared to those treated with water only. Competitor and CP_2+BS among the biostimulants significantly increased yield, plant dry biomass (PDB), plant height, stem diameter, leaf greenness (SPAD reading), photosynthetic rate (Pn), relative water contents (RWC), nitrate level in petiole sap, and fruit quality (citric acid, malic acid, tartaric acid, soluble solid concentration and fruit firmness). In addition, enzymatic activities of nitrate reductase (NR) and nitrite reductase (NiR) were also increased by biostimulants. Among all the biostimulants tested, Competitor and CP_2+BS showed the greatest augmentation in plant biomass, plant height, stem diameter, leaf greenness, Pn, RWC, nitrate level in petiole sap, fruit yield and quality. Similar, trend was also observed in case of NR, NiR, Ca, K, Mg and P. Based on the findings of this study it is concluded that application of Competitor or CP_2+BS may potentially become a BMP tool for tomato production but more trials are needed for large scale field demonstration.

5:45 PM Wastewater-Grown Algae As Fertilizer

J Austin Gimondo*; Christopher J. Currey; Darren H. Jarboe and William R. Graves, *Iowa State University*

Abstract: Drawbacks of synthetic fertilizers led us to explore wastewater-grown algae as biologically based alternative. Such algae may allow for the recycling of polluting nutrients for use as fertilizer. Six formulations of extruded algal pellets comprising various amounts of polylactic acid, soy flour, biochar, and wastewater-grown algae were compared as fertilizers for African marigold (*Tagetes erecta* L.) and gerbera daisy (*Gerbera jamesonii* Bolus ex Hooker f.). A synthetic, controlled-release fertilizer (CRF), and a commercially available co-product of wastewater treatment, also were studied. Fertilizers were incorporated throughout the root-zone at 641.2 g N·m–3, the rate of N that corresponded to the CRF label recommendation. Plant growth index, shoot dry weight, and shoot nutrient concentrations, as well as substrate pH and EC, were measured after 40 and 64 d for marigolds and gerbera daisies, respectively. Extruded bio-based fertilizers increased the dimensions and weights of shoots of both species compared to those measures of unfertilized plants and of plants supplied with the commercially available co-product of wastewater treatment. Growth of plants provided with certain extruded bio-based fertilizer formulations were similar to those measures of plants fertilized with CRF. Nutrient deficiency symptoms and associated insufficient nutrient concentrations of shoots were evident in plants provided some formulations of bio-based fertilizers and the commercially available co-product of wastewater treatment. Bio-based fertilizers did not negatively impact substrate pH or EC. Overall, extruded bio-based fertilizers were effective fertilizers, though our results show that growth of marigolds and gerbera daisies depends on the formulation of these materials. We conclude that use of algae as a source of biologically sequestered and recycled nutrients has potential for reducing environmental impacts associated with nutrient management of horticultural crops.

4:30 PM – 5:45 PM *Lincoln East*

Tropical Horticultural Crops/Ecological Physiology/Medicinals

Moderator: Russell Galanti, *University of Hawaii at Manoa*

4:30 PM Photosynthetic Capacity, Stomatal Behavior and Ultrastructure of Chloroplasts in *Carpinus Putoensis* Leaves during Gaseous NO_2 Exposure and Recovery

Sheng Qianqian Jr.*, *Nanjing Forestry University*

Abstract: Gaseous nitrogen dioxide (NO_2) can disturb normal plant growth and trigger complex physiological response. In this study, we investigated epidermis and stomata related physicochemical responses of *Carpinus putoensis* leaves when exposed to NO_2 (6 ml/l) for seven time periods (0, 1, 6, 12, 24, 48, and 72 h) and 30 d of recover without NO_2 exposure. Our results showed that NO_2 exposure for 72 h led to the decline of chlorophyll content, maximal PSII quantum yield (Fv/Fm), net photosynthetic rate (Pn) compared with the control and other exposure time. Moreover, NO_2 exposure significantly increased the thicknesses of palisade/spongy tissue, caused swelling of the thylakoids within the chloroplasts, this thylakoid swelling could be reversed by removing the pollutant from the air flow. Recovery alleviated NO_2-caused toxic effects as indicated by increased chlorophyll content, and high values of Pn and Fv/Fm. This result could provide a reference of recovering method when road greening trees exposed to NO_2 as the road main pollutants. Gaseous nitrogen dioxide (NO_2) can disturb normal plant growth and trigger complex physiological response. In this study, we investigated epidermis and stomata related physicochemical responses of *Carpinus putoensis* leaves when exposed to NO_2 (6 ml/l) for seven time periods (0, 1, 6, 12, 24, 48, and 72 h) and 30 d of recover without NO_2 exposure. Our results showed that NO_2 exposure for 72 h led to the decline of chlorophyll content, maximal PSII quantum yield (Fv/Fm), net photosynthetic rate (Pn) compared with the control and other exposure time. Moreover, NO_2 exposure significantly increased the thicknesses of

palisade/spongy tissue, caused swelling of the thylakoids within the chloroplasts, this thylakoid swelling could be reversed by removing the pollutant from the air flow. Recovery alleviated NO_2-caused toxic effects as indicated by increased chlorophyll content, and high values of Pn and Fv/Fm. This result could provide a reference of recovering method when road greening trees exposed to NO_2 as the road main pollutants.

Specified Source(s) of Funding: The National Natural Science Foundation of China (31770752)

4:45 PM The Effects of Soil Amendments on Tree Growth, Yield, and Soil Properties in Mature Macadamia Integrifolia Orchards

Russell Galanti* and Alyssa Cho, *University of Hawaii at Manoa*

Abstract: Current management practices in macadamia production call for the removal of all tree litter-fall from the orchard floor to facilitate nut pick up during harvesting season, which can be up to 10 months of the year. This and derivative management practices lead to degradation of soil and environmental health and reduced nut production. Hawaiian farmers have expressed interest in sourcing alternative locally sourced soil amendments. Several new and novel soil amendments, including effective microorganisms (EM1), biochar, and soil profiling, have been identified and were compared to traditional amendments including macadamia husk mulch and wood chip mulch. The effects of these amendments on root growth, SPAD readings, and yield/quality in macadamia and soil Carbon, Nitrogen, pH, and EC were studied. SPAD readings positively correlated to leaf N content with the highest r^2 of .74 occurring in March of 2018. SPAD readings showed cyclical fluctuations with a negative trend in spring and a positive trend in summer throughout the year-long experiment. Husk+EM1 and soil profiling treatments significantly increased mean SPAD values within the year time frame. Mean total yield was highest for the soil profiling treatment (mean of 86.5 kg/tree). Trees under husk mulch+EM1 applications had greater mean total root weight, proteoid root weight, and a higher mean proportion of proteoid roots than all other treatments after one year. Total soil N was not significantly affected by treatments. Soil nitrate concentrations increased with the husk treatment showing the greatest increase and ammonium levels decreased. Soil pH was not affected by treatments. Soil EC was significantly increased by the husk+biochar treatment. Soil C was also not affected by treatment. Soil profiling may be an option to increase yield in the short term, but if repeated annually could cause loss of plant vigor. Application of mulches have been shown to reduce yields in the short-term, but this is not evident in this study. Husk+EM1 showed the most promising tree health results within one year. A longer term study is necessary to examine the effects of these treatments on tree and soil response variables.

5:00 PM Expression Profile of Floral Genes in Avocado (*Persea americana*Mill.) during Floral Development Promoted By Low Temperature

Aleyda Acosta Rangel*; Rui Li; Peggy Mauk; Louis S. Santiago and Carol J. Lovatt, *University of California*

Abstract: Avocado trees flower in response to periods of low temperature but little is known regarding the gene-environment interaction associated with floral development. In this research, temporal expression profiles of the floral promoter genes *FLOWERING LOCUST* (*FT*), *LEAFY* (*LFY*), *FRUITFUL* (*FUL*) and *APETALA2* (*AP2*) and downstream genes associated with avocado floral organ identity, *APETALA3* (*AP3*), *PISTILLATA* (*PI*), *AGAMOUS1* (*AG1*) and *AGAMOUS3* (*AG3*), were quantified in buds of 'Hass' avocado trees (3 years from budding) maintained under warm temperature (WT) (30 °C, 14-h day/20 °C, 10-h night) for 14 weeks relative to those of trees subjected to 8 weeks of low temperature (LT) (14 °C, 10-h day/10 °C, 14-h night) followed by 6 weeks of WT. Only LT-treated trees flowered (week 14). All trees were maintained under WT for 5 months prior to initiation of the experiment in July. At this time, buds of all trees expressed *LFY*, *FUL*, and *AP2*, with *FT*, *AP3* and *PI* mRNA at detectable levels, suggesting the possibility that all buds were induced to flower but not determined (irreversiblly commitment to floral development). By week 8 of LT treatment, bud expression of *LFY*, *FUL*, and *AP2* increased to levels significantly greater than that of WT-treated trees. Two weeks after transfer of LT-treated trees to WT, bud expression of *FT* significantly increased followed by activation of the downstream genes *AP3*, *PI, AG1* and *AG3* by week 12. In contrast, for WT trees, bud expression of *FT*, *AP3*, and *PI* remained at the limit of detection, with *AG1* and *AG3* below the limit of detection through week 14. Taken together, our results support that LT directly or indirectly up regulated expression of the floral promoter genes *FT, LFY*, *FUL*, and *AP2*, which activated the downstream floral organ identity genes and resulted in flowering. The results further suggest that bud expression levels of *LFY*, *FUL* and *AP2* in week 8 of LT treatment were sufficient to confer bud determinacy, since transfer of the trees from LT to WT did not prevent flowering. In light of the fact that bud expression of *FT*, *AP3*, *PI*, *AG1* and *AG3* did not occur until after transfer of the LT-treated trees to WT, our results further suggest that LT serves as both a promoter and inhibitor of flowering, preventing floral organogenesis until the low temperature stress was removed and warm temperature prevailed.

Key words: Floral gene-environment interaction, floral promoter genes, floral organ identity genes, floral organogenesis, 'Hass' avocado

Specified Source(s) of Funding: University of California Riverside

5:15 PM Essential Oil Productivity and Volatile Aromatic Compounds of Angelica Gigas Nakai for Aromatherapy

Gyeong-suk Jo*[1]; soo-Hyun Ji[2]; Jeong-Hwa Kang[2]; You-Seok Lee[2]; Sun-Kyung Lee[2]; Sung-jin Park[3] and Hwang Hong-Sik[4], *(1)Jeollanamdo Agricultural Research & Extension Services., (2)Jeollanamdo Agricultural Research & Extension Services, (3)Jindo Agricultural Technology Center, (4)National Center for Agricultural Utilization Research, US. Department of Agricultural,*

Abstract: The productivity of Angelica Gigas NakaI essential Oil was investigated using the Steam-water distillation method for aromatherapy essential oil production. And the aroma Compounds of the produced Angelica Gigas NakaI essential oil was analyzed with the GC-MS. Essential oils produced from water-steam distillation were extracted from 2.5 to 2.7 milliliters per kg, and byproduct hydrosol was calculated to produce 70L. After analyzing the essential oil produced by the steam-water distillation method with GC-MS, the major products such as 2-methyl octane, 2, 4, 6-trimnehyhyl heptane, α-pinene, camphene, α-limonene, and β-eudesmol were analyzed. Terpenoid compounds were identified as α-pinene, β-eudesmol, α-limonene, camphene, vervenol, α-eudesmol, sphatulenol, verbenone, and α-murrolene. Eugenol and β-eudesmol have anti-inflammatory and cancer-causing effects, and among these components β-eudesmol was classified as a major aroma component of Angelica gigas nakaI. The most common volatile organic compounds for Angelica Gigas NakaI are α-pinene, β-eudesmol, and others, most of them terpenoid compounds to more than 70 % of their total content. Thus, the volatile aromatic component analysis results show that it can be used as a natural essential oil for aromatherapy purposes

Specified Source(s) of Funding: Government funds of Rural Development Administration

5:30 PM Studies for Productivity of Essential Oils and Aroma Constituents of*citrus Junos* Producing Two Different Areas in Korea

Gyeong-suk Jo*, *Jeollanamdo Agricultural Research & Extension*

Abstract: The productivity of Angelica Gigas NakaI essential Oil was investigated using the Steam-water distillation method for aromatherapy essential oil production. And the aroma Compounds of the produced Angelica Gigas NakaI essential oil was analyzed with the GC-MS. Essential oils produced from water-steam distillation were extracted from 2.5 to 2.7 milliliters per kg, and byproduct hydrosol was calculated to produce 70L. After analyzing the essential oil produced by the steam-water distillation method with GC-MS, the major products such as 2-methyl octane, 2, 4, 6-trimnehyhyl heptane, α-pinene, camphene, α-limonene, and β-eudesmol were analyzed. Terpenoid compounds were identified as α-pinene, β-eudesmol, α-limonene, camphene, vervenol, α-eudesmol, sphatulenol, verbenone, and α-murrolene. Eugenol and β-eudesmol have anti-inflammatory and cancer-causing effects, and among these components β-eudesmol was classified as a major aroma component of Angelica gigas nakaI. The most common volatile organic compounds for Angelica Gigas NakaI are α-pinene, β-eudesmol, and others, most

of them terpenoid compounds to more than 70 % of their total content. Thus, the volatile aromatic component analysis results show that it can be used as a natural essential oil for aromatherapy purposes.

4:30 PM – 6:00 PM *Georgetown East*

Nursery Crops and Floriculture: Substrates

Moderator: Jeb S. Fields, *Louisiana State University*

4:30 PM (X-ray) Vision for the Future of Substrate and Plant Science?

Paul C. Bartley III*; Brian Eugene Jackson and William C. Fonteno, *North Carolina State University*

Abstract: Horticulture offers the unique capability to design the rooting environment based on the plant's requirements. In order to better exploit this potential, researchers require the ability to non-destructively and non-invasively characterize rooting environments and plant responses. Advancements in X-ray technology, software, and commercially available instruments have opened the door for X-ray tomography to be utilized for this purpose. At resolutions ranging between 50 and 15 µm, pine bark, peat, coir, and wood fiber substrates were imaged and quantitatively analyzed. At all resolutions, materials were effectively imaged with clear distinctions between substrate particles and pores. Increasing the scan resolution resulted in more definable internal pore structures observed most notably in pine bark. Under the appropriate conditions, plant roots, though similar in density to the surrounding substrate, can be segmented to collect qualitative and quantitative data. As plant science continues to strive for higher precision, image analysis techniques such as X-ray tomography are well placed to significant contributed in this endeavor.

4:45 PM Wood Fiber Substrates: Current Status of Research, Commercialization, and Use

Brian Eugene Jackson*, *North Carolina State University*

Abstract: In the U.S. there has been a tremendous amount of effort, resources, investments, and energies spent on the development and trialing of wood substrates and substrate components in the past 15 years. Evaluations have been conducted by academic researchers at numerous universities, substrate manufactures, private entrepreneurs, and by independent growers. Research on wood substrate components has indeed made great strides towards better understanding how, and to what extent, these materials can be used with or without peat, bark, or other traditional materials. A decade ago it was common practice to just "grind up trees" and try to get the resulting wood product to grow plants. Not anymore! Work has now evolved to be very focused to answer very specific questions, solve specific problems, and explore new opportunities relating to the use of wood components. An overview of some of the main topics relative to the commercialization and use of wood substrate materials will be covered including commercial products and their differences, fertility, pH, toxicity, and hydrological properties.

5:00 PM Engineering a Soiless Media Using Fine Wood Dust Incorporation into a Commercial Nursery Pine Bark

Edward W. Bush*, *Lsu AgCenter* and Schyler Lee, *LSU*

Abstract: Incorporating organic matter into a commercial nursery medium is often recommended to increase water holding and cation exchange capacity. The objective of this study was to determine the use of wood dust as an inexpensive peat moss substitute. Pine bark (5/8") was incorporated with either 1) 20% peat moss (pm), 2) 15% pm + 5% fine wood dust (wd), 3) 10% pm + 10% wd, 4) 5% pm + 15% wd, or 5) 20% wd. All media were amended with 2 lbs N/cubic yard of a 15-9-11 complete Osmocote fertilizer and 8 lbs/cubic yards of dolomitic lime. Petunia, tomato and salvia plug growth was measured over time determining that wood dust combinations resulted in similar growth as the peat moss control. Combinations of peat moss were effective both for plant growth and reducing the cost of organic substrates. Plant growth indices and dry weight of combinations were either similar or greater than the control.

5:15 PM Investigating the Hydraulic Conductivity of a Pine Bark Substrate and Crop Responses to Two Irrigation Regimes

Jeb S. Fields*, *Louisiana State University* and James S. Owen Jr., *Virginia Tech*

Abstract: Soilless substrates were initially developed with high porosity to balance air to water ratio and ensure good drainage. As a result, researchers and allied suppliers tend to rely heavily upon "static" physical properties (water holding capacity and air filled porosity) to prescribe substrate recommendations which may be unachievable physical states in production such as saturation. Due to the reliance upon these minima and maxima values, conventional soilless substrates used by the nursery industry may not be efficient in regards to water resource management. Our research manipulated the hydrology of pine bark-based soilless substrates through fractioning by particle size or blending with fibrous materials (*Sphagnum* peat and coir) to yield varying substrate dynamic, hydrological parameters while maintaining static physical properties. We were successfully able to alter the unsaturated hydraulic conductivity of the soilless substrates while holding static physical properties similar. Containerized crops were then grown in pine bark-based substrates with altered hydraulic properties at optimal (*Hibiscus rosa-sinensis* 'Fort Myers') and sub-optimal (*Hydrangea arborescens* 'Anabelle') substrate water potentials. The increased substrate hydraulic conductivity allowed for added hibiscus growth and vigor, as well as increased water use at optimal substrate water potentials (-50 to -100 hPa). At suboptimal substrate water potentials (-100 to -300 hPa), increased substrate hydraulic conductivity allowed for salable hydrangea crops to be produced with < 6.5 L water which resulted in poor crop performance in conventional pine bark substrates. It was also determined that fiber type recommendations should be influenced by growing irrigation parameters. Peat addition yielded the greatest increase in hydraulic conductivity at optimal water potentials and coir yielded the greatest increase in hydraulic conductivity at sub-optimal substrate water potentials. No observable relationship existed between saturated hydraulic conductivity and production hydraulic conductivity indicating the easily measured saturated hydraulic conductivity is not a good indicator of crop water relations in soilless systems. Thus, a shift to utilization of dynamic substrate hydraulic properties can provide beneficial information to researchers and allied suppliers by enabling more informed recommendations based upon water flux that mimics actual production conditions. Moreover, optimizing the hydrology of pine bark-based substrates resulted in the water efficient production of ornamental container crops under both optimal and sub-optimal irrigation regimes. Aside from benefits associated with increased water resource management, and potential reduction in costs associated with subsequent fertility requirements, production time was reduced.

Specified Source(s) of Funding: Clean WateR3

5:30 PM pH Buffering Capacity of Pine Bark Substrates

Magdalena Pancerz*, *Ohio State University* and James Altland, *USDA-ARS, MWA ATRU*

Abstract: Stability of substrate pH is a crucial factor in managing nutrition of container-grown crops. Substrate pH is one of the chemical parameters that influences nutrient availability but may change rapidly under some cultivation practices. Fluctuating pH can cause problems with managing nutrition in the crop. High pH buffering capacity of substrates is needed to prevent rapid changes that may lead to losses in quality and quantity of cultivated plants. Soil buffering capacity is well known and depends mainly on the clay and organic matter content, but in organic soilless growing media factors influencing this parameter are not well understood. To assess the pH buffering capacity of pine bark in comparison to peat moss, four pine bark substrates with different size particles ranging from fine to coarse (< 0.3 cm, < 0.6 cm, < 1.3 cm, and < 1.6 cm), were collected from a pine bark supplier. Three replications of each bark substrate and peatmoss with weights equivalent to 100mL were placed in 250mL jars and filled with 100mL of and acid or base solution. Acid and base solutions were prepared with HCl and NaOH, respectively, at concentrations ranging from 0 to 50 meq·L^{-1} in 10 meq·L^{-1}increments using deionized water (18 MΩ). Jars were fitted with lids and stirred for 10 minutes. Stirring was repeated after 24 hours and pH was measured immediately to prepare pH

buffering curves for each substrate. Peatmoss had the highest buffering capacity. Pine bark substrates differed slightly among each other but showed lower pH buffering capacity compared to peatmoss. Moreover, all pine bark substrates tended to have higher buffering capacity for bases than acids. These data can be used to better understand how substrate type and particle size affect changes in pH over time during plant cultivation.

5:45 PM **Influence of Lime Type and Rate on Pine Bark Substrate pH**

James Owen Jr.*[1]; Richard Jarrett[1] and James Altland[2], *(1)Virginia Tech, (2)USDA Technology Application Unit*

Abstract: Pine bark is the dominant component of soilless substrates in the eastern U.S. for producers or woody ornamental crops. The low pH of the unbuffered pine bark substrate is commonly adjusted with a lime material in order to promote proper nutrient uptake and ensure general plant health to avoid abiotic disorders. Our objective was to evaluate the long-term effect of pulverized dolomitic, pulverized calcitic, ground dolomitic, and granular calcitic lime at rates of 0, 0.5, 2.5, 4.5 and 6.4 kg·m^{-3} on pH of a < 15.9 mm aged pine bark substrates over 267 d. Each substrate was also amended with 5.5 kg·m^{-3}of an 8-9 month 18N-2.2P-10K coated, controlled-release fertilizer. All substrates were used to pot *Ilex crenata* `Bennett's Compacta´ into 2.8 L containers. The main effect of lime material on substrate pour-through pH was not significant; however, the significance of sampling time x rate x material indicates the interaction of the three factors may provide opportunities for growers to have increased control over substrate pH. Increasing incorporation rate of lime from ≈ 4.0 to 6.4 kg·m^{-3}, regardless of lime material used, resulted in a > 2 pH unit sigmoidal increase. All lime materials applied at less than 4.5 kg·m^{-3} failed to maintain the desired pH (5.2 to 6.5) for ornamental crop production after ≈ 50 DAI. kg·m^{-3}, regardless of lime type, pH range of 5.2 to 6.5 currently recommended for general healthy plant growth. However, it remains uncertain if lime rates > 5.0 kg·m^{-3} would have a significant impact on increasing pH further since effectiveness of lime decreases with increasing rate beyond a critical point. Ground dolomitic lime had the least effect on increasing the substrate pH and provided no greater longevity than pulverized materials applied at rates > 4.5 kg·m^{-3}. These data, along with past research, will aid producers in using the proper lime material and rate to maintain their desired pH during an 8-9 month production period.

Specified Source(s) of Funding: Virginia Nursery and Landscape Association

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5:00 PM – 6:00 PM *Oak Lawn (Lobby Level)*

Produce Quality, Safety, and Health Properties (QUAL) Meeting - Open to All Attendees

Chair: Matthew Kleinhenz, *The Ohio State University-OARDC*
Chair-elect: Chris Gunter, *North Carolina State University*
Secretary: Xin Zhao, *University of Florida*
Objectives:
To promote more creative research, teaching, and industry liaison among horticulturists and food scientists.

5:30 PM – 6:00 PM *Jefferson West*

Herbs, Spices, and Medicinal Plants (HSMP) Meeting - Open to All Attendees

Chair: Katherine Warpeha, *University of Illinois at Chicago*
Chair-elect: Changbin Chen, *University of Minnesota*
Secretary: Xiaozhong Liu, *Amway Corporation*
Objectives:
spices, and medicinal plants, emphasizing botanical, cultural, environmental, genetic, harvesting, physiochemical, processing, and pharmacological aspects of these plants.

5:30 PM – 6:00 PM *Lincoln West*

Pomology (POM) Meeting - Open to All Attendees

Chair: Stefano Musacchi, *Washington State University*
Chair-elect: Derek Woolard, *Valent Biosciences Corp*
Secretary: Thomas M. Kon, *Pennsylvania State University*
Objectives:
To assist the planning and development of research, extension, and teaching programs in pomology and to serve the current and future needs of the fruit industry.

6:00 PM – 9:00 PM *Georgetown West*

Scholars Ignite Competition

Chair: Brian Pearson, *University of Florida, Mid-Florida Research and Education Center*

6:00 PM **Sheng Qianqian**
Sheng Qianqian Jr.*, *Nanjing Forestry University*

6:05 PM **Shanthanu Krishna Kumar**
Shanthanu Krishna Kumar*, *University of Guelph, Vineland*

6:10 PM **Marlee Trandel**
Marlee Anne Trandel*, *North Carolina State University*

6:15 PM **Archana Khadgi**
Archana Khadgi*, *Cornell University*

6:20 PM **Debalina Saha**
Debalina Saha*, *University of Florida - Mid Florida Research and Education Center*

6:25 PM **Pinki Devi**
Pinki Devi*, *Washington State University*

6:30 PM **Raymond Odeh**
Raymond Odeh*, *University of Florida*

6:35 PM **Nathan D Hecht**
Nathan D Hecht*, *University of Minnesota*

6:40 PM **Ignasi Riera Vila**
Ignasi Riera Vila*, *University of Minnesota*

6:45 PM **Mahnaz Kargar**
Mahnaz Kargar*, *Auburn University*

6:50 PM **Mohammad Radhi Alsabri**
Mohammad Radhi Sahib Alsabri*, *university of kentucky*

6:55 PM **Qi Zhou**
Qi Zhou* and Juan Carlos Melgar, *Clemson University*

7:00 PM **Yanjun Guo**
Yanjun Guo*; Terri Woods Starman and Charles R. Hall, *Texas A&M University*

7:05 PM **Zachary J. Stansell**
Zachary J. Stansell*, *Cornell University*

7:10 PM **Huan Zhang**
Huan Zhang*, *Washington State University*

7:15 PM **Ignasi Riera Vila**
Ignasi Riera Vila*, *University of Minnesota*

7:20 PM **Qianwen Zhang**
Qianwen Zhang*, *Mississippi State University*

7:25 PM **Abigail Attavar**
Abigail Attavar*, *Washington State University*

7:30 PM **Kellie J. Walters**
Kellie J. Walters*, *Michigan State University*

7:35 PM **Lu Yin**
Lu Yin*, *University of Minnesota*

7:40 PM **Madalyn Shires**
Madalyn Shires*, *Texas A&M University*

7:45 PM **Leynar Leyton Naranjo**
Leynar Leyton Naranjo*, *University of Georgia*

7:50 PM **Brian A. Mitchell**
Brian A. Mitchell*, *Colorado State University*

7:55 PM **Subhankar Mandal**
Subhankar Mandal*, *New Mexico State University*

8:00 PM **Krishna Bhattarai**
Krishna Bhattarai*, *Gulf Coast Research and Education Center, University of Florida*

8:05 PM **Amanda Y Accampo**
Amanda Y Accampo*, *Clemson University*

8:10 PM **Derek J. Plotkowski**
Derek J. Plotkowski*, *University of Guelph*

8:15 PM **Gehendra Bhattarai**
Gehendra Bhattarai*, *University of Arkansas*

8:20 PM **Zachary N. Hoppenstedt**
Zachary N. Hoppenstedt*, *Kansas State University*

8:25 PM **Sadikshya Sharma**
Sadikshya Sharma*, *University of Florida*

8:30 PM **Rebecca J Wiepz**
Rebecca J Wiepz*, *The Pennsylvania State University*

7:00 AM – 8:30 AM

Vegetable Crucifer Crop Germplasm Committee Meeting
Jay (Lobby Level)

Coordinator: Mark W. Farnham, *USDA-ARS U.S. Vegetable Laboratory*

7:00 AM – 2:00 PM

Speaker Ready Room - Friday
Cabinet

7:30 AM – 3:00 PM

Registration Open - Friday
Concourse Level Foyer

8:00 AM – 9:30 AM

Presidential Address and ASHS Annual Business Meeting
International Ballroom West

Speaker: Carl Sams, *The University of Tennessee*

8:00 AM – 5:00 PM

Clean WateR3 Annual Meeting
Oak Lawn (Lobby Level)

Coordinator: Sarah White, *Clemson University*

9:30 AM – 10:15 AM

Keynote Address: Dr. Jack Gilbert on Embracing the Benefits of our Microbes
International Ballroom West

9:30 AM **Embracing the Benefits of Our Microbes**

Jack A. Gilbert*, *University of Chicago*

Abstract: The global microbiome is a keystone element of our planet's health, just as the microbiome within all of us is associated with our health and wellbeing. Over the last decade we have been cataloguing the interpreting the dynamics of the world's microbiome, including those in plants, humans, animals, and every other conceivable ecosystem. This has provided us with an extensive understanding of the distribution and impact of the microbial ecology of our planet and our bodies. Using this information we are changing the paradigm of research and application in virtually every discipline. I will present some of the most exciting research and talk about the implications for this in our effort to improve health overall.

10:15 AM – 10:45 AM

Coffee Break (Friday Morning)
International Ballroom East/Center

10:30 AM – 12:00 PM *Boundary (Terrace Level)*

Endowment Fund Committee Meeting

Chair: Paul Thomas, *University of Georgia*
Members: Kedong Da, *Institute for Advanced Learning and Research*; Joan Davenport, *WSU Prosser*; John Dole, *North Carolina State University*; Vanessa Gordon, *USDA-ARS SEA Sugarcane Field Station*; John Griffis, *Florida Gulf Coast University*; Ajay Jha, *Institute for Global Agriculture & Technology Transfer (IGATT)*; Wayne Mackay, *Univ of Arkansas*; Michael Neff, *ASHS*; Ellen Paparozzi, *University of Nebraska*; Paul Read, *University of Nebraska*; Curt Rom, *University of Arkansas*; Chrislyn Particka, *Cornell University* and Dennis DePaolo, *N/A*

10:30 AM – 12:00 PM *Georgetown East*

Growth Chambers and Controlled Environments 5

Moderator: Brian Poel, *LumiGrow Inc.*

10:30 AM **Characterizing Timeframe for Necessary Soybean Photoperiod Control in Greenhouse Production**

Brian Krug* and Tyler Engelhart, *DuPont Pioneer*

Abstract: Soybean (*Glycine max* L.) is a short-day plant, requiring a controlled photoperiod to produce seeds in a greenhouse environment year-round. The purpose of this experiment was to define the duration (number of weeks) of short-days soybean plants need to stimulate reproductive growth in order to not revert back to vegetative growth after exposure to long-days(16 h). Two determinate soybean varieties, within the same maturity group, were sown into 32-cell flats filled with a peat-based soilless substrate, and placed in a greenhouse with a 16-h photoperiod. After 3 weeks, plants were transplanted into 22.8-cm-diameter plastic pots, and transferred to a photoperiod controlled greenhouse. The day/night temperature set points were 26.6/21.1 °C. The soybean plants were then subjected to a 14-h photoperiod for 2 weeks. Upon completion of the 2nd 14-hour week, the 7 treatments of the experiment began. Plants were treated with 1, 2, 3, 4, 5, 6, or 7 weeks of a 12-h photoperiod after which plants were returned to 16-h photoperiod. A control group received a 12-h photoperiod beginning with other treatments but remained at that photoperiod for the remainder of the experiment. Number of nodes with pods, cycle time, and yield were recorded. Both varieties and all treatments showed just as good or better yield, cycle time and number of nodes with pods compared to the control. Based on the data from this experiment, photoperiod control past one week at 12-hours does not have any negative impacts on yield, cycle time or number of nodes with pods for the two varieties tested.

10:45 AM **Successes and Challenges in Taking a Scientific Approach to Grower Trials with Light-Emitting Diodes for Supplemental Lighting**

Brian Poel*, *LumiGrow Inc.*; Jake Holley, *LumiGrow* and Melanie Yelton, *LumiGrow, Inc.*

Abstract: Light-emitting diodes (LEDs) have been a viable method for providing supplemental lighting (SL) in a range of greenhouse crops for many years, however their general adoption still has not become the standard practice in many greenhouse production systems. As the operating efficiencies of LEDs continue to increase, installing fixtures at a density to provide upwards of 300 $\mu mol \cdot m^{-2} \cdot s^{-1}$ is no longer a rare occurrence in high-light crops. However, due to the high capital cost of LEDs for SL, there must be an additional benefit of SL beyond increased production. In partnership with two commercial greenhouse operations, we have conducted a multi-year, multi-crop investigation into the optimal SL intensities for production of greenhouse cucumbers and strawberries, followed by quantifying the effect of SL spectrum on yield and fruit quality. For strawberry and cucumbers, adding SL reduced time to first harvest and promoted early yield. Through economic modeling we determined SL

intensity of 85 µmol·m^{-2}·s^{-1} was optimal for strawberry production for the grower's specific location and production system, but further analysis is required to determine optimal SL spectrum for fruit quality beyond yield. Additional challenges involved with conducting lighting experiments in a commercial environment such as light contamination effects, environmental changes, and grower expectations will also be presented. These findings and experiences should be integrated into future lighting experiments at commercial facilities.

11:00 AM Diurnal Patterns of Carbon Export in Tomato Leaves Exposed to Wavelength Specific Lighting

Jason Lanoue*; Evangelos D. Leonardos and Bernard Grodzinski, *University of Guelph*

Abstract: Advances in light-emitting diode (LED) technology over the past few decades have brought about the ability to fine-tune lighting systems for plant production in controlled environments. Light-emitting diodes are also a valuable tool for physiologists interested in understanding the phenotype of plants when exposed to different spectra of light. Translocation is an under-explored, fundamental process involving carbon and water balance affecting source/sink relationships. Source leaf strength is defined by photosynthesis and carbon export; both processes being essential for growth. The process of carbon export involves additional steps downstream of photosynthesis including multiple cell lines, enzymes, and transporters which can be environmentally regulated. Our primary objective was to examine diurnal patterns of photosynthesis and carbon export via $^{14}CO_2$ steady-state labelling under different spectra generated by LEDs, but at similar CO_2 influx rates. Daily patterns showed that photosynthesis and export were supported by all wavelengths of light tested including orange and green alone. Export in the light, under all wavelengths was always higher than that at night, varying from 65-83% of daily carbon fixation depending on light intensity. Photosynthesis and export were highly correlated under all wavelengths (r=0.90-0.96). Relative export decreased as photosynthesis increased under all wavelengths indicating an upper limit for export. Interestingly, only at the medium photosynthetic rate were differences found. At this rate, relative export under blue and orange LEDs were higher than under white and red-white LEDs. Furthermore, we also investigated the relationship between carbon export and water status. The current hypothesis is that transpiration and carbon export are linked in woody species. However, so far, our data with tomato under different spectral quality are inconclusive. Understanding the phenotypic responses of the carbon export pathway to light can aid in the optimization and implementation of LED lighting systems for controlled environment crop production.

Specified Source(s) of Funding: Agriculture & Agri-Food Canada

11:15 AM Optimizing Supplemental Light Spectral Composition for Greenhouse Sweet Pepper Production with Top and Intra-Canopy LED Lighting

Xiuming Hao*[1]; Rong Cao[1]; Celeste Little[1]; Shalin Khosla[2] and Melanie Yelton[3], *(1)Agriculture and Agri-Food Canada, (2)Ontario Ministry of Agriculture Food and Rural Affairs, (3)LumiGrow, Inc.*

Abstract: With ever-improving energy efficiency and decreasing light fixture costs, light-emitting diodes (LEDs) are becoming a promising new light source for greenhouse vegetable production. However, significant questions remain on the best light quality or spectral compositions for greenhouse fruiting vegetable (such as tomatoes, cucumbers and sweet peppers) production. Greenhouse fruiting vegetables are of tall crop, with most of leaf growth occuring in the top and middle canopy while fruit growth in the middle and bottom canopy, and these different growth processes may require different light spectra. LEDs can be used both as top lighting (above the crop canopy) and intra-canopy lighting because of their low surface temperature. Therefore, the light spectrum or spectral compositions of top and intra-canopy LEDs can be optimized for both leaf/vegetative and fruit growth. This study was conducted from Oct. to May in a large greenhouse (200 m^2) to compare different spectral compositions of LED top lighting and intra-canopy lighting for greenhouse sweet pepper production. The greenhouse was divided into 4 sections (50m^2/section) so that 2 different top light spectral compositions (100% Red or Mixed (red:blue:white = 76:16:8), at the same 140µmol m^{-2} s^{-1}) could be applied with 2 replications. Four intra-canopy light spectral compositions (Control - no intra-canopy lighting, Red (660nm), Blue (455nm) and White at the same 30µmol m^{-2} s^{-1}) were applied to the 4 plots inside each section. Therefore, a total of 8 vertical light spectral compositions/regimes were evaluated in the experiment. The light compositions/regimes resulted in significant difference in leaf photosynthesis, F_v/F_m, plant productivity (total fruit fresh weight and fruit size), and fruit anti-oxidant contents. Therefore, this study has clearly demonstrated that optimized light compositions/regimes should be and can be developed for improving plant growth and fruit yield & quality in greenhouse sweet pepper production with LED supplemental lighting.

11:30 AM Biomass Allocation and Nutrient Use Efficiency of Three Temperate Conifer Species Under Water Stress

Ismail Koc*[1]; Pascal Nzokou[1]; Patrick Shults[2] and Chad C. Papa[1], *(1)Michigan State University, (2)Washington State University*

Abstract: Two-year-old (plug+1) balsam fir [*Abies balsamea* (L.) Mill.], and concolor fir [*Abies concolor*], and one-year-old bare-root Eastern White Pine [*Pinus strobus* (L.)] transplants were grown under three irrigations treatments (low, medium, and high) and two fertilization treatments (low and high) in greenhouse conditions. The goal was to determine the biomass allocation and nutrient use efficiency in response to the interactive effect of irrigation and fertilization under water stress. Relative root collar diameter (RRCD), relative height growth (RHG), relative root length (RRL), fresh and dry shoot mass (FSM and DSM), fresh and dry root mass (FRM, DRM), root number, and shoot/root (S/R) ratio were measured as growth parameters. We analyzed total nitrogen concentration of needles, stems, and roots and calculated resource-use efficiency parameters, such as assimilatory nutrient efficiency (ANUE), whole plant nutrient efficiency (NUE), index of nitrogen (N) availability (N/RW) and root weight ratio (RWR) to evaluate nutrient use physiology of the three species. Results obtained indicate significant differences between the two fir and white pine seedlings for stem water potential (SWP), growth parameters, biomass allocation, and nutrient use physiology. Specifically, concolor fir had a greater capacity to hold acquired water and improve water uptake compared to white pine. Furthermore, concolor fir showed higher aboveground growth and S/R ratio. The fir species had a higher nitrogen concentration compared to white pine. All species had higher N concentrations in their needles followed by roots and stems. White pine seedlings showed the highest ANUE, NUE and RWR values but the lowest N/RW value. These findings have strong implications for the management of these species in horticultural systems.

11:45 AM Quantifying the Effects of Electrical Conductivity, pH and Foliar Application of Calcium Chloride on Yield and Tipburn of *Lactuca sativa L.* Grown Using Nutrient Film Technique (NFT)

Uttara Samarakoon*[1]; Jack Palmer[1]; Peter Ling[1] and James Altland[2], *(1)The Ohio State University, (2)USDA-ARS, MWA ATRU*

Abstract: Tipburn on lettuce has an adverse effect on its market value. Tipburn is a common issue with some cultivars of hydroponically grown lettuce in Nutrient film techniques (NFT). Inability to uptake calcium at a faster rate has been reported to cause tipburn. We investigated the yield and degree of tipburn of three lettuce cultivars 'Red butter', 'Green butter', and 'Oak leaf' of Salanova ® series under varied EC and pH levels. We also investigated the effect of application of calcium chloride ($CaCl_2$) as a foliar spray using the lettuce cultivar 'Green butter'. For the experiment with EC treatments, the plants were grown at a constant pH of 5.8, and four EC levels: 1.4, 1.6, 1.8 or 2.0 mS·cm. For the experiment with pH treatments, the plants were grown at a constant EC of 1.8 mS/cm and four pH levels 5.8, 6, 6.2 or 6.4. For the experiment with $CaCl_2$ foliar sprays were applied at a concentration of 0, 400 or 800 mg·L-1 Ca a week after transplanting into NFT channels. The solution pH and EC was managed at 5.8- 6.0 and 1.8 mS·cm. During the EC trial, the maximum yields were observed at or above 1.8 mS/cm for 'Green butter' (263 ± 14 g per head), and 'Red butter' (202 ± 8 g), and above 1.6 mS·cm for 'Oak leaf' (183 ± 6 g). Tipburn symptoms were less at 1.4 mS·cm for 'Green Butter' while other cultivars were not highly susceptible. The yield of 'Green Butter' was 75g less at 1.4 mS·cm compared to 1.8 mS·cm. During the pH trail, the

maximum yields were observed at pH 6.0 and 6.2 for all cultivars. There was no variation in tipburn symptoms across pH levels. Preliminary investigations with once a week $CaCl_2$ foliar sprays was found ineffective in controlling tipburn. A twice a week application of 800 $mg \cdot L^{-1}$ Ca, showed promising results in controlling the tipburn as compared to other treatments. The yield with the 800 $mg \cdot L^{-1}$ $CaCl_2$ spray, however, was 25g less than 0 and 200 $mg \cdot L^{-1}$ $CaCl_2$. Reducing EC of the fertilizer solution below 1.4 $mS \cdot cm$ or twice a week application of 800 $mg \cdot L^{-1}$ Ca in the form of $CaCl_2$ can control tipburn of the lettuce cultivars evaluated. Application of $CaCl_2$ provided a better control as the symptom of tipburn was minimal and the impact on yield was minor as compared to reducing EC.

10:30 AM – 12:00 PM

It's Native. Wait! It's Exotic... Oh No, It's a Nuisance! *CEU Approved*

Jefferson East

Coordinator: Lyn A Gettys, *University of Florida Ft Lauderdale Research and Education Center*

Moderator: Lyn A Gettys, *University of Florida Ft Lauderdale Research and Education Center*

Objectives:

The goal of this workshop is to increase attendee awareness and understanding of the phenomenon of invasive native species. Although some may consider the term "invasive native" to be an oxymoron, we argue that some native species can exhibit nuisance-level growth that crowds out other native species, decreases ecosystem diversity and causes problems normally associated exclusively with non-native (introduced) species.

Description: **Workshop format:** Introduction (5 minutes), 4 case studies (60 minutes), open discussion/panel (25 minutes)

Introduction to the workshop (Lyn Gettys – workshop coordinator and moderator, 5 minutes)

If waterlettuce is native, why is it taking over? (Lyn Gettys, 15 minutes): *Arguments for why we consider Pistia stratiotes to be an exotic species despite its presence in fossil records will be the focus of this lead presentation. This talk will uncover some of the buried history of this invasive species, how it came to be such a problem despite its native status, and why things changed. The speaker will discuss the implications of how such burial of a native's background can create false impressions in the face of the desperate need for control.*

Other bad-acting native species (Mike Schnelle, 15 minutes): *Natives can evolve and be just as problematic as exotic (non-native) species. They often go unnoticed due to their strategic advantage of being recognizable natives even if they have deleterious effects on humans, landscapes, and local flora and fauna. Natives with subtle but invasive tendencies can affect ecosystem services and sweep through landscapes, often as ornamentals with allied species of economic importance. This talk will focus on but not be limited to the following species capable of escaping cultivation: Black cherry (Prunus serotina), Yaupon holly (Ilex vomitoria), Inland seaoats (Chasmanthium latifolium), and Woodbine (Clematis virginiana). This presentation will examine some of the factors leading these indigenous species to invade landscapes and natural areas, and the issues horticulturists and land managers face in light of their presence.*

Challenges of establishing native vs. exotic status of herbarium specimens (Andrzej K. Noyszewski, 15 minutes): *In cases where invasive species are presumed to be strictly exotic, the discovery that the species is also native can be disconcerting for researchers and land managers responsible for eradicating an exotic invasive. Such is the case with reed canarygrass, Phalaris arundinacea, where decades of misinformation had led to the call for nationwide control of this species in the US. However, native populations were first reported by LaVoie and then later confirmed by Casler with molecular analyses. This, coupled with the discovery by Anderson that this species has been used in weavings by Native Americans for centuries, also made the native forms of interest for protection. Questions of importance that should be answered when identifying native while controlling exotic/invasive genotypes are the subject of this talk. Identifying the native status of historic, herbarium specimens via molecular analyses is of great interest to determine localities of native populations for confirmation with extant specimens. Historic specimens are often degraded which makes DNA extraction challenging.*

Throwing out the bathwater but keeping the baby (Neil O. Anderson, 15 minutes): *How and why invasive species evolve has long been prejudiced by their labeling and presumed invasive abilities (native=noninvasive; exotic=invasive). Historic ignorance of species' native range, expansion due to unintentional involvement by vectors, and their quiet evolution has caused several invasive species to become "poster children", such as purple loosestrife (Lythrum salicaria), reed canarygrass (Phalaris arundinacea), and others. Common misconceptions on how these became problematic have involved a variety of causes, including sympatry and cross-compatibility creating introgressive hybrids, lack of phytophagous insects for control, wind pollination and intercontinental distribution for their native range. Current research is focusing on how misappropriating the historical contexts can reverse our misconceptions of native species being non-invasive and how this affects control by land managers. Lythrum and Phalaris will be used as example species to demonstrate challenges that native vs. exotic, intra- and inter-specific differences confer to land managers. Issues such as a lack of phenotypic differences challenge land managers' charge to control invasive genotypes yet retain noninvasive; this is fraught with challenges when native vs. exotic status is invoked or cultural values are entwined. To avoid a monumental impasse, particularly when native and exotic types are phenotypically indistinguishable, this dilemma could be solved via modern techniques using molecular biology.*

Open discussion and roundtable (25 minutes): *This is an opportunity to talk about problems, challenges and solutions related to nuisance natives. All workshop speakers will be available and audience participation is encouraged.*

10:30 AM If Waterlettuce Is Native, Why Is It Taking over?

Lyn A Gettys*, *University of Florida Ft Lauderdale Research and Education Center*

Abstract: *Arguments for why we consider Pistia stratiotes to be an exotic species despite its presence in fossil records will be the focus of this lead presentation. This talk will uncover some of the buried history of this invasive species, how it came to be such a problem despite its native status, and why things changed. The speaker will discuss the implications of how such burial of a native's background can create false impressions in the face of the desperate need for control.*

Why this speaker? Dr. Lyn Gettys is an Assistant Professor of Agronomy (aquatic and wetland plants) at the University of Florida IFAS FLREC in Davie, FL. She has developed methods to improve establishment of native aquatic plants (e.g., *Vallisneria americana*, *Schoenoplectus californicus*, and others) and conducts research on techniques to manage exotic aquatic invaders, including *Hydrilla verticillata*, *Eichhornia crassipes* and *Rotala rotundifolia*. As a result of her work using integrated pest management (IPM) for control of invasive weeds, Lyn has expertise in non-herbicidal plant management and is well-suited to outline the fauna that should co-occur with waterlettuce – and keep its growth in check – if the plant truly is native to Florida.

10:45 AM Other Bad-Acting Native Species

Michael A Schnelle*, *Oklahoma State University*

Abstract: *Natives can evolve and be just as problematic as exotic (non-native) species. They often go unnoticed due to their strategic advantage of being recognizable natives even if they have deleterious effects on humans, landscapes, and local flora and fauna. Natives with subtle but invasive tendencies can affect ecosystem services and sweep through landscapes, often as ornamentals with allied species of economic importance. This talk will focus on but not be limited to the following species capable of escaping cultivation: Black cherry (Prunus serotina), Yaupon holly (Ilex vomitoria), Inland seaoats (Chasmanthium latifolium), and Woodbine (Clematis virginiana). This presentation will examine some of the factors leading these indigenous species to invade landscapes and natural areas, and the issues horticulturists and land managers face in light of their presence.*

Why this speaker? Dr. Mike Schnelle is the Charles and Linda Shackelford Endowed Professor of Floriculture, Department of Horticulture & Landscape Architecture at Oklahoma State University, Stillwater. He holds an extension appointment and works with the Oklahoma Nursery and Landscape Association in the floriculture and nursery industry – the commodity group associated with the majority of invasive ornamentals. Mike conducts research programs covering greenhouse and urban integrated pest management (IPM) and cooperates with green industry allied professionals. He participates with and has

lectured at the Oklahoma Invasive Plant Council's Annual Conference. Mike's greatest expertise is in native and non-native herbaceous and woody ornamental taxa, particularly in respect to their invasive potential and control.

11:00 AM Challenges of Establishing Native Vs. Exotic Status of Herbarium Specimens

Andrzej K. Noyszewski*, *University of Minnesota*

Abstract: *In cases where invasive species are presumed to be strictly exotic, the discovery that the species is also native can be disconcerting for researchers and land managers responsible for eradicating an exotic invasive. Such is the case with reed canarygrass, Phalaris arundinacea, where decades of misinformation had led to the call for nationwide control of this species in the US. However, native populations were first reported by LaVoie and then later confirmed by Casler with molecular analyses. This, coupled with the discovery by Anderson that this species has been used in weavings by Native Americans for centuries, also made the native forms of interest for protection. Questions of importance that should be answered when identifying native while controlling exotic/invasive genotypes are the subject of this talk. Identifying the native status of historic, herbarium specimens via molecular analyses is of great interest to determine localities of native populations for confirmation with extant specimens. Historic specimens are often degraded which makes DNA extraction challenging.*

Why this speaker? Dr. Andrzej Noyszewski is a PostDoctoral Research Associate in the Department of Horticultural Science, University of Minnesota, St. Paul, MN. He has expertise in molecular biology and plant reproductive barriers and is harnessing these skills to address the question of native vs. invasive status of historic and extant reed canarygrass populations in Minnesota, using corollary collections from central Europe (Czech Republic). Andrzej will aid Dr. Neil Anderson's invasive species research team in developing a hand-held device for land manager use in distinguishing between native and exotic forms of reed canarygrass.

11:15 AM Throwing out the Bathwater but Keeping the Baby

Neil O. Anderson*, *University of Minnesota*

Abstract: *How and why invasive species evolve has long been prejudiced by their labeling and presumed invasive abilities (native=noninvasive; exotic=invasive). Historic ignorance of species' native range, expansion due to unintentional involvement by vectors, and their quiet evolution has caused several invasive species to become "poster children", such as purple loosestrife (Lythrum salicaria), reed canarygrass (Phalaris arundinacea), and others. Common misconceptions on how these became problematic have involved a variety of causes, including sympatry and cross-compatibility creating introgressive hybrids, lack of phytophagous insects for control, wind pollination and intercontinental distribution for their native range. Current research is focusing on how misappropriating the historical contexts can reverse our misconceptions of native species being non-invasive and how this affects control by land managers. Lythrum and Phalaris will be used as example species to demonstrate challenges that native vs. exotic, intra- and inter-specific differences confer to land managers. Issues such as a lack of phenotypic differences challenge land managers' charge to control invasive genotypes yet retain noninvasive; this is fraught with challenges when native vs. exotic status is invoked or cultural values are entwined. To avoid a monumental impasse, particularly when native and exotic types are phenotypically indistinguishable, this dilemma could be solved via modern techniques using molecular biology.*

Why this speaker? Dr. Neil Anderson is a Professor of Flower Breeding and Genetics in the Department of Horticultural Science, University of Minnesota, St. Paul, MN. His internationally-recognized program specializes in risk assessment to prevent new invasive species from being introduced into the market and causing future problems. Neil commenced invasive species research in 1989 on fertility and cross-compatibility of invasive, exotic purple loosestrife newly sympatric with populations of N. American winged loosestrife (*Lythrum alatum*). Such hybridization was aided with the widespread use of ornamental interspecific cultivars. Since that time his research program has focused on additional invasive species with misconstrued histories, such as *Cleome* and *Phalaris.* His talk will focus on the culmination of more than a decade of research involving reed canarygrass.

10:30 AM – 12:00 PM

Lessons Learned: A Forum on Communication, Funding, and Student Life By and for Graduate Students *CEU Approved*

Lincoln West

Coordinators: Travis Robert Alexander, *Washington State University, NWREC* and Jack McCoy, *University of Arkansas - Fayetteville*

Moderator: Kaylee Anne South, *The Ohio State University, OARDC*

Objectives:

To provide an opportunity for comfortable discussion of major challenges currently facing graduate students, as surveyed this past year, and more importantly, sharing of strategies for overcoming these challenges.

Description: Workshop (1.5 hours): Forum on navigating graduate school in the United States as a non-domestic student, balancing funding with realized opportunities, and communicating effectively within and beyond science.

Schedule: Informal presentation by *Shuresh Ghimire* on his experience as a non-domestic Ph.D. student at Washington State University and his successful transition to the University of Connecticut as an Extension Specialist, followed by a Q&A session* (30 minutes)

Informal presentation by *Jack McCoy* on balancing funding with realized opportunities, followed by a Q&A (30 minutes)

Informal presentation by *Sonja Birthisel* on communicating effectively within and beyond science, followed by a Q&A session (30 minutes)

* Q&A sessions are intended to involve everyone in attendance, questions to be asked of the presenter and/or experiences shared by attendees. Often it takes a couple of individuals to speak up before a healthy conversation can really start.

An output will be a summary article in the ASHS newsletter, extending information gained to students unable to attend the annual conference.

Business meeting (30 minutes): Assessing the overall graduate student experience at the annual conference of ASHS.

Schedule: Acquire feedback on: Scholar's Ignite, Poster Competition, Oral Competition (20 minutes).

Hold elections, address responsibilities, and wrap-up meeting (10 minutes).

An output will be a summary article in the ASHS newsletter, providing ASHS administration with a unified voice.

10:30 AM Navigating Graduate School As a Non-Domestic Student

Shuresh Ghimire*, *Washington State University*

10:45 AM Balancing Funding As a Horticulture Graduate Student

Jack McCoy*, *University of Arkansas - Fayetteville*

11:00 AM Communicating within and Beyond Science

Sonja Birthisel*, *University of Maine*

10:30 AM – 12:00 PM *Lincoln East*

Postharvest 3

Moderator: Mahnaz Kargar, *Auburn University*

10:30 AM Influence of Drying Method on Visual Quality of Hops (*Humulus lupulus*)

Sean Campbell*[1]; Brian Pearson[2]; Chris Marble[3] and G. Shad Ali[1], *(1)Univ of Florida, (2)University of Florida, Mid-Florida Research and Education Center, (3)University of Florida - Mid Florida Research and Education Center*

Abstract: Hops (*Humulus lupulus*), a perennial herbaceous plant cultivated primarily in the United States and Europe for its mature cones, are an essential ingredient to the production of beer. Like many other fresh horticultural products, hops require drying post-harvest to preserve quality and allow for successful long-term storage of plant material. Increased demand for hops has

resulted from growth in the popularity of highly-hopped beer styles coupled with increased production of craft beer. As a result, small-scale (0.1 to 0.2 ha) hop farms have become established in many non-traditional hop production regions. Given their small size and limited economic resources, small-scale farms may not have ability to construct or purchase a traditional hop drying facility, known as an oast. As an alternative, small-scale hop farms dry hops utilizing a variety of mechanisms to include ovens, fans, and food dehydrators. Although effective at drying hops, popular small-scale hop drying methods may reduce hop quality. To assess the impacts of drying method on visual quality of dried hops, 54 hop samples comprised of two hop cultivars, 'Cascade' and 'Neo1', were dried by convection oven, through application of cool air, or by passive evaporation on 21 June 2017. Visual quality of hops pre- and post-dehydration was quantified using a colorimeter. Hops dried by either convection oven or movement of cool air reached targeted moisture content within 24 hrs, whereas hops dried passively required 72 hrs before reaching adequate moisture content for storage. Oven dried hops had significantly (P<0.001) lower hue and were lighter (P<0.05) in color than those dried by either application of cool air cool air or passive dehydration. Changes in hue were significantly greater ($P<0.$05) in 'Cascade' than 'Neo1' regardless of drying method utilized. Results indicate that greater visual quality of hops is maintained when dried using movement of cool air or allowed to passively dehydrate. Given the 3-fold increase in time required for passive dehydration, application of cool air is likely the most efficient way to dry hops post-harvest while maintaining high visual quality. Additional research, however, is needed to better understand the influence of drying method on hop oil quality to maximize both visual and consumptive quality of hops.

Specified Source(s) of Funding: Florida Department of Agricultural & Consumer Services

10:45 AM Changes in Volatile Profiles in Orange Peel Oil Extracted from Huanglongbing Affected 'Hamlin' and 'Valencia' Orange Fruit

Jinhe Bai[*1]; Elizabeth A. Baldwin[1]; Anne Plotto[1]; Huqing Yang[1]; Elise Bourcier[1] and Mike Irey[2], *(1)USDA-ARS, (2)Southern Gardens Citrus Nursery, LLC*

Abstract: Huanglongbing (HLB)-affected oranges are typically green or yellow in color, rather than orange, and the latter is more common in the Florida citrus groves. The yellow color is often associated with insufficient accumulation of carotenoids (the reason for lack of orange color) in the flavedo, lack of natural shine, and shriveled peel (due to water loss). The green color is an indicator of maturity due to HLB-associated phloem malfunction and resulting retarded growth and development of the fruit. All HLB-affected fruit produced a lower volume of peel oil compared to healthy fruit, however, only green fruit showed substantially different volatile profiles from healthy fruit. The green fruit contained low concentrations of most of sesquiterpene hydrocarbons and derivatives, such as, nootkatone, valencene, α-selinene, 7-epi-α-selinene and caryophyllene oxide, some monoterpene hydrocarbons and derivatives with orange/citrus characteristics, such as, limonene, myrcene, α-pinene, neral, geranial, and α-terpineol, and straight-chain aldehydes, such as, octanal, nonanal and decanal. However, eight compounds were determined in the green fruit peel which were not present, or present in very minor quantities, in the healthy fruit. Other compounds found more in HLB-affected green fruit than in healthy fruit feel oils were cis-3-hexenol, cis-pinocarveol, carvone, and α-cubebene.

11:00 AM Changes in Free Amino Acid Content in the Flesh and Peel of 'Cavendish' Banana Fruit As Related to Branched-Chain Ester Production, Ripening, and Senescence

Nihad G. Alsmairat[*], *The University of Jordan* and Randolph Beaudry, *Michigan State Univ*

Abstract: The concentrations of free amino acids in the peel and pulp of banana (*Musa* L. spp., AAA group, Cavendish subgroup. 'Valery') fruit during ripening at 20 °C were studied. A high-throughput method combining high performance liquid chromatography (HPLC) with multiple reaction monitoring (MRM) of selected mass spectra ions were used to quantify amino acids at seven distinct ripening stages as defined by measures of internal ethylene, O_2, and CO_2 concentrations, aroma volatile emissions, and peel color. Volatile production commenced two days after the peak in ethylene production and a day following the climacteric peak in internal CO_2. The maximum rate of branched-chain ester synthesis occurred two to three days days after its onset. Production of 2-propyl and 3-methylbutyl esters was much higher in the pulp compared to the peel, confirming that the pulp rather peel is the primary site of banana aroma synthesis. Of the 20 amino acids measured, only leucine, valine, and cysteine increased concomitantly with ester formation. This was observed in the pulp, but not in the peel. The data support the role of the metabolic pathways for valine and leucine in the formation of, respectively, 2-methylpropyl and 3-methylbutyl esters. There was a slight peak in the formation of several amino acids in the pulp (e.g., alanine, arginine, asparagine, glutamine, and methionine) coinciding with the climacteric peak in CO_2, but a similar pattern was not seen for the peel. These data are the first to demonstrate distinct differences in amino acid metabolism in the peel and pulp of banana related to their role in ripening and aroma biosynthesis.

Specified Source(s) of Funding: Self funded

11:15 AM Enzymatic Browning of Genomically Diverse Banana Cultivars (*Musa* spp.) during Postharvest Storage

Mahnaz Kargar[*1]; Floyd M. Woods[1]; Kalidas Shetty[2]; Marisa M. Wall[3]; J. Raymond Kessler[1]; Esendugue G. Fonsah[4]; Ramesh B. Jeganathan[1] and Nicholas Larson[5], *(1)Auburn University, (2)North Dakota State University, (3)USDA ARS, (4)University of Georgia, Tifton Campus, (5)University of Florida*

Abstract: Banana (*Musa* spp.) is one of the most popular fruits worldwide, because of good taste, nutrition, and health aspects. The major postharvest concern of banana fruit is browning which reduces the marketing value and the attractiveness of fruits. The current study was designed to determine the influence of cultivar, and stage of maturity on degree of browning, polyphenol oxidase (PPO), and peroxidase (POD) in banana peel and pulp tissue. Banana cultivars varying in genome, including 'FHIA 1' (AAAB), 'Hua Moa' (AAB), 'Kandarian' (ABB), 'Pisang Raja' (AAB), 'Saba' (ABB) and 'Williams' (AAA) were harvested at full three-quarter stage of maturity and room ripened at 20^{o}C and 95% relative humidity. Samples were separated into four ripening stages (mature green, transition, ripe, and overripe) and total phenolics, degree of browning, PPO and POD enzyme activity of fruits were analyzed. Measured total phenolics in peel was higher than pulp in all cultivars except 'Williams'. 'Hua Moa', 'Kandarian', 'Pisang Raja', and 'Williams' showed the highest total phenolic content at ripe and over ripe stages in peel and pulp tissues. Degree of browning increased in all cultivars with advancing of maturity in peel and pulp tissues. 'Hua Moa, and 'Pisang Raja' had the highest values of degree of browning. Whereas, 'FHIA 1', and 'Saba' showed the lowest values. The results also indicate that PPO activity of pulp was higher than peel in all cultivars. In addition, activity of PPO varied in cultivars with different genomes. 'Hua Moa', 'FHIA 1', 'Pisang Raja', 'Williams', 'Kandarian', and 'Saba' had the highest to lowest PPO activity in banana fruits peel. In pulp tissue, 'Hua Moa', had the highest and 'Kandarian', 'Saba', and 'Williams' had the lowest PPO activity. The highest activity of POD was observed in 'Hua Moa' for both peel and pulp tissue. However, POD did not show any significant activity in peel tissue of 'Kandarin', 'Pisang Raja', 'Saba', and 'William's. This study helps to understand the role of polyphenol oxidase (PPO) and peroxidase (POD) as two of the major enzymes involving in enzymatic browning in banana peel and pulp tissue.

11:30 AM GC-O, Volatile and Qualitative Differences in Locally Grown Rabbiteye and Southern Highbush Blueberries, and Juices

John C Beaulieu[*1]; Maureen A. Tully[1]; Donna A Marshall-Shaw[2]; Steve W. Lloyd[2] and Casey C. Grimm[2], *(1)USDA ARS, (2)USDA-ARS*

Abstract: Southern and southeastern US production of blueberries has increased markedly in recent years. Gas chromatography-olfactometry (GC-O) and volatile and semi-volatile compounds are seldom reported in rabbiteye blueberry (RAB). Few comparisons have been made between the organoleptic differences between RAB and southern highbush (SHB) fruits and pressed juices therefrom. We performed GC-O, GC-MS, volatile and physiological quality appraisals in six varieties of SHB and RAB harvested twice in a single season. Three

varieties of RAB ('Alapaha', 'Columbus' and 'Montgomery') and SHB ('Biloxi', 'Magnolia' and 'Misty') blueberries were hand harvested fully ripe, 10 days apart in Poplarville, MS. Fruit were either sampled fresh after hydraulic pressing in a small Ferrari press with nylon-mesh to mimic steps toward making a mash and juices, or frozen immediately after harvest, and pressed after thawing via muslin cloth. Commercially frozen RAB ('Tifblue') heated mash was enzyme-treated, hydraulically pressed, not filtered and ultrafiltered, and pasteurized juices prepared in our pilot plant for a comparison. Samples were assessed for rapid qualitative differences (pH, brix, titratable acidity, color). SPME carboxen/DVB/PDMS fiber absorption on a fully automated Gerstel MPS2 was followed by splitting the run into an Agilent 7890-A Gas Chromatography (GC) FID with a BreckBühler Sniffer 9000 GC-O (Olfactometer). Volatiles were confirmed separately via identical runs on an Agilent 6890/5973 GC-MS.

Freshly pressed berry juice had higher L*, a*, b* and C* but lower hue angles than juices prepared from frozen berries, and similar values compared to pasteurized samples. On the other hand the freshly pressed juices had markedly lower titratable acidity and conversely higher soluble solid:acid ratios compared with frozen pressed samples. Volatiles such as (*Z*)-3-hexen-1-ol, (*E*)-geraniol, linalool, linalool oxide, eugenol and β-damescenone were identified and assessed, and compared against sample aromas and known standard compounds. 'Alapaha' contained potent aromas of alcohol, chocolate, blueberry, grass, sweet, fruity, floral, and spice. 'Montgomery' had aromas of blueberry, chocolate, fruit, cinnamon, coffee, and alcohol. 'Magnolia' was very fragrant, perfume-like juice. The other varieties did not exhibit such potent and distinct odors but, had faint blueberry, sweet, coffee beans, fruity, floral, heated plastic and iron notes. Specific compounds such as (*E*)-geranyl acetone, linalool oxide, β-pinene and camphene had matching GC-O, RT and MS confirmations, and these are compounds that are important or possibly important in fruit aroma (e.g. blueberry, sweet, green flower, fruity and floral notes). Berry and juice differences along with volatile and aroma nuances and findings will be explored further.

Specified Source(s) of Funding: US Government

11:45 AM Influence of Tree Position on Free Non-Polar Cuticular Metabolites of 'd'Anjou' Pear during Controlled Atmosphere Storage

David R. Rudell*[1]; Stefano Musacchi[2]; Sara Serra[2] and James P. Mattheis[1], *(1)Tree Fruit Research Laboratory, USDA-ARS, (2)Washington State University*

Abstract: Tree position, especially in larger canopies, can impact fruit maturity, ripeness, and quality potentially influencing every management decision throughout the cold chain. Our earlier reports reveal the extent to which metabolism is altered including areas as diverse as those directly associated with fruit quality, aroma, appearance, and cellular integrity at harvest and throughout storage. The current report focuses on a relatively novel group of freely extractable metabolites including hydroxycinnamoyl triterpenes (coumaryl triterpenes) as well as fatty acyl esters of hydroxyfarnesene (hydroxyfarnesene esters), hydroxycinnamoyl alcohols (*p*-coumaryl esters), and ursolic acid (ursolic esters). (7*E*,9*E*)-2,6,10-Trimethyl-2,7,9,11-dodecatetraen-6-ol (CTOL) and detected 16:0, 18:0, 18:1, and 18:2 CTOL esters were composed of 3 different hydroxyfarnesene head groups. Fatty acyl moieties *p*-coumaryl, ursolic, and amyrin esters ranged from 16:0 to 22:0. CTOL, hydroxyfarnesene esters, *p*-coumaryl, and ursolic esters were elevated in peel of external fruit. CTOL and 2 hydroxyfarnesene esters were only detectable beyond 3 months in storage and *p*-coumaryl and ursolic esters were detectable at harvest. Both classes increased with storage duration. Coumaryl triterpenes were higher in peel from internal fruit at harvest and did not increase with storage duration. The function of these metabolites is largely unknown but are thought to be primarily structural or functional as specialized monomers of cutin with potential antioxidative functions or even providing polar paths through the cuticle. However, the outcome of these differences may be as evident as fruit appearance where superficial scald only developed on external fruit and CTOL and hydroxyfarnesene ester levels were highest. These results warrant further study of conditions leading to metabolic differences and the impacts they may have on fruit quality.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

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10:30 AM – 12:00 PM *Jay (Lobby Level)*

SR-ASHS Executive Committee Meeting

Presiding: David Reed, *Texas A&M Univ*

10:30 AM – 12:00 PM

Using the GRIN-Global Database As a Research and Breeding Tool *CEU Approved*

Jefferson West

Coordinator: Theodore Kisha, *USDA-ARS*

Moderator: Theodore Kisha, *USDA-ARS*

Objectives:

Attendees will learn how to 1) register as a cooperator on the GRIN-Global Public Website, 2) search and download observations and descriptors to facilitate research and breeding objectives, 3) place and follow the progress of an order for germplasm 4) learn what additional requirements may be needed for import permits into countries under the International Treaty on Plant Genetic Resources and 4) learn about some new horticulture data bases.

Description: In 1990, the U.S. Congress authorized establishment of a National Genetic Resources Program (NGRP) to: acquire, characterize, preserve, document, and distribute to scientists, germplasm of all lifeforms important for food and agricultural production. The National Plant germplasm System (NPGS) maintains about 600,000 seed samples and distributes almost 250,000 accessions annually to both foreign and domestic researchers. The GRIN-Global Public Website entered into production in 2015 and contains descriptor information on available accessions to aid end users in choosing the best material to order for their breeding and research needs. This workshop is a hands-on tutorial on using GRIN-Global to search and download information on plant genetic resources from the US National Plant Germplasm System. Additionally, several representatives of other new databases will provide information pertinent to certain species of interest.

10:30 AM Using the GRIN-Global Database As a Research and Breeding Tool

Marty Reisinger*, *USDA-ARS*

Abstract: In 1990, the U.S. Congress authorized establishment of a National Genetic Resources Program (NGRP) to: acquire, characterize, preserve, document, and distribute to scientists, germplasm of all lifeforms important for food and agricultural production. The National Plant germplasm System (NPGS) maintains about 600,000 seed samples and distributes almost 250,000 accessions annually to both foreign and domestic researchers. The GRIN-Global Public Website entered into production in 2015 and contains descriptor information on available accessions to aid end users in choosing the best material to order for their breeding and research needs. This workshop is a hands-on tutorial on using GRIN-Global to search and download information on plant genetic resources from the US National Plant Germplasm System.

10:45 AM Cuccap Project Bioinformatic Platforms

Rebecca Grumet*, *Michigan State Univ*

Abstract: A primary objective of the CucCAP project is to develop genomic and bioinformatic platforms for sequence data processing and analysis, and genotype, phenotype and QTL databases for the four major cucurbit crops: watermelon, melon, cucumber and squash. To this end we have performed genotyping by sequencing (GBS) analysis of the full USDA PI collections (1000-2000 accessions) for the four crops, and are using these data to develop sequence-informed functional panels of 300-400 accessions per crop representing ~99% of the genetic diversity along with key disease resistance, horticultural and agronomic traits. Sequence and SNP (single nucleotide polymorphism) data along with maps, markers, population and accession phenotyping data, and gene/trait descriptors can be accessed through the centralized cucurbit genomics database (*http://cucurbitgenomics.org/*) website.

11:00 AM Coordinated Development of Genetic Tools for Pecan

Jennifer Randall*, *New Mexico State University*

Abstract: The development of a website and integrated databases that will house both pecan genomic data and phenotypic data is one of the deliverables for the USDA NIFA SCRI "Coordinated development of genetic tools for pecan" initiative. The modern US commercial pecan industry developed from the native pecan forest in North America, distributed from Illinois and Iowa south to Oaxaca, Mexico. During the past 30 years, open pollinated seeds from pecan and other *Carya* species were collected from the wild to represent the native region and planted at two USDA sites. These collections have been characterized for a number of phenotypic traits including inception and duration of growth, disease resistance, nutrient uptake and leaf morphology, and nut quality. Both collections represent the diverse native population with different phenotypic and genotypic characteristics that are invaluable to the industry, making these repositories a national treasure for one of America's most important tree species. An ArcGis geodatabase supported by BG-base is being implemented that houses the historic origination records and phenotypic data that represent collections of NCGR *Carya* and this database will connect to GRIN Global. The centralized pecan toolbox will allow for accessibility to the phenotypic and genomic data being generated for the pecan and other *Carya* accessions in the repository. The genomic data includes high resolution genome sequences, genome wide association studies, and RNA-Seq data. We will discuss the formation and implementation of the pecan toolbox that will become an industry-owned website.

10:30 AM – 1:30 PM *T Street Entrance - Terrace Level*

Bureau of Engraving & Printing

10:45 AM – 12:00 PM *International Ballroom West*

Vegetable Crops Management 3

Moderator: Carol Miles, *Washington State University, NWREC*

10:45 AM Grafting Increases Yield of Watermelon in a Cold Climate

Rob Brown[1]; Ed Scheenstra[2] and Carol A. Miles*[2], *(1)Flattop Farm, (2)Washington State University, NWREC*

Abstract: In Alaska, more than 95% of the $2 billion spent on food purchases each year is imported via boat or plane, and grocery stores have a maximum of two weeks supply. Prices for fresh produce are very high in rural communities, and this limits consumption. Climate modifying structures such as high tunnels can enable growers to produce fruits and vegetables locally, and the USDA estimates it has awarded $4 million in contracts and grants for high tunnels in Alaska. High tunnels in Alaska require extra construction considerations to withstand heavy snow loads (10 ft at Flattop Farm, the site of this experiment in Anchorage) and deep ground freezing. Additionally, crops such as watermelon require additional strategies for successful production. We grafted two watermelon cultivars, Blacktail Mountain and Marmaladny, on Tetsukabuto rootstock and evaluated fruit production. Seeding was 10 June 2017, and grafting was with the hole-insertion method on 17 June 2017. This was the third planting as the first and second plantings were lost due to seed-borne disease on cultivars that were locally sourced and that spread to experimental plants. Seedling production, grafting, and hardening were in grow rooms in the house basement, with fluorescent or halide grow lights and temperature maintained at 75-83 ^{O}F. Grafted plants were healed for 9 days in a grow tent (50 in. X 50 in. X 79 in.), also inside the house; an ultrasonic humidifier and humidistat provided 90% RH, temperature was 74-75 ^{O}F, and lighting was a fluorescent grow tube. Transplanting into the high tunnel was on 29 June. The experimental design was a randomized complete block with 6 plants per plot. Raised beds were covered with IRT olive-colored mulch (1 mil). Plants were hand pollinated within a cultivar. Soil temperature in the plots was 60 ^{O}F on 24 Aug. Fruit were harvested on 28 Sept., and all fruit were immature (TSS 5-6%). Grafted Marmaladny produced almost 2 times the number of fruit and 3 times the total fruit weight per plot than grafted Blacktail Mountain, and 4 times the number of fruit and 9 times the total fruit weight than non-grafted Blacktail Mountain and non-grafted Marmaladny (*P < 0.0001*). Average weight per fruit was 5.73 lb for grafted Marmaladny, which was 1.7 times greater than other entries (*P = 0.02*). Grafting of watermelon increased fruit production with cold soil temperature in southcentral Alaska. The experiment will be repeated in 2018.

Specified Source(s) of Funding: Western Sustainable Agriculture Research & Education

11:00 AM Effect of Irrigation and Plastic Mulches on Verticillium Wilt Severity of Rootstock for Watermelon Grafting

Pinki Devi*[1]; Carol A. Miles[2] and Yorav Dave Klawer[1], *(1)Washington State University, (2)Washington State University, NWREC*

Abstract: Verticillium wilt, caused by *Verticillium dahliae*, is a destructive soilborne disease that limits watermelon production worldwide. Control of this disease is becoming challenging for watermelon producers in Washington state due to the widespread distribution of the pathogen, the persistence of its microsclerotia in soil for many years, and phase-out of soil fumigants such as methyl bromide. Grafting watermelon onto resistant rootstock represents a promising disease management strategy, but there is little information regarding rootstock resistance to verticillium wilt. Evaluating rootstocks for resistance to *V. dahliae* is the first step in developing a management strategy for controlling this pathogen via the use of grafted plants. This study investigated the reactions of seven commercially available rootstocks, 'Tetsukabuto', 'Super Shintosa', 'Java', 'Flexifort', 'Shintosa Camelforce', 'Cobalt' and 'Carnivor', and seedless watermelon 'Fascination' (verticillium wilt- susceptible control) to *V. dahliae* in a naturally infested field (5 cfu/g of soil) at Washington State University Northwestern Washington Research and Extension Center. To evaluate the disease severity in combination with crop management, we tested black and clear plastic mulch, and two irrigation treatments, management allowance depletion (MAD) water application vs. scheduled water applications through drip irrigation. The irrigation time difference between scheduled and MAD treatment was 30-40 minutes per irrigation application, and overall, 33% less water was applied in MAD treatment compared to scheduled treatment. Area under disease progress curve (AUDPC) values did not differ significantly due to irrigation treatment or mulch treatment. The overall AUDPC value for verticillium wilt was higher for non-grafted watermelon than for the seven rootstock treatments (*P* = 0.0006). Results indicate that verticillium wilt severity was greater for 'Fascination' than for the seven rootstock treatments at the end of the growing season, but irrigation treatment and type of plastic mulch did not significantly effect on the disease severity in this study.

*Keywords***.** *Verticillium dahliae*, soilborne disease, grafting**,** AUDPC

11:15 AM Development of Photosynthetic Models of Kimchi Cabbages Incorporating CO_2 Concentration and Plant Growth Stage Under Extreme Weather

Sung Kyeom Kim*; Sang Gyu Lee; Hee Ju Lee; Mun Boheum; An Se Woong; Lee Jinhyung and Lee Hee Su, *Vegetable Science Division, National Institute Horticultrual & Herbal Science*

Abstract: The aim of this study was to develop the photosynthetic models of Kimchi cabbages under the abnormal temperatures at the different growth stages for evaluation of the net photosynthetic rate. The Kimchi cabbage plants were applied to the extreme high temperatures (25/22, 30/27, 35/31^{O}C; photo-/dark periods) at 7 to 10 days after transplanting (DAT) and 40 to 43 DAT using the extreme weather simulators. Except for these periods, the environments in terms of air temperature, relative humidity, radiation, and precipitation were set by the previous meteorological data (mean of September to November 2014-2016, Haenam, Republic of Korea). The photosynthetic CO_2 response curves (An-Ci) were measured at 16, 29, 43, 59, and 70 DAT using a portable gas exchange system. An-Ci data were used to calculate three biochemical parameters in terms of photochemical efficiency, carboxylation conductance, and dark respiration at each measuring date. Those were used to develop the photosynthetic models, modified Thornley's model, representing the prediction of net photosynthetic rate by CO_2 concentration and growth stages. The simulated net photosynthetic rates (s-An) differed as affected by extreme weather events, the s-An with extreme high temperature treatment (35/31^{O}C) was 19.7 μmol m^{-2} s^{-1} which was evaluated

approximately 3% deduction compared with control. Results indicated that developed photosynthetic models might be applied to evaluate retard growth and the net photosynthetic rate under abnormal temperature conditions.

Specified Source(s) of Funding: This work was carried out with the support of the "Cooperative Research Program for Agriculture, Science & Technology (Project No. PJ 01196501)", RDA

11:30 AM Effect of Growing Systems on the Production of Specialty Cantaloupes (*Cucumis melo* L.) in Indiana

Petrus Langenhoven*[1]; Wenjing Guan[2]; Daniel S. Egel[2]; Ariana P Torres[1] and Amanda J. Deering[1], *(1)Purdue University, (2)Purdue University, Southwest Purdue Agricultural Center*

Abstract: Over the past two decades, the planted acreage of Indiana fresh market cantaloupe has declined by 50%. Increased competition from neighboring states and higher production risks due to food safety related issues have contributed to the decline along with growing conditions that limit production to a small selection of cantaloupe types. The decrease in acreage and market share is a threat to the long-term sustainability of the cantaloupe industry in Indiana. Improved production technologies may change this situation. The production of a more diverse range of cantaloupe types (i.e. Charentais) and the use of production technologies that would increase yield and enhance product quality could increase the current market share of Indiana fresh cantaloupe. Charentais is a popular melon in France. They are fragrant with high sugar content. North American type cantaloupes (*C. melo var. reticulatus*) and Charentais (*C. melo var. cantalupensis*) were grown as a spring/summer crop to determine the effect of growing systems on yield and fruit quality. During 2017, eight specialty cantaloupe cultivars were grown in a conventional open field production system and in two passively ventilated high tunnels at the Throckmorton and Southwest Purdue University Agricultural Centers in Lafayette and Vincennes (Indiana), respectively. In one high tunnel, cantaloupes were grown in a soilless growing media using hydroponic production techniques, and in the other they were planted in soil. Mean fruit number per plant varied between the different cultivars, but a consistent trend was observed between the different production systems. All cultivars produced between 3 and 6.3 fruit per plant, except Savor, which produced significantly lower yields in the open field and soil-grown high tunnel. Average fruit weight was consistent between production systems, except for Inspire and Escorial, which produced significantly larger fruit in the open field evaluation. Tasty Bites and Inspire produced a significantly higher total fruit weight per plant in the open field and soil-grown high tunnel evaluation. Yields varied between 5.7 and 7.1 kg per plant. However, yields were significantly higher in the high tunnel production systems compared to the open field. This is mainly due to the 3.2 times higher planting density in the high tunnels. Mean TSS was 10.6 °Brix or greater in the open field evaluation. Cultivars in both high tunnel growing systems produced fruit with lower TSS compared to the open field. High tunnels produce significantly higher yields, but fruit quality will need to be improved.

Specified Source(s) of Funding: Purdue University AgSEED Grant

11:45 AM Effects of Bacteria and Methylamine on Yield and Plant Growth of Squash Under Water Stress

Melek Ekinci*[1]; Selda Ors[1]; Ertan Yildirim[1]; Ustun Sahin[1]; Atilla Dursun[1]; Recep Kotan[1]; Metin Turan[2] and İbrahim Demir[3], *(1)Atatürk University, (2)Yeditepe Üniversity, (3)Ankara University*

Abstract: In this study, we investigated the effects of bacteria and methylamine on fruit yield and plant growth of squash (*Cucurbita pepo* L. cv. Sakız) under different irrigations levels. For this purpose; three bacteria strains (*Bacillus megaterium* TV-91C, *Bacillus megaterium* TV-6D, *Bacillus subtilis* RK-1900*),* the product of methylamine (MA), and a control (no bacteria+MA) were used as treatments. Four irrigation levels (Full-irrigation; 100%, 85% of the full-irrigation, 70% of the full-irrigation, and 55% of the full-irrigation) were applied to plants in the field.

The effect of treatments on parameters such as yield per plant, fruit number, fruit weight, fruit diameter, fruit size, leaf chlorophyll reading value, fruit TSS, vitamin C, and fruit dry matter was statistically significant. In particular, drought stress significantly reduced these parameters. However, these reductions were lower with bacteria+MA applications. In severe drought stress conditions, generally better results were obtained with TV6D+MA application for fruit number, fruit yield, fruit weight, fruit length, plant dry weight, and chlorophyll reading value. On the other hand, RK1900+MA application increased fruit diameter, vitamin C, and fruit dry matter under severe drought stress. Plant fresh weight, stem diamete,r and leaf number were increased with TV91C+MA application under severe drought compared to other applications. With full irrigation, TV6D+MA and RK1900+MA applications showed the greatest increase in fresh and dry weights as compared to the control treatment.

We have observed that the negative effect of drought stress on the growth and fruit of squash was more affordable with the application of bacteria+MA as compared to the control. This research reveals that application of bacteria together with MA enhances tolerance capability against drought stress, and they can be used for reducing the deleterious effects of drought conditions on yield and growth of squash as an eco-friendly approach.

Specified Source(s) of Funding: TUBİTAK

10:45 AM – 12:15 PM *Georgetown West*

Commercial Horticulture 3

Moderator: Yan Chen, *Louisiana State University Agriculture Center & Research Station*

10:45 AM Louisiana Tea Consumer Survey and Willingness-to-Pay for U.S. Grown Tea

Yan Chen*[1]; Kathryn Fontenot[2]; Jeff Beasley[3] and Jeff Kuehny[3], *(1)Louisiana State University Agriculture Center & Research Station, (2)LSU AgCenter, (3)Louisiana State University*

Abstract: US tea consumption reached $12 billion in 2016, and is projected to have a 6% to 10% annual increase over the next ten years. Consumers are increasingly interested in where tea is sourced and whether or not it was produced in an environmentally and socially sustainable manner. The “grow-local” movement in recent years also provides an opportunity for US growers and investors to consider this traditional Asian crop as a new specialty crop. This survey was conducted with more than 200 Master Gardeners, and focused on purchasing preference and willingness-to-pay for tea products grown and processed domestically. Results indicated that about 92% of survey participant drink tea, and retail stores and super markets (84%) are major places for purchasing tea products, followed by consumption at restaurants (48%). Tea bags are still the most popular tea products (82%) followed by ready-to-drink bottled tea (36%). About 19% of participants purchased loose tea in the past 6 months which is encouraging because currently loose tea is the most profitable type of product for U.S. tea growers. Compared with hot tea, especially those prepared from loose leaf, iced tea is still the most popular form in tea consumption, especially during the summer. For this specific age group, motivations for drinking tea are (by ranking): “it tastes good”, “health benefits”, and “relaxation”, and the top three factors affecting purchasing decisions were (by ranking) quality, availability, and cost. About 27% of participants prefer purchasing tea grown and processed locally or domestically, while 70% said origin does not affect purchasing decision. About 39% of participants preferred tea grown with sustainable production practices, while only 22% would like to purchase tea products that are organically grown. Assuming similar quality, about 54% of participants would pay the same price for domestically grown tea as they would for imported tea, and the rest would like to pay 10% to 20% more for domestically grown tea. These results indicate that there is a market demand for domestically grown tea and the demand is likely to increase when US-grown tea becoming more available.

Specified Source(s) of Funding: Louisiana State Department of Agriculture and Forestry

11:00 AM Tea As an Alternative Crop for Mississippi

Judson S. LeCompte*[1]; Guihong Bi[1]; Eugene K. Blythe[2]; Qianwen Zhang[1] and Tongyin Li[1], *(1)Mississippi State University, (2)Mississippi State University Coastal Research and Extension Center*

Abstract: Tea is second only to water as the most popular beverage in the world. In 2017, over 84 billion servings were sold

in the US, with projected sales to double over the next 10 years. Nearly all the tea sold in the US is imported, making the US the third largest tea importer in the world. The promising market trend and increasing consumer demand in locally grown products have promoted growers' interest in domestic tea production. *Camellia sinensis,* the source for tea leaves, is an evergreen shrub grown in tropical and subtropical regions. The soil and climate in Mississippi is suitable for growing tea. While tea has been grown in other countries for centuries, there is limited tea production in the US and little research-based information to guide US farmers on tea production. A series of experiments were conducted to evaluate tea cultivar performance and identify best management practices for tea production. Preliminary results showed that tea cultivars vary in leaf size, color, growth habit, vigor, and heat and cold tolerance. Providing plants with shade after transplanting into the field improves plant survival rate, especially when irrigation is limited. Transplanting during February and March improves plant survival rate. Mulching a newly planted tea field with pine bark, pine straw, and wheat straw effectively controls weeds and improves plant growth.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant Program

11:15 AM The Changing World of Tea Production – the Potential Impact of a Scientific Exchange in China on the US Tea Production Industry

Brent Pemberton*, *Texas A&M AgriLife Research and Extension Center, Texas A&M University*; Yan Chen, *Louisiana State University Agriculture Center & Research Station*; Jason W. Stagg, *Louisiana State University Agricultural Center*; Donglin Zhang, *University of Georgia* and Jason McDonald, *Great Mississippi Tea Company*

Abstract: Consumption of tea in the US as a healthy beverage has increased six-times over the last decade and reached $12 billion in 2016. During the same time, the number of tea (*Camellia sinensis*) growers in the continental US has also increased and the US Tea Association predicts that the tea market will continue to develop in this country over the next decade. There is a great potential for US tea growers to profit on domestically-grown and processed tea, but knowledge of how US production and marketing schemes are related to world industry and cultural dynamics will be essential for success. A Scientific Exchange trip to China was made in October 2016 by a group of horticulturists from the LSU AgCenter, Texas A&M AgriLife Research, the University of Georgia, and a tea grower from the Great Mississippi Tea Company. Tea research institutes and universities with tea science departments in the southeastern region of China were visited with opportunities to learn about the history and current state of the tea industry there along with research findings and current challenges. In addition, tea production areas and the tea market in Shanghai were toured with an opportunity to meet with tea marketing leaders to discuss marketing strategies. There were also opportunities to experience many different facets of tea culture in China including a tea ceremony and tastings. The rise of both domestic and export specialty tea production and marketing (vs. commodity tea) in China, the emphasis seen on plant selection and improvement, the changes discussed in world tea production dynamics, and the importance of a tea culture to the Chinese people were all seen as important considerations that could have an enormous impact on tea production, marketing, and consumption in the US.

Specified Source(s) of Funding: USDA Scientific Cooperation Exchange Program

11:30 AM Growing Tea As a Cash Crop in the Southeastern US

Donglin Zhang*, *University of Georgia*; Yan Chen, *Louisiana State University Agriculture Center & Research Station*; Brent Pemberton, *Texas A&M AgriLife Research and Extension Center, Texas A&M University*; Jason W. Stagg, *Louisiana State University Agricultural Center* and Jason McDonald, *Great Mississippi Tea Company*

Abstract: Tea, *Camellia sinensis* (L.) Kuntze, is a native plant to China with more than 3,000 years of cultivation. Although it has been grown here in the continental US, for some reasons, perhaps the cost of processing, the cost of cultivation, and the cost of labor, it has never become a large-scale cash crop. With growing interest in craft teas and innovations in breeding and harvesting technologies at hand, it is the time for Americans to start supplying their cups of tea from local tea farms. Tea is one of the great horticultural crops for its double duty in the beverage/food and beauty industries. Currently, more than 4,000 tea cultivars have been documented for beverage tea production around the world. But there are only about 140 cultivars of tea in the continental US and the majority of them are planted as ornamentals, except for the Charleston Tea Plantation. The wholesale value of tea in US grew from $1.84 billion in 1990 to $11.5 billion in 2015. Of that, 99% of the ea was imported. The most popular tea types are green, red, white, yellow, brick, and oolong tea. Both tea cultivar and tea processing determines the tea type and quality. Some specialty tea types could be sold for thousands of dollars per lb. Compared with a regular cup of coffee, caffeine content may be its half (red tea) or one-third (green tea). However, tea provides much more essential elements for better health. American South shares the similar climate and soil conditions with tea production centers of the southeastern Asia and it is time to develop tea as our new cash crop.

11:45 AM In-Ground Vegetative Propagation of Single Node Tea (*Camellia sinensis*) Cuttings

John M. Ruter*, *University of Georgia*

Abstract: The relative merits of different propagation techniques of tea (*Camellia sinensis* (L.) Kuntze) were investigated. Single node cuttings of three cultivars of two varieties (var. *assamica* and var. *sinensis*) of the tea plant were rooted separately in raised beds of native Cecil clay-loam soil, or in a layer of sand laid on flat ground, in shaded low tunnels outdoors with mist nozzles. Percentage of rooted propagules were recorded and rooted plants were evaluated 18 weeks after sticking for root dry weight and root length measurements. Cuttings propagated with a sand substrate on flat ground had higher rooting percentages (85%) than cuttings placed in native soil (78%). Cultivar had no influence on percent rooting. Root length was influenced by substrate and cultivar. Root dry weight was affected by an interaction between substrate and cultivar. Rooting plants in the ground may be a good alternative to traditional container propagation systems.

12:00 PM Coffee (Coffea arabica): A New Crop for Southern California?

Ramiro Lobo*[1]; Christopher Van Norden[2]; Keith Kittredge[2]; Duncan McKee[2]; Jose Fernandez de Soto[3]; Gary S. Bender[4]; Gary Tanizaki[5]; Valerie Mellano[2] and Darren L. Haver[4], *(1)UC Cooperative Extension, (2)Cal Poly Pomona, (3)UC Hansen Agricultural Research & Extension Center, (4)University of California, (5)University of California Cooperative Extension*

Abstract: **Coffee (Coffea Arabica): A New Crop for Southern California?**

Coffee ranks second only to oil as the most important commodity in world trade and is the primary agricultural export for many countries. Coffee (Coffea spp.) is native to Africa where an estimated 100 species are found in diverse geographic and climatic regions. Coffee species vary greatly depending on the region and climate of their origin, resulting in various coffee types with different genetic make-ups, different morphological traits (size and shape of plants, fruits, and growing habits), flavor profiles, tolerance to pests and diseases, and tolerance to drought. Coffee plants adapt and grow well in frost-free microclimates in California from San Luis Obispo to San Diego County. Specialty coffee consumption and the demand for specialty coffees have increased dramatically in the US and the world over the past several years. This trend, combined with increased demand for high value, differentiated agricultural products (local or California grown) and declining profit margins for existing crops, has generated a strong interest in the production of specialty coffee among farmers in Southern California and in coffee as an ornamental, household plant. Replicated field trials using a Randomized Complete Block Design were established at two different geographic locations in Southern California to evaluate the adaptation and performance of a selected number of coffee varieties: (1) An organic trial, under full sun, in monoculture was established at Cal Poly Pomona; and (2) A conventional trial, under shade, in association with cherimoyas was established at the University of California South Coast Research and Extension Center (SCREC) in Irvine, CA . In addition, observation/demonstration trials were established under conventional production systems and in full sun at UC-SCREC in Irvine and in collaboration with several Master Gardener

volunteers across Southern California. Preliminary results indicate that coffee grows/adapts very well to growing conditions of select microclimates in the region and could be successfully grown to bear fruit. However, the results also showed that coffee is highly susceptible to extreme weather conditions (strong winds and hot and cold temperatures) and site selection and plant protection are critical for successful establishment and production. This poster/presentation will help illustrate all phases for coffee production from seedbeds to field establishment, summarize results and observations to date and discuss future plans.

11:00 AM – 12:00 PM *Piscataway (Lobby Level)*

Extension Advisory Council Meeting - Open to All Interested Members

Chair: Desmond Layne, *Washington State University*
Member: Susan Barton, *University of Delaware*

11:00 AM – 12:00 PM *Northwest (Lobby Level)*

Propagation (PROP) Meeting - Open to All Attendees

Chair: Maria Jenderek, *USDA ARS NCGRP*

Secretaries: Youping Sun, *Department of Plants, Soils, and Climate, Utah State University* and Javier Castillon, *Duarte Nursery*

Objectives:

To exchange ideas and information on propagation of horticultural crops and to provide interaction between industry and public institutions interested in propagation of horticultural crops.

12:00 PM – 12:30 PM *Jefferson West*

Genetics and Germplasm (GG) Meeting - Open to All Attendees

Chair-elect: Wenhao Dai, *North Dakota State University*

Secretary: Kimberly Shearer, *N/A*

Moderator: Theodore Kisha, *USDA-ARS*

Objectives:

To provide a forum for plant breeders, geneticists, botanists, general horticulturists, and others interested in collecting, preserving, evaluating, distributing, and/or using germplasm in or for research or teaching programs.

12:00 PM – 12:30 PM *Lincoln West*

Graduate Student (GRAD) Meeting - Open to All Attendees

Chair: Travis Robert Alexander, *Washington State University, NWREC*

Chair-elects: Jack McCoy, *University of Arkansas - Fayetteville*; Nathan Jahnke, *North Dakota State University* and Hunter Hammock, *University of Tennessee*

Secretary: Kaylee Anne South, *The Ohio State University, OARDC*

Objectives:

To provide a formal organization for Graduate Students in ASHS to support programs and issues facing Graduate Students in Horticulture.

12:00 PM – 12:30 PM *Jefferson East*

Invasive Plants Research (INPR) Meeting - Open to All Attendees

Chair: Neil Anderson, *University of Minnesota*

Chair-elect: Lyn A Gettys, *University of Florida Ft Lauderdale Research and Education Center*

Secretary: Chris Marble, *University of Florida - Mid Florida Research and Education Center*

Objectives:

To communicate research ideas, techniques, and methods on the identification, study, and control of invasive plants in cross-commodity horticulture production and in urban and rural lands; and the assessment of exotic plants for potential invasiveness.

12:30 PM – 1:15 PM *International Ballroom East/Center*

Floriculture 2: Substrates, Light, Temperature (Poster)

Silicate Amendments Reduce Bacterial Blight Infection in *Anthurium andraeanum* Hort. 'Marian Seefurth' (poster)

Teresita Amore*, *Tropical Plant and Soil Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa*; Peter J. Toves, *University of Hawaii* and Anne M Alvarez, *College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa (Poster Board #097)*

Abstract: Newly deflasked anthurium tissue culture plantlets are susceptible to infection by bacterial blight, resulting in mortality and economic losses for growers. Bacterial blight of anthurium is caused by the pathogen *Xanthomonas axonopodis* pv. *dieffenbachiae* (Xad). Silicates have been reported to increase plant resistance to disease. *Anthurium andraeanum* Hort. 'Marian Seefurth', is susceptible to bacterial blight and was selected to assess the effects of silicate amendments in reducing bacterial blight infection in newly deflasked microplants. Single nodes of 'Marian Seefurth' were cultured in liquid medium containing 3/8 strength Murashige and Skoog (MS), 2% sucrose and 0.2 mg/L benzyl adenine supplemented with either 1 mg/L sodium silicate or potassium silicate. After one month in liquid culture, the nodes with developing shoots were transferred to ½ strength MS containing 2% sucrose, 15% coconut water, 2% gellan gum and amended with 1 mg/L of either sodium silicate or potassium silicate. Control media did not contain any silicates. After 20 weeks on semi-solid medium, microplants were deflasked and grown in individual pots. Microplants were inoculated with a bioluminescent strain of Xad. Leaves and stems were detached from the microplants to assess disease incidence and severity 4 weeks post-inoculation. Disease incidence, as measured by the percentage of leaves infected per plant, was similar for the control and silicate treatments. However, disease severity, as measured by the leaf and stem areas colonized by Xad, was less in the silicate treatments. Silicate amendments appear promising as a means to increase microplant survival by reducing the severity of bacterial blight infection. Future experiments will evaluate reducing systemic infection of bacterial blight in microplants by extending the exposure to silicate amendments.

Specified Source(s) of Funding: USDA-NIFA Hatch project HAW09031-H and HAW0868-H managed by the University of Hawaii College of Tropical Agriculture & Human Resources.

Reversal of High Temperature Induced Flowering Delay in Poinsettia with Photoperiod (poster)

Brent Pemberton*, *Texas A&M AgriLife Research and Extension Center, Texas A&M University*; Ruth Kobayashi, *Dummen NA, Inc.*; Cody Bishop, *Texas A&M AgriLife Research and Extension Center, Texas A&M University* and William Roberson, *Texas A&M AgriLife Res. and Ext. Center (Poster Board #098)*

Abstract: Plants of 'Prestige Red' poinsettia (*Euphorbia pulcherrima* Willd. Ex Klotzsch) were grown in greenhouses in Overton, Texas USA to determine if photoperiod could be used to hasten flowering under high temperature conditions. Flowering of this cultivar is known to be delayed by 4 weeks of high temperatures under natural photoperiod during floral initiation. Plants were potted in early September and pinched to 5 nodes two weeks later for natural season flowering. Plants were exposed to either 0, 2, or 4 weeks of a high temperature treatment consisting of a daily average temperature of 27C starting at the time of the pinch. During the high temperature treatment, half the plants were exposed to a natural photoperiod and the other half were exposed to a 9 hour short day with a 15 hour night using black cloth. For the rest of the forcing period, an average daily temperature of 22C was maintained. Dates of first bract color, visible bud, and anthesis were recorded for each plant. There was no difference in number of days to anthesis from start of

treatment for plants with 2 weeks of high temperature at either photoperiod compared to those with 0 weeks of high temperature. However, short days hastened anthesis for plants with 4 weeks of high temperature when compared to plants with 0 or 2 weeks of high temperature under either photoperiod. These relationships held for days to visible bud from treatment as well. When considering days to first bract color from treatment, 4 weeks of high temperature delayed color development on plants under natural days. But, this effect was reversed by short day exposure during the high temperature treatment, though no further hastening by short days was seen. This indicates that short days can be used to reverse the delaying effects of high temperature on flowering.

Specified Source(s) of Funding: Dümmen NA, Inc.

Development of a High Performance Liquid Chromatography (HPLC) Protocol for Identification and Quantification of Anthocyanins in Poinsettia Bracts (poster)

Emily Teng*, *University of Hawaii at Manoa*; Jon-Paul Bingham, *University of Hawaii* and Teresita Amore, *Tropical Plant and Soil Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa (Poster Board #099)*

Abstract: Poinsettia (*Euphorbia pulcherrima)* is the most popular holiday potted plant, with eye-catching bracts colored by anthocyanin pigments that attract consumers to buy the plants every holiday season. Poinsettia breeders are constantly challenged to create new and improved cultivars for the industry, and anthocyanin profiles can aid in cultivar development. Identification and measurement of anthocyanins in poinsettia cultivars has not been conducted since the 1980's, thus pigment profiles of modern poinsettia cultivars are lacking. A standard method to identify and quantify the anthocyanins in poinsettia bracts using High Performance Liquid Chromatography (HPLC) does not exist. Methods for extracting and analyzing anthocyanins in pitanga fruit were adapted for poinsettia bracts. Methanol extraction was followed by pre-purifications to remove lipophilic compounds and separation from other flavonoids using a C18 solid matrix. Finally, acid hydrolysis removed sugars from the compound before analysis using HPLC. The adapted protocol results in accurate identification and quantification of the anthocyanins in poinsettia bracts and also in optimal HPLC chromatograms of high resolution with sharp symmetrical shape on a flat baseline. An updated, efficient HPLC protocol to identify and quantify the anthocyanins in poinsettias will be used to characterize the anthocyanin profiles of modern cultivars and create a database of the pigments. It will also be used in future studies to quantify the effects of temperature and light on anthocyanin content in poinsettia bracts. Ultimately this information will be beneficial to poinsettia breeders when characterizing new germplasm and new hybrids. We thank the Monsanto Graduate Fellowship for funding.

Specified Source(s) of Funding: Monsanto Graduate Fellowship

Effect of Light Qualities Modified By Dye-Sensitized Solar Cells and Light-Emitting Diodes on Plant Shape, Growth and Flowering of Petunia (poster)

Suhyun Park*, *Yeungnam University (Poster Board #100)*

Abstract: **Effect of Light Qualities Modified by Dye-sensitized Solar Cells and Light-emitting Diodes on Plant Shape, Growth and Flowering of Petunia**

Dye-sensitized solar cell (DSC) can be used as a greenhouse glazing material because it is translucent with various colors and produces electricity. However, light quality under DSC is different to that of sunlight and its transmittance of visible light is low. Therefore, we compared the growth and physiological responses of petunia (*Petunia ×hybrida*), a very sensitive plant to light condition, under transparent glass and red-colored DSC. Petunia 'Madness Red' were grown in transparent (T, the control), shading (S), and DSC (D) chambers maintained at 23±2℃, and DSC chambers supplementally lighted with light-emitting diodes (LEDs) (D+L) of blue (B), green (G), white (W), B+G, and R+B+W colors for 16 hours from 06:00 to 22:00 with 60 $\mu mol \cdot m^{-2} \cdot s^{-1}$ PPFD. S and D increased plant height compared with T, and $D+L_{(W)}$ LEDs decreased plant height to the level of T. Plant height under $D+L_{(G)}$ was higher than D, whereas that of $D+L_{(R+B+W)}$ was lower than T. Number of leaves and shoot weights decreased under S and D compared with T, and supplemental lighting with all the LEDs significantly increased number of leaves and shoot weight to the lower level under T. Chlorophyll content decreased under S and D and was recovered to the level of T by LED supplemental lighting except for G. Whereas root weight under LEDs was higher than that under T. So T/R ratios under $D+L_{(B)}$ and $D+L_{(B+G)}$ were lower than that under T. In addition, DSC delayed flowering compared with T, whereas LED lighting except for R+G+B enhanced flowering compared with T. The flower color under T, $D+L_{(B)}$ and $D+L_{(B+G)}$ was darker and redder than that under S and D. In conclusion, petunia grown under DSC had stretched stems and less leaves, lighter biomass, later flowering date and lighter flower color compared with T. Supplemental lighting by LEDs with blue wavelength under DSC improved growth, flowering and plant quality such as plant form and flower color.

This work was supported by the Korea Institute of Energy Technology Evaluation and Planning (KETEP) and the Ministry of Trade, Industry & Energy (MOTIE) of the Republic of Korea (No. 20163030013800).

Assessing the Application of Supplemental Lighting for Short-Day Crops Using Light-Emitting Diodes (poster)

Brian Poel*, *LumiGrow Inc.*; Alexandra Farkas, *Andrew Hendriks and Sons Greenhouses*; Belal El-Hassan, *Andrew Hendriks and Sons Greenhouses* and Melanie Yelton, *LumiGrow Inc. (Poster Board #101)*

Abstract: Reducing time to flower and improving overall crop quality by providing supplemental lighting (SL) for bedding and potted plants that are either day-neutral or facultative long-day is a proven strategy. However, there is less research on the benefit of SL on short-day plants with respect to plant morphology, growth, and time to flower delivered during both the long-day and short-day phases. Through a coordinated grower trial, winter-spring 2017-18, we investigated the effect of SL on the short-day plant *Kalanchoe blossfeldiana* with respect to growth and development.

Initially, during the long day grow phase SL was delivered at 85 $\mu mol \cdot m^{-2} \cdot s^{-1}$, provided when necessary to achieve an approximate daily light integral (DLI) of at least 10 $mol \cdot m^{-2} \cdot d^{-1}$ during an 18-h photoperiod. Depending on ambient light intensity, SL typically was utilized for an average of 14 $h \cdot d^{-1}$. Supplemental lighting from both light-emitting diodes (LEDs) and high-pressure sodium (HPS) lamps were evaluated in separate sections of the greenhouse. The composition of wavelengths from the LEDs was approximately 19% blue, 4% green, and 77% white. At transfer from long days to short days, compactness, an important measure of plant quality, was greater among plants grown under LED SL than those grown under HPS SL.

A portion of the plants, initially grown under LEDs for the long day, 18-h photoperiod, were shifted to grow under LEDs at the same light level of 85 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for 12-h short days. Time to flower was reduced when providing SL from LEDs during both the long days and short days phases, when compared to plants grown under HPS SL for the long-day phase alone. These findings will be integrated into a follow up study to evaluate the economic feasibility of provided SL in both the long day and short-day phases to reduce time to market for short-day plants.

Effects of Pine Bark Substrate Age on Paclobutrazol Efficacy and Growth Control in Marigold (poster)

James T. Smith*, *NC State University*; Brian Jackson, *North Carolina State University*; William Fonteno, *North Carolina State University* and Brian Whipker, *North Carolina State University (Poster Board #102)*

Abstract: **Previous research has shown that pine bark as a horticultural substrate can reduce the efficacy of drench applied plant growth regulators (PGR). There is however no understanding or evaluation of the effect of pine bark age on substrate interaction with PGRs. Physical and chemical characteristics of pine bark have been shown to change significantly over time during the aging or composting process. Therefore, the efficacy of PGRs in substrates containing pine bark may be affected by the age of the pine bark used. To address this question, Paclobutrazol drench applications of 0, 1, 2, and 4 mg were applied to 'Antigua Yellow' marigold (*Tagetes erecta*) grown in 1L plastic containers filled with a 2:2:1 (v:v:v) peat: pine bark: perlite substrate. The pine bark of various ages was obtained from a commercial bark supplier. Bark substrates obtained and used**

in this study were 0, 3, 6, 9, and 12 months old. After six weeks, plant height, growth index, and dry weights were recorded. There was an interaction between PGR rate and bark age for marigold growth indices but not for plant height and dry weight. Marigold height increased when grown in substrates containing 6 month aged bark and was similar in 9 and 12 month aged bark as well. Plant dry weights increased as pine bark age increased from 0 to 12 months. These results indicate that pine bark age does affect marigold growth but the interaction between pine bark age and paclobutrazol efficacy was inconclusive.

Comparison of Calcium and Silicon Sources for *Botrytis* Efficacy and Phytotoxicity (poster)

Katherine Bennett*, *Clemson University*; Uttara Chandani Samarakoon, *The Ohio State University*; Guido Schnabel, *Clemson University* and James Faust, *Clemson University (Poster Board #103)*

Abstract: Spray applications of calcium applied to petunia plants improve the resistance of petunia (*Petunia xhybrida*) flower petals to *Botrytis cinerea* infection. The objective of this experiment was to evaluate the effect of various calcium sources for *Botrytis* control and their potential phytotoxicity. Products examined included, calcium chloride, calcium silicate, potassium silicate, calcium EDTA, calcium nitrate, and calcium metalosate. Three application rates were chosen for each calcium source. A 1-5 scale was used to evaluate spray damage on petunia flowers (1=no damage; 5=75-100% damage). Flower bleaching (pigment loss) was evaluated on a 1-3 scale (1=no bleaching; 3=severe pigment loss). Flowers were treated at different stages of development (buds and 1, 3, 5 and 7 d old open flowers prior to treatment). After the single spray application of the calcium treatments, flowers were then rated 1, 3, 5, and 7 d after the spray. Three to 5 day old flowers were the most susceptible to spray damage, whereas buds were the least susceptible. Calcium chloride and calcium nitrate had the least amount of spray damage and flower bleaching, while potassium silicate and calcium EDTA had the most. Once all the opened flowers had died, the plants returned to a normal appearance except for the higher rates of calcium EDTA which continued to produce damaged flowers for several days after the treatment. *Botrytis* efficacy trials were conducted to determine which nutrient sources provided the most disease control.

Specified Source(s) of Funding: Floriculture Research Alliance, American Floral Endowment

Survey of North American and European Wood Substrate Products and Manufacturing Processes (poster)

Brian Jackson*, *North Carolina State University (Poster Board #104)*

Abstract: With the continued interest in alternative horticultural substrates, specifically wood-based substrates, there remains a void of published information describing the differences in many of the commercially available materials on the market today. The results from many grower trials and independent company R&D trial results are trickling information out to the industry but a thorough overview of products and product differences is needed. A survey of wood substrate materials in North America and Europe was conducted from 2015-2018 during which time as many of the available wood product's as possible were acquired for the purpose of laboratory and greenhouse testing and comparison trials. In addition to product acquisition, information was gathered (when possible) on the type of machinery and processing techniques that were used to create each specific wood component. Of the 30 plus materials collected, observed, evaluated, or tested there were three different machine types identified that produced most all of the wood products: 1) single or twin screw extruders/retruders; 2) twin disc refiners; or 3) hammer mills. Each machine/processing type creates unique wood particles and unique substrate blends/mixes. The different processing types have different effects on the wood chemical properties and phytotoxic potential of the end product. The three processing methods also have differing abilities to be modified or manipulated to create variations among or within their products (fiber thickness, fiber length, wood particle shape, wood particle size, etc.). Upon evaluation of numerous materials manufactured from each of the three machine types, no one product (or process) is superior to others and each one has pro's and con's relative to expense, variability in product offerings, annual maintenance costs, product consistency, properties of the end product material, etc. As commercialization of wood substrates continues, more scientific information and product trial testimonies from growers who choose to use them will be available.

Influence of Dolomitic and Hydrated Limestone on Substrate pH and Iron Deficiency in Calceolaria (*Calceolaria* × *herbeohybrida*) (poster)

W. Garrett Owen*, *Michigan State University (Poster Board #105)*

Abstract: Calceolaria (*Calceolaria* × *herbeohybrida*) is a flowering potted crop that is often challenging because plants develop upper leaf chlorosis (yellowing), interveinal chlorosis, and marginal and leaf-tip necrosis (death) either from greenhouse cultural practices or the production environment. The objectives of this research were to determine the influence of dolomitic and hydrated limestone amendment on substrate pH, plant growth, and tissue nutrient concentration. In the current study, sphagnum peat was amended with 20% (by vol.) perlite. Two liming materials were used, a pulverized dolomitic carbonate limestone (DL) [(85% $CaCO_3$·$MgCO_3$)] and hydrated lime (HL) and were incorporated into 0.02 m^3 (28.3 L) substrates at the following rates: 48.1 (pH 4.1) or 144.2 kg·m^{-3} DL (pH 5.5); 13.2 kg·m^{-3} DL + 2.6 kg·m^{-3} HL (pH 6.5); or 8.8 kg·m^{-3} DL + 5.3 kg·m^{-3} HL (pH 7.2). Substrates were sealed in plastic bags and incubated at 20 ºC for 24 d to allow for lime/pH equilibration. Rooted cuttings of calceolaria 'Orange', 'Orange Red Eye', 'Yellow', and 'Yellow Red Eye' were transplanted into containers filled with the prepared peat-based substrate. Substrate pH and electrical conductivity (EC) was determined bi-weekly and plant growth indices (GI), dry mass, and leaf tissue nutrient concentration were determine at 8 weeks after transplant (WAT). For all cultivars, as limestone amendment rate and WAT increased, substrate pH increased, though to different magnitudes. For instance, as limestone amendment increased, substrate pH for 'Orange' increased from pH 4.1–4.8 to pH 6.9–7.2 at 2 and 8 WAT, respectively. Substrate EC and GI was not significantly influenced by limestone amendment rate, though dry mass increased with lime rate. Iron (%) content of leaf tissue decreased as limestone amendment rate increased up to a substrate pH 6.5–6.9. Therefore, maintaining a pH <6.5 will avoid high pH induced iron deficiency and prevent chlorosis.

12:30 PM – 1:15 PM *International Ballroom East/Center*

Local Food Systems (Poster)

Consumer Acceptability of Locally and Commercially Grown Spinach. (poster)

Eleni Pliakoni*, *Kansas State University*; Konstantinos Batziakas, *Kansas State University*; Marianne Swaney-Stueve, *Kansas State University*; Martin Talavera, *Kansas State University* and Cary L. Rivard, *Kansas State University (Poster Board #225)*

Abstract: The consumer demand for locally grown fresh produce is continuously increasing in the United States. The high tunnel systems have been successfully utilized by small acreage growers for local production. Consumers are typically assessing appearance, freshness, flavor and aroma when purchasing produce. A common perception is that locally grown produce tastes better than non-local. However, there is not much information about the effect of locality on the consumer acceptability and sensory characteristics of spinach. The objective of this study was to identify consumer acceptability and the sensory characteristics of locally grown spinach in open field or in high tunnel and non-local commercially grown spinach. The consumer study (n=205) was conducted at Kansas State University, Olathe campus, and the descriptive sensory analysis was conducted by a highly trained descriptive analysis panel in the Center for Sensory Analysis and Consumer Behavior at Kansas State University, Manhattan campus, in spring 2017. Spinach, *Spinacia oleracea* cv. "Corvair" was grown in open field and in high tunnel at Kansas State University Olathe Horticulture Research and Extension Center (OHREC) in spring 2017 and the commercially grown spinach was purchased at a local retail store. Consumer questionnaires evaluated the preference of the three types of spinach on the basis of appearance, overall liking, flavor and texture using a 9-point hedonic scale. The consumer test showed that high tunnel spinach scored significantly higher in overall liking ($p<0.0001$), flavor liking ($p<0.0001$) and texture liking

($p<0.05$) when compared to open field and store purchased spinach. There was no significant difference in appearance liking between the three types of spinach. Descriptive analysis showed that locally grown spinach had higher intensity of attributes that indicate high quality, such as green color and green/spinach flavors. Our results indicate that locally grown spinach is preferred from the consumers for its high organoleptic quality

Planting Density Effects on Romaine Lettuce Grown in Sub-Irrigated Containers (poster)

Gary R. Bachman*, *Mississippi State University Coastal Research and Extension Center*; Christine H. Coker, *Mississippi State University Coastal Research and Extension Center*; Patricia Knight, *Mississippi State University Coastal Research and Extension Center*; Jenny B. Ryals, *Mississippi State University Coastal Research and Extension Center*; Scott A. Langlois, *Mississippi State University Coastal Research and Extension Center* and Corey Wheeler, *Mississippi State University Coastal Research and Extension Center (Poster Board #226)*

Abstract: Homeowners interested in the source of their food are continuing to drive the increased interest in home vegetable gardens. This is especially true in urban areas where small yards are the norm. Self-irrigated containers offer a successful gardening system for gardeners with limited space such as small yards, porches, or even balconies to grow vegetables. The goal of this project was to grow at three planting densities green and red romaine lettuce (*Lactuca sativa* var. *longifolia*) transplants commonly found by home gardeners at garden centers. The commercially available sub-irrigated EarthBox was used. Following the home owner instructions each EarthBox received pre-plant fertilizer (1 cup 10-10-10) and dolomitic lime (2 cups). Transplants grown in Jumbo 606 packs were planted on January 30, 2017 into peat-based container mix (Sunshine #8). Planting density treatments were 2, 4, or 8 transplants per sub-irrigated container. All plants were harvested on March 21, 2017. Data collected included weight of individual romaine lettuce heads and total weight per sub-irrigated container. Overall, the green romaine head weights were greater than the red. The total head weights for the green romaine produced greater weights per sub-irrigated container regardless of planting density. Planting density total head weights regardless of lettuce type were similar for the 4 and 8 transplant treatments and greater compared to the 2 transplant treatment. When comparing the green and red romaine lettuce there was no difference in the two head treatment, but individual green heads were greater than the red in the four and eight head density treatments. This information is valuable for the home gardener with limited growing to determine how much romaine lettuce to grow to meet family needs.

12:30 PM – 1:15 PM *International Ballroom East/Center*

Orchid (Poster)

Strategies for Developing Cold Tolerant Epiphytic Orchids (poster)

Hideka Kobayashi*, *Kentucky State University, College of Agriculture, Food Science, and Sustainable Systems (Poster Board #106)*

Abstract: Orchids are currently one of the most popular floriculture crop worldwide, and rank top in production in the U.S. Consumers nowadays can purchase exotic orchids from various venues, not limited to traditional orchid nursery, but also from grocery and hardware stores. The present popularity of orchids is partially due to the continuous effort by hybridizers to increase flower size, improve flower shape and color. Despite a rather intense breeding effort, additional characteristics such as cold hardiness or tolerance should be considered to make orchids even more popular or approachable to the general public or reduce the heating cost during production. Several species of *Cymbidium*, *Dendrobium*, and ones belonging to the subtribe Laeliinae show a certain degree of cold hardiness and those species have been casually used in developing hybrids. However, no specific and systematic attempt has been made to impart cold hardiness into commonly available orchids. At Kentucky State University, breeding effort is underway to develop temperature tolerant epiphytic orchids, utilizing some of these cold hardy orchids such as *Cymbidium goeringii*, *Dendrobium moniliforme*, *Epidendrum magnoliae*, *Encyclia tampemsis* and *Laelia anceps*. In this presentation, strategies in for developing cold tolerant epiphytic orchids will be discussed.

Specified Source(s) of Funding: USDA Evans-Allen Research Grant

Adaptation and Challenges of Orchid Conservation in South Florida (poster)

Alondra Cruz, *Florida International university*; Jason Downing, *Fairchild Tropical Botanic Garden* and Amir Khoddamzadeh*, *Florida International University (Poster Board #107)*

Abstract: South Florida has an ever changing community and climate; however, with these changes comes a lot of pressure on the natural environment. With climate change, overpopulation, and invasive species our native orchids face the threat of extinction. In the Million Orchid Project at the Fairchild Tropical Botanic Garden, native and non-native orchid species are propagated in the tissue culture lab mostly from the seeds, transferred to the nursery, and eventually back into the South Florida Environment. This research analyzes the way these sprouting orchids begin to adapt into the environment as they are attached onto different tree species, orientations, and heights throughout the Garden. *Encyclia tampensis, Bletia purpurea, Oncidium ensatum,* and *Cyrtopodium punctatum* orchids ranging from natives to non-natives will be placed around the Garden. Different parameters such as root count, root length, number of the leaves, and the soil-plant analyses development non-destructive handheld sensor will be used in order to determine overall plant health to determine the plants adaptation. Once the orchids have begun to adapt to their new environments, the roots will be examined for fungi and it will be determined if the fungi affects development of the plant and seedlings. The species of beneficial fungi will also be determined in order to be able to use that strain to help the development of those orchid species in the lab for the future.

Specified Source(s) of Funding: USDA-NIFA Hispanic Serving Institutions Higher Education Grants Program (2016-03476-2009)

Growth Response of *Doritaenopsis* Queen Beer 'Mantefon' By Changes of Light Intensity and Nitrogen Supply Under CO_2 Enrichment (poster)

Yoon Jin Kim, *Seoul Women's University*; Ah Ram Cho, *Seoul Women's University* and Sun Woo Chung*, *Seoul National University (Poster Board #108)*

Abstract: Light intensity and nitrogen is required to increase leaf growth under CO_2 enriched conditions. The first, second, third, fourth, and fifth emerged leaf growth was investigated under 800 $\mu mol \cdot mol^{-1}$ CO_2 during 40 weeks with two light intensity (150 and 300 $\mu mol \cdot m^{-2} \cdot s^{-1}$) and four nitrogen concentrations (N1 (0.013 $kg \cdot L^{-1}$), N2 (0.033 $kg \cdot L^{-1}$), N3 (0.053 $kg \cdot L^{-1}$), and N4 (0.073 $kg \cdot L^{-1}$)). Phosphate (0.013 $kg \cdot L^{-1}$) and potassium (0.013 $kg \cdot L^{-1}$) was supplied at each treatment. At N2, total number of leaves increased in the plants under 300 $\mu mol \cdot m^{-2} \cdot s^{-1}$ than the plants under 150 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Survival rates were 100, 93, and 60 % in the plants with N1, N2, and N3, respectively, grown under 150 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Survival rate was 100, 100, and 80 % in the plants with N1, N2, and N3, respectively, grown under 300 $\mu mol \cdot m^{-2} \cdot s^{-1}$. At N1, the length and width of the second, third, fourth, and five emerged leaves was not significant between 150 and 300 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Leaf span decreased by increasing nitrogen supply, regardless of light intensity. Plants were not survived at N4 in 150 and 300 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Overall, Plants survival could improve under 300 $\mu mol \cdot m^{-2} \cdot s^{-1}$ compared to 150 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and nutrient supply at N2 is economic benefit for farmers, considering leaf span. This work was carried out with the support of "Cooperative Research Program for Agriculture Science & Technology Development (Project No. PJ01206901201801)" Rural Development Administration, Republic of Korea and a grant (NRF-2015R1C1A1A02037704) from Nation Research Foundation of Korea.

Tissue Culture Laboratory Transformed Orchid Businesses on a Tropical Island of Guam. (poster)

Alicia Wiecko*, *University of Guam (Poster Board #109)*

Abstract: Orchids represent 600-800 genera with close to 35,000 species. Tropical Guam has the perfect climate to grow them.

Flowers are highly desired by residents and the 1.5 million tourists visiting the island every year. Over the last several decades, most of orchids that were being grown on Guam were imported from Hawaii and Southeast Asia. Unfortunately, detrimental viral diseases entered Guam with the imported plants infecting about 70% of existing orchid plants and causing their steady decline. Starting in 2012, the Guam Department of Agriculture initiated a tissue culture program aimed to eliminate diseased plants, significantly reduce Asian imports and to develop a sustainable production of disease free orchids on island. Within three years, the Tissue Culture Lab developed orchid production to such a level that the importation of diseased plants was largely reduced. Local nurseries and the general public were given the opportunity to replace their diseased plants with healthy ones. In addition, they were able to purchase inexpensive, well-developed seedlings of disease free orchids in large quantities. Harmful in-house propagation of diseased plants virtually ceased in nurseries and was greatly reduced in amateur growers. Additionally, several Guam residents (employed by the project) developed the skills of tissue culture propagation that gave them a competitive edge in this emerging job market. As a result of the program, hotels, restaurants, and Guam's residents had a way to acquire healthy less expensive orchids so that millions of Guam visitors could experience more of the beauty the island has to offer.

12:30 PM – 1:15 PM *International Ballroom East/Center*

Plasticulture (Poster)

Soil Sampling to Assess Biodegradable Plastic Mulch Fragments in Soil (poster)

Shuresh Ghimire*, *Washington State University*; Arnold Saxton, *The University of Tennessee* and Carol Miles, *Washington State University, NWREC (Poster Board #184)*

Abstract: Biodegradable plastic mulch is designed to be tilled into the soil after use, eliminating environmental and economic issues associated with plastic mulch removal and disposal. There is a need for a soil sampling protocol that can accurately assess the amount of biodegradable mulch remaining in a field post soil-incorporation. An experiment was carried out at Mount Vernon, WA to develop such a protocol. Three blocks each of five beds measuring 1 m wide and 10 m long, spaced 2 m on center, were covered with a biodegradable mulch (Organix, Organix Solutions, Maple Grove, MN). Sixty-one days later, beds were disced, first in the direction parallel to the beds and then in the direction diagonal to the beds, as is the common grower practice in this region. Blocks were separated from each other by 8 m so the tractor-tiller could turn without entering an adjacent block. In each block, 24 soil samples were collected 1-3 day after discing: 12 were from the center of the three center mulched beds (four samples per bed), and 12 were from the center of the three center alleys (four samples per alley). For each sample, soil was collected from a 1 m^2 area to a depth of 15 cm using a shovel. The amount of soil sampled was then reduced using the quartering method: the soil was placed on a piece of plywood, mixed thoroughly, divided into quarters by two lines intersecting at right angles at the center of the pile, and two diagonally opposite quarters were discarded. This procedure was carried out a total of three times so that the final sample size (19 L) was $1/8^{th}$ of the original sample size. Mulch fragments were then recovered from each soil sample, and the mulch area was measured. There was no difference in the amount of mulch recovered from the beds and the alleys (91-110%), indicating that mulch fragments were distributed evenly throughout the field. The 95% confidence interval for the recovery rate was 100 ± 11%, indicating this method was reliable and repeatable. Thus, soil sampling using the quartering method can be used to assess the amount of mulch remaining in the field after tillage incorporation when the field is tilled parallel to the bed and then diagonally, and the location of the soil sample relative to the bed center will not affect the amount of mulch recovered.

Rowcover Reduces Water Requirements and Increases Water Use Efficiency in Spring Production of Brussels Sprouts (poster)

Tej Acharya*, *Virginia Tech* and Ramon Arancibia, *Virginia Tech (Poster Board #185)*

Abstract: Determining irrigation requirements for Brussels sprout production under rowcover is essential to maximize yield and improve water use efficiency (WUE). The response of spring planted Brussels sprouts to two plastic mulches (black and white) in combination with spun bonded rowcover and no rowcover was investigated at the Eastern Shore Agricultural Research and Extension Center of Virginia Tech on a Bojac sandy loam soil. The objective of this study was to determine the difference in water requirement and WUE under rowcovers compared to open field conditions. Plants were irrigated based on soil moisture and an irrigation event was initiated at 50% deficit of the plant available water. The amount of water applied (irrigation time) was estimated to bring soil moisture in the root zone to field capacity. In addition, temperature, humidity, wind speed, and solar radiation were measured in the canopy to estimate and compare evapotranspiration under rowcovers with the open field. Rowcovers increased air temperature in the growing season, but reduced solar radiation and wind, so evapotranspiration was less under rowcovers in comparison to the open field. Lower evapotranspiration was associated with less irrigation under the rowcovers compared to the open field. Rowcovers increased plant growth, stem length, number of sprouts, and total yield. In conclusion, rowcovers increased Brussels sprout production and WUE, which may justify their use to improve the sustainability of vegetable production in water limited areas.

Specified Source(s) of Funding: Southern SARE

Promoting Productivity and Efficiencies in Summer Planted Tissue Culture Floricane Raspberry Using Biodegradable Plastic Mulches (poster)

Huan Zhang*, *Washington State University*; Carol Miles, *Washington State University, NWREC*; Shuresh Ghimire, *Washington State University*; Chris Benedict, *Washington State University*; Inga A. Zasada, *USDA-ARS* and Lisa DeVetter, *Washington State University (Poster Board #186)*

Abstract: Floricane red raspberry (*Rubus ideaus*) in northwest Washington is typically grown in raised beds and weeds are managed through a combination of herbicide applications and hand weeding. Late summer plantings of tissue culture (TC) raspberry are increasing in Washington because growers find improved establishment relative to traditional spring planting. However, TC transplants can be difficult to establish relative to traditional dormant roots and cane planting materials. Ongoing research has shown polyethylene (PE) and biodegradable plastic mulches (BDMs) improve weed management and promote vegetative plant growth in spring planted TC raspberry transplants. Yet, impacts of plastic mulches in late summer plantings are unknown. Plastic mulches applied in late summer need to overwinter with minimal damage, should provide weed suppression until the following spring, and should also not increase populations of root lesion nematode (*Pratylenchus penetrans*; RLN), a plant-parasitic nematode with a wide host range. The overall objective of this study is to develop knowledge and practical strategies to improve establishment of late summer planted TC raspberry transplants through application of PE mulch and BDMs prior to planting. Six treatments, including four BDMs, a PE mulch, and a bare ground (BG) control are being evaluated in a commercial 'WakeHaven' raspberry field planted Aug. 2017 in northwest Washington. Crop growth, weed suppression, mulch performance [as percent soil exposure (PSE)], soil temperature and moisture, and RLN populations were measured in 2017. Average primocane height was 5 cm greater in all mulched treatments relative to BG control 30 days after planting, but this numeric difference was not statistically significant. There were no weeds in any of the mulched treatments, whereas BG control plots were weedy (51 weeds per m^2) both in Sep. and Oct. 2017. Despite lack of statistical differences, average PSE was 1.4% and 2-15% by Dec. 2017 in the PE and BDMs treatments, respectively. Mulch damage was mainly caused by farm equipment and resultant punctures were enlarged by wind. RLN populations in soil in Oct. 2017 were not different between treatments. Plant growth, RLN population dynamics, and yield data will be collected in 2018 and 2019.

Specified Source(s) of Funding: Washington Red Raspberry Commission and Washington Commission on Pesticide Registration

Commercial Biostimulants Increase Biodegradation of Polylactic Acid Based Agricultural Mulches Containing Alfalfa or Soy Particles (poster)

Ashley A. Thompson*, *University of Nebraska - Lincoln*; M. Benjamin Samuelson, *University of Nebraska - Lincoln*; Ignatius Kadoma, *3M*; Rhae Drijber, *University of Nebraska - Lincoln* and Sam E. Wortman, *University of Nebraska - Lincoln (Poster Board #187)*

Abstract: Polylactic acid (PLA) based agricultural mulches provide several benefits including environmental sustainability, durability, weed control, and soil moisture conservation. Despite these potential benefits, large-scale adoption of PLA mulches in organic and conventional agricultural systems has been hampered by unpredictable biodegradation and persistence in soil. A 16-week microcosm study was implemented to assess the effects of four commercially available biostimulants including Biocat 1000, Extract PBA, Custom GP, and Environoc 501, a compost extract, and distilled water, urea, and sucrose controls on biodegradation and microbial respiration of bio-based agricultural mulches in native soil. Mulches included PLA biofabric, two novel composite PLA biofabrics with embedded alfalfa (PLA-A) and soy (PLA-S) particles, paper mulch (PA), and bioplastic film (BF). After 16 weeks, the PLA-A and PLA-S mulches lost 195% more mass than the PLA mulch. Cumulative microbial respiration in the PLA-A and PLA-S mulch microcosms was 245% and 239% greater than respiration in PLA mulch microcosms. Cumulative and weekly microbial respiration measurements were similar for PLA and BF treatments. The effects of biostimulants on biodegradation and microbial respiration were inconsistent across mulch treatments. However, Extract PBA increased PLA-A biodegradation by 64% and cumulative microbial respiration by 43% compared to water. These results are consistent with previous research demonstrating correlation between mulch biodegradation and microbial respiration. Overall, results suggest that composite PLA-based biofabrics with embedded plant-based particles degrade more quickly than pure PLA mulches in soil, and that some biostimulant products can further accelerate biodegradation.

Specified Source(s) of Funding: USDA NIFA ORG award # 2016-51106-25711

Assessing Microbial Communities of Compost Extracts and Their Effects on Lettuce Growth after Residue Incorporation in Soil (poster)

M. Benjamin Samuelson*, *University of Nebraska - Lincoln*; Elizabeth Jeske, *University of Nebraska - Lincoln*; Rhae Drijber, *University of Nebraska - Lincoln* and Sam E. Wortman, *University of Nebraska - Lincoln (Poster Board #188)*

Abstract: Biodegradable and organic mulches are potentially sustainable alternatives to polyethylene film in vegetable production, but annual soil incorporation of biobased mulch may interfere with subsequent crop growth. However, it may be possible to speed degradation (and minimize nitrogen immobilization) by inoculating residues with compost extracts. Little is known about the microbial composition of compost extracts from different feedstocks and how these extracts influence plant growth following mulch incorporation. We completed a series of biological tests to characterize 10 compost extracts, including nematode extraction, protozoa most probable number assay, fatty acid methyl ester (FAME) profiles and microscopic counts for total bacterial and fungal indices, a colorimetric assay, and a lettuce seed phytotoxicity bioassay. Based on test results, three non-phytotoxic compost extracts (from vermicompost, yardwaste, and chicken manure feedstocks) were selected to explore effects on lettuce growth in residue-rich soils in a greenhouse. Extracts contained a diverse range of bacterial (6-12 nmol FAME/mL), fungal (0.67-2.15 nmol FAME/mL), protozoa (4,660-466,780/mL), and nematode (0-22/mL) concentrations. Soil-incorporated mulch residues included alfalfa (equivalent to 11.2 Mg/ha), straw (4.5 Mg/ha), and wood particle-loaded polylactic acid (PLA) mulch (3.8 Mg/ha), and all residues were inoculated with extracts at a nitrogen-adjusted rate of 3.4 kg N/ha (2,000-4,800 L/ha). The interacting effects of residue and extract influenced lettuce growth. High carbon residues, including PLA mulch, reduced growth and extracts had no effect in these treatments; however, inoculation of alfalfa residue with yardwaste and chicken manure compost extracts increased lettuce growth 60% to 72%, respectively. The growth-promoting extracts contained less microbial biomass and microfauna than the vermicompost extract, which performed comparably to the control. Results suggest that certain compost extracts can enhance lettuce seedling growth when applied to high nitrogen residues before soil incorporation.

Specified Source(s) of Funding: USDA NIFA ORG award # 2016-51106-25711

Nitrogen Requirement and Use Efficiency Increased for Optimal Basil Production Under Rowcover Compared to Open Field (poster)

Tej Acharya*, *Virginia Tech* and Ramon Arancibia, *Virginia Tech (Poster Board #189)*

Abstract: Nitrogen (N) use efficiency (NUE) is important in a sustainable vegetable production system and has a significant impact on the system's nutrient management. Rowcover enhances vegetative growth but N requirement may differ from open field for optimal growth and yield, and N use efficiency. The study was conducted at the Eastern Shore Agricultural Research and Extension Center (AREC), Painter, Virginia Tech, Virginia (longitude -75.82114 and latitude 37.58466). The objective was to determine differences in N requirement and use efficiency in basil under rowcover compared to open field. The experimental design was a split plot with four replications. The main effect was N fertilizer rate (0, 37, 74, 111, 148, and 185 $Kg{\cdot}ha^{-1}$) and the secondary effect (subplots) was low tunnel covered with spun-bonded row cover (Dewitt, 1oz/sqyd, River Birch Mall, 905 S Kings highway, Sikeston, MO 63801) and no cover. Total fresh weight, and biomass increased with rowcover by 61.0 %, and 73.5% respectively. Fresh weight per plant increased exponentially (R^2=0.99) with N fertilization from 832 to 1520g under rowcover, and linearly (R^2=0.87) from 555 to 844 g without rowcover. Although NUE increased with rowcover overall and at each fertilization rate, it decreased as the N fertilization rate increased. Height and stem diameter were not different among the fertilization rates. In conclusion, the increase in basil growth and yield due to N fertilization, and the NUE were greater under rowcover than open field.

Specified Source(s) of Funding: Southern SARE

Tomato Grafting: *Developing High Tunnel Grower Recommendations and Enhancing Our Understanding of the "Rhizobiome"* (poster)

Cary L. Rivard*, *Kansas State University*; Lani Meyer, *Kansas State University*; Ravin Poudel, *University of Florida*; Ari Jumpponen, *Kansas State University*; Megan Kennelly, *Kansas State University* and Karen Garrett, *University of Florida (Poster Board #190)*

Abstract: Tomato grafting is being rapidly adopted by high tunnel growers, particularly those that utilize specialty cultivars. Inter-specific hybrid rootstocks can confer resistance to many soilborne pathogens and may provide added vigor. The objectives of this project were to (1) determine successful grafting methods for small-scale propagators, (2) identify rootstocks that improve crop productivity through on-farm and university research trials, and; (3) evaluate the effects of rootstock genotype on rhizosphere microbial communities (rhizobiome). We investigated the formation of adventitious roots during the propagation of grafted plants. Leaf removal significantly decreased adventitious root formation (P<0.05) and 50% leaf removal led to higher quality transplants. High tunnel trials were conducted from 2013-2016 on three commercial farms (two organic) and at the Olathe Horticulture Center. 'Arnold', 'Maxifort' and 'Colosus' rootstocks provided 20% to 73% increases in fruit yield in our trials (P<0.05). Conversely, 'RST-04-106' and 'RT 1028' rootstocks provided no benefit under little disease pressure and across four locations. We profiled the root rhizobiome by sequencing bacterial 16s ribosomal rRNA and fungal ITS regions from the rhizosphere and within plant roots from the trial sites. The majority of observed microbial taxa were shared; however, a small percentage (less than 3%, P<0.05) were associated with genotype. Interestingly, a more diverse community was observed on 'Maxifort' rootstock. The results of this project identify certain rootstocks that lead to higher productivity for organic and conventional high tunnel tomato growers and show that the rhizobiome of grafted plants is somewhat different than nongrafted tomato. This presentation will highlight the activities and impacts of a North Central Region SARE project (LNC13-355) and was also supported by the Ceres Trust and USDA SCRI.

Specified Source(s) of Funding: NCR-SARE, Ceres Trust

The Impact of Light on Yield and Quality of Tomato and Lettuce Grown in High Tunnels (poster)

Kelly Gude, *Kansas State University*; Cary L. Rivard*, *Kansas State University*; C.B. Rajashekar, *Kansas State University* and Eleni Pliakoni, *Kansas State University (Poster Board #191)*

Abstract: The utilization of high tunnels is growing across the United States and is particularly important for facilitating an expanding local food production system. The benefits of season extension and/or environmental protection have been shown to improve crop productivity characteristics within a number of fruiting vegetables and leafy crops. However, there are sporadic reports of inconsistent and/or negative impacts on nutritional quality when compared to the open-field. In particular, UV light can affect antioxidant capacity and other phytochemical production. The goal of this project was to evaluate the impact of different polyethylene films (standard poly, diffusion poly, clear poly (no UV blocking), UVA + UVB blocking (<380-400 nm)), as well as 55% shade cloth and a simulated movable tunnel on light, temperature, crop yield, shelf life, and nutritional quality of tomato and lettuce. Trials were conducted in 2017 (summer tomatoes, fall lettuce) at the KSU Olathe Horticulture Center in four, 12' x 130', seven-foot tall high tunnels. The trials were arranged in a RCBD and each tunnel served as a replication. Average soil and canopy temperatures were affected by high tunnel covering and the average soil temperature was higher in the plots where the clear poly was used (P<0.001). The plants grown with 55% shade cloth (applied 6 WAP) had dramatically lower marketable tomato fruit yield than all the others with the exception of the UVA + UVB blocking poly (P<0.05). Similar results were seen with lettuce (P<0.001) and visual observations show varying levels of red color in 'New Red Fire' whereas green lettuce, 'Two Star' was generally unaffected. There were no significant differences in ascorbic acid (vitamin C) amongst the different treatments for tomato. High tunnel production systems offer a unique opportunity to manipulate light with various coverings such as different polyethylene films and/or shade cloth that typically cannot be accomplished in the open-field. In order to address production limitations, a further understanding of the impact of light on vegetable crops will be instrumental to furthering local and regional production of fresh-market vegetables.

Specified Source(s) of Funding: USDA NIFA AFRI

12:30 PM – 1:15 PM *International Ballroom East/Center*

Produce Quality, Safety, and Health Properties (Poster)

On-Farm Readiness Review a Collaboration between the Food and Drug Administration, National Association of State Departments of Agriculture, United States Department of Agriculture, State Extension Services and State Regulators (poster)

Wesley Kline*, *Rutgers Cooperative Extension*; Meredith V. Melendez, *Rutgers Cooperative Extension*; Michelle D. Danyluk, *University of Florida*; Travis K. Chapin, *University of Florida*; Chris Gunter, *North Carolina State University*; Philip Tocco, *Michigan State University* and Elizabeth Bihn, *Cornell University (Poster Board #227)*

Abstract: The Produce Safety Rule (PSR) was published by the U.S. Food and Drug Administration (FDA) in the Federal Register in November 2015 as one of seven major new regulations under the Food Safety Modernization Act (FSMA). The PSR covers activities related to the growing, harvesting, packing, and holding of fresh-market produce, with a few specific exemptions. Growers need to go through an FDA approved food safety training prior to being inspected. Currently the Produce Safety Alliance training is the only recognized training. After attending the course and developing awareness of the key PSR requirements, many growers still have questions about different ways that the PSR requirements might be met in their operations. To bridge this critical gap, the National Association of State Departments of Agriculture (NASDA), in partnership with FDA, state departments of agriculture, and extension from Rutgers University, Michigan State University, North Carolina State University and the University of Florida, received funding to develop and deliver an "On-Farm Readiness Review" (OFRR) tool.

The OFRR toolkit contains several parts, including an exemption questionnaire to determine if any or all parts of the operation could be excluded from the PSR, a PSR decision tree to determine the sections of the tool that pertain to the operation, FSMA factsheets, and the OFRR resource document. The OFRR resource document consists of 12 sections that refer to each requirement of the PSR. Within each section, there is information on the regulatory requirement for each, examples of possible activities that may lead to compliance with each regulatory requirement, and ways that someone who comes onto your operation may evaluate compliance with each requirement (what they're looking for) including if a record is required. Every grower participating will receive a copy of the full OFRR tool at the time of the visit.

To prepare for On-Farm Readiness Reviews to be conducted in each state training workshops are being conducted nationwide. These On-Farm Readiness Review trainings began in January of 2018 to train the FDA, the State regulators, and Extension personnel on how to conduct an On-Farm Readiness Review. The trainings are led by the On-Farm Readiness Review Extension Development team. Data is being collected to evaluate the On-Farm Readiness Review training workshops and actual On-Farm Readiness Reviews.

Evaluating the Presence of Foodborne Pathogens in Aquaponics in Comparison to Hydroponics.Wang, Y.J., T. Yang, a.J. Deering, and H.J. Kim (poster)

Yi-Ju Wang*, *Purdue University*; Teng Yang, *Purdue University*; Amanda J. Deering, *Purdue University* and Hye-Ji Kim, *Purdue University (Poster Board #228)*

Abstract: Aquaponics, a growing trend in food production, integrates aquaculture and hydroponics into one system where plants get nutrition from aquaculture wastewater. Bacteria function as biofilter to convert ammonia into nitrite and nitrate plants absorb mineral nutrients from the water, and then purified water is returned to the fish tanks. Aquaponics offer a promising solution for sustainable food production by reducing the usage of water and chemical fertilizers. However, due to the reuse and recycling of waste and waste-derived materials, it is important to appropriately assess and manage potential risks associated with food safety in aquaponics systems. Therefore, the aim of this study was to determine the presence of foodborne pathogens in aquaponics systems. To assess food safety, we collected irrigation water and plant tissues from two different food production systems: aquaponics and hydroponics. Common foodborne illness pathogens (*Escherichia coli* O157:H7, *Listeria monocytogenes*, and *Salmonella enteritidis*) of vegetables were analyzed. We collected roots and edible parts of lettuce, basil, and tomato after 30-day production period. Weighing 25 g of plant tissue into 225 ml peptone water buffer, blend or stomach briefly as necessary. A series of inoculum dilutions were prepared and spread onto selective agar plates. Colonies were counted after incubated at 37 ^{o}C for 20 hours. Even though there are more bacteria in water samples in aquaponics than in hydroponics, there were no significance differences in the colony-forming units (CFU) of foodborne illness bacteria in plant tissues. In aquaponics and hydroponics, we observed that bacteria are 99.9% in the water, nearly 0.1% inside the roots, and less than 0.1% in the edible part. Because we didn't change water in production period and there are many nutrition in the water, bacteria can grow in the water. However, foodborne illness bacteria are hard to be transported in plant tissues, so there are less bacteria in roots and edible parts than in the water. We also found that the CFU of bacteria in tomato roots is 34 times to lettuce roots and 9 times to basil roots, because tomato have longer roots, which provide more space to bacteria growth. Key outcomes are expected to identify the food safety issues in aquaponics systems and to enable future research projects to be targeted for commercial production of concern to fill any knowledge gaps.

Specified Source(s) of Funding: USDA-AFRI

Internalization of *Salmonella* Inoculated on the Surface of Cucumber Fruit (poster)

Brenda Kroft*, *University of Maryland* and Shirley A. Micallef, *University of Maryland (Poster Board #229)*

Abstract: An increasing number of foodborne illness outbreaks associated with cucumber has been observed in recent years.

During the period from 2006 to 2016, a total of 15 cucumber-associated *Salmonella* outbreaks occurred in the United States. An outbreak in 2014, traced back to the Eastern Shore of Maryland, affected at least 275 people and an environmental source for the *Salmonella* contamination was suspected.

Contamination of produce can occur at multiple points throughout the food supply chain but a focus on pre-harvest contamination has increased as a result of knowledge that pathogens have the ability to become internalized within a variety of crops, including tomatoes, spinach and lettuce. Routes of fruit internalization remain largely unexplored, but enteric pathogens have been reported to undergo chemotaxis towards, and enter, leaf stomata. Stomata provide a micro-environment shielded from sanitizers and a source of photosynthetically-produced nutrients that facilitate survival.

Here we investigated the potential for the human enteropathogen *Salmonella enterica* to exhibit surface attachment on and internalization into cucumber fruit. Mini cucumbers purchased from a local store were exposed to light and inoculated in the mid-section with ~10^8 CFU/mL of *Salmonella* serotype Newport or Poona. After incubation periods of either two or 24 hours, half of the cucumbers were dark-treated to close stomata while the other half were used to enumerate attached cells using direct plating on tryptic soy agar. Dark-treated fruit were then surface sterilized with 0.2% sodium hypochlorite to remove surface-associated cells. Inoculated sections were removed with a sterile scalpel, macerated with a pestle in buffered peptone water and enumerated similarly.

For each fruit analyzed, at least one of the two inoculated sections yielded recoverable internalized cells for both the 2- and 24-hour time points, with a statistically significant increase in internalized cells after 24 hours (p<0.05) for both serotypes. After a two-hour incubation and a water rinse to remove unattached cells, reductions of approximately 2 and 0.8 log CFU of Newport and Poona cells/fruit, respectively, were observed. Attachment values were significantly different between serotypes (p<0.05). Quantification of bacteria present after a two-hour incubation and surface sterilization yielded approximately 2 log CFU/fruit for both serotypes, indicating *Salmonella* was able to penetrate the cucumber fruit exocarp and escape application of sanitizing treatment. More work is needed to determine route of entry, however the high degree of internalization reveals a significant food safety risk, as internalized pathogens are protected during subsequent transport and storage.

Specified Source(s) of Funding: University of Maryland, Center for Food Safety and Security Systems

Evaluating the Presence of Foodborne Pathogens in Aquaponics Incomparison to Hydroponics. Wang, Y.J., T. Yang, a.J. Deering, and H.J. Kim (poster)

Yi-Ju Wang*, *Purdue University (Poster Board #230)*

Abstract: Evaluating the presence of foodborne pathogens in aquaponics in comparison to hydroponics
Wang, Y.J., T. Yang, A.J. Deering, and H.J. Kim

Aquaponics, a growing trend in food production, integrates aquaculture and hydroponics into one system where plants get nutrition from aquaculture wastewater. Bacteria function as biofilter to convert ammonia into nitrite and nitrate, plants absorb ammonia and nitrate, and then water is returned to the fish tanks. Aquaponics offer a promising solution for sustainable food production by reducing the usage of water and chemical fertilizers. However, due to the reuse and recycling of waste and waste-derived materials, it is important to appropriately assess and manage potential risks associated with food safety in aquaponics systems. Therefore, the aim of this study was to determine the presence of foodborne pathogens in aquaponics systems. To assess product safety, we collected irrigation water and plant tissues from two different food production systems: aquaponics and hydroponics. Common foodborne illness pathogens (Escherichia coli O157:H7) of vegetables were analyzed. We collected lettuces leaves and roots after 30-day production period. Weighing 25 g of plant tissue into 225 ml peptone water buffer, blend or stomach briefly as necessary. A series of inoculum dilutions were prepared and spread onto selective agar plates. Colonies were counted after incubated at 37 ºC for 20 hours. We found there were no differences in the number of colonies in the leaves of lettuce grown in aquaponics and hydroponics; however, the number of colonies was 2.8-fold higher in the roots of lettuce grown in hydroponics than aquaponics. This may be due to the fact that the concentrations of nitrogen and phosphorous in hydroponics systems are nearly 4-fold higher, respectively, than aquaponics, providing more resources for bacterial growth in hydroponics. We are investigating a culture-based survey of E.coli O157:H7, Salmonella spp., and Listeria monocytogenes in basils and tomatoes in addition to lettuce. Key outcomes are expected to identify the food safety issues in aquaponics systems and to enable future research projects to be targeted for commercial production of concern to fill any knowledge gaps.

Specified Source(s) of Funding: USDA-AFRI

Survival and Growth of *Salmonella* and *Listeria Monocytogenes* on Fresh-Cut Fruits and Radish Under Different Temperature Abuse Conditions (poster)

Jinwei Huang, *Sichuan Agricultural University*; Bin Zhou*, *USDA-ARS*; Jie Zheng, *FDA*; Xiangwu Nou, *USDA-ARS* and Yaguang Luo, *USDA-ARS (Poster Board #231)*

Abstract: Fresh-cut fruits and vegetables are increasingly being recognized as important vehicles for transmission of human pathogens such as *Salmonella enterica*, and *Listeria monocytogenes*. Understanding the population dynamics of these foodborne pathogens on cut fruits and vegetables stored at different temperatures is critical to improve food safety. We evaluated the survival and growth of *S. enterica* and *L. monocytogenes* on different types of fresh-cut melons and other produce which were exposed to different temperature abuse conditions during seven days of storage. Produce items were purchased from a local wholesale market, including fresh-cut cantaloupe, honeydew, watermelon, pineapple, and radish, cut to cuboid pieces of approximately 8 cm3 and placed into 4 oz portion cups for storage at 4^{o}C until inoculated with a cocktail of three *S. enterica* (SE) serovars and a *L. monocytogenes* (LM) cocktail consisting of three serotypes of *L. monocytogenes* and stored under different temperatures (4, 8, 12 and 35 °C). The results indicated that, under chronic temperature abuse conditions of 8 and 12 ^{o}C, all cut melon samples supported significant growth of the inoculated foodborne pathogens, with *S. enterica* populations reaching up to 5.28 log CFU/g and *L. monocytogenes* up to 7.77 log CFU/g. On the other hand, neither *S. enterica* nor *L. monocytogenes* showed any significant growth on fresh-cut radish and pineapple at all the temperatures investigated, with those on fresh-cut pineapple exhibiting rapid population decline. Temperature abuse can foster the proliferation of pathogens in fresh-cut fruits and vegetables. This study showed the potential for *Salmonella* and *L. monocytogenes* survival and growth at a variety of temperatures on cut cantaloupe, watermelon, honeydew, pineapple and radishes, highlighting the importance of maintaining an uninterrupted cold chain for TCS (temperature control for safety) foods and the need for strict controls to prevent or minimize the presence of pathogens before, during, and after the processing of these fruits and vegetables.

Survival of *E. coli* in Manure-Amended Certified Organic Soils and Transfer to Tomatoes, Radish, and Spinach in Maryland Eastern Shore (poster)

Annette Kenney*, *University of Maryland Eastern Shore*; Patricia Millner, *USDA-ARS-BARC*; Alda Pires, *University of California Davis*; Michele Jay-Russell, *University of California Davis* and Fawzy Hashem, *University of Maryland Eastern Shore (Poster Board #232)*

Abstract: Organic fresh produce growers often use raw animal manure to improve and maintain soil quality, fertility and thus productivity. However, untreated, i.e., raw, animal manure used as soil amendment can result in contamination of fresh produce by pathogenic microorganisms that can cause foodborne illnesses. Contamination can occur at any stage throughout fresh produce production and processing. Concerns about potential produce contamination by foodborne illness pathogens, led the National Organic Program to require a 90-day wait time between soil amendment application and harvest for produce not in direct contact with soil, e.g., staked tomatoes and pepper. For produce in direct contact with raw manure-amended soils, a 120-day wait time before harvest is stipulated in the regulation. In this study, the survival of *E. coli* in organic soils amended with raw animal manure were inoculated with a three-strain cocktail of non-pathogenic, rifampicin-resistant *E. coli (rif*-EC*)* at 6 log CFU/ml (1-L per 2m^2 plot). A randomized complete block design with 4

replications for each of 4 treatments: horse manure (HM), dairy manure (DM), poultry litter (PL) and unamended (UnA), were established at the University of Maryland Eastern Shore Research Farm. Soils were analyzed on days 0, 7, 14, 28, 60, 90, and 120 pre- and post-inoculation. Transfer of EC to tomatoes, spinach, and radish was determined at 90 and 120 days post-application of manure and EC inoculum. The EC survival was higher and more persistent in the PL-amended soils, than in any other treatment. In all tomato plots, yellow-striped army worms invaded and caused major crop damage by day 90, and were suspected of contributing to the large number of EC-positive tomato fruits when assayed. Spinach did not mature before frost set, and radishes from all treatments, except UnA, had surviving EC in the initial wash water of the bulbs. This study provides useful information for advancing microbial food safety in fresh organic produce and paves the way for future evaluations of the microbiological and physico-chemical factors in the manure-amended soils that contribute to persistence and/or die-off of the inoculated EC strains.

Specified Source(s) of Funding: USDA-NIFA

Plant Water Stress Limits the Growth of *Salmonella* on Lettuce (poster)

Xingchen Liu*, *University of Maryland, College Park*; Mary Theresa Callahan, *University of Maryland* and Shirley Micallef, *University of Maryland (Poster Board #233)*

Abstract: Introduction: The human enteric pathogen *Salmonella enterica* subsp. *enterica* can colonize leafy greens and cause foodborne illness on consumption. *Salmonella* can thrive on plant surfaces by utilizing nutrients from surfaced-leached exudates. Our previous work reported that the presence of various specialized (secondary) metabolites is negatively correlated with the growth of *Salmonella* on tomato surfaces. When plants are under water stress, they are likely to synthesize more specialized compounds.

Purpose: The purpose of this study was to evaluate the effect of water stress on the growth of *Salmonella* on lettuce leaf surfaces.

Methods: Four-week-old lettuce plants (red loose leaf lettuce cultivar 'Mascara' and Romaine lettuce 'Parris Island Cos') were subjected to water stress for 6 days, or watered regularly (control). Colonies of *Salmonella* Newport and Typhimurium adapted for rifampicin resistance were grown overnight on tryptic soy agar (TSA) at 35°C , then suspended in 0.1% Peptone Water (PW) to a concentration of 10^7 CFU/ml. Aliquots (100 µl) of the cell suspension were inoculated onto the abaxial side of each leaf. The inoculated leaves on each plant were clipped 24 hours post-inoculation (hpi), and put in a Whirlpak bag with 30 ml of 0.1% PW. Serial dilutions from the rinsate were plated onto TSA with rifampicin for bacterial enumeration.

Results: Population levels of *Salmonella* retrieved from water-stressed and control plants differed. The survival of *Salmonella* were significantly lower on red loose leaf lettuce than Romaine lettuce. For the red loose leaf lettuce, when leaves were inoculated with ~6.0 logCFU/ml *Salmonella*, the number of *Salmonella* Newport cells recovered from water-stressed plants after 24 hpi was 1.6±0.2 logCFU/ml, compared to control plants at 2.4±0.2 logCFU/ml (p<0.05). *Salmonella* Typhimurium recovered from water-stressed plants was estimated at 1.3±0.3 logCFU/ml, while the level on control plants was 2.2±0.3 logCFU/ml (p<0.05).

Significance: These data suggest that lettuce plants responding physiologically to water stress may provide a less favorable environment for *Salmonella* colonization. Cultivar also plays a role in limiting the growth of *Salmonella*. Understanding how human pathogen-plant interactions are affected by extreme fluctuations in climate is important as climate variability increases.

Fruit Quality and Volatile Compounds of Specialty Muskmelon As Affected By Grafting Under Organic Fertilization and Plant-Growth-Promoting Rhizobacteria Management (poster)

Xin Zhao*, *University of Florida*; Yufan Tang, *University of Florida*; Denise M. Tieman, *University of Florida*; Harry J. Klee, *University of Florida* and Jeffrey Brecht, *University of Florida (Poster Board #234)*

Abstract: While interspecific hybrid squash rootstocks are effective in managing soil-borne diseases in grafted melon production, their adverse impacts on fruit quality remains a major concern. This study was conducted to examine the influence of grafting with an interspecific hybrid squash rootstock on fruit quality modification, including volatile compounds, in muskmelon (*Cucumis melo*) under different field management systems. A specialty muskmelon 'Tasty Bites', developed from a cross between Charentais and Ananas melons, was grafted onto a *Cucurbita maxima* × *C.* moschata rootstock 'Super Shintosa' with organic or conventional fertilization, with or without application of plant-growth-promoting rhizobacteria (PGPR). The field trial was carried out during the 2016 spring season in Citra, FL. A split-plot design with four replications was used with the fertilization system and PGPR treatment combinations in the whole plots and grafted vs. non-grafted plants in the subplots. Fully ripe fruit were sampled for quality assessment. Glucose content was significantly higher for organic than conventional fertilization, whereas conventional fertilization resulted in a significantly higher fructose content. The PGPR decreased fruit glucose content, but led to higher sucrose. Fertilization and PGPR showed significant interaction effects on the sugar profile of melon fruit. Flesh firmness of melons decreased under PGPR application or organic fertilization and it was also affected by the interactions among grafting, fertilization, and PGPR. Treatment effects were not observed in fruit soluble solids content, pH, or titratable acidity. Fifty-six volatile compounds were detected, including mainly esters, alcohols, and aldehydes. Non-grafted melons with organic fertilization plus PGPR had the lowest levels of total volatile compounds and esters. Although grafting did not show a significant main effect on total volatile and ester contents, it significantly increased the levels of certain ester compounds such as ethyl propionate, butyl acetate, amyl acetate, prenyl acetate, furfuryl acetate, hexyl acetate, isoamyl butyrate, and benzyl formate. Melons from grafted plants had higher contents of total aldehydes and alcohols than non-grafted melons. In contrast, other volatile compounds such as allyl methyl sulfide were lower in the grafted melons. Overall, grafting appeared to exhibit greater impacts on melon volatile compounds compared with fertilization and PGPR treatments. Future research is warranted to determine the influence of melon volatile profile modification by the *C. maxima* × *C. moschata* rootstock on fruit flavor and other sensory properties perceived by consumers.

Specified Source(s) of Funding: SCRI

Influence of Silver Nanoparticles on Health Promoting Compounds of Watermelon (*Citrullus lanatus*). (poster)

Pratibha Acharya*, *Texas A&M University*; G.K. Jayaprakasha, *Texas A&M University*; Kevin Crosby, *Texas A&M University*; John Jifon, *Texas A&M AgriLife Research Center* and Bhimanagouda Patil, *Texas A&M University (Poster Board #235)*

Abstract: Nanotechnology has the potential to revolutionize the food industry by enhancing productivity, resource efficiency, nutritional quality, and consumer-preferred functional (health-promoting) properties in a cost-effective manner. In this study, we investigated the impact of nano-based seed priming on productivity and accumulation of health-promoting compounds (ascorbic acid, lycopene, and L-citrulline) in watermelon. Silver nanoparticles (AgNPs) were synthesized using onion bulb extracts which have been shown to activate seed phytohormones as well as to stimulate physiological processes and growth. The AgNP-delivery system was used to prime seeds of two watermelon varieties namely: Riverside (diploid) and Maxima (triploid). AgNP priming was compared with a turmeric oil nanoemulsion while dry unprimed seeds were used as controls. Following seed priming, seedlings were raised in a greenhouse and later field-transplanted at four locations within Texas; Edinburg, Pecos, Grapeland and Snook. An increase in lycopene, total ascorbic acid and L-citrulline contents was observed in fruits of Riverside nano-primed with AgNPs. Total ascorbic acid was increased by 54.6 % (Snook), 25% (Grapeland), 10% (Edinburg) and 7% (Pecos) in compared to controls. L-citrulline levels increased up to 62% in fruits of AgNPs treated plants grown in Pecos. Similarly, lycopene contents in fruits of AgNPs treated Riverside seeds were relatively higher in all the locations compared to the control. No consistent changes in nutritional levels were observed in fruits of Maxima. Similarly, seed treatment with turmeric oil nanoemulsion did not have any significant effects on fruit quality of both varieties. These observations suggest that seed priming with AgNPs as a delivery system has a potential to enhance post-harvest fruit functional quality and that outcomes could depend on cultivar, ploidy level, as well as production location. Further investigations are needed to characterize these interactions.

Specified Source(s) of Funding: Texas Department of Agriculture

Sensory Evaluation of Methyl Jasmonate Treated Raw and Steamed Broccoli (poster)

Yu-Chun Chiu*, *West Virginia University*; Kristen Matak, *West Virginia University* and Kang-Mo Ku, *West Virginia University (Poster Board #236)*

Abstract: Application of methyl jasmonate (MeJA) has been reported to enhance the potential health-promoting compound, glucosinolates (GS), especially inducible indole GS-neoglucobrassicin by mimicking insect damage. When plant cells are raptured, myrosinase hydrolyzes GS into its hydrolysis product that may impact consumer acceptance of brassica crops even though myrosinase is usually inactivated during cooking. To our knowledge, there is no report on the consumer acceptance and sensory evaluation on MeJA-treated broccoli (insect-damaged produces). The aim of this study was to determine if an untrained consumer panel can detect differences between control and 250 µM MeJA treated broccoli (raw or steamed 4 min) using sensory evaluation (triangle test, attribute test, and preference test). To further associate the phytochemical profiles with the sensory evaluation, we measured the change in GS, GS hydrolysis profiles, and primary metabolites from broccoli tissue. Results of the triangle test showed that panelists were able to correctly identify the odd raw broccoli samples ($p<0.05$) but not the odd cooked broccoli samples ($p>0.05$), which is consistent with attribute and preference test results. While there was no significant difference in appearance, the raw control broccoli was rated more favorably in taste, texture and overall liking ($p<0.05$). On the other hand, panelists showed no preference between steamed MeJA-treated and steamed control broccoli in any of the attributes tested ($p<0.05$). MeJA treatment significantly induced neoglubrassicin compared to the control broccoli (7.6-fold) and this increment was observed after steaming as well (7.8-fold). MeJA treatment also significantly decreased total aliphatic GS concentration by 25%. *N*-methoxyindole-3-carbinol and N-methoxyindolyl-3-carboxaldehyde, neoglubrassicin-derived hydrolysis products were significantly increased 7.6-fold and 2.4-fold in raw MeJA-treated compared to raw control broccoli. There was significantly less serine in raw MeJA-treated compared to raw control broccoli; however, after steaming the level of galactose, citric acid, and serine was not statistically different between control and MeJA-treated broccoli. Steaming significantly reduced total neoglubrassicin in control (22.3%) and MeJA-treated broccoli (20.5%) compared to raw broccoli. *N*-methoxy indole-3-carbinol was decreased by 89.8% (control) and 96.2% (MeJA treatment). Notably, *N*-methoxy indole-3-acetonitrile was under detection limit in both samples. The decrement of hydrolysis products may result from deactivation of endogenous myrosinase during steaming; therefore, the hydrolysis process was interrupted. This study showed that consumer attribute testing was less favorable toward MeJA-treated raw broccoli; however, cooking the broccoli negated this effect. Partial least square regression model indicates that *N*-methoxyindole-3-carbinol, *N*-methoxyindolyl-3-carboxaldehyde, and *N*-methoxyindole-3-acetonitrile are the most important on sensory quality.

Desirable Light Intensity for Growing *Lactuca indica* As Leafy Greens in Controlled Environment System (poster)

Jaekyung Kim, *Kangwon National University*; Ki-Young Choi*, *Kangwon National University*; Il-Seop Kim, *Kangwon National University*; Ho-Min Kang, *Kangwon national University* and Chiwon W. Lee, *North Dakota State University (Poster Board #237)*

Abstract: The young leafy greens of lettuce have higher levels of vitamins, minerals, antioxidants, and other nutrients than the older mature vegetables on a unit fresh weight basis. The usage of baby leaf and microgreen vegetables as salads and food toppings is on the rise especially in South Korea where smaller family sizes and single-person homes are increasing. *Lactuca indica* 'Sunhyang' is a cultivar developed from a wild species native to Korea that has desirable flavor, aroma, and a short growing period from seed to harvest. The purpose of this research was to determine the optimum light intensity for growing this plant cultivar as baby leaf greens and to characterize the accumulation of phytochemicals under various light levels. Seeds were sown in a standard horticultural root substrate. Upon seed germination, the seedlings were exposed to 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ artificial light for 14 days. When the seedling plants were 6.2 cm tall on the average with 2.9 true-leaves, they started to receive four different levels of light (50, 100, 250, 500 $\mu mol \cdot m^{-2} \cdot s^{-1}$) for 21 days in a controlled environment facility (plant factory). The average desirable plant height was set at 10-12 cm. Starting from 6 days after light treatment began, measurements on plant growth, hunter 'a' value, anthocyanins, phenolics, and chlorophyll were made 6 times at 3-day intervals. The time required for seedlings to reach the desired plant size and actual fresh weights were: 9 days and 1.1 g, 1.8 g per plant at 100 and 250 $\mu mol \cdot m^{-2} \cdot s^{-1}$, respectively. Under 50 $\mu mol \cdot m^{-2} \cdot s^{-1}$ light intensity, it took 12 days to reach the desired plant size with a fresh weight of 1.0 g per plant. When plants were grown under 500 $\mu mol \cdot m^{-2} \cdot s^{-1}$, it took 15 days to reach the desired plant size at 1.5 g per plant. Plants grown with 500 $\mu mol \cdot m^{-2} \cdot s^{-1}$ developed a reddish leaf color with a hunter 'a' value of -2.0-1.5. As light intensity increased, the anthocyanin and phenol contents of the leaves increased, but leaf chlorophyll content decreased. In conclusion, growing plants under 250 $\mu mol \cdot m^{-2} \cdot s^{-1}$ was the best for achieving the desired fresh biomass yield in a minimum time (9 days). For the highest concentrations of functional food ingredients, it is recommended to grow the plants under 500 $\mu mol \cdot m^{-2} \cdot s^{-1}$ light intensity for 15 days.

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Specified Source(s) of Funding: This work was supported by Korea Institute of planning and Evaluation for Technology in Food, Agriculture, Forestry(IPET) through Agri-Bio industry Technology Development Program, funded by Ministry of Agriculture, Food and Rural Affairs.

Flavonol and Anthocyanin Profiles in Some Cowpea [Vigna unguiculata (L.) Walp.] Accessions (poster)

John Morris*, *USDA, ARS, PGRCU*; Ming Li Wang, *USDA, ARS, PGRCU* and Brandon Tonnis, *USDA, ARS, PGRCU (Poster Board #238)*

Abstract: Seeds from 38 cowpea accessions stored in the USDA, ARS, PGRCU freezer were evaluated for delphinidin, cyanidin, myricetin, quercetin content using high performance liquid chromatography (HPLC), and seed coat color. These flavonols and anthocyanins ranged from 0 to 1,378 ug/g in the cowpea seeds. Seed coat colors ranged from cream to black. This data will be subjected to an analysis of variance, mean separations, and correlation analysis to determine significant levels for the phytochemicals as well as interrelationships with chemicals and seed coat color. This information will assist breeders and other scientists in the development of cowpea cultivars with optimum levels of flavonols and anthocyanins.

Seasonal Difference in Nutritionally Important Carotenoid Pigment Concentrations in Microgreens Grown in Controlled Environments (poster)

Dean Kopsell*, *University of Florida*; Rosalie Metallo, *University of Tennessee*; Carl Sams, *The University of Tennessee* and David Kopsell, *Illinois State University (Poster Board #239)*

Abstract: Brassica, lettuce, and herbal crops are the most commonly grown microgreens due to their simple cultivation, quick germination and short production cycles. Microgreens are increasing popular among consumers, and are especially suitable for greenhouse and controlled environment production. Specialty leafy vegetable crops can be excellent sources of carotenoid phytonutrients, which possess reported health benefits of reducing cancers, cardiovascular disease, and aging eye diseases when regularly consumed in the diet. The objective of this study was to screen fifteen commercially available microgreen cultivars across several greenhouse production seasons for accumulation of nutritionally important carotenoid pigments. Five cultivars each of lettuce, herb, and brassica crops were grown under greenhouse conditions using a soilless peat mix in solid-bottom plastic trays (26 x 52 x 3 cm) and misted daily using a fine spray nozzle head. Dates and average growing conditions for greenhouse grown microgreen cultivars were: winter (Jan.-Feb.; DLI, 14 $mols \cdot d^{-1}$; air temperature, 20 °C); spring (Mar.-April; DLI, 32 $mols \cdot d^{-1}$; air temperature, 22 °C); summer (May-July; DLI, 40 $mols \cdot d^{-1}$; air temperature, 25 °C); and fall (Aug.-Sept.; DLI, 36 $mols \cdot d^{-1}$; air temperature, 27 °C). Shoot tissues were harvested after cultivars reached the first to second leaf stage. Samples were frozen at -80 °C, freeze-dried, and measured for concentrations of b-carotene, lutein, and zeaxanthin pigments

using HPLC. Data were analyzed using mixed model in SAS. b-carotene, lutein, and the total concentration of carotenoids pigments within the brassica and lettuce species were influenced by season ($P \leq 0.001$), cultivar ($P \leq 0.001$), and the interaction of season by cultivar ($P \leq 0.001$). b-carotene, lutein, and the total concentration of carotenoids pigments within the herb species were influenced by season ($P \leq 0.001$) and the interaction of season by cultivar ($P \leq 0.001$). Carotenoid pigment concentrations were higher during the summer and fall seasons when DLI and air temperatures were higher for the brassica, lettuce and herb microgreens and lowest in the winter and spring seasons when average DLI and air temperatures were lowest. With the increasing popularity of microgreens, information on the impacts of cultivar selection and growing conditions on nutritional values would be useful information for producers serving local food systems.

Composition of Hollow Heart Flesh in Grafted and Non-Grafted Liberty Seedless Watermelon (poster)

Marlee Trandel*, *North Carolina State University*; Penelope Perkins-Veazie, *North Carolina State University*; Eva Johannes, *NCSU*; Suzanne Johanningsmeier, *USDA-ARS* and Jonathan Schultheis, *North Carolina State University (Poster Board #240)*

Abstract: Triploid (seedless) watermelon is a fruit of great economic importance. However, seedless watermelon cultivars tend to be more susceptible than diploid (seeded) watermelon cultivars to internal defects such as hollow heart (HH). HH is characterized as an internal crack or void developing in the center of the fruit. Watermelon are required as pollinizer plants in seedless watermelon production. Incomplete pollination plays a crucial role in the development of HH. Watermelon cultivars that have less dense flesh also tend to be more prone to HH; however, the effect of rootstock (rs) on HH is unknown. Experimental objectives were to induce HH formation in watermelon, assess rootstock influence, and determine quality. Liberty, prone to HH, was the scion grafted onto four treatments; no graft (control), Carnivor and Kazako (interspecific hybrid rootstock , *C. moschata* x *C. maxima*), and Emphasis (*Lageneria siceraria*, bottle gourd rs). Fruit were cut longitudinally and rated for HH incidence, void airspace and tissue firmness. Firmness was measured with a FDIX penetrometer with 0.8 cm diam. probe in heart and interlocular flesh tissue spaces. Flesh firmness was increased by 1 N in fruit of interspecific rs and fruit with no HH. Sugar content (%fructose, %glucose and %sucrose) of heart tissue was strongly and positively correlated to pH. Fruit from Emphasis rs had the highest %glucose and total sugar content ($p<0.05$). HH incidence and graft rs had no effect on lycopene, citrulline, or arginine content. Confocal micrographs were used to count the number and area (μm^2) of cells in fruit rated no, moderate, and severe HH. At least 750 cells were measured in fruit using ImageJ software. The number of cells was not affected by grafting or HH severity; the average cell area was largest for fruit of Emphasis rs with a average cell area at 110,805 μm^2. Fruit with moderate HH also had a larger cell area (102,873 μm^2). Fruit of Emphasis rs showed decreased tissue firmness and increased in total sugar content. Although fruit with HH tended to have higher total sugar content, no significant differences were seen compared to fruit with no HH. Interspecific hybrid rs increased watermelon tissue firmness and cell density and decreased HH incidence. Fruit were more susceptible to HH when total sugars were higher and firmness/cell density were lower. HH can be field-induced in susceptible watermelon cultivars, and in contrast, HH may be reduced with rs of some interspecific hybrids.

Specified Source(s) of Funding: NIFA-SCRI

12:30 PM – 1:15 PM *International Ballroom East/Center*

Tropical Horticultural Crops (Poster)

Conversion Efficiency of Organic Ginger Rhizomes to Seedlings As Affected By Pre Sprouting Covers (poster)

Lurline Marsh*, *University of Maryland, Eastern Shore* and Brett Smith, *University of Maryland Eastern Shore (Poster Board #378)*

Abstract: Ginger (*Zingiber officinale*, Roscoe) is a high antioxidant spice crop grown for its rhizomes which are used as condiments in various dishes, as medicinals, and as antimicrobials. Native to tropical Asia, it is an herbaceous perennial, which is propagated directly from rhizome pieces that grow optimally in the extended growing season. Under short season conditions, its development is limited, but it has been produced from seed pieces or multi-tillered seedlings derived from rhizome pieces of about 60 – 120 grams. However, there is the potential to increase the number of seedlings derived from seed pieces and the need to determine if pre-sprouting storage of the rhizomes affect budding and seedling production. Thus, a study was conducted to determine if storage of organic ginger rhizomes in organic mix or paper prior to propagation had any influence on sprouting and seedling production. Organic ginger rhizomes harvested in late fall, were covered in organic mix or paper and kept at 20-23.2°C for 4 months until they were removed for propagation in a greenhouse. The growing environment was organic mix in flats where the temperature ranged from 22.2- 36.1°C . The study was conducted as a completely random design with the covers as treatments and three replications. Neither paper nor an organic mix cover affected the number of buds produced prior to propagation, or number of sprouts produced after propagation. Seedling sprouting occurred slowly over the first month. After nine weeks, the average rhizome weight required to produce a seedling, (conversion efficiency) was 50 grams or less. The results indicate that producing multiple seedlings from rhizome pieces may be feasible for producing ginger, particularly, if the seedlings can be started early to give a head start on their tiller number when transplanted.

Specified Source(s) of Funding: Evans Allen

Developing a Production Guide for High Elevation Strawberries in Tropical Timor-Leste (poster)

Russell Wallace*, *Texas A&M University*; Cesaltino Lopes, *USAID's Avansa Agrikultura Project*; Tim Davis, *Texas A&M Univ* and Emily G. Monroe, *Borlaug Institute for International Agriculture (Poster Board #379)*

Abstract: During the past two years, small-acreage growers on the tropical and mountainous island nation of Timor-Leste have initiated strawberry (*Fragaria* x *ananassa*) production as a potential market for fresh, locally-grown berries, and to increase grower profitability and sustainability. Strawberries are a cool weather crop requiring relatively colder temperatures to increase plant growth, crown production and subsequent berry yield. In tropical Timor-Leste, therefore, strawberry production can only succeed at high elevations (1,000 – 1,500 m). Strawberries are currently produced in high tunnels, greenhouses, and open fields. However, growers have had little country-appropriate production information to aid their pursuits. Accordingly, a project funded by USAID (known as the USAID's Avansa Agrikultura Project) in collaboration with Cardno Emerging Markets USA and the Borlaug Institute for International Agriculture at Texas A&M University was initiated to produce a strawberry production manual, as well as train district agricultural agents in strawberry production. Travel to Timor-Leste by the senior author occurred during Aug 15 – 30, 2017 to visit producers, document their needs and production issues, diagnose crop, and field problems, and create the production manual. The assessment indicated that strawberry growers in Timor-Leste are capable of quality and profitable production; however, a lack of basic production knowledge, sufficient growing experience, and significant crop issues limiting high production were observed. Currently, common leaf spot (*Mycosphaerellea fragariae*) is an increasing concern. Results of the visit were summarized, district agents trained and recommendations for country-appropriate techniques were developed and published in the USAID's Avansa Agrikultura Project booklet titled: *Strawberry Production in Timor-Leste: Good Agricultural Practices Manual*. Overall results of the in-country assessment and publication of the manual will be summarized and presented.

Specified Source(s) of Funding: USAID

Ionomic Responses of Papaya and Sapodilla Plants to Two Forms of Root-Zone Salinity (poster)

Thomas Marler*, *Univ of Guam (Poster Board #380)*

Abstract: Root-zone salinity was provided to *Carica papaya* 'Sunrise' (papaya) seedlings and grafted *Manilkara zapota* 'Ponderosa' (sapodilla) plants as diluted ocean water or NaCl solution in order to determine the ionomic responses of root, stem, and leaf tissues. Sand culture was employed and the two salinity treatments were supplied to the intolerant papaya plants at 8 $d \cdot S^{-1}$ and to the tolerant sapodilla plants at 20 $d \cdot S^{-1}$. The

control plants received dilute nutrient solution at 1 $d \cdot S^{-1}$. All experimental units were harvested after 6 weeks of exposure for papaya or 10 weeks of exposure for sapodilla. In papaya, sodium concentration of leaves was greater for ocean water than for NaCl, and chloride concentration of leaves was greater for NaCl than for ocean water. In sapodilla, sodium concentration of leaves was similar between the two salinity treatments, but chloride concentration of leaves was greater for ocean water than for NaCl. Compared to control plants, sodium:potassium of papaya leaves increased 25-fold for NaCl and 41-fold for ocean water; and sodium:potassium of sapodilla leaves increased 5-fold for NaCl and 10-fold for ocean water. Other leaf stoichiometric traits such as nitrogen:phosphorus and nitrogen:potassium were also dissimilar between the two forms of salinity. For both species, root and stem sequestration of sodium was greater in ocean water plants, but root and stem sequestration of chloride was greater in NaCl. These results indicate that previously published analyses of ionomics following exposure to NaCl do not sufficiently reflect true ionomics of plants exposed to salinity stress associated with oceanic coastal environments. The covariance structure of essential nutrients within plant tissue cannot be adequately understood if NaCl exposure is used to study coastal salinity conditions. Many published studies of plant responses to coastal saline conditions should be revisited if NaCl was used to impose the saline conditions.

Nutrient Levels in Date Palm (*Phoenix dactylifera* L) and Ornamental *Phoenix* Spp (poster)

Marylou Polek, *USDA-ARS-NCGRCD* and Robert Krueger*, *USDA ARS NCGRCD (Poster Board #381)*

Abstract: Nutrient concentrations of date palm (*Phoenix dactylifera* L) cv 'Barhee', 'Deglet Noor', 'Khadrawy', 'Khalasa', and 'Medjool' were compared with the breeding line 'Deglet Noor BC5' and ornamental *Phoenix* spp *P canariensis*, *P roebelinii*, and *P reclinata.* All palms were mature trees growing in a genebank maintained by the United States Department of Agriculture in a low desert environment and all received similar cultural care. Leaves were sampled as previously described and analyzed for total N, P, K, S, B, CA, Mg, Zn, Mn, Fe, and Cu. Concentrations of all nutrients studied, except for Mn and Cu, differed significantly ($P > 0.05$) between accessions. In general, macronutrient concentrations tended to be higher in the ornamental species than in *P dactylifera* but this was not true for all *P dactylifera* cultivars due to variations in macronutrient concentrations between *P dactylifera* cv. Regarding micronutrients, the differences in concentrations between *P dactylifera* cv were less pronounced than for macronutrients. Nutrient concentrations in *P canariensis* tended to be similar to *P dactylifera*, but were more variable and lower in *P roebelinii* and *P reclinata*, particularly with regard to micronutrients. These results may be useful in assessing nutrient status of production date palms and of ornamental *Phoenix* spp.

Effects of Biostimulants and Nitrogen on Juvenile Breadfruit Trees (poster)

J. Pablo Morales-Payan*, *University of Puerto Rico (Poster Board #382)*

Abstract: Until recently, in Puerto Rico breadfruit (*Artocarpus altilis*) was not grown in organized orchards. In the 21st century, interest in breadfruit as a commercial crop has been increasing in the island. Although production technology for breadfruit has been researched and developed elsewhere, so far few research projects dealing with breadfruit production have been conducted in Puerto Rico. This research is part of a series of experiments and research activities to address various aspects of crop production such as fertilization, germplasm collection and variety trials, pruning, and others. The research reported here was conducted to evaluate nitrogen (N) fertilizer and biostimulant applications during the first year in new orchards of breadfruit in the island. This experiment was conducted in Lajas, southwestern Puerto Rico. 'Martinez-Toro' breadfruit trees were planted in the field and treated with either 180 or 225 g N per tree per year, combined with either no biostimulant, 40 ml per tree of an *Ascophyllum nodosum* extract or a blend of short-chain peptides. The treatments were established in a randomized complete block design with 8 trees per treatment. Plants receiving 180 g N per tree were shorter, had less leaf area, and lower chlorophyll values in the leaves than trees receiving other treatments. In general, trees treated with 225 g N were more vigorous than those with 180 g N, and trees treated with biostimulants were more vigorous than those without biostimulant treatment. These results indicate that young breadfruit trees are responsive to N rates and that biostimulants may be used to enhance their growth in the tree juvenile stage.

Specified Source(s) of Funding: NIFA/USDA/UPR-Mayaguez Agricultural Experiment Station H-480

Effects of Gibberellic Acid Application to the Avocado Variety Semil 34 (poster)

J. Pablo Morales-Payan*, *University of Puerto Rico (Poster Board #383)*

Abstract: 'Semil 34' is one of the most popular avocado varieties in Puerto Rico. This avocado is a mixed race of Guatemalan and West Indian parentage, and it is typically harvested in November-February. Gibberellic acid has been reported to influence avocado flowering and enhance fruit yield in avocado in subtropical regions. Documentation on the effects of gibberellic acid in 'Semil 34' was lacking. The objective of this research was to determine the effects of foliar applications of gibberellic acid 3 on 'Semil 34' avocado in a tropical location in northwestern Puerto Rico. The avocado trees were in their second fruit-bearing year. There were 10 trees per treatment, in a randomized complete block design. Gibberellic acid 3 was applied at 250 mg per tree, either in March (flowering), June, September, or December. Trees without gibberellic acid treatment were used as a control. Spraying the trees during flowering resulted in increased number of fruits harvested per tree, and increased average fruit weight. Also, the percentage of fruits harvested later in the season was greater in trees sprayed while flowering, which may be advantageous to growers, as 'Semil 34' is among the last avocado varieties harvested in Puerto Rico.

Specified Source(s) of Funding: NIFA/USDA/UPR-Mayaguez Agricultural Experiment Station H-467

Influence of Cover Crops Integration on Newly Established Abaca (*Musa textilis* Nee) Crop Growth and Soil Health in Eastern Central Philippines (poster)

Janet M Miller*, *South Dakota State University*; Romel Armecin, *Visayas State University*; Sharon Clay, *South Dakota State University*; Jenyrose Ang-og, *Visayas State University* and Flordemaelyn Baranda, *Visayas State University (Poster Board #384)*

Abstract: Cover crops provide potential benefits to crop production, soil and water quality, and soil health. They can greatly reduce soil erosion, capture and cycle nutrients, increase soil organic carbon, water infiltration, and microbial biomass, influence microbial diversity, reduce greenhouse gas emissions, and suppress weeds. However, major challenges of adopting cover crops include plant establishment, species selection, soil moisture management, and cover crop termination. We hypothesized that planting cover crops would provide vegetative cover during abaca establishment and maintain soil health but not negatively affect abaca growth. The objectives of this study were: a) to determine if cover crops could be established under abaca; b) examine cover crop growth and biomass production of different species (broadleaf vs grass); c) determine total nitrogen in cover crops and soil; d) evaluate abaca growth to determine (positive, negative, or neutral) impact of cover crops. Cover crops (peanut-*Arachis hypogaea*, mung bean-*Vigna radiata*, upland rice-*Oryza sativa*) were seeded three weeks after transplanting of tissue cultured abaca. Peanut produced greater biomass (3.38 tons ha^{-1}) than mung bean (2.59 tons ha^{-1}) and upland rice (1.86 tons ha^{-1}). The total nitrogen and total carbon of cover crops averaged about 3% and 40%, respectively, regardless of species. Soil microbial biomass averaged about 520ug C g^{-1} soil at 0-15cm, and 396ug C g^{-1} soil at 15-30cm soil depth, and was similar among all treatments. Abaca growth parameters such as plant height, stem diameter, and number of leaves, were similar among control (no cover crop) and cover crop treatments. These results demonstrate that different cover crop species can be integrated successfully under abaca production system while maintaining abaca growth. These cover crops may be extremely important to help with erosion control especially during establishment.

Specified Source(s) of Funding: Borlaug Fellows Program, Purdue Center For Global Food Security, Purdue University,West Lafayette,Indiana

Classification of Macadamia Cultivars Using Near Infrared Spectroscopy (NIRS) and Multivariate Analysis (poster)

Lívia C. Carvalho, *1Universidade Estadual Paulista (UNESP), Faculdade de Ciências Farmacêuticas (FCFAR), Campus de Araraquara*; João Paixão Santos Neto, *Universidade Estadual Paulista (UNESP), Faculdade de Ciências Agrárias e Veterinárias (FCAV)*; Gustavo W. P. Leite, *2Universidade Estadual Paulista, Faculdade de Ciências Agrárias e Veterinárias (FCAV), Campus de Jaboticabal.*; Izabella P. Casagrande, *Universidade Estadual Paulista (UNESP), Faculdade de Ciências Agrárias e Veterinárias (FCAV)*; Gabriele S. Oliveira, *Universidade Estadual Paulista (UNESP), Faculdade de Ciências Agrárias e Veterinárias (FCAV)* and Gustavo Teixeira*, *Universidade Estadual Paulista (UNESP), Faculdade de Ciências Agrárias e Veterinárias (FCAV) (Poster Board #385)*

Abstract: Brazil is the seventh largest macadamia producer in the world with a cultivated area of 6,500 hectares. The main existing macadamia cultivars were introduced from Hawaii Agricultural Experiment Station (HAES) and some were selected by Instituto Agronômico de Campinas (IAC) based on Hawaiian cultivars. Although growers can recognize macadamia cultivars based on nut appearance and morphology, some cultivars produce nuts quite similar to each other, which makes difficult to classify the fruit. As near infrared spectroscopy (NIRS) has been used to classify various food produces, the objective of this study was to evaluate the feasibility of near infrared spectroscopy (NIRS) to classify intact shelled macadamia nuts. A total of 255 shelled macadamia nuts were collected from the following cultivars: IAC 4-20 'Keaumi' (n=80), IAC 5-10 'Kakeré' (n=60), IAC 8-17 'Waiaré' (n=80), IAC 2-23 'Keaudo' (n=40), HAES 246 'Keauhou' (n=80). Two spectra were acquired per nut using a NIR spectrometer (Tango, Bruker, Ettlingen, Germany) in the reflectance mode over the wavelength range of 11,544 a 3,952 cm^{-1}, resolution of 16 cm^{-1}, and 64 scans. Different pre-processings were applied to spectra, namely standard normal variate (SNV), De-trend, multiplicative scatter correction (MSC), and first derivative of Savitzky-Golay. Spectra were subjected to principal component analysis (PCA) and partial least squares discriminant analysis (PLS-DA) and models were developed for each cultivar. The best results were obtained for the cultivars IAC4-20 'Keaumi' (SEP = 0.24%, R_p^2 = 0.68, with 9 LVs) and IAC 2-23 'Keaudo' (SEP = 0.19%, R_p^2 = 0.68, with 11 LVs). The other cultivars could not be separated from each other due to genetic similarities (progeny). These results indicate that NIR spectroscopy can be useful for the classification of macadamia cultivars based on their nuts and could be a valid and simple tool to reduce the quality control costs of monitoring macadamia nuts' quality. However, is recommended more experimentation to include more data variability in order to increase the classification accuracy to 100%.

Specified Source(s) of Funding: CAPES

12:30 PM – 1:15 PM *International Ballroom East/Center*

Vegetable Breeding 2 (Poster)

A Large Genotype-Environment Interaction for Challenging Adaptation Traits Promises Greater Genetic Gain in Breeding Broccoli Adapted to Eastern Growing Conditions. (poster)

Thomas Björkman*, *Cornell University*; Jeanine Davis, *North Carolina State University*; Mark G. Hutton, *University of Maine*; Mark Farnham, *USDA-ARS*; Phillip Griffiths, *Cornell University NYSAES* and Margaret Bloomquist, *North Carolina State University (Poster Board #047)*

Abstract: Expansion of broccoli production in the Eastern US requires adapted varieties. They have not been available because commercial breeders found adaptation too hard to breed for. The eastern environment is notable for greater variation in temperature and water, with warm and humid nights during the growing season. Traits for adaptation include temperature sensitivity of growth and reproductive development. Rapid, uniform but not excessive vegetative growth despite transient excesses of temperature and water, coordinated flower bud development through elongation and arrest at a small size, ability to shed rainwater, and resistance to purple sepals from sunburn or cold.

Some of the traits have been difficult to select for because heritability is low. There are two possibilities for the low heritability: the variation is largely due to environment, or traits are expressed only in specific environments where selection was not done. If the latter is true, breeding by selection has good promise. In both cases the main effect of genotype would be relatively low, but only in the latter case would genotype-by-environment interaction be large (as long as some of the environments produced genotype-dependent variation).

Breeding lines that showed promise an initial screen replaced in replicated trial consisting of 20 environments (five planting dates at each of four locations—Maine, New York, North and South Carolina). Four control entries were consistent in each of four years, with 8 to 13 entries changing annually as new hybrids were produced by breeders and whose promise was identified in screening. The traits were evaluated on a referenced scale with the raters at each site trained to use the scale in the same way.

A particularly difficult trait to improve has been temperature sensitive delay of floral development. This defect occurs when insufficient low temperature exposure temporarily arrests development of reproductive meristems and floral primordia, and causes the flower buds to vary in size at harvest maturity. We scored that trait as "bead uniformity". In the four years, genotype explained 11, 7, 3 and 21% of the total variance. Genotype by environment accounted for 18, 20, 24, and 18.5% of the total variance. The greater contribution of the interaction indicates that the trait can be improved by selecting in the right environment. The comparable numbers for High Dome were lower, with G = 6, 8, 7, 17% and GxE = 15, 12, 13, 28%.

Understanding Salt Tolerance in Lettuce (poster)

Neil Adhikari*, *USDA* and Beiquan Mou, *USDA-ARS (Poster Board #048)*

Abstract: Salinity is a concern in the major lettuce growing districts in California and will be increasingly important. Lettuce is sensitive to salt stress, which reduces biomass and causes other undesirable effects. We sought to identify physiological traits, proteins and genes important in salt tolerance that can be selected for and introduced in new cultivars in order to adapt to high salinity without affecting productivity. Following up on information from previous salinity tolerance studies, crisphead lettuce cvs. Laura and Early Bird were chosen for more detailed analyses. The cultivars were evaluated in a growth chamber at 20°C, 50% relative humidity, 250 $\mu mol/m^2/s$ continuous light and Hoagland nutrient solution without or with NaCl and $CaCl_2$. Salt concentration in the salt treatment started from 0 mM/0 mM NaCl/ $CaCl_2$ (2100 µS/cm) at the time of seeding and was gradually increased every week to 30 mM/15 mM NaCl/ $CaCl_2$ (8600 µS/cm) to prevent salt shock. These high salt concentrations are non-lethal, permissive to lettuce growth and representative of salt concentrations commonly observed in areas of high salinity. We measured leaf chlorophyll content, photosynthetic CO_2 assimilation, leaf transmittance, photosynthetic efficiency (Fv/Fm) and fresh weight at the end of the 4-wk growth period. Shoot and root tissues were harvested for detailed analyses, including quantitative proteomics. Plants in the growth chamber produced significantly more shoot biomass compared to previous salinity-tolerance studies conducted in the greenhouse, and more clearly expressed phenotypic differences between control and salt treatments. Salt-sensitive 'Laura' had a much larger decrease in shoot mass compared with the salt-tolerant 'Early Bird'. Salinity significantly increased chlorophyll content and photosynthetic CO_2 assimilation, but did not affect Fv/Fm in sensitive and tolerant lines. This contrasts with observations in other crop and model plants in which salt stress significantly decreases chlorophyll, photosynthesis, and Fv/Fm. The physiological responses of 'Laura' and 'Early Bird' to salinity are interesting for further studies that could identify unique adaptations in lettuce that may be important in salt tolerance. 1472 proteins from 'Laura' and 975 from 'Early Bird' were identified using quantitative isobaric peptide labeling, off-gel fractionation, and LC/MS/MS analysis. Twenty-eight proteins were upregulated and 31 downregulated significantly in 'Laura', while in 'Early Bird', 5 were upregulated and 8 downregulated significantly in high-salt treatment compared to control. We are currently conducting similar analyses in lettuce cultivars from other lettuce types to identify physiological traits, proteins and genes that are important for salinity tolerance.

Specified Source(s) of Funding: California Department of Food And Agriculture

Reduced Seed Count Improves Versatility of Specialty Snack Peppers (*Capsicum annuum* L.) (poster)

John Stommel*, *USDA, ARS, GIFVL (Poster Board #049)*

Abstract: Small/miniature sweet and hot peppers (*Capsicum annu*um L.) are a rapidly growing class of specialty peppers. The peppers are popular among consumers because of their versatility, snackability, vibrant colors and their nutrition attributes. While field production of traditional pepper commodities is in decline in parts of the country, other parts including snack peppers are expanding greenhouse acreage for high-value specialty pepper production. A relatively small number of commercial snack cultivars with acceptable uniformity have been developed. Additional research is needed to improve product uniformity, fruit quality and shelf-life. Low seed count is an important attribute for consumer acceptance of snack peppers. Seed count within populations exhibiting small round, blunt, and lobed snack size pods was scored and typified by several discreet classes defined by high, reduced and low seed numbers. Seed count was not correlated with fruit shape and segregated independent of pod type. Inheritance of low seed count in the specialty snack pepper market class will be discussed. Our results demonstrate that via extensive selection, low seed count can be combined with snack size pods, superior fruit shape, thick pericarp, and sweetness on plants with compact habit for garden culture and on large stature plants that maximize yield for commercial production.

Fine Mapping of the Genic Male-Sterile Gene (ms_3) in Chili Pepper (*Capsicum annuum* L.) (poster)

Bora Geum*, *Chonbuk National University* and Jundae Lee, *Chonbuk National University (Poster Board #050)*

Abstract: In South Korea, most of peppers (*Capsicum annuum* L.) are F_1 hybrid varieties, which are superior to homozygous varieties in all characteristics such as high uniformity, high productivity, and strong resistance to biotic/abiotic stress. Genic male sterility (GMS) is one of the most used methods for the economic production of hybrid seeds. A GMS gene ms_3 is known for being used to develop the European pepper varieties. The previously developed GMS3-CAPS marker is closely linked to the ms_3 gene. However, it has some problems including no polymorphism, presence of repulsion phase, and existence of recombinants, because it is just the trait-linked marker. Therefore, in this study, we constructed a fine map of ms_3 gene to develop gene-based markers. A total of 119 primer sets for high-resolution melting (HRM) analysis were designed based on the SNPs identified by next generation sequencing (NGS) analysis in the previous study. As a result, a total of 54 HRM markers were developed. Of them, 14 HRM markers were cosegregating with the phenotypes of 332 individuals segregating into male-fertile (MF) and male-sterile (MS). This fine mapping approach revealed the ms_3 gene is positioned within a region of 207.3 kb on chromosome 1, including three candidate genes. This information will be helpful to develop the ms_3 gene-based markers.
Specified Source(s) of Funding: Cooperative Research Program for Agriculture Science & Technology Development (Project no. PJ 01229801), Rural Development Administration, Republic of Korea

Inheritance and Segregation Analysis of Anthocyanin Content in Backcross Population of Tomato (*Solanum lycopersicum* L.) (poster)

Navin Shrestha*, *North Carolina State University* and Dilip R. Panthee, *North Carolina State University (Poster Board #051)*

Abstract: Anthocyanin is one of the significant components of flavonoid in plant systems which has been reported to have antioxidant properties playing preventive roles for important diseases such as cancers and cardiovascular. Anthocyanin in tomato (*Solanum lycopersicum* L.) is phenotypically expressed as purple color. While three genes; *Anthocyanin fruit* (*Aft*), *Aubergine* (*Abg*) and *atroviolaceum* (*atv*) have been reported to be associated with purple color in tomato, no detailed inheritance analysis has been performed for anthocyanin content. A backcross population (BC1) was developed from NC74 CAP (2009) (purple) x Ailsa Craig (green) crossings. The backcross population consisting of 250 individual plants along with P1 (NC74 CAP (2009)), P2 (Ailsa Craig), and F1 (NC11142) were grown at Mountain Horticultural Crops Research & Extension Center (MHCREC), Mills River, North Carolina in summer 2017. Traits like hypocotyl color and its intensity, presence of purple color in seedling leaf and its intensity, and presence of purple color in fruit were observed. Anthocyanin content in parents and BC1 population was analyzed by high-performance liquid chromatography (HPLC) method. Anthocyanin content in 74 CAP (2009) and Ailsa Craig was 15.51 and 7 *nmole/gfw,* respectively. Population mean of anthocyanin was 12 *nmole/gfw* ranging from 0 to 84.31 *nmole/gfw*. Some progenies fall outside the range of parents, suggesting them to be transgressive segregants, which is one of the characteristics of a quantitative trait. We are confirming it in summer 2018 by growing BC2 population. Furthermore, segregation pattern of all the traits did not follow an expected Mendelian ratio for a single or double gene in a backcross population indicating that anthocyanin may be a quantitative trait suggesting that other than reported three genes may be responsible for controlling anthocyanin content in tomato.
Specified Source(s) of Funding: AFRI-USDA

Mapping Quantitative Trait Loci Controlling Fruit Morphology and Color Parameters in Intra-Specific Ril Population of Tomato (poster)

Pragya Adhikari*, *North Carolina State University (Poster Board #052)*

Abstract: Tomato (*Solanum lycopersicum* L.), is world's second most consumed vegetable after potato and cultivated throughout the world. The market value and culinary purposes of tomato are often determined by its appearance and morphology. Genetic characterization of such morphological and appearance traits in intra-specific population will aid in their genetic improvements without any limitation by linkage drag. Objective of this study was to identify the QTL associated with fruit shape, size and color of tomato. QTL analysis for these traits was performed in an intra-specific population of tomato developed from a cross between NC-22L-1(2008) x NC 30P consisting of 110 recombinant inbred lines (RIL). A linkage map with 886 single nucleotide polymorphism (SNP) molecular markers was constructed covering 739.5 cM of 12 chromosomes of tomato, with an average of 0.83 cM between markers. The total of 35 fruit morphology attributes and nine color attributes based on RGB color space (Red, Green, Blue) and CIELAB color space (L*, a*, b*), including two color descriptors (Hue and Chroma) were measured using Tomato Analyzer in two environments. Four fruit size traits (area, perimeter, maximum width, and width mid-height) were mapped to chromosome 2 with a LOD score value of 5 to 8 explaining 19% of phenotypic variance. Three color traits Average Red, Average L, and Average B were mapped to chromosome 4, 9, and 6 respectively with a LOD score value of 3 to 5 explaining 11-20% of phenotypic variance. Fruit shape traits were mapped to chromosome 10 and 12, with a LOD score value of 4 to 5 explaining 24%. phenotypic variance. This information may be useful to improve fruit morphology and color related traits in tomato in the future.

A SNP-Based Genetic Map of Bulb Onion (*Allium cepa* L.) Using Its Transcriptome Sequences As a Reference and Genotyping-By-Sequencing (GBS) Analysis (poster)

Yousoo Choi*, *Chonbuk National University*; Sunggil Kim, *Chonnam National University* and Jundae Lee, *Chonbuk National University (Poster Board #053)*

Abstract: Genetic linkage maps of bulb onion (*Allium cepa* L.) remain relatively rudimentary despite its economic significance as one of the most important vegetable crops globally. It is very difficult to study on genomics and genetic mapping of onion due to large genome size (16.3 Gbp), biennial life cycle, cross-pollinated habit, and high inbreeding depression. High-density genetic maps of onion are inevitably required for completion of its whole genome reference and development of molecular markers associated with traits of interest. In this study, we attempted to generate a high-density genetic map of onion using an F_2 segregating population derived from a cross between a DH line 'H6' and an inbred line 'SP3B', and using genotyping-by-sequencing (GBS) analysis. First of all, 101.8 Gbp of raw sequence data and 1 G of reads were generated by Illumina HiSeq 2500. Clean reads of each sample were mapped to the onion

transcriptome reference sequences. When the filtering condition was set to the minimum depth of 3, a total of 8,431 SNPs were detected. Of them, 704 SNPs were positioned on the genetic linkage map consisting of 8 linkage groups, and the entire genetic distance was 928.3 cM. In addition, each chromosome number of 8 linkage groups was assigned by comparing with the previously reported onion genetic linkage map, OH1×5225. A total of 248 primer sets for high-resolution melting (HRM) analysis were designed based on common SNPs between H6×SP3B and OH1×5225. A total of 35 polymorphic HRM markers were mapped on the onion genetic map of this study and used for comparison of two genetic maps. Finally, the genetic map covered 8 chromosomes with a total genetic distance of 870.4 cM, and contained total 736 markers consisting of 701 SNPs by GBS and 35 HRM markers. This high-density genetic linkage map of bulb onion will be helpful to develop molecular markers for important traits and to accelerate the improvement of onion.

Specified Source(s) of Funding: Korea Institute of Planning and Evaluation for Technology in Food, Agriculture, and Forestry (IPET) through Golden Seed Project, funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) (213007-05-2-WTB11), South Korea

Taro Breeding at the University of Hawai'i (poster)

James E. Keach*, *University of Hawai'i at Mānoa*; Roshan Paudel, *University of Hawaii at Manoa*; J. 'Ama Lilly, *University of Hawai'i* and Susan Miyasaka, *University of Hawaii at Manoa (Poster Board #054)*

Abstract: For over 70 years the University of Hawai'i has been involved in the breeding, selection, and genetic preservation of taro. Taro, *Colocasia esculenta* (L.) Schott, is grown worldwide as a staple starch. Known as 'kalo' in Hawai'i, it has a deep significance to the indigenous people, being an incarnation of the older sibling to humanity in the Hawaiian creation myth. Over 200 landraces of taro were recognized as existing in Hawai'i prior to Western contact; however, only around 60 still exist and are maintained in the University's collections. The globalization of the islands has introduced new cultivars as well as new diseases. Taro Leaf Blight, caused by the oomycete *Phytophthora colocasiae* Racib., is arguably the most damaging disease as it reduces functional leaf area, resulting in reduced corm yield and also less edible leaf vegetable matter. This disease previously resulted in the almost total loss of the Samoan taro crop and export market. Various corm rots also reduce yields, resulting in unsaleable crops and shortened shelf life. Dasheen Mosaic Virus and other viral diseases are also on the rise and have the potential to affect future crop production and quality. To combat these diseases, a succession of researchers at the University of Hawai'i have made crosses between native landraces and germplasm from a range of countries around Asia and the Pacific; using the latter as sources of resistance and increased genetic diversity for their traditional breeding programs. These have lead to releases of several new cultivars with improved resistance and higher yields. However, some of the earlier releases have been controversial, due to patenting of lines developed from native germplasm and questions raised about indigenous biological sovereignty. The current taro breeding program has built upon some of these previous releases, while respecting indigenous rights, improving agronomic performance, and maintaining high eating quality. While we predominately select for poi quality, we have also evaluated lines for use as steamed 'table taro' as well as kulolo: a sort of coconut and taro pudding. The program is working also to foster connections and get feedback from the native Hawaiian community, and we are actively learning from those directly involved in the program as well, including our recently retired breeder Christopher 'Popo' Bernabe. Here we present an overview of our breeding process, some historic cultivar releases, and some of the promising breeding lines we hope to release in the near future.

12:30 PM – 1:15 PM *International Ballroom East/Center*

Vegetable Crops Management 3 (Poster)

Profiling the Phytohormones and Sugars Contents of Orders and Tissues of Kimchi Cabbage Leaves As Affected By Deficit Irrigation (poster)

Hee Ju Lee*, *Vegetable Science Division, National Institute Horticultrual & Herbal Science*; Sang Gyu Lee, *Vegetable Science Division, National Institute Horticultrual & Herbal Science*; Sung Kyeom Kim, *Vegetable Science Division, National Institute Horticultrual & Herbal Science*; Leon A. Terry, *Cranfield University* and Maria del Carmen Alamar, *Cranfield University (Poster Board #026)*

Abstract: This study was conducted to determine the variation in phytohormones and sugar contents of Kimchi cabbage as affected by deficit irrigation treatments. Those biochemicals were elucidated in different leaf orders in terms of both non-head and head formation leaf, and each tissue (midrib white and outer green parts). The abscisic acid (ABA) content of Kimchi cabbage which commenced at the 12 days after deficit irrigation (DI) was higher than that of severe DI treated (commenced after 39 days) in all tested leaf orders and tissues. Diphaseic acid contents of non-heading Kimchi cabbage caused by DI treatments were increased 2 times compared with that of control. DI treatment enhanced ABA oxidation in Kimchi cabbage leaves. In DI treatment, hydroxy-ABA (conjugation form) content of head formation leaf with green part was greater than other leaf types and tissues, while those results were opposite in non-head formation leaf. The glucose and fructose contents of non-head formation leaves with DI treatment ranged from 40-60 mg/gDW, which was higher than head formation leaves. The fructan contents of all tested leaf types and tissues were improved by DI treatment. Results indicated that drought or water stress might induce oxidation of ABA metabolites and enhance biosynthesis fructans in Kimchi cabbage leaves. In addition, there was variation in reaction to DI treatment in various leaf types and tissues of Kimchi cabbage. Furthermore, that information can be used to develop practical methods for coping with environmental stresses.

Specified Source(s) of Funding: RDA of Korea

Influence of Nitrogen Level and Type of Fertilizer on Yield and Nutrient Content of Cabbage (poster)

Timothy Coolong*, *The University of Georgia (Poster Board #027)*

Abstract: Georgia is one of the leading cabbage (*Brassica oleracea* var. capitata) producing states in the U.S. with more than 3500 ha grown annually. Currently, The University of Georgia recommends applying between 196 to 252 kg·ha^{-1} of nitrogen (N) fertilizer to grow cabbage in southern Georgia. It is generally recommended to apply one-third of necessary fertilizer at planting with two additional side-dress applications during the season. Recently growers have begun banding liquid fertilizer several times during the season to reduce N leaching and enhance productivity. To determine the validity of current recommendations as well as the efficacy of applying periodic liquid fertilizer throughout the growing season cabbage, 'Cheers' was grown during Fall 2016 and 2017 with four levels of fertilizer applied (196, 224, 252, 280 kg·ha^{-1} N) to the crop. All plots received 56 kg·ha^{-1} N (5N-4.4P-12.5K) prior to planting. Plots then received a granular (27N-0P-0K, 5% calcium) or liquid calcium nitrate (9N-0P-0K, 14% calcium) applied in two or six side-dress applications during the season. Plots were arranged in a randomized complete block design with three and four replications in 2016 and 2017, respectively. There were no interactions between year, N level, or application type. Therefore main effects were analyzed. There were no treatment effects on total yield; however, N-level significantly affected early yields of cabbage. In both study years plants grown at the 196 kg·ha^{-1} N level had significantly lower yields for the first two harvests compared to all other N-levels. Leaf tissue nutrient concentrations were generally not significantly affected by N fertilizer levels. However, the liquid calcium nitrate treatments did have significantly higher foliar calcium levels compared to the granular treatments. Study year significantly affected yields, average head weights, and foliar nutrient concentrations. In general plants grown in 2017 had higher foliar nutrient concentrations than those produced in 2016. Total yields were greater in 2016, but earlier harvested yields were greater in 2017. This study suggests that current recommendations are adequate for cabbage production in Georgia; however, early yields may be negatively impacted when utilizing the lowest range (196 kg·ha^{-1}) of recommended N fertilizer rates.

Specified Source(s) of Funding: Georgia Vegetable Commodity Commission

Evaluation of Growth and Stomatal Conductance of Kimchi Cabbage with Applied Prototype Irrigation System in Open Fields (poster)

Lee Hee Su, *Vegetable Science Division, National Institute Horticultrual & Herbal Science*; Sung Kyeom Kim*, *Vegetable Science Division, National Institute Horticultrual & Herbal Science*; Hee Ju Lee, *Vegetable Science Division, National Institute Horticultrual & Herbal Science*; Sang Gyu Lee, *Vegetable Science Division, National Institute Horticultrual & Herbal Science*; Mun Boheum, *Vegetable Science Division, National Institute Horticultrual & Herbal Science*; An Se Woong, *Vegetable Science Division, National Institute Horticultrual & Herbal Science* and Lee Jinhyung, *Vegetable Science Division, National Institute Horticultrual & Herbal Science (Poster Board #028)*

Abstract: The aim of this study was to evaluate the performance of a prototype irrigation system on growth and transpiration of Kimchi cabbage. The prototype irrigation system (PIS) consisted of wire or wireless soil moisture sensors (FDR type), data logger, output control panel, and solenoid irrigation valves. The initial irrigation points were set by each soil moisture condition (pF 1.2, 1.7, 2.2, and 2.7). At 56 days after transplanting, the fresh weight and leaf area of Kimchi cabbages at pF 1.2 were the greatest among all the tested treatments, while those of pF 2.2 were lowest. The fresh weight at pF 1.2 was increased by 77% in 2 weeks, however that at pF 2.7 was 29%, while the growth of Kimchi cabbage was retarded in scarcity soil conditions applied by PIS. The results for leaf area were similar to fresh weight data. The stomatal conductance of Kimchi cabbage leaves at pF 1.2 was 266.2 mmol $H_2O \cdot m^{-2} \cdot s^{-1}$, which was the greatest among all the tested treatments. The difference of stomatal conductance was 168 mmol $H_2O \cdot m^{-2} \cdot s^{-1}$ between pF 1.2 and 2.7. Results suggested that PIS can control soil moisture for optimal growth of Kimchi cabbage and it will be feasible for controlling irrigation in open fields.

Specified Source(s) of Funding: This work was carried out with the support of the "Cooperative Research Program for Agriculture, Science & Technology (Project No. PJ 01277502)", RDA

Sustainable Ethnic Crops Production on the Delmarva Peninsula (poster)

Corrie Cotton*, *University of Maryland Eastern Shore*; Nadine Burton, *University of Maryland Eastern Shore* and Celia Whyte, *University of Maryland Eastern Shore (Poster Board #029)*

Abstract: Demographics on the Delmarva Peninsula are becoming more diverse; hence, the need for small farmers to capitalize on this trend and diversify crop offerings. The goal of this project was to provide research-based production practices for high-yielding ethnic crops that can be grown on the Delmarva Peninsula. Six studies were conducted, at two separate locations at the UMES Agricultural Experiment Station, to examine yield of *Brassica rapa* cv. Bosai Chinensis (bok choy), *Amaranthus viridis* Linn (amaranth), and *Hibiscus sabdariffa* L. (hibiscus), using sustainable production practices. Two varieties of bok choy, Mei Qing Choi F1 and Joi Choi F1, were planted using a complete randomized design with six treatments ((1) Control (chemical fertilizer 20:20:20), (2) Vermicompost Tea and Fish Emulsion (VCT+FE), (3) Poultry Litter Leachate (PLL), (4) Control + Azospirillum (AZO), (5) VCT+FE+AZO, and (6) PLL+AZO) and four replications each. Two fertilizer regimes, biofertilizers and organic fertilizers, were used for amaranth and hibiscus production using a complete randomized design with three treatments and four replications each. The biofertilizer treatments included (1) Control, (2) AZO, and (3) Endo/Ecto Mycorrhizae, (Endo/Ecto), and the organic fertilizer treatments included (1) Control, (2) VCT+FE, and (3) PLL. Bok choy was harvested at the mature stage, amaranth was harvested for thirteen consecutive weeks, and hibiscus calyces were harvested four months after planting. Results showed that the yields for all three crops treated with sustainable fertilizers were not different from the control (chemical fertilizer). The yields of bok choy and hibiscus calyces grown in different locations with different soil properties were significantly different ($P<0.05$), but those of amaranth leaves were not. At both locations, the yield of the PLL treatment for the amaranth organic fertilizer study, the yield of the AZO treatment for the amaranth biofertilizer study, and the yield of the VCT+FE for the hibiscus organic fertilizer study was higher than the other treatments. The higher yields varied among treatments and locations for the bok choy studies. There was no significant difference between the control and treatments for each study, which indicates that either treatment can be used to produce a quality yield.

Specified Source(s) of Funding: USDA/NIFA 1890 Capacity Building Grant and USDA/NIFA Evans Allen

Evaluation of Insecticides for the Management of Rough Sweetpotato Weevil, *Blosyrus Asellus* (Coleoptera: Curculionidae) in Hawai'I Island (poster)

Ishakh Pulakkatu-thodi, *University of Hawaii at Manoa*; Sharon Motomura, *University of Hawaii, College of Tropical Agriculture and Human Resources* and Susan Miyasaka*, *University of Hawaii at Manoa (Poster Board #030)*

Abstract: Sweetpotato is an important staple food crop in Hawaii, both for local consumption and export. Insect damage, especially from weevils, is a major production constraint of sweetpotato in the state of Hawaii. Rough sweetpotato weevil is an invasive pest recently detected in the Hawaiian Islands. The immature stages of the weevil gouge shallow groves on the surfaces of the storage roots that adversely affect its appearance, reduce its marketability, and result in wounds that could allow secondary microbial infections. Sustainable pest management practices are limited for this pest, due to its recent introduction in these areas. As an interim approach, efficacy of four insecticides including one bio insecticide were compared against a control to manage this pest in the field. Results from two replicated trials indicate that broad spectrum insecticides such as Belay and Carbaryl are effective in managing this pest. Bio insecticide *Beauveria bassiana* was not very effective at the tested rate. Planting sweetpotatoes continuously in the same area would likely increase pest pressure in subsequent crop cycles because of the buildup of populations in the field. Cultural practices such as crop rotation and use of clean planting materials should help to reduce the incidence of pests in the field.

Specified Source(s) of Funding: USDA NIFA Hatch Project #08029-H administered by the College of Tropical Agriculture & Human Resources, University of Hawaii at Manoa; County of Hawaii Department of Research & Development

Evaluating Cover Crops and Rhizobacteria on Different Sweet Pepper Varieties to Maximize Fruit Yield in a Semi-Arid Region of Puerto Rico. (poster)

Ermita Hernandez*, *University of Puerto Rico*; Bryan Brunner, *University of Puerto Rico* and Julia O'Hallorans, *University of Puerto Rico (Poster Board #031)*

Abstract: Sweet pepper (*Capsicum annuum*) is one of the most important vegetable crops with high demand for consumption in Puerto Rico and the United States. This crop ranks among the top five vegetables produced on over 700 small farms located mainly in the southern region of Puerto Rico. Over the past decades many factors have contributed to the decline in production of sweet pepper on the island, including changes in rain and drought patterns, lack of improved varieties, inadequate crop management practices, and emergence of new pests that limit production. Therefore, growers have become heavily dependent on consecutive applications of synthetic agrochemicals to maintain higher yields, making their business unsustainable. The objective of this study was to develop a sustainable management system for sweet pepper that integrates a mix of cover crops as a soil amendment and the application of microbial inoculants on varieties of Cubanelle-type sweet pepper that could improve fruit yield while maintaining a healthy soil. During the growing seasons of 2016 and 2017 we studied the single and combined effects of a cover crop mix of *Canavalia ensiformis L., Mucuna pruriens* L., and *Crotalaria juncea L*. as a soil amendment and rhizobacteria *Bacillus subtilis QST713* and *Bacillus amyloliquefaciens D747* applied as soil or foliar treatment, respectively, on sweet pepper varieties 'Key West' (F1), 'Grenada' (F1) and SPP9301. In 2016 the mix of cover crops incorporated as green manure significantly increased sweet pepper fruit weight by 18% compared to plots without cover crops. There were no significant differences among varieties or microbial inoculant treatments during this year. However, at the end of the 2016 growing season bacterial leaf blight, caused by *Xanthomonas campestris pv. vesicatoria,* was identified in sweet pepper varieties and disease was suppressed by 6% in plants that were treated with *B. amyloliquefaciens* strain *D747* compared to the control, but this was not statistically significant. During the

2017 growing season the variety SPP9301 had a 20% greater fruit weight than 'Grenada' and 18% greater than 'Key West'. No significant differences were observed due to cover crop or microbial inoculant treatments on sweet pepper yield in 2017. The strategies evaluated give an alternative to small scale farmers to implement a low-input crop management practice that best suits their specific farming system.

Specified Source(s) of Funding: USDA-NIFA funded all part of the research associated with this abstract

University of Maine Paper Agricultural Mulch Project (poster)

Mark G. Hutton*, *University of Maine*; Nicholas Rowley, *University of Maine* and David Handley, *University of Maine (Poster Board #032)*

Abstract: Developing high functioning degradable agricultural paper mulch has been a high research priority at Highmoor Farm. Previous work produced resulted in a commercially viable product that was eventually orphaned by the commercial partner. In 2016 initial tests were performed with new paper formulations. A randomized complete block experiment was conducted with four replications using eight paper mulch treatments and three crop subplots. The following eight mulch treatments were evaluated: Bare soil (no mulch), Planter's Paper (Paris Farmers Union, Oxford, ME), WeedGuard (Sunshine Paper Co., Aurora, CO), black paper mulch (Verso Paper Corporation, Bucksport, ME a product remaining from earlier work), degradable plastic mulch (Paris Farmer's Union, Oxford, ME), black plastic mulch (Pliant Corporation, Washington, GA), CP577, CP581, CP588. The CP series are paper mulches developed at the University of Maine and produced by Monadnock Paper Mills, Inc. (Bennington, NH). Application of the CP paper mulch was straightforward and uncomplicated with only minor adjustments needed to the mulch layer. The roll was placed in the roller cradle closest to the tractor and the roller tension set as loose as possible. The tension wheels were held off the mulch by tying them up to the mulch layer frame. The Planter's paper and WeedGuard papers could only be applied by hand. The plastic mulch showed no signs of degradation through the growing season. The degradable plastic mulch had slight degradation by the end of the growing season. CP588 showed only slight degradation through the growing season. The Verso Planter's paper and WeedGuard paper mulches had rapid degradation of the buried portion soon after application. On 7 August, winds tore large sections of CP577, WeedGuard, Planter's paper and CP581 mulches. The overall performance of the paper mulches was very promising. The paper mulches produced yields in this experiment similar to both standard plastic mulch and degradable plastic mulch. The experimental CP paper mulches are superior to the commercially available papers in that they are able to be applied using stand agricultural mulch laying equipment. Of the papers tested CP 588 was considered superior. The paper remained intact through the entire season and produce yields of the three crops evaluated comparable to the standard production practice of black plastic mulch.

Tomato and Zucchini Squash Yields Are Increased in No-till Compared to Conventional Tillage Plots (poster)

T. Casey Barickman*, *Mississippi State University*; Thomas Horgan, *Mississippi State University*; Cameron Tate, *Mississippi State University*; Will Sublett, *Mississippi State University* and Mike Cox, *Mississippi State University (Poster Board #033)*

Abstract: No-till production systems are gaining attention as a practical way to produce vegetables sustainably and improve soil quality. Growing and managing cover crops to provide ground cover mulches is an important component of these production systems. The combination of cover crop mulches on the surface, and reduced tillage practices can have numerous benefits to soil health and vegetable quality, while positively impacting yields. Non-chemical methods, such as strip tillage, mowing, and rolling and crimping, of cover crop termination to provide a killed cover crop mulch for a no-till production system can be used with great success. Thus, the objective of this research project were to determine the benefits of no-till production system on summer squash and tomato yield and quality Cover crops were established in September 2016. Cover crop plots consisted of cereal rye, hairy vetch, a combination of cereal rye and hairy vetch, and a no cover crop control. Cereal rye was seeded at 150 lbs/ac, hairy vetch at 120 lbs/ac, and the combination of at 75 and 60 lbs/ac, respectively. Plots were 12 x 50 ft and were fertilized with 60 lbs/ac of a composted chicken litter. Cover crop biomass and weed population data were taken just before termination. Weed populations were taken every two weeks throughout the growing season. In April 2017, the cover crops were terminated with a roller-crimper. Seeds of "Skyway" tomato were sown into Pro-Mix BX soilless medium and germinated in greenhouse conditions at 25/20 °C (day/night). Zucchini squash "Yellow Fin" were direct seeded into the killed cover crop plots. Tomato plants were transplanted with a modified no-till vegetable transplanter. Plants of tomato and zucchini were arranged in randomized complete block design with four replications. Tomato and Zucchini fruit were harvested and graded by size according to USDA standards. Results indicated that the cereal rye and the combination of cereal rye and hairy vetch cover crop plots had significantly lower weed densities. Cereal rye also had a positive impact on total tomato and zucchini fruit number and weight when compared to the control treatment. Cereal rye and the combination of cereal rye and vetch the number of large and extra-large tomato fruit and weight. Additionally, all cover crops had a significant increase in medium zucchini fruit and weight when compared to the control treatment. Overall, tomato and zucchini fruit yields were positively impacted by a no-till cover crop production system.

Specified Source(s) of Funding: This study was a contribution of the Mississippi Agriculture and Forestry Experiment Station and USDA-NIFA Hatch S294 project MIS 146030

Tolerance to over the Top Applications of Halosulfuronon on Tabasco Pepper (poster)

Kathryn Fontenot*, *LSU AgCenter*; Ronald Strahan, *LSU AgCenter*; Mary Sexton, *LSU AgCenter* and Matthew Voitier, *LSU AgCenter (Poster Board #034)*

Abstract: Purple nutsedge (*Cyperus rotundus* L.) is a significant weed of Tabasco peppers grown on plastic mulch in Avery Island, Louisiana. Because nutsedge pierces plastic mulch, it competes directly with the crop. This presents a difficult pest control problem for producers, as there is no effective sedge control herbicide labeled for over the top application in Tabasco peppers. Due to its effectiveness at controlling many sedge species, halosulfuron is commonly used to control purple nutsedge in other vegetable crops. Halosulfuron was applied over the pepper plants at rates of 0.25, 0.50, and 1.00 oz/Acre, with 0.25% (by volume) non-ionic surfactant using a CO_2 backpack sprayer delivering 18 GPA. Tabasco pepper yield was not reduced by the halosulfuron rates evaluated in the study.

Integrating Weed and Nutrient Management in Vegetable Crops with Corn Gluten Meal and Soybean Meal (poster)

Allison Butterfield*, *University of Nebraska* and Sam E. Wortman, *University of Nebraska - Lincoln (Poster Board #035)*

Abstract: Bioprocessing byproducts, including corn gluten meal (CGM) and soybean meal (SM), are often used as organic fertilizers and also have demonstrated herbicidal potential. Using these products to integrate weed and nutrient management may increase the profitability of vegetable farms by reducing labor required to control weeds and apply fertilizer. Our research objective was to determine the effects of different bio-based products and application rates on weed suppression, mineral soil nitrogen (N), and crop yield in tomato (*Solanum lycopersicum* 'Defiant') and broccoli (*Brassica oleracea* var. *italica* 'Arcadia'). Four rates of CGM and SM were applied to each of 10 plants in a 15 ft linear bed to achieve 0.5 g, 1 g, 2 g, and 5 g N/plant. These treatments were compared to weedy, weed-free and synthetic fertilizer controls. Velvetleaf (*Abutilon theophrasti*) was seeded into each planting hole prior to treatment application, and emergence recorded weekly. Soil N was measured continuously for 4-8 wks after treatment application with ion-exchange resin membranes. Tomato fruit and broccoli heads were removed at harvest maturity and weighed. Weed emergence was reduced up to 60% and 75% with the highest rates of SM and CGM, respectively. Soil N increased with amendment rate and spikes in ammonium may have contributed to weed suppression; however, amendment type and rate did not influence crop yield. A minimum of 180 g of CGM/ft^2 was required to achieve consistent weed suppression, which is 4.5 to 9 times greater than current industry recommendations (20-40 g/ft^2).

Specified Source(s) of Funding: USDA AMS Specialty Crop Block Grant Program

Sustained Fruit Load Development in Greenhouse Bell Peppers (poster)

Meriam Karlsson*, *University of Alaska, Fairbanks* and M Grandfield, *University of Alaska Fairbanks (Poster Board #036)*

Abstract: Bell pepper selections suited specifically well for intense management in greenhouse environments are now available. For optimal crop management and use of space, these peppers are usually trellised in vertical growing systems. A practice of one to four primary stems with pruned side shoots is often used to encourage reproductive growth and enhance productivity. Some cultivars have a tendency to produce a large number of fruits followed by periods of limited pepper development. To balance the fruit load over the season, selective removal of flowers has been suggested. The greenhouse bell pepper cultivars Felicitas (red), Sympathy (orange), and Bentley (yellow) were included to evaluate reducing the flower number for more consistent fruit development and harvest. Seeds were sown on Feb. 8 and the study conducted from Mar. 17 through Sept. 11. The plants were grown in a high-wire drip irrigation system using dutch (bato) buckets (17.7 L volume) filled with a 50/50 mixture of perlite and a peatlite medium (Pro-Mix BX). The plants were trellised using two primary shoots off the main stem in a "V" shaped system. The lateral side-stems developing on the two primary stems were trimmed over three leaves throughout the study. In treatments with flower removal, every third flower was removed to allow no more than two sequential nodes on a stem to develop fruits. The pepper fruits were harvested mature with at least 90 percent color formation. Plants with no flower removal produced slightly higher yields over the 16 weeks of harvest. The total yield per plant was 4.2 ± 0.99 kg for Felicitas, 3.7 ± 0.51 kg for Sympathy and 4.1 ± 0.75 kg for Bentley. Although there were small variations in overall yield, the size of individual peppers was not affected by the flower management. Subsequently, additional pepper fruits developed for harvest on intact plants. The number of harvested peppers per plant averaged 20 ± 3.7 (Felicitas), 18 ± 2.8 (Sympathy), and 17 ± 2.3 (Bentley). Flower removal reduced the number of harvested fruits on a plant with 2 for Bentley or 3 for Felicitas and Symphony. The average weight of individual fruits was 217 ± 18.7 grams for Felicitas, 199 ± 13.8 for Sympathy and 242 ± 11.6 grams for Bentley. Removing flowers to balance the fruit load over the season resulted in less variation in individual fruit size and more uniform pepper development and harvest.

Liqui-Plex® Increased Hot Pepper Yield and Plant Size in Soil Amended with Soil-Set® Formulation (poster)

George Antonious*, *Kentucky State University*; Eric Turley, *Kentucky State University*; Bijesh Mishra, *Kentucky State Univ.* and Quinn Heist, *Kentucky State Univ. (Poster Board #037)*

Abstract: Hot pepper intake in the U.S. has increased during the last decade due to increased interest in indigenous food. The impact of Soil-Set® (a soil amendment that contains natural enzymatic compounds and balanced nutrients), Grain-Set® (a foliar fertilizer that supplies Mn, S, and Zn to growing plants), and Liqui-Plex® Bonder WP (a foliar fertilizer that comprises minerals complexed with amino acids) on pepper, *Capsicum annuum* var. Georgia Flame yield, fruit and plant quality characteristics, and soil enzymes (urease and invertase) activity were investigated. A randomized complete block design (RCBD) experiment was conducted at Kentucky State University Research Farm. Four treatments (Soil-Set, Grain-Set, Liqui-Plex, and a control) were replicated four times. Pepper seedlings of 52 d old were planted and drip-irrigated as needed. Mature red fruits were collected at three harvests, weighted, counted, and their quality characteristics (length, width, and wall-thickness) and antioxidants (vitamin C, β-carotene, total phenols), and soluble sugars content were determined. In harvest 1, results revealed that the plants treated with Soil-Set and Grain-Set formulations during the growing season produced the greatest fruit length (12.2 cm), whereas plants treated with Liqui-Plex formulation produced the greatest yield and greatest number of ripe fruits compared to the other treatments. Overall three harvests, results revealed that Liqui-Plex produced the greatest yield, greatest number of ripe fruits, and highest fruit wall thickness. These results could recommended to promote the use of Soil-Set and Liqui-Plex new formulations in growing pepper and other vegetables in the U.S.

Specified Source(s) of Funding: USDA/NIFA Funds

12:30 PM – 1:15 PM *International Ballroom East/Center*

Viticulture and Small Fruits 2 (poster)

Fruiting Characteristics of Three Primocane-Fruiting Blackberry Selections at Kentucky State University (poster)

Megan Gearhart*, *Kentucky State University*; Jeremiah Lowe, *Kentucky State University*; Sheri Crabtree, *Kentucky State University* and Kirk Pomper, *Kentucky State University (Poster Board #402)*

Abstract: Kentucky's climate is well-suited for blackberry production. Two cane types exist within brambles: primocanes (or first-year canes), which are usually vegetative, but in primocane-fruiting cultivars will flower and fruit from late summer until frost, depending on temperature, plant health, and the location in which they are grown; and floricanes, which are the same canes, flowering and producing fruit the next growing season in mid summer. A primocane-bearing blackberry trial was planted at the Kentucky State University Research and Demonstration Farm. The planting contained the selections 'Prime-Ark® Traveler', 'Stark® Black Gem®', and APF-268, which are all primocane fruiting selections from the University of Arkansas. The objective of this study was to determine if 'Stark® Black Gem®' (APF-205T) and the advanced selection APF-268 is superior to 'Prime-Ark® Traveler' in terms of yield and fruit quality under Kentucky growing conditions. In 2017, no significant differences were found among the three selections in berry size for the floricane crop. APF-268 had significantly greater yield than the other two selections; 'Prime-Ark® Traveler' showed a trend to have a higher yield than 'Stark® Black Gem®. Primocane fruit size varied significantly; 'Stark® Black Gem®' and APF-268 had a larger fruit size than 'Prime-Ark® Traveler. APF-268 had significantly higher primocane yield whereas 'Prime-Ark® Traveler had the lowest yield and 'Stark® Black Gem®' was between the two. Year-to-year yield characteristics will need to be further evaluated; however, the first-year data suggests that 'Stark® Black Gem®' has large fruit and yields well in Kentucky, and should be considered by growers interested in producing primocane fruiting blackberries for markets with little shipping.

Impacts of Border Vegetation on Multifunctional Biodiversity and Crop Production in Washington Blueberry (poster)

Lisa DeVetter*, *Washington State University*; Matthew Arrington, *Oregon State University*; Beverly Gerdeman, *Washington State University*; Hollis Spitler, *Washington State University*; Olivia Smith, *Washington State University* and William Snyder, *Washington State University (Poster Board #403)*

Abstract: Herbaceous flowering or woody plant borders adjacent to highbush blueberry (*Vaccinium corymbosum*) fields have the potential to benefit both native pollinators and predatory insects and birds that feed on key blueberry pests, such as spotted wing drosophila (*Drosophila suzukii*; SWD). However, they may also draw pollinators away from the crop, serve as overwintering and/or refugia sites for SWD, and increase populations of wild birds that feed on fruit and transmit foodborne pathogens. The objective of this project was to explore the impacts of border vegetation adjacent to blueberry fields on multifunctional biodiversity. In 2017 we measured pollination services, populations of beneficial and pest insect and bird species, and production attributes of blueberry grown with or without adjacent border vegetation on 9 commercial farms in northwest Washington. Our border vegetation treatments include: 1) Control (primarily medium-height grasses); 2) Woody perennial vegetation [mixture of woody species including Cedar (*Cedrus* sp.) and Arborvitae (*Thuja* sp.)]; and; 3) Herbaceous vegetation [mixture of monocots (e.g., *Poa* sp. and quackgrass (*Elymus* sp) and broadleaves (e.g., *Taraxacum officinale*)]. There were no differences in pollinator abundance, pollinator visitation rates, estimated yield, and fruit quality across the treatments. Pest and beneficial insects were collected during a 16-week period using an insect vacuum and apple cider vinegar traps. All treatments exhibited similar pest:beneficial ratios, but arthropod numbers varied widely between treatments. Herbaceous borders represented nearly 50% of the total arthropods collected, while

the control exhibited over twice that of perennial borders. Spotted wing drosophila were absent in all localities. Sticky card data used to monitor arthropod movement between blueberry fields and their borders suggested there were no differences in field populations by treatment. However, there were overall greater populations of both pest and beneficial insects in the border vegetation relative to in the blueberry field. Point count surveys conducted in hedges and blueberry fields were used to evaluate the effects of border vegetation on wild bird populations. Pest species were observed in all habitats, but treatment trends suggest greater density of some species in some habitats. Preliminary data from this project show that while arthropod numbers vary among different borders, blueberry fields remain low in insect biodiversity, which is likely influenced by weekly SWD insecticide applications. Our evaluated border treatments have small to negligible impacts on our measured variables and no clear multifunctional benefits associated with our different border vegetation treatments were detected.
Specified Source(s) of Funding: WSU BIOAg

Quality of Blueberries Harvested By a Modified over-the-Row Harvester (poster)

Wei Yang*, *North Willamette Res & Ext Center*; Lisa DeVetter, *Washington State University*; Scott Korthuis, *Oxbo International* and Fumiomi Takeda, *Appalachian Fruit Research Station (Poster Board #404)*

Abstract: A modified over-the-row (OTR) harvester (Oxbo Model 7240) with experimental-catch surfaces was used for harvesting 'Duke' and 'Draper' blueberry in Oregon and 'Elliott' and 'Aurora' blueberry in NW Washington. All plants were hand-harvested once and then machine harvested (MH) about 7 days later. The modifications to the harvester included a soft intermediate surface over the plastic conveyor belt and hollowed out plastic catch plates (e.g. tennis racket head) to which neoprene sheet (SCS) installed on one side and on the other side a canvass like intermediate surface over the conveyor belt and standard plastic catch plates (HCS). In Oregon, handheld pneumatic shakers operated by workers standing on a platform and in Washington a totally mechanical Orbirotor picking system were used. Harvested fruits were run through commercial packing lines with fresh pack-out recorded and fresh fruit quality evaluated during various length of cold storage. The fresh pack-out for 'Draper' and 'Duke' were at 73% and 83%, respectively, and no difference was noted between MH with SCS and HCS. 'Draper' and 'Elliott' fruit firmness was the highest with hand harvesting, followed by MH with SCS and HCS which had the same firmness. Hand-harvested 'Aurora' had the same fruit firmness as MH with SCS. After 2-4 weeks cold storage, fruit firmness for both 'Draper' and 'Duke' decreased in MH fruits. For 'Elliott' and 'Aurora', fruit firmness was the same among harvesting methods after 2 weeks of cold storage. 'Aurora' fruit had similar bruise ratings between hand harvesting and MH with SCS, while 'Elliott' fruit showed more bruise damage by MH with both SCS and HCS than in hand harvested fruit. Postharvest bruise ratings of 'Elliott' fruit were not affected by harvesting method, while the bruise ratings of 'Aurora' was lower in hand harvested fruits compared to MH with both SCS and HCS. Although our studies showed slightly lower fresh market blueberry pack-outs (%), increased bruise damage, and loss of firmness in fruit harvested by the experimental MH system compared to the hand harvested fruit, these findings were much better than those achieved by commercial OTR harvesters. We demonstrated that fresh market blueberry quality is achievable by using an OTR harvester with softer fruit catching surfaces.

Soil Moisture Variability and Management in a Cranberry Bog (poster)

Peter Jeranyama, *University of Massachusetts Amherst* and Rebecca Brennan*, *UMASS Amherst (Poster Board #405)*

Abstract: Summer irrigation is a major management input in cranberry production, and traditionally, cranberry beds have received 25 mm of water per week from either rain, capillary action from groundwater, irrigation , or some combination of these from late spring through the summer. However, environmental conditions and drainage characteristics can vary from bog to bog, meaning that the 25-mm rule does not always result in ideal soil moisture conditions. Measurement of cranberry soil water status has been based on two technologies; (i) measuring the amount of water in the soil using volumetric water sensors or measuring the depth of the water table in the soil by means of water level floats, and (ii) measuring the energy status of the water (water potential) using a tensiometer. Ideally, irrigation scheduling should consider plant processes in conjunction with the status of the soil water matrix to quantify water stress under different soil conditions. This project assessed various tools of measuring soil water moisture in cranberry beds including a FieldScout TDR 300 Soil Moisture Meter and wireless tensiometers. Six cranberry beds primarily growing cultivar 'Stevens' were monitored throughout the growing season for tension readings; wireless tensiometers reported data to a web portal at 15-min intervals, making it easy to download data. The FieldScout TDR 300 Soil Moisture Meter was used to develop soil moisture maps of monitored beds on a weekly basis during the season. The Moisture Meter was connected to a GPS unit so that generated maps could be overlaid on a satellite image of the bed providing precise locations of soil moisture content at the time of measurement. The FieldScout TDR 300 Soil Moisture Meter maps indicated a great variability in soil moisture throughout monitored cranberry beds. Soil moisture variability demonstrated a 10-20% range of differences. This lack of uniformity in soil moisture content makes it difficult to choose an ideal location for installing a soil moisture monitoring device such as a tensiometer.
Specified Source(s) of Funding: Cape Cod Cranberry Growers' Association

Performance of *Aronia Mitschurinii* 'Viking' Grafted Onto Pyrinae Tree Rootstocks. (poster)

Mark Brand*, *University of Connecticut*; Jessica Lubell, *University of Connecticut*; Jon Mahoney, *University of Connecticut* and Nathan Wojtyna, *University of Connecticut (Poster Board #406)*

Abstract: *Aronia* is a novel fruit crop that produces black fruits that are one of the richest sources of dietary polyphenols and anthocyanins. *Aronia* grows as a multistemmed shrub with many basal shoots. Aronia berries are machine harvested commercially, but low branches laden with fruit are missed by harvesters resulting in 20 to 30% loss of harvest. The low branching also makes weed management difficult. We studied the compatibility and performance of *Aronia mitschurinii* 'Viking' grafted onto various tree rootstocks in the Pyrinae including *Crataegus laevigata*, *Pyrus communis*, *Sorbus alnifolia* and *Sorbus aucuparia* in comparison to own-root cutting plants. Chip bud grafting was used and scions were grafted at 15cm and also at 60 cm for *Sorbus aucuparia*. Best grafting success occurred with *S. aucuparia* at over 85%, while *Crataegus* had the lowest success rate at 33%. Success with *Pyrus* and *S. alnifolia* was ~50%. Significant losses of grafts on *Pyrus* and *Crataegus* occurred in the second and third growing seasons, while no losses occurred with *Sorbus* rootstocks. Plants grafted onto *S. aucuparia* were larger and produced more shoot growth than any other rootstock species or own-root plants. Plants grafted onto *Sorbus* rootstocks yielded substantially more fruit than own-root plants or plants with *Crataegus* or *Pyrus* rootstocks. *S. aucuparia* produced about three times as much fruit as own-root plants and produced substantial yields at an earlier age than own-root plants. Mineral nutrient content of foliage and fruits were analyzed but did not show biologically significant differences between different rootstocks and own root plants. Some statistical differences were seen for fruit Brix and titratable acidity between study plants, but the differences are not significant as far as fruit quality is concerned. *A. mitschurinii* 'Viking' grafted at 60 cm high produced plants with architecture where all branches were held erect and well above the ground. These high grafted plants would allow mechanical harvesters to completely pick all fruit from the plants. Weed control, either by mechanical or herbicide applications, would be easy with the high grafted plants. *Crataegus* and *Pyrus* are not suitable species for use as rootstocks with *Aronia*. *Sorbus*, especially *S. aucuparia*, is an ideal rootstock for use with *Aronia*.

Diversity of Fruit Quality Traits in *Aronia* species (poster)

Peter Apicella*, *University of Connecticut*; Jacob A. Griffith Gardner, *University of Connecticut*; Jon Mahoney, *University of Connecticut* and Mark Brand, *University of Connecticut (Poster Board #407)*

Abstract: The genus *Aronia is a* group of deciduous shrubs in the Rosaceae family, subtribe Pyrinae and are native to eastern regions in North America. The four commonly accepted species include *A. arbutifolia* (L.) Pers., red chokeberry; *A. melanocarpa* (Michx.) Elliott, black chokeberry; *A. prunifolia* (Marshall) Reheder, purple chokeberry; and *A. mitschurinii* (A.K. Skvortsov & Maitul), involving *A. melanocarpa ´ Sorbus aucuparia* hybridization. The

sugar content of *Aronia* fruit is one of the primary traits perceived by consumers. The development of new *Aronia* cultivars with sugar-enhanced content is a primary objective of our breeding program. The *Aronia* germplasm collection at the University of Connecticut, comprised of 120 wild and domesticated accessions, was evaluated for fruit physical traits (weight, size, and percent water content) and fruit chemical traits (total soluble solids [brix] and titratable acidity [TA]) at peak ripe development. A subset of accessions representing six taxonomic groups (six *A. melanocarpa* [2x], two *A. melanocarpa* [4x], two *A. melanocarpa-S* [4x], one *A. prunifolia* [3x], two *A. prunifolia* [4x], two *A. arbutifolia* [4x]) were evaluated at three stages of fruit development. There was a significant amount of variability for physical and chemical traits within and between each taxonomic group at stage two (peak ripe). In general, fruit size, water content and brix increased at each developmental stage. There was a significant negative correlation between water content and brix values. Brix:TA ratios of *A. melanocarpa-S* accessions were significantly higher than all other *Aronia* species. *A. mitschurinii* had the lowest brix:TA ratios, suggesting that wild *Aronia* species may be useful in a breeding program to improve flavor of *Aronia* fruits for commercial production and fresh consumption. The results from this study will provide useful information on future breeding efforts of *Aronia* for commercial fruit production.

Texas Pomegranate Variety Trial: Differences in Yield and Fruit Quality (poster)

Genhua Niu*, *Texas A&M AgriLife Research Center at El Paso, Texas A&M University*; Triston Hooks, *Texas A&M AgriLife Research, Texas A&M University*; Christina Perez, *Texas A&M AgriLife Research, Texas A&M University*; Haijie Dou, *Texas A&M University*; Youping Sun, *Department of Plants, Soils, and Climate, Utah State University* and Joseph Masabni, *Texas A&M AgriLife Research & Extension Center (Poster Board #408)*

Abstract: Pomegranate (*Punica granatum* L.) is an emerging fruit crop for Texas and other US southern states. Due to its low water usage, high tolerance to drought and salt stresses, and unique bioactive phytochemical profile in fruits, demand for pomegranate is increasing worldwide. However, US farmers are unfamiliar with this specialty crop, and little information is available regarding cultural practices, fertilization requirements, and cultivar selection. A 19 × 19 m^2 field plot with 22 pomegranate cultivars ('Al-Sirin-Nar', 'Angel Red', 'Apseronski', 'Arturo Ivey', 'Ben Ivey', 'Carolina Vernum', 'Chiva', 'DeAnda', 'Early Wonderful', 'Kandahar', 'Kazake', 'Kunduzski', 'Larry Ceballos 1', 'ML', 'Mollar', 'Purple Heart', 'Russian 8', 'Salavatski', 'Spanish Sweet', 'Surh Anor', 'Utah Sweet', and 'Wonderful'), four plants per cultivar, was established at Texas A&M AgriLife Research Center at El Paso in April 2015. Yield and fruit quality (brix, phenolic compound and antioxidant from fruits of 7-year old trees) were determined. Fruit yield harvested in 2017 (2 years old orchard) indicated that 'Salavatski' had the highest yield of 7.96 kg per tree, while 'Early Wonderful', 'Kandahar', 'Mollar', and 'Angel Red' had the lowest yield with 0.99 to 2.54 kg fruits per tree. The top five cultivars with the highest percentage of fruit sunburn were 'Angel Red', 'Surhanor', 'Russian 8', 'Kandahar', and 'Salvatski', the top five for the highest percentages of fruit split were 'Angel Red', 'ML', 'Early Wonderful', 'Ben Ivey' and 'Larry Ceballos 1'. To compare the differences in fruit phenolic compounds and antioxidant capacity, fruit samples were collected from a seven-year old mature orchard. The top five cultivars with high phenolic contents and antioxidant capacity were 'Early Wonderful', 'DeAnda', 'Wonderful', 'Larry Ceballos 1', and 'Purple Heart' and top five for Brix were 'Early Wonderful', 'DeAnda', 'Ben Ivey', 'Salvatski', and 'Wonderful'. In summary, 'DeAnda', 'Early Wonderful', and 'Wonderful' are among the top cultivars regarding fruit phytonutrient contents.

Specified Source(s) of Funding: Specialty crop block grant

12:30 PM – 2:00 PM *Shaw (First Floor)*

Featured Speaker Luncheon: Dr. Chris Walsh and Wade Butler, Long-Term Mutual Benefits of Partnering between the University of Maryland Extension and Butler's Orchard

Moderator: Desmond Layne, *Washington State University*

12:30 PM Long-Term Mutual Benefits of Partnering between the University of Maryland Extension and Butler's Orchard

Chris S. Walsh*, *University of Maryland* and Wade Butler*, *Butler's Orchard*

Abstract: The productive long-term partnership between the University of Maryland Extension and Butler's Orchard began more than 60 years ago after the loss of a peach crop and the subsequent recommendation to consider a pick your own operation for strawberries. The establishment of an Agriculture Reserve in Montgomery County, Maryland in 1980 helped to protect important agricultural land from urban encroachment. It enabled the Butlers to expand from 60 acres to a 280-acre commercial farm that is a short drive from the Washington, D.C. metro area. Over the years, they have established a strong base of repeat local customers who come to the farm for everything from Christmas trees, to fresh fruit and vegetables. But it is also a destination farm for tourists also seeking agritainment. They currently have 17 ac. blueberries, 15 ac. strawberries, along with cherries, raspberries, blackberries and many other crops for pick your own harvest. In the summer, they employ over 150 people. They also source other products (e.g., milk, eggs, peaches, apples) from local producers in the county. Mr. Butler's three adult children represent a third generation of this family farm. The Butlers support other growers in the region by hosting the Young Growers Alliance tours, participating as a scouting site for spotted wing drosophila with UMD Extension, and engaging with UMD Ag. Law on a produce traceability program. Over the years, they have partnered with UMD Extension on various research and demonstration projects including the evaluation of fungicide resistance of *Botrytis* and the possibility of using regulated-deficit irrigation. Mr. Butler is serving his second term as President of the Maryland State Horticultural Society. He and Dr. Chris Walsh will share additional details about the important mutual benefits they have experienced by partnering over the years.

1:00 PM – 2:00 PM *Jay (Lobby Level)*

National Issues Committee Meeting

Chair: Thomas Björkman, *Cornell University*

Members: Dewayne Ingram, *University of Kentucky*; Desmond Layne, *Washington State University*; Holly Little, *Acadian SeaPlants*; Michael Neff, *ASHS*; Curt Rom, *University of Arkansas*; Carl Sams, *The University of Tennessee*; John M. Dole, *North Carolina State University*; Mary Rogers, *University of Minnesota*; Mercy Olmstead, *University of Florida* and James Flore, *Michigan State Univ*

1:00 PM – 2:00 PM

Resume Review Session III

Concourse Level Foyer

Objectives:

Schedule a time to go over your CV and ask career questions with a professional mentor. These will be scheduled in 20 minute sessions.

1:15 PM – 2:00 PM *International Ballroom East/Center*

Fruit Breeding (Poster)

What Resonates with Our Stakeholders? the Impact of Rosbreed As Communicated By Trade Magazine Writers (poster)

Kathleen E. B. Rhoades*, *Michigan State University*; James McFerson, *Washington State University, TFREC*; Cameron Peace, *Washington State University*; Audrey Sebolt, *Michigan State University*; Michael Coe, *Cedar Lake Research Group* and Amy Iezzoni, *Michigan State University (Poster Board #055)*

Abstract: RosBREED, a large-scale research and development project funded since 2009 by USDA-SCRI, is a collaborative effort across multiple states and institutions focused on improving U.S. rosaceous crops through DNA-informed breeding. The end goal is new cultivars that meet industry standards for horticultural quality and disease resistance and exceed consumer expectations for attributes like flavor, aroma, and texture. A critical outcome is to increase awareness of and support for DNA-informed breeding for rosaceous crops through regular engagement with stakeholders. A comprehensive, non-technical report provides a vehicle to share progress and obtain feedback at our annual advisory panel meeting. RosBREED's strategic approach is to highlight outputs as success stories at such meetings, in individual interactions with clientele, in the project newsletter emailed to stakeholders three times a year, and as one-page "RosBRIEFs." In addition to these stories of how DNA information is obtained and applied to meet the goals of plant breeding programs and their beneficiaries, the newsletter and RosBRIEFs include regular profiles of RosBREED team members and advisory panel members, features on the "disease nemeses" that RosBREED is targeting to develop durably resistant cultivars and breeding populations, and information about new cultivars being released by RosBREED-affiliated breeding programs. To more effectively communicate a technical deliverable like the discovery of large-effect loci for traits of value and the use of DNA information about the locus in parent and seedling selection, we developed the "Jewels in the Genome" analogy. A concise, color-coded DNA test table was then developed to illustrate to our industry clientele the progress towards "jewel" discovery and use in breeding programs, as well as track deliverables to breeders. References to these communication efforts in trade publications indicate that some success stories and communication tools are resonating with stakeholders. This study summarized and analyzed trade publication articles covering RosBREED in order to identify communication strategies that resonated with our stakeholders. The results suggest ways in which the project has communicated its outcomes and deliverables most effectively with clientele and where efforts should be focused to achieve widespread name-recognition of RosBREED and robust support for DNA-informed breeding in rosaceous crops.
Specified Source(s) of Funding: Funding for RosBREED: Combining disease resistance with horticultural quality in new rosaceous cultivars is provided by the Specialty Crop Research Initiative Competitive Grant 2014-51181-22378 of the USDA's National Institute of Food and Agriculture.

Genetic Structure of U.S. Rosbreed Sweet Cherry Germplasm Revealed By Genome-Wide SNPs (poster)

Lichun Cai*, *Michigan State University*; Stijn Vanderzande, *Washington State University*; Cameron Peace, *Washington State University* and Amy Iezzoni, *Michigan State University (Poster Board #056)*

Abstract: Sweet cherry (*Prunus avium* L.) is a clonally propagated, diploid, outcrossing crop for which cultivar development uses a pedigree-based breeding approach. Although sweet cherry breeding has been conducted in the Pacific Northwest for more than half a century, genetic structure of this sweet cherry germplasm is not well understood based only on incomplete pedigree records. In this study, a pedigreed population of 65 elite and wild sweet cherry clones and 463 unselected offspring from 86 crosses in the Washington State University sweet cherry breeding program, comprising a germplasm set established to be representative of U.S. public breeding germplasm for this crop, was genotyped with the RosBREED Illumina Infinium® 6K cherry SNP array. After data curation, a total of 1617 robust SNPs were identified and used to define 196 haploblocks (HB) delimited by historical recombinations. Many parentage records were corrected or deduced using this most detailed-yet genotypic dataset. Several statistical parameters were calculated including minor allele frequency, heterozygosity, polymorphic information content, inbreeding coefficient, and relatedness coefficient to understand genetic structure. A high degree of relatedness among many founders was discovered. The quantitative genetic relationships among ancestral and elite individuals as well as the particular shared haplotypes and other patterns of allelic variation revealed will be useful for informing breeding decisions.
Specified Source(s) of Funding: Funding for RosBREED: Combining disease resistance with horticultural quality in new rosaceous cultivars is provided by the Specialty Crop Research Initiative Competitive Grant 2014-51181-22378 of the USDA's National Institute of Food and Agriculture

Variation in Floral Bud Development between Early and Late Blooming Tart Cherries (poster)

Charity Goeckeritz*, *Michigan State University*; Joseph Hill, *Michigan State University*; Audrey Sebolt, *Michigan State University*; Amy Iezzoni, *Michigan State University* and Courtney A. Hollender, *Michigan State University (Poster Board #057)*

Abstract: Flowering success directly translates to yield potential in perennial fruit trees such as cherry. Thus, erratic weather events that affect flowering can have a deleterious effect on crop yield. For instance, in 2012 Michigan tart cherry growers lost 97% of their crop after sporadic freezing temperatures in April killed most floral buds. Events like these can have long-lasting negative economic impacts on the tree fruit industry. And, as global climate change intensifies, unpredictable weather events are becoming more frequent. Two potential ways to reduce the risk of crop loss from frost damage include: 1) Breeding trees that bloom later in the season, and 2) identifying the point in development when flower buds are most susceptible to frost damage. This second strategy would enable growers to employ cultural practices to increase temperatures in their orchards if needed. The development of both mitigation methods would benefit from a greater understanding of the biology behind the regulation of bloom time. As a first step in this direction, we tracked developmental changes that occurred in dormant flower buds from naturally early and late blooming tart cherry trees as they accumulated heat units. Differences in morphology as well as pollen development between the genotypes were evident.

Rosbreed: Enabling Marker-Assisted Selection (MAS) for Mealiness in Peach (poster)

Jennifer Lewter*, *University of Arkansas*; John Clark, *University of Arkansas*; Margaret Worthington, *University of Arkansas*; Cassia Da Silva Linge, *Clemson University*; Ksenija Gasic, *Clemson University*; Zena Rawandoozi, *Texas A&M University*; David Byrne, *Texas A&M University* and Carlos Crisosto, *University of California - Davis (Poster Board #058)*

Abstract: Commercial peaches are frequently stored in chilled conditions to maximize shelf life by delaying decay and deterioration. Chilling injury (CI) symptoms caused by exposure to these low temperatures are problematic and have a commercial impact. CI symptoms include flesh or pit browning, a lack of flavor and/or off flavor, and dry, mealy, or even leathery flesh. The extent of CI symptoms varies greatly depending on the peach genotype, so unique cultivars and breeding selections must each be assessed for shipping and storage life potential. Enabling marker-assisted selection (MAS) for mealiness in peach would be highly useful to peach breeders. The production of new fruit cultivars routinely requires 10-15 years using traditional breeding methods, but MAS could potentially reduce this time period and improve breeding efficiency. In this study, two seasons of post-harvest phenotypic data from pedigreed germplasm including seven peach populations and their parents at the University of Arkansas Fruit Research Station are analyzed. Data on nearly 30 phenotypic traits were collected from peaches that were exposed to cold storage conditions (5° C) for two weeks. The traits measured included: fruit size and weight, color measurements on skin and flesh, flesh firmness, expressible juice, mealiness indication, flesh browning and bleeding, mouth feel (texture), presence of "off flavor," soluble solids, pH and titratable acidity. Trait data were analyzed among and between all seven populations for each of the two seasons, as well as between the two seasons. Expressible juice was the most informative trait studied. Expressible juice ranged from 0% (no juice expressed) to 94.7% among the seven Arkansas populations and parents during the two year period. The implications of this study for the development of a new DNA-based tool for early prediction of post-harvest performance in peach breeding programs using MAS will be discussed.

Specified Source(s) of Funding: RosBREED

Quantifying Variation in Warm Growing Degree Hour and Base Temperature for Floral Bud Break in Peach (poster)

Douglas Bielenberg*, *Clemson University*; Rosa Kome, *Clemson University*; Tyler McIntosh, *Clemson University* and Ksenija Gasic, *Clemson University (Poster Board #059)*

Abstract: Bud break timing in peach (*Prunus persica* [L.] Batsch) is determined by the fulfillment of a chilling requirement (CR) and a heat requirement (HR) for development. Genotypic variation in CR has been well-characterized in peach. Potential variation in HR among varieties has received less attention, in part due to the overlap of effective temperatures for CR and HR and dynamic modification of HR by continued chilling accumulation beyond the minimum threshold CR for bud break. HR could vary in the magnitude of growing degree hours (GDH) and/or the base temperature for accumulating GDH. We estimated the GDH and base temperature for floral bud break by forcing replicate stem cuttings at constant temperatures of 12, 14, 16, 18, and 20 °C and analyzing the effect of temperature on the inverse of hours accumulated to reach median bud break (defined by appearance of sepal or petal coloration). We evaluated >40 varieties (representing a range of CR) in which chilling had been saturated after 1800 h at 3 °C. Varieties differed in both GDH requirement and apparent base temperature for GDH accumulation. Phenotyping the separate components of HR without the confounding effect of unsaturated chilling was possible. This will allow standardized HR phenotyping in germplasm as a foundation for breeding delayed bloom and frost exposure avoidance. One variety was evaluated through a range of partial to fully satisfied chilling accumulations. Chilling accumulation reduced GDH while also altering base temperature for GDH accumulation. Improved descriptions of variety specific dynamics of GDH and base temperature response to chilling may allow improved bloom date modeling in peach.

Specified Source(s) of Funding: USDA-AMS-TM-Specialty Crop Block Grant Program, South Carolina Department of Agriculture

QTL Mapping with Pedigree- Based Analysis for Blush, Soluble Solid Content, and Titratable Acidity in Peaches (poster)

Zena Rawandoozi*, *Texas A&M University*; Timothy Hartmann, *Texas A&M AgriLife Extension*; Ksenija Gasic, *Clemson University*; Lichun Cai, *Michigan State University*; Nahla V. Bassil, *USDA-ARS Corvallis* and David Byrne, *Texas A&M University (Poster Board #060)*

Abstract: Fruit quality traits have significant effect on consumer acceptance and subsequently on the consumption of peach (*Prunus persica* L. Batsch). The improvement of quality traits such as sweetness, flavor, and texture can be enhanced throughout QTL discovery and validation to enable the use of marker assisted breeding (MAB). A Bayesian QTL mapping approach implemented in FlexQTL^{TM} software has been conducted on seven F_1 low to medium chill families along with the founders and parents. Phenotypic data were collected for two years at a high chill (Clovis, CA) and a medium chill (College Station, TX) location (Clovis) and genotyped using the 9K SNP Illumina array. The objective of this study was to discover and/or validate the number and positions of quantitative trait loci (QTL) for three quality traits: titratable acidity (TA), soluble solid content (SSC), and fruit skin blush (Blsh). Fourteen QTLs were identified for the three traits across the environments: eight QTLs with strong and decisive evidence and the other six QTLs with positive evidence. Several QTLs were reported in previous studies and a few were novel QTLs. QTLs for SSC in TX 2012 and TA in TX 2013 were not mapped because of lack of phenotypic data. The proportion of phenotypic variance explained (PVE) by a QTL for the three traits ranged from 18.9 to 94.8%. This approach would help to develop DNA marker test and subsequent marker-assisted breeding for developing new peach cultivars of superior quality traits.

QTL Mapping for Fruit Weight and Diameter through Pedigree-Based Analysis in Peach (poster)

Cassia Da Silva Linge*, *Clemson University*; Lichun Cai, *Michigan State University*; Ksenija Gasic, *Clemson University*; Margaret Worthington, *University of Arkansas* and David Byrne, *Texas A&M University (Poster Board #061)*

Abstract: Peach is one of the most important fruit crops in the world, with the global annual production exceeding 24.9 million tons. The United States is the fourth largest producer after China, Spain and Italy. Peach consumption has decreased over the last decade, most likely due to inconsistent quality of the fruit in the market. Fruit weight (FW) and diameter (FD) are important traits for market success, since consumers tend to prefer homogeneous fruits of large size. Marker assisted selection for FW and FD is at the top of the wish list for fresh market peach breeding programs and one of the major goals of the RosBREED project. The ability to use DNA information to select desirable fruit size would enable peach breeders to efficiently plan crosses and select seedlings with large FW and FD, early in the selection process before even seeing the fruit. Therefore, to understand genetic background of FW and FD in peach, we assembled pedigree connected breeding material of 620 individuals from three public fresh market peach breeding programs (Arkansas, Texas and South Carolina). The material was genotyped using 9K SNP array and FW and FD were phenotyped over two seasons. Pedigree based analysis (PBA) using both additive and dominance genetic effects identified seven QTLs on three chromosomes. Three QTLs were associated with FW on linkage groups (LG) 1 (*qPP-FW_1.1*), 4 (*qPP-FW_4.1*), and 6 (*qPP-FW_6.1*). Four QTLs were associated with FD; two on LG 1 (*qPP-FD_1.1*; *qPP-FD_1.2*), and one on each LG 4 (*qPP-FD_4.1*) and 6 *qPP-FD_6.1*). The strong positive correlation between FW and FD was reflected in clustering of the QTL for the two traits on LG 4. Haploblock/haplotype analyses revealed 1-3 haploblocks per QTL region with 7-31 haplotypes per haploblock. The highest number of haploblocks was detected on LG 4 (*qPP-FD_4.1*) and the highest number of haplotypes within the haploblock were detected in QTL *qPP-FD_4.1_Hap1*. The validation and characterization of functional alleles for fruit weight and size and their predictive effects, frequency and distribution in U.S. peach breeding germplasm will be presented.

Specified Source(s) of Funding: USDA-NIFA-SCRI "RosBREED: Combining disease resistance with horticultural quality in new rosaceous cultivars" (2014-51181-22378)

Expression of Some Specific Cell Genes Reveals Key Facilitators of Cell Production during Development of Apples (poster)

Yuanzhi Yang*, *Purdue university* and Peter Hirst, *Purdue University (Poster Board #062)*

Abstract: Cell production is an important factor to affect fruit size during fruit development. Fruit development can fall apart into three parts: flower-tube growth, fruit set and fruit growth. All of them are regulated by genes expression. In this project, the aim is to test the effect of some specific genes expression on cell production, and then how them influence apples size. At the end, a connection of specific genes expression, cell production and apple size will be made by this research. In this research, two varieties of apples trees, Gala and Golden Delicious Smoothee, will be selected. These two varieties of trees can produce different size of apples. Two kinds of data should be collected, phenotype and genotype. Phenotype includes apple diameter, length, weight, cell number, relative cell production rate. Genotype includes specific genes expression. All of these data will be collected every week from flower-tube growth to fruit growth. After that, based on statistics analysis, a dynamic variation rule will be detected with the time development. For example, Cell production will be inhibited by specific genes expression during floral-tube development, resulting in growth arrest before bloom. At the end, a connection between phenotype and genotype will be found and these specific genes function would also be detected. In the next project, all genes which can control cell production would be tested by QTL analysis and then the secret of co-expression of genes will be found in this project.

Development of High-Throughput SNP Markers for Fruity Aroma and Marker-Assisted Selection in Cultivated Strawberry (*Fragaria ×ananassa*) (poster)

Youngjae Oh*, *University of Florida*; Saket Chandra, *University of Florida*; Zhen Fan, *University of Florida*; Vance Whitaker, *University of Florida* and Seonghee Lee, *University of Florida (Poster Board #063)*

Abstract: Fruit flavor is one of the most important trait for strawberry breeding. In our previous study, γ-decalactone regulated by *FaFAD1* gene, contributes to fresh peach flavor and is associated with an increase in sweetness in fruit. The dominant FaFAD1 marker developed from the *FaFAD1* gene is currently used for the high-throughput marker-assisted seedling selection (MASS) for γ-decalactone. However, the main limitation in using dominant marker is not possible to differentiate homozygosity and heterozygosity. Also because of the unique amplification of the target fragment, failures in polymerase chain reaction (PCR) or non-amplifications can be interpreted as an absence of the allele. Thus, an internal amplification control has to be carried out to determine the success of PCR. This is a bottleneck for high-throughput MASS with large breeding samples. . Therefore, in this study, codominant single-nucleotide polymorphism (SNP) markers for *FaFAD1* were developed for the effectiveness of MASS. To identify SNPs associated with FaFAD1, the 100kb genomic region of FaFAD1 was sequenced with GD producing and nonproducing accessions: 10 producer (FL10-24, 'Sweet Charlie', 'Albion', FL11.28-34, Florida 127, 'Winterstar', FL12.115-10, 'Elyana', 'Benicia', and FL11.139-10) and five non-producer ('Festival', 'Winter Dawn', 'Mara des Bois', FL13.55.195, and FL12.74-39). Four unique SNPs that can differentiate GD producers and non-producers were identified and used to develop for high-resolution melting (HRM) markers. Two HRM markers GD2-001 and GD4-001 successfully detect the presence and absence of GD in all accessions tested. We further tested these markers with crude extract DNA to examine the accuracy of the high-throughput MASS. Both markers accurately detected γ-decalactone producing accessions The markers developed from the present study will be useful for strawberry breeding program for enhancing fruit quality.

Specified Source(s) of Funding: "RosBREED: Combining disease resistance with horticultural quality in new rosaceous cultivars" under award number 2014-51181-22378

Evaluation of Genetic Stability of F_1 Hybrids in Octoploid Strawberry (poster)

In Seok Um, *Department of Agronomy, Gyeongsang National University*; Min Ju Lee, *Department of Agronomy, Gyeongsang National University*; Ju Hee Nam, *Department of Agronomy, Gyeongsang National University*; Sun Yi Lee, *National Institute of Horticultural & Herbal Science* and IL Rae Rho*, *Institute of Agriculture & Life Science,Gyeongsang National University (Poster Board #064)*

Abstract:

The morden, cultivated strawberry is propagated vegetatively using stolons and crown as clones, but it is required the many labor and time for the propagation of the nursery plant, and become the cause of greatly reducing yield by viruses and pathogen infection. Therefore, seed propagation in strawberry plants has been in demand for a long time. The present study aimed to test genetic stability of F_1 hybrids strawberry through crosses between S9 generation plants of inbred lines derived from octoploid strawberry, because the stability and uniform phenotypes of F_1 hybrids strawberry have been confirmed in prior studies. Breeding of inbred lines (S9 generations) for seed propagation in octoploid strawberry could be achieved that individuals showing inbreeding depression were eliminated and vigorous individuals were selected, resulting in a strong heterosis of F_1 hybrids through crosses between inbred lines. Genetic stability of F_1 hybrids strawberry was tested using seven simple sequence repeat(SSR) markers. We detected high (<0.90) genetic similarity among individuals of F_1 hybrids and individuals of S9 or S11 inbred lines derived from 'Benihoppe', 'Toyonoka', and 'Akihime', the original ovary and pollen parental cultivars. The genetic similarity among inbred lines increased with the advancement of selfing generations, and that of F_1 hybrids produced through hybridization between inbred lines was also very high. Although the genetic similarity among these individual inbred lines and F_1 hybrids was very high, some variation was detected, but it did not result in morphological differences. With the advancement of selfing generations, the yield and fruit weight tended to decrease in the F_1 hybrids. To develop commercially useful seed-propagated cultivars, the breeding techniques such as the effects of different cross combinations or crossing among and within selfing generations should be investigated.

Specified Source(s) of Funding: This work was supported by grant No. PJ010911 from the Agricultural R&D, Rural Development Administration,Republic of Korea.

Construction of a Genetic Linkage Map of Octoploid Strawberry (*Fragaria × ananassa*) Using HRM Markers Developed from the SNP Identified By Next-Generation Resequencing of Parents (poster)

Ye Rin Lee, *Chonbuk National University*; Jundae Lee, *Chonbuk National University* and Doie Park*, *Chonbuk National University (Poster Board #065)*

Abstract: Strawberry is one of the most popular important berry fruits in the world and the cultivated strawberry (*Fragaria × ananassa* Duch.) is allo-octoploid (2n=8x=56). There were few genomic studies of the octoploid strawberry due to polyploidy and complexity of its genome. In this study, we tried to construct a genetic linkage map of the octoploid strawberry using single nucleotide polymorphism (SNP) markers derived from next-generation resequencing (NGS) of two parents, which were 'Sulhyang' as a maternal parent and 'Senga-sengana' as a paternal parent. Their F_1 segregating population consisting of 97 individuals was used to construct a genetic linkage map. A total of 19.0 Gbp ('Sulhyang') and 21.8 Gbp ('Senga-sengana') of genomic sequences, which were 30- and 26- times longer than the reference strawberry genome (the reference genome size = 720 Mbp), were obtained through NGS analysis. Subsequently, 215,461 SNPs were identified by comparing the sequences between two parents and 1,857 primer sets for high-resolution melting (HRM) analysis were designed through bioinformatic analysis. Finally, a total of 835 polymorphic HRM markers were developed and 651 markers were mapped on the genetic linkage map of octoploid strawberry. The genetic linkage map contained 36 linkage groups, covered a total distance of 1379.1 cM. The information on the genetic map and markers will be helpful to analyze QTLs for important traits in octoploid strawberry.

Specified Source(s) of Funding: Korea Institute of Planing and Evaluation for Technology in Food, Agriculture and Forestry, South Korea (315047-3)

Mapping of Eastern Filbert Blight Resistance in 'Estrella#1' Hazelnut (poster)

Golnaz komaei Koma, *Oregon State University* and Shawn Mehlenbacher*, *Oregon State University (Poster Board #066)*

Abstract: Eastern filbert blight (EFB) caused by *Anisogramma anomala* was first discovered in Oregon's Willamette Valley in 1986 and remains a costly concern of the US hazelnut industry. Host resistance is the most effective method of disease control. A very high level of EFB resistance, discovered in 'Gasaway', is controlled by a dominant allele at a single locus. This resistance may not be durable, as new races of the fungus able to overcome this R-gene could be introduced or arise from mutation or recombination. The pyramiding of multiple resistance genes in a single genotype is a promising approach for more durable resistance. Segregation for EFB response was studied in seedlings from a controlled cross of resistant 'Estrella #1' and susceptible selection OSU 1174.033. Estrella #1 was released by private breeder Cecil Farris and is a hybrid of *C. heterophylla sutchuensis* x *C. avellana*. The seedlings were exposed to EFB spores under a structure topped with diseased branches as well as field exposure. Disease severity was rated 18–20 months after exposure on a scale of 0 (absence of disease) to 5 (severe disease symptoms). DNA of the seedlings was extracted and amplified with several microsatellite primer pairs, and correlation coefficients calculated between disease response and marker allele scores. 'Estrella #1' resistance was assigned to linkage group 6 (LG6) based on high correlation of disease response with marker scores at mapped LG6 microsatellite markers. A total of 14 markers on LG6 showed correlation coefficients >0.7, and these map to the same region as 'Gasaway' resistance. A linkage map was constructed for the 'Estrella #1' resistance region and aligned with the 'Gasaway' resistance region. 'Estrella #1' provides a novel source of EFB resistance, for which linked markers will be useful for marker-assisted selection and the pyramiding of EFB resistance alleles from different sources.

Specified Source(s) of Funding: USDA-NIFA-SCRI 2016-51181-25412

Comparison of Self- and Cross-Pollination on Pollen Tube Growth and Ovule Development in Chinese Chestnut (*Castanea mollissima*) (poster)

Feng Zou, *Central South University of Forestry and Technology*; Huan Xiong, *Central South University of Forestry and Technology*; Su-juan Guo, *Beijing Forestry University*; Genhua Niu*, *Texas A&M AgriLife Research Center at El Paso, Texas A&M University* and De-yi Yuan, *Central South University of Forestry and Technology (Poster Board #067)*

Abstract: Chinese chestnut (*Castanea mollissima* Blume) has noteworthy ecological, economic, and cultural importance in China. However, a high proportion of empty cupules is mainly responsible for low yield in chestnut. To elucidate the causes of the empty cupules, we investigated pollen germination and pollen tube growth into pistils, and ovule development after self-pollination (SP) and cross-pollination (CP). Controlled pollinations were carried out with chestnut trees cultivated on the qianxi county of Heibei province. Ten pistils for each treatment were sampled at different intervals (0, 3, 6, 9, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 30 days) after pollination for observation of pollen tube growth into pistils and ovule development by microscopy. The results showed that there were no significant differences in pollen tube behavior following SP and CP during the first 18 days of growth, regardless of different pollen tube speed in the style. We found that most self-pollen tubes were hampered in the ovule after 23 days. Double fertilization was significantly higher following CP vs. SP. We observed that a lot of embryo sac atrophy, or gradually disintegrated embryo sac, and ovule abortion 30 days after SP. Most selfing ovules could not develop normally, indicating that there was an obstacle before fertilization in SP. These results indicated that a high frequency of ovule abortion contributed to the high proportion of empty cupules in chestnut.

Specified Source(s) of Funding: the National Natural Science Foundation of China (No.31500554).

1:15 PM – 2:00 PM *International Ballroom East/Center*

Genetics and Germplasm 2 (Poster)

Capture-Seq Based Blueberry Linkage Map Construction and QTL Identification (poster)

Xinpeng Qi, *United States Department of Agriculture-Agricultural Research Service*; Elizabeth L. Ogden, *United States Department of Agriculture-Agricultural Research Service*; Massimo Iorizzo, *North Carolina State University*; Hamed Bostan, *North Carolina State University*; Daniel J. Sargent, *Driscoll's Genetics Ltd.*; Judson Ward, *Driscoll's* and Lisa J. Rowland*, *United States Department of Agriculture-Agricultural Research Service (Poster Board #278)*

Abstract: Reduced Representation Sequencing approaches such as Genotyping by Sequencing have been widely applied in major crops such as maize and soybean and are now being used in horticultural crops like berries and fruit trees. As the original and largest producer of blueberry, the United States maintains the most diverse blueberry germplasm resources. We previously developed a diploid blueberry F_1 interspecific population for genetic linkage map construction by crossing the parent F_1#10 (*Vaccinium darrowii* Fla4B × *Vaccinium corymbosum* W85-20) with the parent W85-23 (*Vaccinium corymbosum*). Employing a Capture-Seq technology developed by RAPiD Genomics, with emphasis on probe design in predicted gene regions, 117 F_1 progeny, two parents, and two grandparents of this population were sequenced, yielding 138.64 Gbp raw sequenced reads with a depth per locus of ~13.23x. A total of 143,313 raw SNPs referenced to 95% of publicly available blueberry genome scaffolds were called and filtered to arrive at an approximately 80k high quality SNP set. We then developed a parental-dependent sliding window approach to further genotype this population, deduced bin markers from sliding windows along each reference scaffold, and used the markers for linkage map construction. Twelve blueberry linkage groups were constructed using OneMap (an R package) resulting in the highest density map reported to date in blueberry. We also scored many horticulturally significant traits in this population including important fruit quality traits such as fruit color, firmness, flavor, and weight over multiple years. Correlation among these traits was calculated using Spearman's rho function. An R/qtl package was used to associate these traits to our fine map and identify corresponding regions with high LOD scores. In summary, we report here the first Capture-Seq based blueberry linkage map of our diploid population with a saturated marker density. This map is being used to identify QTL for important traits and will facilitate ongoing efforts to develop a chromosome level blueberry genome assembly.

Differential Gene Expression of Southern Highbush Blueberry (*Vaccinium corymbosum* L.) Cv. 'O'Neal' Floral Buds in Response to Freeze Treatment and Recovery Periods (poster)

Lauren Redpath*, *North Carolina State University*; Ashley Yow, *NC State University*; Rishi Aryal, *North Carolina State University*; Amanda M. Hulse-Kemp, *USDA-ARS*; Robert Franks, *North Carolina State University*; Ross Whetten, *North Carolina State University* and Hamid Ashrafi, *North Carolina State University (Poster Board #279)*

Abstract: Cold hardiness and chill hour requirement in blueberries are functions of germplasm composition. Southern highbush blueberries (SHB) are less cold tolerant than northern highbush blueberries and have a lower chill hour requirement, causing buds to deacclimate and break earlier. Deacclimation and bud swell heightens susceptibility to spring freezes, a recurring event in southeastern U.S. The objective of this study was to determine the differentially expressed genes in floral buds prior to bud swell and post-bud break of SHB cv. 'O'Neal', selected for its unique flowering behavior. Flower buds at two stages, bud swell and tight cluster, were exposed to either non-freezing (4 °C) or freezing conditions (-12 °C) achieved through an environmental control chamber decreasing 4 °C h^{-1}. Following temperature treatment, the buds recovered at 4 °C for periods of either 1 day or 1 week and were subsequently flash frozen in liquid nitrogen. A total of 24 stranded mRNA-Seq libraries (8 treatments x 3 biological replications) were paired-end sequenced to generate 185 Gbp of raw reads. After trimming, 150 Gbp of data was retained. A 156 Mbp transcriptome assembly with 180,487 contigs (N50=1,100) was constructed and functionally annotated with BLAST2GO (V5) software package; 2,482 (43%) differentially expressed unigenes had BLAST hits out of which 1,900 (77%) were annotated. Bioconductor package DeSeq2 implemented in Trinity (V2.5.1) was used to map the clean reads to the assembly and identify differentially expressed genes (DEGs) between tissue, temperature, and recovery periods. RNA-Seq analysis ($\log_2$ fold change $>|2|$; $p \leq 0.05$) revealed that there were 1,913 DEGs related to tissue, 3,810 DEGs related to temperature, and 4,440 DEGs related to recovery that were upregulated. With 4 °C as a reference, DEGs associated with -12 °C temperature treatment had more upregulated unigenes associated with tight cluster tissue type at either recovery treatment. Between tissue types, tight cluster universally had more upregulated unigenes considering both freezing treatments in conjunction with either recovery period. Unigenes corresponding to treatments of -12 °C, prior to bud swell, at one-day recovery had more uniquely expressed unigenes across the three treatments. Future work involves mapping and analyzing the assembly against the 'O'Neal' genome and its PacBio Iso-Seq data as well as gene network analysis. This research will provide the first data of its kind in genetic regulation of bud cold tolerance and recovery from spring freeze events, which establishes a molecular foundation for future molecular breeding projects.

Specified Source(s) of Funding: This research was funded by the North Carolina Blueberry Council, the North Carolina Department of Agriculture and Consumer Services, the North Carolina State University Agriculture Foundation, and the Southern Regional Small Fruit Consortium

Genetic Mapping of the Spine-Free Locus in Red Raspberry (*Rubus idaeus* L.) Using Genotype-By-Sequencing (GBS) (poster)

Archana Khadgi*, *Cornell University* and Courtney Weber, *Cornell Univ (Poster Board #280)*

Abstract: Red raspberry (*Rubus idaeus* L.) is a globally commercialized specialty crop. Field management of raspberry canes and harvesting of raspberry fruit can be complicated by the presence of spines or prickles (as is botanically more accurate) on the stems, petioles and underside of the leaves. Prickles are an

outgrowth of epidermal tissues that lack vasculature. The development of new raspberry varieties with fewer or prickle-free canes will aid in both harvesting of the fruit and field management. A population segregating for the presence of prickles was used in this study to understand the regulation of prickle development. Quantitative trait loci (QTL) mapping of single nucleotide polymorphisms (SNPs) developed through genotype-by-sequencing (GBS) identified one QTL in a 1 Mb region with 186 genes associated with the trait. RNA-sequencing analysis further gave insights on the genes that are likely to regulate prickle development in red raspberry. This study provides the basis for understanding prickle development mechanisms in red raspberries and could be used as the foundation for genetic engineering to produce prickle-free raspberry varieties and to study other traits possibly associated with prickle development.

Assessment of Leaf Chlorophyll Content Under Salt Conditions in Cowpea (*Vigna unguiculata* (L.)) Seedlings over Time (poster)

Lingdi Dong, *University of Arkansas*; Waltram Second Ravelombola*, *University of Arkansas*; Yuejin Weng, *University of Arkansas*; Jun Qin, *University of Arkansas*; Wei Zhou, *University of Arkansas*; Gehendra Bhattarai, *University of Arkansas*; Bazgha Zia, *University of Arkansas*; Wei Yang, *University of Arkansas* and Ainong Shi, *University of Arkansas (Poster Board #281)*

Abstract: With poor quality of irrigation water, cultivated areas facing salinity keep increasing, hence preventing cowpea from being cultivated in areas where its optimal growth and development conditions are found. However, to date, few salt-tolerant cowpea cultivars have been reported, which has resulted in a less performing cowpea breeding program for salt tolerance. Previous investigations showed that accumulations of Na^+ and Cl^- in leaves resulted in reduction in chlorophyll content, thus affecting photosynthesis. Understanding how chlorophyll content evolves over time will assist plant breeders in selecting cowpea genotypes with better tolerance to salinity by choosing those with more stable chlorophyll content under salt stress. Therefore, the objective of this study was to evaluate the chlorophyll content of cowpea genotypes over 24 days of salt stress at seedling stage. A total of 30 cowpea accessions previously shown as having different responses were used in this study. Salt treatments were 0 mM and 200 mM NaCl. Experiment design was completely randomized (CRD) with three replications per genotype and salt treatment combination, and organized in a split-plot manner. Salt stress was imposed for 24 days. Results revealed that: (i) time X genotype interaction was significant in both salt conditions and without salt conditions; (ii) chlorophyll content slowly decreased in the salt-tolerant genotypes; (iii) chlorophyll content slightly increased at 6 and 9 days of salt stress in both moderate and sensitive genotypes, but decreased at a faster rate than in the salt-tolerant ones; and (iv) the salt sensitive genotypes were completely dead at 24 days of salt stress, whereas the salt-tolerant ones were able to maintain a significant amount of chlorophyll content at that time. These results can be used for advancing breeding programs for salt tolerance in cowpea.

Identifying Phenotypes, Markers, and Genes in Carrot Germplasm to Deliver Improved Carrots to Growers and Consumers (poster)

Phillipp Simon*, *USDA-ARS Vegetable Crops Research Unit*; Shelby Ellison, *USDA-ARS Vegetable Crops Research Unit*; David Spooner, *USDA-ARS Vegetable Crops Research Unit*; Douglas Senalik, *USDA-ARS Vegetable Crops Research Unit*; Micaela Colley, *Organic Seed Alliance*; Laurie McKenzie, *Organic Seed Alliance*; Julie C Dawson, *University of Wisconsin-Madison*; Sherry Tanumihardjo, *University of Wisconsin-Madison*; Edgar Spalding, *University of Wisconsin-Madison*; Joe Nunez, *University of California Cooperative Extension, Farm and Home*; Philip Roberts, *University of California*; Allen Van Deynze, *University of California-Davis*; Daniel Sumner, *University of California-Davis*; William Matthews, *University of California-Davis*; Hyunok Lee, *University of California-Davis*; Massimo Iorizzo, *North Carolina State University*; Lindsey du Toit, *Washington State University*; Timothy D. Waters, *Washington State University* and Jairo Diaz-Ramirez, *University of California (Poster Board #282)*

Abstract: A survey of U.S. carrot growers and seed industry stakeholders was conducted and a meeting was held in 2015 to identify key traits important for improved carrot quality and productivity anticipated to meet future market demands. The feedback revealed that the carrot industry needs breeding stocks and genomic tools that can be used to develop carrots with improved field performance, including disease and pest resistance, and abiotic stress tolerance; and improved flavor and nutritional quality to better meet consumer needs. Given this critical stakeholder input, the goals of this project are to: 1) phenotype diverse carrot germplasm and breeding stocks to discover and characterize variation for traits important for improving carrots for the U.S. market; 2) develop an expanded carrot genomic and phenotypic database for breeders to catalogue genomic variation and track genes underlying important traits; 3) initiate the development of breeding pools from diverse germplasm and breeding stocks that include alleles for improved crop production and consumer quality traits, and test them on-farm with growers, including for flavor and nutritional value for consumers; and 4) assess the market value and impacts of carrot traits on grower and consumer decisions. A timeline of activities has been developed, with evaluation of approximately 750 modern and heirloom open-pollinated cultivars; landraces from the Middle East, Asia, Africa, Europe, and South America; and breeding lines from public sector carrot improvement programs initiated. To date, new sources of resistance to Alternaria leaf blight and root-knot nematodes, reduced incidence of bolting, and improved stand establishment, flavor, and nutritional quality have been identified preliminarily. The development of breeding pools has been initiated to capture enriched sources of allelic variation useful for carrot breeders, and an expanded carrot database that includes both genomic and phenotypic data is being created.

Specified Source(s) of Funding: USDA-NIFA-SCRI 2016-51181-25400

Genetic Diversity in Sweetpotato (*Ipomoea batatas*) Germplasm in Japan Revealed By Genome Wide RAD-Seq (poster)

Keisuke Suematsu*, *National Agriculture and Food Research Organization*; Masaru Tanaka, *National Agriculture and Food Research Organization*; Sachiko Isobe, *Kazusa DNA Research Institute*; Kenta Shirasawa, *Kazusa DNA Research Institute* and Yumi Kai, *National Agriculture and Food Research Organization (Poster Board #283)*

Abstract: Sweetpotato (*Ipomoea batatas*) is one of the most important root crops in the world, especially in Asian and African countries. It (called 'satsuma-imo') has been widely cultivated in Japan, and are utilized in many favorite dishes as well as industries. In Japan, sweetpotato breeding is conducted vigorously to improve the yield, components of storage root and tolerance to pest and disease resistances. However, the genetic information in sweet potato germplasms has been limited due to its hexaploidy (2n=6x=90) and self-incompatibility characteristics, which complicated genetic analysis. Whole genome sequence of the diploid relatives of sweetpotato, *I. trifida*, has been revealed recently and enabled to develop genome wide single nucleotide polymorphisms (SNPs) in sweetpotato. In this study, genetic variation among 94 diverse sweet potato accessions conserved in the National Agriculture and Food Research Organization, Japan, was assessed using genome wide SNPs to elucidate genetic background in sweetpotato germplasm and thereby to accelerate the use of suitable germplasm for breeding new cultivars. The 94 accessions consist of 13 Japanese landraces, 67 exotic landraces and cultivars (Central and South America, USA, East and Southeast Asia, Oceania and Uganda) introduced into Japan, 9 recent cultivars released in Japan and 5 wild-relatives (*I. trifida*). Morphological traits of each accession were evaluated under field condition. A total of 23,535 SNPs was detected among 94 accessions using double-digest restriction site-associated DNA sequence (ddRAD-seq) method. Analysis of genetic population structure indicated that sweetpotato accessions were divided into 5 clusters (*K*=5). Phylogenetic tree based on neighbor-joining method with 23,535 SNPs revealed the relationship among the accessions, which reflected the geographical origin of the accessions and known kinship of the released cultivars.

Identification and Evaluation of White Rust Resistance in Spinach Germplasm (poster)

Wei Zhou*, *University of Arkansas*; Yuejin Weng, *University of Arkansas*; Bo Liu, *University of Arkansas*; Gehendra Bhattarai, *University of Arkansas*; Jun Qin, *University of Arkansas*; Bazgha Zia, *University of Arkansas*; Waltram Second Ravelombola, *University of Arkansas*; Chunda Feng, *University of Arkansas*; Jim Correll, *University of Arkansas* and Ainong Shi, *University of Arkansas (Poster Board #284)*

Abstract: White rust is an economically important diseases of spinach (*Spinacia oleracea*) caused by *Albugo occidentalis*, which is epidemic in spinach production areas of the central and eastern United States. A total of 440 spinach genotypes including 400 USDA germplasm accessions and 40 Arkansas spinach breeding lines were evaluated for white rust resistance during the 2016-17 and 2017-18 winter seasons at the Del Monte White Rust Nursery in Crystal City, TX where heavy disease pressure has consistently been observed for 30 years. Each accessions was naturally inoculated. Disease reactions of the each accession were evaluated at the before bolting stage in the trial. Percentage leaf infection was assessed visually using a 0–9 scale (0 = no disease symptom, 1 ≤ 10%, 2 ≤ 20%, 3 ≤ 30%, 4 ≤ 40%, 5 ≤ 50%, 6 ≤ 60%,7 ≤ 70%, 8 ≤ 80% and 9 ≥ 90%). The results showed that ten accessions (CPPSIH 3 03, NSL 6098,PI 175311,PI 220686,PI 224959,PI 226671,PI 227045,PI 648958,PI 662302 and PI 677114) exhibited resistant to white rust (90% or more of leaf area are not got infected). By selection under heavy disease pressure, ten UARK breeding lines (08-03-316-1, 08-269-1, 08-275, 08-301-2, 08-321, 08-88-310, 08-198, 08-143-1, 08-103, 03-316-7) exhibit high resistant to white rust, their true leaves almost do not get infected and show symptoms. These resistant genotypes provide a valuable resource for functional gene exploration and as a source of white rust resistance for breeding programs.

Development of Genome-Wide Simple Sequence Repeat (SSR) Markers in Spinach (poster)

Gehendra Bhattarai*, *University of Arkansas*; Bazgha Zia, *University of Arkansas*; Wei Zhou, *University of Arkansas*; Jun Qin, *University of Arkansas*; Waltram Ravelombola, *University of Arkansas*; Yuejin Weng, *University of Arkansas*; Chunda Feng, *University of Arkansas*; Jim Correll, *University of Arkansas*; Ainong Shi, *University of Arkansas* and Beiquan Mou, *USDA-ARS (Poster Board #285)*

Abstract: The decreasing costs of genome sequencing and the availability of well-assembled genome sequences for many crops has facilitated the identification and development of simple sequence repeats (SSR) markers. The genome sequence of inbred spinach line Sp75 (168X coverage) is publicly available. Genome sequences of six Sp75 chromosomes (463.4 Mb) were used to search for SSRs using the MISA program. The search criteria were set for the minimum number of repeats of 6, 5, 4, 4, 4 for di-, tri-, tetra-, penta-, and hexa- repeats respectively, and the maximal number of nucleotides interrupting two SSRs were set to 1. In total, 42,155 SSRs were identified from Sp75 chromosome scaffolds in 40,552 loci. Stepwise removal of compound loci (1450), di-repeats loci (15, 942), and repeat motifs containing only A and T (10, 529) reduced the number of unique SSR loci to 12, 631. The remaining tri-, tetra-, penta-, hexa- repeats SSRs were sorted according to the chromosomes. Subsequently, SSR motifs along with 250 bp from either side of the motif were extracted, which serves as the reference sequence. A whole-genome resequencing (30x) of 30 additional spinach genotypes was completed. Paired-end Illumina reads from the resequenced accessions will be aligned against the SSRs containing reference sequence using BWAmem. Visualization of aligned sequence in the Tablet software allows *in silico* identification of polymorphic loci. A subset of polymorphic loci identified following a visual inspection using the Tablet program will be amplified using fluorescent primers and the allele sizes will be determined using capillary electrophoresis. We plan to use the newly developed polymorphic SSRs to fingerprint spinach genotypes and to conduct genetic diversity assessment of USDA spinach germplasm.

Phosphorus Bioavailability Adjustments of Insoluble Phosphates for Tomato By Adding Companion Ions or Chelates (poster)

Mary Dixon*, *University of Florida* and Guodong David Liu, *University of Florida (Poster Board #286)*

Abstract: Florida's soils for vegetable production are rich in insoluble phosphates tied up with aluminum, calcium, iron, magnesium, etc. Mobilizing the insoluble phosphates is critical for crops such as tomato (*Solanum lycopersicum)* to use phosphorus efficiently. The objective of this experiment is to expound the mechanisms of P bioavailability adjustment with three typical P-efficient and P-inefficient tomato genotypes – Great White Og, Japanese Black Trifele, Mariana F1 in hydroponics. Seedlings of the genotypes will hydroponically grow in modified Hoagland solution using tric-calcium phosphate (TCP) as the only P source with different concentrations of calcium or chelates such as EDTA until two sets of leaves fully expand. Chlorophyll content, pH, height, biomass, and concentration of N, P, and Ca will be determined. Our expected results will be (1) Great White Og and Japanese Black Trifele will be more P-efficient than Mariana F1; (2) Extra calcium added to the culture solution will significantly downregulate P bioavailability of TCP; (3) Great White Og, Japanese Black Trifele can absorb more calcium than Mariana F1, and hence can mobilize more P from TCP; (4) adding chelate to the solution will greatly upregulate P bioavailability of TCP. This means that calcium should not be applied with phosphate fertilizer on soil rich in calcium to enhance P use efficiency. As compared with ordinary genotype, elite genotypes may release more organic acids such as citric acid to the rhizosphere to mobilize the insoluble phosphates in soil.

Differential Gene Expression Profile between Resistant and Susceptible Tomato Genotypes in Response to Tomato-Potato Psyllid (*Bactericera cockerelli*) Infestation (poster)

Henry Awika*, *Texas A&M AgriLife Research*; Renesh Bedre, *Texas A&M AgriLife Research*; Thiago Marconi, *Texas A&M AgriLife Research*; Ismael Badillo, *Texas A&M AgriLife Research*; Kranthi Mandadi, *Texas A&M AgriLife Research* and Carlos Avila, *Texas A&M AgriLife Research (Poster Board #287)*

Abstract: The tomato-potato psyllid (TPP), *Bactericera cockerelli*, vectors the phloem-limited bacteria *Candidatus Liberibacter solanacearum* (Lso), the causative agent of economically important plant diseases in Solanaceae species including the tomato vein-greening and potato zebra chip. The TPP has the ability to produce a three-pronged damage to its host plant. The TPP punctures the vascular bundles, secretes toxic saliva into the host, and vectors the disease-causing Lso bacterium. In response, the host plant deploys multiple layers of defense against the invading pest-pathogen complex. The objective of this study was to identify differentially expressed genes associated with host plant resistance reaction and to determine the role of Lso in the plant-insect interaction. Insect-resistant (*Solanum habrochaites* RIL) and susceptible (*S. lycopersicum* cv CastleMart) genotypes were mock-inoculated or infested with Lso positive TPP-Lso(+), negative TPP-Lso(-) insects. After 48-hrs, plant tissue was collected for RNAseq analysis. Differentially expressed genes (DEG, log2FC ≥ 2 and P-value ≤ 0.05) were identified between insect treatments and genotypes. Thirteen genes were uniquely up-regulated in the insect-resistant plants, but downregulated in susceptible plants when infested with Lso(-) psyllids. However, only one gene was up-regulated in resistant plants and down-regulated in susceptible plants when plants were infested with Lso(+) psyllids. In the other hand, a total of 20 genes were uniquely down-regulated in resistant genotype while up-regulated in susceptible plants independently of Lso. Orthologues of these genes were mapped to determine putative molecular function and biological processes associated with plant defensive signaling. DEG included transcripts associated with catalytic activity (46%), binding activity (33%), transporter activity (12%), receptor activity (3%), antioxidant activity (2%), signal transducer activity (2%), and structural molecular activity (2%). Moreover, plant-defensive hormone salicylic acid (SA) is up-regulated in both resistant and susceptible plants when infested with TPP-Lso(+), but only in resistant plants when infested with TPP-Lso(-) insects. Taken together, these results suggest that different resistance and susceptibility factors are involved in regulating plant responses to TPP. Furthermore, Lso may play an indirect role by either enhancing or eliciting additional plant resistance responses against the psyllid.

Specified Source(s) of Funding: Texas A&M AgriLife Vegetable Seed Grant

Phylogenetic Patterns, Population Structure and Domestication Footprints in Broccoli and Other *B.*

oleracea Vegetables. (poster)

Zachary J. Stansell*, *Cornell University* and Thomas Björkman, *Cornell University (Poster Board #288)*

Abstract: Improvement efforts in *Brassica oleracea* vegetables such as broccoli (*B. oleracea* var. *italica*) are often limited by a lack of knowledge of the genetic diversity contained within available germplasm. Here, we employ genotype-by-sequencing on a diverse panel of (N=134) *B. oleracea* entries including landrace and improved broccoli, landrace and improved cauliflower, kale, Chinese kale, Brussels sprouts, cabbage, collard, kohlrabi, and undomesticated *B. oleracea* relatives. We identified over 45K high-quality SNPs (mean=91.0/Mbp or 45.5/haploblock) revealing a complex and admixed population structure. Vegetable groups were effectively resolved using principal coordinate analysis. When compared with a pool of landrace broccoli (N=37), all improved broccoli entries (N=26) released after 2000 were shown to be closely related, in higher linkage disequilibrium than landrace broccoli, and largely represented by a single subpopulation indicative of a genetic bottleneck occurring during modern cultivar development. Over 96% of SNPs differentiating improved cauliflower from landrace cauliflower were common to a larger pool of broccoli entries, supporting a "broccoli before cauliflower" domestication model via apparent introgression of broccoli alleles into improved cauliflower germplasm. Fixation index analysis identified several chromosomal regions differentiating improved broccoli and cauliflower entries. Of all the *B. oleracea* vegetable groups, kale and Brussels sprouts entries shared the greatest similarity with undomesticated *B. oleracea* wild relatives. Collard and cabbage entries shared high mutual similarity; supporting earlier work indicating cabbage as the primary collard progenitor. Chinese kale entries formed a monophyletic clade but share population structure components with Russian kale entries and the undomesticated *B. insularis* and *B. macrocarpa.*

Specified Source(s) of Funding: Specialty Crop Research Initiative grant no. 2016-51181-25402

Identification and Molecular Mapping of Gummy Stem Blight (GSB) Resistance Gene in Wild Watermelon (*Citrullus lanatus* var. *citroides*) Germplasm PI 189225 (poster)

Runsheng Ren*, *Jiangsu Academy of Agricultural Sciences*; Jinhua Xu, *Jiangsu Academy of Agricultural Sciences*; Man Zhang, *Jiangsu Academy of Agricultural Sciences*; Guang Liu, *Jiangsu Academy of Agricultural Sciences*; Xiefeng Yao, *Jiangsu Academy of Agricultural Sciences* and Xingping Yang, *Jiangsu Academy of Agricultural Sciences (Poster Board #289)*

Abstract: Gummy stem blight, caused by *Didymella bryoniae*, is a destructive foliar disease of watermelon in areas with hot and humid climates. Wild watermelon germplasm, PI 189225 is a known source of resistance to gummy stem blight. The identification and the use of the molecular markers linked to resistance genes in the wild-type germplasm will speed up the introgression of the gummy stem blight resistance into new watermelon varieties. An F2 segregating population was obtained from a cross between resistant wild watermelon genotype PI 189225 and susceptible genotype K3, after which genetic analysis of F2- derived F3 families was performed by inoculating plants with a single isolate of *D. bryoniae* (isolate 002, Jiangsu Academy of Agricultural Sciences). The results of genetic analysis demonstrated that gummy stem blight resistance in PI189225 was controlled by a major QTL, temporarily designated gsb-8.1. Based on the results of BSAseq, two associated regions spanning 0.27 Mb (Chr8: 6,938,347–9,639,798) and 0.57Mb (Chr8:10,358,659–16,101,517) on the short arm of chromosome 8 were identified responsible for the resistance to gummy stem blight using the Δ(SNP-index) method. The result of QTL linkage analysis with KASP SNP markers further mapped the GSB locus between the SNP marker A009383 and SNP marker A009168 at a genetic distance of 0.4 cM and 0.9 cM, respectively. According to the watermelon gene annotation database (http://cucurbitgenomics.org/organism/1), the region contains about 19 annotated genes and out of the 19 genes, two genes showed disease resistance gene analogs, Cla001017 (Cc-nbs-lrr resistance protein) and Cla001019 (pathogenesis-related). This result will facilitate fine mapping and cloning the gsb-8.1 locus. The tightly linked markers for the gsb-8.1 locus will further provide a useful tool for marker-assisted selection of this QTL in watermelon breeding programs.

Specified Source(s) of Funding: National Natural Science Foundation of China

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1:15 PM – 2:00 PM *International Ballroom East/Center*

Ornamentals/Landscape and Turf 2 (Poster)

Combating Rose Rosette Disease: Exploring Development of Accurate, Rapid, Efficient, Easy-to-Use and Affordable Virus Diagnostic Tools (poster)

Ramon Jordan, *U.S. National Arboretum, USDA-ARS*; John Hammond, *U.S .National Arboretum*; Francisco Corona, *Oklahoma State University*; Jennifer Olson, *Oklahoma State University*; Mathews Paret, *University of Florida*; Binoy Babu, *University of Florida*; Kevin Ong, *Texas A&M AgriLife Extension Service* and David Byrne*, *Texas A&M University (Poster Board #120)*

Abstract: Over the past several decades Rose Rosette Disease has become very serious and threatens to decimate the US rose industry. The causal agent, Rose rosette virus (RRV, Emaravirus), is transmitted by wind-blown eriophyid mites (Phyllocoptes fructiphilus) and can kill a rose within 2-3 years of infection. A recently-funded USDA, NIFA, Specialty Crops Research Initiative grant involves 17 scientists in 6 states working on a range of approaches to study this disease and determine how best to manage it. The only strategy currently available for disease management is early identification and eradication of the infected plants, thereby limiting its potential spread. Key to this effort is the development of efficient and affordable diagnostic tools to enable accurate detection of the virus. Molecular- and serological-based assays with potential for technology transfer and/or on-site implementation should be easy to use, offering visual detection, reliability and sensitivity to the end user. RRV-specific primers and probes (for nucleic acid-based tests) and monoclonal and polyclonal antibodies (for serology-based tests) have been developed. The rabbit polyclonal and five mouse monoclonal RRV-specific antibodies can detect viral nucleoprotein (NP) in various ELISA and western-blot formats. Several unique NP-specific epitopes have been identified. Validation of virus detection from field-collected samples in is progress. An additional goal is to produce a serological lateral flow device for in-field diagnosis. Loop-mediated isothermal amplification (LAMP) and thermophilic helicase dependent amplification (tHDA) assays have been developed and are isothermal DNA amplifications which combine several desirable criteria and do not require a thermocycler. A rapid 15 minute probe-based isothermal Reverse Transcription-recombinase polymerase amplification (RT-exoRPA) assay was also developed. Broad detection of Emaravirus and species discrimination was targeted with Reverse Transcription polymerase chain reaction (RT-PCR) coupled to High Resolution Melting (HRM) analysis. A single primer-set suitable for use with three different chemistries [Endpoint RT-PCR, TaqMan-quantitative RT-PCR (RT-qPCR) and SYBR Green RT-qPCR with High Resolution Melting] was also developed. An immune-capture RT-PCR based protocol is also under evaluation. The most consistent assay(s) will be tested and validated by several diagnostic labs and then moved via outreach to other plant diagnostic labs. The contribution of these methods within a holistic perspective of RRV diagnostics will be presented.

Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches" 2014-51181-22644/SCRI

Cultural and Chemical Methods for Reducing the Impact of Rose Rosette Disease (poster)

Mark Windham, *University of Tennessee*; Alan Windham, *University of Tennessee*; Frank Hale, *University of Tennessee*; David Byrne*, *Texas A&M University* and Qunkang Cheng, *University of Tennessee (Poster Board #121)*

Abstract: Rose rosette disease, caused by Rose Rosette Virus, is a lethal disease of roses that has killed thousands of roses in the eastern U.S. The virus is vectored by the eriophyid mite, Phyllocoptes fructiphilus. The only known remedy for this disease is to destroy symptomatic plants. We evaluated cultural and chemical control strategies to reduce the impact of this disease.

Pruning to remove symptomatic canes at first detection of symptoms was ineffective for preventing other canes from becoming symptomatic on test plants. The use of Miscanthus sinensis as a green barrier, reduced incidence of rose rosette disease in test plots although once the disease became established in test plots, the rate of disease progression was similar to that observed in plots without barriers. Plants sprayed at 14 day intervals with Akari, Forbid, Kontos or Talstar did not develop symptoms whereas all control plants (sprayed with water) became symptomatic for the disease. Spray treatments of Avid+horticultural oil and Sevin were ineffective. The use of miticides for reducing the impact of rose rosette is promising. More research is needed to determine when spraying should be initiated, how many sprays are needed, if spray intervals can be increased to reduce the amount of pesticide used and if spray intervals are the same for all miticides.

Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches" 2014-51181-22644/SCRI

An Automated Unmanned Aerial System Equipped with a Multispectral Sensor Reveals Abiotic and Biotic Interactions in Commercial Roses (poster)

Melanie Kalischuk, *North Florida Research and Education Center, University of Florida*; Darren Rajendranath, *Agribugs*; Mathews Paret, *University of Florida* and David Byrne*, *Texas A&M University (Poster Board #122)*

Abstract: With rapid advances in unmanned aerial systems (UAS) and automated multispectral sensing, agriculture professionals are adopting these technologies to manage their operations. Multispectral imaging data in the wavelengths of 550 nm, 650 nm, 709 nm and 820 nm were collected from three commercial fields of roses in California. The automated UAS classified the images based on normalized vegetation difference indices (NDVIs) and identified regions of the fields that appeared stressed. Field verification of these areas indicated that there were interactions between abiotic and biotic stress types. The three main areas identified using multispectral imagery and field verification included: (1) a rapidly drained area with coarse textured soils and rose plants affected with rose rosette virus (RRV), or powdery mildew (*Sphaerotheca pannosa* var. *rosae*), (2) an area with excess moisture and drainage issues with a heavy cultivar specific rust infection and two other varieties affected with rose mosaic disease and, (3) a cultivar of *Rosa rugosa* affected with grey mold (*Botrytis cinerea*) and minor infections of Cercospora leaf spot (*Cercospora rosicola*). Here, we show that an automated UAS can identify regions of a field where a combination of poor site factors and disease exist. Future work will involve evaluating multispectral imagery in differentiating between individual biotic stress types and monitoring rose plant health and cultivar-specific flower production.

Specified Source(s) of Funding: NIFA, SCRI grant "Combating Rose Rosette Disease: Short and Long Term Approaches" 2014-51181-22644/SCRI

Suitability of Recycled Municipal Wastewater for Landscape Perennials Growing in Arid Environments (poster)

Lloyd L. Nackley*, *Oregon State University*; Darren L. Haver, *University of California*; Grant Johnson, *University of California* and Lorence Oki, *UC Davis (Poster Board #123)*

Abstract: Recycled wastewater is a popular alternative water resource. Recycled water typically has a higher salinity than potable water and therefore may not be an appropriate water source for landscapes planted with salt-intolerant plant species. Our previous research demonstrated that recycled wastewater could be detrimental to the growth of long-lived conifer species. We hypothesized that recycled wastewater might also be detrimental to the growth of perennial landscape species. To test our hypothesis, we established a research trial in which we grew varieties of popular landscape perennials (*Calibrachoa, Calamagrostis, Deschampsia, Fuchsia, Guara, Hemerocallis, Heuchera, Lantana, Lavandula, Rosa, Salvia*) in pots in a greenhouse with irrigation sourced from recycled municipal wastewater or potable water. In a parallel experiment, we tested the growth responses of six of these varieties (*Calibrachoa, Fuchsia, Guara, Lantana, Lavandula, Salvia*) to elevated levels of irrigation salinity (EC 0.5, 2.5, 6.0). The final component of our study was to determine if the differences in growth between recycled water and potable water were discernable by the public, which could reduce the saleability of these plants. To learn public opinion, we masked the treatment irrigation (recycled or potable water) and surveyed the desirability of the different plants based on a variety of aesthetic qualities. Our results showed that there were no significant growth differences between the plants grown with recycled wastewater and plants grown with potable water ($p > 0.05$). Accordingly, the public perception was not affected by the irrigation treatment. There is little public research available reporting how people chose plants for their yards. Our plant preference survey can inform researchers and industry members about the acceptability of new species or cultivars that may have certain functional qualities, like drought tolerance, yet may not lack other aesthetic qualities, like lack of flowers. Our results strongly suggest that recycled wastewater is a suitable source for cultivating perennial landscape species. However, the results of our increased salinity trial revealed significant ($p < 0.05$) negative effects on plant growth at 2.5 and 6.0 EC levels compared with 0.5 EC. These findings suggest that in landscapes were salts will accumulate, such as locations with insufficient leaching that salinized recycled water may present a threat to long-lived herbaceous perennial species.

Specified Source(s) of Funding: CDFA Specialty Crops Block Grant Program

Florida's Green Industries Best Management Practices Training Promotes Sustainable Urban Landscapes (poster)

Esen Momol*, *University of Florida*; Donald Rainey, *University of Florida*; C J Bain, *University of Florida*; Laurie Trenholm, *University of Florida*; Lyn Ward, *University of Florida*; Michael Thomas, *Florida Department of Environmental Protection* and John Bossart, *University of Florida (Poster Board #124)*

Abstract: Florida enjoys an abundance of lakes, rivers and coastal waters, many with densely populated urbanized watersheds. Urban landscaping practices, including water, fertilizer and pesticide use, contribute to nonpoint source pollutant loading to surface and ground waters. Landscaping and lawn care is a major business in Florida, employing tens of thousands of green industry professionals. To help minimize the potential nonpoint source loading from inappropriate landscaping practices, the UF/IFAS Extension Florida-Friendly Landscaping™ Program, in partnership with the Florida Department of Environmental Protection (FDEP), trains thousands of landscaping professionals statewide through the Green Industries Best Management Practices (GI-BMP) Training Program. State of Florida statutes require this training for all landscaping professionals who apply fertilizers. The training program has four main program goals: reducing off-site transport of sediment, nutrients, and pesticides to surface water or groundwater; promoting appropriate site design and plant selection; using appropriate rates and methods for irrigation and fertilizer application; and promoting integrated pest management (IPM) practices. The GI-BMP training includes six learning modules covering efficient use of water and fertilizer, integrated pest management, fertilizer application, and pollution-minimizing lawn and landscape cultural practices. Course delivery is available through several formats, including in-person classes, or self-paced instruction available online or through a DVD. Courses are available in English and Spanish, with Haitian Creole available through in-person classes. Those persons successfully completing the training and a written exam receive formal GI-BMP certification. Since the program's start in 2006, over 54,000 persons received training, with 46,067 of these trainees receiving their GI-BMP certification. Surveys conducted 6 months after each training class assess the extent to which trainees have changed their landscaping behaviors and practices to conserve water and reduce pollutants. For 2017, these surveys found that, post-training, 92-98% of the attendees used the GI-BMPs on a regular basis, with substantial improvements shown in those who always use the following practices: apply no more than 0.5-0.75 inches (1.27-1.91 cm) water per irrigation event (for water savings of 25-50%); reset irrigation controls/timers seasonally; reduce fertilizer application; and use integrated pest management. Further, the post-training surveys documented adoption of new technologies, specifically 72% using soil tests to determine fertilizer needs and

85% using soil moisture or other sensing devices to ensure effective water use.

Non-Destructive Measurement of Bermudagrass Salinity Tolerance (poster)

Justin Moss*, *Oklahoma State University (Poster Board #125)*

Abstract: Turfgrass managers are using reclaimed water as an irrigation resource because of the decreasing availability and increasing cost of fresh, potable water. Therefore, it is important to develop, select, and utilize salinity tolerant turfgrass cultivars. Bermudagrass is a warm-season turfgrass that has relatively high salinity tolerance, but information is needed on the relative performance of both common bermudagrass and interspecific hybrid bermudagrass cultivars and experimental selections. The objective of this study was to evaluate 10 common bermudagrass seeded cultivars and experimental selections and 7 clonal-type bermudagrasses for salinity tolerance using several objective, non-destructive measurement tools. Experiments were performed under a controlled environment with six replications for each treatment. Bermudagrasses were exposed to four salinity levels (1.5, 15, 30, and 45 dS m^{-1}) consecutively using a sub-irrigation system. Measurements included the subjective human measurements of turf quality and leaf firing, as well as the objective, non-destructive measurements of normalized difference vegetation index (NDVI), digital image analysis (DIA), visual rating with a smartphone app (VR), and dark green color index (DGCI). Correlation analysis showed that the parameters LF, TQ, NDVI, DGCI, and DIA were all highly correlated with one another, indicating that they can be useful as for measurement of relative salinity tolerance among bermudagrass cultivars.

Response of Five St. Augustinegrass Cultivars to Drought and Recovery (poster)

Tim Pannkuk*, *Sam Houston State University* and Ryan Saucier, *Sam Houston State University (Poster Board #126)*

Abstract: Water resources are becoming increasingly restricted for use in amenity landscapes, and the inability of water users to characterize drought stress related to plant health can result in inappropriate use of water during drought conditions. St. Augustinegrass (SA) [*Stenotaphum secundatum* (Walt.) Kutnze] is a widely used warm-season turfgrass found throughout the southern United States and near the Gulf Coast. Data comparing SA cultivar's performance during extended drought stress conditions and recovery is limited, and existing results are from late summer and fall conditions. Cultivars Delmar, Floratam, Palmetto, Raleigh, and Tamstar were evaluated in a consecutive 60-day drought in spring 2018. Following drought, turf will be evaluated during a 60-day recovery period. Using a rating system, drought response and recovery will be quantified as number of days to increase or decrease to 50% green ground cover. Results may have significant impact on both landscape irrigation behaviors and turfgrass cultivar recommendations.

Specified Source(s) of Funding: Sam Houston State University

Transition Aid Timing Effects on Photosynthetic Rate of Overseeded Bermudagrass (poster)

Charles Fontanier*, *Oklahoma State University (Poster Board #127)*

Abstract: During winter, bermudagrass (*Cynodon* spp.) enters a dormancy period resulting in a brown, unattractive appearance and inability to recover from traffic. In some cases, turf managers overseed bermudagrass with perennial ryegrass (*Lolium perenne* L.) in order to maintain an actively growing surface during winter and early spring months. An acceptable spring transition back to a bermudagrass surface can be difficult as perennial ryegrass can effectively compete for light and nutrients during this period. Transition aid herbicides have become a commonly-used tool for turfgrass managers seeking to expedite the spring transition. The objective of this study was to quantify the effect of transition aid herbicide timing on photosynthetic rate and botanical composition of an overseeded bermudagrass turf in Oklahoma.

To achieve this objective, a field study was conducted on an overseeded hybrid bermudagrass (*C. dactylon* x *C transvaalensis* 'Patriot') field during the winter of 2016-17 at the Oklahoma Agriculture Experiment Station Turfgrass Research Center in Stillwater, OK. The field was mowed three times per week at 25 mm. The experiment was arranged as a randomized complete block with three replications, two products, and eight application dates (between Mar 27 and Jun 5) plus a non-treated control. The products evaluated were foramsulfuron (Revolver) at a rate of 0.13 mL m^{-2} or ammonium sulfate at a rate of 24 kg ha^{-1} N. Visual ratings of percent ryegrass, percent bermudagrass, and percent brown straw were recorded throughout the spring transition period. Gross photosynthesis was measured on three dates using a Li-Cor 6400XT and a custom chamber.

Fertilizer treatments did not show consistent effects (positive or negative) in terms of gross photosynthesis, perennial ryegrass decline, or bermudagrass recovery. Reductions in gross photosynthesis were greater but more delayed after early season applications of foramsulfuron. Perennial ryegrass decline was similarly delayed following early season applications as compared to late season applications. Results suggest applications of transition aid herbicides when soil temperatures (5cm depth) are above 16 C result in a markedly faster response than when applied earlier in the season.

Not Only Green but Sustainable Living Roofs for Guam. (poster)

Greg Wiecko*, *University of Guam* and Lieve Dierckx, *Zurich University of Applied Sciences (Poster Board #128)*

Abstract: Concrete houses vastly dominate the architecture on the tropical island of Guam. Although they are exceptionally strong in withstanding typhoon winds, they absorb massive amounts of heat that build up during daylight hours and remain in the building material until the next morning. To escape the heat, air conditioning is frequently used and in many houses the AC units run year round, day and night. Concrete roofs are also sturdy enough to carry a load of growing media (soil) and vegetation. This layer of soil covered by plants may effectively shield the roof from the hot sun. Constructing an extensive (minimal maintenance) type of green roof in the tropics can be relatively easy. The growing medium (soil mixed with gravel and lava) needs to be only 10 cm thick and must be placed on some type of drainage layer. On the university campus, a green roof was established on top of a typical one story residential house. Locally plentiful coconut husks (halved and chopped) were placed on the concrete roof and covered by 10 cm of soil. Commercially recommended synthetic drainage material was also used to compare its efficiency with much lower-cost coconut husks. Research conducted examined irrigation needs, the ability of coconuts to absorb and hold water, time needed to deplete water from organic versus synthetic amended plots, as well as daily fluctuations in concrete roof temperature. It was found that shredded husks were the most effective in storing water and ultimately delaying drought stress during dry periods. There were up to a 15^{o}C difference in exposed concrete when compared to the concrete covered by soil and vegetation. The type of drainage layer had only a minimal influence on roof temperature. Complete data will be presented and discussed.

Sedum Evaluation for Green Roofs in Oklahoma (poster)

Bruce Dunn*, *Oklahoma State University* and Megha R. Poudel, *Oklahoma State University (Poster Board #129)*

Abstract: Because of their wide range of environmental and economic benefits, green roofs have become important elements of both small and large scale sustainable landscapes. Plant recommendations vary based on the type of system (extensive or intensive), substrate, as well as the geographical location. Sedums generally do well in both types of systems; however, information on which species and cultivars should be recommended in Oklahoma does not exist. The objective of this study was to evaluate nine different *Sedum* cultivars planted in an extensive system using a 70:30 ratio mix of calcined clay and compost at a depth of 15 cm. Rooted cuttings were planted late March in 2016 in Stillwater, OK in a randomized design with eight plants per cultivar. Plants were watered as needed during the summer and no supplemental irrigation was applied in the winter. Of the eight species and 72 total plants, only 25% of plants survived. Recommended species include *S. album* 'Coral Carpet', and *S. reflexum* 'Sandy Silver Crest', as both had 63% survival. 'Coral Carpet' had the greatest growth. *Sedum* 'Dr. John Creech' had 37% survival followed by *S. reflexum* 'Angelina' and *S. spurium* 'Fuldaglut' with both having 25% survival. *Sedum divergens*, *S. japonicum* 'Tokyo Sun', *S. confusum*, and *S. spurium* 'Tricolor' did not survive past the first year.

Specified Source(s) of Funding: This work [is/was] supported by the USDA National Institute of Food and Agriculture, Hatch

project and the Division of Agricultural Sciences and Natural Resources at Oklahoma State University.

1:15 PM – 2:00 PM *International Ballroom East/Center*

Plant Biotechnology 2 (Poster)

Transgene-Mediated Flowerless Plants without Using a Toxin Gene (poster)

Wei Li, *University of Connecticut*; Xiaojing Wang*, *University of Connecticut*; Richard McAvoy, *University of Connecticut* and Yi Li, *University of Connecticut (Poster Board #300)*

Abstract: The AGAMOUS (AG) gene is required for development of some reproductive organs. Here we report that expression of an rPTAGI::GUS fusion gene is sufficient to produce a flowerless phenotype in tobacco, a model plant. The rPTAGI sequence is an intron sequence cloned from the AGAMOUS gene of poplar. The flowerless phenotype has been observed in both greenhouse and field conditions. We have observed that shoots of the rPTAGI::GUS flowerless plants are flowerless if they are grafted onto wild-type plant rootstocks. On the other hand, wild-type plant shoots flower normally if they are grafted onto rootstocks derived from the rPTAG2I::GUS flowerless plants. We have investigated the molecular basis of the flowerless phenotype observed in the rPTAGI::GUS plants via analyses of transcriptomes of shoot tip tissues of both wild type and transgenic plants. We have observed that expression of a number of flowering genes is altered in the rPTAGI::GUS plants when compared to the wild type plants. We believe that the rPTAG2I::GUS gene may provide a better tool to reduce pollen- and seed-mediated gene spread problems of transgenic woody plants.

Specified Source(s) of Funding: USDA-NIFA BRAG (2010-33522-21697) and USDA Hatch Grant to YL.

The Cold-Regulated Genes of Blueberry and Their Response to Overexpression of *VcDDF1* in Several Tissues (poster)

Guo-Qing Song*, *Michigan State University* and Aaron Walworth, *Michigan State University (Poster Board #301)*

Abstract: **Abstract:** Expression of blueberry cold-regulated genes (VcCORs) could play a role in the variable cold hardiness of blueberry tissues. In this study, transcriptome comparisons were conducted to reveal expression of VcCORs in non-acclimated leaves, flower buds, and flowers of both non-transgenic and transgenic blueberries containing an overexpressed blueberry *DWARF AND DELAYED FLOWERING* gene (*VcDDF1*), as well as in fully chilled flower buds of non-transgenic blueberry. In non-transgenic blueberries, 57.5% of VcCOR genes showed differential expression in at least one of the three pairwise comparisons between non-acclimated leaves, flower buds, and flowers; and six out of nine dehydration-responsive element-binding factors showed differential expression. In addition, expression of *VcDDF1* was not cold-inducible in non-transgenic blueberries and had higher expression in flowers than in leaves or non-acclimated flower buds. In transgenic blueberries, overexpression of *VcDDF1* resulted in a higher *VcDDF1* expression in leaves than in flower buds and flowers. *VcDDF1* overexpression enhanced expression of blueberry *CBF1* and *CBF3* in leaves and repressed expression of *CBF3* in both flower buds and flowers. Overall, the results revealed tissue-specific patterns of VcCORs' expressions. The response of VcCORs to overexpression of *VcDDF1* suggest that it is possible to increase plant cold hardness through overexpression of a non-cold-inducible gene.

Development of Variegated Lettuce Using CRISPR/Cas9 Technology (poster)

Juncheng Li, *University of Florida*; Heqiang Huo*, *University of Florida*; Chi Nguyen, *University of Florida/IFAS* and Beiquan Mou, *USDA-ARS (Poster Board #302)*

Abstract: The clustered, regularly interspaced, short palindromic repeat (CRISPR)-CRISPR associated endonuclease 9 (CRISPR/Cas9) system has emerged as a powerful approach for precision breeding to create plants with desirable traits. However, gene editing efficiency of CRISPR/Cas9 in plant relies on the efficacy of generating transgenic plant or tissues with high expression of Cas9 endonuclease. Here, we have constructed a CRISPR-Cas9 vector with NPT-GFP with high editing efficiency. The high expression of GFP during plant regeneration allowed us to minimize the positional effect on T-DNA expression and preferentially select transgenic seedlings with high expression of Cas9. With this construct, we have targeted the variegation gene *LsVar2* in lettuce. Forty independent lines were generated, 27 of which showed strong GFP signals. None of transgenic lines with no GFP signals exhibited phenotypic difference in leaves compared to the control lines, although these lines carried T-DNA insertions. Six of 27 T0 transgenic lines with GFP signals exhibited variegated leaves. Albino seedlings were observed in segregated progenies of these variegated lines, and sequencing results revealed that homozygous mutations created by Cas9 editing occurred to all these albino seedlings. By contrast, heterozygous mutations were only identified in the plants with variegated leaves, and chlorophyll content of these variegated plants were significantly reduced. The results suggested that *LsVar2* is essential for plant leaf development. Additionally, segregation of T-DNA and mutations can be easily tracked with GFP signal detection. In conclusion, the unique designing of our CRISPR/Cas9 construct allow us to improve gene-editing efficiency and efficiently screen non-TDNA mutants through detecting GFP signals during plant regeneration and progeny segregation.

Developing Genetic and Molecular Resources to Improve Spinach Production and Management (poster)

Ainong Shi*, *University of Arkansas*; Jim Correll, *University of Arkansas*; Chunda Feng, *University of Arkansas*; Beiquan Mou, *USDA-ARS*; Carlos A. Avila, *Texas A&M AgriLife Research*; Lindsey du Toit, *Washington State University*; Larry A. Stein, *Texas A&M University*; Rob Hogan, *Texas A&M AgriLife Extension Service*; Jun Qin, *University of Arkansas*; Wei Zhou, *University of Arkansas*; Gehendra Bhattarai, *University of Arkansas*; Bazgha Zia, *University of Arkansas*; Waltram Second Ravelombola, *University of Arkansas*; Yuejin Weng, *University of Arkansas*; Bo Liu, *University of Arkansas*; Sanjaya Gyawali, *wasgington State University* and Shyam Kandel, *USDA (Poster Board #303)*

Abstract: Spinach (*Spinacia oleracea* L., 2n=2x=12) is an economically important vegetable crop worldwide. The objectives of this spinach project are: (1) genetic mapping and SNP marker identification for downy mildew and white rust resistance; (2) QTL and association mapping and SNP marker identification for Fusarium wilt resistance; (3) introgression of downy mildew and white rust resistance into spinach lines with diverse leaf quality characteristics to satisfy market demand; and (4) construction of high density SNP consensus genetic maps of the six chromosomes in spinach using whole genome resequencing. The project is a collaborative effort with the University of Arkansas, USDA-ARS at Salinas, Texas A&M AgriLife, and Washington State University. A total of 480 spinach genotypes are being evaluated for downy mildew, white rust, and Fusarium wilt disease resistance. Downy mildew resistance is being evaluated under both field and greenhouse/growth chamber conditions; white rust resistance is being evaluated at the Del Monte White Rust Nursery in Crystal City, TX and at the White Rust Nursery in Weslaco, TX; and Fusarium wilt resistance is being evaluated in the greenhouse at the Washington State University Mount Vernon NWREC in Mount Vernon, WA and at the University of Arkansas, Fayetteville, AR. Genotyping is being conducted at BGI and Novogene using genotyping by sequencing (GBS) and whole genome resequencing (WGR). Approximately 500,000 SNPs have been identified in in spinach genotypes thus far. Both QTL and association mappings are being used to identify QTLs and SNP markers for disease resistance to the three diseases. The WinQTLCart, Q-gene, and QTLNetwork are being used for QTL mapping, and the general linear model (GLM) and mixed linear model (MLM) from TASSEL, GAPIT, and FarmCPU will be used for genome wide association studies (GWAS). So far, numerous SNP markers linked to downy mildew resistance locus *RPF1* have been identified, and SNP markers strongly associated with white rust resistance have been identified. The QTLs and SNP markers will provide breeders with robust tools to improve resistance selection for resistance to these economically important diseases through marker-assisted selection (MAS) and genomic selection (GS).

A SNP Set for Spinach Cultivar Determination (poster)

Jun Qin, *University of Arkansas*; Ainong Shi*, *University of Arkansas*; Wei Zhou, *University of Arkansas*; Yuejin Weng, *University of Arkansas*; Waltram Second Ravelombola, *University of Arkansas*;

Gehendra Bhattarai, *University of Arkansas* and Bazgha Zia, *University of Arkansas (Poster Board #304)*

Abstract: Spinach (*Spinacia oleracea* L., 2n=2x=12) is an economically important vegetable crop worldwide and one of the healthiest vegetables due to its high concentrations of nutrients and health-promoting compounds. Currently, there are about 400 spinach (*S. oleracea*) accessions in USDA-GRIN. Because spinach is a dioecious species, it is hard to keep each accession as an inbred line and also hard to determine its purity and uniquity. We develop a 24-SNP set used to spinach germplasm determination to detect and distinguish each spinach accession for USDA germplasm accessions. Based on our genetic diversity analysis among the 400 accessions using SNPs postulated from whole genome resequencing (WGR) and genotyping by sequencing (GBS) data, we select 6 SNPs distributed evenly on each of the six chromosomes in the spinach genome to form a total of 24 SNP set. Using this SNP set, we can detect and determine each accession among the 400 accessions and also this SNP set can be used to determine commercial spinach hybrids, opened-pollinated cultivars, and Arkansas spinach lines.

Genetic Architecture of Abiotic Stress Tolerance in Cowpea through Multiple Genomic Selection Models (poster)

Waltram Second Ravelombola*, *University of Arkansas*; Yuejin Weng, *University of Arkansas*; Jun Qin, *University of Arkansas*; Wei Zhou, *University of Arkansas*; Gehendra Bhattarai, *University of Arkansas*; Bazgha Zia, *University of Arkansas* and Ainong Shi, *University of Arkansas (Poster Board #305)*

Abstract: Predictive breeding has become more and more popular in efforts to unravelling the genetic control of complex traits in plants. Cowpea (*Vigna unguiculata* (L.) Walp) is one the most important legumes grown worldwide but significantly affected by various types of abiotic stress. To the best of our knowledge, little has been done with respect to studies pertaining to genomic selection to assist cowpea breeders with efficiently gaining genetic gain. In this study, the focus will be on stresses such as drought, salt, low phosphorus conditions, and iron chlorosis deficiency, which have been proven to substantially limiting cowpea production. Therefore, the objective of this study will be to estimate the accuracy of genomic estimated breeding values (GEBV) for these aforementioned abiotic stresses. Phenotyping on drought, salt, low phosphorus conditions, and iron chlorosis deficiency was conducted on a total of 200, 155, 357, 353 cowpea accessions, respectively. Genomic estimated breeding values will be computed for at least 1000 SNPs postulated from genotyping-by-sequencing. Training set will consist of subsets randomly chosen from the association panel. Set sampling will be conducted using R through 10-fold cross validation at each sampling process. Genomic selection will be performed in R using rrBLUP, Bayes A, Bayes B, and LASSO. We expect that: 1) genomic selection accuracy will vary from low to moderate depending upon the type of abiotic stress, 2) At least 10 SNPs will have large effects for each trait, 3) Bayes B will provide the highest genomic selection accuracy, 4) there will be positive correlation between training/testing set size and genomic selection accuracy. The results from this investigation can be used in breeding cowpea cultivars for more tolerance to drought, salt, low phosphorus conditions, and iron chlorosis deficiency.

Genomic Selection-Based Approach for Resistance to Aphids and Cowpea Mosaic Virus in Cowpea (poster)

Waltram Second Ravelombola*, *University of Arkansas*; Jun Qin, *University of Arkansas*; Gehendra Bhattarai, *University of Arkansas*; Yuejin Weng, *University of Arkansas*; Wei Zhou, *University of Arkansas*; Bazgha Zia, *University of Arkansas* and Ainong Shi, *University of Arkansas (Poster Board #306)*

Abstract: Cowpea (*Vigna unguiculata* (L.) Walp) is a legume which is widely cultivated in tropical and semi-arid areas. It provides affordable nutritional food for human and is used to feed livestock. Previous investigations reported that cowpea aphid (*Aphis craccivora*) and cowpea mosaic virus (CPMV) unfavorably affect cowpea production. Phenotyping for resistance to aphids and cowpea mosaic virus could be challenging, time-consuming, and labor intensive, which could slow down the breeding process. Fortunately, this can be addressed by using a genomic selection approach which aims at predicting phenotypes using the information from the genotypes. Therefore, the objective of this study will be to conduct a genomic selection study and to determine the accuracy of genomic estimated breeding values for resistance to aphids and cowpea mosaic virus resistance in cowpea. A total of 333 and 338 cowpea accessions were phenotyped for resistance cowpea aphids and cowpea mosaic virus, respectively. Each association panel will be divided into subsets of training and testing populations using R. Genomic selection will be also conducted in R using rrBLUP, Bayes A, Bayes B, and LASSO. Genomic selection will be performed using a ten-cross fold validation approach. Effects of a total of at least 1000 SNPs will be computed. We expect that: 1) genomic selection accuracy will range from low to moderate, 2) higher accuracy will be obtained using Bayes B, 3) a larger training set will provide higher accuracy for genomic selection, and 4) SNPs from previously reported GWAS will have the largest effects. The results from this study could be used to advance predictive breeding for resistance to aphids and cowpea mosaic virus in cowpea.

Evaluation and Association Analysis of Seed Protein Content in USDA Cowpea Germplasm (poster)

Yuejin Weng, *University of Arkansas*; Jun Qin, *University of Arkansas*; Wei Yang, *University of Arkansas*; Waltram Second Ravelombola, *University of Arkansas*; Haizheng Xiong, *University of Arkansas*; Gehendra Bhattarai, *University of Arkansas*; Bazgha Zia, *University of Arkansas*; Wei Zhou, *University of Arkansas*; Ainong Shi*, *University of Arkansas* and Beiquan Mou, *USDA-ARS (Poster Board #307)*

Abstract: Cowpea (*Vigna unguiculata* (L.) Walp) is a legume crop grown worldwide to provide protein for human consumption and animal feed. The objective of this research is to estimate the cowpea seed protein content and at the same time conduct association mapping and SNP marker identification for seed protein content in USDA cowpea germplasm. A total of 173 USDA cowpea germplasm accessions were evaluated for their seed protein contents, including 18 accessions with black seed coat color, 26 blackeye, 29 browneye, 12 cream, 8 pinkeye, 15 red, 19 red holstein, 26 tan, and 20 varied color. The field experiment was conducted in two locations within Arkansas State (Fayetteville and Alma) in 2016. A randomized complete block design (RCBD) with three blocks was used for the experiment in each location. In each plot, cowpea accessions were planted in four rows 10 feet long, with three feet between rows. The seed protein content averaged 25.6%, with a range from 19.6% to 31.0%, and had a standard deviation (Std) of 1.82% with 0.06% Std Error, indicating the seed protein content had large variation in the 173 cowpea accessions. The seed protein content showed difference among the seed coat color: cream and pinkeye seed types had the highest seed protein content with 27.2% and 26.7% respectively; black, blackeye, and browneye second highest with 25.9%, 26.0%, and 26.0% respectively; then, red and tan with 25.3% and 25.3%, respectively; and finally the red Holstein with 23.7%. Association analysis was conducted with the single marker regression (SMR) without structure and without kinship, the regression linear model (GLM), and the mixed linear model (MLM) methods as described in TASSEL 5. Eight SNP markers, C35058883_723, C35069896_1985, C35074656_2002, C35084640_31, Scaffold40268_5600, Scaffold72747_120, Scaffold75749_1913, and Scaffold94454_419 were founded to be associated with seed protein content in the panel of 173 cowpea accessions. This study will provide a tool for breeders how to use USDA cowpea resource and to select high seed protein contents in cowpea breeding program through marker-assisted selection.

Screening of Rose Rosette Primers to Identify the Most Sensitive Primer (poster)

Madalyn Shires*, *Texas A&M University*; Jake Ueckert, *Texas A&M AgriLife Extension Service* and Kevin Ong, *Texas A&M AgriLife Extension Service (Poster Board #308)*

Abstract: *Rose rosette virus* (RRV) is a negative sense, single stranded RNA virus. The host for RRV is roses of all classes, as no resistant variety has been identified. Rose rosette disease (RRD) has been a problem in the United States for about 20 years; however the virus was only identified as the causal agent in 2011. Because RRD is a viral disease, there are no known treatments for infected plants. Thus, management requires that infected plants are removed from the landscape slow the spread of the disease. Currently the most accurate way to diagnose a rose with RRV is

through Takara Reverse Transcription qualitative PCR (qPCR). However, as this is a costly system, the most common molecular diagnostic for the virus is with Reverse Transcription PCR tests. Unfortunately, there have been many issues with false negative results. This study compared the eight primers developed for 4 of the 7 segments of the *Rose rosette virus* genome to determine which of these primers is the most effective for the two common diagnostic methods. Samples used in comparison were collected from various parts of Texas along with numerous out of state samples. When comparing the five available qPCR primers for RRV, it was found that primers developed for the third viral segment were the most sensitive for RRV detection. RRV2, which is a primer developed in Oklahoma, was found to be the most sensitive for qPCR detection. When comparing the three available primers for RT-PCR, it was found that the RRV3 primer, from Minnesota, developed for the third viral segment was the most sensitive. The two primers are in different locations on the third segment, but there is little difference in their detection capabilities. The eight primers tested come from four different states and while there were some false negatives, many primers worked for all samples, suggesting that there is little difference in the viral genome across the United States.

Rose Rosette Virus: Effective and Low-Cost Extraction Method (poster)

Madalyn Shires*, *Texas A&M University*; Jake Ueckert, *Texas A&M AgriLife Extension Service* and Kevin Ong, *Texas A&M AgriLife Extension Service (Poster Board #309)*

Abstract: When performing diagnostics on plant samples, it is desirable to use methods that have low inputs of time and money, while still being effective. This is especially true with RNA virus extractions, like ones done for the diagnosis of *Rose rosette virus*. The kits that are used in RNA extraction are typically costly and time consuming, with some kits taking as much as 2 hours per sample. From a diagnostic stand point, this is high time input, especially when other diagnostic procedures can be completed quickly. Whenever the need arose to extract 100+ samples at a time, the kit extraction methods were not feasible for use because of the costs and the time required. Recently a direct antigen extraction method was developed for the *Rose rosette virus*. However, this method is still time and resource consuming and not for practical use in a diagnostic lab. This cost effective direct antigen extraction method was modified to allow for rapid extraction (15 min per sample) and the use of common resources in diagnostic clinics such as mesh bags and phosphate-buffered saline/tween (PBST). Extracts using the modified direct antigen method and the Qiagen RNeasy Plant Mini Kit are similar in sensitivity. The extracts are stable for repeated use, however Ct values on Takara Reverse Transcription quantitative PCR (qPCR) tend to increase by 1 to 2 cycles after repeated freeze-thaw cycles on the extract. However, most diagnostic labs do not retain extracts for research, so this may not be a problem. This extraction method is also effective at extracting stable RNA with other rose RNA viruses that can be used for detection.

1:15 PM – 2:00 PM *International Ballroom East/Center*

Postharvest 2: Fruit (Poster)

Changes and Quantifications of Eight Major Plant Growth Regulators during Non-Climacteric Ripening in Strawberry Fruit (poster)

Eun Jin Lee*, *Seoul National University, Department of Plant Science (Poster Board #251)*

Abstract: Strawberry fruit (*Fragaria* × *ananassa*) has been considered as non-climacteric fruit. However, the roles of other major plant hormones and ripening mechanism of strawberry fruit have not been well studied clearly. To understand hormonal regulation mechanism of strawberry fruit ripening, we analyzed eight major hormones of abscisic acid (ABA), indole-3-acetic acid (IAA), gibberellin 4 (GA_4), jasmonic acid (JA), methyl-jasmonate (MJ), jasmonoyl isoleucine (JA-Ile), salicylic acid (SA) and ethylene (ET) according to strawberry fruit development stages. The quantification of hormones was conducted at six developmental stages: S1, small green; S2, green; S3, breaker; S4, pink; S5 red and S6, fully red coloration. IAA and GA_4 levels showed the highest levels at S1 stage and gradually declined during the fruit development. The level of ABA was low at from S1 to S3 stages and then rapidly increased at S6 which showed the maximum value. In contrast, the level of MJ did not significantly change during the fruit development stage. SA increased gradually during strawberry fruit ripening. JA and JA-Ile were detected but not enough to quantify as a trace amount. ET was not detected in all fruit development stages. Additionally, the ABA biosynthesis genes of *FaNCED1* and *FaABA2* had positive correlations with fruit ripening. The ABA degradation genes of *FaCYP707A1, FaUGT75C1* encoding 8-hydroxylase had negative correlations with fruit ripening. The transcription factor expression levels of *FaMYB1, FaMYB5,* and *FaMYB10* increased with the ripening of strawberry fruit. Therefore, the ripening of strawberry fruit would be controlled under the changes of ABA and its transcriptional regulations.

Specified Source(s) of Funding: This work was supported by the Basic Science Research Program through the National Research Foundation (NRF, 2016R1A1A1A05919210) and the Rural Development Administration (RDA, PJ01364804), Republic of Korea.

Metabolic Responses of Amino Acids and Volatile Organic Compounds to Fruit Ripening Stages and Shelf Life in 'Seolhyang' Strawberry Fruit (poster)

Jingi Yoo, *Kyungpook National University, Department of Horticultural Science*; Si-Eun Byeon, *Mokpo National University, Department of Horticultural Science*; Eun Jin Lee, *Seoul National University, Department of Plant Science*; Myoung-Gun Choung, *Kangwon National University, Department of Herbal Medicine Resource*; In-Kyu Kang, *Kyungpook National University, Department of Horticultural Science* and Jinwook Lee*, *Chung-Ang University, Department of Integrative Plant Science (Poster Board #252)*

Abstract: Strawberry fruit develops a complex favor during ripening. The objective of this study was to evaluate the metabolic responses and relationship between amino acids and volatile organic compounds (VOCs) during ripening and shelf life of 'Seolhyang' strawberry fruit. Fruit were harvested at green, pink, and red maturity stages and left at ambient temperature for 7 days for shelf life. Fruit fresh weight, diameter, and length decreased during 7 days shelf life, compared with fruit at harvest at all maturities. Soluble solids content (SSC) and titratable acidity (TA) decreased with maturity. SSC remained unchanged with shelf life while TA increased. Levels of aspartic acid, glutamic acid, valine, isoleucine, leucine, tyrosine, phenylalanine, histidine, arginine, and proline declined with shelf life while β-alanine and γ-amino-n-butyric acid (GABA) levels increased. Levels of ethyl acetate, methyl butanoate, ethyl butanoate, methyl hexanoate, butyl butanoate, ethyl hexanoate, and hexyl acetate increased but hexanal, (*E*)-2-hexenal and 2-heptenal responses decreased with shelf life. Overall, the inverse relationship between amino acids and certain VOCs that occurred with increasing fruit maturity and continued during 7 days shelf life. These results indicate that amino acids may be involved in VOCs production during shelf life.

Potential of Programmed Cooling to Expand Handling Options for Fresh-Market Strawberry: Semi-Commercial Scale Tests (poster)

Steven Sargent*, *University of Florida (Poster Board #253)*

Abstract: Fresh-market strawberries grown on commercial scale are typically picked, field-packed and transported for forced-air (FA) cooling within 1 to 2 hr of harvest. FA cooling typically requires 60 to 180 min to achieve 7/8 Cooling. Our previous studies with blueberries showed that fruit cooled to 10 °C by FA cooling day of harvest, held overnight, then 7/8 cooled the following day had similar fruit quality during subsequent storage as fruit completely cooled with FA the day of harvest. We also demonstrated that strawberries in clamshells that were partially cooled by immersion hydrocooling (HY) cooled more rapidly and uniformly (8 min) than those cooled by FA (61 min). Successful HY requires constant sanitation of the cooling water (100-150 ppm free chlorine; pH 6.8-7.0). The result is strawberries that have been rinsed and sanitized prior to shipping. We term this procedure "programmed cooling", or the deliberate partial cooling of fruit or vegetables for defined times prior to final cooling, with minimal effect on storage quality. The objective of these tests was to determine the effect of six programmed-cooling scenarios on strawberry quality ('Sweet Sensation'), considering delay from harvest (immediate cooling vs. 1.5 hr), holding temperature

(ambient or 10 °C) and HY vs. FA. Tests were conducted during March and April of 2018 at a commercial farm. Partially cooled treatments were 7/8-cooled with FA, stored at 1°C for 7 days and evaluated quality. There was no statistical difference in strawberry quality due to cooling regime. Firmness ranged from 2.3 to 3.5 N, fruit brix:acid ratio was 10 and external hue* value of 30 to 35°. The incidence of bruising was quite high for all treatments, even at the initial evaluation (37% to 65%). This could be a result of unexpected late season cold weather and heavy rain events. Use of programmed cooling shows potential to provide more handling options for strawberry growers.

Evaluation of Fruit Quality of Five Novel Peach Cultivars and Advanced Selections, 'Evelynn', 'Selena', 'Tiana', 'Brigantine' and 'Silverglo'. (poster)

Daniel Ward*, *Rutgers Agricultural Research and Extension Center* and Hemant Gohil, *Rutgers New Jersey Agricultural Experiment Station (Poster Board #254)*

Abstract: Three exciting new peach ('Evelynn', 'Selena', and 'Tiana') and two nectarine cultivars ('Brigantine' and 'Silverglo') have been released from the Rutgers Stone Fruit Breeding Program. These new varieties were created and selected by Joseph Goffreda at the Rutgers Fruit and Ornamental Research Extension Center in Cream Ridge, New Jersey. To understand how best to select and market these varieties, growers need to better understand the characteristics of their fruit. We performed three years of studies (2015-2017) to estimate fruit qualities, both chemical and physical, that determine much of the value of peaches. For each study fruit were harvested from three to five-year-old trees established in commercial orchards in southern New Jersey. Harvesting at the time of commercial maturity for each cultivar was based on ground color change and size. After picking, fruits were transported to the laboratory at Rutgers Agricultural Research and Extension Center, where all analyses were performed. Fruit were evaluated for firmness, size, total soluble solids (°Brix), total titratable acidity, and pH. 'Evelynn' has produced large fruit with very good firmness that are low in acid, giving them a sweet and delicate flavor. 'Selena' are late season yellow, firm-fleshed peaches with excellent firmness and can hang well in the tree. 'Tiana' has yielded consistently firm, large fruit that are sweet and acidic giving them a tangy flavor. 'Brigantine' has produced very attractively finished fruit with good size and firmness that are sweet, acidic and tangy in flavor. 'Silverglo' is very firm, and larger and more attractive than other white nectarines during their early harvest window. These five varieties can be recommended for trial planting or replacing poorly performing, concurrently harvested peach or nectarine varieties.

Specified Source(s) of Funding: New Jersey Peach Promotion Council

Cause of Shrunken Shoulders in 'Tommy Atkins' Fruit Grown in Diverse Ambient in Mexico (poster)

Jorge Osuna-Garcia*, *INIFAP-Santiago Ixcuintla Experimental Station*; Yolanda Nolasco-Gonzalez, *INIFAP-Santiago Ixcuintla Experimental Station* and Ricardo Goenaga, *USDA-ARS (Poster Board #255)*

Abstract: In 'Tommy Atkins', it is common to find a high percentage of fruit with 'shrunken shoulders'. The objectives of this work were to study if fruit ripening degree, quarantine hot water treatment (QHWT), hydrocooling, rest after hydrocooling, and nutritional status of the orchard influence this anomaly in 'Tommy Atkins' fruit. The study was conducted during the 2017 season with fruit harvested in Jalisco, Nayarit and Sinaloa. Treatments included: 1) Origin; 2) Ripening degree (partial ripe and ripe); 3) Time of QHWT (75 or 90 min); 4) Hydrocooling (immediate, after 30 min and without), and 5) Rest (without or rest for 24 h). Once the treatments were applied, fruit were stored for seven days in refrigeration (53.6 ± 1.5 °F; 95 ± 5 % RH) and then under marketing simulation (71.6 ± 3 °F; 75 ± 10 % RH) until consumption stage. Sampling was done at the beginning and end of the refrigerated storage and at consumption stage. Variables measured were percentage of shrunken shoulders, weight loss, firmness, pulp color, and total soluble solids content. A completely randomized design with a factorial arrangement was used. Results showed almost 30 % of fruit with shrunken shoulders. Fruit harvested in Jalisco did not show the damage whereas fruit from Nayarit and Sinaloa had 27.1 and 28.3 % damage, respectively. The factors that most influenced presence of shrunken shoulders symptoms were ripening degree at harvest and rest. Fruit harvested partially ripe showed a higher percentage of this anomaly in all the samplings. At the beginning, the partially ripe fruit showed 18.1 % of fruit with shrunken shoulders, as compared to only 3.9 % of the ripened fruit. At the end of refrigeration, partially ripe fruit increased shrunken shoulders symptoms to 25.3 %, while ripened fruit showed only 8.9 %. At consumption stage, the partially ripe fruit had 25.6 % of fruit with symptoms, while ripe fruit only 11.4 %. The other factor that significantly influenced the presence of fruit with shrunken shoulders was the rest, mainly in the initial sampling, where the fruit with rest of 24 h showed three times more fruit with symptoms (16.1 %) than those without rest (5.8 %). In conclusion, to reduce or avoid the incidence of fruit with shrunken shoulders, it is recommended to harvest ripe fruit, as well as to avoid a rest period of 24 or 48 h traditionally carried out by the packers.

Specified Source(s) of Funding: National Mango Board

Effects of Site and Cultivar on Consumer Acceptance of Pomegranate (poster)

John M. Chater*, *University of California, Riverside*; Donald Merhaut, *University of California, Riverside*; Zhenyu Jia, *University of California, Riverside*; Mary Arpaia, *University of California*; Peggy Mauk, *University of California* and John Preece, *National Clonal Germplasm Repository USDA-ARS (Poster Board #256)*

Abstract: Pomegranate (*Punica granatum* L.) is an important fruit in many cultures. The fruit and juice have risen in popularity as it was discovered that pomegranate has relatively high antioxidant activity compared to most other fruits. In this study, six cultivars were utilized to determine consumer acceptance compared to the industry standard, 'Wonderful', which comprises 90-95% of commercial production in the USA. Fruit were sourced from two cultivar field trials, one in inland Riverside, CA and one in coastal Ventura County, CA. Cultivars selected for the study included 'Eversweet', 'Green Globe', 'Haku Botan', 'Loffani', 'Phoenicia', 'Wonderful', and 'cv. 857', an heirloom cultivar from Ventura County, CA USA. Pomegranate arils were subject to sensory evaluation by 87 untrained consumer panelists in late 2016. Panelists were given pomegranate arils and asked to score the samples using a 9-point Hedonic scale for the following fruit quality traits: aril color, sweetness, tartness, seed hardness, bitterness and overall desirability. There were significant differences among cultivars for all traits assessed by the sensory panelists. There were differences in acceptance among consumers for 'Wonderful' depending on if it was grown on the coast versus inland, and consumers preferred inland- versus coastal-grown 'Wonderful'. 'Wonderful' pomegranate was associated with cultivars that consumers scored low on desirability for bitterness. Cultivars that scored well in overall desirability versus 'Wonderful' were 'cv. 857', 'Eversweet', 'Green Globe', and 'Phoenicia'.

Specified Source(s) of Funding: University of California Office of the President Global Food Initiative

Impact of Preharvest Weather Conditions on the Incidence of Apple Fruit Storage Disorders (poster)

Gaetan Bourgeois*, *Agriculture and Agri-Food Canada*; Jennifer DeEll, *Ontario Ministry of Agriculture, Food and Rural Affairs*; Dominique Plouffe, *Agriculture and Agri-Food Canada*; Maude Lachapelle, *Environment Canada*; Marie-Pier Ricard, *Agriculture and Agri-Food Canada*; Virginie Grégoire, *Agriculture and Agri-Food Canada*; Cyrille Viens, *Agriculture and Agri-Food Canada* and Antoine Plourde-Rouleau, *Agriculture and Agri-Food Canada (Poster Board #257)*

Abstract: Inter-annual variability in apple fruit storage disorders is associated with weather conditions during fruit development prior to harvest. Bioclimatic models for apple phenology, pests (insects and diseases), and storage disorders to assess risks associated with this weather variability were implemented in CIPRA, a computer system that uses real time weather data to assist crop producers in their daily decision-making process. The objective of this study was to update existing apple storage disorder models and develop new models based on fruit quality data collected over many years and sites in Eastern Canada. 'Honeycrisp' apples are quite susceptible to a number of storage disorders such as soft scald, soggy breakdown and bitter pit. 'McIntosh' and 'Empire' apple fruits show susceptibility to low

temperature disorders such as vascular browning and core browning, respectively. Apple phenological data, weather data during fruit development and storage disorder incidences were collected over many years with the objective of identifying which weather parameters influence storage disorder incidences. Data from apple orchards were obtained on 'Honeycrisp' and 'McIntosh' in Ontario (2002-2006), and on 'Honeycrisp', 'McIntosh' and 'Empire' in Ontario and Quebec (2009-2017). The following weather data and parameters were measured or estimated: daily precipitations, maximum and minimum air temperatures, solar radiation, potential evapotranspiration and water balance, during six sub-periods of fruit development, expressed in days after flowering (DAF): 0-14, 15-29, 30-44, 45-59, 60-89 and 90-Harvest. Every year in each commercial orchard, apples were harvested at optimum maturity for storage and were evaluated immediately for fruit quality, including firmness, soluble solids content and starch index. They were then placed into air or controlled atmosphere storage for up to 10 months. The incidence of all storage disorders was assessed at the time of storage removals and 7 days later. All data for each storage disorder were analyzed using principal component analyses and stepwise linear regressions to establish the effect of weather after each sub-period of fruit development. For the years and sites of this study, results from these bioclimatic modelling activities show that weather during apple fruit development, as soon as 45 DAF, explains an important part of the observed variability of all storage disorder incidences in Eastern Canada. Such bioclimatic models will be very useful tools for apple producers in their marketing and storage strategies in order to provide high quality apples to their consumers.

Cooperative Effects of Preharvest Calcium and Gibberellic Acid on Tissue Calcium Content and Quality Attributes of Sweet Cherry (poster)

Yu Dong*, *Oregon State University*; Yingli Li, *Oregon State University* and Shaoying Zhang, *Oregon State University (Poster Board #258)*

Abstract: In the U.S. Northwest, sweet cherries that are shipped to distant markets are subject to various arrival issues including fruit softening, flavor loss, skin darkening, pitting, splitting, pedicel browning, and decay. The objectives of this study were to develop preharvest calcium (Ca) and gibberellic acid (GA_3), separate or in combination, spray protocols to improve cherry harvest/shipping quality. Six weekly applications of 0.15% Ca were required between pit-hardening and 1-week before harvest (WBH) to increase fruit tissue Ca concentration of 'Lapins'. Two applications of Ca applied at pit hardening and WBH did not improve tissue Ca concentration compared to the 6-application regime. For 0.15% Ca + 25 ppm GA_3 application, GA_3 was applied a single time, alone or combined with Ca, at pit-hardening, then afterwards Ca was sprayed five weekly to 1 WBH. Soluble solid (SSC), titratable acidity (TA), and fruit diameter at harvest were not affected by the Ca + GA_3 applications, while fruit firmness and tissue calcium content of 'Skeena', 'Lapins' and 'Regina' were significantly increased compared to the alone Ca or GA_3 applications. Ca+GA_3 treatment improved shipping quality by enhancing tissue Ca content, reducing cracking, surface pitting, decay, pedicel browning, skin darkening, and loss of firmness and TA after 4 weeks of cold storage.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

Measurement and Evaluation the Development of Melting Texture in European Pears (*Pyrus communis* L.) Using Hygroscopic Holding Capacity (poster)

Yu Dong*, *Oregon State University*; Yingli Li, *Oregon State University* and Shaoying Zhang, *Oregon State University (Poster Board #259)*

Abstract: Melting (buttery and juicy) texture is one of the most important traits in European pears (*Pyrus communis* L.) affecting consumer purchasing decisions. Flesh firmness (FF) and extractable juice (EJ) are the currently two indicators for predicting eating potential in European pears. However, many people do not understand why the fruit developed a characteristic of juicy during melting texture development is associated with a loss in EJ. In this study, we developed a simple and rapid method for evaluating the melting texture in pear flesh based on the holding of the water by water-soluble polyuronides (WSP), hygroscopic holding capacity (HHC), after extractable juice was removed from the flesh sample. The HHC data were monitored in three pear cultivars ('Bartlett', 'Golden Bosc', and 'd'Anjou') following regular-air (RA) storage plus a ripening period at 20 °C in two years. There was a high negative correlation between EJ and HHC (r^2 = 0.996 in 'Bartlett', 0.884 in 'Golden Bosc' and 0.928 in 'd'Anjou'). The development of HHC was negatively correlated with FF and EJ, while positively correlated with WSP and melting texture. The factors of cultivar, harvest maturity, produced elevation, storage duration, storage temperature and controlled atmosphere (CA) affected the development of HHC in pears. HHC may be used as a critical melting index with FF in European pears due to its significant increase during ripening.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

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1:15 PM – 2:00 PM *International Ballroom East/Center*

Water Utilization and Management (Poster)

Can Reclaimed Wastewater from Local Breweries be Used to Produce High-Value Urban Crops? (poster)

Ignasi Riera Vila*, *University of Minnesota*; Mary Rogers, *University of Minnesota* and Neil Anderson, *University of Minnesota (Poster Board #210)*

Abstract: Modern agriculture faces many challenges for increasing production to meet growing global food needs. Agriculture is water intensive, and changing precipitation and temperature patterns threatens water availability in many parts of the world. Hydroponic crop production is water and fertilizer efficient but is dependent on synthetic fertilizers and good water quality. Urban agriculture can play a key role in reusing water and nutrients in urban environments. Irrigation with municipal wastewater from food industries may be an alternative to reclaiming wastewater and capturing excess nutrients. Brewery wastewater has a moderate nutrient load and a reduced presence of pathogens and heavy metals, which makes it ideal for agriculture. Treating this water in a decentralized way prevents it from further contamination. Decentralized treatment paired with urban agriculture could allow for water reuse and reclaim the nutrients for food production. This has the potential to help enhance food security while protecting the environment and creating new economic opportunities. In this project, we have developed a system where wastewater from breweries is treated in situ and the effluent is used to produce leafy greens and herbs in a non-circulating hydroponic system and substrate based production. Wastewater is first treated using an anaerobic reactor that obtains energy as hydrogen and reduces the carbon load of the water. Treated wastewater is adjusted for the optimal pH and electrical conductivity and used for hydroponic production as well as in soilless substrate-based production. Crop yields are compared to plants grown using a commercial hydroponic solution. Preliminary results show significant lower yields in the plants grown using wastewater. Successful development of the model and greater understanding of nutrient mineralization in hydroponics will allow for a decentralized treatment technology and promotion of soilless urban agriculture.

Specified Source(s) of Funding: University of Minnesota Grand Challenge

Nitrate Leaching Index for Lettuce Subjected to Different Irrigation Regimes (poster)

Dave Goorahoo*, *California State University- Fresno*; Charles Cochran, *California State University- Fresno*; Janet Robles, *California State University- Fresno*; Florence Cassel S., *California State University - Fresno* and Touyee Thao, *California State University - Fresno (Poster Board #211)*

Abstract: Nitrate (NO_3) contamination of groundwater is a significant unresolved environmental issue worldwide. Any Nitrogen (N) fertilizers not taken up by shallow rooted vegetable crops with high demand for N, such as lettuce, can leach to the groundwater. Adoption of a preventative strategy to mitigate nitrate contamination of groundwater is critical for controlling the amount of nitrate below the root zone while optimizing crop yield. When combined with the appropriate fertilizers, surface drip irrigation can be a useful tool to help mitigate the nitrate leaching potential of a lettuce crop. The overall goal of our on-going research is to optimize nitrogen use efficiency (NUE) and water use efficiency (WUE) in vegetable production. In this phase, the

objective was to assess the potential for nitrate leaching for a lettuce crop subjected to three irrigation regimes and four fertilizer N rates. Butterhead lettuce (*Lactuca sativa* cv Optima) was planted on a sandy loam soil on 150 cm beds with three rows per bed and intra-row spacing of 30 cm. The experimental design was a strip block with four replicates of three irrigation treatments (Manual, ET-based, and Soil Sensor-based) and four rates of N fertilizers (0, 67, 134, and 202 kg N /ha of CAN17). At harvest, both irrigation (*P=0.02*) and fertilizer (*P=0.08*) had a significant effect on above ground biomass. The plots irrigated manually and with the 100% ET-based technique yielded relatively higher biomass than the plots in which irrigation scheduling was based on soil moisture sensors. There was a positive fertilizer response, best described by the polynomial equation $y = 1E\text{-}06x^3 - 0.0003x^2 + 0.0303x + 1.658$ ($r^2 = 1$), with an overall 46% increase in biomass with the addition of 202 kg N/ha. Both fertilizer and irrigation treatments had a significant effect on petiole nitrate levels, with the manually irrigated plants having the highest nitrate content followed by soil sensor based and ET-based scheduling, respectively. In the top 12 inches of soil, fertilizer rates had a significant (P=0.0002) effect on post-harvest nitrate levels, with values in excess of 40 ppm in the plots receiving 134 and 202 kg N/ha, and 17ppm in the 67 kg N/ plots, compared to less than 2ppm in the unfertilized plots. These preliminary results further validate the need to quantify biomass yield and nitrate concentrations in plant and soil, if an N- balance approach is to be adopted in an effort to mitigate nitrate leaching.

Keywords: Nitrate leaching, Irrigation scheduling, Butterhead lettuce, N Leaching potential.

Specified Source(s) of Funding: CSU- Agricultural Research Initiative (ARI)

Improving Irrigation Scheduling for Fruit Trees in the Southeastern U.S. (poster)

Amanda Y Accampo*, *Clemson University* and Juan Carlos Melgar, *Clemson University (Poster Board #212)*

Abstract: Irrigation scheduling in fruit tree orchards requires measurements that are easy to translate into irrigation advice. Many growers in the Southeastern U.S. irrigate their trees only based on rainfall records, visual monitoring of tree and fruit growth, and estimating soil moisture with a hand squeeze test. Measuring soil tension with tensiometers is becoming more common since they are relatively affordable but, depending on the soil type, they may only indirectly reflect the tree water status. Tree-based water status indicators have been proven to be the best indicators for irrigation of tree orchards. However, drastic variation in daily environmental conditions, especially relative humidity and temperature, make difficult their application. The goal of this project is to improve the correlations and adjusted coefficients between soil and tree measurements to improve irrigation scheduling in fruit tree orchards. Tensiometers allowed the comparison of soil tension readings with dendrometers that measured the micro-variations in the tree trunks caused by movement of water. The maximum daily shrinkage (MDS) of the trunk diameter showed remarkably more variability under water deficit than the well-watered peach trees. Nevertheless, the daily fluctuating environmental conditions of South Carolina, especially relative humidity and temperature, seemed to be the main challenge to correlating values between the dendrometers to the tensiometers. Tensiometers deeper than 12" did not correlate to the tree based sensors at all. Humidity levels on days that were reading differently than expected were explored as well as when those humidity levels had a dramatic daily change compared to the MDS in stressed trees vs. non-stressed trees.

Specified Source(s) of Funding: South Carolina Peach Council

Location, Location, Location: The Influence of Topographic Position on Plant Health in Bioswales Along I-95 (poster)

Joshua Caplan, *Temple University*; Allyson Salisbury, *The Morton Arboretum*; Wiley Kollar, *Temple University*; Alyssa Chattin, *Temple University*; Michael Cappon, *Temple University* and Sasha Eisenman*, *Temple University (Poster Board #213)*

Abstract: Plants are critical components of the sustainable stormwater management systems, as they provide both ecosystem services and aesthetic value. However, plant health and survival can be compromised by the extreme hydrological conditions that characterize stormwater systems, as well as by the salts and contaminants present in stormwater. We determined how the health of nine plant species varied as a function of exposure to stormwater in large bioswales that capture runoff from a section of Interstate 95 in Philadelphia. We evaluated canopy size, leaf areas, and leaf-level physiology in 72 plants (eight per species) after two years of growth; individuals within each species were selected such that they spanned a wide range of micro-topographic positions. For the majority of species (*Asclepias incarnata*, *Calamagrostis* × *acutiflora*, *Hemerocallis*, *Iris sibirica*, and *Monarda didyma*), canopy volumes became progressively smaller as plants were positioned lower in the basins. Two additional species (*Cornus sericea* and *Viburnum trilobum*) had reduced canopy sizes at both low and high topographic positions. However, leaf-level physiological rates exhibited a very different pattern. In most species, gas exchange rates were reduced at higher topographic positions, while several additional species had maximal physiological rates in the middle of the elevation range. Although the growth of most species was strongly reduced when plants grew in wetter soils, our results suggest that neither photosynthetic capacity nor heavy metal toxicity limit growth at the corresponding elevations. Instead, our results are consistent with limitation by high salinity in spring or the high carbon requirements for growth in anoxic soil conditions. Our results also suggest that plants experienced water limitation at higher elevations, though this was far less severe than were the effects of growth at low elevation.

Specified Source(s) of Funding: Pennsylvania Department of Transportation and AECOM

Biofilm Accumulation on Polyvinyl Chloride and Polyethylene Pipes with Solution Flowing for 30 s Every 9.5 Min, 2 Min Twice a Day, and Continuously. (poster)

Juan Cabrera*, *University of Connecticut* and Rosa E. Raudales, *University of Connecticut (Poster Board #214)*

Abstract: Biofilms are commonly found on the inside surface of pipes and irrigation emitters. Biofilms consist on bacteria attached to surfaces and enclosed in protective matrix of polysaccharide. Biofilms can accumulate and clog irrigation systems and result in uneven irrigation. The objective of the experiment was to determine if pipe material and irrigation frequency can affect biofilm accumulation. The experiment was a full factorial in which the factors were *irrigation frequency* (sub factors: continuous flow, 30 s every 9.5 min, and 2 min twice a day) and *pipe material* [polyethylene (PE) and polyvinyl chloride (PVC)]. Nutrient solutions were prepared using pond water and 200 $mg{\cdot}L^{-1}$ N. The solutions were recirculated for four weeks and the experiment was conducted twice. Total aerobic bacteria attached to the surface and biofilm dry biomass were measured as indicators of biofilm accumulation. Biofilm differed by pipe materials at the different irrigation frequencies. Biofilm in PVC pipes was more abundant than in PE pipes when the nutrient solution flowed continuously or 30 s every 9.5 min. Biofilm in both pipe materials at irrigated for 2 min twice a day had the lowest amount of biofilm. These results indicate that using PE can delay the accumulation of biofilm in irrigation pipes within a four week-period and may reduce the risk of clogging.

Specified Source(s) of Funding: This work is supported by Critical Agricultural Research and Extension grant no. GRANT11947449 and Hatch Multistate Accession Number 1004968, project number #CONS00944 from the USDA National Institute of Food and Agriculture.

Storm Water Surface Runoff and Road Debris from Urban Communities As Sources of Water Pollution (poster)

Brian Pearson*, *University of Florida, Mid-Florida Research and Education Center*; Jianjun Chen, *University of Florida, Mid-Florida Research and Education Center* and Richard Beeson, *University of Florida (Poster Board #215)*

Abstract: Nonpoint source pollution is the leading contributor to impairment of water quality in rivers and streams within the U.S. Nationally, 12% of storm water nutrient runoff is estimated to originate from urban residential landscapes. Street sweeping is regularly performed within cities and residential communities to reduce leaf litter, soil, and roadway debris that may otherwise compromise functioning of storm water management systems.

Removal of plant and soil debris through street sweeping activities may also reduce nonpoint source pollution. To assess the effect of street sweeping on storm water pollutants, 36 storm water collection devices were installed within six residential communities in Central Florida. Areas within communities were randomly assigned to be swept or not swept. Precipitation and storm water retention pond leachate samplers were installed to quantify pollutant sources that may enter and leave selected urban communities. Despite high variability in percentage of impervious surfaces, population density, and volume of road debris among communities, no significant ($P \leq 0.05$) differences were observed for total Kjeldahl nitrogren (TKN), nitrate + nitrite (NOx), and total phosphorus (TP) concentrations in storm water among communities or between swept and unswept areas of communities. Similarly, no significant differences were observed for TKN, NOx, and TP concentrations in precipitation and storm water. Significant differences in orthophosphate (ortho-P), however, were observed between communities and precipitation. Additionally, storm water TP concentrations were greater than discharge estimated to originate from communities within the study area. Although street sweeping may be effective at reducing volume of roadway debris, our data did not find it reduced N or P in storm water discharged from selected urban communities in Central Florida.

Potential Phosphate Removal from Nursery Runoff Water Using an Iron-Based Remediation System (poster)

Francisca Ordonez Hinz, *University of Florida*; Joseph Albano*, *USDA-ARS* and Patrick Christopher Wilson, *University of Florida (Poster Board #216)*

Abstract: Phosphorous (P) applications in containerized plant nurseries are an essential for the growth of healthy plants. However, due to the low nutrient holding capacity of soilless media, some P not utilized by plants may leach into drainage systems and downstream water bodies where it can contribute to eutrophication and reduce water quality. As environmental regulators establish and enforce nutrient criteria, effective methods are needed to reduce amounts of P in runoff and drainage water. This study investigated the use of a small scale flow-through ferrous iron (Fe(II))-based remediation system to chemically precipitate P. This system was developed as an add-on module to a nitrate-bioremediation system previously characterized (Wilson and Albano, 2013). The add-on duplicate systems were connected to the outflow of the nitrate-removal bioreactors, and consisted of two 242 L tanks containing kaldness media. Water was pumped from a retention pond located within a commercial nursery. Phosphorus was supplied using Peters Professional 20-10-20 fertilizer dissolved in lake water to achieve initial P concentrations of approximately 3-5 mg/L. Tanks were aerated to maintain average redox conditions greater than +50 mV. An Fe(II) solution was injected into the tanks at dosing rates of ~1.3, 2.0, 3.6, and 4.7 mL/min. Multiple samples were collected from inflows, outflows, and within each tank during each treatment evaluation. Filtered samples were analyzed by ion chromatography. Phosphorus removal efficiencies of 66, 78, 95, and 99% were observed for each respective treatment, indicating great potential for this conceptual system at iron dosing rates ≥3.6 mg/min and phosphorus concentrations between 3 and 5 mg/L. This type of system may especially be useful for nurseries with space limitations.

Where's My Water? Spatial Distribution of Water within Containers Revealed By X-Ray Tomography (poster)

Paul C. Bartley*, *North Carolina State University*; Brian Jackson, *North Carolina State University* and William Fonteno, *North Carolina State University (Poster Board #217)*

Abstract: Growing media consists of mixtures of substrate components such as peat, pine bark, and coir. These components provide structure within the container to support plants and supply the essential water, air, and nutrients to promote plant growth. Factors which may affect air and water status within containers are the substrate components, container height, and irrigation practices. Understanding how these factors influence the retention and distribution of water within a container is essential in promoting water-use efficient practices. However, visualizing and quantifying the spatial distribution of water within a container has been difficult due to the opaque nature of substrate components. Recent advances in X-ray tomography and commercially-available analytical software have allowed researchers in plant and soil science to 3-dimensionally visualize and quantify plant-soil-water relations. Using a high-resolution X-ray microtomography scanner, the spatial distribution of water within various substrate components were volumetrically and spatially quantified after three irrigation practices were applied: over-head, drip, and sub-irrigation. As expected, water content increased from the top of the container to the bottom following irrigation. The layer commonly referred to as the "zone of saturation" in substrates was quantitatively characterized. For example, following an application of overhead irrigation, a pine bark substrate's zone of saturation extended 2 cm above the base of the container and contained approximately 0.12 cm^3/cm^3 of air filled porosity. These results indicate that X-ray tomography is well equipped to assist researchers in understanding the dynamic interactions between substrates, containers, and irrigation practices.

Sensor-Based Technology to Optimize Irrigation Scheduling in Drip-Irrigated Vegetable Systems (poster)

Florence Cassel S., *California State University - Fresno*; Pappu Yadav, *California State University - Fresno*; Dave Goorahoo*, *California State University - Fresno*; Touyee Thao, *California State University - Fresno* and Anthony Mele, *California State University - Fresno (Poster Board #218)*

Abstract: The sustainability of irrigated vegetable cropping systems is highly dependent on the effective management of water resources. This is particularly relevant in arid regions such as California which are highly impacted by climate variability and diminished water supplies. Thus, water conservation has become a top priority in the state and has required vegetable producers to adopt management practices that optimize irrigation and water use efficiency. One approach to improve irrigation efficiency is to implement irrigation scheduling practices to accurately estimate crop water requirements and determine how much and when to irrigate. Such implementation can be accurately and timely conducted with the use of sensor technology. Many sensors and data logging equipment are currently available to trigger irrigation applications based on measurements of crop evapotranspiration (ET) or soil water content. To evaluate these options and assess their effectiveness in optimizing irrigation and water use efficiency, we conducted field studies on various crops (lettuce, tomato, broccoli) which were drip-irrigated following an ET- and a soil sensor-based scheduling approach. The study site, located at California State University, Fresno, was characterized by sandy loam soils. For the ET-based approach, an irrigation scheduling program was developed to: 1) poll daily ET data from a local state weather station using the CIMIS web Application Programming Interface (API) over radio and internet links, and 2) calculate daily irrigation applications. For the sensor-based approach, six capacitance-soil moisture devices installed at three locations and two depths (6" and 12") were used with a datalogger and a 24VAC solenoid valve. Irrigation scheduling was programmed using upper (field capacity) and lower thresholds (30% maximum allowable depletion) of soil available water. Irrigation applications were triggered when the average soil moisture values reached the lower threshold and ended after field capacity was attained. In addition, some fields were irrigated based on visual crop and soil observations and manually operating irrigation valves. Results show that both ET- and soil sensor-based technology can improve water use efficiency and help growers optimize their irrigation scheduling.

1:15 PM – 2:00 PM *International Ballroom East/Center*

Weed Control and Pest Management 2 (Poster)

Macrophomina phaseolina Biomass Accumulation in the Presence of Fungicide Treatments in Vitro (poster)

Patrick McLoughlin, *Mississippi State Univeristy* and Shaun Broderick*, *Mississippi State University (Poster Board #174)*

Abstract: Interspecific hybrid impatiens have been recently identified as a host for the soil-borne fungal pathogen *Macrophomina phaseolina*. No control methods for this fungus have been developed in impatiens for growers, landscapers, or

homeowners. The goal of this study was to screen the efficacy of three commercially available fungicides (Tanos, Banrot, and T-Bird) on biomass accumulation of *M. phaseolina* (isolate MP1) in vitro. To accomplish this, *M. phaseolina* was grown in liquid basal media containing one of the three fungicides at 0.25x, 0.5x, 1.0x, or 2.0x the recommended application rate in a completely randomized design. All samples were grown at 27°C and shaken continually to keep the fungicide suspended and the media oxygenated. Biomass accumulation was quantified using dry weights of the samples taken at three sampling dates. Banrot applied at 2.0x concentration and T-Bird applied at 1.0x concentration were the most effective at reducing dry weights of *M. phaseolina* by more than 25%. The greatest reduction (31.7%) was achieved by T-Bird at 1.0x concentration. *M. phaseolina* treated with Tanos 0.25x were 12.5% larger than the controls after 3 weeks; however, it was able to limit growth at the 2.0x concentration. Future work will include field trials to determine the efficacy of Banrot and T-Bird in situ. This will include identifying the optimal rates and application time to control the pathogen.

Specified Source(s) of Funding: Funding provided by the Mississippi Department of Agriculture and Commerce and the USDA Hatch MIS-212060

Efficacy of Biofungicides to Control Pythium Root Rot and Damping-Off in Lettuce (*Lactuca sativa*) Seedlings (poster)

Cora S. McGehee*, *University of Connecticut* and Rosa E. Raudales, *University of Connecticut (Poster Board #175)*

Abstract: Pythium root rot and damping-off is a common disease in greenhouse crops including lettuce grown in hydroponic systems. Synthetic chemical products registered for specific use in hydroponic production systems in greenhouses are limited. The objective of this project was to assess the efficacy of microbial biofungicides for control of root rot caused by *Pythium* spp. in lettuce (*Lactuca sativa* cv. Rex and Spretnak) seedlings. Seven day old lettuce seedlings were treated with Companion (*Bacillus subtilis* GB03), RootShield Plus *(Trichoderma harzianum* T-22 and *Trichoderma virens* G-41*)*, Triathlon BA (*Bacillus amyloliquefaciens* D747), and Cease (*Bacillus subtilis* QST 713) following specimen label instructions. One day after treatment, the plants were inoculated with *Pythium* spp. at 1 x 10^5 zoospores per mL. After seven days, we measured root necrosis, disease incidence and severity, fresh and dry shoot and root weight. Lettuce plants infected with *Pythium* spp. had between 73.9% and 86.5% lower shoot and root dry weight than non-inoculated plants, respectively. All plants inoculated with Pythium and treated with microbial biofungicides were bigger than plants inoculated with Pythium and no microbial biofungicides. Root necrosis was observed in all plants treated with Pythium. However, differences in plant wilting and mortality were not observed between treatments. We did not see any damping-off. Results from this experiment suggest that beneficial microbes can reduce the negative effects of *Pythium* spp. infection at the seedling stage. However, in the absence of disease, biomass was reduced by the microbial biofungicides.

Specified Source(s) of Funding: USDA via the Connecticut Department of Agriculture – Specialty Crop Block Grant # AG151260

Antifungal Activity of Sulfur Compounds Against *Sclerotinia Minor.* (poster)

Dong Sub Kim*, *University of California, Davis*; Steven Kim, *California State University, Monterey Bay*; John Rachuy, *University of California, Davis* and Steven A. Fennimore, *University of California, Davis (Poster Board #176)*

Abstract: Sulfur has been used to control plant pathogens such as *Uncinula necator* and *Botrytis cinerea*. Sulfur compounds such as allyl-isothiocyanate are registered as fumigants, but some sulfur compounds have not been tested against soilborne pests. The objective of this study was to test the antifungal activity of allyl-isothiocyanate (commercial name: Dominus), water and ethanolic extracts of mustard seed meal (MSM), and allicin against mycelial growth and sclerotial germination of *Sclerotinia minor* which can cause significant economic losses in lettuce fields. MSM was extracted by distilled water (1:5) or 99% ethanol (1:5, 1:2.5, and 1:1.25). The extract of one mL was added to 100 ml potato dextrose agar for the agar dilution test. The concentrations of allicin and allyl-isothiocyanate were 5.4, 10.8, and 14.4 mg mL^{-1} and 10, 50, 100, and 500 µL mL^{-1}, respectively. As the concentration of ethanolic extract of MSM and allicin increased, the mycelial growth and sclerotial germination of *S. minor* decreased significantly. Allyl-isothiocyanate at 500 µL mL^{-1} completely inhibited the mycelial growth and sclerotial germination of *S. minor*. To verify the effectiveness of short-time exposure of the sulfur compounds, the sclerotia were dipped into aqueous solution of the sulfur compounds for one minute. The sclerotial germination was inhibited by allyl-isothiocyanate, ethanolic extract of MSM, and allicin until the fourth day after the dipping. The results indicated that the sulfur compounds, except water extract of MSM, demonstrated antifungal activity against the growth and germination of *S. minor*, and the compounds may be potential sources of natural fungicides and fumigants. Further investigation is needed to increase the duration of effective control.

Specified Source(s) of Funding: USDA NIFA Methyl Bromide Transition Program

Powdery Mildew Control and Spray Application Characteristics of a Laser-Guided Sprayer (poster)

Amy Fulcher*, *University of Tennessee*; Jeff McHugh, *University of Tennessee*; Heping Zhu, *USDA-ARS Application Technology Research Unit*; Robert Collier, *Pleasant Cove Nursery*; Wesley Wright, *University of Tennessee* and Whitney Yeary, *UT (Poster Board #177)*

Abstract: A variable rate sprayer was developed that applies pesticides based on real-time scanning laser rangefinder measurements of plant presence, size, and density. The objectives of this experiment were to evaluate (1) control of dogwood powdery mildew and (2) characterize spray applications to *Cornus florida* in a multi-row block from the newly developed laser-guided "intelligent" sprayer and a conventional air-blast sprayer.

Water sensitive cards (WSCs) were placed in 'Cherokee Princess' flowering dogwood trees prior to each of four fungicide applications to characterize spray penetration and drift. Cards were analyzed for coverage (%) and droplet density (deposits/cm^2) using the DepositScan program. Powdery mildew severity was ranked weekly throughout the season. Whole trees were rated on a 0-4 scale following Hagan et al. 1998 with 0 signifying no disease and 4 signifying 76-100% disease.

Increase in plant height over the season was 49 and 48 cm for the intelligent and conventionally sprayed trees, respectively, and increase in caliper was 13 and 10 mm for the intelligent and conventionally sprayed trees, respectively. On May 26, June 28, and July 27, 2017, the overall tree disease ratings were 0 and 0, 0.75 and 0.625, and 0.58 and 0.50 for intelligent and conventionally sprayed trees, respectively.

Intentional spray coverage and droplet density on WSCs were lower from the intelligent sprayer than the conventional sprayer by 47 and 59%, respectively. The average deposit density was within 6.5% of the recommended range for fungicides when spray was applied by the intelligent sprayer but was 38.3% from the range when applied by the conventional sprayer. Drift coverage was reduced 63.5% by using the intelligent sprayer.

The intelligent sprayer reduced spray volume by 53.7% compared to the conventional sprayer. The average per application cost for this trial was $5.07/2.4 acres for the intelligent sprayer and $14.95/2.4 acres for the conventional sprayer, a 66% cost reduction from using the intelligent sprayer. A second generation intelligent sprayer that can be retrofitted to existing air-assisted sprayers is currently under evaluation.

Exposure and Behavioral Assays of Omri Approved Insecticides on Green Lacewing, *Chrysoperla Rufilabris* (poster)

Daniel Payne, *West Virginia State University*; Kshitiz Dhakal*, *West Virginia State University*; Chelsie M. Chapman, *West Virginia State University* and Barbara Liedl, *West Virginia State University (Poster Board #178)*

Abstract: Tomatoes (*Solanum lycopersicum*) are susceptible to a wide array of arthropod pests. Varieties on the market do not have pest resistance incorporated to allow for a reduction of pesticides used on the crop. In protected culture, using biological control agents is a critical part of IPM, especially for the control of

the two major pests: whiteflies and aphids. Limited research is available on the effect of OMRI approved insecticides on biological control agents in producted culture. We evaluated the selectivity of five OMRI approved insecticides against 2nd instar larvae of the generalist beneficial control agent, *Chrysoperla rufilabris*, in triple exposure and behavioral assays. Triple exposure assays were conducted with thirty 2nd instar larvae per treatment with positive and negative controls and five insecticides applied at the highest rate on the label. Insects were monitored daily for mortality and developmental time points. All insects treated with the positive control, DEET, died within an hour. Two thirds of the Azatin-O® treated larvae pupated and delay of a day and a half was statistically different from the control and four other insecticides, EcoTec®, M-Pede® PyGanic® and SucraShield®. None of the Azatin-O® treated larvae produced adults compared to over 90% for the other treatments.

Behavioral assays were conducted with the same treatments versus a control using thirty 2nd instar larvae per treatment with the ViewPoint™ tracking system, where data was collected on ambulatory time, distance walked, velocity, and proportion of time spent in each half of the arena for 10 minutes. This assay violates ANOVA assumptions of normality and homoscedasticity thus, the Wilcoxon rank sum test was used to test the significance of differences in treatment response. *C. rufilabris* larva expressed repellency characteristics upon contact of DEET in the paired behavioral assays based on Wilcoxon Signed-Rank Test for ambulatory time, distance and % time, but not velocity. The acetone control showed no significance for any parameter. Larvae exposed to Azatin-O® had a significant response to the distance traveled. While PyGanic® had a significant effect on the velocity of the larvae, which was no surprise since if they encountered PyGanic they died on that side of the arena.

Care must be taken when applying insecticides in combination with beneficial insects. Our work found one impeded insect development and foraging ability (Azatin-O®), but others only reduced foraging ability of the larvae on sprayed surfaces (PyGanic®). Three of OMRI approved insecticides (Ecotec®, M-Pede® and SucraShield®) did not affect green lacewing larvae development or foraging ability.

Specified Source(s) of Funding: USDA CBG #2014-38821-22413

Behavioral Assays of Five Omri Approved Insecticides on Lady Beetle, *Hippodamia Convergens* (poster)

Chelsie M. Chapman*, *West Virginia State University*; Daniel Payne, *WVSU R&D Corp* and Barbara Liedl, *West Virginia State University (Poster Board #179)*

Abstract: Protected culture production of specialty crops has increased over the last twenty years alongside a minor increase in approved insecticides. These insecticides have been investigated for their effects on small soft body arthropods, but very little has been investigated in regards to potential impacts on beneficial insects. Beneficial insects are crucial in integrated pest management systems that require a finely orchestrated balance of plant and pest treatment interactions, which is heavily used in protected culture production. The focus of this research was testing the behavior of adult lady beetles in a choice assay with five OMRI approved insecticides, a positive control (DEET) and negative control (acetone) to ascertain if there is any associated repellence or irritability characteristics from these insecticides versus the solvent (acetone). A ViewPointä tracking system was used with a single adult released in the untreated center of a Plexiglas arena with two adjacent areas for choice (treated and control). Collected data included ambulatory time, walking distance, velocity, and proportion of time spent in each area for 10 minutes. This assay violates ANOVA assumptions of normality and homoscedasticity thus, the Wilcoxon rank sum test was used to test the significance of differences in treatment response. Adult lady beetles expressed repellency characteristics upon contact with DEET, but not for the acetone control. Of the five OMRI pesticides, PyGanic® showed repellency and Ecotec® showed irritability. OMRI approved insecticides can affect beneficial insect foraging as we saw with two of insecticides (PyGanic® and Ecotec®) which impeded the foraging ability of the adult lady beetles.

Specified Source(s) of Funding: WV NASA Space Grant

Introducing a New Codling Moth Biofix Option to Utah Growers (poster)

Marion Murray, *Utah State University*; Diane Alston, *Utah State University* and Rick Heflebower*, *Utah State University (Poster Board #180)*

Abstract: Codling Moth (*Cydia pomonella*) is a serious pest of apple throughout the world and has been found wherever apples are grown. Control is generally achieved by setting out pheromone traps at first bloom, then tracking degree days after first catch. Pesticide sprays are applied around 250-300 degree-days. In Utah, setting a codling moth biofix from pheromone traps has become problematic due to inconsistent spring weather conditions, and higher use of mating disruption. In addition, an online decision-aid tool (Utah TRAPs) which includes 91 locations is offered to growers. Currently the biofix dates for each location must all be entered manually; automating this system would save time and resources.

Research by Jones et al. (2013) found that site-specific codling moth emergence (in degree days) is predictable using a formula based on latitude alone, or in combination with elevation for sites > 400 m in elevation. The study hypothesized that errors in setting the biofix with the formula timing were low, as it represented only a small percentage of the degree-day accumulations needed for predicting subsequent flight and egg hatch. This project objective is to introduce the “formula biofix” to Utah apple growers by demonstrating a low error rate in predicting codling moth phenology between the formula- and trap catch-based methods.

Through season-long trapping and determination of first larval entry into fruit for 1st and 2nd generations, we found that predictions for egg hatch and subsequent moth flight using the two biofix options varied by 0 to 3 days in 2016, and by 1 to 7 days in 2017. Our target was a variance of ≤ 5 days. The formula-based biofix (with a March 1 start date) meets our goal for most locations in most years, and performs as well as the trap-catch biofix.

The final phase of the project will be to continue with grower outreach, and in gauging grower confidence in switching to the formula biofix option.

Jones, V. P., R. Hilton, J. F. Brunner, W. J. Bentley, D. G. Alston, B. Barrett, R. A. Van Steenwyk, L. A. Hull, J. F. Walgenbach, W. W. Coates, and T. J. Smith. 2013. Predicting the emergence of the codling moth, *Cydia pomonella* (Lepidoptera: Tortricidae), on a degree-day scale in North America. Pest Management Science DOI 10.1002/ps.3519 (www.wileyonlinelibrary.com)

Specified Source(s) of Funding: USDA Specialty Crops Block Grant

Characterizing Spray Penetration of a Novel Sprayer into *Malus Domestica* ‘Golden Delicious’ Apple Trees at a Commercial Orchard (poster)

Amy Fulcher*, *University of Tennessee*; David Lockwood, *Univ Tennessee*; Wesley Wright, *University of Tennessee*; Heping Zhu, *USDA-ARS Application Technology Research Unit*; Mark Burnett, *Oren Wooden's Apple House*; Lebron "Chubby" Smith, *Oren Wooden Apple House*; Jeff McHugh, *University of Tennessee* and Grace Pietsch, *University of Tennessee (Poster Board #181)*

Abstract: Novel, variable-rate spray technology was developed that can be retrofitted to existing airblast sprayers. The sprayer applies pesticides based on real-time scanning laser rangefinder measurements of plant presence, size, and density. The objective of this experiment was to evaluate spray coverage and deposit density at four application rates applied to *Malus domestica* ‘Golden Delicious’ apple trees from the newly developed technology.

Uniform trees in two 408-ft long rows running in an East-West orientation were used for this study. Four pairs of trees, the 3rd, 15th, 25th and 35th trees, across the driveway from one another were selected, and four clips for water sensitive cards (WSCs) were placed equidistant from one another within each canopy. Clips were attached to branches at increasing distances from the driveway at a height of 170 to 180 cm from the ground. One of four rates, 0.03, 0.05, 0.07, or 0.09 fl oz/ft^3, was randomly assigned to each pair of trees within the row so that all four rates were tested on each run. WSCs were placed in the clips, and the trees were sprayed with water. Rates were randomly re-assigned to trees, and a WSC was placed in each clip prior to each of the

three subsequent runs. Cards were analyzed for coverage (%) and droplet density (deposits/cm^2).

There was an orientation effect on sprayer performance due to wind direction. Coverage was 24, 16, 10, and 3% greater for cards 1, 2, 3, and 4, respectively, on the North set of trees compared with the South set. In the North row of trees, card position 1 had 35% more coverage than card position 2 and had 47% and 209% greater coverage than card positions 3 and 4, respectively. Similarly, card position 1 in the South row of trees had 26% more coverage than card position 2 and had 30% and 159% greater coverage than card positions 3 and 4, respectively.

For all rates, increasing distance between the sprayer and card position increased droplet density for trees on the North row, likely due to the heavier coverage on the North side causing droplets to coalesce on the cards in closest proximity to the sprayer. On the South row, droplet density was relatively consistent across the canopy at the 0.03 and 0.05 fl oz/ft^3 rates but increased with increasing distance from the sprayer at the higher two rates.

Nanotechnology for Insect Pest Management (poster)

Naveen Kumar*, *University of Maryland Eastern Shore*; Sudipta Seal, *University of Central Florida* and Nidhi Rawat, *University of Maryland College park (Poster Board #182)*

Abstract: Nanotechnology can transform the face of current agriculture and promote sustainable green technology to manage plant pests and pathogens. In the present work, we showed the promising effects of nanoparticles [nano-clay (NC); 200-700nm, nano-zinc-oxide (NZO); 20-50 nm, and nano-sulfur (NS); 20-60 nm] on soybean looper [*Chrysodeixis includens* (Walker)], beet armyworm [*Spodoptera exigua* (Hübner)], Japanese beetle [*Popillia japonica* (Newman)], and cucumber beetle [*Diabrotica undecimpunctata howardi* (Barber)]. Three independent experiments (2017) were conducted in a randomized complete block design with ten blocks, and one plant of each treatment per block in the field conditions. Ten plants were used for each treatment. The means per plant was determined and subjected to analysis of variance (SAS Institute, Cary, NC) and separated using a protected least significant difference (LSD) at $P < 0.05$. Similar design was used for *in vitro* studies. The standard error of the mean was also calculated. *In vitro* results showed 80 to 100% mortality of first, second, and third instar stages of soybean looper and beet armyworm within 5 to 24 hr using NC, NZO, and NS. In field conditions, five spray applications of NZO (5, 10, 15, 20 mM), NS (5, 10, 20 mM), NC (0.5% and 1.0%) at V1 (first trifoliate leaf) to V5 (five trifoliate leaf) stage of soybean development showed decline in leaf damage and blemishes in comparison to control plants. Behavioral studies were conducted in cages by enclosing the adults of Japanese and Cucumber beetle on NZO (15 and 20 mM) treated and control leaves. Adults never attacked on NZO treated leaves and preferentially consumed untreated control leaves. However, adults also consumed NZO treated leaves in the absence of control leaves in cages. These result showed the potential of nanotechnology in management of soybean insect pests and can be the part of organic horticulture.

Specified Source(s) of Funding: Maryland Soybean Board

Allelopathic Effect of Horseradish Extract on Lettuce Germination and Growth (poster)

Tyler Simpson*, *West Virginia University* and Kang-Mo Ku, *West Virginia University (Poster Board #183)*

Abstract: Horseradish (Armoracia rusticana) is a root crop in the Brassicaceae family. Horseradish extract (HRE) contains many bioactive secondary metabolites such as glucosinolates. Sinigrin is the most common glucosinolate accounting for 80% of the HRE glucosinolate content. Sinigrin naturally undergoes hydrolysis to produce isothiocyanates such as allyl isothiocyanate (AITC) as a defense response. AITC can act as an herbicide, insecticide, fungicide, bactericide and more making it valuable for the agricultural industry. Because horseradish is generally utilized for its roots, the glucosinolate rich leaves are often discarded when they could be utilized. The aim of this study is to increase our understanding of the allelopathic effects of HRE for these agriculturally beneficial properties. Lettuce was chosen as an ideal organism for HRE treatment due to its high germination rate and biological reproducibility. Lettuce root length and root hair length were measured after 3 days of treatment with control, 1%, 2%, 4%, and 8% HRE w/v. The average root lengths respectively were 21.9 mm, 22.6 mm, 23.3 mm, 17.0 mm, 11.0 mm. Concentrations of HRE above 2% w/v were significant with all other concentrations. The average root hair lengths respectively were 1.30 mm, 1.27 mm, 0.76 mm, 0.69 mm, and 0.20 mm. All HRE treatments were significant excluding 1% w/v. Lettuce root length increased insignificantly with lower concentrations of HRE and then decreased significantly as the dose increased while root hair length decreased in a dose-dependent manner. H_2O_2 was quantified in lettuce treated with 1% w/v HRE at days 1 through 5 using ABTS and spectrophotometer reading at 414 nm. Control and treatment values at days 1-5 respectively were 2,759, 687.5, 376.2, 575.1, 217.3, and 4,100.8, 835.9, 386.7, 632.3, 239.6 µmol/g fresh weight. There was a significant difference in H_2O_2 concentration at day 1 though after there was no significance and there was a similar trend. Lettuce primary metabolite analysis was done on 36 metabolites using GC-MS and Metaboanalyst. Lettuce were grown for 2 days and then treated with 1% and 2% w/v HRE for 1 day and collected. Proline (Pro), valine (Val), and tryptophan (Trp) all increased significantly in a dose dependent manner with variable importance for projection (VIP) values of 0.46, 0.45, and 0.43 respectively. Trp is a precursor to IAA which can increase root growth via cell elongation at lower concentrations though inhibits growth at higher concentrations which was observed. Pro is the precursor to hydroxyproline which is an important component of extensin in the cell wall which causes mechanical wall stiffening associated with an oxidative burst. This was seen with increased H_2O_2 concentration in HRE treated lettuce at day 1 along with decreased root growth. Valine increases are likely due to feeding electrons to the mitochondria for increased demand and signaling.

1:45 PM – 3:15 PM

An Overview of High Tunnel Production in the United States *CEU Approved*

Jefferson West

Coordinator: Lewis Jett, *West Virginia University*

Moderator: Lewis Jett, *West Virginia University*

Objectives:

The objective of this workshop is to provide an overview of high tunnel specialty crop production across diverse geographical regions of the U.S. The workshop will identify production problems and opportunities that are common among high tunnel specialty crop producers. Given that ASHS will be in Washington, D.C. this gives us a unique opportunity to invite USDA policy personnel who are involved in the Seasonal High Tunnel Program to the workshop. The information presented in the workshop will be an update for commercial horticulturists and USDA personnel. The workshop will include and opportunity for discussion at the end of the presentations and will be a forum for establishing collaborative research and outreach projects.

Description: The objectives of this workshop are to present an overview of high tunnel specialty crop production and identify areas which require further research and education. High tunnels are a dynamic season extension technology that is being rapidly adopted by specialty crop growers across the U.S. The USDA-NRCS Season Extension Program has facilitated high tunnel production across the U.S. However, there is a need to identify and solve problems which may be limiting the maximum productivity and efficiency of high tunnels in the U.S. In addition to problem solving by extension professionals, there is a need for extension horticulturists to successfully connect with high tunnel producers. This workshop will attempt to identify specific areas of high tunnel integrated crop production which require focus from extension and research horticulturists. Successful outreach models for training new high tunnel producers will be discussed. Each presenter in this workshop will pose and answer specific questions related to high tunnel production in their region of the U.S. The moderator will channel the expertise and feedback of the audience to address each topic or question. Specific questions which will engage the workshop audience include:

- *What is the relationship between Extension and NRCS in individual states with respect to training new high tunnel producers?*

- *What are some successful outreach methods for training high tunnel producers?*
- *Are high tunnel specialty crop producers organized into grower organizations?*
- *Please identify the production issues which may be limiting the efficiency of high tunnels in your region.*
- *Are high tunnels being used for resource conservation (nutrient, water, soil)?*
- *How have irrigation and nutrient management recommendations been made to high tunnel producers?*
- *What are the dominant crop choices for high tunnels in each region and how do growers select crops?*
- *What are publication and training gaps for high tunnel producers in each region*
- *What are some emerging technologies being used for high tunnel crop production in each region (lighting, heating, etc.)?*
- *How have high tunnel designs been modified for the climate in each region?*

1:45 PM High Tunnels in the Northwest U.S.

Carol A. Miles*, *Washington State University, NWREC*; Heather Stoven, *Oregon State University* and Rob Brown, *Flattop Farm*

Abstract: **High Tunnels in the Northwest U.S.**

Carol Miles*, Vegetable Extension Specialist, Washington State University

Heather Stoven, Extension Horticulturist, Oregon State University

Rob Brown, Flattop Farm, Anchorage, Alaska

*presenting author

The use of high tunnels has been somewhat slow to become established in Washington and Idaho, whereas in Oregon high tunnels have been used for several decades in the nursery industry. Direct market farms in the urban periphery in the region use high tunnels predominantly for tomato in the summer and salad greens in the winter. Our research showed that late blight (caused by *Phytophthora infestans*), the disease most limiting tomato production in the region, could be controlled by growing tomato in high tunnels with appropriate management conditions (e.g., good ventilation, not overly high relative humidity). Temperature throughout the winter in western Washington and Oregon tends to be relatively mild, and cold-tolerant crops can be grown in high tunnels with minimal additional protection. In contrast, most of Alaska has very cold winter temperatures, high winds and high snowfall; about $4 mil. has been awarded by NRCS for high tunnels in Alaska. High tunnels in Alaska must be constructed with additional structural support to withstand winter weather.

2:00 PM High Tunnel Production in the Mid-Atlantic U.S.

Lewis Jett*, *West Virginia University*

Abstract: High tunnels have been widely adopted across the Mid-Atlantic region of the U.S. West Virginia has over 500 high tunnels in production. Many of these structures have been funded through the USDA NRCS. In the Appalachian region, growers are successfully using high tunnels to mitigate the effects of climate change. In addition, four-season cropping plans have been implemented to support local food systems. Research with high tunnels in the Mid-Atlantic has revealed that temperature and nutrient management are areas which require future research. This presentation will summarize cropping systems, designs and management systems used by high tunnel specialty crop producers in the Mid-Atlantic region.

2:15 PM High Tunnel Production in the Deep South U.S.

Bill Evans*, *Mississippi State University*

Abstract: High Tunnels in the Southeast Growing in Number and Value. W.B. Evans* and L. Jett. Up In farms Food Hub, Jackson, MS 39056. bill@upinfarms.com.

In 2006, there were very few high tunnels in the southeastern U.S. Since that time, hundreds of acres of tunnels have been set in the region bringing production, income and opportunity to large and small farmers. Every state in the south now has high tunnels, with Florida recently reporting 186 acres of installed tunnels. Nearly every land grant institution has installed tunnels to support research, teaching and extension programming now. University research completed or underway include cultivar trials, crop timing, budgeting, organic production, cover crop. With exceptions like Florida's growing blueberry tunnel production, most high tunnels in the southeast are installed on smaller farms, with hundreds of single bay ranges scatted across each state. USDA NRCS offices throughout the south have provided funding to support many of these smaller installations. These have also served as capacity building vehicles for small and limited-resource farms. Tunnels are being used to raise organic and non-organic vegetables, herbs, cut flowers and fruit. Grower training and success continues to build with partnerships between grower groups, non-government agencies, state agriculture departments and universities.

2:30 PM High Tunnel Production in the Intermountain West U.S.

Karen Panter*, *University of Wyoming*

Abstract: To paraphrase: Go west young horticulturists! In this pictorial expedition through the western United States, we will discover ways high tunnels are used from the Rocky Mountain states west. The range of uses varies from season extension in the Rockies to protection from the elements in the Pacific Northwest. High tunnels are very much a part of the western horticulture landscape. On our journey we will explore many different construction styles such as roll-up sides, roll-down sides, PVC frames, galvanized steel frames, double poly covers, and fabric covers. A myriad of different crops grown within high tunnels in the west will be highlighted, ranging from aster cut flowers to zucchini fruits."

2:45 PM High Tunnel Production in New England U.S.

R Grube Sideman*, *University of New Hampshire*

Abstract: **High tunnel production in New England**

Rebecca Grube Sideman, University of New Hampshire Cooperative Extension, Durham, NH

In New England, the numbers of high tunnels in use, and acreage covered by high tunnels, has increase dramatically over the last decade. In New Hampshire alone, an estimated 10 hectares of new high tunnels have been installed during this time period, spurred in part by the U.S. Department of Agriculture Natural Resource Conservation Service high tunnel program. Season extension structures used in New England are highly customized, sometimes incorporating one or more advanced technologies (automatic ventilation, supplemental heating, in-ground heating, etc.) in various combinations. While high tunnels lack permanent foundations and sophisticated environmental controls, the distinction between greenhouse and high tunnel is not always clear. High tunnels are most commonly used to extend the growing season and increase crop quality for warm-season crops such as tomato, pepper and eggplant, but they are also often used year-round in the Northeastern U.S. For example, fall-planting of cold-tolerant vegetable crops in unheated high tunnels for harvest and sales throughout the fall and winter months is increasingly common. We will present a regional overview of the most common high tunnel structures and production systems, with an eye towards identifying region-specific and more broadly applicable needs for research and outreach.

1:45 PM – 3:15 PM

Opportunities and Challenges for Transgenic and Gene Editing Approaches to Vegetable and Fruit Breeding *CEU Approved*

Jefferson East

Coordinator: Carlos A. Avila, *Texas A&M AgriLife Research*

Moderator: Carlos A. Avila, *Texas A&M AgriLife Research*

Objectives:

Increasing genetic variation beyond natural variation is an important aim in plant breeding. New genetic engineering emerging technologies offer the possibility to improve plant resistance and tolerance to biotic and abiotic stresses, agronomic fitness, and produce/fruit quality. Current work on these technologies is mostly

performed at the fundamental level, however we need to incorporate these technologies into cultivar development pipelines. The workshop will give an overview of current technologies, opportunities, challenges, and their application in plant breeding programs. Objectives:1) Explore several examples of how transgenic and gene-editing technologies are being used for crop improvement. 2) Discussions of how these tools are currently perceived by the general public.

Description: **Description:** The goal is formidable: to achieve sustainable food security for the world's growing population. Crop breeders play an important role in this effort, as new varieties are expected to have: increased yields; improved water and nutrient use efficiencies; durable resistance against a myriad of current, emerging and evolving diseases and pests; improved quality characteristics; and resilience in a changing climate. Success will depend upon multidisciplinary efforts for efficient utilization of molecular and conventional crop improvement resources, including newer tools such as transgenic and gene editing technologies. Rather than a technical session on the new emerging technologies, this workshop will highlight some of the opportunities and challenges to the application of these technologies for crop improvement.

Target Audience: Workshop will be open to ASHS Annual meeting attendees from private and public sector who are interested in the practical application of genetic engineering and gene editing tools for crop improvement. No technical knowledge on the subject is required.

Workshop format: The workshop will consist of three 15-min presentations by invited guests, followed by a 15-minute panel discussion. The panel discussion will begin with a round of common questions to all speakers. These questions will be selected by the organizing committee from a list received from members of the Vegetable Breeding Interest Group. To obtain initial discussion questions, an email will be sent to members of the VBIG to request their discussion topics. After the common questions round, questions will be opened to attendees. Attendees will be encouraged to participate in the discussion.

1:45 PM Genes and Genetic Interactions That Modulate Flowering and Yield in Tomato: How Gene Editing Technologies Are Facilitating the Translation of These Fundamental Discoveries to Improve Crop Productivity

Sebastian Soyk*, *Cold Spring Harbor Laboratory*

Abstract:

With the recent widespread deployment of genome editing technology in plants, we have entered an era of great excitement and enormous opportunity for plant breeding. Based on knowledge gained on the power of exploiting CRISPR-Cas9 for improving tomato, I will present what is already possible and will likely become feasible in the coming decade of crop improvement. This includes our work on integrating discoveries in basic plant development with agriculture to customize and optimize major productivity traits, and a powerful approach that we have developed to engineer and fine-tune quantitative trait variation.

2:05 PM Development of HLB-Tolerant Citrus: From Gene Discovery to Commercial Deployment.

Kranthi Mandadi*, *Texas A&M AgriLife Research*

Abstract: In the U.S., citrus greening or Huanglongbing (HLB) disease is devastating the citrus industry in Florida and starting to spread in Texas and California. No known HLB resistance exists among the cultivated citrus. There is a dire need to control HLB. In this workshop, I will discuss our ongoing efforts to develop HLB-tolerant citrus utilizing the latest genomics, genetics, and biotechnology tools. Furthermore, through partnerships with the citrus industry we are working towards deregulation and commercial deployment of HLB-tolerant transgenic citrus. Such private-public partnerships are critical to save the 1 million commercial citrus acres and $3 billion in annual losses caused by citrus greening in the U.S.

2:25 PM Genetic Engineering Approaches for Cultivar Development: Economic Impact and Policies

Jose Falck-Zepeda*, *International Food Policy Research Institute (IFPRI)*

Abstract: Genetically engineered crops continue to be a controversial issue. GE approaches to cultivar development include a broad spectrum of techniques from conventional plant breeding and tissue culture to advanced gene editing approaches such as CRISPR/CAS9. The policy debate of whether New Plant Breeding Techniques (NPBTs) such as gene editing, will be regulated as genetically engineered crops in horticulture and other crops continues and has not been resolved. A number of GE technologies exist in the regulatory and/or the decision making pipeline which will be released commercially in the near future. Within this pipeline, NPBTs offer a number of advantages that make them attractive to the public sector worldwide. However, if regulated as GE crops, they may face the same fate of regulatory uncertainty and may not reach end users. The state of affairs in most developing and some developed countries is that of an increasingly complex policy and regulatory landscape. Thus the need exists for innovative strategies to ensure deployment of valuable technologies that may be released by public, private and multi-sector collaborations in the near future. This presentation will examine policy issues related to private and public sectors R&D and deployment of GE crops including those developed using NPBTs. This presentation will also update the current status of GE crops globally, examine the role that policies and regulations may have over technology choice and the level of investments necessary to generate knowledge and thus reduce uncertainty by the public and private sectors with a focus on NPBTs such as gene editing. The presentation concludes with a tentative overview of the challenges and recommendations to support GE crops' innovation globally.

1:45 PM – 3:15 PM

Urban Horticulture: From Local Initiatives to Global Success Stories *CEU Approved*

Lincoln West

Coordinators: Roland Ebel, *Autonomous University of the State of Mexico* and Dilip Nandwani, *Tennessee State University*

Moderator: Roland Ebel, *Autonomous University of the State of Mexico*

Objectives:

In urban horticulture, space seizes a redefinition to grow vegetables, herbs, fruits, or flowers in big cities. This applies for both, unused areas of deteriorated neighborhoods, where new economic perspectives emerge and food supply increases, as well as for buildings in prosperous quarters, which receive an additional, sustainable usage. It is an upward segment of horticulture, in the USA as well as in developing countries, where the enormous growth of megalopolis is not backed by a simultaneous increase of farmland or of agricultural productivity. Research in urban horticulture is still a relatively "virgin soil" and experienced practitioners are rare. Consequently, expert advice is requested all over the world. This makes urban horticulture one of the fastest growing employment opportunities for international consultants. This workshop provides success stories related to urban horticulture. Thus, interested consultants can learn about how urban communities have revived the areas surrounding them – a source of inspiration about how to succeed (inland and abroad) in this thriving but challenging business.

Description: Urban horticulture comprehends everything from small community gardens to complex vertical farms. It brings together what has always been separated: agriculture and urban space. Although urban gardens may not be the one single solution to supply food for a growing global population, due to their potential to provide high yields in small, formerly unproductive areas, they have the capability to significantly change the world's horticultural scenery. They stand for food sovereignty for unprivileged neighborhoods, healthy diets in big cities, low transport costs, efficient resource use, and mitigation of environmental impacts. It is an area of interest for absolute newcomers in horticulture and for local initiatives. Public institutions (schools, hospitals, or universities) represent potential markets. And: it is definitely an area of opportunity for horticultural consultants, nationally and internationally. This workshop deals with success stories of urban horticulture in developing countries, highlighting both the most recent developments and historic achievements. However, since this year's conference is held in a truly cosmopolitan city, the workshop also involves fruitful initiatives from the urban areas in the USA, where university-community partnerships are growing all

over the country. In detail, the workshop features eight presentations with examples from Japan, Senegal, Mexico, Iran, Tajikistan, Washington DC, Minneapolis, and Fairfax (Virginia). In a final group discussion round, the presenters interact with the audience: Questions from the audience will be taken and answered by a determined workshop speaker. Eventually, the audience and the speakers discuss the nature of successful urban farming projects.

1:45 PM Growing North: Connecting Youth and Community through Garden-Based Experiential Learning in North Minneapolis

Mary Anne Rogers*; Illana Livstrom and Amy Smith, *University of Minnesota*

Abstract: Growing North Minneapolis is an urban agriculture and youth development summer program sited in the North Minneapolis neighborhood. The program is a university-community partnership between faculty and community organizations including Project Sweetie Pie, Youth Resources, and NoMi Roots. We leverage resources from the City of Minneapolis Step-Up program to recruit, train and employ youth (14-15 years old) who face barriers to employment, particularly youth from low-income families, youth of color, youth from immigrant families, and youth with disabilities. Youth interns are placed in a 10-week long summer program and matched with undergraduate student mentors from the University of MN College of Agriculture, Food and Natural Resource Sciences; and community garden stewards from the neighborhood. The student mentors and garden stewards work together to lead youth intern teams and work in multiple urban garden sites located in North Minneapolis, a designated low-resource community in the metro. One of our goals is to develop leadership experience for UMN undergraduate students and improve food and horticultural skills and attitudes among urban youth through garden-based education. Learning is experiential and contextualized in the various community garden sites as well as hands-on activities surrounding food justice, food accessibility, food production systems, horticulture science, aquaponics and composting. The experience was designed to develop interpersonal skills for both youth participants and UMN students including the ability to work in teams, communication skills, learning about oneself and others, and responsibility and leadership. We measured skills, knowledge, and attitude changes of youth that resulted from this experience over summer 2017 through quantitative and qualitative metrics. Quantitative metrics included a pre/post test assessing changes in garden-based and food knowledge and attitudes. Focus group sessions or interviews were held for each cohort. Results show that youth participants showed an increase in positive attitudes toward vegetable consumption, cooking, and confidence in gardening skills after the 10-week program.

1:54 PM Urban Agriculture in Asia

Dilip Nandwani*, *Tennessee State University*

Abstract: Half of the population of developing countries lives in cities, higher (74%) in developed countries. Recently, urban agriculture has gained increasing attention of world communities for the household security of the urban poor and improved land use between urban and rural. However, increase in land prices and taxes, poor infrastructure, disruption of farming activity, pollutions, are a few problems result of extensive urban growth. In Asia, food availability is becoming critical in cosmopolitan areas where most of the urban growth has occurred. Uneven distribution of incomes, shrinking farmlands, inefficient distribution systems, low yields, and poverty have all contributed food supply and distribution for urban poor. Few Asian cities have been successful in providing foods, most cities in Asia have not paid attention to their prospective food-production or developed policies. Several Asian countries becoming economically strong and depending on imported foods. Japan, South Korea, Singapore, Malaysia are few examples, whereas Bangladesh, Pakistan, Indonesia, India and Thailand, still depend on domestic food production supply. Japan provide good lessons to other Asian countries where high economic growth, urbanization and advent of modern citizens are taking place correspondingly. A viable division of urban farming is urban horticulture, which has produced innovative systems like organic farming, organoponics and simplified soilless cultures due to malnutrition, the high cost of urban land and with the need of high water- and fertilizer-use efficiency. This presentation discusses benefits, limitations and factors affecting urban agriculture in selected cities and countries in Asia.

2:02 PM Curriculum Development and Training about Ornamental Plant Production Practices in Rural Senegal with Winrock International and the USAID Farmer-to-Farmer Program

John L. Griffis Jr.*, *Florida Gulf Coast University*

Abstract: In most highly developed countries, ornamental plants and landscaping are just regular parts of the urban environment. However, in third world countries, this is not the situation outside of the large cities. Landscaping and ornamentals are associated with hotels, public parks, government buildings and wealth, not the average individual. However, as urban areas in these countries such as Senegal expand and modernize, there is an increased demand for ornamental plants. An increased opportunity also exists for new jobs and sources of income for individuals who are properly trained in ornamental plant production and maintenance. Senegal has several rural training centers where some courses in agronomy and vegetable production are already taught, but ornamental plants are not included in the curriculum. This Farmer-to-Farmer project was conducted at one of those rural training centers both to introduce this topic into the curriculum and to make the students aware of ornamental plant production practices and the opportunities available to them if they chose to become involved in this "new" business.

2:10 PM DC Central Kitchen: The Pioneers from the Washington DC Area

Amy Bachman*, *DC Central Kitchen*

Abstract: As the nation’s first community kitchen, DC Central Kitchen develops and operates social ventures targeting the cycle of hunger and poverty. The organization focuses on creating opportunities for meaningful careers, expanding access to locally produced and healthy food, and supporting urban farming initiatives in the Washington DC area. This presentation features DC Central Kitchen’s healthy corners program in which they provide fresh fruits and vegetables to local corner stores; its truck farm, a mobile garden that is used to educate students around the city on how food grows; DC Central Kitchen’s procurement of product grown by urban farms and how it is transformed into healthy meals for the community; as well as DC Central Kitchens’ Gleaning Program working with urban farms.

2:18 PM Universities As “Engines” of Urban Horticulture, a Success Story from Virginia

Donielle Nolan*, *George Mason University*

Abstract: A special program at George Mason University helps students (and interested community members) to learn how to grow their own food in- and outdoors using hydroponics, worm composting and permaculture techniques. This on campus program supports hundreds of students every semester to earn class credit and gain leadership skills. One of the dining halls on campus serves the salad greens and tomatoes grown in the hydroponic greenhouse. Another approach of the Office of Sustainability at George Mason University is the permaculture design method that relies on perennial plants, like fruit trees and herbs, to grow food with less maintenance. It is practiced on the student campus. Community members can volunteer on campus to receive hands-on training to learn how to grow food sustainably, from seed to harvest.

2:26 PM Chinampas: An Urban Farming Model of the Aztecs and a Solution for the Megalopolis of Our Times

Roland Ebel*, *Autonomous University of the State of Mexico*

Abstract: Urban horticulture is not as new as many people think. A chinampa is a garden built as a small, artificial island on a freshwater lake surrounded by canals and ditches. Chinampas were first developed in Aztecs times and still can be found in the region of Xochimilco (close to Mexico City). They are built of aquatic vegetation and mud. The lake delivers water and fertile organic wastes; and fences made of native willow species protect a chinampa from wind and pests, apart from preventing erosion. Main crops are maize, amaranth, legumes, squash, tomato, chili pepper, diverse spice plants, and ornamentals. Complex rotations and associations between these crops allow up to seven harvests per year. Today, chinampas are still producing, but serve primarily

as tourist attraction. Recently, diverse research and community initiatives are trying to recover the productive potential of chinampas and align this sustainable and productive system with the achievements and the needs of the 21st century. The chinampa model could help to supply food for big cities, even benefiting from waste water rich in organic matter.

2:34 PM Ancient Urban and Botanicals Gardens of Persia

Esmaeil Fallahi*, *University of Idaho Parma Research and Extension Center*; Pontia Fallahi, *Montgomery* and Morteza Khosh-Khui, *University of Shiraz, College of Agriculture*

Abstract: The history of Persian gardens goes back to a few millennia before the emergence of Islam in Iran (Persia). Designs of Persian or Iranian gardens have influenced the designs of gardens all around the globe. Styles of Persian gardens are used extensively in the gardens of Al-Andalus in Spain and Humayun's Tomb and Taj Mahal in India, and many gardens in the USA and other countries. Bagh in the Persian language (Farsi) means "garden". For example, it is believed that the word Baghdad (the capital city of Iraq) is rooted from the words "Bagh" and "Daad" (meaning the garden of justice), since the ancient Persian city of Ctesiphon and supreme court of Ivan-e Madein during Sassanid dynasty of Persia were located near Baghdad. Pasargadae, the capital city and tomb location of Cyrus the Great, is the earliest example of Persian botanical garden design known in human civilization as Chahar Bagh or fourfold garden design. "Bagh-e Eram" or "Garden of Eden" or "Eram Garden", which is one the most amazing botanical gardens in the world, is located in Shiraz, Iran. Bagh-e Eram was established during the Persian Saljughi dynasty era (1037-1193) and is now over 1000 years old. There are numerous other botanical and urban ancient gardens in Iran, including Bagh-e Shazdeh in Mahan, Golestan National Park near the Caspian Sea, Bagh-e Fin in Kashan, Bagh-e El-Goli in Tabriz, and Bagh-e Golshan in Tabas. The design of each Persian garden is influenced by climate, art, culture, poetry, literature, and romance of the country and the region where the garden is located. Additionally, each garden represents a wide range of germplasm of fruit, flowers, herbs, and vegetables. Although countless gardens were destroyed in the hands of invaders over centuries, Persians have attempted to either rebuild or build new gardens generation after generation, each of which has become a favorite destination for tourists from all around the world.

2:42 PM Challenges and Success of the USAID Farmer-to-Farmer Program, the Example of Central Asia

Ross Penhallegon*, *Oregon State Univeristy*

Abstract: Teaching orchard management in Central Asia is a challenging mission. Gardeners are very poor, have no equipment, little access to agrochemicals, and lack orchard management skills. Since 2005, the goal of USAID farmer-to-farmer volunteers in Tajikistan and Kyrgyzstan has been to teach orcharding skills to horticulturists, emphasizing in pruning techniques, a simple and low-priced way to double their income in two years. The "pruner project" was developed among local Master Gardeners and Oregon farmers. In Lake Issyk-kul, Kyrgyzstan, 75% of the trees are now pruned. And since 2012, 65% of the Tajik trees are pruned as well. One of many success stories: Near the Afghanistan border, volunteers met a local gardener, who was very depressed. The man was barely growing enough food to keep his three kids from starving to death. The man attended the pruning and orchard management class. He and other gardeners also received equipment to share. Three years later, the same man welcomed the volunteers with a big smile on his face and showed them his prosperous orchard. Thanks to pruning, a person who was in the depth of depression is now a successful father that can support his family; and counting with more input resources, his orchard could still produce the double.

2:50 PM Panel Discussion and Audience Participation

Dilip Nandwani*, *Tennessee State University*; Roland Ebel*, *Autonomous University of the State of Mexico*; John L. Griffis Jr., *Florida Gulf Coast University*; Mary Anne Rogers, *University of Minnesota*; Amy Bachman, *DC Central Kitchen*; Donielle Nolan, *George Mason University*; Esmaeil Fallahi, *University of Idaho Parma Research and Extension Center* and Ross Penhallegon, *Oregon State Univeristy*

Abstract: The final discussion gives the audience the opportunity to interact with all presenters of this workshop. The nature of successful urban farming projects will be discussed by means of a specific question regarding each presentation:

- **Growing North: Connecting Youth and Community through Garden-Based Experiential Learning in North Minneapolis** - What horticultural and interpersonal development skills can be gained by a summer immersion program for youth in urban agriculture?
- **Urban Agriculture in Asia** - Several countries in Asia improved food supply in urban areas and many others are struggling. What could be the factors of success and failures in urban development as food supply in Asia?
- **Curriculum Development and Training about Ornamental Plant Production Practices in Rural Senegal with Winrock International and the USAID Farmer-to-Farmer Program** - Is ornamental production a growth market within urban farming?
- **DC Central Kitchen: The Pioneers from the Washington DC Area -** How would you assess the relationship between the success of locally grown food and changing food consumption habits?
- **Universities As "Engines" of Urban Horticulture, a Success Story from Virginia** - What does it require for a small campus initiative to "spread" to an urban region?
- **Chinampas: An Urban Farming Model of the Aztecs and a Solution for the Megalopolis of Our Times** - Today, urban horticulture is restricted to niches in big cities. Could production systems like chinampas help to increase its scope?
- **Ancient Urban and Botanicals Gardens of Persia -** How can the designs of ancient Persian Gardens with their multiple purposes be adopted and be fulfilling for the needs of today's modern gardens?
- **Challenges and Success of the USAID Farmer-to-Farmer Program, the Example of Central Asia -** In countries like Tajikistan, are there any differences between farmer-to-farmer missions in rural and in urban regions?

The speakers are encouraged to answer these questions shortly and precisely so as to leave space for contributions and questions from the audience. The workshop ends with an invitation to join the Interest Group meeting.

2:00 PM – 3:00 PM *Boundary (Terrace Level)*

Graduate Student Activities Committee Meeting

Chair: Brian Pearson, *University of Florida, Mid-Florida Research and Education Center*

Members: Christopher J. Currey, *Iowa State University*; Amir Khoddamzadeh, *Florida International University*; Alex Rajewski, *University of Georgia* and Manjul Dutt, *University of Florida*

2:00 PM – 3:15 PM *Georgetown West*

Computer Applications in Horticulture/Ornamental Breeding

2:00 PM Using Interactive 3D Models Generated By R/Plotly to Answer Questions within a Breeding Program

Jeekin Lau*; Ellen L. Young; Stella Kang; Seza Noya and David H. Byrne, *Texas A&M University*

Abstract: Basic questions such as: disease variation in a field, disease progression throughout the season, effect of nearby covariates, and the progression of desirable genotypes, are normally answered by analyzing the data through statistical software such as SAS, JMP, SPSS, or R. However, it is often the case that searching through the long outputs of these programs for one or two p-values is less informative and harder to comprehend than a basic R-script utilizing R/plotly to visualize the data. We investigated the use of interactive 3D plots generated by R/plotly to answer the following important inquiries: Which genotypes to use as parents in this year's crosses based on best performance in our environment throughout the year. Whether

the distribution of flower yield or disease incidence was affected by the presence of a dirt road running by one side of the field or by partial flooding of the field due to Hurricane Harvey. Outputs are interactive and can help identify outliers and specific individuals in large datasets without having to search for specific values within spreadsheets with thousands of rows.

Specified Source(s) of Funding: "Combating Rose Rosette Disease: Short Term and Long Term Approaches" (2014-51181-22644/SCRI).

2:15 PM The Polyploidization of Novel Poinsettia 'Dulce Rosa'.

Ya-Fen Lu and Yen-Ming Chen*, *National Chung Hsing University*

Abstract: Poinsettia is one of important pot flower crops in the world. In recent years, interspecific hybridization is adopted to introduce new plant character of Poinsettia. In 2003 US company Ecke created 'Dulce Rosa', novel interspecific hybrid conducted by the pollination between *Euphorbia pulcherrima* and *E. cornastra*. However the pollen sterility of 'Dulce Rosa' prevents it from being material for continuous breeding work. The main purpose of present research was to restore its fertility by polyploid mutagenesis. The in-vitro internode explants of 'Dulce Rosa' were cultured on artificial medium which contains colchicine for mutation treatment. The survival mutants evaluated the plant characteristics and pollen fertility, as well as the relative DNA content also confirmed by flow cytometry to compare the differences. The results indicated that 'Dulce Rosa' bract color being RHS-57D, the bract color of mutant significantly darkened (RHS-57B&57C). In addition, the blade aspect ratio of 'Dulce Rosa' being 2.37, but the mutant's blade is widened (aspect ratio 1.71), as well as thickened leaf and increased hair villus amount. The width and length of mutant's guard cell is increased 1.3 times. In addition, the lack of stamen due to 'Dulce Rosa' flower abnormality, the mutant with functional reproductive organs, and the anther stretches from involucrum and releases fertility pollen after colchicine induction treatment. Under optical microscope, mutant's pollen characteristic turns normal without wrinkling. The M2 mutant has highest pollen germination rate and its pollen tube germinates well in BK medium (20% sucrose). The DNA content of mutant is twice as many as those of 'Dulce Rosa', proving the evidence of colchicine mutant being polyploidy.

2:30 PM Assessing Genetic Compatibility within and Among *Asclepius* Spp. and Creation of Novel Cultivars for the Floriculture Market

Mary Lewis*; Matthew Chappell and Paul A. Thomas, *University of Georgia*

Abstract: *Asclepias* is an important ecologic host and food source for many butterfly species that utilize nectar and foliage as a food source. It is also known for its attractive floral structures and performance in landscape environments with minimal fertilizer and irrigation inputs. Despite having ornamentally and ecologically valuable traits, cultivars of *Asclepias* spp. are not commonly found in the ornamental market as *Asclepias* spp. does not tolerate commercial growing protocols that incorporate high fertility and irrigation rates, and as a result grow to heights too large for efficient racking and shipping or suffer from pathogens. Another major challenge in developing hybrid cultivars is that hybrid fertilized embryos often undergo late-term abortion. This has deterred many ornamental breeding programs from attempting interspecific crosses within the genus. In this project, *Asclepias tuberosa* was used as the female parent, as this species is the most widely-grown taxa and possessed many traits superior to other species in the genus. The pollen donors were *Asclepias speciosa, A. syriaca, A. viridis, A. incarnata, A. purpurascens, A. hirtella, and A. fascicularis*. Each of the species used as pollen parents was selected to introgress beneficial traits that could improve yield commercially viable cultivars. For example, A. *incarnata* and *A. hirtella* thrive under wet soil conditions, similar to production environments and irrigated landscapes. *A. fascicularis, A. incarnata*, and *A. viridis* have naturally occurring branching, another trait valuable to the industry. *A. viridis*, *A. purpurascens and A. fascicularis* are diminutive in height, differing drastically from most species that range from 1.2 to 1.8 meters. Flower color of species used in this study is far different than *A. tuberosa*, ranging from white to green to pinks and purples, all of which could result in broadening the floral color palette of hybrids. To overcome late term abortion, embryo rescue protocols were established and used to increase the success rates of interspecific crosses that would normally undergo late-term abortion. Embryo rescue has not been attempted before and based upon parental selection could lead to *Asclepias* hybrids that have enhanced production/landscape tolerances and ornamental values. This would include shorter stature, better branching, improved floral display, and tolerance to consistently moist soils (and associated pathogen pressure). All information from this study will be used to establish working protocols for embryo rescue and vegetative propagation through tissue culture, stem cutting, and root cuttings. This information will provide the industry an avenue to increase production and distribution of *Asclepias* to the market.

2:45 PM Genomic Analysis of the Domestication of *Sinningia Speciosa*

Tomas Hasing*[1]; David Zaitlin[2] and Aureliano Bombarely[1], *(1)Virginia Tech, (2)University of Kentucky*

Abstract: *Sinningia speciosa* (Gesneriaceae) is a perennial, herbaceous flowering plant native to the Atlantic Coastal Forests of Brazil. After the species was introduced into England in 1815 its cultivation as an ornamental house plant developed quickly. Within only a few short years it gained popularity across London and soon after specimens reached several parts of the world, including the U.S. Modern cultivars exhibit a broad range of phenotypes. Their large, colorful, upright, bell-shaped (actinomorphic) flowers differ markedly from the smaller, lavender, nodding (zygomorphic) flowers commonly found in the wild forms. Given its short history of cultivation, *S. speciosa* can serve as a model to understand the significant genomic changes that are associated with the process of plant domestication. The genome of the wild accession 'Avenida Niemeyer' (~ 400 Mb) was sequenced and assembled (PacBio corrected with Illumina reads) as a reference for subsequent alignments. A collection of 128 individuals within the tribe Sinningieae was genotyped using the Genoyping by Sequencing (GBS) method. Sixty-two individuals were *S. speciosa* (41 commercial cultivars and 21 wild accessions) and the remaining 66 represented 35 species sampled across the tribe. We retained 9,913 high quality non-missing SNPs across all species, and 25,083 within *S. speciosa*. Additionally, we phenotyped and genotyped (GBS) 160 individuals from an F_2 population derived from the cross of 'Buzios' (wild) by 'Empress' (cultivar). Principal component analysis on genetic distances clustered all the species according to the three major clades in the tribe: Sinningia, Corytholoma, and Dircaea. Cultivated and wild accessions of *S. speciosa* clustered together with no signs of interspecific hybridization events driving the process of domestication. We also detected a reduction of between 40 and 58% in genetic diversity across the cultivars relative to their wild counterparts. This bottleneck is likely the result of the limited number of individuals originally brought into cultivation (founder effect). In fact, distance clustering and ADMIXTURE analysis revealed only two wild accessions in the background of cultivated material: 'Avenida Niemeyer' and 'Antonio Dias'. Quantitative Trait Loci analysis of flower symmetry (actinomorphic vs. zygomorphic) and flower color (purple vs. red) revealed highly significant single loci for each trait. Under the QTL responsible for flower symmetry we located a CYCLOIDEA-Like (CYC) gene with two small deletions that correlate with the trait. CYC encodes a transcription factor that controls floral symmetry in the snapdragon (*Antirrhium majus*).

3:00 PM Comparison of Linkage Maps for Diploid *Rosa*

Ellen L. Young*; Jeekin Lau; Stella Kang; Muqing Yan; Patricia Klein and David H. Byrne, *Texas A&M University*

Abstract: Although roses are the backbone of the ornamental plant industry, genetic studies in roses have been complicated by the lack of an available rose genome sequence. However, with the release of the *Rosa chinensis* sequence, new opportunities have arisen for rose genetics and breeding. Prior to the release of the diploid rose genome, we genotyped 15 inter-related diploid rose populations using genotype by sequencing (GBS) for single nucleotide polymorphisms (SNPs) using the *Fragaria vesca* genome as a reference and created an integrated consensus map for use in quantitative trait locus (QTL) discovery. This resulted in the discovery of 40-50,000 SNPs over the 15 populations with about 3,500 determined to be useful for the integrated consensus map created via JoinMap 4.1. To determine if the map could be improved after the release of the rose genome, the GBS reads were aligned with the rose genome and SNPs were called. This

resulted in approximately 60-80,000 SNPs (depending on the family), which is significantly greater than the number of SNPs called when the *Fragaria* genome was used as a reference. These SNP calls were filtered and used to make a new integrated consensus map via JoinMap 5. The two maps were compared on the criteria of marker number, map length, mean distance between markers, and the largest distance between markers.

Specified Source(s) of Funding: USDA-SCRI, "Combating Rose Rosette Disease: Short Term and Long Term Approaches" (2014-51181-22644/SCRI)

2:00 PM – 3:15 PM *Georgetown East*

Weed Control and Pest Management 2

Moderator: Michael Gutensohn, *West Virginia University*

2:00 PM Potato Psyllids and Zebra Chip Disease: What Have We Learned in Six Years of Psyllid Monitoring in the Columbia Basin of Washington?

Carrie Wohleb* and Timothy D. Waters, *Washington State University*

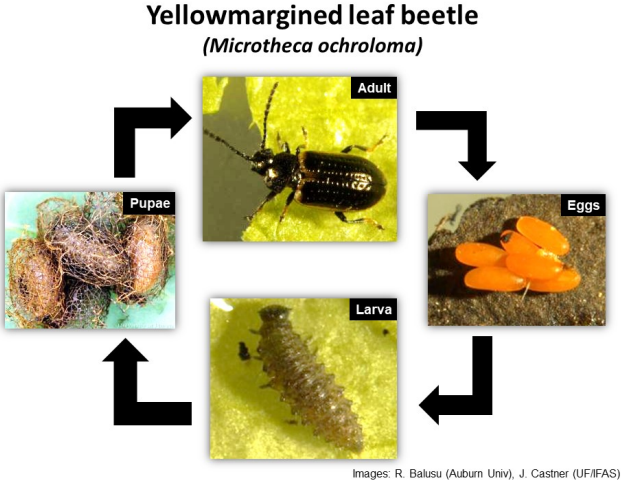
Abstract: Zebra chip is a disease of potatoes caused by a bacterium (*Candidatus* Liberibacter solanacearum) that is vectored by a tiny insect, the potato psyllid (*Bactericera cockerelli*). Plants infected with zebra chip die early and produce tubers with an internal necrotic defect. The disease, which was known to occur in other parts of the United States for more than a decade, was not found in the Columbia Basin of Washington until 2011. This initial outbreak resulted in the complete destruction of at least two potato fields and symptomatic tubers were reported from several more fields in the region—the losses were estimated at over a million dollars. In 2012, potato psyllids were added to our regional insect monitoring program (established in 2009 to monitor aphids, beet leafhoppers, and potato tubwerworm). After some trial and error, we determined that a combination of yellow sticky cards and leaf samples was the best way to monitor potato psyllids. The most important output from the monitoring program is a weekly e-newsletter, called *WSU Potato Pest Alerts,* that includes reports about the current prevalence and distribution of potato psyllids, scouting instructions, and management recommendations. This information assists growers in making informed and timely management decisions and may explain why zebra chip has been seen in the Columbia Basin since 2011, but has not resulted in significant losses. The monitoring program also helps us learn more about psyllid biology and behavior. It has revealed details about psyllid migration and distribution in the region, and has led to the discovery of some important overwintering hosts. We have also documented some very large swings in the size of psyllid populations each year; almost 30,000 psyllids were collected in 2016 compared to only 152 psyllids in 2017 using the same number of traps. The infection rate of psyllids has been less varied, with Liberibacter detected in only 0.00% to 0.17% (average 0.14%) of the psyllids each year. These percentages are smaller and less varied compared to the infection rate of psyllids in Idaho during the same period. The low infection rate of psyllids in Washington means that our monitoring and testing program has not been able to predict exactly when and where isolated incidences of zebra chip will occur. But, in the future we will know to anticipate zebra chip if the monitoring program collects unusually large numbers of psyllids or detects a larger proportion of psyllids carrying Liberibacter.

Specified Source(s) of Funding: The Washington State Potato Commission, USDA Technical Assistance for Specialty Crops (TASC), and USDA-ARS-State Partnership Potato, Program

2:15 PM Pest Status and Management Updates for the Yellowmargined Leaf Beetle (*Microtheca ochroloma,* Coleoptera: Chrysomelidae) in Organic Brassica Production in Alabama

Ayanava Majumdar*, *Alabama Cooperative Extn System*; Matthew Price, *Auburn University* and James Pitts, *AAES*

Abstract: The yellowmargined leaf beetle (YMLB) is a major insect pest of brassicas across the southeast and has increased in occurrence in Alabama where crop devastation can easily exceed 50 percent. YMLB is native to South America and it was first detected in Mobile, USA, in 1947. Two researchers at Auburn University (R. Balusu and H. Fadamiro) along with collaborators at the University of Florida (O. Liburd) initiated a YMLB research projects in 2010 that gradually added an educational component with Alabama Extension Commercial Horticulture Program to rapidly disseminate pest alerts and management information. With increasing number of small farms growing winter crops in Alabama, the threat of YMLB has also increased significantly since 2010 with many reports of crop failure and produce contamination. At present, organic insecticides alone do not provide adequate crop protection due to strong migration pattern and rapid buildup of YMLB. Adults and larvae of YMLB can defoliate turnips and Napa cabbage in a few days followed by movement to other brassica crop or weedy hosts. Since YMLB is strongly attracted to turnips, it can be used as a trap crop in conjunction with biorational insecticides to become a true integrated pest management (IPM) strategy. Based on small-plot research, the extension IPM team developed large-scale trap crop test plots that serve as demonstration areas for grower education. Based on multi-year studies, there is evidence that two to four rows of early-planted turnips as a perimeter trap crop is very effective in attracting YMLB adults away from a main crop like cabbage, where YMLB control gets complicated due to plant structure and need for complete coverage of crop with bioinsecticides. Research into the efficacy of individual organic bioinsecticides since 2010 has now diversified into replicated plots for testing complex organic insecticide rotations and tank-mixes. While natural pyrethrin (PyGanic) and spinosad (Entrust) have shown adequate effectiveness against YMLB, additional effective materials such as Monterey Garden Insect Spray (a General Use Pesticide with spinosad) and Grandevo (*Chromobacterium subtsugae* strain PRAA4-1) appear to slow down defoliation. Integration of above insecticides with *Bacillus thuringiensis*-based formulations is promising for growers facing multiple insect threats, e.g., caterpillars and YMLB. Audience members attending the talk will be provided copies of major educational publications (scouting field guide, IPM slide charts, and bulletins) as examples of IPM education and communication strategy for the statewide program that continue to evolve and assist small producers save high-value crops.



2:30 PM Glandular Trichome-Derived Terpenes of Wild Tomato Accessions Affect Aphid Performance and Feeding Behavior

Fumin Wang; Yong-Lak Park and Michael Gutensohn*, *West Virginia University*

Abstract: Piercing-sucking insects such as aphids pose a serious problem in the commercial production of horticultural crops including tomato, since damage is caused not only by direct feeding, but also by transmission of viruses for which these herbivores serve as vectors. Current control strategies involving synthetic insecticides are increasingly considered as problematic due to emerging resistances, costs for growers, and concerns of consumers, highlighting the need to develop new efficient and sustainable approaches to control these pests. Recent studies of terpene production in glandular trichomes of tomato plants, found on their leaves and stems, and known to be involved in plant-insect interactions, demonstrated significant differences

between cultivated and wild tomato species, as well as quantitative and qualitative variation among wild tomato accessions. Since these wild tomato accessions potentially represent good sources of defensive traits against aphids, we have performed a number of assays to compare the performance and feeding behavior of the potato aphid, *Macrosiphum euphorbiae*, on leaves of cultivated tomato (*Solanum lycopersicum*) and multiple wild tomato accessions (*Solanum habrochaites*) representing different terpene chemotypes. Non-choice assays demonstrated that longevity and fecundity of potato aphids was significantly lower on two groups of *S. habrochaites* accessions compared to *S. lycopersicum*. Subsequently, we analyzed aphid feeding on an artificial medium containing either leaf extracts with glandular trichome derived terpenes from cultivated and wild tomato accessions, or pure terpene compounds. Our analysis of aphid survival, as well as accumulation of salivary sheath and honeydew production, both indicators of aphid feeding, suggest that selected glandular trichome derived terpenes found in some *S. habrochaites* accessions influence aphid performance by affecting their feeding behavior. In addition we performed olfactometer choice assays to study the effect of terpenes emitted from different tomato accessions on the search behavior of winged potato aphids towards host plants. The same *S. habrochaites* accessions that showed significant effects in the previous non-choice and feeding assays, were also found to be repellent towards winged aphids. Moreover, addition of leaf extracts of these *S. habrochaites* accessions or respective pure terpene compounds to leaves of cultivated tomato plants significantly reduced the attractiveness of these to aphids. The identification of several terpenes from *S. habrochaites* accessions with the potential to affect the overall performance, feeding and search behavior of potato aphids no allows us to introduce these defensive traits into cultivated tomato by introgression and metabolic engineering.

Specified Source(s) of Funding: USDA NIFA AFRI

2:45 PM Parasitoid Surveys in Cycad Habitats on Guam

Benjamin E. Deloso*[1]; Aubrey Moore[1] and Thomas E Marler[2], *(1)University of Guam, (2)Univ of Guam*

Abstract: Scale-infested cycad leaves were sampled on the island of Guam in a wide range of habitats in 2017 and 2018 to determine the extent of parasitoid control of the scale. The sampling unit was a leaflet selected from five trees per habitat during each sampling date. The number of scales were counted with a hand lens and parasitoids were reared in a growth chamber at 60% relative humidity. Infested leaflets were transferred to new rearing vessels after 48 hour intervals and returned to the growth chamber. Insects were rinsed with 70% EtOH and parasitoids were counted with the aid of a microscope. The abaxial leaflet surfaces harbored greater numbers of scale than the adaxial surfaces. In a Northern Guam site where parasitoids were first fortuitously discovered in 2013, only 20% of the samples yielded parasitoids. For each geographic site, the presence of parasitoids on one sampling date did not always lead to evidence of parasitoids at a later sampling date. The number of parasitized scales was minimal despite the widespread geographic occurrence of the parasitoids. Several native and exotic *Cycas* cycad species were historically heavily used in the commercial and residential landscapes of Guam, and the recent invasion of the cycad Aulacaspis scale (CAS) *Aulacaspis yasumatsui* Takagi has devastated these cycad populations. These results provide the first evidence that scale parasitoids are established throughout most of the island, but they are not effectively controlling the scale infestations. This case study is an example of how the horticulture profession can aid in responding to an ecological disaster.

3:00 PM Potential of Nanotechnology in Horticulture

Naveen Kumar*, *University of Maryland Eastern Shore*; Sudipta Seal, *University of Central Florida* and Nidhi Rawat, *University of Maryland College park*

Abstract: Nanotechnology is an emerging branch of science with an enormous potential to manage plant pests and pathogens. Our current work on soybean looper [*Chrysodeixis includens* (Walker)], beet armyworm [*Spodoptera exigua* (Hübner)], Japanese beetle [*Popillia japonica* (Newman)], cucumber beetle [*Diabrotica undecimpunctata howardi* (Barber)], and Fusarium Head Blight (*Fusarium graminearum*) using nanoparticles [nano-clay (NC); 200-700nm, nano-zinc-oxide (NZO); 20-50 nm, and nano-sulfur (NS); 20-60 nm] showed promising results. Three independent experiments (2017) were conducted in a randomized complete block design with ten blocks, and one plant of each treatment per block in the field conditions. Ten plants were used for each treatment. The means per plant was determined and subjected to analysis of variance (SAS Institute, Cary, NC) and separated using a protected least significant difference (LSD) at $P < 0.05$. Similar design was used for *in vitro* studies. The standard error of the mean was also calculated. *In vitro* results showed 80 to 100% mortality of first, second, and third instar stages of soybean looper within 5 to 24 hr using NC, NZO, and NS. Similarly, 80 to 100% mortality of first, second, and third instar stages of beet armyworm were observed within 5 to 24 hr using NC, NZO, and NS. *In vivo* application of NZO (5, 10, 15 mM), NS (5, 10, 15 mM), and NC (0.5%) showed less damage on soybean leaves using first instar stage of soybean looper. However, no effect of these particles were observed on second and third instar stages of soybean looper. In field conditions, five spray applications of NZO (5, 10, 15, 20 mM), NS (5, 10, 20 mM), NC (0.5% and 1.0%) at V1 (first trifoliate leaf) to V5 (five trifoliate leaf) stage of soybean development showed decline in leaf damage and blemishes in comparison to control untreated plants. Behavioral studies were conducted in cages by enclosing the adults of Japanese and Cucumber beetle on NZO (15 and 20 mM) treated and control leaves. Adults never attacked on NZO treated leaves and preferentially consumed untreated control leaves. However, adults also consumed NZO treated leaves in the absence of control leaves in cages. These studies were conducted using a narrow range of nanoparticle. There is a possibility of more success *in vivo* conditions by using wide range of nanoparticles.

Specified Source(s) of Funding: Maryland Soybean Board

2:00 PM – 3:30 PM *Lincoln East*

Temperate Tree Nut Crops

Moderator: Louise Ferguson, *University of California, Davis*

2:00 PM Changes in the Nutrient Profiles of Developing Chinese Chestnut (*Castanea mollissima,* Blume) Seeds

Ryan McNeill*; Matthew Chappell and Scott Merkle, *University of Georgia*

Abstract: As plants grow and develop, they acquire mineral nutrients from their environment. Developing seed embryos acquire their mineral nutrition through their mother plants. The relative proportions of these nutrients in developing seeds can vary according to their respective stages of development. Chinese chestnut (*Castanea mollissima*, Blume) is an economically important nut tree species in Asia. Although its cultivation in the United States is limited, it is used as a genetic source of disease resistance in breeding programs in support of restoration efforts of the American chestnut (*Castanea dentata*, (Marshall) Borkh.). Developing seeds from three Chinese chestnut trees located in Athens, Georgia were collected on three dates each in 2016 and 2017. The seeds were excised from their burs and their pericarp and seed coat layers were removed. The remaining kernels were then dried and analyzed for their inorganic nutrient composition at the University of Georgia's Soil, Plant, and Water Lab.

Variations in environmental conditions can cause differences in developmental ontogeny of seeds between years. To standardize the nutrient profiles of kernels that were sampled at similar dates between years, digital images of the dried kernels were made before they were processed for analysis. These images were analyzed using Image J software to gauge the relative sizes of the kernels. These two-dimensional area measurements were correlated with their respective nutrient analyses. There were strong Pearson correlations ($r \geq |0.70|$) between the average sizes of the dried kernels and their respective average levels of potassium, zinc, copper, and nickel, with moderate correlations ($|0.69| \geq r \geq |0.50|$) of average kernel size with average levels of magnesium and nitrogen.

The correlations of kernel sizes and nutrient contents will guide future research toward development of optimized fertility regimes for bearing chestnut trees as well as the formulation of optimized tissue culture media for development and maturation of chestnut somatic embryos.

2:15 PM Bud Abscission Dynamics in Pistachio As a Function of Branch Carbohydrate Status and Embryo

Growth

Leigh F Archer*[1]; Narges Mahvelati[1]; Lu Zhang[1]; Daniel YP Syverson[2]; Gureet Brar[2] and Louise Ferguson[1], *(1)University of California, Davis, (2)California State University Fresno*

Abstract: We examined the hypothesis that the premature floral bud abscission that produces alternate bearing in pistachios is a function of carbohydrate status. This study focused on shoots with and without crop to better characterize the carbohydrate status at the individual branch level. At α=.05 average percent abscission was significantly higher in "on" branches (91.5%), compared to "off" branches (50.1%). Additionally, carbohydrate analysis of individual branches showed a significant difference ($p<0.05$) between the starch content of one-year-old wood and that of current-year wood of the same branch. Results suggest competition for stored carbohydrates in the new wood of fruit-bearing shoots may initiate a hormonal signal that precipitates bud abscission on current year's shoot growth.

Specified Source(s) of Funding: California Pistachio Research Board; Acadian Seaplants LLC

2:30 PM The Genetic Analysis of UCB-1 (*Pistacia atlantica* x *P. integerrima*) Seedling Rootstocks in Experimental and Commercial Pistachio Orchards

Ewelina Jacygrad*[1]; William J. Palmer[2]; John E Preece[3]; Richard Michelmore[4] and Deborah Golino[1], *(1)Foundation Plant Services, UC Davis, (2)Genome Center, UC Davis, (3)National Clonal Germplasm Repository USDA-ARS, (4)University of California, Davis*

Abstract: 'UCB-1' is currently the most commonly planted pistachio rootstock in California, home to the majority of pistachio orchards in the USA. UCB-1 is grown from F_1 hybrid seed created by crossing *Pistachia atlantica* and *P. integerrima*. However, UCB-1 varies as is expected from a cross between two heterozygous outbreeding species. Some rootstocks in the population have low vigor resulting in low-yielding trees. In order to study this variability, we planted 960 'UCB-1' seedlings in 2013 that have been phenotyped annually thereafter. Data have been collected on tree height, trunk caliper, and tree architecture. Early growth was a poor predictor of subsequent growth of the non-grafted trees supporting the grower experience that early rouging is ineffective. As the trees aged, the population showed greater variation and there are now six standard deviations in trunk caliper. We have generated draft genome assemblies for the parental *P. atlantica* and *integerrima,* as well as sequenced a total of nearly two thousand UCB-1 F_1 seedlings from our experimental and four commercial orchards. To generate these data, we used 10x Chromium, Dovetail Hi-C, and reduced representation sequencing. Genome-wide association studies identified three major loci controlling trunk caliper in our experimental orchard of ungrafted trees. Two of these loci were also highly significant in determining the trunk caliper of grafted trees in commercial orchards. Development of predictive markers for UCB-1 rootstock vigour will be highly beneficial to the industry, allowing removal of seedlings with likely poor performance prior to planting in orchards.

Specified Source(s) of Funding: California Pistachio Research Board

2:45 PM Pecan Maternal Genotype: Implications for Nutrient Uptake in Alkaline Soils

Jason French; Robert Flynn and Richard Heerema*, *New Mexico State University*

Abstract: Pecan (*Carya illinoinensis*) is native to Mexico and the south-central US, spanning diverse humid to semi-arid environments. The southwestern US is playing an increasingly significant role in pecan production, now comprising nearly 25% of improved US pecan acreage. Suitable climate, low pest and disease pressure, deep soils, and the availability of irrigation water have led to rapid expansion of pecan acreage in the Southwest. Maximizing productivity and profitability requires identification of pecan rootstocks that can thrive in this region's unique environment. High soil pH and lime content limit soil availability of micronutrients, resulting in severe nutrient deficiencies. In this study we investigated the interactive effects of pecan seedling maternal genotype and soil lime content on nutrient uptake in alkaline soils. We hypothesized that seedlings with western-region maternal ancestry are better adapted to extract nutrients from calcareous, alkaline soils than those with eastern- or southern-region ancestry. Eight maternal genotypes across the native range of pecan were used in this study: eastern-ancestry genotypes ('Curtis', 'Elliott', and 'Moore'), western-ancestry genotypes ('Riverside', 'VC1.68', 'Shoshoni', and 'Burkett'), and one southern-ancestry genotype ('87MX1.5.7'). The seedlings were grown in 18.5-liter pots under three soil lime treatments, representing the range of soil lime content in the Southwest. Agricultural lime was added to soil at 3 rates: 30% lime, 15% lime, and no added lime ("Control"). Each genotype x lime content combination was replicated 6 times. Trees received 30 g of 16N—3.5P—6.6K fertilizer 6 times annually, but no micronutrient fertilizers were applied. Leaf tissue nutrient concentrations were measured each growing season for 3 years. In 2015, soil lime treatments and maternal genotype had no apparent effect on leaf mineral nutrient levels with the exception of manganese and zinc. Compared with lime-treated seedlings, Control seedlings had 18%, 66%, and 46% higher leaf manganese concentration in 2015, 2016, and 2017, respectively. Seedlings from all maternal genotypes except 'Moore', 'Curtis', and 'Shoshoni' were deficient for zinc (<50 ppm) in 2015. All maternal genotypes were deficient for zinc in 2016 and 2017, however, 'Shoshoni' seedlings had 60% and 209% higher zinc concentrations, respectively, compared with other genotypes. These data suggest that maternal genotype influences zinc uptake, but, in most cases, seedlings of western maternal ancestry did not have higher zinc levels than seedlings of eastern or southern maternal ancestry. Additional research is needed to investigate if the same patterns persist in grafted trees and in a field setting.

3:00 PM Developing a Phenological Model to Manage Pistachio Production

Lu Zhang[1]; Emilio Laca[1]; Liyu Ying[2]; Ruoyi Gao[2] and Louise Ferguson*[1], *(1)University of California, Davis, (2)University of California*

Abstract: Pistachio (Pistacia vera L.) nut growth has 3 successive/simultaneous stages: 1) first, pericarp expansion growth that produces the final in-shell nut size; 2) second, thickening and hardening of the pistachio endocarp which is a process of lignification; 3) and simultaneously with the late lignification, embryo growth. In pistachio, it is crucial for growers to know when these specific growth stages will happen to maximize efficiency of irrigation, pest management, and harvest time to optimize quality, yield and profit. Based on three years' data, a pistachio nut growth model was developed to describe the three growth stages as a function of heat units for the cultivars Kerman, Lost Hills, Golden Hills, Kaleghouchi and Pete 1. The three nut growth stages were measured weekly starting with bloom and ending with harvest. Hourly temperatures were monitored in each location and the thermal unit accumulation was calculated with the base temperature of 7 ^{o}C. Four non-linear models–the Asymptotic Regression, Michaelis – Menten, 3-parameter Logistic and Gompertz models–were coded and analyzed using R Statistics software with functions of SSasympoff, MMoff, SSlogis and SSgompertz, separately. The Gompertz model produced a better coefficient of determination and Akaike's Information Criterion values. It best predicted pistachio nut growth at both low and high heat unit accumulation. Based on the selected Gompertz model, a service website, powered by the Spring Framework, was developed heat units by applying the prediction curve. Pistachio growers only need to input the orchard information of the bloom date, cultivar and location.

Specified Source(s) of Funding: California Pistachio Research Board

3:15 PM Field Dust Damages Stigmatic Structure and Crop Production in Pistachio (*Pistacia vera* L.)

Lu Zhang[1]; Robert Beede[2]; Narges Mahvelati[1]; Alan Scroggs[3]; Brian Blackwell[3] and Louise Ferguson*[1], *(1)University of California, Davis, (2)University of California Cooperative Extension, (3)Westside Farm Management, Inc.*

Abstract: Substantial dust generated by flail mowers in California's Central Valley pistachio (*Pistacia vera* L.) orchards led to the hypothesis that field dust disrupts pollination and fruit set in pistachio. In spring, clusters with flowers at the green tip stage were bagged and hand-pollinated with pollen:dust mixtures at the different ratios on five successive days. The stigmatic structure, the rates of viable pollen, fruit set, nut drop, blank and nut split were all investigated as factors involved in the progress of pollen-

stigma interactions. This study also evaluated the effect of herbicide residues in dust to both pollen viability and pistil morphological structure. The gibberellic acid (GA) concentration in the florets of the pollen and dust trials, and the bagged control was tested. In 2016 and 2017 both pollen viability and stigma quality were damaged by dust, resulting in a poor crop yield via decreased fruit set, increased parthenocarpy and a lower proportion of split nuts. The stigmatic surface were wilted and distorted following the dust contamination. The papillae cells disappeared in the toxic 1:1 trial. The GA_3 content in flowers of both the pollen and dust treatments was higher than in the non-pollinated flowers, which suggested dust could stimulate the parthenocarpy of pistachio, and therefor nut blanking.
Specified Source(s) of Funding: California Pistachio Research Board

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3:15 PM – 3:45 PM *Jefferson West*

Commercial Horticulture (CHEX) Meeting - Open to All Attendees

Chair: Lewis Jett, *West Virginia University*

Objectives:

To increase ASHS membership and meeting participation of horticultural extension specialists working with industry and/or community groups, to foster communications between such specialists, and to share ideas and methods for working with growers and commodity groups.

3:15 PM – 3:45 PM *Lincoln West*

International Horticultural Consultants (ICON) Meeting - Open to All Attendees

Chair: Russell Galanti, *University of Hawaii at Manoa*

Chair-elect: Roland Ebel, *Autonomous University of the State of Mexico*

Secretary: Louise Ferguson, *University of California, Davis*

Objectives:

To discuss the credentials and accreditation of international consultants and sources of information, backstopping, teamwork, training, experience, and communications necessary for effective employment as an international consultant in either the private or public sector, and to develop a directory of international horticultural consultants in ASHS and their sources of information.

3:15 PM – 3:45 PM *Jefferson East*

Vegetable Breeding (VGBR) Meeting - Open to All Attendees

Chair: Carlos Avila, *Texas A&M AgriLife*

Chair-elect: Geoffrey Meru, *University of Florida-TREC*

Secretary: Subas Malla, *Texas A&M AgriLife Research*

Objectives:

To promote the exchange of information on breeding procedures, screening techniques, and other areas of specific interest to vegetable breeders, to encourage the exchange of germplasm among vegetable breeders, and to maintain current lists of vegetable variety names and descriptions.

4:15 PM – 10:30 PM *T Street Entrance - Terrace Level*

Closing Night Event: Night at the Ball Park - Cincinnati Reds vs. Washington Nationals

See you next year in Las Vegas!

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The Tropicana Las Vegas-A Doubletree by Hilton
Las Vegas, Nevada