Proceedings

Of the

66th New Jersey Annual Vegetable Meeting

Offered Virtually

February 22-25, 2021

Dedicated to and in Memory of:
William J. Roberts
1932-2020
Rutgers Distinguished Professor Emeritus and
Extension Specialist in the Department of Agricultural Engineering

---

Sponsored by,

Vegetable Growers' Association of New Jersey, Inc.

In conjunction with:

Rutgers Cooperative Extension and
The Rutgers New Jersey Agricultural Experiment Station

RUTGERS
New Jersey Agricultural
Experiment Station

William J. Roberts

1932-2020

Rutgers Distinguished Professor Emeritus and
Extension Specialist in the Department of Agricultural Engineering

Bill and Dottie Roberts with their warm and friendly smiles.

William J. Roberts passed away on May 21, 2020 at the age of 88. Bill was born April 7, 1932 on his family's farm in New Monmouth, NJ to the late Thomas S. and Helen (Conover) Roberts. He graduated from Leonardo High School in 1949 and earned his BS and MS degrees in Agricultural Engineering at Rutgers University. After completing ROTC, he served his country from September 1953 to July 1955 in the Far East Command in Japan as a First Lieutenant. He then taught at Cook College (formerly College of Agriculture and Environmental Science), Rutgers University, where he worked as an Extension Specialist in the Department of Agricultural Engineering that later changed its name to Biological and Agricultural Engineering and most recently to Bioresource Engineering. He rose through the ranks, achieving Distinguished Professor status, and served as Department Chair for 23 years. Bill retired from Rutgers in 1999 after a distinguished 41-year career. He left an indelible imprint on all he served. Early in his career, he invented the air-inflated, double-layer polyethylene film system for covering the roof of a greenhouse. Today, approximately 65 percent of all commercial greenhouses in the United States use the air-inflated system. This practical innovation revolutionized the greenhouse industry by enhancing the structural integrity and reducing heat loss compared to a single-layer covering system. In 2004, the site of the original greenhouse at Rutgers University was designated as the 44th National Historic Landmark by the American Society of Agricultural and Biological Engineers. Other notable influences on the agricultural industry included engineering designs for winter, post-harvest storage buildings for winter squash and sweet potatoes. These innovations greatly helped NJ farmers and other producers extend their markets and improve quality of stored crops. Bill received various other honors, including the Distinguished Service in Agriculture Award from the NJ Farm Bureau and the Gold Medallion Award from the NJ Agricultural Society. He was elected as a Fellow by American Society of Agricultural and Biological Engineers in 1983. As a humble man, Bill felt more joy from seeing farmers, students and colleagues succeed than he did in his own personal awards. If you were blessed to know Bill, you already knew this fact. His smile was infectious, and he was a person who brought out the best in others.

Throughout his life, Bill was an active member of New Monmouth Baptist Church and proud to be the great-great-grandson of its founding pastor. Along with his wife, Dottie, he served as a youth leader for twenty years and led a Wednesday night Bible study for over forty years until his death. He taught Sunday School classes and also while in Japan and continued to do so until his death. He will be especially remembered for his warm personality that included many hugs, jokes, and stories. Bill will be greatly missed, and he left the world a better place.

Proceedings Compiled By:

Michelle L. Infante-Casella
Agricultural Agent and Professor
Rutgers Cooperative Extension
Of Gloucester County
Shady Lane County Complex
254 County House Road
Clarksboro, NJ 08020

And

Dr. Wesley L. Kline
Agricultural Agent and Associate Professor
Rutgers Cooperative Extension
Of Cumberland County
291 Morton Avenue
Millville, NJ 08332

Table of Contents

Session 1

Ornamentals/Nursery I

Session Chairs:

Tim Waller / Bill Errickson

Rutgers Cooperative Extension

GROWING MUMS FOR FALL MARKETS

William Errickson
Monmouth County Agricultural Agent
Rutgers Cooperative Extension
4000 Kozloski Road
Freehold, NJ 07728
william.errickson@njaes.rutgers.edu

Garden mums (*Chrysanthemum morifolium*) are members of the Asteraceae family and are a familiar sight for fall markets. There is a wide diversity of mum cultivars available, with each displaying different growth habits, bloom times, and colors. Producing a crop of garden mums can be a profitable and efficient experience when proper growing practices are followed.

Plant Material

Plants that are grown for targeted sales in September and October should be started in the first to fourth week of June. Most mum growers start with rooted cuttings obtained from a reputable supplier. When the plugs are received, they should be inspected for any physical damage, disease, or signs of abiotic stress. Healthy plants should be planted as soon as possible, and short-term storage should not exceed 2 to 3 days in a cooler at 33-40^{o}F or on a greenhouse bench with a minimum temperature of 60^{o}F. The rooted cutting should be kept moist and should never be allowed to dry out.

Containers

Rooted cuttings should be planted directly into their final containers. It is important to provide enough space to produce high quality plants and to reduce disease pressure. 8-inch and 10-inch pots are commonly planted with one plug per pot. Larger pots (12 to 20 inches) can have up to 3 plugs per pot.

Potting Media

A well-drained potting mix that does not dry out too quickly is ideal for growing mums. The mix should be heavy enough that it can support the weight of a fully mature plant, however, not so heavy that it will restrict root growth of newly planted plugs. A soil-based mix should have a pH between 6.0 and 6.5, while a soil-less mix should be between 5.8 and 6.4.

Planting

The growing media should be lightly moistened before planting and plugs should be planted into the pots at the same depth that they were in their cell trays. Newly transplanted plants should be watered in with a 20-10-20 fertilizer at 300 to 400 ppm. Abiotic stress can cause garden mums to prematurely initiate flower buds. If any terminal buds are observed in the early stages of growth, the plants should be pinched back to 4 or 5 leaves when they are fully turgid. Plants that exhibit both terminal and lateral flower buds at this early stage should not be planted and should be discarded, as they will not perform well.

Temperature
Nighttime temperatures should not go below 60ºF, with ideal nighttime temperatures being 65ºF. Cool nighttime temperatures (50ºF) can initiate premature bud formation, so starting plants in a greenhouse is recommended if your area is likely to experience cool temperatures during establishment.

Fertilizer
Plants should be kept well fertilized, starting with a 20-10-20 fertilizer at 300 to 400 ppm from the first day of planting. When the plants start to mature, fertility levels can be reduced, and fertilization is unnecessary once buds begin to show color.

Spacing
Plants can be placed pot to pot at first, until they begin to expand. Pots should be spaced far enough apart so that plant foliage is not touching. Properly spaced 8-inch pots will ultimately be on 18 to 24-inch centers depending on the size of the individual plants.

Irrigation
Automated irrigation is the most efficient method to irrigate mums, with drip tubes or subirrigation being most favorable. Overhead irrigation will result in a greater loss of water and greater potential for foliar diseases. Irrigating early in the day will allow any moisture on the foliage to dry and reduce disease potential. Sufficient moisture should always be supplied, and plants should never be allowed to wilt, especially in the early stages of growth as water stress can lead to the premature development of flower buds.

Pinching
Most modern mum cultivars do not require pinching and have been bred to develop a natural branching pattern. If pinching is to be performed on a crop, the first pinch should occur after the first 1 to 2 inches of top growth, when the roots have just reached the bottom of the pot. Plants can be pinched down to 6 or 7 leaves at this stage. A second pinch is performed after 2.5 to 3 inches of regrowth occurs.

Growth Regulators
Growth regulators are typically not necessary for modern mum cultivars that are grown outdoors in full sun with adequate spacing.

Flowering Times
Natural season fall mums that are started in early summer will be ready in time for fall sales. Specific flowering dates will vary for different cultivars. Early cultivars have an average flowering date between September 8-17. Mid-season cultivars flower September 18-26. Late season cultivars are ready September 27-Octpber 5, and Very Late cultivars produce flowers between October 6 and 20.

Shipping and Retail

During the last 7 to 14 days of production, plants should be irrigated with fresh water to reduce the salt levels in the pots before shipping. It is important to ship mums as quickly as possible under temperatures of 38 to 40ºF. When plants are displayed in a retail setting, they should be maintained at 45 to 60ºF with high light levels and consistent moisture.

Problems

Premature Budding and Flowering

Prolonged cool nighttime temperatures can trigger premature flower bud development. If this occurs, the buds should be pinched off and the plants should be provided with sufficient water and fertilizer. If the buds are removed in a timely manner, there should be no major impacts on the quality of the crop. Photoperiods greater than 12 hours will also result in flower bud initiation.

Drought Stress

Insufficient water can have serious impacts on the production of a high-quality fall mum crop, especially if drought stress is experienced in the early stages of growth. Plants need to maintain vigorous vegetative growth during the early stages and drought stress can result in premature bud development.

Insect Pests

Aphids, mites, several species of caterpillars, leaf miners, and thrips can all impact mum production. Maintaining proper sanitation and monitoring to keep insects below threshold levels is important to minimize losses due to insect damages.

Disease Problems

Pythium root and stem rot, fusarium wilt, bacterial leaf spot, botrytis blight, and Chrysanthemum white rust can cause issues in mum production. Most of these diseases can be prevented by encouraging air flow amongst plants and using well-drained potting media.

Cultivars

Each year, local nurseries conduct trials of garden mums to evaluate the best cultivars for a specific region. Top performers from a 2020 mum trial conducted at Louis Davino Greenhouses in Millstone, NJ are included below. Plants were grown in 8” pots with one plant per pot and were not pinched. Flowering dates are listed below, with grower ship dates recommended 7-10 days before flowering dates.

Top Performing Mum Cultivars for Central NJ: Louis Davino Greenhouses 2020 Trials

Very Early: Before Sept 9

- Sunrise Yellow (Yellow)

Early: Sept 10-18

- Jump White (White)
- Elena Gold (Yellow)
- Debbie Hot Pink (Pink)
- Ursula Lavender (Lavender)
- Misty Lilac Pink (Pink)
- Veronica Dark Pink (Dark Pink)
- Lucky Purple (Purple)
- Danielle Purple (Purple)

Midseason: Sept 19-26

- Chelsey White (White)
- Starburst White (White)
- Celestial White (White)
- Yolanda Yellow (Yellow)
- Chelsey Yellow (Yellow)
- Honeyblush Yellow (Yellow)
- Zinger Yellow (Yellow)
- Chelsey Pink (Pink)
- Carousel Pink (Pink)
- Flamingo Neon Pink (Pink)
- Poppin Purple (Purple)
- Fireglow Bronze (Bronze)
- Zuma Orange (Orange)
- Rhinos Orange (Orange)
- Radiant Red (Red)

Late Season: Sept 27 – Oct 4

- Butter N' Cream (White)
- Sundance Yellow (Yellow)
- Wanda Lavender (Lavender)
- Plumberry Purple (Purple)
- Wicked Purple (Purple)
- Wanda Purple (Purple)
- Copper Coin Brz (Bronze)
- Sunset Orange (Orange)
- Mumosa Orange (Orange)
- Red Ryder (Red)

Early Season Extender: Oct 5 – 12

- Alpine White (White)
- Gold Riot (Yellow)
- Yellow Tang (Yellow)
- Jazzberry Pink (Pink)
- Pomona Violet (Purple)
- Blazing Orange (Orange)
- Mumma Mia Red (Red)

Late Season Extender: Oct 13 +

- Sunny Day (Yellow)
- Avalon Sunny Yellow (Yellow)
- Avalon Salmon (Peach/Coral)
- Avalon Pink (Pink)
- Avalon Purple (Purple)
- Avalon Orange (Orange)

Session 2

Hydroponics/Controlled Environment Systems I

Session Chairs:

Bill Sciarappa, AJ Both, Albert Ayeni
Rutgers Cooperative Extension
And
Rutgers NJAES

HYDROPONIC GROWING SYSTEMS

A.J. Both
Extension Specialist
Rutgers University
Department of Environmental Sciences
14 College Farm Road
New Brunswick, NJ 08901; both@sebs.rutgers.edu

One of the benefits associated with hydroponic production systems is the additional control of the root zone. Typically, an inert growing medium is used to start the seedlings, but after that, the controlled supply of water and nutrients contributes to optimum plant growth and development. There's no soil involved to complicate the growing system. This means there is no buffering capacity for water or nutrients and no soil-borne diseases. Of course, water-borne diseases are still a concern, especially when the nutrient solution is recirculated between irrigation cycles. Having better control over the timing and dosing of water and nutrients gives growers additional tools to grow high quality crops. But this capability comes with added responsibilities: A mistake can have immediate consequences for the crop (e.g., leaf wilting, nutrient deficiencies, nutrient toxicity).

Typical hydroponic growing systems include the nutrient film technique (NFT) system that involves the use of shallow troughs, and the deep flow system (a.k.a. the floating system). In addition, growers use a variety of bag/container culture systems involving soilless growing media and drip irrigation. Sometimes, aeroponics and aquaponics are also included in the list of hydroponic systems. Figure 1 shows sketches of various hydroponic systems.

The NFT system delivers a small quantity of nutrient solution to the crop (often leafy greens and/or culinary herbs) grown in slightly sloped troughs: Water is pumped to the high end of the covered troughs and it flows by gravity to the low end. Some crops do well with a continuous flow, others do better with an intermittent flow. This system works well, but the plants have little water reserves when the pump fails.

The deep flow system uses boards (often cut from Styrofoam™ sheets) that support the plants (often leafy greens and/or culinary herbs), while their roots hang in a volume of nutrient solution that is 8-12 inches deep. The relatively large volume of nutrient solution acts as a buffer in case the heating system malfunctions or the nutrient supply is disrupted. But the nutrient solution needs to be aerated in order to maintain an adequate dissolved oxygen concentration.

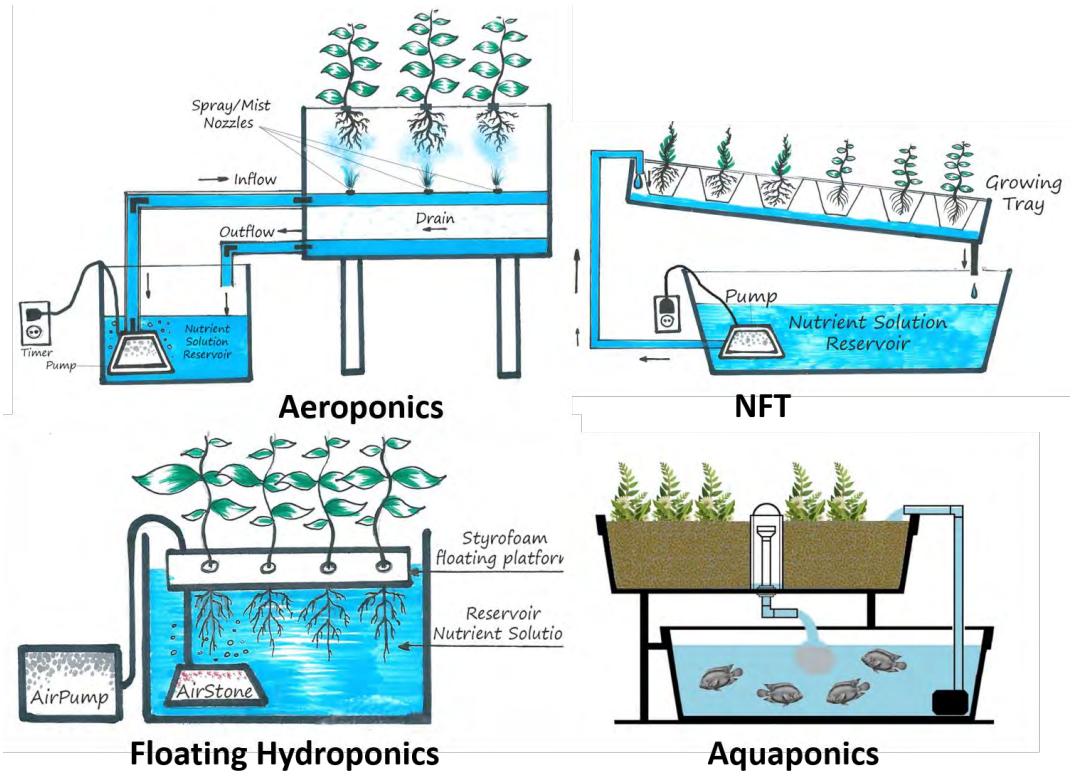


Figure 1. Different types of hydroponic growing systems. NFT = Nutrient film technique. *Images retrieved from various websites.*

The bag/container culture systems use growing media such as mineral wool, coconut coir, expanded perlite or expanded clay particles. These systems are particularly suited for growing vine crops such as tomato, pepper, and cucumber and require a trellis system to support the stems, leaves and fruit.

In aeroponic systems, the plant roots are suspended in air inside a dark enclosure and sprayed periodically with nutrient solution. Spray droplet size is important for good coverage and nozzle openings should not easily clog. While effective, plants grown in this growing system are also quickly affected by pump failures.

Aquaponics systems combine the production of plants with fish cultivation. The advantage of these systems is that the nutrients contained in the fish waste can be used to grow plants, but combining these two production systems also creates significant challenges (e.g., need for nitrification, pH control) and may result in sub-optimum growing conditions for either or both the plant and fish cultivation components. While mentioned in this summary, aquaponics systems will not be further discussed during the presentation.

During the presentation, different hydroponic crop production systems will be reviewed, and their advantages and disadvantages will be discussed.

PRODUCTION AND MARKETING OF HYDROPONICALLY GROWN LEAFY GREENS AT RUTGERS' SCHOOL OF ENVIRONMENTAL AND BIOLOGICAL SCIENCES (SEBS)

Albert Ayeni[1], A.J. Both[2] and William Sciarappa[3]
[1]Plant Biology Dept, [2]Dept of Environmental Science, [3]Dept. of Agric and Resource Management Agents
Rutgers' School of Environmental and Biological Sciences
New Brunswick, NJ 08901
Contact: aayeni@sebs.rutgers.edu; 848-932-6289

Why Hydroponics at Rutgers University? New Jersey has the highest population density (average1195 people per sq mile) in the United States; the only state in the Union with every county considered urban (≥400 people per sq mile, US Census Bureau 2010). Available land area for field crop production is limited. Communities are becoming more interested in locally produced food for good nutrition, biosafety and health reasons. We must develop other more space-efficient agricultural technologies to produce locally to meet the needs of our communities. Rutgers University's SEBS/NJAES with Land Grant responsibilities has a unique opportunity to research and develop novel growing systems that will ensure the necessary supply of fresh and locally grown produce throughout the state. Hydroponic and aeroponic crop production systems offer promising and exciting opportunities and can increase the number of high paying job opportunities that are necessary to attract the next generation of farmers. These crop production systems also offer excellent teaching, research and outreach opportunities.

What is Hydroponics/Aeroponics/Geoponics? Hydroponics refers to growing plants in a soilless medium, usually done in a controlled environment. The plant root system derives the essential nutrients directly from water solution in liquid (hydroponic) or vapor (aeroponic) form. Geoponic is the culture of plants in a "soil" medium, usually in a controlled environment.

Hydroponics at Rutgers' SEBS: Started in November 2016 as part of a bigger initiative called the Indoor Cultivation initiative or Controlled Environment Agriculture (CEA)

Mission: To provide experiential learning opportunities for SEBS students involving several indoor cultivation systems, including the geoponic and hydroponic (soilless) plant production systems. The initiative also provided an opportunity to showcase indoor plant production systems to a wider audience. Research collaborations with SEBS and other researchers were also promoted through this initiative.

Production of Leafy Greens: Four production systems shown in Figure 1 were compared in the New Jersey Ag Experiment Station greenhouse on Cook Campus in

New Brunswick, namely: Geoponic, 4-ft tall Mini & Vine Column pods (Vertical hydroponics), 8-ft tall Octagonal pods (Vertical hydroponics) and Nutrient Film Technique (NFT) (horizontal hydroponics) platform.

- Geoponic system: Leafy greens were grown in 8-inch pots using potting mix (Pro-Mix by Premier Tech Ltd., Canada), watered with trickle lines and fertilized twice using NPK 20-20-20 solution (0.5-1oz/gal).
- Hydroponic systems: Leafy greens were grown in rockwool, which served as the medium for holding the plant in place and intercepting water/nutrient solution for plant growth.

Leafy greens were nurtured for 5-6 weeks in the production systems and harvested. A combination of Jack's Professional Hydroponic NPK 15-0-0 (480g/gal) and NPK 5-12-26 (510 g/gal) were the nutrient sources. pH and nutrient strength of the water solution based on electrical conductivity (EC) measurement were monitored using the "Blue Lab Combo plus" meter. Optimum pH for the leafy greens was 5.8-6.2, while the optimum EC was 1.8-2.0 umhos/cm. The geoponic and hydroponic systems were monitored regularly to ensure normal functioning. The source of light was high pressure sodium (HPS) at 14hr light/24-hr cycle

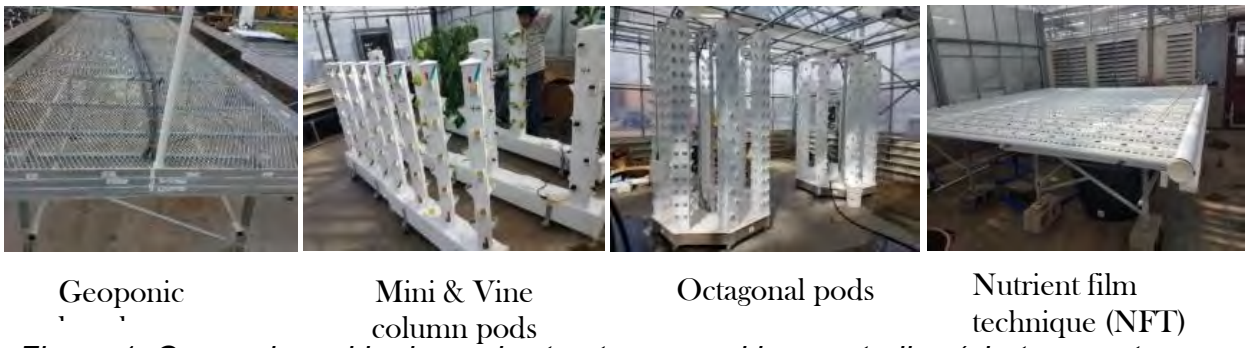


Figure 1. Geoponic and hydroponic structures used in our studies (photos courtesy Albert Ayeni)

Growth of leafy greens in the geoponic and hydroponic systems: Figure 2 shows the growth characteristics of Rutgers Scarlet Lettuce (RSL) in the four growing systems we compared.

Figure 2. The growth of Rutgers Scarlet Lettuce (RSL) in geoponic and hydroponic systems at Rutgers' SEBS (photos taken 5-6 weeks after sowing) Courtesy Albert Ayeni

Rutgers scarlet lettuce grew vigorously in all the growth systems with the NFT and the mini pod systems showing superior growth compared to the geoponic and octagonal pod systems (Table 1). In another study, Premier kale was compared among the four systems. NFT also gave the best result followed by the mini pod, octagonal pod and geoponic in that order (Table 1). In general, the NFT gave the best results followed by the mini pod. Both systems were superior in growth per plant to the octagonal and geoponic growing systems. Even though these systems seem superior on weight per plant, the octagonal pod gave the highest yield per unit area due to the high production capacity of the 8-ft tower.

Table 1. Comparative growth of Rutgers Scarlet Lettuce (RSL) and Premier kale in geoponic and hydroponic systems. Data show the weight (lb) of 10 randomly harvested plants six weeks after sowing

Growing system	RSL	Premier kale
Geoponic	7.3	3.3
Mini pod	12.7	5.6
Octagonal pod	8.9	4.2
NFT	14.9	8.6

Light impact on the growth of leafy green: Light significantly influenced leafy green growth on the octagonal tower growing system. As shown in Figure 3, bibb lettuce plants at the top of the tower produced more than twice the yield of plants in the middle or at the bottom of the tower.

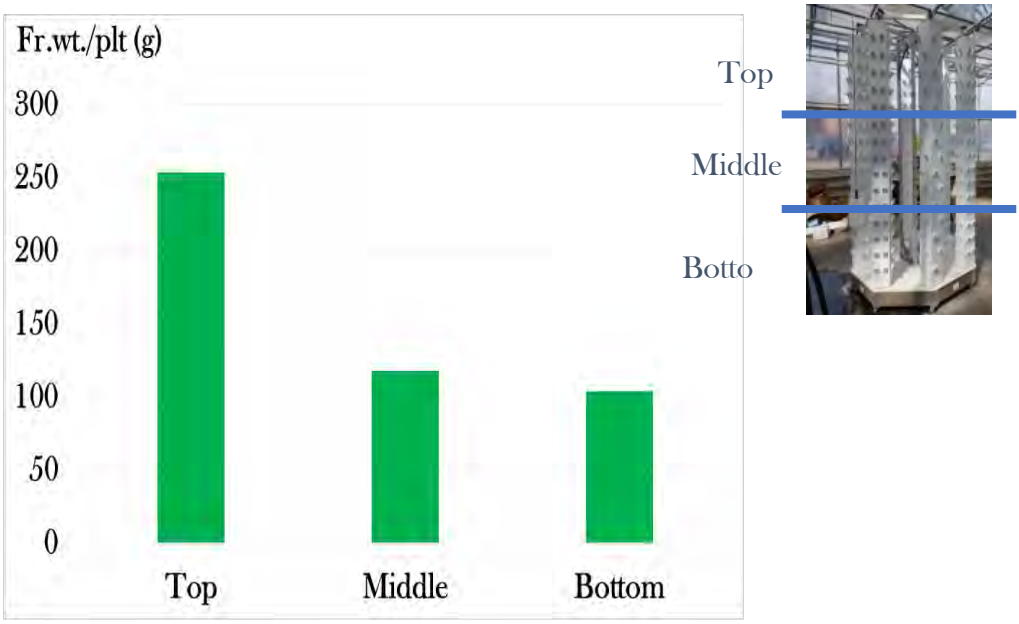


Figure 3. Bibb lettuce growth on the Octagonal pod 5 weeks

It was also observed that the column located near the light source yielded more than those further from the source. No light impact was observed in the NFT (horizontal hydroponic) system as all plants seem to have equal access to light. These observations suggest that strategic lighting is required to increase the production capacity of octagonal/vertical pods.

Marketing of Leafy Greens: Based on understanding reached prior to vegetable production, all our leafy greens in this initiative were purchased by Rutgers Dining Services at ongoing market rates. Since our deliveries were same day, packaging was by boxing as soon as harvesting was done followed by delivery. When there were unexpected delays, harvested vegetables were kept in cold room at 45-50^{o}F and delivered as soon as possible. The economics of production were being studied and inconclusive at this time.

Acknowledgements: We are indebted to SEBS Administration for providing the funds to get this project started. We also thank the Departments of Plant Biology and Environmental Sciences for supporting the project financially. Our private sector partner AERO Development Corp and the Rutgers Dining Services provided great support for this initiative. Finally, several SEBS interns and student workers helped us immensely to manage the project and we acknowledge their contributions.

MARKETING TOOLS FOR SMALL BUSINESS

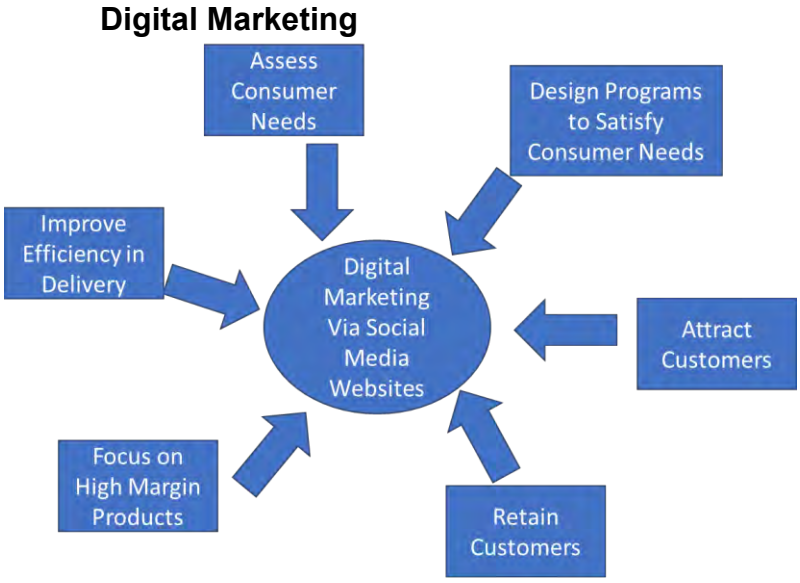
Ramu Govindasamy
Professor and Chair
Department of Agricultural, Food and Resource Economics
55 Dudley Road,
New Brunswick, NJ 08901-8520
govind@sebs.rutgers.edu

Surendran Arumugam
Research Associate
Center for Agricultural and Rural Development Studies
Tamil Nadu Agricultural University
Coimbatore, Tamil Nadu, India
Suren.tnau@gmail.com

Robin Brumfield
Professor and Specialist in Farm Management
Department of Agricultural, Food and Resource Economics
55 Dudley Road
New Brunswick, NJ 08901-8520
brumfiel@njaes.rutgers.edu

Marketing has evolved with the increase in industrialization. The growing importance of product differentiation has shifted the focus from the product to the customer. During the early eighteenth century, marketing was focused on the wealthy with very little concern for the average consumer. There was fierce competition to get the attention of wealthy consumers through advertising. During the early to mid-nineteenth century sales era, one must have a superior product and need to convince the customer of its superiority so they would buy it. This traditional method of marketing consists of developing an idea, conducting market research, formulating a product, testing marketing, and placing the product in the market. Since the mid-nineteenth century, business enterprises first document the needs of the consumers and then find a way to satisfy them. During this era, advertising directed at consumers played a major role. Since the late nineteenth century, business enterprises have moved toward customer relationship marketing in a digital environment.

The digital marketing environment is changing rapidly, and, for micro-enterprises, digital marketing is currently a vitally important opportunity. Digital marketing creates opportunities to develop successful businesses in a way that previously was not possible for small enterprises and is becoming an increasingly important source of competitive advantage in both business-to-business and business-to-consumer markets. Attracting customers, engaging customers' interest and participation, retaining customers, learning customers' preferences, and relating to customers are key strategies in building strong customer relationships.



In the digital marketing era, like any other marketing era, assessment of consumer needs is the first step. We live in a demand-driven world where the consumer's wants, and need are the drivers. Once the consumer's wants and needs are assessed, business enterprises must design programs to satisfy them. Ultimately, the products and services offered by the business enterprise should attract consumers to their venue or brand in the case of wholesale business enterprises. In most enterprises, 80% of the revenue is generated by 20% of repeat customers. Therefore, offer businesses should try to offer incentives to retain customers. Even when you have a large customer base, your margin depends on the products and services. In the case of agricultural products, value addition enhances the margin to the producers. Once the need is assessed, the right products are offered, and customers keep coming back, business enterprises have an opportunity to assess the entire process through a bird's eye view and improve efficiency in the process. This is very true for general marketing as well as agricultural enterprises.

One of the ways to improve your marketing margin is through direct marketing. The term direct marketing is often used in conjunction with other marketing phrases such as database marketing, loyalty marketing, retention marketing, one-to-one marketing, relationship marketing, customer relationship management, interactive marketing, responsive marketing, digital marketing, and micro-marketing. These terms and techniques are part and parcel of the agricultural direct marketing operations. Instead of paying brokers, packers, and shippers to market their produce, the direct marketing technique allows producers to sell directly to consumers. Recent studies from the Economic Research Service estimates suggest that only 19 cents of the consumer dollar go to the farmer, with the balance going to packaging, marketing, transporting, and other services needed to bring farm products to the consumer. Some of the benefits

of direct marketing include a higher marketing margin, cash sales, immediate payment, and more control over the prices. Also, most producers value their relationship with the consumer and appreciate the immediate feedback on their products and services from them. Consumers value fresh and high quality produce at a reasonable price from direct marketers. Consumers get greater satisfaction by supporting a local enterprise, thus enhancing the local economy. Over the years, fewer and fewer people live on or visited a farm. By introducing a value-added food component to a recreational component, direct marketing draws urban consumers to rural settings where they experience a serene environment, possibly enjoy an outing with their family, and spend extra money on food, specialty items, and other services. This supports local communities. This is a win-win marketing strategy for both the producer and the consumer. Some of the limitations to the producer include zoning restrictions, insurance liabilities, marketing infrastructure costs, and increased labor costs. Farmers engaged in direct marketing need to pay attention to other infrastructure such as parking, washrooms, regulations, etc. Many direct marketing options are available to producers. The primary direct marketing opportunities are pick-your-own (PYO), farmers markets, community-supported agriculture (CSA), direct farm market, and roadside stands. Other related activities such as agritourism, e-commerce, and direct sales to restaurants also fit into this category.

Direct-market farmers face closures of farmers markets, restaurants, and other in-person sales outlets due to COVID-19. What options can replace these important markets? “Online Sales Platforms” provides a great opportunity for farmers during these challenging times. Buyers are looking for quality, nutritious food, without standing in the long queues and meeting the social distancing guidelines. Due to the nature of online shopping, ultimately, a good brand gives peace of mind to the consumers about the quality of the products. Most of the online platforms operate similarly. Farmers set up an online “store” with their products and prices listed. Consumers visit the website, select products, fill their “cart,” check out, the drive to the farm or pickup location to pickup their order; or, alternatively, have it delivered. The platforms are designed to make it easy for customers to navigate and choose healthy, locally grown food. And they want to give farmers tools to manage inventory, customer communications, sales, and delivery options. More than 90% of the consumers would like to buy local and the food online sales surged ten times in the recent past due to its convenience and safety factor during these COVID-19 times. Most purchases (more than 65%) happen on the mobile platform and therefore, these platforms need to be integrated across all devices. They can generate a collection list based on orders, and packing labels, and delivery route map for drivers.

Producers will have the option to offer the products individually or as a bundle. In terms of units of sale, there is an option to choose as a bag, bunch, head, box, or bundle. Prices can be fixed based on unit or weight. All orders, including the pre-order can be offered in a secured environment before fulfillment. If time permits, harvest can be coordinated with live orders. Producers will have the option to collect the payment

upfront or on delivery. These platforms do take up a lot of time to manage, they can be expensive, and farmers need to be prepared to invest. It may be beneficial for some farmers to explore those partnership opportunities. Many portals have alternative pricing options for retail, wholesale, and private buying groups. Depending on the groups, fulfillment options will vary. Buyers love local food, but they love convenience more. These online platforms make it easy to offer your Farm-fresh produce for sale online with convenient delivery, pickup, or shipping to help you increase sales, access more customers, and save time.

Online Platform Comparison Chart for Aggregated Sales

	Red Market	Local Orbit	Farmers Web	Local Food Marketplace	Barn To Door	Locally Grown	What's Good	GrazeCart
Overall:	★★	★★★	★★	★★★	★★	★★	★★	★★
Start up cost:	Depends on geographic /aggregation	0	0	$999+	$199-$399 /Farm	0	0	$35 annual fee for domain
Pricing (monthly) per market unless otherwise specified:	0	$70/month to start	$75/month	$149/month	$29-99/month per farm	3%	1.5% wholesale 2.85% retail	$199/month
Ease of use/ Comprehensiveness:	★★★	★★★	★★★	★★★	★★	★★	★★★	★★★
Integrated Payment Processors:	✓	✓	✓	✓	✓	✓	✓	✓
Customer Service:	★★	★★	★★★	★★★	★★★	★	★★★	★★★
Shopping Cart:	✓	✓	✓	✓	✓	✓	✓	✓
Mobile Friendly:	★★	★★★	★★★	★★★	★★★	★★	★★★	★★★
Design/Appearance:	★★	★★★	★★★	★★★	★★	★	★★★	★★★
Aggregation Capable:	Yes, but will see all farms on platform	YES! Each farm logs in separately.	Single Admin Single user entering all data	YES! Each farm logs in	Will develop for us	Yes	Will develop for us	Developing *can now w/multiple admin
Transaction Fees:	7%	2.9% +0.30/order	3.5% +0.30/order	Authorize.net	3.5%	2.9% +0.30/order	3%	2.9% +0.30/order
Pricing Variations:	No	✓	✓	✓	✓	✓	✓	✓
Terms available:	No	✓	✓	✓	✓	✓	✓	✓
1 payment/split invoices:	✓	✓	✓	✓	✓	✓	No	✓
Minimum order Or Delivery Fee?	No	✓	✓	✓	✓		✓	✓
Delivery Options:	✓	✓	✓	✓	✓	✓	✓	✓
Experience:	★	★★★	★★★	★★★	★★	★★★	★★★	★★★
Searchability:	★★	★★★	★★★	★★★	★★★	★★★	★★★	★★★

Data compiled by Lake Pepin Local Food Group
Paid for by North Central SARE Farmer Rancher Grant

March 2018

FOOD SAFETY 101 IN HYDROPONIC OPERATIONS: MARKET ACCESS AND FEDERAL COMPLIANCE

Meredith Melendez
Agricultural Agent
Rutgers Cooperative Extension
1440 Parkside Avenue
Ewing, NJ 08648
melendez@njaes.rutgers.edu
https://onfarmfoodsafety.rutgers.edu

The fresh produce industry is under increased pressure to improve their food safety practices, including greenhouse producers. Historically food safety has been market access driven through buyer required third party audits. The Food Safety Modernization Act Produce Safety Rule (FSMA PSR), which went into effect for the largest of farms on January 26, 2018, making food safety regulatory for fresh produce growers. This rule is the result of large-scale human pathogen outbreaks associated with produce typically consumed raw.

While these outbreaks are commonly associated with large scale wholesale production, farms of all sizes and distribution types are affected by the FSMA PSR. Greenhouse produce growers use production practices that are impacted by the regulation and should understand how the regulation affects their farm. Growers of produce typically consumed raw who sell more than $25,000 worth of produce need to comply with some or all of provisions of this federal regulation depending on their sales method. Those selling primarily through wholesale channels will need to comply with the entire rule. Those selling primarily through direct market channels will be qualified exempt provided they sell less than $500,000 of food, both human and animal, on average each year. Some New Jersey greenhouse farms producing fresh produce will be exempt from the FSMA PSR regulation, others needed to comply as of January 2018, and for others it will only be a matter of time before their sales exceed the exemption threshold as their operations grow.

An increasing number of fresh produce buyers, typically retail marketers, require producers to comply with a third-party audit to purchase their produce. Third party audits are separate from the FSMA PSR and passing a FSMA PSR inspection will not replace the need for an audit. Passing a third-party audit will not replace the need for a FSMA PSR inspection. Farms know if they need to comply with a third-party audit based on their conversations with buyers of their produce. Buyers should provide the farm with information including which audit firm they want the grower to use, what produce commodities they expect to have the audit for, and when they require the passed audit certificate by. For a farm to request a third-party audit they need to attend approved food safety educational training, have a written food safety plan specific to their operation and audit standards, and have at least seven days of the records their plan indicates they keep. The farm calls the auditing firm to schedule the audit, and once the audit is passed and the invoice for the audit is paid, they will then receive the

certificate needed to show they passed the required audit. Typically, buyers require this certificate annually to make purchases from individual farms.

The Rutgers On-Farm Food Safety team provides farm walk throughs to help producers prepare for a FSMA PSR inspection and mock-audits. To assist growers with the educational requirement for FSMA and third-party audits we offer full day certificate based educational workshops annually. On-Farm Readiness Reviews are provided by trained Extension and NJDA staff to assess preparedness for a FSMA PSR inspection.

The most common areas of improvement noticed when conducting mock-audits and OFRRs in greenhouse operations are rodent controls, worker training, and the handling, cleaning, and sanitizing of product contact surfaces. Resources for produce growers can be found on the Rutgers On-Farm Food Safety Teams webpage Rutgers On-Farm Food Safety

Session 3

Know Your Numbers, Know Your Options I

Session Chair:

Robin Brumfield

Rutgers NJAES

KNOW YOUR NUMBERS, KNOW YOUR OPTİONS

Robin G. Brumfield, Ph.D.
Professor and Specialist in Farm Management
Department of Agricultural, Food and Resource Economics
55 Dudley Road
New Brunswick, NJ 08901-8520
brumfiel@njaes.rutgers.edu
http://farmmgmt.rutgers.edu/

Financial analysis and planning is an important part of describing the business to someone else. Financial projections give some indication of where the business is headed in the next few years and describe the financial ramifications of changes that are implemented in the future. It helps the business evaluate alternative business investments. The financial section should also describe the assumptions used in making financial projections. These assumptions might include projected prices that will be received in the future, input costs, or production levels. These projections should be kept and compared against actual business performance. When developing and analyzing financial documents, it is important to work with an accountant who is familiar with the farming industry.

Financial Projections

- The **income statement** documents profitability over a set period of time and compares budgeted versus actual income and expenses.
- The **balance sheet** presents the company's financial position including assets, liabilities, and net worth.
- The **cash flow statement** indicates how much to borrow and when.
- **Financial ratio analysis** compare the projections with industry norms and establish return-on-investment requirements.
- **Benchmarks** are used to monitor and evaluate progress in meeting established goals.

Building Financial Resilience During Tough Times

People – Employees and Customers, are the most important part of your business, and taking care of people during this crisis is key. Cornell University's Small Farms Program has established a resource page to support the farming community during this crisis (https://smallfarms.cornell.edu/resources/farm-resilience/). You can't be there for your employees and customers unless you take care of yourself. Here are some tips from Cornell's farm resilience website on how to care for yourself:

- Take care of your farm's most important asset: **you**. Wash your hands more frequently and make sure you are getting adequate sleep. We need our strength these days.

- Don’t think social distancing means social isolation. We are being asked to practice social distancing to slow the spread of the virus, but we have many ways to keep and grow our connections with each other. Call someone. Stay connected to those around you. Ask for help. Offer help. We are in this together.
- Reach out to farmers and community members around you that you know are having challenges. Now is the time to strengthen the fabric of our own communities by increasing our social connections. Pick up the phone and call them. It is that simple.
- Release stress. In times of stress, it helps to take a pause and slow down. Do what works for you, such as:
    - Laugh, pray, dance, meditate, chat with friends.
    - Practice tactical breathing. Inhale, count to five, and then exhale slowly to help clear your head and steady your hands.
- Intensify your production plans, if you can. In the face of possible shifts in our global food system, eating locally will be an important strategy to respond to potential disruptions.
- Bring extra farm product to food banks, or work with gleaning organizations. We have always had people in need in our communities, but this pandemic could make things worse for those most vulnerable. As a producer, you have the ability to help ease some of that suffering.
- Revisit your farm’s food safety plan, especially the health and personal hygiene plan. Keep yourself and your employees in good health.
- Make a plan for running your farm if you, your family or employees get sick. Consider the scenarios of 10, 50 or 75% of farm labor out sick for 2 weeks and try to be realistic. Involve the whole farm team in this conversation. Reach out to neighbors or other farm friends who might be able to help. Here are some questions to consider:
    - What farm operations must go on? What would be cascades or ripple effects if that activity stopped? Who would be responsible, and what happens if they are not available?
    - What operations or activities could be put on hold?
    - How can we cross-train our team now to better cover our bases and be more resilient?
    - Who is willing to pitch in and help if you are out of commission for two weeks? Anyone off the farm you could call upon?
    - Could you step up to help a neighbor?

- Prepare for market changes. We are already seeing impacts of this pandemic on wholesale and direct markets and getting calls from farmers who are concerned. Customers may shy away where there are crowds. What creative solutions could help address these concerns and keep customers connected to our locally-grown food?

As farmers and gardeners, we have tremendous biological wealth. While we may not always have cash, we have access to soil, plants and animals that are the foundation of life. We can share that wealth and help lead our communities through this time of struggle. In New Jersey, reach out to your local county agent. We R here when you need us.

Constructing and Interpreting a Balance Sheet

A balance sheet indicates the amount of equity the owner has in the business and the structure of assets and liabilities. It shows how funds are invested in the business (assets) and the financing methods used (liabilities and owner's equity). Unlike the income statement, which represents a period of time, the balance sheet represents a single moment in time. It is used to help understand the business's financial situation, especially solvency or net worth.

Net worth indicates the equity position of the business (assets minus liabilities). Net worth is important in evaluating the risk position of the business and in considering future borrowing capacity. Net worth growth is usually one of the major goals of a business.

A balance sheet is included in the business plan if the plan is being developed to be shown to lenders, potential investors, or partners. A balance sheet will probably not be included in the plan if it is being developed to communicate the direction of the business to those employees to whom the owner wishes not to disclose the entire financial situation.

Mrs Greenjeans Greenhouse Balance Sheet

Assets

Current Assets	
Cash on hand	$10,000
Accounts receivable	-
Plant inventory	$50,000
Supply inventory	$20,000
Total Current Assets	$80,000
Long-Term Assets	
Machinery/equipment	$75,000
Buildings/fixtures	$200,000
Land	$100,000
Total Long-Term Assets	$375,000
Total Assets	$455,000

Liabilities

Current Liabilities	
Accounts payable	$10,000
Short-term notes	$7,000
Taxes	$2,800
Total Current Liabilities	$19,000
Long-Term Liabilities	
Mortgage	$175,000
Long-Term Notes	$25,000
Total Long-Term Liabilities	$200,000
Total Liabilities	$219,000
Net Worth	$235,200

Managing Risks Using 3 Key Ratios from Your Balance Sheet

One method of assessing the financial health of a business is using financial ratios. Ratios are calculated using numbers from the balance sheet and income statement. Let's look at 3 of them.

- Working capital should be positive and stable.
  - Total current assets - Total current liabilities
  - Approximates the amount of funds available from within the business to purchase crop inputs and equipment necessary to produce products. In general, a lot of working capital = more success since you can expand and improve operations.
- Debt to asset ratio should be less than 30%
  - Total liabilities / Total assets
  - Measures the percentage of the total assets to which creditors have claims. Measures financial risk with debt financing. If 0, the business is out of debt.
- Net Worth should be positive and stable or increasing.
  - Total assets - Total liabilities
  - Approximates the amount of assets owned by the business.

What the the ratios tell you – Risk management techniques

- Trend directions
- Lines of credit
- Restructuring debt
- Bankruptcy
- Communicating goals and plans

Income Statement: Measuring Profitability

An *income statement* (also called profit and loss statement, P&L statement, or operating statement) documents the firm's profitability. Profitability is the measure of how much income the business is making in relation to the resources used to produce

that income. Net income is one measure used to quantify profitability and us calculated as revenue minus expenses, including depreciation. Profitability should usually be the major factor considered when making most financial decisions. Over time, profits generally drive the solvency and liquidity of a business.

The costs incurred in the farm business can be grouped into two categories: variable costs and overhead costs. *Variable costs* are costs that vary with the level of production. Examples of variable costs are the costs of seeds and fertilizer; both relate specifically to the level of production. *Overhead* or *fixed costs* are those costs that are incurred regardless of the level of production and are common to all crops. These costs include depreciation of the farm structures, equipment, and other facilities and costs such as interest, repairs, insurance, taxes, and salaries of overhead personnel (i.e., the manager, salespeople, growers, secretaries, bookkeepers, etc.). The total cost of production is the sum of variable and overhead costs.

Some tips for income statements:

- Do not assume that you will sell 100% of the crops produced.
- Don't forget to pay yourself. This is frequently overlooked when starting out because money is tight. However, the first few years of being in business often are not profitable, and the owner needs some source of income. It is recommended to pay yourself based on what you could make if you were paying someone else to operate this business.
- Don't forget to budget for retirement. At some point, the owner will no longer want to or be able to continue to operate the business. As with any other retirement plan, start saving as early as possible.
- Owners also need health insurance, and should consider disability insurance in case an injury prevents you from working, as well as life insurance if others are depending on your income.
- If you lack skills in certain areas, budget to hire consultants so that all jobs are done right. Examples include accountants, lawyers, bookkeepers, marketing specialists, and horticulturalists. Look for professionals who have had experience with the farming industry.

The simpilist income statement is:

Sales

- Direct Costs - Easily allocated to each crop

- Overhead Costs – Occur no matter what crop is produced

Net Profit or Loss

Projected Income Statement for Mrs. Greenjeans Greenhouse

	Year 1 ($)	Year 2 ($)	Year 3 ($)	Year 4 ($)	Year 5 ($)
Income					
Sales	240,750	258,900	270,350	289,650	312,925
Expenses					
Labor	85,000	98,000	104,000	118,000	130,000
Heating	10,000	11,000	12,000	13,000	14,000
Materials	76,300	77,000	78,000	79,000	80,000
Rent and depreciation	16,000	16,500	17,000	17,500	18,000
General maintenance	3,000	3,500	4,000	4,500	5,000
Insurance	2,000	2,100	2,200	2,300	2,400
Office expenses	1,000	1,100	1,200	1,300	1,400
Auto and truck expense	1,000	1,000	1,100	1,200	1,300
Interest	5,000	5,100	5,200	5,300	5,400
Advertising	74,255	85,764	99,058	114,412	132,146
Freight and trucking	5,000	5,000	5,000	5,000	5,000
Bad debt	69,255	80,764	94,058	109,412	127,146
Taxes	17,314	20,191	23,514	27,353	31,786
Meetings/conventions	1,000	1,100	1,200	1,300	1,400
Professional fees	800	900	1,000	1,100	1,200
Dues and subscriptions	200	250	300	350	400
Total expenses	$222,900	$239,750	$250,600	$268,950	$285,300
Net Income	**$17,850**	**$19,150**	**$19,750**	**$20,700**	**$27,625**

Session 4

Ornamentals/Nursery II

Session Chairs:

Tim Waller / Bill Errickson

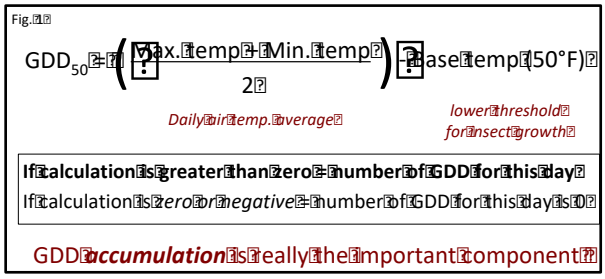
Rutgers Cooperative Extension

USING GROWING DEGREE-DAY MODELS TO PREPARE FOR THE FUTURE

Timothy James Waller, Ph.D.
Cumberland County Agricultural Agent
Rutgers Cooperative Extensionfor t
291 Morton Avenue
Millville, NJ 08332
twaller@njaes.rutgers.edu
https://njaes.rutgers.edu/nursery/

Summary: The use of growing degree-day models (GDD_{50}) and other pest or disease predictive systems will be discussed as they relate to preparations for upcoming seasons in agriculture. The use of these models in combination with site-specific scouting and climatic knowledge is critical to sustainable, economical, and environmental approaches to IPM. Examples of currently available models will be introduced and participants will be guided through a virtual tour of these valuable tools in an effort to showcase their real world application when preparing for pest and disease management.

What are degree-day models?



Timing is everything in pest management! Degree-day models allow us to predict when pest management strategies will be most effective by utilizing accumulated heating units that correlate to key developmental (and often vulnerable) life stages specific to individual pests. These can include egg hatch, emergence, crawler activity, and adult flight as well as when weed species are emerging or host plants are going into bud swell or flowering (useful for preventative plant disease management strategies). These models also track beneficial insect development, thus protecting our IPM investments ($$).

Degree-day models can be hyper specific to individual pests; however, utilizing the more generalized **growing degree-day (GDD_{50})** model allows us to approximate a wide variety of pests with one simple and easy to use tool. A growing degree-day model records the maximum and minimum temperatures over a 24-hour period, which are added together and divided by 2, then subtracted by a **base-temperature of 50°F** (lower temp. threshold for the growth of many insects and plants) (Fig.1). These are the accumulated degree-day units for 1 day, however, the accumulation of these units from a start date, such as March 1st in the Northeast (aka. Biofix Date) provides the real information needed to make predictions and understand the development of key pests. For example bagworms emerge between 600-900 GDD_{50}. This value is far greater than could be accumulated in a single 24h period; rather 600 GDD_{50} is reached late spring or early summer in New Jersey. **Luckily, we do not need to manually enter or track this data due to the availability of FREE online modeling tools.**

Where do I find growing degree-day and other predictive models?

USPEST (https://uspest.org/dd/model_app). USPEST.org contains a wide variety of degree-day, climatic, and risk-based modeling tools for various applications in agriculture. This resource also has a number of important disease predictive tools such as the **Boxwood Blight Risk Model**. The growing degree-day model (web address above) allows for day-to-day monitoring as well as historical and predictive data. The following directions seem complicated but after a few attempts, it is easy to be proficient with this incredibly powerful modeling system. *Remember **BASE TEMP MUST = 50°F** (for all models to be considered a 'growing' degree-day model)*

USPEST specific instructions: **Station Tab**; enter area code (locate weather station closest to operation or worksite). **Model Tab;** Model Category = all models ; Model = degree-day calculator (general purpose) ; Calculation Method = simple average/growing dds ; ***Lower = 50***, **Higher = 95**. Once this material is selected for the date ranges you wish to view, select the **Output Tab**; then select boxes such as "show full table" for individual dates if desired (note: monthly accumulation is the default).

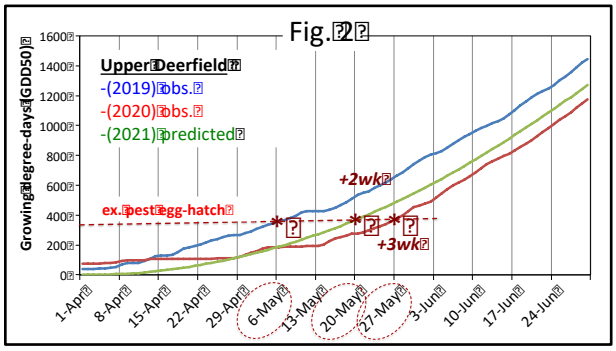
NEWA (http://newa.cornell.edu/index.php?page=growing-degree-days). Cornell University in cooperation with twenty-eight other groups and universities coordinate NEWA. NEWA contains a wide variety of degree-day, climatic, and risk-based modeling tools for various applications in specific crop systems. This resource also has a number of very useful predictive tools for **fruit, row, and vegetable diseases** in addition to growing degree-day information. Does not feature future dates for degree-days, however historical data can help understanding missed pest management opportunities.

NEWA Specific Instructions: **State** = select ; **Weather Station** = find in list or locate with map. **Degree-day type** = Degree Days – ***Base 50***. Select appropriate Month –Year, press **Get Report**.

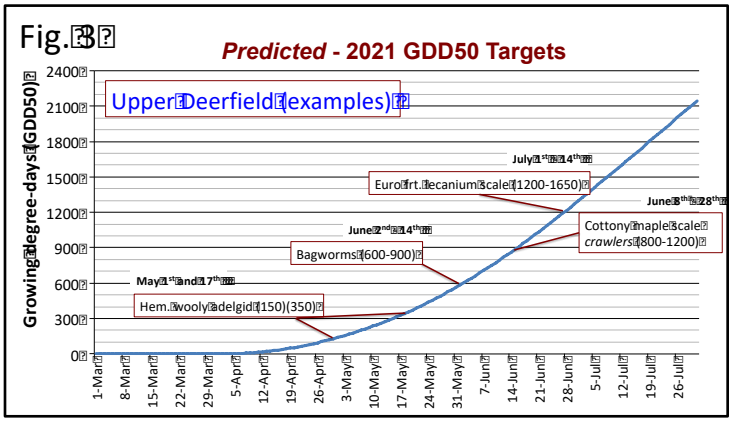
Historical and future predictions: The site-specific tables and graphs available through the two example growing degree-day model systems can help when trying to understand a variety of economically important pest related factors.

Historical data: The following example will be based around the information available when using the USPEST platform. Once a location has been selected, the dates can be modified in the **Model Tab** to provide historical data in both table and graphical formats, thus allowing growing degree-day progression as it relates to climate factors such as a very cold (or warm) spring or periods of extremely high heat across multiple years, to be visualized. For example 2020 (in Upper Deerfield, NJ (NJ50)) was a cooler year than 2018 and 2019, which could have shifted the efficacy of pesticide applications if one was only following a calendar-based spray program. If a pest was treated for, but not controlled the historical data provides an opportunity to delve it what possibly went wrong; was the pest not in a vulnerable life stage (such as scale crawler or larval activity)? Did the application go on too late or too early? In both cases, the historical data can help in future decision making whether that be scouting or application timing.

Predictive data: This example is again based around the USPEST platform. Once a location has been selected, the dates can be modified in the **Model Tab** to provide predicative data in both table and graphical formats, as they relate to previous years. However, it is important to note that these are only predictions and scouting is imperative to proper in-field correlations. Yet, these predictions allow producers to know when certain pests should be scouted for or managed, thus allowing ample time to acquire the materials or resources needed to do so (*instead of waiting for compounds when they are really needed = $$ savings*). In the predictions for Upper Deerfield, 2021 will be a bit warmer than 2021. However, by focusing in on regularly important pest management months (April-July) producers can further refine the resolution of their anticipated management requirements (Fig. 2), once the growing degree-day targets have been identified for their pests (Fig. 3, below).



Resources for pest specific growing degree-day targets: The following list (*many others*) of online resources provides target dates of specific pests' vulnerable life stages or notable activities such as adult flights (focused around ornamental and landscape). Combining these two ideas; once the table or graphical predictions are obtained, the targeted growing degree-days for important pests can be mapped for any given location. **Thus, growing degree-days *<u>are now</u>* defined within a calendar-based system.**



1. Rutgers Plant and Pest Advisory: https://plant-pest-advisory.rutgers.edu/
2. Unv. Maryland Pest Predictive Calendar *(Great resource):* https://extension.umd.edu/ipm/pest-predictive-calendar-landscapenursery
3. Ohio State: http://cues.cfans.umn.edu/old/Web/049DegreeDays.pdf
4. University of New Hampshire: http://ccetompkins.org/resources/using-growing-degree-days-for-insect-management
5. University of California: http://ipm.ucanr.edu/MODELS/index.html

However, it is important to note: there is considerable variation of growing degree-day target dates between resources. It is **<u>IMPERATIVE to keep site-specific scouting records</u>** for key pests in all production areas. Additionally, the predictive dates are not set in stone and can fluctuate throughout the season based on unpredictable climatic factors. Remember, degree-days are completely tied to the climate of a location.

APHIDS - BIOCONTROL IN GREENHOUSE, HIGH TUNNELS AND MICRO GREEN PRODUCTION SYSTEMS

Stanton Gill
Extension Specialist in IPM and Entomology
University of Maryland Extension, CMREC
And Professor, Montgomery College - Landscape Technology Program
Sgill@umd.edu
https://extension.umd.edu/ipm

Aphid populations can virtually explode in greenhouses, in micro greens, hydroponic leafy lettuce and high tunnel production systems. Biological control is the best long-term control methods but often a grower finds that the aphid populations have exploded and they must bring it under immediate control. You will want to select materials that have minimal impact of biological releases you may wish to employ after using as bio-pesticide.

Azadirachtin would be a good option as a preventative to supplement other tactics as long as you understand the mode of action. It acts primarily as an insect growth regulator, killing immature insects when they molt to the next developmental stage. That means it is slower to kill than some other insecticides, which can be a challenge with a rapidly reproducing insect such as aphids.

Growers may have to mix with another insecticide like **Entrust** (organic spinosad) to kill the adults if there is already an established infestation, then go on a preventative program with azadirachtin.

Since azadirachtin is taken up systemically in the plant through translaminar translocation, after 2 or 3 weekly applications it becomes difficult for the nymphs to build back up. Azadirachtin is relatively soft on beneficials, with a low hazard rating on both the BioBest and Koppert side effects lists.

BioWorks sells a 3% a.i. formulation as Molt-X. Certis Company of Columbia, Maryland make a more concentrated formulation (4.5% a.i.) that is sold as Azatin by OHP and as Neemix by ag retailers (Nutrien, Helena, etc.) or online sources such as 7 Springs Farms.

A premix of azadirachtin and natural pyrethrins is also available (as Azera from MGK) that provides both knockdown and IGR effects. All of these azadirachtin products are approved by OMRI for use in organic production, but the pyrethrins in Azera may have a detrimental impact on the beneficials.

Another bio-pesticide that can be use on aphids is ***Beauveria bassiana,*** which is sold under several brand names. Which one you choose depends if you are an organic grower or not.

BotaniGard is an entomopathgenic fungus (insect killing fungus) that can be used on aphid in non-organic operations. BotaniGard is not approved for use on organic crops.

Mycotrol WPO (wettable powder) and Mycotrol ESO (emulsifiable suspension) are approved by the WA State Dept. of Ag for organic use, although OMRI has not listed them. Both products are available from BioWorks.

All of these products contain the same active ingredient (viable spores of the entomopathgenic fungus *Beauveria bassiana* GHA strain). In terms of spore count, Mycotrol WPO is the same as BotaniGard 22WP and Mycotrol ESO is the same as BotaniGard ES. However, the co-formulants in the Mycotrol formulations are organically acceptable.

FIGHTING BOXWOOD BLIGHT TOGETHER

Chuan Hong
Virginia Polytechnic Institute and State University
1444 Diamond Springs Road
Virginia Beach, VA 23455
chhong2@vt.edu
https://www.arec.vaes.vt.edu/arec/hampton-roads/people/hong-bio.html

Boxwood blight caused by *Calonectria pseudonaviculata* is an emerging disease that keeps growers, retailers, landscapers, garden managers and other horticulturists awake at night. This disease was first reported in the United Kingdom and New Zealand back in the 1990s; and now it is widespread in Europe. In the U.S., North Carolina and Connecticut were among the first severely affected States by boxwood blight in 2011. Since then this disease has spread to other states primarily via nursery trade. As of December 31, 2020, thirty states and District of Columbia have reported boxwood blight rampages or interceptions of diseased plant materials.

This presentation highlights some latest research and innovations to help horticulturists better understand the blight pathogen biology, reduce its accidental introduction, and manage the disease at sites of contamination. The importance of fighting this disease together, with everyone in the horticultural chain doing his/her shares while research and extension communities continuing to develop and deliver better understanding of the disease biology and more cost-effective mitigation tools is also discussed.

Know the blight pathogen

This blight pathogen is known to attack boxwood, pachysandra and sweet box. On boxwood, it causes light to dark brown leaf spots, followed by leaf blighting and leaf drop as well as black streaks on young branches (**Figure**). These diagnostic symptoms differentiate boxwood blight from other common foliage diseases such as Volutella blight and Macrophoma leaf spot.

Figure 1 Three diagnostic symptoms of boxwood blight

This pathogen also causes leaf spots on Japanese spurge (Pachysandra terminalis) and Himalayan sweet box (Sarcococca hookeriana var. humilis) under landscape settings (Figure 2). Inoculation of Allegheny spurge (P. procumbens), Windcliff Fragrant pachysandra (P. axillaris), and several sweet box species - Sarcococca confusa, S. orientalis, S. vegans, S. ruscifolia, S. saligna, and S. wallichii also resulted in leaf spots.

Likewise, under controlled environments this pathogen caused disease symptoms and reproduced itself in a dozen of non-Buxaceae common groundcover plants. These plants included *Alchemilla mollis, Arctostaphylos uva-ursi, Brunnera macrophylla, Epimedium* × *youngianum, Galium odoratum, Geranium sanguineum, Phlox subulata, Tiarella cordifolia, Callirhoe involucrata, Iberis sempervirens, Mazus reptans,* and *Vinca minor*. These plants are potential hosts of this pathogen. They could potentially carry and spread the pathogen from infected nurseries or sites to new locales. They, along with pachysandras and sweet boxes, should be added to the watchlist and taken into consideration when developing boxwood blight mitigation programs.

Figure 2 Leaf spots of Japanese spurge and Himalayan sweet box caused by the blight pathogen

Fend off the blight pathogen

Keeping the pathogen out remains most effective and should be the primary approach for counties, areas, production nurseries and gardens where boxwood blight is not yet present. This pathogen produces sticky spores as its dispersal and disease-causing agent. These spores can easily attach to tools that have come in contact with contaminated materials. They may also attach to shoes, clothes and other personal belonging during visits to sites of contamination. Its long-distance spread is primarily via movement of infected plant materials. Followings are some steps that may be taken to block these avenues of pathogen entry.

- Use on-farm blight-free mother plants to take cuttings, propagate and grow locally. This applies to all boxwood, pachysandras and sweet boxes.
- Where local propagation and growing is not an option, purchase only from reputable suppliers, inspect incoming stock plants and greeneries for blight symptoms and disease signs upon receipt, then place them in an isolated area away from existing host crops for a few weeks.
- Develop and implement a protocol to mitigate the risk of inadvertent pathogen introduction to production nurseries or landscaping sites via other avenues. These include, but not limited to:
    - Designate an area away from boxwood production and plantings for visitor parking.
    - Set up a footbath with a disinfectant (https://ext.vt.edu/agriculture/commercial-horticulture/boxwood-blight.html) and direct visitors to disinfect their shoes before walking around.
    - Provide a pair of disposable Tyvek booties and suit for visitors to boxwood production fields and accompany them all the time.
    - Have field crew wear freshly laundered clothing each day when working in boxwood production fields or gardens and public spaces that are not known to have the disease.
    - Sanitize all tools including pruners, saws, equipment, gloves, vehicles, etc. before leaving a production field and landscaping job site.

- Schedule boxwood pruning when foliage is dry. Maintenance of known infected landscape sites should be placed as the last job of the day, allowing for more effective sanitation.
- Landscapers are also advised to: 1) share with clients their sanitation protocols and documentation on how all tools have been sanitized including sanitizer product and concentration, exposure times right before leaving the last job site, and get their consent prior to starting a new job, and 2) encourage business and home owners to exercise the same precautions when working and walking in the garden.
-

Better manage and contain the disease at sites of contamination

This consists of scouting, eradication and remediation, aiming to prevent the disease from outward radiating to adjacent plants, plantings and production nurseries.

- Focus scouting on three highest risk areas:
  - Where the blight disease has been seen in its proximity.
  - Where new boxwood and other host plant materials have been recently added or utilized.
  - Where maintenance was recently performed.
- Intensify scouting for new infection in spring and fall seasons, especially after rain events.
- When blight is confirmed, promptly and safely remove and dispose all blighted plant and planting materials.
  - For production nurseries, this is mandated by the New Jersey Department of Agriculture - infested field are marked as out of compliance until removal of all infected plants as well as other host plants in 10 feet perimeter surrounding, followed by three consecutive inspections consistently showing free of the blight disease.
  - For gardens and public spaces, there are two additional options: 1) cut to leave a stump, and 2) trim only symptomatic branches and stems while leaving the shrub intact. Both have their pros and cons.
- Remediation is recommended mostly for gardens and public spaces with option site-dependent.
  - For sites where blighted boxwood including stumps have been completely removed, flame soil surface to burn as much leaf and plant debris as possible, plant NewGen Boxwood – Independence and Freedom, or other less susceptible cultivars such as Little Missy then mulch the floor to prevent soil inoculum from splashing onto boxwood foliage.
  - For sites where blighted branches have been removed or shrubs have been heavily trimmed while leaving a stump for regrowth, fungicide protection, along with flaming and mulching, is crucial to protecting existing and new growth. A general list of fungicides for boxwood blight is available at https://ext.vt.edu/agriculture/commercial-horticulture/boxwood-blight.html. Actual availability varies with user (grower, retailer, landscaper and home owner). As always, chemical protection should be used as the very last resort and fungicide label must be followed strictly. This is especially important for

gardens and public spaces as fungicide may drift and pose hazards to human and environmental health.
    - To help better time fungicide application, a 'boxwood blight' app has been developed for smart phones and other mobile devices. With this app, you can find out your local blight infection risk with just a few clicks - selecting your closest weather station on the national network, start date, and time span that you like to have the forecast. You also can set up to have a weekly infection risk report sent to an email address of your choice. These reports should be used as a reference because the infection risk model is being validated and improved. Nevertheless, they improve crop protection while cutting unnecessary applications.

Fighting boxwood blight together

Fighting a good fight against boxwood blight requires everyone in the horticultural chain and in the community/neighborhood doing his/her shares.

- It is fundamental for growers to produce, sell and ship only blight-free stock plants so national spread of this disease via nursery trade is reduced to the minimum.
- Retailers, landscapers and ground maintenance personnel are in the frontline of this fight with an area-wide impact. It is highly advisable to:
    - Buy stock plants from a reputable supplier.
    - Retailers not to co-mingle incoming plant materials from different suppliers.
    - Landscapers and ground maintenance personnel also to decontaminate all tools before leaving each job site.
- Public garden managers and home gardeners to:
    - Exercise the same precautions when bringing new plants to a property.
    - Have an effective sanitation protocol in place.
    - Be vigilant and always on the lookout for blight symptoms and disease signs.
    - When boxwood blight is suspected, send a sample in double bags to a plant disease clinic for confirmation.
    - Once the disease is confirmed, promptly and safely remove and dispose all blighted shrubs or foliage to prevent the disease from outward radiating to adjacent host plants, plantings and production nurseries.

Also required are more robust and cost-effective blight mitigation tools and timely transfer of new innovations from research lab to field. Towards these goals, a national consortium - Boxwood Blight Insight Group (BBIG) has been recently established with a new grant from the USDA National Institute of Food and Agriculture (Agreement #: 2020-51181-32135) and continuing support from the USDA Animal and Plant Inspection Service. The BBIG consists of 14 scientists and their associates from twelve labs in seven states and a 11-member advisory panel representing different sectors of the horticulture industry, plus extensive stakeholder partnerships and international collaboration. Together we save boxwood crops and plantings.

Session 5

Hydroponics/Controlled Environment Systems II

Session Chairs:

Bill Sciarappa, AJ Both, Albert Ayeni
Rutgers Cooperative Extension
And
Rutgers NJAES

ENVIRONMENT CONTROL FOR HYDROPONIC SYSTEMS

A.J. Both
Extension Specialist
Rutgers University
Department of Environmental Sciences
14 College Farm Road
New Brunswick, NJ 08901; both@sebs.rutgers.edu

When we make investments in hydroponic growing systems, we typically put those systems in an enclosed structure such as a greenhouse or a building. The reason is that it reduces the risk of adverse weather impacts. Figure 1 provides an example of what outdoor temperatures can be expected throughout the year in New Brunswick, NJ. Figure 2 shows the daily light integral (sum) in Newark, NJ over an 11-year period. As these figures show, not all outdoor conditions are suitable for crop production. Therefore, growing crops in greenhouses or buildings allows us to provide optimum growing conditions throughout the year. But maintaining those optimum conditions requires equipment, sensors and control systems. Thus, investments and energy inputs are needed to make it all work. And in order for a grower to make a profit, the production costs need to be lower than the selling price.

This presentation will review different strategies that can be used to optimize the growing environment for hydroponic production systems. Most of these strategies will also apply to other production systems for crops grown in containers or pots. In addition, control options for various environmental parameters (e.g., temperature, humidity, light intensity) will be discussed. Where appropriate, issues specific to hydroponic crop production will be highlighted.

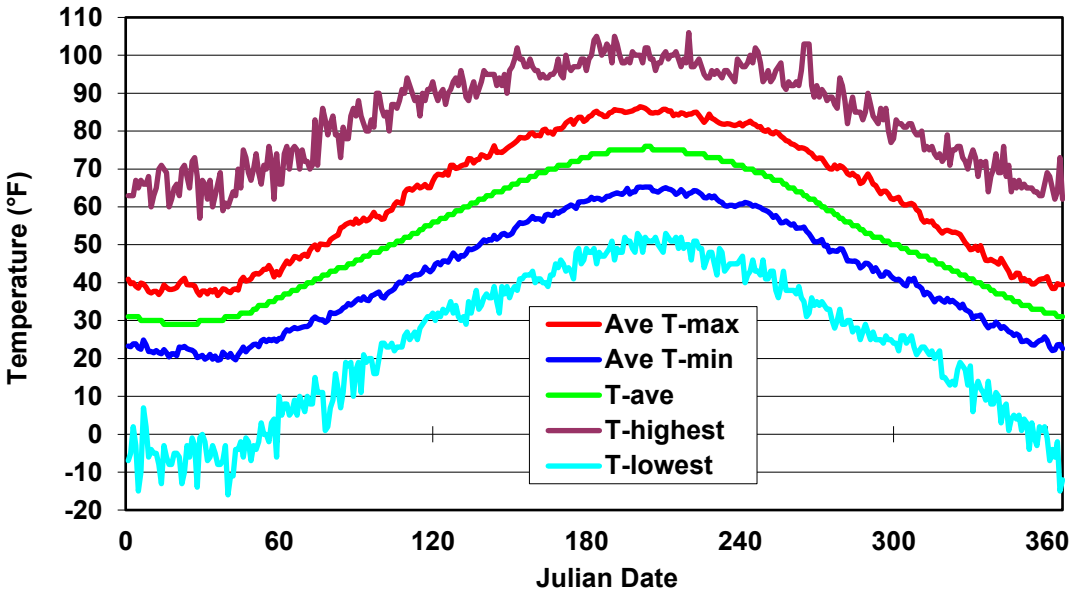


Figure 1. Outdoor temperatures for New Brunswick, NJ measured over the period 1893-2000. Julian date is the day of the year (January 1 = 1, December 31 = 365).

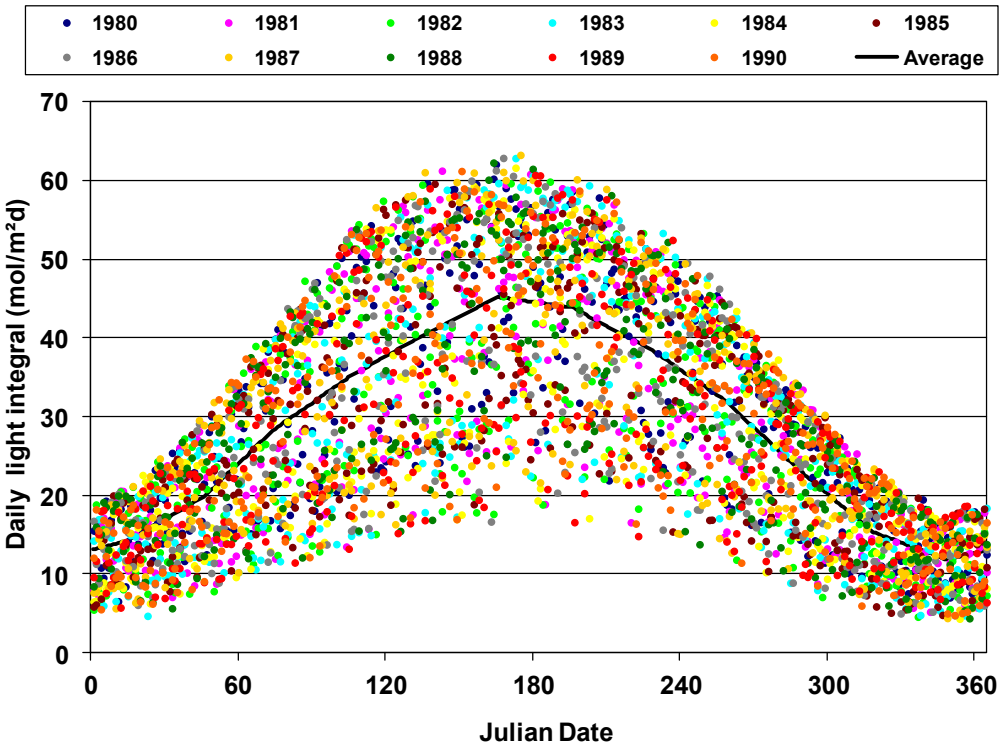


Figure 2. Daily light integral (DLI) for Newark, NJ measured over the period 1980-1990. The black line shows the average over the 11-year period. Julian date is the day of the year (January 1 = 1, December 31 = 365).

EXPLORING FUNDING OPPORTUNITIES FOR THE AGRICULTURAL ENTREPRENEUR

Joseph M. Cronin, Director of Grants Facilitation and Elaine Griffin, Manager Compliance and Quality Control, Office of Grants Facilitation
Rutgers University
88 Lipman Drive
New Brunswick, NJ 08901
cronin@njaes.rutgers.edu erossi@njaes.rutgers.edu

Exploring Funding Opportunities for the Agricultural Entrepreneur provides an overview of the funding landscape for anyone interested in looking for and securing an active funding portfolio. This presentation is designed for both academic and non-academic audiences with an emphasis on the types of opportunities available for the agricultural landscape.

The Office of Grants Facilitation (OGF) is a unit of the New Jersey Agricultural Experiment Station at the School of Environmental and Biological Sciences (SEBS). The office reports to the Dean of Research, Dr. Wendie Cohick. The OGF provides direct support to faculty who are interested in obtaining and sustaining grant funding portfolios. It is able to accomplish this through utilization of a unique approach, one that combines outreach and education.

The office provides a unique set of services, including (but not limited to): develop funding plans to help build program/project capacity, helping to establish and build connections to funders, collaborators, and partnering organizations, serving as a liaison to funding agencies and organizations (including cultivation activities), creating tools to educate faculty and their staff to be responsive to funders, and delivering educational programming on compliance regulations.

Specifically, with this presentation, participants will learn how to begin their search for competitive grant funding. Next, participants will learn how to develop a fundable idea. Taking an idea from the gestational phase and moving in into something more concrete. We share strategies on planning considerations (Conceptual, Strategic, and Logistical) that help shad idea development and lead to project impact.

After idea development comes being able to communicate your idea. The importance of being able to succinctly explain and convey your idea is also discussed. What should be conveyed is important. What are some things that you need to ask yourself? Self-reflection is important, what agricultural entrepreneurs should be prepared to answer.

- Can you communicate your idea?
- Do you have a refined pitch?
- Do you know what it costs to implement your business idea?
- Is there any intellectual property associated with your idea? Have you consulted with an attorney regarding protecting your business model?
- Have you incurred debt to establish your business?
- How do you stay relevant?
- How will you determine the next steps of your idea? How do you know when you are no longer relevant?
- Do you have a record of success that you can convey to others?

After idea development and refinement, it is time to start looking at the funding opportunities that are out there. Two important places to start are grants.gov and the Foundation Center Directory. These are among the most common search engines. Grants.gov is your gateway to the federal funding landscape. Every federal funding opportunity is listed on this website. All you have to do is go to grants.gov and start your search.

The Foundation Directory Online (Professional) provides information on more than 100,000 foundations, corporate giving programs, and grant making public charities in the United States. It also includes searchable databases of recently awarded grants, sponsoring companies, and recently filed IRS information returns (Forms 990 and 990-PF). All four databases, as well as the Foundation Center's philanthropy news, nonprofit jobs, Request for Proposals, foundation publications, and nonprofit literature databases, can be searched simultaneously.

There are resources for available for small businesses that should also be noted. Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) are highly competitive programs that encourage domestic small businesses to engage in Federal Research/Research Development (R/R&D with the potential of commercialization. Each federal agency administers its own individual program within guidelines established by Congress. Eleven federal agencies participate in the SBIR and 5 of these agencies also participate in the STTR program. The mission of these (SBIR/STTR) programs to support scientific research and new intellectual property development though the investment of federal research funds in critical American priorities to build a strong national economy. These two programs foster and encourage participation in innovation and entrepreneurship by women and socially or economically disadvantaged persons. They also increase intellectual property development from the private sector from innovations funded from Federal research and development initiatives. In addition, the STTR program aims to encourage technology transfer

through cooperative research and development between small businesses and research institutions.

Lastly, it is important to understand how proposals fail. A myriad of reasons can impact your proposal. Some of which include (but not limited to): The competitive landscape, not understanding the audience, scope of work that is too vague, narrow, or broad, poorly written evaluation plans is disjointed, and a basic failure to follow the submission rules It is important to note that reviewers can smell “sloppy copy” a mile away. Ensure all statements are well-researched and based on fact, with citations where necessary. Federal funding is a competitive arena. Identify the appropriate programs and contact federal agencies early in the process, before submitting formal applications. Identify the most appropriate sources of funding early in the process to ensure that the effort expended is worthwhile.

Session 6

Know Your Numbers, Know Your Options II

Session Chair:

Robin Brumfield

Rutgers NJAES

KNOW YOUR NUMBERS, KNOW YOUR OPTİONS

Robin G. Brumfield, Ph.D.
Professor and Specialist in Farm Management
Department of Agricultural, Food and Resource Economics
55 Dudley Road
New Brunswick, NJ 08901-8520
brumfiel@njaes.rutgers.edu
http://farmmgmt.rutgers.edu/

Ratios from the Income Statement: Profitability and Financial Efficiencies

Profitability ratios measure the ability of the business to earn a good profit and generate a satisfactory return on investment. These ratios are typically a good indicator of management's overall effectiveness.

The **net profit margin** is the most common. It is a measure of the operating efficiency of the business. It measures how effectively the business is controlling expenses relative to its value of output. A high profit margin indicates good cost control. The net profit margin is the profit per dollar of sales after paying the owner's salary and accounting for opportunity cost of capital invested. The ***gross profit margin*** is another measure of profitabilityand indicates the amount of contribution to the business enterprise, after paying direct costs.

Common Problems with Profit Margin are

- Wrong pricing system
- Prices have not been increased as costs have increased
- Costs are too high relative to size of the farm
- Not enough sales for the resources allocated
- High overhead costs
- Wasteful spending on inputs
- Poor production

It is important to keep in mind that every dollar saved by cost control equals a dollar of profit.

The **return on assets** (ROA) ratio measures the profit-generating capacity of total assets of the business. It measures the business's effectiveness in using all of the available total capital—both debt and equity. Return on assests shows how well the business is using its assets to generate a profit.

Efficiency ratios help explain why the business is making or losing money. While financial efficiency is related to profitability, it is quite different. The profit margin shows the return or loss for a given year. Financial efficiency seeks to understand the

components of sales and determine if an operation is spending excessive amounts on operating expenses, interest, depreciation, and so forth. Therefore, it is important not only to understand the components that come together to determine profitability but also to understand why a business is or is not profitable. Financial efficiency ratios tell you how well the business employs its assets.

Measure	Target	Formula	Explanation
Net income (profit)	>$50,000 per family	Sales – Total costs	What remains after subtracting all the costs (including depreciation, interest, salaries, and taxes) from your sales. Also called bottom line, net earnings, net profit.
Gross margin	30–40%	(Sales – Total direct costs) / Sales	The amount of contribution to the business enterprise, after paying direct costs.
Profit margin	10–15%	Net income / Sales	Profit per dollar of sales after paying the owner's salary and accounting for opportunity cost of capital invested.
Return on equity	>10%	Net income / Net worth	Measures how effectively you are using your reserves to produce income.
Return on assets	>10%	Net income / Total assets	Measures how you employ your assets to obtain sales revenue.
Financial efficiency ratio	<65%	(Total expenses – interest – depreciation) / Sales	Measures how you employ your assets to obtain sales revenue.
Asset turnover ratio	>25–30%	Sales / Total assets	How you are in utilizing your assets in generation of sales revenue. Higher is better. If low, it indicates the current level of investment needs to be used more efficiently or maybe some capital can be sold without adversely affecting operating efficiency.
Operating expense ratio	<65%	(Operating expense – Depreciation) / Sales	For every dollar you took in, how much did you need to spend?
Depreciation expense ratio	< 15%	Depreciation expense / Sales	Provides a measure of the capital costs incurred by the business.
Interest expense ratio	< 15%	Interest expense / Sales	Shows percent of your income needed to pay interest.

Cash Flow: A survival strategy in tough times

A Cash Flow Statement shows how much cash will enter and leave you business over a specified time, such as monthly or quarterly. A cash flow projection is an important tool for evaluating the liquidity of your farm business, the annual operating loan needs, and your ability to repay loans. A cash flow projection can indicate potential financial problems and alert you that changes might be needed. Profitable businesses

can still fail because of cash flow problems. It is important to know when the major inputs and outputs of cash will take place and be prepared for them. Lenders usually want to evaluate the projected cash flow when making loan decisions, and you will want to have a line of credit or operating loan to cover short falls.

Pro Forma Cash Flow Statement for Mrs. Greenjeans Greenhouse

	Total inflows	Surplus outlays	deficit	Total cash balance	Cash	Total Cash to borrow
January ($)	0	58,317	−58,317	10,000	−48,317	−48,317
February ($)	70,000	10,817	59,183	−48,317	10,866	0
March ($)	51,000	20,817	30,183	10,866	41,049	0
April ($)	2,075	19,117	−17,042	41,049	24,007	0
May ($)	20,000	19,617	383	24,007	24,390	0
June ($)	39,825	11,813	28,012	24,390	52,402	0
July ($)	17,000	2,817	14,183	52,402	66,585	0
August ($)	3,000	22,817	−19,817	66,585	46,768	0
September ($)	2,000	7,817	−5,817	46,768	40,951	0
October ($)	5,875	10,317	−4,442	40,951	36,509	0
November ($)	4,975	11,617	−6,642	36,509	29,867	0
December ($)	25,000	11,817	13,183	29,867	43,050	0
Total ($)	240,750	207,700				−48,317

How the Pieces Fit Together

It is important to review your finacial plan at least yearly and benchmark how you compare year to year and adjust your plans to meet your goals, or adjust your goals.

Often, the most common reason for developing a business plan is to be able to present your business's ideas for a new or expanded business to investors or lenders. After investors or lenders see the plan, they will want to know how much money is needed and how the money will be used.

You should think about what financial resources are needed for the following list:

1. Equipment and facilities
2. Lease versus purchase
3. Suppliers: delivery schedules, beginning inventories, economic order quantities, cost of storage, and lead times for delivery
4. Start-up costs: overhead components, incidental costs, initial advertising and promotions, utilities installation costs, renovations, working capital start-up, timing and source of investment, insurance, licensing, and accounting fees
5. Typical annual and monthly estimates
6. Desired mix of financing: equity, long-term loans, short-term or working capital loans, equipment or facilities loans, leases or rentals

Describe how you will acquire and manage capital assets. Will you purchase, lease, or custom-hire to meet equipment needs? If you plan to rent land or buildings, describe the lease arrangements. You may want to include a summary of retirement or savings investments.

Financial Risk Management Strategies

- Insurance – crop, property, liability, health, life
- Containing costs
- Right-sizing operations
- Marketing
- Non-farm income
- Diversification
- Tax planning
- Reaching out to neighbors in a way that lets them open up

Session 7

Organic

Session Chair:

Joseph Heckman

Rutgers NJAES

SOIL HEALTH AND ORGANIC SWEET POTATO PRODUCTION

Joseph Heckman
Extension Specialist Soil Fertility
Rutgers University
59 Dudley Rd
New Brunswick, NJ 08901

Sweet potato can be a profitable crop for organic growers when they focus on soil health and production management details. Typically selling at $3 per pound the crop may generate considerable revenue. Crop rotation is a requirement in the organic production system and is an important practice to minimize challenges from pest, weeds, and disease. Fields previously farmed to organic corn, small grains, or grass sod are generally good sites for planting sweet potato. The soil must be well drained. Sandy loam soils are preferred but excellent crops can be produced on finer texture soils, such as loams and silt loams with good soil physical condition and 3 to 4% organic matter. Sites without good soil tilth should be avoided or remediated with cover cropping.

Research is underway to develop soil test interpretations under certified organic growing conditions. It is generally assumed that soils under organic farming management develop unique biological properties and for this reason may function differently. Testing soils for N availability during an early growth stage of annual crops is useful for predicting when or if supplemental N fertilizer is needed. Under organic production, soil tests can also inform growers about the effectiveness of their soil fertility building program.

In years 2016 to 2020, sweet potato was grown at several certified organic research sites with the objective of investigating the crop's need for supplemental fertilizer in relation to soil test nitrate-N values. Sweet potato has a relatively low N requirement and adding excess N can have a negative effect on yield.

Findings so far suggest that some soils under organic management may have sufficient N to grow sweet potato without adding sidedress N fertilizer. Furthermore, adding more N to the system when the soil test level (2 weeks after planting or vine run stage) is 20 ppm Nitrate-N or greater may cause a yield depression. However, sweet potato yield may also increase with added N fertilizer when the soil test nitrate level is much lower. Although, more field trials are needed to better define soil test nitrate-N interpretations, findings already suggest that soil testing for nitrate-N during the growing season can help to optimize soil fertility for organic sweet potato production.

References: Soil Nitrate Testing as a Guide to Nitrogen Management
https://njaes.rutgers.edu/pubs/publication.php?pid=E285

VIABLE TACTICS FOR MANAGING ALLIUM LEAF MINER FOR ORGANIC ONION PRODUCTION

Gladis Zinati
Director- Vegetable Systems Trial
Rodale Institute
611 Siegfriedale Road
Kutztown, PA 19530
Gladis.Zinati@rodaleinstitute.org

The Allium Leafminer (ALM) (*Phytomyza gymnostoma* Loew, Diptera: Agromyzidae), an invasive herbivore pest, feeds on allium crops such as leeks, chive, onion, and garlic, causing damage that results in crop losses. It was first reported in European countries such as Denmark, Sweden, Poland, and the Mediterranean Basin in 1976 and now is widespread in Europe. In United States of America, the ALM pest was first recorded on allium crop in Lancaster County, Pennsylvania (PA) in December 2015 and expanded to many other counties in PA and adjacent states such as New Jersey, Maryland, New York, and Massachusetts in 2019. With climate change, this pest is expected to spread to other states in the Northeast, causing damage to allium cropping.

Allium Leafminer Identification

The allium leafminer adult is a true fly, greyish in color, 3 mm long, and with a yellowish-orange area on its head with black behind the eyes (**Photo 1**), Legs are dark with yellowish knees and striped yellow abdomen. Two white halteres (appear as dots) located under clear wings with dark veins (**Photo 2**).

Photo 1. Allium leafminer adult and damage markings on onion leaf. Photo credit: Gladis Zinati

Photo 2. Top view of ALM adult showing white halteres, small knobbed structures under its transparent wings. Photo Credit: Gladis Zinati

Biology and Lifecycle

The ALM pest has two generations in Pennsylvania and the Mid-Atlantic states. The first generation appears in March-April, where the adults emerge from overwintering and mate within 48 hours. Both males and females feed on plants. The female ALM pest punctures

holes and lays eggs into allium foliage between late March to early May and again in late August to Mid-October in the Northeast. Generation times differ somewhat based on geographic location.

One week after making the punctures, the female lays whitish, slightly curved eggs in the leaves. When eggs hatch, the yellowish larvae, 8 mm in length, mine down inside the leaf, leaving trails that widen as they travel down to the stem (**Photo 3**). The larvae then pupate in the stem, producing 3.5 mm long oval, reddish to dark brown pupae. The pupae can be found in the soil surface outside the plant until September, when adults emerge for the second generation. The cycle repeats in the fall and the pupae overwinter until next spring.

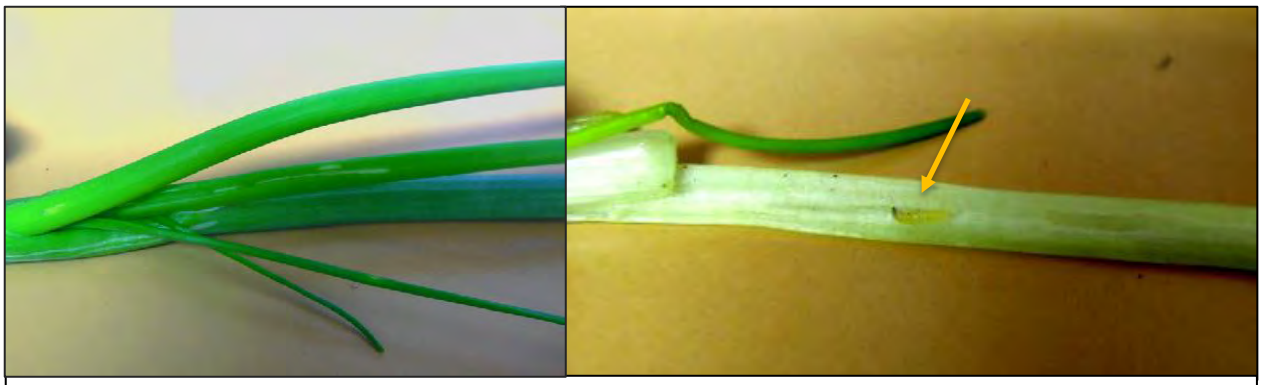


Photo 3. Left: Exterior marks of tunneling by ALM larva; Right: ALM larva (at yellow arrow) with internal tunneling marks. Photo Credit: Gladis Zinati

Allium Leafminer Damage

In addition to foliage damage and depending on the time of the year, you might find pupae and/or larvae as shown in leeks (**Photo 4**), onion bulbs, and garlic cloves. All life stages produce damage making the allium crop non-marketable and can lead to tremendous losses for growers.

Photo 4. Tunneling damage and larvae in onion (left) and inner leek leaves caused by ALM (right). Photo Credit: Gladis Zinati

Economic Importance and Damage

In Pennsylvania, sales of certified organic onion and garlic are $373,852 and $321,469, respectively. Unlike conventional growers, organic allium growers have limited options for registered organic pesticides to control or reduce the ALM pest impact.

To advise allium specialty crop growers on non-chemical practices for managing ALM, a field research trial was conducted over two years (2017-2019) at Rodale Institute, Berks County, PA. The results presented here will provide allium growers with scientific-based information to make informative decisions in using practices that reduce losses to ALM and improve production of organic yellow onion.

Management of ALM

Background: Three yellow onion varieties (Cortland, Sedona, and Talon) were evaluated in plots that were cropped previously to two cover crop mixtures. One cover crop mixture is referred to as 'Myco' and the other mixture as 'Brassica'. The Myco mixture included hairy vetch, rye, oats, sunflower, and white Dutch clover. The roots of these cover crop plants form an association with soil mycorrhizal fungi. The 'Brassica' mixture included mustard, rape, and daikon radish. These cover crop plants do not form mycorrhizal fungi association. The cover crops were tested as biological option and use of sticky cards, floating row cover and plastic mulch as cultural options.

Results

Cover crop mixtures

Onion seedlings were grown in bare-ground and plastic mulch (black, reflective silver and red). While there was no significant damage on onion plants grown in any plastic mulch in either 2018 or 2019, our results showed that onion plants grown in plots preceded by Myco cover crops were 2-times more damaged by ALM than the plants preceded by Brassica in 2018 and 2019 (i.e. 8 plants in Myco versus 4 plants in Brassica per 7.6 m (25 ft) long plot).

Sticky cards

Allium growers use visual cues, as the damage symptom on leaves, when inspecting allium foliage for adult flies and oviposition marks. However, this method can be late for organic growers who are not using pesticides to spray the ALM adults and the damage is done. One of the tactics that was tested for early detection is the use of colored sticky cards. Blue and yellow sticky cards were used to monitor the early flight of ALM adults and during the first six weeks of onion plant growth in spring. The yellow sticky cards proved to be more attractive to ALM adults than the blue ones and are recommended for ALM monitoring.

Floating row covers

Covering recently transplanted young allium seedlings in spring and fall provides exclusion of ALM adult from laying eggs in allium foliage and increase yield. Three periods of covering were tested (0, 30 and 45 days). The row cover served two purposes: a) as an exclusion, by protecting onion seedlings from being damaged by ALM during the ALM flight/laying eggs period, and b) as a micro-climate warmer, that led to increased onion yield when covered for 30 or 45 days, averaging 16,500 lb/acre compared to those without cover, averaging 14,000 lb/acre.

Plastic mulch versus bare ground

Over the two years trial, more damage from ALM was seen in plants grown in bare ground. While ALM damage was minimal on plants grown in plastic mulch, it is worth noting that the damage was only seen on onion seedlings grown in black plastic mulch plots that were preceded by Myco cover crop.

The onion yield in bare ground and plastic mulch was significantly greater in Brassica plots (averaging 12,900 lb/acre) than in Myco (averaging 11,250 lb/acre) in 2018. The yield in 2019 followed the same trend in bare ground (Brassica: 8,650 lb/acre; Myco: 5,750 lb/acre). The yield was also significantly greater in plastic mulch, averaging 19,750 lb/acre in Brassica plots and 18,680 lb/acre in Myco. Therefore, the combined tactics of using plastic mulch and Brassica cover crops provided reductions in ALM damage and higher onion yields.

In summary, **the tested tactics have been deemed viable in reducing the impact of ALM damage in organic onion crop.** Organic and non-organic allium growers in Pennsylvania and the Northeast could benefit from adopting these non-chemical tactics, such as transplanting into soils that were cropped with Brassica cover crop mixture to increase sulfur and reduce the attraction of ALM adults, yellow sticky cards for early detection of ALM flights and floating row covers to protect young seedlings from ALM female adults laying eggs and consequently reduce allium yield losses. These multitactics can be incorporated into an IPM program for managing ALM in the Northeast. Furhter research is needed to understand the benefits cover crop mixtures play in reducing pest damage and increasing allium crop production.

SATISFYING THE SULFUR NEEDS OF CROPS

Joseph Heckman
Extension Specialist Soil Fertility
Rutgers University
59 Dudley Rd
New Brunswick, NJ 08901
heckman@njaes.rutgers.edu

Sulfur is needed by crops in about the same amount as phosphorus but is often neglected. Soil testing for sulfur is not common practice. Until recently there was an abundance of sulfur freely available from the atmosphere from combustion of sulfur-containing fuels. However, advances in air quality standards have now increased the potential for sulfur deficiency in crops.

Symptoms of sulfur deficiency are typically exhibited as yellow or pale green leaves and slow growth. It is sometimes mistaken for nitrogen deficiency. But unlike nitrogen deficiency, sulfur deficiency is exhibited most clearly on younger leaves. Reduced flowering and increased susceptibility to plant diseases are also associated with sulfur deficiency.

There are many reasons why all vegetable growers should work to ensure that sulfur is not a limiting nutrient. Sulfur-containing amino acids are necessary to make quality proteins. Sulfur is a component of several vitamins. Enhanced levels of sulfur nutrition help a crop resist disease. And very importantly from the standpoint of direct marketing and customer satisfaction - sulfur nutrition enhances the flavor of vegetables.

Even without soil testing we can use agronomic information to predict where sulfur deficiency is likely to occur and where it is plentiful. Sandy soils and any soil with low organic matter content is at high risk of being sulfur deficient. Loams and silt loam soils and soils rich in organic matter are less likely to be sulfur deficient. Fields recently amended with compost or where manures have been applied can be expected to be well supplied with sulfur.

Subsoils with a clay layer often accumulate sulfur but if there is a hardpan crop roots might not be able reach it. Breaking up hardpan layers with deep tillage or growing deep rooted cover crops can improve access to sulfur.

Some crops have a much greater demand for sulfur than others. Crops that have an especially high demand for sulfur include legumes and any vegetable in the Brassica family. A good harvest of cabbage, for example, can take up over 40 pounds of sulfur per acre. Hay and silage harvest also remove large amounts of sulfur.

Organic amendments such as compost, manures, and shade tree leaves are all good sources of sulfur fertility. Other fertilizer sources of sulfur that may be used in organic farming include potassium sulfate, potassium magnesium sulfate, and gypsum.

Besides sulfur these fertilizer choices may be carefully considered for the other valuable nutrients they can supply. Before application, organic growers should confirm that a product is approved for use in organic farming. Non-certified farms have a much wider range of sulfur fertilizer products from which to choose.

For further information visit Rutgers NJAES for fact sheet on Sulfur Nutrition and Soil Fertility Management.

BALANCING SAFETY AND NUTRITION IN ORGANIC FOODS

Mark McAfee
CEO and Risk Reduction HACCP Plan Specialist
Raw Farm by Organic Pastures Dairy Company
7221 S Jameson Ave, Fresno, CA 93706
mark.m@organicpastures.com

At the heart of the organic movement, lies the desire to produce foods that are whole, unprocessed, and nutritious. Such foods provide true nourishment, with increased levels of health supporting nutrients as well as superior taste. Organic foods embrace biology and the diversity of life that is found in flourishing soils.

Yet, along with the life-giving properties of soil and organic environments, there are potential pathogens which may cause human illness such as *Listeria mono*, *Salmonella*, *Campylobacter*, and *E. coli* 0157-H7. For instance, leafy greens have become one of the most common sources of pathogen outbreaks.

There are three basic conditions that must occur in order for pathogens to trigger human illness:

1. A virulent pathogen must be present.
2. The load or amount of pathogen must be high enough to overwhelm the person's defenses.
1. The person must be susceptible to the pathogen.

In healthy, robust people, a little exposure to pathogens often produces no signs of illness. However, in today's world there are many people whose immune systems are compromised such that even a small exposure to pathogens can cause serious illness. Therefore, a balance must be found between producing organic foods that are whole and nutritious alongside the often-competing goal of food safety.

The Conflict Between Making Foods Safe and Preserving Optimal Nutrition

Organic means living, whole, diverse. It means biodiversity of life, and that includes the microscopic bacteria that are the basis of life on earth. Beneficial bacteria are critical to the human gut and microbiome, and are therefore foundational to the immune system. Bacteria keep people healthy and protect them from pathogens. This is the life-giving virtue of organic food in whole form.

Under current FDA and USDA regulations, many foods are pasteurized, irradiated, exposed to high pressure, or exposed to UV light in order to kill off any pathogens and increase the shelf life of foods. The problem is that, in destroying the pathogens, the nutritive properties of the foods are often damaged as well. Enzymes are inactivated, beneficial bacteria are killed, bioavailability of minerals and vitamins is reduced, proteins are denatured, and flavor is changed.

Should a society render its foods sterile to assure that the most immune depressed consumers will never be exposed to any pathogen? Doing so would perpetuate the problem through compromised immune systems, obesity, and other comorbidities. The consumption of sterile and highly processed foods coupled with use of antibiotics and preservatives has already created a widespread problem of weakened immune systems who are more vulnerable to pathogens.

How can consumers rebuild their immune systems and gut microbiomes? By eating whole, unprocessed organic foods! This is the natural pathway to strong immune health. As society embraces biologically diverse whole foods which are complete with the active enzymes, protein integrity, and beneficial bacteria which nourish the immune system and gut microbiome, the health of the community as a whole is reinforced. Yet, these types of foods have shorter shelf lives and are harder to distribute.

Finding a Niche for Whole Organic Foods
All across the world, health-conscious consumers are seeking whole and unprocessed foods. This creates a powerful niche opportunity for farmers to brand themselves and connect directly to consumers. These farmers adapt ways to increase the safety of foods while also preserving nutritional integrity. The consumers win with access to healthier foods, and the farmers are able to earn a better wage than they would by supplying food to centralized processors.

Truly Raw Almonds
Organic “raw” almonds illustrate this concept well. Prior to 2007, organic raw almonds were actually raw. However, as a result of *Salmonella* outbreaks in conventional almonds, in 2007 it was mandated that both conventional and organic almonds be sterilized. For organic almonds, heat treatment was the only approved method. These heat-treated almonds, which had been heated to 200 degrees, were still allowed to be labeled as “raw.”

The organic community was in an uproar for 10 years over this mandatory pasteurization step with labeling that said “raw almonds.” Consumers that knew about this labeling deception where outraged. Consumers that soaked their almonds before consumption (to increase bioavailability of nutrients) found that pasteurized almonds became moldy when soaked.

This created a niche market for truly raw organic almonds. One small exception to the pasteurization rule is that farmers can sell up to 100 pounds of unpasteurized raw almonds direct to individual consumers. Farmers began to sell truly raw organic almonds directly to consumers and received a premium price for this whole food product.

A Niche for Raw Apple Juice
Raw apple juice is another example of farmers finding ways to produce a safe food while preserving optimal nutrition. Back in 1996, there was an outbreak of *E. coli* 0157-H7 from Odwalla raw apple juice. 21 kids were sickened and one child died after

consuming this very popular unpasteurized raw apple juice. The subsequent investigation discovered that apples which had fallen off the apple trees, “grounder apples,” had been used to make the raw apple juice. These “grounder apples” were contaminated with *E. coli* 0157-H7 from deer manure in the orchard.

Starting in 1997, all apple juice sold in stores was required to be pasteurized to reduce the pathogen risk. However, farmers can still produce raw apple juice and sell it directly to consumers. This created another niche market, and many farmers began to sell carefully produced raw apple juice to consumers. This juice was made from apples that were harvested directly from the trees and carefully washed before being made into juice.

Safe Raw Milk

Raw milk serves as a final example. After numerous millennia flourishing with raw milk, mankind’s relationship with raw milk took a wrong turn in the mid-1800’s in America. Some raw milk production had shifted away from farms and into highly-populated cities. Big cities did not have pastures or clean water, and the cows in city dairies were kept in filthy conditions with poor nutrition and poor animal health. Many of these cows were fed byproducts from alcohol distilleries, leading to illness in the cows. Raw milk had become a source of deadly diseases such as tuberculosis, typhoid, diphtheria, and scarlet fever.

In the late 1800's, it was recognized that raw milk being produced in these conditions was dangerous, and two solutions were proposed. Pasteurization was ushered in to address filthy conditions and unhealthy cows in cities. It answered the question of how to commercialize dirty milk, rather than spending the time and energy it would take to produce clean milk from healthy cows. The other solution was to actually produce the milk in hygienic conditions with healthy animals.

It was known that raw milk was a superior source of nutrition for infants and children, so the American Association of Medical Milk Commissions (AAMMC) was established by New Jersey doctor Dr Henry Coit in 1893, to ensure a supply of safe raw milk. The AAMMC was in operation for nearly a century, certifying medical raw milk for use in hospitals and for feeding infants and children. Walker-Gordon dairy in New Jersey was a certified medical milk dairy for eight decades, up until the 1970s.

Safe raw milk requires greater attention to cleanliness, healthy animals, and refrigeration, making it more expensive than pasteurized milk. Over time, pasteurized milk won the market over raw milk, leading to the demise of millions of small family dairies. Instead, large consolidated dairies have become the norm, such as mega dairies with 20,000 cows. These mega dairies flout the organic standards and wreak havoc on the local environments. Smaller dairies cannot compete such that about 10% of smaller dairies are lost each year.

Meanwhile, the FDA has identified pasteurized milk as the most allergenic food in America. Pasteurized milk is also associated with digestive difficulties and lactose intolerance in many consumers. Raw milk is rarely allergenic, easy to digest, and associated with a reduction in allergies, respiratory infections, eczema, and asthma.

These benefits have created a niche market of raw milk consumers who are willing to pay more for a higher quality, healthier product. Raw milk has become a pathway for keeping small dairies viable and able to thrive.

A Balanced Approach

When farmers embrace the production of safe, whole, unprocessed, organic foods, it is a win-win situation: consumers benefit from superb nutrition while farmers earn a more sustainable wage for their efforts. This is not easy. If it was easy then it would have no value.

It takes thinking and creating and connecting to consumers. It takes effort to build a market and educate consumers about the superior value of whole unprocessed foods. It takes understanding the current "Food Safety Modernization Act" and state laws, while also being willing to innovate new solutions. It takes investigation, research, and the application of science and new technologies, such as rapid pathogen tests.

As we serve humanity, we must protect each individual costumer and the most vulnerable in our society while building and nourishing society as a whole. That means following nature's blueprints for whole unprocessed foods, while assuring that no human pathogens escape into the market place. This approach keeps everyone safe and makes the regulators happy, while allowing the farmer to earn a true living wage. It also fulfills the farmer through building relationships with consumers instead of processors, to reconnect with those who benefit from his labors. It is the true path to sustainability.

References

Securing Fresh Food From Fertile Soil, Challenges to the Organic and Raw Milk Movements. *Renewable Agriculture and Food Systems*, Cambridge University Press. 2017. Heckman J. https://www.cambridge.org/core/journals/renewable-agriculture-and-food-systems/article/securing-fresh-food-from-fertile-soil-challenges-to-the-organic-and-raw-milk-movements/18325E375E068A538E07EF4E6F6ABA22

Recent Trends in Unpasteurized Fluid Milk Outbreaks, Legalization, and Consumption in the United States. *PLOS Currents.* 2018; 10. Whitehead J, Lake B. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6140832

Raw milk producers with high levels of hygiene and safety. *Epidemiology and Infection*. Volume 148, 2020, e14. Berge A, Baars T. https://www.cambridge.org/core/journals/epidemiology-and-infection/article/raw-milk-producers-with-high-levels-of-hygiene-and-safety/ACCC5FD0AC2CEAB12379DFA902491115

Session 8

New Orchard Establishment I

Session Chairs:

Megan Muelhbauer / Hemant Gohil

Rutgers Cooperative Extension

OVERVIEW OF RESOURCES AVAILABLE TO NEW TREE FRUIT GROWERS IN NEW JERSEY

Megan Muehlbauer PhD
Agricultural Agent
Rutgers University
Cooperative Extension of Hunterdon County
314 County Route 12
Flemington, NJ 08822
muehlbauer@njaes.rutgers.edu

It can often be daunting for new or prospective tree fruit growers to navigate all the resources available to them. This presentation serves as an introduction to the most up to date curated tree fruit grower resources. For those who have not yet purchased land, or are looking to rent, we will begin with a discussion of the NJ Land Link website, its search features, and how it connects farmers with landowners. From there we will dive into the nuts and bolts of tree fruit production and illustrate the NJ Tree Fruit Production Guide, its features, and how it is a standby reference for many seasoned growers. Rutgers continuing education is one of the most important components of sustainable tree fruit production in New Jersey. For the timeliest information on insect and disease pests, the Plant and Pest Advisory, Local and Regional Meetings, and Tree Fruit Grower Magazines will be introduced and discussed. Lastly, we will stress the importance of connecting with a grower's local county extension office and ensuring they are included on the local list serves, blogs, and mailings. Rutgers team of Tree Fruit experts will also be introduced.

WEB SOIL SURVEY: AN EFFICIENT TOOL TO UNDERSTAND NATIVE PROPERTIES OF THE SOIL

Hemant Gohil PhD
Agricultural Agent
Rutgers University
Cooperative Extension of Gloucester County
Shady Lane Complex
254 County House Rd.
Clarksboro, NJ 08020-1395
hlg50@njaes.rutgers.edu

Traditional soil surveys (printed in a book format) are bulky and difficult to correlate to specific sites especially since there is considerable diversity in soil profiles of New Jersey. The Web Soil Surveys (WSS) developed by USDA-NRCS (National Resources Conservation Services) provides easy access to the largest natural resource information system in the world while addressing the challenges of printed surveys. WSS allows growers to visualize their site in a completely new geometry based on soil properties. For example, it provides information on the natural pH of the soils, which aids in understanding how a site will respond to pH amendments. There are three main steps in using the WSS to access site-specific information; (1) define the area of interest by inputting a sites address or using scale features to zoom in onto a site and then ADI icons to mark the peripheral boundaries; (2) obtain the soil map which provides information on soil types and slopes. The resulting map can be converted into a printable document by clicking on the tab, *printable version* from the toolbar; (3) use the soil data explorer tab, this allows one to access the physical and chemical soil properties tabs. The entire WSS is also available for GPS enabled android and iOS. The provides users with the same web content as WSS but for the specific GPS location of the mobile phone.

ORCHARD MANAGEMENT IN THE EARLY YEARS: PRINCIPLES AND PRACTICES

Daniel Ward PhD
Assistant Extension Specialist
Rutgers University
Rutgers Agricultural Research and Extension Center
121 Northville Road
Bridgeton, NJ 08302
dward@sebs.rutgers.edu

The early years of a newly established orchard are a critical time for optimizing health and growth of the trees. Training during this time is focused on establishing a strong framework that can support the weight of the fruit crop. Young trees tend to be vigorous in their vegetative growth. The orchardists can moderate this vigor through training practices which encourage generative growth (development of flower buds and fruit). Excellent pest control (of weeds, insects, diseases and vertebrates) is a requirement to achieve a strong root system, sturdy branch structure and precocious bearing patterns. Elimination of plant stress from drought, pests, or excessive cropping is critical to helping the tree fill its space in the orchard, and preparing it to begin bearing profitable crops. The long view should guide decisions made during the early years of an orchard plantings life, because they have long term repercussions.

Session 9

Specialty Crops

Session Chair:

Bill Sciarappa

Rutgers Cooperative Extension

USING DEMOGRAPHIC INFORMATION TO IDENTIFY SPECIALTY CROP MARKETS

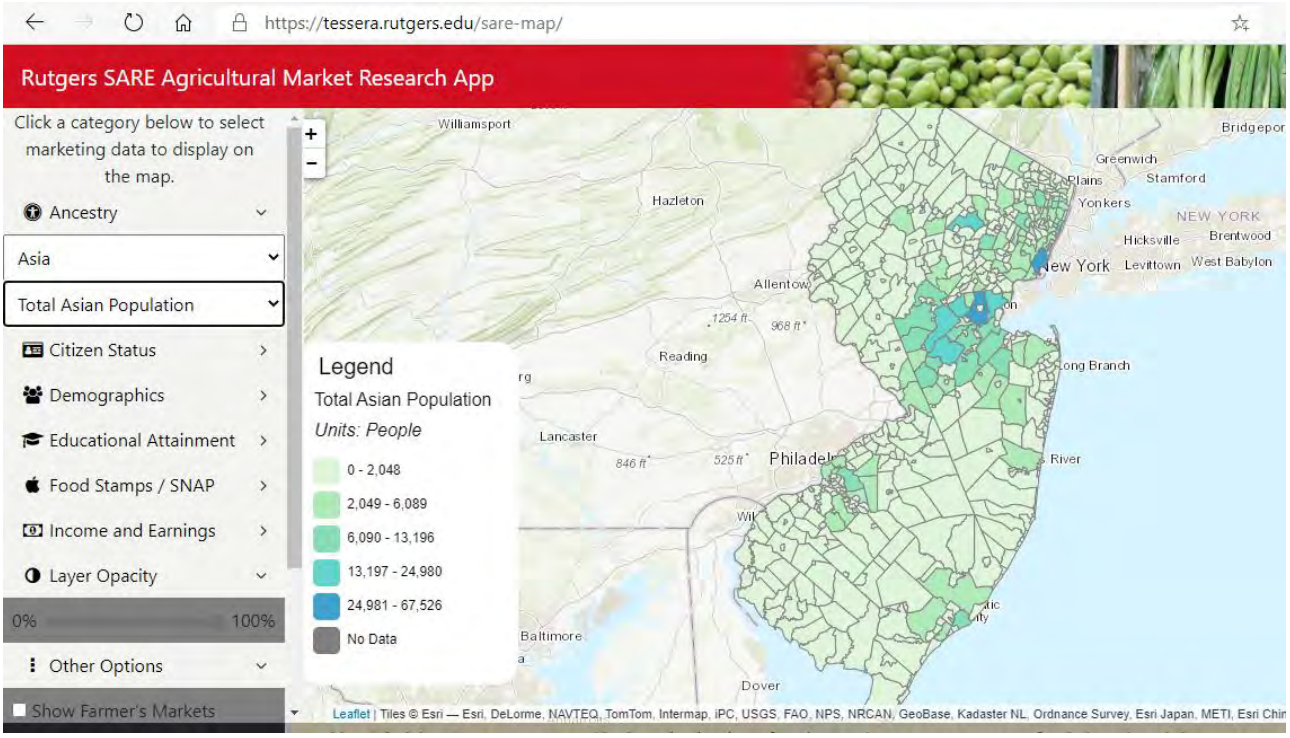
[1]Infante-Casella, M., R. VanVranken, W. Bamka, S. Komar, B. Schilling, and L. Marxen
[1]Rutgers Cooperative Extension
Gloucester County
Shady Lane Complex
254 County House Rd.
Clarksboro, NJ 08020
minfante@njaes.rutgers.edu

An educational program and on-line resources were developed by a team at Rutgers Cooperative Extension to identify demographic areas in the State of New Jersey where demands of specialty produce would be in high demand due to ethnic food preferences. The goal was to develop a web-based tool for population demographics information and marketing sites to improve specialty crop information for farmers. The interactive website provides demographic information with ethnic and high value crops in demand from diverse populations to better help farmers answer the question, “What can I produce to make money?” Communities with ethnic-centric populations have demands for unique farm products, which are not easily accessible, can be produced from a local source, and farmers are willing to sell to unique markets if the potential exists.

New Jersey is an extremely unique state; very intense agricultural production systems, among an extremely diverse and concentrated population. The U.S. Census Bureau reports the population of New Jersey to be 8,944,469 in 2016, making the State the most densely populated in America with 1,210 persons per square mile. In addition, more than 1 in 4 people in New Jersey identify as either Latino or Asian. The U.S. census data also reveals that 21.7% of persons living in New Jersey are foreign born. With this information revealed, growing ethnic crops locally, for the State’s diverse population, has significant potential for New Jersey’s farmers.

Information about demographics, coupled with the ability to produce a crop in New Jersey must be considered. Producers and agricultural service providers have access to population demographic information via the maps provided. The information contained on the website identifies ethnic populations and crops that can be grown in New Jersey to market to specific geographical areas. The use of the World Crops website is coupled with the interactive demographics map to provide information on different crops and production recommendations. The World Crops website has detailed production information on crops from 4 different continents and 26 different countries.

Resources from this program can be found at http://sare.rutgers.edu/market-research.html.



AFRICAN MARIGOLDS FOR FALL MARKETS

William Errickson
Monmouth County Agricultural Agent
Rutgers Cooperative Extension
4000 Kozloski Road
Freehold, NJ 07728
william.errickson@njaes.rutgers.edu

Lauren Errickson
Senior Program Administrator
Rutgers Cooperative Extension
88 Lipman Drive
New Brunswick, NJ 08901
lauren.errickson@rutgers.edu

African Marigolds (*Tagetes erecta*) are an attractive addition to fall agritourism markets, and they are an important flower for the Mexican *Dia de los Muertos* (Day of the Dead) holiday celebrated November 1st and 2nd each year. This versatile, marketable crop is deer resistant, attracts pollinators, and produces high-quality flowers with minimal inputs. However, the plants are frost sensitive and generally require protection to reach full bloom during the target fall harvest window. The New Brunswick Community Farmers Market (NBCFM) has pioneered efforts to produce African Marigolds for the Mexican Community in New Brunswick, leading to cultivar evaluations using moveable high tunnels at the NJAES Fruit and Ornamental Experiment Station in Cream Ridge, NJ.

NBCFM Marigold Project

Community involvement has been the cornerstone of the Marigold Project's success in New Brunswick. Local residents from Central and South America have helped to introduce the Day of the Dead holiday and the cultural tradition of growing ceremonial marigold flowers, engaging many hands in the process at the NBCFM community gardens. The marigold season begins when local families work together to plant seeds around July 4th. Seedlings are generally ready to transplant into hoop house soil in early August, at which time families reconvene for the transplanting process. At the NBCFM site, drip irrigation has been successful in delivering water to the seedlings to maintain even soil moisture levels. In addition to late-season frost protection, the hoop house plastic serves as a wind block, allowing flower stems to grow tall with minimal damage and no staking needed. During the late October harvest, the gardeners work together to cut and bundle long stems with many flowers into bouquets for sale. A cooperative of local gardeners has successfully grown, marketed, and sold marigold flowers for Day of the Dead throughout the city, demonstrating a successful model that could work elsewhere in New Jersey. Additionally, the flowers add visual interest and improve the aesthetics on site at the NBCFM community gardens, which border the

farmers market's sale pavilion and thus add to the customers' shopping experience during the harvest season.

Cultivar Evaluations

To determine the potential for New Jersey growers to produce marigold flowers at scale, cultivar trials were initiated at the NJAES Fruit and Ornamental Extension Station in Cream Ridge, NJ during the 2020 season.

Materials & Methods

Two varieties of African Marigolds (Giant Orange and Coco Gold) were grown in moveable high tunnels. Raised beds were prepared on 6' centers with black plastic mulch and drip irrigation. Marigold seedlings were transplanted on August 17th and were spaced 12" apart. The experiment was conducted as a randomized complete block design with 10 plants per block, and each block replicated 4 times. A 10-10-10 fertilizer was applied before planting and plants received a liquid 10-20-10 fertilizer at the initiation of blooms to encourage flower development. Weekly growth rate, number of blooms per plant, and flower diameter were recorded. Open field grown plants were also cultivated outside the high tunnels to serve as controls and to evaluate the influence of the protective structures. Final measurements were made when the plants were harvested on October 27, 2020.

Results

The high tunnels improved the productivity and quality of both cultivars in the trial and produced marketable bouquets that were ready to harvest in late October. In the high tunnel, Giant Orange had an average of 12.1 flowers per plant and Coco Gold had 15.9 flowers per plant. The average number of flowers was reduced under open field conditions to 6.4 flowers for Giant Orange and 6.9 flowers for Coco Gold (Figure 1). Average Flower diameter was 6.8 cm for Giant Orange and 8.5 cm for Coco Gold plants grown in the high tunnel. Flower diameter of plants grown in the open field were lower for both Giant Orange (5.8 cm) and Coco Gold (6.4 cm) cultivars (Figure 2).

The flowers were harvested on October 27th, with each cultivar yielding approximately one marketable bouquet per plant (which equates to one bouquet per linear foot) when grown in the high tunnels. Each bouquet has an estimated retail market value of $10 to $15. After the conclusion of this project, sixty bouquets were donated to Fulfill Food Bank, who distributed the flowers to families in their network who celebrate the Day of the Dead Holiday. Each flower bouquet included a sticker with the RCE of Monmouth County web address and a QR code to invite these families to explore the services available to them through Rutgers Cooperative Extension. African marigolds grown in high tunnels may offer New Jersey growers an opportunity to produce a high-quality specialty cut flower crop that has cultural importance and value during the fall harvest season. Engaging with communities throughout the state can provide growers an

opportunity to market marigold flowers while sharing in an important cultural tradition, and the introduction of marigold flowers to the farm system also has the potential to increase the aesthetic appeal of on-farm agritourism programs.

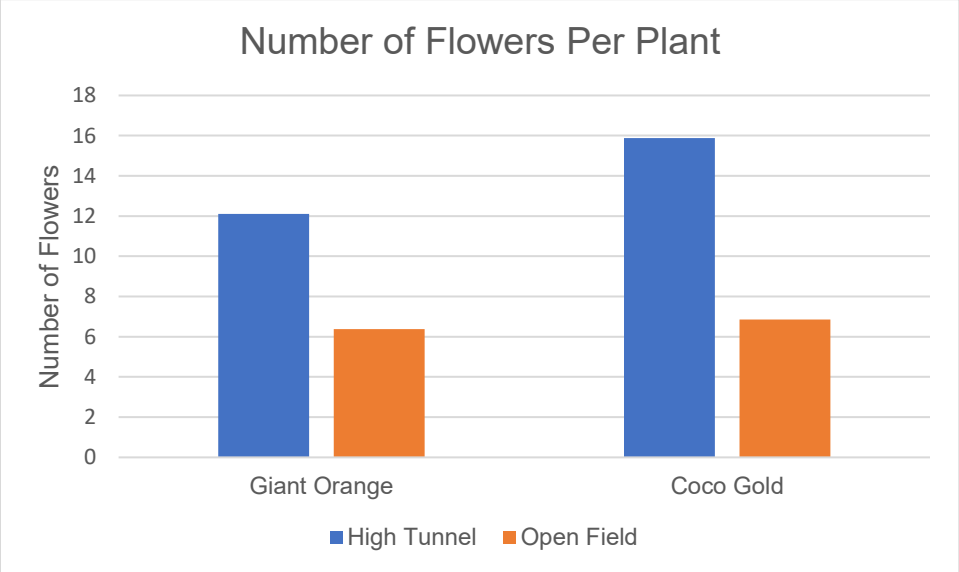


Figure 1: Average number of flowers per plant at harvest: October 27, 2020.

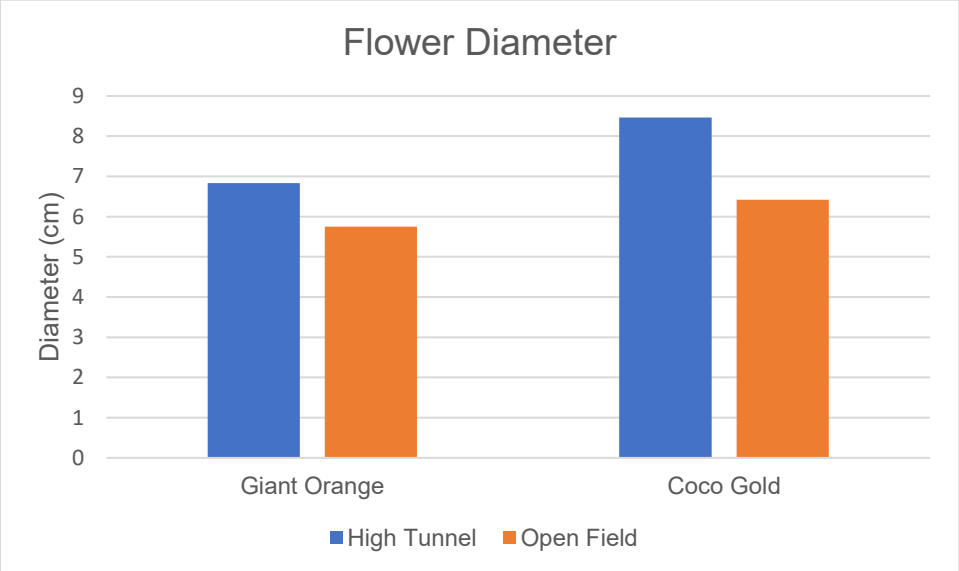


Figure 2: Average flower diameter at harvest: October 27, 2020.

EXOTIC PEPPER PROJECT AT RUTGERS' SCHOOL OF ENVIRONMENTAL AND BIOLOGICAL SCIENCES: ADVANCES SINCE 2009

Albert Ayeni, Thomas Orton and James Simon
Dept. of Plant Biology
Rutgers' School of Environmental and Biological Sciences
New Brunswick, NJ 08901
Contact: aayeni@sebs.rutgers.edu; 848-932-6289

Summary: The exotic pepper content of people's diets continues to rise in the Americas as these nutritious and healthy fruits are finding their ways into all kinds of food products in the market including hot pepper sauce, candies, and snacks of all types. We started our work on exotic peppers with 45 selections collected from NJ farms in 2009. The Habanero types soon became the top on our priority list due to demand in the fresh and hot sauce markets. We conducted a wide array of field trials in different NJ locations with habaneros (*Capsicum chinense*), poblano types (*C. annuum*), African Birdeyes (*C. frutescens*), and others in order to continue to select and develop the most promising types based upon their growth and overall field performance, fruit quality and clientele's interests. By 2017, we released our first habanero selection named 'Rutgers Pumpkin Habanero'™ - a cross between African and Mexican habaneros. This cultivar features low heat (<50K Scoville Heat Units [SHU]) great flavor and pumpkin shape; and comes in yellow, orange, or red color. In 2020, we filed a plant variety patent (PVP) application for our second new release, 'Rutgers Rosebell Red' habanero. We anticipate that seeds should be available to the public in the spring of 2021. Part of our exotic pepper project is to examine and develop value-added products from peppers. In collaboration with Rutgers Dining Service and a private NJ hot sauce company, a new hot sauce named Scarlet Hot Sauce was developed and released to the market late in 2020. The 'Rutgers Rosebell Red' habanero was the major raw material in the Scarlet hot sauce.

Research and Development: Since 2010 the Rutgers Exotic Pepper Project (EPP) has evaluated exotic peppers in different groups, namely: *Capsicum annuum* (Jalapenos, Poblano types, Sweet Minibells,) *C. chinense* (Habaneros, Superhots) and *C. frutescens* (African Birdeyes). Overall, results have shown that all the pepper groups grow well under black plastic mulch in New Jersey. From 2010 to 2017, all evaluations were done under conventional production using NPK fertilizers and herbicide applications as needed. From 2018 to 2020 attention was also focused on production system impact, comparing conventional and organic cultivation conditions.

i) *Plant size*: Our studies showed that, based on plant size, habanero peppers could be classified into small, medium, and large. Of the eight habaneros studied intensely over the years, the Rutgers Pumpkin Habanero ™ released to the public in 2017 was classified as small/medium, the Rutgers Rosebell Red was classified as large, while the

other six, still under evaluation, fall under medium/large classification. Growth condition especially whether conventional or organic significantly affected plant size, with plant size frequently larger under conventional cultivation. Among other pepper types, the superhots and African birdeyes are large plants, while the cayenne types, jalapeno types, minibells, poblano types and serrano types are small/medium in size. Plant size is important when deciding plant spacing in the field. While the small and small/medium size plants may be spaced 15-18" apart, the larger plants will perform better at 18-24" apart.

ii) *Fruit yield, number, and size*: Among the pepper groups we have evaluated, the Poblano types and Jalapenos produced the highest yields (5-7lb/plant) followed by the Sweet minibells and Habaneros (4-6lb/plant); and African Birdeyes (3-4lb/plant). The superhots produced the lowest yield (1-3lb/plant). Fruit number was in the order African Birdeyes >>Habaneros=Sweet Minibells>Superhots> Poblano types > Jalapenos. Fruit size was in the order Poblano types>Jalapenos>Sweet Minibells>Habaneros>Superhots>African Birdeyes. Fruit yield and number were higher in the conventional plot than in the organic, but fruit size did not differ significantly between the two systems.

iii) *Fruit post-ripening and post-harvest integrity:* Fruit behavior post-ripening and postharvest were evaluated in our studies. Table 1 shows the data recorded for habanero peppers in 2016. We found that most habanero peppers retain fruit integrity for four or more weeks after ripening and

Table 1: Life cycle, ripe fruit durability and fruit shelf life of Habanero selections evaluated at Rutgers' Hort Farm 3 in 2016

Habanero ID	Life cycle	RFD* (4 weeks after ripening)	Fruit Shelf Life (weeks)	
			At 45-50°F	At Room Temp
A (Rosebell Red Hab)	Medium/ Late	5	4-5	3
B1	Medium	5	4	2
C	Medium	3	3	1-2
F	Medium	5	4-5	3
H	Early	3	3	2
I	Early	4	3-4	2
YH2	Late	1	3	1-2
YH3 (Pumpkin Hab)	Early	4	3-4	3

*RFD = Ripe fruit durability (i.e. for how long the fruit retains integrity on the plant in the field after ripening). RFD was rated 4 weeks after ripening on a scale of 1-5 where 1= badly deteriorated, 5= excellent integrity

scored 4-5 on the "*ripe fruit durability*" (RFD) rating, using a scale of 1-5 (1= fruit badly deteriorated; 5 = excellent integrity). Rating was done four weeks after ripening. Fruit shelf-life post-harvest was also evaluated. Most habanero fruit would retain integrity for 2-3 weeks at room temperature and storage at 40-50ºF could extend shelf life by 1-2 weeks (Table 1). The habanero peppers with poor RFD (<3) and poor shelf-life (<2 weeks at room temperature) were dropped from further evaluation. Among the other pepper types, we found that the Poblanos and Jalapenos had the poorest RFD and shelf-life after ripening. This observation probably explains why these peppers are sold green on the market and very rarely in the red ripe form.

iv) *Fruit chemistry:* Dried ripe fruits were analyzed to test for capsaicinoids and related compounds that determine the level of heat in conventionally and organically grown habanero peppers. In addition, proximate analyses were done to assess the nutritional value of the peppers.

a) Scoville heat Units (SHU): We observed significant variations in heat level between and among habanero peppers grown in the conventional and organic systems. Overall, the Superhots contained the highest heat level (500,000-1.4 million SHU) followed by the Habaneros (25,000-180,000 SHU), Poblanos (0-180,000 SHU), African Birdeyes (28,000-65,000 SHU) and the Jalapenos (0-20,000 SHU). Among Superhots, fruit from the conventional system was slightly spicier than (or as spicy as) those from the organic plot. Among the Habaneros, two selections (HAB BI and C) produced fruits in the organic system that were spicier than those from the conventional system. Others in the group produced fruit that were slightly more (or equally) spicy in the conventional system as in the organic system. 'Rutgers Pumpkin Habanero', a mild habanero, contains <50K SHU and the 'Rutgers Rosebell Red', a hot habanero, contains 100-200K SHU. These qualities position the peppers for different markets --- tastes for mild and taste for hot peppers, respectively. Based on our observations to date, we can classify habaneros into three groups, namely:

   A. Mild Habaneros <50K Scoville heat units (SHU)
      ('Rutgers Pumpkin Habanero'™ belongs to this group)
   B. Hot Habaneros 50K-500K SHU
      ('Rutgers Rosebell Red' Habanero™ belongs to this group)
   C. Superhot Habaneros >500K SHU

   The African Birdeye group produced spicier fruit in the organic than in the conventional system. In the Poblano group, the cultivation system impacted fruit heat level only in the Padron pepper where the heat level was higher under conventional than organic. Cultivation system had no significant impact on the other members of the group. Heat level in the Jalapeno fruit behaved erratically in response to the cultivation systems.

b) Proximate analysis: All the habanero selections are rich in N & K and have appreciable levels of P, Ca, Mg and S. The fruit of habanero selections YH2 and

YH3 (both are yellow habaneros) are rich in Fe and others have high levels of this micronutrient. Other micronutrients are also present at reasonable levels with YH2 and YH3 demonstrating some affinity for high Zn level.

In addition to the fruit elemental analysis, habaneros are rich in Vit. A and C; and in capsaicin and capsaicinoids wildly reported for pain and cold management across the world. We therefore look at habaneros not just for nutritional values, but equally important, their therapeutic benefits.

Conclusion: The Exotic Pepper Project team has demonstrated that exotic peppers from the *Capsicum annuum, C. chinense,* and *C. frutescens* groups can be grown successfully in New Jersey. This is a major addition to our new crops repository at Rutgers SEBS. They are available to our:

a) growers for future integration into their crop options for the diverse population in New Jersey.
b) researchers in the therapeutic industry for personal care products, pain relief, and wound or insect bite healing.
c) hot sauce companies for unique tastes and flavor.
d) landscapers and nursery enterprises for addition of new and attractive plants to their collection.
e) home gardeners for producing their own special pepper recipes to spice up their diets.
f) vertebrate pest management experts for use as deer and groundhog repellent.

Acknowledgements: We are grateful to Rutgers NJAES, RCE and the USDA-IR4 project for partial funding of the Exotic Pepper Project. We are also indebted to the technical staff at Rutgers Ag Research and Extension Center (RAREC), Bridgeton, NJ; Rutgers Hort. Farm 3, East Brunswick, NJ; and the Snyder Research and Extension Farm, Pittstown, NJ; for crop production services and technical support. We have worked with many interns and student workers since 2009 and wish to acknowledge their invaluable contributions to our exotic pepper project.

Session 10

Weed Control

Session Chair:

Thierry Besancon

Rutgers NJAES

WEED MANAGEMENT UPDATE FOR VINE CROPS

Thierry Besançon

Extension Weed Science Specialist
New Jersey Agricultural Experiment Station
P.E. Marucci Center for Blueberry and Cranberry Research and Extension
125A Lake Oswego Road, Chatsworth, NJ 08019
thierry.besancon@rutgers.edu

Cucurbits are a very diverse group of vegetable crops that includes in our region melons, watermelon, summer and winter squash, pumpkin, and cucumber. These crops will vary in their growth habits and characteristics which will influence our options for managing weeds. Additionally, herbicide sensitivity may significantly differ between species, and even between varieties within a species. The most important period during which weed competition may affect crop development and ultimately yield is around crop seed germination or transplanting, and in the few weeks that follow. During this period, the rapid growth of weeds can deprive crop seedlings from absorbing water, nutrients, and light. Therefore, maintaining a weed-free environment over the course of the three to five weeks that follow crop seed germination is crucial for maintaining your crop yield potential. Later, the trailing growth of some cucurbits (cucumber, melons, watermelons…) will provide sufficient shading of the ground for reducing the need for weed management.

Scouting for Weeds

Weeds have generally to be targeted at the seedling stage since controlling fully developed weeds can be extremely difficult because of their size that prevent effective herbicide distribution on the plant or because of their ability to regrow following mechanical or chemical control. Scouting for detecting weed seedlings shortly after their emergence is a critical component of any successful weed management program.

The goal of weed scouting is to get a representative idea of the weed populations throughout the whole field. For a 100-acre field, make 5-10 stops that are well spread out through the field. At each stop, walk 10 paces (or 30 feet) and record the weed species that are present as well as their lifecycle (summer annual, winter annual, perennial), growth stage or height, and the severity of the infestation based on number of plants (low, medium, high). An efficient scouting program should also provide information on crop phenology as this may extremely important with regards to chemical weed control. The use of farm maps for weed scouting will provide data that can be used to define the control strategy but also assess its efficiency at controlling weeds over time.

Weed Identification

Accurate weed ID is important for effective management because herbicide recommendations vary according to species, as do some mechanical, cultural, and biological strategies. Some species can look like other species from afar but may have drastically different management requirements. They should be examined closely to determine herbicide programs. Guides such as Weeds of the Northeast (http://www.cornellpress.cornell.edu/book/) or weed identification websites (http://oak.ppws.vt.edu/~flessner/weedguide/) can be helpful to accurately determine weed species and become familiar with their biology and ecology. Additionally, cellphone apps such as iNaturalist (https://www.inaturalist.org) can really help identifying weeds in the field if good quality and multiples weed pictures are uploaded to the app or the website.

Weed Management before Planting

To prevent the buildup of weed seed in the soil, cultivate weeds before they set seed in rotation crops. After harvest of the rotation crop, clean cultivate the field, plant a green manure crop, or use an herbicide to prevent weed infestations. To control yellow nutsedge foliage and suppress nutlet formation, spray with a labeled glyphosate product after flowers appear, but before foliage dies. Expect only partial control of yellow nutsedge the first year after initiating the program Effective yellow nutsedge control can be achieved by repeating the application for several consecutive years. A late summer or fall application of glyphosate mixed with dicamba or 2,4-D to healthy weed foliage can help suppress broadleaf perennial weeds such as field bindweed, Canada thistle, horsenettle or bitter nightshade.

Just before planting cucurbits, superficial soil cultivation followed by irrigation of the field will stimulate weed seed germination. Cultivation should be as shallow as possible in order not to bring up dormant weed seed from deeper soil layers. Weed seedlings can then be controlled with cultivation or the use of a nonselective herbicide such as Gramoxone (paraquat) or Roundup (glyphosate) to destroy them. Carrying out this operation as close to planting time as possible ensures that soil temperature and climatic conditions are similar to those that will occur during the crop germination period, thus maximizing the number of weeds controlled.

Plant or transplant cucurbits into uniform beds utilizing a precision planting system that will promote a uniform crop and allow cultivation close to the seed line. This reduces the need for hand hoeing and lowers weed control costs.

Various herbicides are labeled on cucurbits for soil applications prior to weed emergence and crop planting. However, some herbicides may only be labeled for specific cucurbit crops. For example, Sandea (halosulfuron) is labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but **NOT** labeled on muskmelons. Command (clomazone) is labeled for winter squash and processing pumpkins, but **NOT** for jack-o-lantern pumpkins. There are also restrictions on soil-applied preemergence herbicides based on the production system. For example, on cucumbers, Prefar (bensulide) can be soil-applied for preemergence weed control on the row under plastic much or on bare ground as well as between the rows. On the

opposite, Treflan (trifluralin) can only be applied between rows as a directed spray after crop emergence when plants have reached the 3 to 4 true leaf stage of growth.

You should **always** refer to the label or the Mid-Atlantic Commercial Vegetable Production Recommendations for specific restrictions before deciding to apply an herbicide.

Weed Management after Crop Emergence

Close cultivation is only possible before runners (vines) are produced. Hand hoeing is often used to supplement machine cultivation and thin the crop to the required density. Late-season hand hoeing can help reduce weed seed but almost always results in some yield loss.

Gramoxone (paraquat) can be used as a shielded application in row middles to control emerged weed seedlings after planting. As a contact herbicide that will not be translocated within the plant, Gramoxone should be mixed with a nonionic surfactant at 0.25% v/v to maximize the spreading of the spray solution on the weed leaf surface. For efficient weed control, applications should be made on small well seedlings. Shields or hoods should always be used to prevent spray contact with the crop and applications should be made at a low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. Aim (carfentrazone) can be applied as a hooded spray to control small broadleaf weeds between crop rows. Avoid contacting cucurbits, because carfentrazone may cause injury.

Poast (sethoxydim) and Select Max (clethodim) can be used to control seedlings of some annual and perennial grasses. The effectiveness of these materials, however, is reduced when grasses are under moisture stress. Later growth stages of annual grasses are more difficult to control. Follow label instructions regarding the use of adjuvants with these herbicides. Sethoxydim will not control annual bluegrass and it varies in its ability to control particular grass species. For effective control of perennial grasses (bermudagrass and johnsongrass), two applications will be required.

During cooler seasons or for crops that have a long growing season, a layby soil-applied herbicide can be beneficial to control late emerging grasses and annual broadleaf weeds. They are applied as a directed spray to the soil surface when the crop has four to five leaves, taking care not to contact the crop foliage. None of these herbicides will control emerged weeds; they are only effective on germinating seed. Their main benefit is to keep the weed populations low to facilitate harvest. Some carryover can occur under certain conditions, creating a plant back problem. Consult the herbicide label before application.

Session 11

New Orchard Establishment II

Session Chairs:

Megan Muelhbauer / Hemant Gohil
Rutgers Cooperative Extension

ORGANIC APPLE PRODUCTION IN NEW JERSEY, IS IT FEASIBLE?

Megan Muehlbauer PhD
Agricultural Agent
Rutgers University
Cooperative Extension of Hunterdon County
314 State Route 12 Building #2
Flemington, NJ 08822
muehlbauer@njaes.rutgers.edu

There are a number of challenges in establishing an apple orchard in New Jersey, many of which can become exponentially more difficult to manage without conventional pesticides. Conventional orchard management practices are often used in regions with uniquely warm and wet spring and summers like New Jersey. However, a healthy and productive organic apple orchard can be established if a strong foundation of education and preparation is developed by growers. This foundation includes a strong understanding of disease and insect cycles and the importance of proper weed management and mitigation. Additional considerations include proper cultivar selection, nutrient management, organic pesticides, and cultural management techniques.

Session 12

Hemp

Session Chairs:

William Bamka / Stephen Komar

Rutgers Cooperative Extension

2020 - RUTGERS FIRST HEMP TRIALS: OBSERVATIONS AND FUTURE DIRECTION

Bill Bamka and Stephen Komar
Agricultural Agents
Rutgers Cooperative Extension
2 Academy Dr., Westampton, NJ
bamka@njaes.rutgers.edu

Hemp is from the plant species Cannabis sativa and is used to produce a variety of industrial and consumer products. Hemp is a source of fiber and oilseed grown in countries worldwide. Many products, including fibers, textiles, paper, construction and insulation materials, cosmetic products, animal feed, food, and beverages can be produced from hemp. Hemp is low (less than 0.3%) in tetrahydrocannabinol (THC), the cannabis plant's primary psychoactive chemical.

The 2014 Farm Bill initially paved the way for production of industrial hemp once again in the US. There is renewed interest and focus on hemp now as a renewable and sustainable resource for a wide variety of consumer and industrial products. The 2018 Farm Bill removed hemp and its derivatives from the Controlled Substances Act, thus legalizing the cultivation of hemp and the hemp derivative CBD oil. In accordance with the 2018 Farm Bill, NJ passed the NJ Hemp Farming Act and created the NJ Hemp Program which received USDA approval to permit legal hemp production in NJ.

Hemp represents a new crop and market opportunity for farms within New Jersey. There are questions about the viability and suitability of hemp production in New Jersey. To help farmers succeed, agronomic research on hemp is needed, as much of the historical production knowledge for our region has been lost. In response, the Rutgers NJAES initially planned several replicated trials and observation plantings of hemp across the state during the 2020 growing season focusing on grain and CBD production. The primary objective of the first-year university trials was to evaluate the field performance (yield, costs and production) as well as quality from NJ-grown hemp. Restrictions due to the Covid19 pandemic initially resulted in the suspension of all Rutgers hemp trials. In June of 2020 the University permitted reduced scope hemp trials at both the Rutgers Snyder Farm and the Rutgers Agricultural Research Extension Center. The work consisted of replicated trials looking at CBD production systems.

This presentation will review the trials and provide information learned from the 2020 growing season at the Rutgers Snyder Research and Extension Farm. Also discussed will be subsequent research needs identified from this initial study.

MARKETING CONSIDERATIONS FOR INDUSTRIAL HEMP PRODUCTION IN NEW JERSEY

Stephen Komar and Bill Bamka
Agricultural Agents
Rutgers Cooperative Extension
130 Morris Turnpike
Newton, NJ 07860
komar@njaes.rutgers.edul

Industrial hemp was once an important crop in the United States. During the World War, industrial hemp was identified as a critical product needed by the US government, due to difficulty in sourcing fiber from Asia, for packaging, rope and other key products and as such was commercially grown domestically by American farmers. The 2014 Farm Bill paved the way for production of industrial hemp once again in the US. There is renewed interest and focus on industrial hemp now as a renewable and sustainable resource for a wide variety of consumer and industrial products.

Although industrial hemp production may provide an opportunity for New Jersey, it is crucial that producers carefully examine the market and accessibility of market channels as part of their overall operation. As is the case with any emerging agricultural product, limited data exists to quantify the economic feasibility of industrial hemp production in New Jersey.

There are three distinct markets for industrial hemp crops: fiber, grain and cannabidiol (CBD oil). Crop production practices, equipment needs, and plant varieties are specific to the end use products. These differences necessitate that producers develop specific marketing strategies for each hemp product they intend to produce. Recent research in New Jersey suggests that disease and insect pests can have a tremendous influence on the quality and ultimately the marketability of hemp grown in the region. These production parameters need to be adequately assessed before producers enter into a hemp business enterprise.

It is extremely important to know how to market hemp and where to sell it. One of the most common reasons for not succeeding with an alternative or niche crop is from lack of research as to where to sell the crop and its potential value. It is recommended to first determine if there are processors or buyers in close proximity. Producers growing industrial hemp should also determine if there is any requirement to contract with a buyer in order to sell the crop. Keep in mind that certain contracts specify varieties to be grown and may also require the crop to be grown using specific production practices.

This presentation will focus on potential marketing opportunities for New Jersey hemp production and the economic feasibility of production and processing of hemp products. Findings from the 2020 production season will be presented including marketing and other economic considerations.

HEMP DISEASES IN NEW JERSEY: WHAT WE KNOW

Nimmi Rajmohan[1], Andy Wyenandt[1], Richard Buckley[1], Thomas Gianfagna[1], James Simon[1], Stephen Komar[2], Bill Bamka[3] and Raul Cabrera[1]

[1]Rutgers University, Department of Plant Biology
[2]Sussex County Agricultural Agent
[3]Burlington County Agricultural Agent

Email: wyenandt@njaes.rutgers.edu

Hemp or industrial hemp (*Cannabis sativa*) is grown for fiber, seed, or cannabidiol (CBD) oil. On December 27, 2019, New Jersey was among the first three states to have its Industrial Hemp Program approved by the USDA. Hemp varieties were grown for the first time in more than 50 years at two Rutgers research farms in 2020.

Hemp is susceptible to many diseases caused by fungi, bacteria, or viruses as well as insect pests. Abiotic factors like nutrient imbalance and air pollutants, as well as poor weather conditions can also predispose hemp to important pests. Fungi are one of the most common pathogens that can cause disease in hemp. Plants infected by fungal pathogens may exhibit symptoms of leaf spots, root rot, mildew, wilt, and canker.

This presentation is aimed at providing information on emerging hemp diseases in New Jersey which were observed during the 2020 growing season. Several leaf spot diseases (Hemp and Yellow leaf spot) were observed during the summer in field trials at both locations. These spots ranged from tiny tan circular lesions to larger irregular lesions with yellow margins. In susceptible varieties leaf spots can lead to severe leaf loss, stunted growth, and in severe cases plant death. Powdery mildew, a very common fungal disease was observed in both indoor and outdoor grown hemp in southern New Jersey. Other commonly observed diseases on hemp included Botrytis gray mold and Fusarium bud blight.

As production of industrial hemp increases in New Jersey, pathogen and pest populations will need to be carefully monitored. There are currently limited fungicides labelled for control of hemp diseases in New Jersey. See the EPA site for approved pesticides for hemp. Evaluating and choosing resistant cultivars along with proper cultural practices will be a very important aspect of disease and insect management.

HEMP PRODUCTION IN NEW JERSEY: CHALLENGES AND OPPORTUNITIES PANEL DISCUSSION

Stephen Komar, Bill Bamka, Nimmi Rajmohan, Andrew Wyenandt, Richard Buckley, Thomas Gianfagna, James Simon, and Raul Cabrera

Rutgers Cooperative Extension, Rutgers New Jersey Agricultural Experiment Station

https://njaes.rutgers.edu

Industrial hemp was once an important crop in the United States. During the World War, industrial hemp was identified as a critical product needed by the US government, due to difficulty in sourcing fiber from Asia, for packaging, rope and other key products and as such was commercially grown domestically by American farmers. The 2014 Farm Bill paved the way for production of industrial hemp once again in the US. There is renewed interest and focus on industrial hemp now as a renewable and sustainable resource for a wide variety of consumer and industrial products.

Although industrial hemp production may provide an opportunity for New Jersey, it is crucial that producers carefully examine the feasibility of producing this crop including production, management, and accessibility of market channels as part of their overall operation. As is the case with any emerging agricultural product, limited data exists to quantify the economic feasibility of industrial hemp production in New Jersey.

During the 2020 growing season, a team of Rutgers faculty and staff conducted various research programs to address many of these issues. This session will allow producers to discuss these trials with the hemp team members and to learn some of the challenges and opportunities that this crop presented during the 2020 growing season.

Researchers will be discussing hemp agronomy, variety trials, diseases, insect pests and CBD and THC management and analysis. Producers will have an opportunity to ask the Rutgers Hemp Team questions regarding hemp production and management in New Jersey.

Session 13

Blueberry

Session Chair:

Gary Pavlis

Rutgers Cooperative Extension

SEARCHING FOR NOVEL REPELLENTS TO MANAGE SPOTTED-WING DROSOPHILA

Cesar Rodriguez-Saona and Pablo Urbaneja-Bernat
Rutgers University, P.E. Marucci Center
125A Lake Oswego Rd., Chatsworth, NJ
crodriguez@njaes.rutgers.edu; paurbaneja@gmail.com

The spotted-wing drosophila (SWD), *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae), a native to Southeast Asia, has become a major insect pest of soft- and thin-skinned fruit crops, including raspberries, strawberries, blueberries, blackberries, and cherries (Walsh et al. 2011). This pest has rapidly expanded its geographic range across multiple continents, which now includes many Asian, North and South American, and European countries (Asplen et al. 2015). In the United States, SWD was first detected in California in 2008 and quickly spread to other states; by 2011, it was found in New Jersey. Several behavioral and morphological features enable gravid SWD females to be attracted to, and oviposit on, fresh fruit in addition to overripe fruit including its attraction to odors from ripening fruit and an enlarged, serrated ovipositor.

An understanding of the response of SWD to repellent stimuli can help in the development of behavioral control tactics. Repellents have been identified for many insect pests; however, only a few have been tested so far for SWD. Previous studies showed that two fungal compounds, geosmin and octenol, repel SWD in the laboratory and field (Wallingford et al. 2017). However, geosmin is very expensive and highly volatile, while octenol resulted in phytotoxicity at the high concentrations needed to be effective. Thus, there is the need to identify and evaluate new cost-effective and safe repellents for SWD. Here, we summarize our ongoing research towards the identification of new repellents for SWD control. Our lab is testing repellents from three different sources: (1) anthracnose-infected fruit, (2) commercial elicitors of plant defenses, and (3) compounds from fermented apple juice shown previously to repel SWD (Feng et al. 2018).

Repellency of Anthracnose-infected Fruit

Anthracnose, caused by the fungus *Colletotrichum fioriniae*, is an important disease of highbush blueberries in the United States. We conducted choice and no-choice studies to determine the repellent effects of anthracnose-infected fruit and *C. fioriniae* on SWD (Urbaneja-Bernat et al. 2020). In choice tests, SWD was less attracted to anthracnose-infected fruit. Blueberry fruit treated with anthracnose solutions containing spores from either field-collected infected fruit ('fruit') or a laboratory *C. fioriniae* culture ('colony') were less attractive to sexually mature SWD females, but not males, than untreated fruit. The plant tissue (fruit or leaves) did not influence *C. fioriniae* repellency effects on SWD. In no-choice tests, 55% fewer numbers of eggs were laid on (Figure 1), and 65% fewer adults emerged from, blueberry fruit treated with either the 'fruit' or 'colony' anthracnose solution than untreated fruit. Egg-to-adult SWD survival was also 12% lower on *C. fioriniae*-infected fruit. Future studies will be conducted to identify the repellent volatiles from *C. fioriniae*. These findings will help towards the discovery of microbial-derived

repellent compounds that could be used in behavior-based management strategies for SWD.

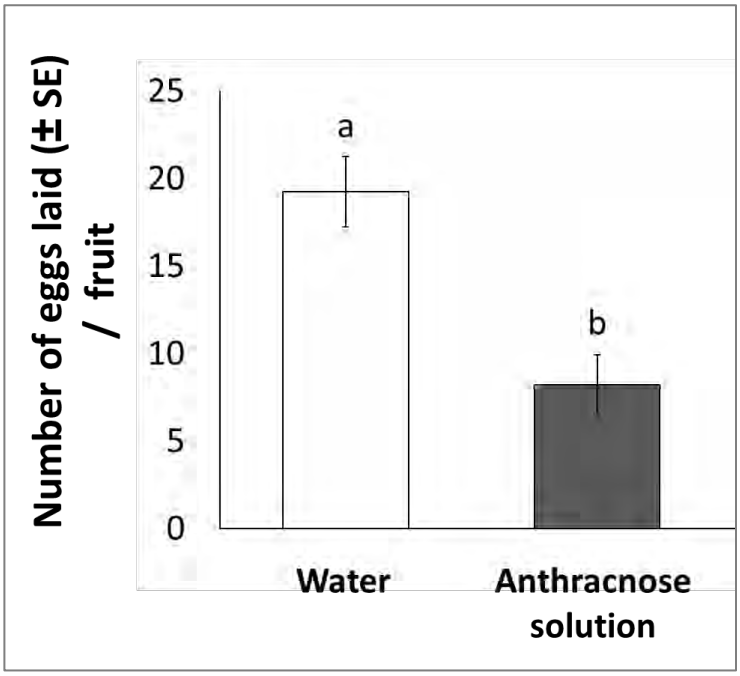


Figure 1. Number of eggs laid by SWD on blueberry fruit sprayed with water (control) or an anthracnose (*Colletotrichum fioriniae*) solution in no-choice tests. Different letters indicate significant differences between treatments.

Elicitors of Plant Defenses on SWD

We evaluated the effects of commercially-available elicitors of plant defenses on SWD behavior and performance. For these studies, we tested five elicitors of plant defenses: Actigard, Blush, LifeGard, Oxidate, and Regalia. Blueberry fruit was treated with these elicitors 24 hours before the onset of the experiments. In no-choice experiments, we observed a negative effect of the elicitors on SWD oviposition (Figure 2), with the lowest numbers of eggs laid in fruits treated with Actigard, LifeGard, and Oxidate compared with the control (untreated fruit). In choice experiments, less number of eggs were laid in fruits treated with the elicitors, except for Blush, compared with the untreated control. However, only one of the elicitors (Regalia) repelled SWD females. Although the mechanism remains unknown, our data show the potential of using these elicitors to reduce SWD fruit infestation.

Repellents from Fermented Apple Juice

We evaluated methyl benzoate (MB), a volatile from fermented apple juice, and nine related compounds (i.e., methyl benzoate analogs) on SWD behavior under laboratory and semi-field (cage) conditions. In preliminary laboratory studies, three of these compounds increased SWD oviposition in fruits (M2CB, nPrB, and VB), while one of them (M2MOB) reduced oviposition at a level similar to geosmin (used as a “positive” control) (Figure 3). M2MOB also decreased the number of eggs laid in treated fruits at levels similar to geosmin under semi-field conditions.

CONCLUSIONS

Our results provide information on potential new natural sources of repellents to manage SWD. More studies are needed to identify the specific active compounds from fungal sources such as anthracnose infection and possible inhibitory mechanisms of the elicitors of plant defenses. Additional studies are also needed under more realistic field conditions to confirm these results. Our ultimate goal is to identify effective repellents that can be used in combination with attract-and-kill strategies to manage SWD.

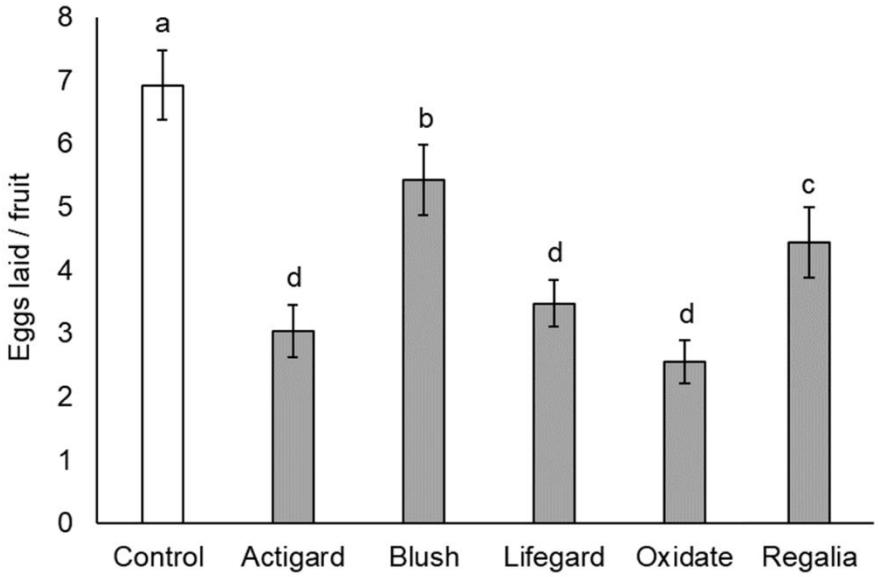
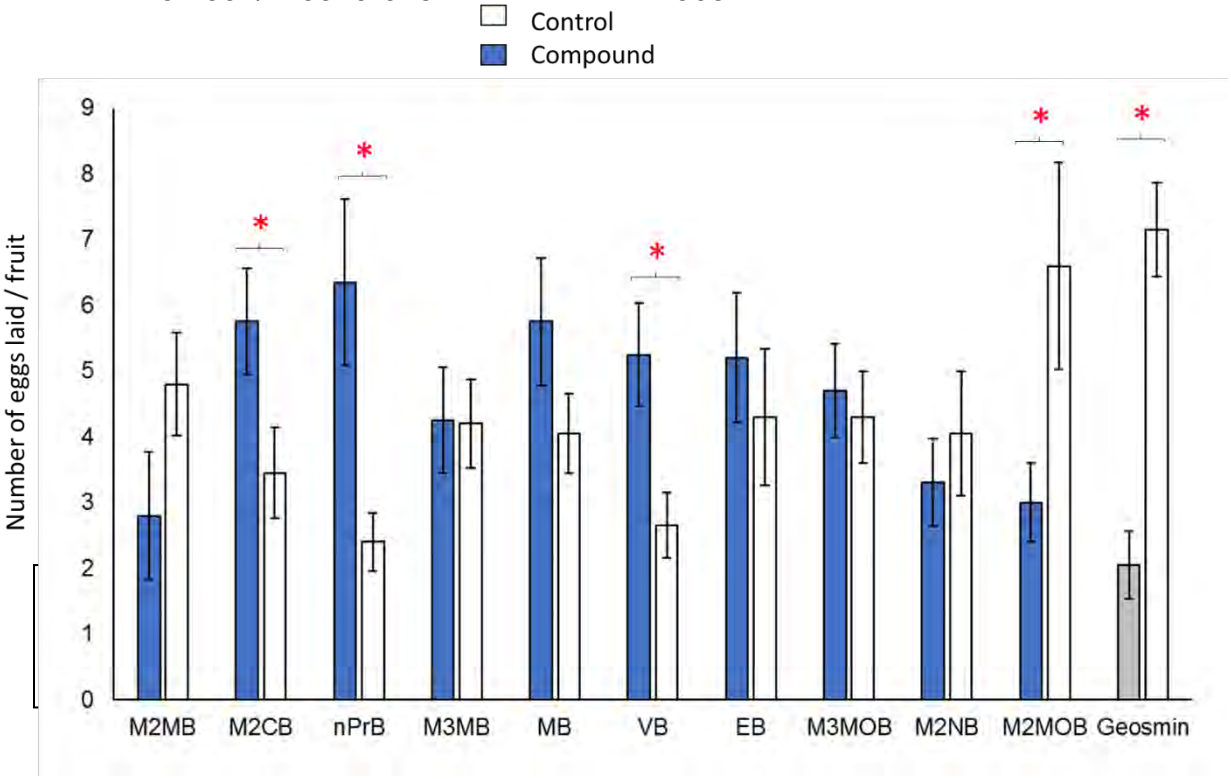


Figure 2. Number (± SE) of eggs laid by SWD on blueberry fruit sprayed with water (control) and five elicitors of plant defenses in no-choice tests. Different letters indicate significant differences between treatments.

REFERENCES

Asplen MK, Anfora G, Biondi A, et al. (2015) Invasion biology of spotted wing Drosophila (Drosophila suzukii): a global perspective and future priorities. J Pest Sci 88:469–494. doi: 10.1007/s10340-015- 0681-z.



Feng Y, Bruton R, Park A, Zhang A (2018) Identification of attractive blend for spotted wing drosophila, *Drosophila suzukii*, from apple juice. J Pest Sci 91:1251–1267. doi: 10.1007/s10340-018-1006-9.

Urbaneja-Bernat P, Waller T, Rodriguez-Saona C (2020) Repellent, oviposition-deterrent, and insecticidal activity of the fungal pathogen *Colletotrichum fioriniae* on *Drosophila suzukii* (Diptera: Drosophilidae) in highbush blueberries. Sci Rep 10:1–9. doi: 10.1038/s41598-020-71341-y.

Wallingford AK, Cha DH, Linn CE, et al. (2017) Robust manipulations of pest insect behavior using repellents and practical application for integrated pest management. Environ Entomol 46:1041–1050. doi: 10.1093/ee/nvx125.

Walsh DB, Bolda MP, Goodhue RE, et al. (2011) *Drosophila suzukii* (Diptera: Drosophilidae): Invasive pest of ripening soft fruit expanding its geographic range and damage potential. J Integr Pest Manag 2:G1–G7. doi: 10.1603/ipm10010

Session 14

Creating Value Added Products & Services to Increase Profits

Session Chairs:

William Hlubik / Megan Muehlbauer
Rutgers Cooperative Extension

NO ARTICLES SUBMITTED

Session 15

Food Safety

Session Chairs:

Meredith Melendez / Wesley Kline
Rutgers Cooperative Extension

CLIMACTIC CONDITIONS ALTER PATHOGEN PRESENCE IN SOIL AND WATER

Kali Kniel
Professor, Microbial Food Safety
Department of Animal and Food Sciences, University of Delaware
044 Townsend Hall, 531 South College Avenue
Newark, DE 19716
kniel@udel.edu

Assessing risks associated with produce food safety is complicated and involves balancing risks from multiple inputs, including water, plants, soil, fertilizers, animals and humans. Water and use of soil amendments are critical to plant growth and risks associated with these inputs may be impacted by climactic changes, which vary from year to year. Complex soil-environmental interactions associated with application of Biological Soil Amendments of Animal Origin (BSAAO) enhance soil nutrients and may support pathogen survival and transfer. Irrigation water may introduce pathogenic bacteria to the crops. This talk will describe findings of bacterial pathogen presence and contamination associated with BSAAO and water. Over 5 years, several field trials were conducted to address bacterial survival and transfer to crops in correlation with climactic and physiochemical parameters with use of poultry litter as a soil amendment. Differences in survival of *E. coli* applied to poultry litter were observed each year as a factor of climate and weather. Differences in transfer of *E. coli* applied to poultry litter and then transferred to crops (cucumbers, watermelons, spinach, radish) were observed as a factor of climate and crop type. Changes in water quality parameters also affected the detection of pathogens in ponds, river, ad reclaimed water in the Mid-Atlantic region of the United States over a 2-year time period. Climatic conditions, specifically precipitation, are critical in pathogen presence, survival and transfer.

NAVIGATING FOOD SAFETY IN THE PICK YOUR OWN PATCH

Jeff Stolzfus
Extension Educator
Penn State Univ

The Food Safety Modernization Act was passed in 2011 as a response to the food borne outbreaks, some of which are caused by workers in the field. FSMA regulations, as well as, most food safety audit standards require growers to train their workers on personal hygiene and other food safety risks. The grower must then have a signed log of workers that have been trained. This obviously becomes unworkable quickly when customers pick their own fruit. Many third-party audit schemes require visitor logs of all visitors who enter the field. FSMA does **not** require visitor logs.

FSMA regulation 112.33 states

"(a) You must make visitors aware of policies and procedures to protect covered produce and food contact surfaces from contamination by people and take all steps reasonably necessary to ensure that visitors comply with such policies and procedures.

(b)You must make toilet and hand washing facilities accessible to visitors."

How do you make visitors of policies and procedures? The same way you make them aware of other procedures, i.e. signs, written instructions, verbal instructions, post them on a website or Facebook page.

How do you monitor compliance? You do not have to hire a food safety policeman. However, you are expected to "take all steps reasonably necessary to ensure that visitors comply". If you see something, say something.

What are the policies you need to make visitors aware of?

Wash ends before picking
Don't pick when you are contagiously sick
No pets or emotional support animals in the field (except service dogs)
Don't pick dropped fruit
No used cardboard containers
Fruit contact surfaces should be cleanable with water or single use disposable.

If pickers are required to wash their hands, where can they do that? There are many options for hand washing stations. Some are permanent, some are temporary and portable, some are self-contained with clean and waste water. Hand wash stations must have the following:

Clean, potable water (does not have to be hot)

Soap, hand sanitizer is not a replacement for soap
Single use paper towels
Trash can with lid
Waste water needs to be captured or drained away from production areas and foot traffic.

What about harvesting fruit for wholesale from PYO fields?

FSMA has no regulations around this practice as long as you are following their visitor policies. However, some auditors and audit standards have not allowed product from PYO fields to harvested for resale after PYO customers have been in them. Check with your auditor to see if this is going to be a problem.

Although food safety regulations may give PYO growers something else to worry about, it ultimately boils down to doing two things;

Make customers aware of your food safety policies and provide toilet and hand washing facilities.

FSMA PSR INSPECTION UPDATE

Christian Kleinguenther
Bureau Chief, Division of Marketing and Development
New Jersey Department of Agriculture
275 N Delsea Drive
Vineland, NJ 08360
Christian.kleinguenther@ag.nj.gov

The NJDA is active in promoting the safety of produce grown in New Jersey by supporting grower education and conducting inspections for the implementation of the FSMA Produce Safety Rule on farms growing covered produce.

The NJDA has an MOU with Rutgers Cooperative Extension to provide Produce Safety Alliance (PSA) Grower Training. The Produce Safety Rule states that a representative from each farm must complete this training or an equivalent, as acceptable to the FDA.

The NJDA and Rutgers perform On-Farm Readiness Reviews (OFRRs) to assess farm readiness for the FSMA Produce Safety Rule. OFRRs are voluntary and confidential, and the objective is to educate growers to assist them in achieving compliance with the Produce Safety Rule. In New Jersey, there were 78 OFRRs in 2018, 10 OFRRs in 2019 and 4 OFRRs in 2020.

The NJDA has 7 Inspectors who have pursued rigorous training and are commissioned and credentialed by the FDA to conduct Produce Safety Rule Inspections. The FDA approach to implementing the FSMA rules is to “educate before and while we regulate”. The NJDA conducts interactive inspections that emphasize education, and enforcement actions are focused on food safety issues that pose a threat to public health.

The FSMA Produce Safety Rule (PSR) specifies the minimum science-based standards for the growing, harvesting, packing and holding of produce for human consumption.

Covered produce subject to this rule are commodities that are normally consumed raw, for example apples, lettuce and tomatoes. A list of covered produce can be found in section §112.1 of the rule (Google 21 CFR 112).

Excluded produce is typically cooked and thus has a “kill step” to address microorganisms of public health significance. If the excluded produce is not grown according to the standards of the PSR, then measures must be taken to segregate this produce and clean and sanitize the food contact surfaces. This is referred to as a “clean break”.

Many farms that participate in Third Party Audit programs are not in compliance with the PSR. The PSR and Third Party Audits are aligned because both address food safety, but the programs are not identical. Audits are voluntary, buyer-driven, commodity-specific, address specific farm areas, and have high standards requiring many records.

PSR inspections are mandated by federal law for all farms in the U.S. that grow covered produce. PSR inspections address all covered produce grown, the entire farm operation, and include the minimum science-based standards with fewer required records. You can participate in both programs, but the PSR inspections are required.

The NJDA inspectors have kept detailed observations from each inspection, and we have identified several common issues that occur frequently on farms in NJ. This presentation will identify and discuss the most common recurring themes.

PSA Grower Training is a requirement for each farm. Inspectors will ask to see your AFDO Certificate of Training, so do not misplace it. Other types of training certificates will not be accepted. There must be an assigned Food Safety Supervisor who oversees all food safety operations and implements the principles of the PSR.

All employees that handle covered produce must receive adequate training in the principles of food safety. This includes family members and seasonal employees that arrive at different times. Employees must be trained upon hiring, and periodically retrained as needed, at least annually. Worker training records are required.

Worker training videos are available on YouTube: “Food Safety Begins on the Farm”
English: https://www.youtube.com/watch?v=-HeYZ9IEUwU

Spanish: https://www.youtube.com/watch?v=BNeov2XYRiU

The FDA does not require a written food safety policy, but you must demonstrate that you understand the PSR requirements and apply these requirements to your food safety program. You must be able to articulate and validate enforcement of your food safety policy.

Hygienic issues that have been noted include not washing hands before starting work, after taking breaks in the field, after field relocations, before putting on gloves, and after cell phone use. Other issues include lack of clarification and/or enforcement for hand jewelry policy and the establishment of designated break areas for the storage and consumption of food and beverages,

Visitor policy is intended to inform visitors of the farm food safety policy and prevent uncontrolled access to farm areas and buildings that are used for covered activities. The purpose is to keep produce safe from contamination and/or adulteration. Anyone who enters the premises and does not work for the farm is a visitor. Sign-in sheets are not required, but if that is your policy, then all visitors should sign in, including inspectors.

Agricultural water is water that contacts the covered produce. You must perform an annual water distribution system risk assessment. Be sure to identify and include all water sources and wells. Keep records of risk assessment and all major repairs. You must use EPA approved sanitizers and monitor and document rates. Also obtain

certificates of compliance annually for municipal water sources, ice, and handwash water. The FDA has not released the final rule on water testing.

Cleaning and sanitizing are to be performed “as needed” to prevent contamination with microorganisms of public health significance.

There are 4 steps to cleaning and sanitizing. 1) Remove any obvious dirt and debris from the food contact surface. 2) Apply a food grade detergent and scrub the surface. 3) Rinse the surface with potable water, making sure to remove all detergent and soil. 4) Apply a sanitizer approved for use on food contact surfaces, rinse as necessary, and let the surface air dry.

Cleaning and sanitizing (steps 1-4) apply to all food contact surfaces, including packing lines, harvest knives, harvest bins and totes. Maintain control of tools and harvest bins and use approved sanitizing materials. Properly store tools, equipment and food packaging materials to prevent contamination. Records of cleaning and sanitizing are required.

Cleaning (steps 1-3) applies to all equipment, tools, and vehicles used for harvesting, packing and holding covered produce. You must also document cleaning of buildings and coolers used for covered activities. Records of cleaning are required, and be sure to keep complete vehicle logs, including rental trucks. Always use food grade grease.

If water is discharged as a result of normal operations, be sure to provide adequate drainage. Standing water can be a breeding ground for microorganisms.

“Dropped produce” has two applicable meanings. First, produce that falls off the plant before harvest is dropped produce, for example apples or peaches that have fallen off the tree. Second, produce that grows off the ground, such as tomatoes, and that drops to the ground before harvested is considered dropped produce, even if that produce is still attached to the plant. Dropped produce must be discarded. Additionally, mishandled produce that has been dropped on the packinghouse floor cannot be picked up, washed and distributed for sale. Intentionally dropping produce for harvest is a risk factor.

You must provide personnel with adequate, readily accessible toilet facilities, serviced and cleaned at a sufficient frequency. The New Jersey State Seasonal Farm Labor Act 12:102-1.5 states that these must be within 500 feet travel distance or a five-minute walking time. Toilets must be separate for each sex and adequate for the number of employees. The law requires 1 seat for every 20 males and 1 seat for every 20 females. Porta Johns need to be reasonably close to workers in the field and you must have a plan for an unintended spill.

Handwashing units must be provided in the work area and the vicinity of toilet units. Handwash units are essential for workers in the field. These units must be supplied with soap, potable water, single-use towels, trash can and disposal for wastewater. Hand sanitizer is not an acceptable substitute.

Contamination can occur from animal intrusion in the fields and in storage and production areas. You must perform a preharvest field assessment to identify intrusion and not harvest contaminated produce. You must have a policy for rodent and bird control to prevent contamination of food contact surfaces and to ensure safe storage of harvest and food packing materials. Pets are to be excluded from covered production fields and areas where covered activities are taking place.

Records required by the PSR at this time are certificate of PSA Grower Training, Worker Training, Cleaning and Sanitizing, Water Distribution System Risk Assessment and Major Repairs, and Certificates of Compliance. Biological Soil Amendments of Animal Origin records and Water Testing records will be required upon finalization of FDA requirements.

Existing records may be used but must include PSR format. Include your farm Name and Address on all required records. See §112.161 for details on record format. These records must be retained for 2 years after they are created.

The PSR inspection timeline for farms growing covered produce is based on a 3-year average of sales, adjusted for inflation. FDA updates the inflation adjusted value yearly. To determine that value use the following link and click on Produce Safety. https://www.fda.gov/food/guidanceregulation/fsma/ucm554484.htm

PSR inspections began in 2019 for farms with average annual food sales of over $500,000, in 2020 for farms with produce sales over $250,000, and in 2021 will include all farms with produce sales over $25,000 and Qualified Exemption (QE) record checks.

Farms that claim Qualified Exemption must have verified income of less than $500,000 in annual income from total food sales, and greater than than 50% of produce sold to qualified end users. An annual assessment and records from the preceding 3 years are required. Inspectors will ask to see your records including tax forms and sales receipts. Farms with produce sales of less than $25,000 are exempt from the rule. Processors are exempt from the rule and are required to register with the FDA.

The FDA requires the NJDA to maintain an inventory of all farms in New Jersey. A representative from the NJDA will contact you for information. Questions will include the number of acres farmed, the number of employees at maximum capacity, crops grown, farm income range, training completed, and participation in Third-Party Audits. Your inclusion in the inventory is required, and your information will remain confidential.

Overall, we have a very strong program and are making progress in New Jersey in terms of implementing farm food safety. To date, NJDA Inspectors have completed 92 On-Farm Readiness Reviews and 159 Produce Safety Rule inspections. We have received a lot of positive feedback from growers for the educational approach we are using as well as our availability for consultation and support.

Please visit our Produce Safety website for information on FSMA, The Produce Safety Rule, OFRRs, PSR Inspections, Third-Party Audits, and Training for the PSR and Third-Party Audits. http://www.nj.gov/agriculture/producesafety/

Session 16

Small Fruit/Strawberry

Session Chair:

Peter Nitzsche

Rutgers Cooperative Extension

WHAT AFFECTS THE FLAVOR OF STRAWBERRIES AND CAN YOU DO ANYTHING ABOUT IT?

Anya Osatuke and Marvin Pritts*
Professor and Director of Undergraduate Studies
137 Plant Science Building
Ithaca, NY 14853
mpp3@cornell.edu
https://cals.cornell.edu

The majority of cultivated strawberries (*Fragaria* × *ananassa)* in the northern United States (US) and Canadian provinces are grown in perennial matted rows across a range of soil types and microclimates. Management practices vary in fertilization rates, intensity of pesticide use, and the source of inputs depending on grower preferences. The goal of this research was to determine which set of factors contribute the most to flavor variation in 'Jewel' strawberries, the most popular in the Northeast. Data were collected on weather variables over three years from 22 farms across New York State and fruit samples were analyzed for sugar, acid, and aromatic volatile content. We found that average air temperatures during early fruit development was correlated with sugar and acid content of the fruit at harvest, but cooler temperatures were also correlated with increasing sugar content. But it was the temperature differential during fruit ripening (average air temperature minus the coldest temperature) that was strongly associated with the accumulation of sugar and acid in samples from regional farms. In other words, warm days and cool nights increased sugar and acid content in harvested berries. There were some differences among farms, but these differences were small relative to the year-to-year differences.

We also established nine treatments on our experimental farm that included three different input sources: Organic (ORG), Conventional (CON), and Low Carbon (LOC). Each input source had three levels of intensity: (-) plots received 50 lbs N·acre-year^{-1}, (o) plots received 100 lbs N·acre-year^{-1}, and (+) plots received 100 lbs N·acre-year^{-1} plus additional applications of non-fertilizer inputs. LOC+ and CON+ plots received applications of herbicides at standard rates (terbacil at 92 g·ha^{-1}) at monthly intervals during the growing season, napropamide (8 kg·ha^{-1}) post-planting, and in the fall, and fungicides (captan at 92g·ha^{-1}) at recommended rates. Other LOC and CON plots were treated only with napropamide post-planting at the same rate as (+) treatments. ORG+ received a pre-plant root dip (MycoGold ® 1g·L^{-1} for 1.5 h, Amelia, OH) and monthly applications of Growcentia foliar microbial biostimulant (Yeti ® at a rate of 10mL·3.78 L^{-1}, Fort Collins, CO) during the growing season. For CON and ORG treatments, straw mulch was applied between rows after establishment, and annually over top of rows prior to winter for cold temperature protection. Straw mulch and cover crop were withheld from all LOC treatments so floating row cover was used for winter protection. LOC treatments were mulched with black plastic between rows during the fruiting period

to keep berries clean. These treatments created a range of N, organic matter, and crop microbial supplementation involving either conventional or organic products.

We measured sugar and acid content, phenolic content, and six aromatic volatiles to see if treatments affected any of these. We also measured yield, leaf carbon and nitrogen, fruit firmness, size and several other variables. Finally, we use a panel of tasters and sniffers to determine if they could detect differences between two contrasting treatments (e.g. organic vs. conventionally grown strawberries).

In this study, yield was positively correlated with total applied N in the form of synthetic urea but not supplemental organic N. Despite different levels of soil carbon inputs, N rates, pesticides, and microbial supplements, fruit quality attributes were not associated with treatment. A human sensory evaluation found no perceptible differences in flavor or aroma among contrasting treatments. Variation in aroma volatiles was large across both studies, but was not associated with weather variables, location or management practice.

To summarize, year-to-year differences in sugar and acid content were large enough to affect flavor perception, and changes were in the same direction from one year to the next across several farms. The air temperature differential during fruit development was the variable most strongly correlated with fruit SSC and TA across the three years of this study. This suggests that warm days with an occasional cold night from flowering through pink fruit can increase the sugar and acid levels at harvest. Sugar and acid content also varied from farm to farm, but this variation tended to be smaller than variation from year-to-year. Aroma volatiles were extremely variable, so changes in their value are unlikely predictors of flavor in strawberry, at least within the same cultivar. It is unclear from our study if environmental variables influenced volatile production.

Within the same farm, applied N was the only exogenous factor that significantly affected any measured variable. Plant N content and yield increased with the amount of applied N, but only when the N was from a non-organic source. Organic fertilizer N, even when applied at recommended rates, resulted in deficient N foliar levels and low yields. Neither SSC, TA, aroma volatiles nor phenolic content were associated with field treatment. Phenolic content was stable under different management regimes, whereas volatile content was quite variable.

Our study suggests that differences in common management practices contribute little to flavor variation in short-day perennial strawberries grown in the field. SSC and TA content were not significantly different among fruit from various treatments and taste panelists were unable to distinguish fruit from differently managed plots. Yield does not appear to be negatively correlated with flavor attributes, so growers should follow the management practices that meet consumer demand, garner sufficient price premiums, and use production systems that improve soil quality and reduce potential negative environmental and human health effects. We were unable to identify a management practice that consistently enhanced flavor components. Factors that did affect SSC and TA were weather-related and mostly beyond the ability of growers to control.

A DECADE AFTER SPOTTED-WING DROSOPHILA INVASION IN THE USA: LESSONS LEARNED

Cesar Rodriguez-Saona
Rutgers University, P.E. Marucci Center
125A Lake Oswego Rd., Chatsworth, NJ
crodriguez@njaes.rutgers.edu

Spotted-wing drosophila (SWD) (Figure 1) continues to represent a major challenge to soft-skinned small fruit growers in the USA. Raspberries, blackberries, blueberries, and strawberries are high risk hosts for SWD and, therefore, especially vulnerable. The arrival of SWD in the Northeast USA in 2011 prompted considerable research activities to develop integrated pest management (IPM) strategies for its management. In the last seven years, we have published 18 refereed and non-refereed articles on SWD (see Reference list below). Although more research is needed, in this talk, I will summarize key findings from this work.

Figure 1. Male spotted-wing Drosophila. Photo: Elvira De

In the past decade, our research has focused on three fundamental aspects of SWD IPM: monitoring, chemical control, and behavioral control.

MONITORING

- Red traps capture more flies than clear traps (Lee et al. 2013; Cloonan et al. 2018).
- Synthetic attractants based on fermentation products attract more flies in blueberries compared to other baits (Burrack et al. 2015,2020; Cloonan et al. 2018).
- Fruit volatiles attractive to SWD were identified from raspberries (Abraham et al. 2015) and blueberries (Urbaneja-Bernat et al. In Press). Although these volatiles have proven attractive under laboratory conditions, they are less attractive than fermentation products in the field.
- Attractive volatiles from yeast and leaves (Cloonan et al. 2018) were also tested in the laboratory and field but they were shown to reduce the attraction of SWD to fermentation-based lures (Cloonan et al. 2019).
- Wild blueberries present in wooded habitats can serve as viable SWD hosts (Rodriguez-Saona et al. 2019, 2020; Urbaneja-Bernat et al. 2020).
- SWD maximum dispersive distance within blueberry fields is 90 m (Rodriguez-Saona et al. 2020).
- We have found that the efficacy of SWD lures/baits varies depending on location and crop (Burrack et al. 2015; Jaffe et al. 2018). Their efficacy also varies depending on whether they are used during the growing season or during the off-season (Cloonan et al. 2019).

CHEMICAL CONTROL

- We have worked with IR-4 towards the registration of insecticides to control SWD.
- Insecticides from five classes are effective against SWD: organophosphates, carbamates, pyrethroids, spinosyns, and diamides (Rodriguez-Saona and Holdcraft 2014a,b, 2018a,b).
- Certain insecticides not only kill SWD adults but can also reduce fruit infestation by negatively affecting larval survival, i.e., curative control (Rodriguez-Saona et al. 2014).
- Adding sugars to some insecticides can increase adult SWD mortality and decrease larval infestation (Cowles et al. 2015).

BEHAVIORAL CONTROL

- We have tested an attract-and-kill formulation to manage SWD (Klick et al. 2019). This formulation was effective in reducing fruit infestation under laboratory and field conditions.
- We are working with ISCA Technologies, IR-4, and EPA towards the registration of this attract-and-kill formulation.

ACKNOWLEDGEMENTS

This work was funded by the IR-4 Biopesticide Program, New Jersey Blueberry Research Council Inc., New Jersey Department of Agriculture Specialty Crop Block Grant (SCBG), USDA Small Business Innovation Research (SBIR) Program, USDA NE IPM, USDA Crop Protection and Pest Management (CPPM), USDA Specialty Crop Research Initiative (SCRI), USDA Organic Research and Extension Initiative (OREI), Hatch funds, and various chemical companies.

REFERENCES

Abraham, J., A. Zhang, S. Abubeker, S. Angeli, and C. Rodriguez-Saona. 2015. Behavioral and antennal responses of spotted wing drosophila, *Drosophila suzukii*, to volatiles from fruit extracts. Environmental Entomology 44: 356–367.

Burrack, H., Lee J., Rodriguez-Saona, C., and Loeb, G. 2020. Progress and challenges in building monitoring systems for *Drosophila suzukii*. In: *Drosophila suzukii* Management. F.R. Mello Garcia (ed.). Springer.

Burrack, H.J., Asplen M., Bahder L., Collins, J., et al. 2015. Multi-state comparison of attractants for monitoring *Drosophila suzukii* (Diptera: Drosophilidae) in blueberries and caneberries. Environmental Entomology 44: 704–712.

Cloonan, K.R., Hernández-Cumplido, J., Viana de Sousa, A.L., et al. 2019. Laboratory and field evaluation of host-related foraging odor-cue combinations to attract *Drosophila suzukii* (Diptera: Drosophilidae). J. Economic Entomology 112: 2850–2860.

Cloonan; K. Abraham, J.; Angeli, S.; Syed, Z.; and Rodriguez-Saona, C. 2018. Advances in the chemical ecology of *Drosophila suzukii* and its applications. J. Chem. Ecol. 44: 922–939.

Cowles, R.S., C. Rodriguez-Saona, R. Holdcraft, G.M. Loeb, J.E. Elsensohn, and S.P. Hesler. 2015. Sucrose improves insecticide activity against *Drosophila suzukii* (Diptera: Drosophilidae). Journal of Economic Entomology 108: 640–653.

Jaffe, B.D., Avanesyan, A., Bal, H.K., Grant, J.,Grieshop M.J., Lee, J.C., Liburd, O.E., Rhodes, E., Rodriguez-Saona, C., Sial, A.A., Yan Feng, Y., Zhang, A., Guédot, C. 2018. Multistate comparison of attractants and the impact of fruit development stage on trapping *Drosophila suzukii* (Diptera: Drosophilidae) in raspberry and blueberry. Environmental Entomology 47: 935–945.

Klick, J., Rodriguez-Saona, C.R., Hernández Cumplido, J., Holdcraft, R.J., Urrutia, W.H., da Silva, R.O., Borges, R., Mafra-Neto, A., and Seagraves, M.P. 2019. Testing a novel attract and kill strategy for *Drosophila suzukii* (Diptera: Drosophilidae) management. J. Insect Sci. 19(1): 3; 1–6. doi: 10.1093/jisesa/iey132.

Lee, J.C., Barrantes, L.D., Beers, E.H., Burrack, H.J., et al. 2013. Trap designs for monitoring *Drosophila suzukii* (Diptera: Drosophilidae). Environmental Entomology. 42: 1348-1355.

Rodriguez- Saona, C., Cloonan, K.R., Sanchez-Pedraza, F., Zhou, Y., Giusti, M.M., and Benrey, B. 2019. Differential susceptibility of wild and cultivated blueberries to an invasive frugivorous pest. J. Chem. Ecol. 45: 286–297.

Rodriguez-Saona, C. and R. Holdcraft. 2014a. Control of spotted wing drosophila on highbush blueberries, 2013. Arthropod Management Tests vol. 39: L6.

Rodriguez-Saona, C. and R. Holdcraft. 2014b. Control of spotted wing drosophila on highbush blueberries, 2012. Arthropod Management Tests vol. 39: L7.

Rodriguez-Saona, C. and R. Holdcraft. 2018a. Control of spotted wing drosophila on highbush blueberries, 2015. Arthropod Management Tests. 43(1): 1-2. DOI: 10.1093/amt/tsy059

Rodriguez-Saona, C. and R. Holdcraft. 2018b. Control of spotted wing drosophila on highbush blueberries, 2016. Arthropod Management Tests. 43(1): 1-2. DOI: 10.1093/amt/tsy060

Rodriguez-Saona, C., N. Firbas, J. Hernández-Cumplido, R. Holdcraft, C. Michel, S. Palacios-Castro, and D. B. Silva. 2020. Interpreting temporal and spatial variation in spotted-wing drosophila (Diptera: Drosophilidae) trap captures in highbush blueberries. Journal of Economic Entomology 113: 2362–2371.

Rodriguez-Saona, C., R. Holdcraft, G. Alberdin Garcia, and S. Tewari. 2014. Curative control of spotted wing drosophila on highbush blueberries, 2013. Arthropod Management Tests vol. 39: L9.

Urbaneja-Bernat, P., Cloonan, K., Zhang, A., Salazar-Mendoza, P., and Rodriguez-Saona, C. Fruit volatiles mediate differential attraction of *Drosophila suzukii* to wild and cultivated blueberries. Journal of Pest Science. In Press.

Urbaneja-Bernat, P., Polk, D., Sanchez-Pedraza, F., Benrey, B., Salamanca, J., and Rodriguez-Saona, C. 2020. Non-crop habitats serve as a potential source of spotted-wing drosophila (Diptera: Drosophilidae) to adjacent cultivated highbush blueberries. The Canadian Entomologist 152: 474–489.

DOUBLE CROPPING RASPBERRIES

Nate Nourse
Nate Nourse Consulting
29 River Road
South Deerfield, Ma 01373
https://www.NateNourse.com
info@natenourse.com

Before making the decision to purchase a variety, I often ask growers, “What are their goals.” Do you want something for wholesale, retail, or pick your own? Do you want summer production, fall production, or both? Will you produce berries with or without protected structures and/or trellis? Where are they located, in the cold of zone 3 or the heat of zone 7? These questions will allow me to prescribe a variety to fit their situation and should be considered in the selection process.

As a new premise to the selection process, there are several primocane fruiting varieties that offer very good summer production in addition to normal fall season harvest. There are also some varieties sold as summer bearers that produce a late fall harvest. The variety Prelude is a great example. These varieties are true ‘Commercial Everbearers’ and are the first I recommend for high tunnel production. Growers in zones 5 and 6 have an opportunity to over winter primocanes and harvest a second crop the following summer. This is the definition for the ‘double crop’ terminology.

The most successful results will be obtained when Commercial Everbearers are grown on a permanent trellis system. Trellis systems can boost production by 20-30%. Trellising is not an expense, it is an investment. On average, a good trellis and pruning effort will yield 50% more berries. Like most things in life, a little extra effort will yield more successful harvests. High tunnels with trellis can double production potentials for almost all varieties.

Before continuing, I want to be sure everyone understands the following terminology:

Primocane Fruiting– A perennial raspberry that bears fruit on first year canes (primocanes). Also known as everbearing, these biennial plants produce berries the following summer on canes that survive the winter. While berries are produced on every variety, not every variety will yield fresh market quality in both summer and fall harvests.

Floricane Fruiting – A perennial raspberry that bears fruit on the second year canes that survive the winter.

Commercial Everbearer – A primocane variety that produces marketable crops on both primocanes and floricanes.

Successful double cropping is accomplished with a system of pruning and trellising. The planting year's growth isn't always enough to justify producing a crop the first summer. I suggest the floricanes have a minimum height of four feet. Attaching the canes with clips to the trellis wire locks the canes into place reducing wind damage and adding winter protection. Depending on the variety, our target is 4-6 canes per foot of row. In mid to late May, we thin primocanes to 6-8 canes per foot of row. I like to leave a few extra primocanes just in case there is a problem. Once the summer harvest is finished, we remove the floricanes and clip the primocanes onto the trellis in the same spot where the floricane was attached. Well after the primocane harvest is complete, sometime in November or early December, I recommend primocanes be topped at 4'-5'and their branches cut to 8"-12".

Monofilament trellis wire is our favorite. It is easy to work with, never rusts, and nursery clips hold canes in place. Self-locking devices, on the end posts, hold wire at the proper tension and allow easy re tensioning. Nourse Farms has been using single and double T trellis posts and an 8-foot angle iron post with double wire. The top wire height needs to be 4'-5' high, the T's need to be 12"-24" wide.

The following varieties are considered Commercial Everbearers:

Prelude is a late producing primocane variety that we treat as a floricane. This variety is a top seller because it is the earliest producing floricane, starting around June 25th for us. I recommend this variety to be planted as 20-30% of a summer raspberry planting. Its harvest finishes before Encore begins. Many growers have been surprised by its abundant fall harvest especially during a late fall. I consider it a commercial everbearer for areas with longer seasons, zone 5 or higher. The berry can be soft, especially during high temperatures and if it is not picked every other day. Prelude performs in many climates. It is subject to winter damage in zone 4.

Anne is the only golden variety we offer, but is capable of fruiting as a Commercial Everbearer. Summer and fall harvests of the largest best tasting golden raspberries will occur with a little extra effort. They are susceptible to botrytis mold and need regular fungicide applications. We always try to pick the berries in the morning.
Caroline picks a week earlier than Heritage and berries are twice the size. It has great flavor and yield. To reach its full yield potential, it should be planted in zone 6 or lower. If exposed to high summer temperatures and it is not drip irrigated, the first few pickings will give crumbly berries. Though floricane harvest can be crumbly, many growers pick the summer and fall berries. While I recommend all raspberries be trellised, this one must be trellised.

Himbo Top is very tolerant to Phytophthora root rot. I have been impressed by both its production and winter hardiness. The fruit tends to be lighter colored and doesn't darken after picking. This is another variety that must be thinned and trellised for best results. Himbo Top also requires much less nitrogen than normal, it will be too soft if fed the same as other varieties. It is a great choice for organic production.

Joan J has very high yield potentials, but it must be trellised and thinned. The top trellis wire should be at least 50-60 inches high. Our new trellis had the greatest yield when the top wire was 72 inches, but most of our pickers couldn't reach the top berries. I would also suggest trying a double T trellis. Joan J's berries are large and flavorful with a very smooth texture. They will get very dark if not picked every other day and will darken after harvest. This would be of concern for those selling to supermarkets. As a commercial everbearer it has a lot of potential, it is not certain that it will consistently overwinter in zone 5 or lower. This variety is a great choice for tunnel production. It is susceptible to late rust.

Session 17

Creative Marketing/Agritourism

Session Chairs:

William Hlubik / Megan Muehlbauer
Rutgers Cooperative Extension

CHALLENGES AND OPPORTUNITIES FOR URBAN FARMERS MARKETS

Lauren Errickson
Senior Program Administrator
Rutgers Cooperative Extension
88 Lipman Drive
New Brunswick, NJ 08901
lauren.errickson@rutgers.edu

Why Urban Farmers Markets?

Community farmers markets, sometimes referred to as “tailgate markets,” are often established in urban centers with the goal of increasing fresh food access for local residents. At the same time, urban markets may also provide growers with a fantastic opportunity to reach large numbers of customers in one set-up location. Consequently, farmers selling at urban markets have the potential to maximize sales volume and profit while meeting the food needs of local residents. It can be a win-win situation, especially if farmers are able to work together with market managers to overcome challenges to success that may exist.

Urban Consumer Produce Choices

It is important for farmers at urban markets to know which types of produce their diverse customers are interested in purchasing. Customer choices will be influenced by taste and price, as well as by other factors such as familiarity with produce types, knowing how to use or prepare various vegetables, and ability to transport and store fresh produce. The New Brunswick Community Farmers Market (NBCFM) “Market Ambassador” team, with a grant from the United States Department of Agriculture, conducted a study to determine urban consumer food preferences to help better match produce types at the farmers market with consumer demand. In 2019, we conducted over 800 surveys and 250 brief interviews with urban New Brunswick residents to ask about their food preferences, shopping habits, and demographic characteristics.

Many common types of produce were found to be important to market shoppers, with little difference based on customer race/ethnicity. Fruits (Table 1) and vegetables (Table 2) of primary interest to urban customers include many varieties already grown by New Jersey farmers. A few types of produce, however, are important to customers but not grown locally due to limitations of the New Jersey growing season. These include mangoes, bananas, and citrus fruits. Because customers have indicated that limited transportation is a barrier to food access, meaning it may be difficult for these customers to shop at multiple locations, having as wide a variety of produce types available at farmers markets can help attract and retain customers.

Table 1. Preferred Fruits

Rank	Fruit	Response Count	%
1	Apples	334	12.9
2	Peaches	257	10.1
3	Strawberries	255	9.9
4	Bananas	173	6.8
5	Grapes	158	6.1
6	Watermelon	155	6.1
7	Mangoes	143	5.5
8	Oranges	133	5.2
9	Blueberries	120	4.7
10	Cherries	107	4.1

Table 2. Preferred Vegetables

Rank	Vegetables	Response Count	%
1	Tomatoes	289	11.3
2	Corn	190	7.4
3	Broccoli	166	6.5
4	Peppers	166	6.5
5	Carrots	146	5.7
6	Cucumbers	119	4.7
7	Lettuce	116	4.5
8	Onions	99	3.9
9	Potatoes	89	3.5
10	Spinach	89	3.5

Table 1 and 2 indicate the most frequently identified fruits and vegetables by customers when asked, "*Please list the three fruits/vegetables you would most like to buy at the farmers market.*"

Table 3. Ethnic Produce for Consideration in NJ Markets

Produce Name	Crop Type/Family	NJ Season
Bitter gourd/melon	Cucurbit	Summer
Bok Choy	Leafy Green	Spring/Summer
Choy-sum (Chinese Flowering Cabbage)	Brassica	Spring/Summer
Dandelion	Leafy Green	Spring/Fall
Epasote	Herb	Summer
Ground Cherry	Solanacea	Summer/Fall
Hot Peppers: Green, Yellow, and Serano Chili	Solanacea	Summer/Fall
Okra	Solanacea	Summer/Early Fall
Papalo	Herb	Summer
Pawpaw	Tree Fruit	Early Fall
Quintoniles (Amaranth Greens)	Leafy Green	Spring/Summer
Tatsoi	Leafy Green	Spring/Fall
Tomatillos	Solanacea	Summer/Early Fall
Yacon	Root Crop	Fall

Table 3 includes fruits and vegetables of cultural interest to customers interviewed or surveyed at the New Brunswick Community Farmers Market.

Another area of interest for urban consumers is the ability to purchase unique, sometimes hard-to-find produce types that are important parts of their cultural food heritage at local farmers markets. Including specific niche products that can be grown in

New Jersey (Table 3) at market stands can help broaden the urban market farmers customer base, who may also purchase more common crops as well.

In another USDA-funded study focused on developing value-added products for local markets, urban New Brunswick consumers who participated in focus group sessions in 2019 indicated a strong interest in purchasing locally made value-added products that contained ingredients from nearby farms. Consumers indicated to our research team that healthfulness and quality of the products were important to them, and that they were particularly interested in products such as fruit preserves, tomato-based sauces, and herb-based marinades made with local ingredients. A few New Jersey farmers have since launched a partnership with the Elijah's Promise Culinary School, in which culinary students are able to learn preservation techniques from the chef instructors who prepare value-added items to be sold by the partner farmers. This collaboration solves the issue of limited commercial kitchen infrastructure on farms while providing an opportunity for culinary education. Value-added partnerships to preserve less common produce types may preserve the shelf life, allowing additional time to build a customer base for new products offered at local markets.

Creative Marketing Strategies to Increase Farm Sales

Once products are available, bringing customers to the market stand becomes the next challenge to overcome. Some markets are well established with a consistent customer base, but new markets will take time to build. Similarly, new vendors in an established market will need to attract customers. A great way to do this is by telling the farm's story. Market managers can likely help as part of the overall market advertising campaign, but farms can also do a lot through their own social media.

Social media posts can be simple: photos of the farm team, animals, close-ups of produce, or scenic shots of the fields all help to tell the farm's story to engage potential customers. To build a following, networking is key. Connect with local community organizations, churches, and even city government pages who can help spread the word, and consider promotions such as a free apple for children at the market.

Another challenge to overcome is helping customers who are unfamiliar with certain types of produce learn more about the various fruits and vegetables you have available. Produce such as broccoli, kale, and eggplant, which might be very familiar to some customers, could be less familiar to others. Offering a variety of prepared samples or produce along with printed or digital recipes can be one way to increase customer knowledge of different types of produce. It will be especially important for customers who are shopping on a budget to know that they, and their families, will enjoy and be able to use the produce they purchase at the market.

Pricing and Payment Types for More Product Sales

Finding the ideal price points to generate a profit for the farm, yet keep products affordable for customers at community markets, can also be a challenge. It may take

some experimentation in your specific market location to determine what prices the customer can bear. Tracking sales over time and observing customer responses at the market will help inform price point decisions. As fewer customers tend to carry cash, considering acceptance of mobile payments such as “Venmo” can allow for quick, secure funds transfers from customers to farmers, which may help to increase sales.

Many urban markets work with farmer vendors to accept various types of food assistance benefits. SNAP benefits are available to customers enrolled in the program via an EBT card, which functions similarly to a debit card with a pre-loaded balance each month. State-administered benefits such as Farmers Market Nutrition Program (FMNP) vouchers are available to women, infants, and children (WIC participants) as well as to seniors; eligible farmers can apply for state approval to accept these vouchers as payment. When markets can offer additional incentives, such as “Double Bucks” vouchers, for customers shopping with these types of payments, it helps the customer access more food while ensuring the farmer is paid full retail price for the product sold.

Responding to the COVID-19 Pandemic at Urban Markets

In 2020, we were all presented with new challenges as the COVID-19 pandemic progressed. The agricultural sector was able to adapt swiftly in many ways, including by developing some creative sales and marketing tactics that may prove beneficial even beyond the pandemic. Implementing a process for customers to pre-order items from local farms, either for on-farm pickup or for pickup at a local farmers market, was a strategic way for many growers to adapt to new social distancing requirements. While some smaller operations may have been able to accept phone orders, online sales became a staple for many farm businesses. Rutgers Cooperative Extension released a new fact sheet, Getting Started in Online Farm Sales During Times of Social Distancing, to guide farmers into the realm of online sales. Additionally, the NJAES provided important guidance for farms regarding safe food handling and social distancing at farm stands and farmers markets during the pandemic.

Looking ahead to the 2021 season, we all hope to see COVID-19 cases drastically reduce as we return to perhaps a new normal. Combining lessons learned out of necessity during the pandemic, such as how to effectively market and sell farm products online, with the results of strategic research to better understand consumer food preferences and purchase habits, can help to strengthen local foods marketing efforts and increase sales for New Jersey farmers into the future.

Resources

1. Fact Sheet- Getting Started with Online Farm Sales During Times of Social Distancing: https://njaes.rutgers.edu/fs1319/

2. Maintaining Social Distancing and Safe Food Handling Practices: Guidance for Farm Markets: https://njaes.rutgers.edu/covid-19/guidance-for-farm-markets.php

EXPANDING MY FARMERS MARKET IN 2020 – MARKETING IN TOUGH TIMES

Lenny and Lauren Prezorski
Cold Spring Farm
Cobleskill, New York
https://www.facebook.com/coldspringfarmny/

Cold Spring Farm is a family-run vegetable, greenhouse and field crop farm nestled in the small hamlet of Lawyersville; owned and operated by the Prezorski family. Lenny started the farm in 1987 with one acre of vegetables, sold on a small wagon on the front lawn. Today, we farm 35 acres of vegetables, 50 acres of hay, 40 acres of field crops and an acre of strawberries. In 2011 erected our first of three greenhouses and expanded into the flower business with annuals, perennials, vegetable transplants and herbs.

Our retail season begins the end of April when we focus on plant sales. The greenhouse operation began as a combined need to expand propagation space for our vegetable plants and a desire to expand the retail side of our business. The farm currently has three greenhouses and demand continues to exceed our supply.

As plant sales begin to slow in June, strawberries were added to bolster sales during the final few weeks of our greenhouse season. A new strawberry field is being planned for 2021 which will provide an option for pick-your-own sales. In 2010, a high tunnel was also added to extend the growing season. After experimenting with several crops, it is now primarily used for tomatoes.

September is a favorite time on the farm. In addition to both summer and fall crops, the farm offers a large selection of pumpkins and ornamentals. Pumpkins remain one of the few crops that the farm still wholesales. Most are sold to farms in the downstate area. For retail sales, the farm also grows a large selection of mums, ornamental corn, straw and cornstalks.

In 2019 the farm upgraded its retail space from an open-air pavilion to a finished post frame building. The new farm stand has extended the retail sales business to a three-season market. In addition, it has expanded the ability to offer other local products, such as, milk, preserves, honey and maple syrup. Since the addition of the new building, retail sales have nearly doubled. The new building has also extended the season from October to December.

Cold Spring Farm is very fortunate to be located three miles from one of New York's agricultural colleges (SUNY Cobleskill). The farm relies on both local and college labor for both harvesting and retail sales. As a small farm operation, students are offered a diverse work experience which has made college internships a desirable opportunity for both the farm and students.

At the current time, the farm foresees numerous opportunities for growth. Time remains the most limiting factor in all changes. Our business goals has always been to only take on what we can handle. We remain hands-on in every aspect of the farm business and are blessed to be supported by our local community.

INNOVATIVE MARKETING, INTERVIEWS WITH NEW FARMERS

Brendon Pearsall
Program Coordinator
Rutgers Cooperative Extension of Middlesex County
EARTH Center
42 Riva Avenue
North Brunswick, NJ 08902
bp415@njaes.rutgers.edu

2020 was a year of unprecedented challenges in most industries. The COVID-19 pandemic led to service disruptions, supply shortages, and lockdowns that few businesses were prepared for. Food system disruptions led to empty shelves in some markets, while crops were simultaneously spoiling in other areas. Once the scope of these disruptions became more clear, many small farmers were able to quickly pivot to new modes of marketing and product sales that allowed them meet the needs of their local community in ways that they never had before. With Extension assistance, farmers set up online stores, developed contactless pick-up options and box shares, and continually adjusted to keep their employees and customers safe and healthy. Established farmers with strong customer bases were, in many cases, able to leverage their online presence to keep their customers informed with up to the minute updates on what products were available and how and where to pick them up. Beginner farmers, some still in their first season, were faced with the challenge of trying to maintain their new business, and grow their customer base, without being able to meet their potential customers face to face.

For this presentation, we interviewed two New Jersey beginner farmers about the challenges that they have face in starting their farm, and the impact that the pandemic had on their business. In both cases these farmers were able to make the most of a difficult year by employing innovative marketing ideas, and looking for any opportunities that presented themselves, including a few quite unorthodox ones. The farmers we talked to were Candice from Duchess Farms in South Brunswick, and Rebecca from Moonshot Farm in East Windsor.

Duchess Farms is situated on 6 acres in South Brunswick and they are going into their 3rd growing season. They grow specialty cut flowers and produce honey using organic practices, though they are not yet certified. The farm is a second career for Candice and her approach to flower farming combines it with her floral design business. She designs for weddings and events, but also markets her flowers through a CSA and community farmers markets. As the reality of COVID began to set in early in the season, Candice decided not to participate in her normal farmers market, and instead focused her efforts on her CSA. She found that due to supply disruptions, people were having a harder time finding fresh flowers, and that the general anxiety of the year was causing an increase in demand for her products. Candice was able to sell out her CSA shares, and developed a new “Flower Fridays” program with contactless pick up that allowed her to move any blooms that she would normally have sold through the farmers

market. The success of these programs resulted in her having a very positive season and she has high hopes that next year's CSA will be even larger thanks to the new customers she attracted.

Moonshot Farm had perhaps an even greater challenge this year, it was their very first growing season. Moonshot Farm is the result of Rebecca and her husband deciding to leave their life in New York City behind after the birth of their daughter. They purchased a small farm in East Windsor and set it up to produce specialty cut flowers, sheep, chickens, and bees using minimum impact, regenerative techniques. They had every intent of hitting the ground running this year and suddenly found themselves wondering if they would even be able to meet their farmland assessment requirements. Through clever marketing, creative thinking, and a robust social media presence, Moonshot was able to have a successful season and set themselves up for a strong second year. In addition to online sales of flowers and honey, Moonshot found and created sales opportunities wherever they could. By establishing a relationship with a local Islamic Center, Moonshot was able to find buyers for all of their lambs with relative ease and discovered an even greater demand for this product than they had initially thought. Rainbow chicken eggs proved a popular item for contactless pick-up, along with flowers. In an effort to not waste any opportunity, Moonshot discovered a market for their honey among local breweries. Since their farm had previously been a Christmas tree operation, they had a few acres of overgrown spruce trees that they discovered they could harvest the new growth tips from for breweries as well. This led to an event partnership with one local brewery where they held an online "Wreathe Making and Beer Tasting" workshop that was a big success. Through creative use of any channel they could find, Moonshot was able to greatly expand their customer base without even getting to meet most of the customers face to face. If they continue forward with these innovative techniques, Moonshot Farm should have a bright future.

Session 18

Soil Health/Cover Crops

Session Chair:

Michelle Infante-Casella

Rutgers Cooperative Extension

SOIL HEALTH 101

William J Bamka, Agricultural Agent and Associate Professor
Rutgers NJAES Cooperative Extension, Burlington County
2 Academy Dr., Westampton, NJ

Soil health, also referred to as soil quality, is defined as the continued capacity of a soil to function as a vital living ecosystem that sustains biological productivity and maintains or enhances air and water quality. Soil scientists have long been trying to come up with a definition for soil health. Though this is not always an easy task give the dynamic nature of soil and the many functions and roles it plays in the living ecosystem. The United States Department of Agriculture's Natural Resources Conservation Service defines soil health as "the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans." Another definition that is embraced by many is the improved function of a soil in terms of crop yield response to inputs, such as fertilizer efficiency. This definition primarily emphasizes the soil fertility or nutrient status of the soil, which is merely one aspect of soil health.

Soil Health tends to be a concept that those working in agriculture seem to easily grasp. However, trying to easily define soil health with words is not always an easy task. Many people measure a soils health relative to plant growth or crop yield. While this is an important aspect of soil health it fails to address many of the other important roles, we rely on the soil to provide. Additionally, a healthy soil maintains a diversity of soil organisms that help to control plant disease as well as insect and weed pressure; form beneficial symbiotic associations with plant roots; recycle essential plant nutrients; improve soil structure with positive repercussions for soil water and nutrient holding capacity; and ultimately improve crop production.

Farmers, researchers, and homeowners all view soil health differently because soil function means different things to them. To a farmer, the primary function of the soil could be to hold enough water, sustain enough nutrients, and provide pest control to produce sustainable crops. To a soil microbiologist, the primary function of soil could be the media that provides food and shelter to soil organisms. To the homeowner, the primary function of soil could be to provide the nutrients for their lawn and garden. So, the question becomes which is correct and why? The answer to that question is not simple. I propose that the answer is that it depends on who you are and what you expect the soil to do for you.

Regardless of your definition of soil health, it is important that the biological components of soil are protected and enhanced. There are four ideas defined by USDA-NRCS that everyone should consider to ensure healthy soil:

- Keep the soil covered as much as possible.
- Disturb the soil as little as possible.
- Keep plants growing throughout the year to feed the soil.
- Diversify as much as possible using crop rotation and cover crops.

SOIL ORGANISMS, THEIR FUNCTIONS AND HOW TO INCREASE BENEFICIAL MICROBES IN THE SOIL

William Errickson
Monmouth County Agricultural Agent
Rutgers Cooperative Extension
4000 Kozloski Road
Freehold, NJ 07728
william.errickson@njaes.rutgers.edu

In one teaspoon of healthy soil there are approximately 600 million bacteria, three miles of fungal hyphae, 10,000 protozoa, and 20 to 30 nematodes. These diverse soil organisms create a soil food web and perform numerous ecological functions. Soil organisms are responsible for the decomposition of organic matter, thus making nutrients available to plants and can outcompete or directly parasitize soil borne pathogens, reducing the potential for disease outbreaks in the field. Soil microbes can also break down agricultural chemicals and improve soil structure and carbon sequestration. By understanding the many different microorganisms that exist in the soil and strategies to improve their populations, resilient soil ecosystems can be developed to sustain high yields and optimum plant health.

Soil Organic Matter

Soil organic matter (SOM) refers to the living, and previously living, carbon-based components of the soil. This includes living organisms (i.e. plant roots, bacteria, and fungi), fresh residues (i.e. fresh leaves or grass clippings), and other components in various stages of decomposition. Soil organic matter enhances biological activity, improves soil structure, increases water holding capacity, sequesters carbon, and improves cation exchange capacity. Cation exchange capacity refers to the ability of SOM or other soil particles to hold onto cations (such as Ca^{2+}, Mg^{2+}, and K^{+}) in a way that makes them available to plants and reduces the potential for leaching of these nutrients.

The area in the soil directly surrounding a plant's roots is referred to as the rhizosphere. The rhizosphere is a zone of increased biological activity due to the sugary root exudates that the plant excretes as the roots grow. These root exudates serve as a food source for soil microorganisms, some of which are able to provide beneficial functions for the plant as well, including nitrogen fixation, chemical detoxification, disease suppression, stimulation of plant growth, and increased stress tolerance.

Bacteria

Bacteria are single celled organisms that are generally the most abundant microbes in agricultural soils. Many species of bacteria function as decomposers, consuming root exudates and plant residues, then converting those materials into nutrients that are

available to plants or other soil organisms. Bacteria can improve soil structure and water dynamics by secreting sticky compounds that help to bind soil particles into stable aggregates. Some bacteria can also fix nitrogen from the atmosphere and make it available to plants. These bacteria are called diazotrophs. A common example of nitrogen-fixing bacteria are *Rhizobia spp.* which form a relationship with the roots of legumes and convert nitrogen gas into a form that the plants can use. There are also free-living diazotrophs, such as *Azotobacter spp.* that exist in the soil and fix nitrogen without forming a direct symbiosis with the roots of legumes. Some soil bacteria can also produce an enzyme called ACC deaminase, which is able to help improve stress tolerance in plants.

Fungi

Fungi can perform several important ecosystem functions, including decomposition, improvement of soil structure, and enhanced access for plant roots to obtain water and nutrients. Fungi form long thread-like strands called hyphae by joining individual cells together in chains. Mycorrhizal fungi colonize plant roots and their hyphae function as an extension of the plant's root system, thus improving the ability of the plant to acquire water and nutrients. Similar to bacteria, fungal hyphae can secrete sticky substances that help to promote soil aggregation and structure, which can lead to better water infiltration and holding capacity. Some fungi can also help to control diseases, either by out-competing pathogens or by directly parasitizing disease causing organisms. Fungi are sensitive to soil disturbances that break up the chains of fungal hyphae, so fields that employ reduced tillage practices typically have higher fungal populations.

Protozoa

Protozoa are classified as single-celled soil 'animals' that are several times larger than bacteria and move through the soil, consuming other organisms. Protozoa mainly feed on bacteria, but also eat fungi, organic matter, and other protozoa. They play a major role in nutrient cycling, as they are releasing the excess nitrogen from their food sources throughout the soil environment and making it available to plants.

Nematodes

Nematodes are non-segmented worms that are approximately 1mm long. Several species of nematodes are notoriously known for causing plant disease problems; however, most species of nematodes are not pathogenic, and many can perform beneficial roles in the soil food web. Nematodes consume bacteria, fungi, protozoa, and other nematodes, helping to cycle and distribute nutrients throughout the root zone. Some predatory nematodes can function as biocontrol agents, by feeding on pathogenic soil organisms. Predatory nematodes are sensitive to soil disturbance and their populations are influenced by their food sources, such that soils with high levels of bacteria and fungi will support more predatory nematodes. Because nematode populations are heavily influenced by certain land management practices, counting the

number of nematodes in different functional groups is used as a measure of estimating soil quality.

Soil Arthropods

Soil Arthropods include many species of invertebrates that dwell in the soil and have an exoskeleton, including insects (springtails, spiders, ants), crustaceans (sowbugs), arachnids (spiders, mites), and myriapods (centipedes, millipedes). Millipedes and sowbugs are referred to as ‘shredders’ because they shred plant material on the soil surface while consuming bacteria and fungi. This helps to break down organic matter into smaller pieces that can be further decomposed by other organisms. Predatory arthropods, such as spiders, mites, and centipedes consume other soil organisms and cycle nutrients throughout the environment. One of the most abundant groups of arthropods in agricultural soils are springtails. These organisms consume bacteria and fungi that are living on the surfaces of plant roots, helping to reduce pathogen populations and provide soluble nutrients in the root zone.

Earthworms

Earthworms are familiar soil invertebrates that influence soil structure and nutrient dynamics in a significant manner. Earthworms consume organic matter, including plant residues and the bacteria and fungi that live on these materials. Earthworms excrete castings that contain high levels of microbes, helping to inoculate the soil with other organisms as they move through it. The castings also contain plant available and slow release nutrients. This process cycles organic matter and nutrients throughout the rhizosphere, as the earthworm burrows provide areas of infiltration for water and plant roots. The burrowing activity of earthworms also helps to aerate the soil, functioning as micro-tillage of the soil and helping to stimulate the decomposition of organic matter. Reduced tillage operations that retain surface residues will encourage earthworm populations in agricultural systems.

Supporting the Soil Food Web

Practices that increase soil organic matter and reduce disturbance in the rhizosphere can help build healthy populations of soil microorganisms that provide numerous benefits to the long-term sustainability of agroecosystems. Adding compost to the soil can increase organic matter and populations of microorganisms while also supplying slow release nutrients. Cover crops, such as sorghum sudangrass, crimson clover, and oats will build organic matter and stimulate microbial activity while suppressing weed growth. Organic mulches including straw in annual garden beds and wood chips or bark mulch in perennial beds provide a food source for soil organisms, while protecting the soil from erosion, reducing weed pressure, and conserving water. Reducing tillage practices will increase soil biodiversity and will favor the development of fungi, arthropods, and earthworms, whereas more frequent tillage will result in higher ratios of bacteria populations. Including a greater diversity of crops in year to year rotations will also support a greater diversity of soil organisms by providing varied food sources

(shoot and root residues). Contributing organic matter and varied sources nutrition to the soil food web supports a healthy and thriving soil ecosystem. This in turn contributes to the growth of healthy and thriving plants that are more resistant to disease and abiotic stress.

THE GREAT DEBATE: RESIDUE MANAGEMENT PROS AND CONS

Kate Brown
Program Associate
Rutgers Cooperative Extension of Burlington County
2 Academy Drive
Westampton, NJ 08060
kbrown@njaes.rutgers.edu

Objective: discuss conservation tillage and introduce ways to integrate crop residues into the soil, pest, disease, and weed management toolbox while successfully maintaining, if not enhancing, crop quality and marketable yield

What is conservation tillage? Conservation tillage includes residue management strategies wherein at least 30% of the previous year's crop residue is retained on the soil surface at planting. Cover crops are often used in combination with or instead of crop residue, especially in cases where crop residue is insufficient. No-till is one conservation tillage strategy; although adoption has been slow among vegetable growers, field crop growers have widely adopted no-till practices. As the name implies, no-till farming means seeds are planted directly into crop residues with minimal soil disturbance from a specially designed planter. Strip-till is a modification of no-till in which only narrow bands – less than 1/3 of the total field area – are tilled for planting.

What are the goals of conservation tillage? The overarching goal of conservation tillage is to protect water quality by preventing soil erosion. There are economic advantages to adopting conservation tillage, too. Fewer passes through the field has associated fuel, equipment, and time savings while less soil disturbance boosts soil health and preserves soil productivity.

What are the challenges of conservation tillage? Maintaining adequate weed control is the greatest challenge of adopting conservation tillage, particularly for vegetable producers. Cultivation is lost as an in-season weed management tool so weed control is dependent on heavy crop residue, rapid canopy closure, and the use of PRE- and POST-applied herbicides. Vegetable growers tend to have limited herbicides available for their crops and, as a result, yield reductions become a major concern. Perennial weeds can also establish where tillage is reduced. Poor or delayed crop emergence and growth due to cool, wet soils in the spring is another concern. Lastly, it is a balancing act to successfully manage pests and diseases where reduced tillage is desired.

How can some of these challenges be overcome? No-till farming is rather specific; the best outcomes are found where vigorous, large-seeded crops (e.g. corn, soybean, cucurbits) are selected and regular crop rotation (accompanied by herbicide rotation) promotes good weed control. Strip-tilling has the potential for more flexibility, as the preparation of "strips" allows for soil aeration, warming, and drying in the planting zone.

Due to the tillage associated with strip-tilling, precautions like selecting vigorous cultivars or transplanting should be considered to insure good weed control and acceptable yield. There are numerous modifications to strip-tilling that can help fit the system to your site – what type of residue, how much residue, how wide and deep to till, which crops/cultivars, whether you till once or twice, and whether you apply herbicide prior to planting all makes a difference. *If at first you don't succeed, try, try again.*

I want to start slow – how can I do that? Rightfully so, the thought of too much residue at planting may have you concerned. In the fall, consider making one of these small changes before diving in head-first:

- Chop or mow crop residues rather than tilling/plowing – residues will still be present to protect soil over winter, but the small and evenly distributed residue will be less cumbersome at planting
- Use straight (not twisted) points or sweeps to plow – more residue will be retained on the soil surface than with other, more aggressive implements
- Plant a cover crop that will winterkill – winterkilled cover crops protect the soil from winter erosion but have already started breaking down by spring planting

Conclusion: tillage is one of the many weed management tools in your arsenal. Where tillage is reduced or eliminated to protect soil health and productivity, the other weed management tools must "turned up". Crop rotation accompanied by herbicide rotation is one complementary strategy to reduced tillage. Selection of vigorous crop cultivars (and cover crops) is another way to improve success with reduced tillage. The benefit of these strategies for pest and disease management cannot be overstated, regardless of your tillage practices. Success with management changes, like adopting conservation tillage, starts with recognizing and planning around all the ways your cropping system is intertwined.

COVER CROP SELECTIONS FOR VEGETABLE CROP PRODUCTION

Kaitlin Farbotnik
State Conservation Agronomist
USDA – NRCS – NJ
220 Davidson Avenue
Somerset NJ 08873
Kaitlin.farbotnik@usda.gov
https://www.nrcs.usda.gov/wps/portal/nrcs/site/nj/home/

Cover crops are the new best thing – so they say. Information is constantly being pushed to growers by companies and conservation agencies promoting the newest and best cover crop varieties. Are some of these species and varieties worth the cost of the seed bill? Are these species and varieties the best for your operation?

There is no "one size fits all" cover crop, and finding the right cover crop, or cover crop mix can be overwhelming and frustrating. An easy way of narrowing down the complete list of cover crops to the best cover crop is to look at three main aspects of selection:

1. Timing
2. Purpose
3. Management

Timing

One of the greatest challenges with cover crops is finding the time for planting, growing, and terminating. Do you have late vegetables? Do you have early vegetables? Do you have a few months of idle fields during your rotation? Are you looking to plant cover over winter or in the summer? Not all cover crops are created equal. Not all days are equal. The right cover crop needs to be compatible with the days (temperature, light, etc.) and the amount of time the ground is available between crops.

Cool season covers generally occupy the space between two cash crops harvested in the fall and planted in the spring. The warm season cover crops can be planted in late spring – summer and grow through summer – fall, or they can be planted in late summer to set up for a winter kill cover crop. In general, the longer a cover crop can be in the ground the more value that cover will return to the field. Planting high cost covers in short windows that don't allow the cover to grow as needed to produce results could hurt the bottom line. As spoken time and time again by Steve Groff, one day in September can be worth seven days in October.

Summer cover crops vary greatly in their ability to achieve quick results. Some covers such as berseem clover and buckwheat need just a few weeks to two months to begin yielding results, while others could require two to three months to yield results. This of course, also depends on the reason the cover crop was planted in the first place.

Another challenge to choosing the right cover crop is to make sure the cover crop is compatible with the next crops in the rotation. Some cover crops will harbor pest or insects for the following cash crop while others may present challenges (or advantages) because of allelopathic properties. Cover crops need to be planted at a time in the rotation where they will not hinder the production of the cash crop.

Purpose

Cover crops can be planted for a multitude of purposes. Nutrient scavenging retention, erosion control, weed prevention, building organic matter, pollinator habitat, and breaking compaction – to name a few.

Nutrient scavenging

For nitrogen scavenging any of the small grains will do a good job, although rye is generally preferred. Rye can be planted alone in fields that received a late fertilizer application or that have a good amount of crop residues remaining. Rye is also great in mixes with legumes and winter kill cover crops because any nitrogen that is developed from those crops, or the decomposition of those crops, will be held in the rye plant until termination. Sorghum-sudan grass is a warm season cover crop, that like rye is deep rooted and has a high ability at scavenging and storing nitrogen within the plant.

If phosphorus scavenging is a concern throughout the growing season, buckwheat can be used to keep phosphorus in the upper soil profile. Buckwheat is a very short season crop and can fit into many vegetable rotations. Buckwheat does need to be managed because it can become weedy if allowed to go to seed.

Erosion control

The ability of a cover crop to control erosion is dependent on the root structure of the plant, the amount of biomass produced by the plant, and the time of year erosion control is needed vs. the time of the year the crop is expected to be growing.

Depending on the climate and field conditions winter kill cover crops might not provide adequate coverage for erosion control if the plant decomposed quickly leaving little residue on the surface come spring. Additionally, if a small grain was planted late in the season and doesn't begin putting on growth until spring, there might be the potential for erosion to occur in the winter and early spring.

Any cover crop planted for erosion control needs to be planted with enough time for that crop to grow a canopy capable of preventing raindrop splash on the soil surface. Root structure is also important if the cover crop is planted in natural depressions or channels within the field. Shallow rooted crops will not be able to withstand water flows and may be torn out of the ground.

Compaction

When referring to compaction and cover crops there are two different kinds of compaction that need to be considered – surface compaction and subsurface compaction. Depending on the degree of compaction, surface compaction can generally be treated using cover crops with very fibrous, branching root systems. Whereas, when treating subsurface compaction plants with deep roots or tap roots are preferred.

Pollinators

Most of the cover crop species that will increase the number of pollinators are the warm season species. Fall planted clovers that are allowed grow to flowering the next spring are also good pollinator covers. Buckwheat, berseem clover, and cowpeas are excellent cover crop species that promote pollinators and grow quickly. Sunflowers make excellent cover crops because of their roots, ability to attract pollinators, and they look great in the field - free advertising anyone? Depending on the operation, sunflowers can also provide an additional source on income to the farm.

Though there are cover crops that work to treat specific field problems, most of the problems can be linked back to soil structure and organic matter. Anytime additional biomass is added to the system from decomposing above ground (roots and stems) and below ground cover crops, organic matter will begin to increase given a whole field management system is in place.

Management

One of the most important factors to choosing a cover crop is the amount of time someone needs to invest in the cover crop, specifically the amount of time someone has to manage that cover crop. Cover crops take time to plan, plant, and terminate. Choosing the right cover crop can reduce the amount of time needed to manage the cover crop.

Winterkill cover crops are popular with no-till vegetable producers because the covers do not need to be sprayed or mowed in the spring. Planting can begin without additional work in the field, although more management is generally required adjusting the crop rotation to allow sufficient growth of the cover crop in the fall.

If weed and disease control is desired, rolling, or mowing cover crops are becoming more popular especially in cucurbit growers. Sometimes termination of the cover crop can be achieved in one pass, and other times repeated passes or spray applications are needed. More management is needed for monitoring the crop to ensure the crop is terminated at the correct growth stage for a complete termination and to meet the purpose of the crop.

Resources

For additional information on cover crop species and varieties check out the following resources (which link to a myriad of other valuable resources):

Managing Cover Crops Profitably is published by Sustainable Agriculture and Research Education (SARE) and can be accessed and downloaded for free online. This publication is a great desk reference for select cover crops.

The Northeast Cover Crop Council has numerous resources for producers regarding cover crop species and management. The NECCC is developing the Northeast Cover Crop Decision Tool which has not yet been finalized, but is expected to be released in the near future. Users, based on hardiness zone, will select desired features of a cover crop. The tool will give the user recommendations that meet the user parameters, climate conditions, and specific field conditions.

Session 19

Grapes I

Session Chair:

Hemant Gohil

Rutgers Cooperative Extension

Preventing Herbicide Drift and Injury to Grapevines

Gary C. Pavlis
Agricultural Agent
Atlantic County Cooperative Extension
6260 Old Harding Highway
Mays Landing, NJ 08330
pavlis@njaes.rutgers.edu

As a county agricultural agent in New Jersey for the past 36 years, I have been working with grape growers diagnosing their problems for a long time. The subject of herbicide drift damage has come up time and time again and seems to be increasing every year. I am currently working with vineyards that have experienced injury not only in New Jersey but on the North Fork of Long Island, in Ohio and Pennsylvania. I felt that this topic needed to be addressed to try to prevent future escalation of the problem.

Grape production represents a small portion of total acreage in total agricultural production, however it is one of the fastest growing segments of agriculture in New Jersey. In 1984 there were seven wineries in the state and today there are over sixty and still growing. This growth has taken place throughout the state and much of this growth consists of vinifera and hybrid grape varieties. Grapes are a high value crop, with and annual value of $4,000 to $5,000 per acre, and a processed value that may be ten times that amount. This poses a challenge for wine growers as many vineyards are located in areas abutting subdivision sprawl and may be interspersed with area of agricultural production and residential landscapes. Grapevines are very sensitive to certain herbicides and many farmers and homeowners are not aware of the hazard the commonly used herbicides, such as 2,4-D, present to grapes.

2,4-D belongs to a group of herbicides referred to as Plant Growth Regulators (PGR). PGR are the most common active ingredients in herbicides used to control broadleaf weeds. They affect the plant's natural growth and development. Exposure to PGR can cause abnormal growth of leaves and stems. PGR herbicides can be absorbed by both roots and leaves, however grapes are typically injured through foliar absorption. These herbicides are systemic, meaning they move from the site of absorption to areas of rapid growth. These herbicides are often used on lawns, golf courses, right-of-ways, turf farms, and agricultural fields. Growth regulators pose a great risk because they can cause significant injury at fractions of typical application rates. For example, 2,4-D can damage grapes at 100 times lower than labeled rates.

Injury to grapes typically occurs due to drift. Non-target drift can occur in one of two ways, either as spray drift or vapor drift. Spray drift occurs when small droplets move off the treatment site at or near the time of application. Vapor drift occurs when the spray material volatilizes or evaporates off the target area and is carries off-site by wind as a gas or vapor. Vapor drift is not visible to the applicator. The potential for vapor drift is chemical specific and based on the herbicides' vapor pressure. Vapor pressure is

affected by temperature and relative humidity. Because 2,4-D has a high vapor pressure it readily volatizes, especially under higher temperatures and low humidity.

Time of exposure is important, as injury is much more severe during periods of rapid shoot growth between bud break and bloom. Herbicide drift exposure before bloom but after bud break can cause flower abortion, curling of shoot tips, cessation of shoot growth, and regrowth of deformed leaves after exposure.
Mid-and late-season exposure usually causes minor leaf deformation, since most shoots are fully grown and there are few developing leaves to react to the herbicide. But exposure of developing berries to herbicides may greatly delay or even prevent ripening. The sensitivity of grapes to herbicide drift also depends on the grape cultivar. However, with severe and repeated exposures all cultivars are vulnerable. Vines may be injured several miles from the application site due to vapor drift.

Injury from growth-regulator herbicides usually appears within 2 days of the drift exposure. Symptoms of 2,4-D injury include a very characteristic fan-shaped leaves with sharp points at leaf margins, downward bending of leaves, leaf strapping with deep sinuses, and leaf puckering with constricted veins (Figure 1).

Figure 1

Grape growers need to take a proactive approach to minimize potential problems due to drift from 2,4-D, dicamba and other PGR herbicides. It is recommended that grape growers inform your neighbors about your vineyard location. This would include lawn care companies, highway departments, commercial applicators, and homeowners.

Providing aerial maps of vineyard locations to neighbors is advisable and posting signs stating that grapes are sensitive to herbicide drift is also a good idea.

Lastly, if drift damage occurs there are very important things that should be done in a timely manner:

1. Identify the area affected and flag the entire area.
2. Note the date and growth stage of the grapes.
3. Secure weather data for the drift date, especially wind speed and direction.
4. Take high resolution pictures of the damage. (Very important)
5. Contact you state department of agriculture as soon as possible to make a formal complaint.

Contact your cooperative extension to confirm the damage type and to help determine the source of the drift.

Session 20

Integrated Pest Management

Session Chairs:

Kris Holmstrom & Joe Ingerson-Mahar
Rutgers NJAES

BATTLING CORN EARWORM IN SWEET CORN

Thomas P. Kuhar[1], Kemper Sutton[1], and Hélène B. Doughty[2]
[1]Virginia Tech Dept. of Entomology, 170 Drillfield Drive, Blacksburg, VA 24061-0319
[2]Eastern Shore AREC, 33446 Research Drive, Painter, VA 23420
e-mails: tkuhar@vt.edu; kempersutton@gmail.com; hdoughty@vt.edu

In the mid-Atlantic U.S., the primary pest concern for sweet corn growers is corn earworm (CEW) *Helicoverpa zea*, which drives the majority of insecticide applications. In Virginia, on average, 80 to 90% of ears will be damaged by this pest if control measures are not taken. As very little overwintering survival of pupae occurs north of 40 latitude, CEW pest pressure is driven by dispersing moths arriving from more southerly regions. Because of the variability in pest pressure from year to year and throughout the season, the use of blacklight or pheromone traps to monitor local moth activity is a useful IPM tool for commercial sweet corn growers. Trap catch can provide the grower with knowledge of when the moths are actively reproducing and laying eggs as well as the relative size of the pest density on their farms. Such information can guide spray intervals. For instance, a catch of 5 or fewer moths per night is relatively low, and a spray interval of 4 days between sprays may be adequate; whereas, a trap catch of 10 or more moths is high, suggesting a need to reduce the spray interval to every 2-3 days.

Evaluation of a sweet corn IPM program in Virginia

At three locations in Virginia from 2017-18, we conducted a replicated small plot field experiment. Each experiment was the same and evaluated sweet corn ear damage in plots that were under three treatment regimes: 1) no insecticide sprays (control); 2) use of an IPM-friendly insecticide Coragen at silking and following sprays based on economic thresholds for CEW from trap catch monitoring; or 3) regular pyrethroid sprays 3 times per week tassel to harvest.

Results. Unsprayed control plots suffered significant damage from CEW and averaged only 13.8% clean ears across all sites and years (Fig. 1). IPM-based treatments averaged 80.3% clean ears and regular pyrethroid sprays averaged a similar 83.1% clean ears. The IPM approach however required only 4 and 6.4 sprays in 2017 and 2018, respectively, compared to

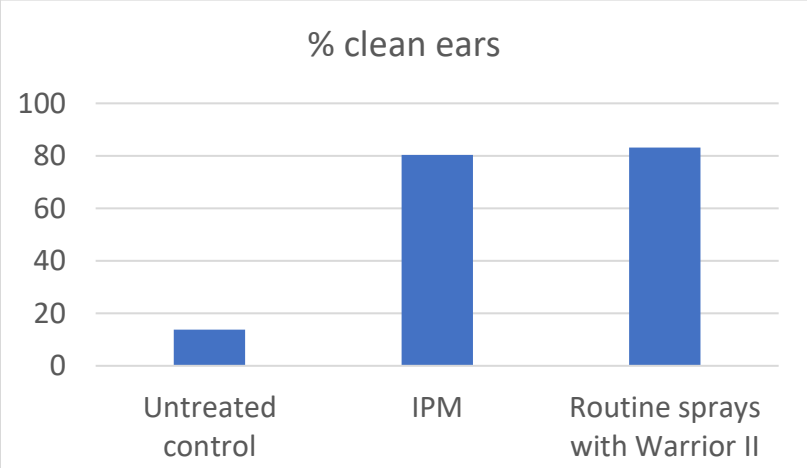


Fig. 1. Percentage ear damage of sweet corn under three pest management strategies in VA, based on 5 small plot evaluations.

5.8 and 7.5 sprays in the conventional (routine spray) approach. These data demonstrate that growers can save about two insecticide sprays per crop with IPM scouting without a loss in marketable yield of sweet corn.

Which insecticides should you use?

For the past three decades, pyrethroids have been the most widely used class of insecticides in sweet corn, and include products such as: Asana XL (esfenvalerate), various permethrin formulations, Tombstone (cyfluthrin), Baythroid XL (beta-cyfluthrin), Warrior II and other formulations of lambda-cyhalothrin, Mustang Max (zeta cypermethrin), various bifenthrin formulations, or Hero, which contains two pyrethroids zeta cypermethrin and bifenthrin. However, recent concerns over **pyrethroid resistance**, particularly in CEW, has made control challenging in some regions of the U.S. In addition, because they are broad-spectrum poisons, pyrethroids as well as the carbamate Lannate LV, typically destroy natural enemy populations in fields and thus are not compatible with IPM/biological control programs or with recent heightened concerns over pollinator protection.

In 2020, we evaluated several pyrethroid products available to sweet corn growers to assess how each is performing. In Whitethorne, VA, all of the pyrethroids provided very good control of CEW (Fig. 2); however, in Painter, VA (Eastern Shore), most of the pyrethroids did not provide effective control; only Beseige, which contains a diamide insecticide with the pyrethroid lambda-cyhalothrin, effectively controlled CEW (Fig. 3).

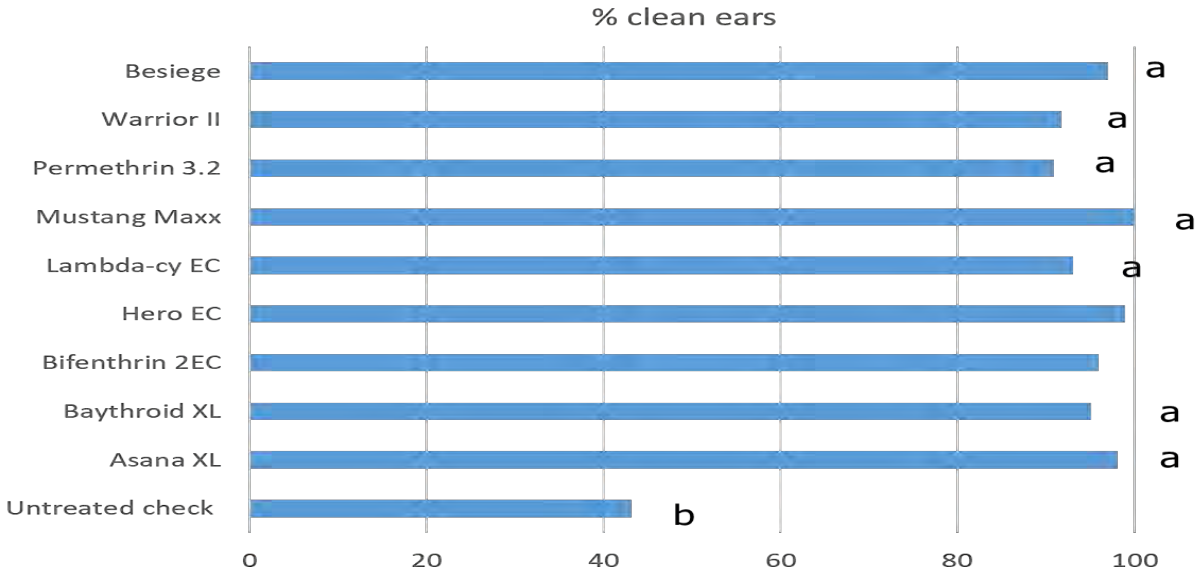


Fig. 2. Performance of pyrethroid insecticides on sweet corn – Whitethorne, VA 2020. (7 Sprays: 5, 8, 10, 14, 17, 20, 24-Aug).

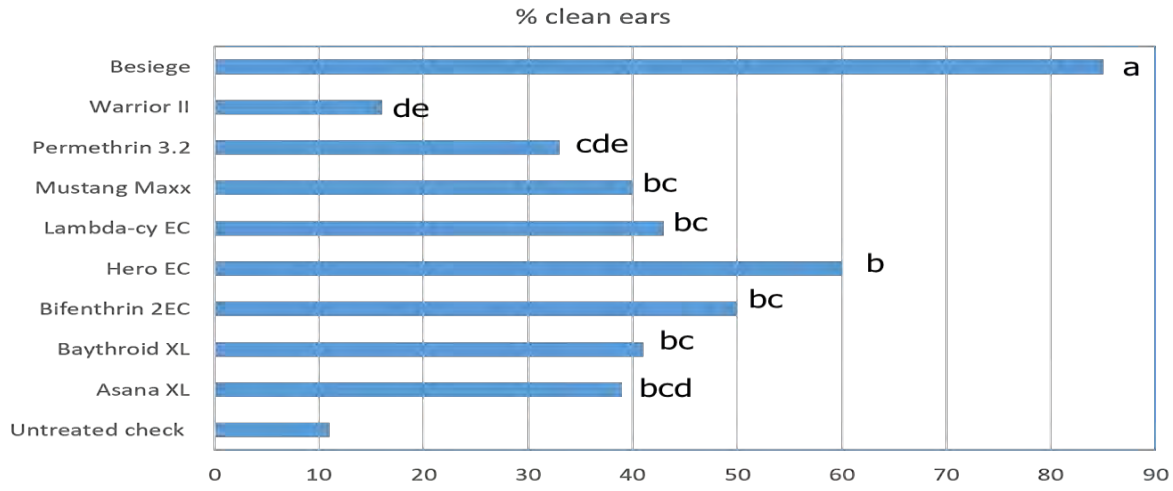


Fig. 3. Performance of pyrethroid insecticides on sweet corn – Painter, VA 2020 (Sprays 17, 19, 21, 24, 26, 28, 31 August).

Insecticide Resistance Management (IRM). Rotation of insecticides in spray programs is highly recommended for IRM. Products such as Coragen or Vantacor (containing the diamide insecticide chlorantraniliprole) or spinosyn insecticides such as Blackhawk (spinosad) and Radiant (spinetoram) provide effective, safer, IPM-friendly chemistries for sweet corn growers. Besiege and Elevest are combo products that add a pyrethroid to chlorantraniliprole, giving a 1-2 punch.

Although not IPM compatible, the carbamate Lannate is still a popular and effective rotational insecticide for sweet corn growers.

Insect control for organic growers

Organic sweet corn growers have fewer insecticide options and none that meet the control levels produced by the aforementioned synthetic insecticides. Products containing *Bacillus thuringiensis kurstaki* (such as Dipel) or *Bt aizawai* (such as Xentari) are terrific insecticides for many leaf-feeding lepidopteran pests, but unfortunately have not performed well at controlling CEW in sweet corn (Fig. 4).

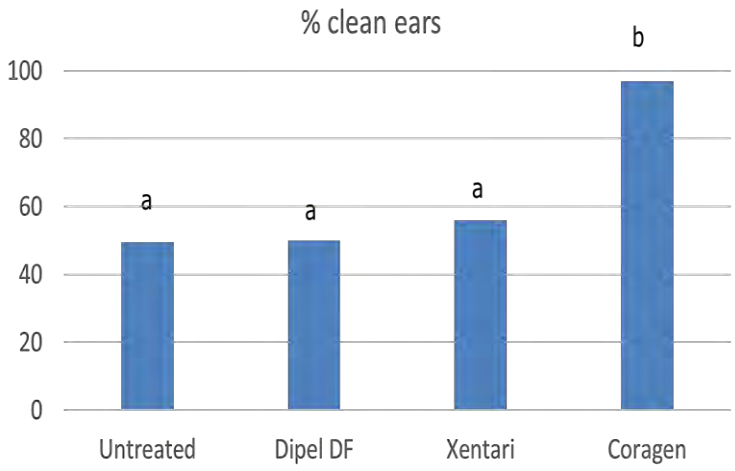


Fig. 4. Percentage of clean ears following 7 spray applications of insecticides in Whitethorne, VA, 2020.

Another organic insecticide option for CEW control is

Heligen (AgBiTech) and Gemstar (Certis USA), which are commercial products that contain Helicoverpa nucleopolyhedrovirus (H-NPV) particles (called a virions). The NPV virion is eaten by the host to produce an infection, which is typically fatal to the insect.

Because H-NPV must be ingested, takes a few days to actually kill the larva, and is not very efficacious on large larvae, the performance of H-NPV in small plot sweet corn insecticide efficacy trials has not been on par with other insecticides. In 2020, we conducted large plot demo trials on a commercial sweet corn farm in Blacksburg, VA. Our objective was to evaluate the effectiveness of Heligen (H-NPV) applied early at tassel push and often (~every 3 d) to sweet corn to determine if there is potential for this product in commercial sweet corn production. Each planting had 3 treatments: untreated control, a low rate of Heligen (1.2 fl oz/A), and a high rate (2.4 fl oz/A) each applied to plots ~0.25 acre.

Results. In all three plantings, Heligen noticeably increased the amount of marketable yield, but not significantly (Fig. 5). No significant differences were found between the low and high rates of Heligen. This study indicates that Heligen (H-NPV) may have potential for control of CEW in sweet corn. More research under different pest pressures and regions is encouraged. Rotations of Heligen with other insecticides should also be explored.

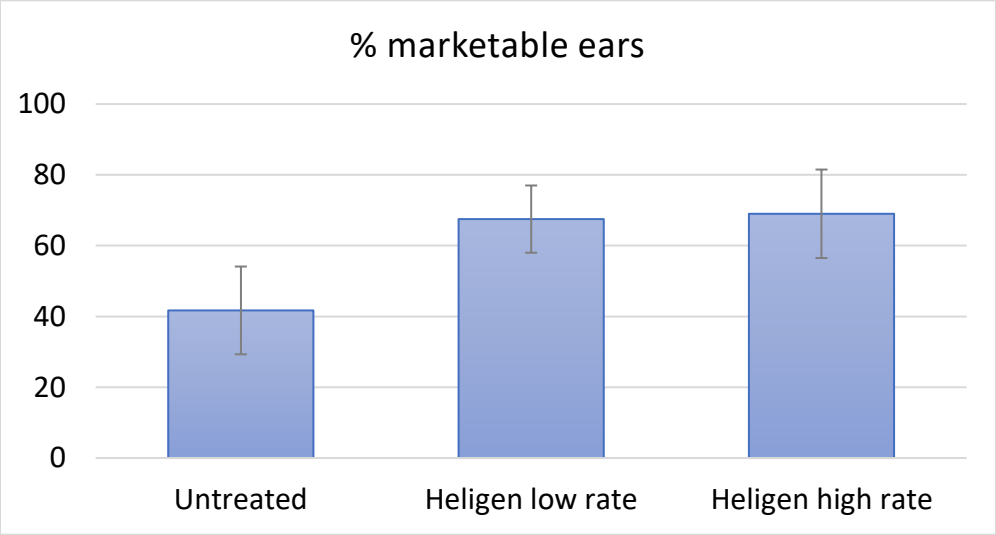


Fig. 5. % marketable ears from three plantings of sweet corn not treated with insecticides or treated with seven applications of Heligen at 1.2 fl oz/A or 2.4 fl oz/A in Blacksburg, VA in 2020.

REFINING YOUR DISEASE MANAGEMENT PROGRAM FOR PUMPKIN AND WINTER SQUASH

Margaret Tuttle McGrath
Plant Pathology & Plant-Microbe Biology Section, SIPS, Cornell University
Long Island Horticultural Research & Extension Center
3059 Sound Avenue, Riverhead, NY 11901 mtm3@cornell.edu
http://blogs.cornell.edu/livegpath/; https://www.vegetables.cornell.edu/pest-management/

A disease management program for cucurbits needs a tune up every year to maximize success. This is because managing the numerous diseases that can affect these crops is critical to obtain good yield of quality fruit. Key to success is knowledge about these diseases in particular knowing about new management tools (fungicides, resistant varieties, etc.) and also about information generated through research on these diseases. Winter is a good time to read about diseases (including ones that could occur but have not yet on your farm to be prepared), become familiar with symptoms, and plan a fungicide program for diseases that have occurred in the past that is based on knowledge of new fungicides and current information about fungicide resistance in the pathogen. Fungicides continue to be the most important tool for managing many diseases partly because modern fungicides are highly effective due to targeted activity and mobility in plants, but single-site mode of action makes them prone to resistance developing in pathogens. Several fungicides need to be included in a fungicide program because some of the most effective ones have activity for just one to two diseases (e.g. powdery mildew), they have label use restrictions on number of consecutive applications and total number that legally can be applied, and they need to be used in alternation to delay development of resistance and avoid control failure when resistance develops.

There are lots of resources on the web. Those from a reputable source (eg university) are best. I have seen incorrect statements posted at other sites including about a pathogen's ability to survive over winter in soil. I have been posting information at two Cornell websites that are listed above. Information at the VegetableMD Online website, which is on an out-of-date platform, is being up-dated and posted at the Vegetables Cornell website. Content will continue to be updated as needed, such as when a new fungicide is registered or research generates information relevant for growers. Most content is also posted as printer-friendly pdf files that can be downloaded.

Resistant variety lists. https://www.vegetables.cornell.edu/pest-management/disease-factsheets/disease-resistant-vegetable-varieties/.

Articles about diseases and management practices affecting multiple crops are at https://www.vegetables.cornell.edu/pest-management/disease-factsheets/. Topics include Phytophthora blight, fungicide resistance management, biopesticides, and when to apply fungicides. There is also a table listing targeted fungicides for three major

cucurbit diseases: powdery mildew, downy mildew, and Phytophthora blight. It includes REI, PHI, seasonal limits, plus a lot of additional information in footnote section.

Photographs of symptoms for many of the diseases occurring in the northeast, plus information about the causal pathogen and its management, are in Disease Factsheets: https://www.vegetables.cornell.edu/pest-management/disease-factsheets/

The cultural management practice information from the Cornell Management Guidelines for Vegetable Crops is available at the Cornell IPM website. The cucurbit crop chapter is at https://nysipm.cornell.edu/agriculture/ vegetables/vegetable-ipm-practices/chapter-18/

Information from my research on managing cucurbit diseases is at http://blogs.cornell.edu/livegpath/research/

Powdery mildew management:

See https://www.vegetables.cornell.edu/pest-management/disease-factsheets/cucurbit-powdery-mildew/.

Select resistant varieties.
Scout for symptoms starting at flowering. Examine both surfaces of at least 50 older leaves. When symptoms seen, even 1 spot, start applications.

Alternate among targeted, mobile fungicides in several chemical groups and apply with protectant fungicide to manage resistance development. Mobile fungicides currently recommended include Vivando (FRAC Code 50), Gatten (Code U13), and DMI fungicides (Code 3; Proline, Procure, Luna Experience, and Rhyme). Quintec (Code 13) and a carboxamide (SDHI) fungicide (Code 7; Luna Experience, Miravis Prime) are recommended included in the fungicide program to a limited degree because of resistance. Sulfur is most effective protectant. Chlorothalonil and some biopesticides are also good choices.

Rate success of management program by looking at underside of leaves and identify ways to improve if inadequate. Promptly incorporate crop after harvest (mow and disk) primarily to reduce inoculum for other plantings.

Downy mildew management:

See https://www.vegetables.cornell.edu/pest-management/disease-factsheets/downy-mildew-of-cucurbits/.

Sign up to receive alerts when downy mildew has been detected nearby at https://cdm.ipmpipe.org/.

Monitor https://cdm.ipmpipe.org/ to know when downy mildew is developing in crops in the eastern US and when there is a forecasted risk for your area. Focus on crops you are growing and related ones (same Latin name; see list below). The forecast

program is predicting movement of the pathogen from known sources of the disease based on forecast wind trajectories and predicted favorability of conditions both for survival of the pathogen's spores during transport (cloudiness) and for infection after spores are deposited (rain is ideal).

Latin name	**Cucurbit type**
Cucurbita moschata	Butternut squash
Cucurbita pepo	Acorn squash, pumpkin, zucchini, summer squash
Cucurbita maxima	Kabocha and buttercup squash, giant pumpkin
Cucumis sativus	Cucumber
Cucumis melo	Cantaloupe
Citrullus lanatus	Watermelon

Scout for symptoms. Increase frequency to at least weekly as reports of downy mildew get closer. The forecast program has accurately predicted many outbreaks, but it can miss predicting a risk in particular when downy mildew is not reported. See http://blogs.cornell.edu/livegpath/gallery/cucurbits/downy-mildew-o-cucurbits-early-symptoms/ for photographs of early symptoms.

Apply protectant fungicides (mancozeb or chlorothalonil) when there is a low to moderate forecast risk and there have been documented occurrences of downy mildew on crops you are growing (or related ones) within the highlighted risk plume in the forecast map. If you are risk adverse, apply protectant fungicides before rain. Start applying targeted fungicides for downy mildew when there is a moderate to high risk or as soon as symptoms detected. Most targeted fungicides are also labeled for Phytophthora blight. When applying fungicides for both diseases, select those with greatest concern for resistance in the downy mildew pathogen (Revus, Forum, Presidio) to use early in the season before downy mildew is a concern. The downy mildew pathogen exists as two lineages called clades. Most fungicide resistant isolates detected so far in the U.S. have belonged to clade 2. Isolates in this clade preferentially infect cucumber and cantaloupe. Clade 1 isolates infect watermelon, squashes and pumpkin. Recommended fungicides include Orondis Ultra, Orondis Opti, Ranman, Zampro, Omega, and Zing! or Gavel or Elumin.

Report occurrence to extension specialist or post at https://cdm.ipmpipe.org/. Include a photograph if you report yourself.

Rate success of management program and identify ways to improve if inadequate.

Promptly incorporate crop after harvest (mow and disk) primarily to reduce inoculum for other plantings.

Phytophthora blight management:

See https://www.vegetables.cornell.edu/pest-management/disease-factsheets/phytophthora-blight-and-its-management-in-cucurbit-crops-and-other-vegetables/.

Select field with good drainage. Plant any low areas to cover crops. Manage soil moisture by subsoiling, using drip irrigation, etc.

Use reduced tillage or mustard biofumigation.

Clean farm equipment, shoes, etc. of soil between fields.

Apply fungicides on a preventive schedule starting before symptoms seen. Rotate among large diversity of chemistry to manage resistance.

Scout routinely.

Remove or disk in affected plants when found.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede this information, if there is a conflict. Before purchase, make sure product is registered in your state. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

Table contains many conventional fungicides labeled for diseases of cucurbit crops, approximate cost per acre of an application, number of acres that can be treated with the package size available, and diseases labeled. Most products listed have mobility and targeted activity. The last three are contact protectant fungicides.

Fungicide	Price	Unit	Rate/A	Unit	Cost/A	Pkg Size	A/treated	AB	AL	A	ALS	BLS	DM	F	GSB	PhB	PIB	PM	S
Actigard	$57.08	oz	0.5-1	oz	$29-57	8 oz	8-16				R	R	L					L	L
Aprovia Top 1.62 EC	$389.91	gal	10.5-13.5	fl oz	$32-41	1 gal	9.5-12.2	R	R	R					R		R		R
Curzate 60 DF	$57.16	lb	3.2-5	oz	$11-18	4 lb	12.8-20						R						
Elumin 4 SC	$467.99	gal	8	fl oz	$29	1 gal	16						R			R			
Endura	$92.11	lb	6.5	oz	$37	6.5 lb	16	R							nr			nr	
Forum 4.17 SC	$391.96	gal	6	fl oz	$18	1 gal	21.3						R/nr			R			
Gatten	$125	qt	6-8	fl oz	$23-31	1 qt	4-5.3											R	
Gavel 75 DF	$12.49	lb	1.5-2	lb	$19-25	30 lb	15-20						R			R			
Inspire Super 2.82 EW	$325.13	gal	16-20	fl oz	$41-51	1 gal	6.4-8.0	R	R	R					R		R	nr	
Luna Experience 3.34 SC	$5.93	oz	6-17	fl oz	$36-101	32 oz	1.9-5.3		R	R					R			R	
Miravis Prime 3.34 SC	$569.08	gal	9.2-11.4	fl oz	$41-51	2.5 gal	28.1-34.8	R	R						R			R	R
Omega	$506.68	gal	0.75-1.5	pt	$48-95	2.5 gal	13.3-26.7		R				R		R	R			
Orondis Gold	$1,838.30	case			$92-184											R			
Orondis Opti	$210.49	gal	1.75-2.5	pt	$46-66	2.5 gal	8.0-11.4						R						
Orondis Ultra	$1,018.50	gal	5.5-8	fl oz	$44-64	1 gal	16.0-23.3						R			R			
Phiticide (phosphorus acid)	$21.40	gal	2.5-5	pt	$7-13	2.5 gal	4.0-8.0						nr			R			
Presidio 4 SC	$350.93	qt	3-4	fl oz	$33-44	1 qt	8.0-10.7						R/nr			R			
Previcur Flex 6F	$92.09	gal	1.2	pt	$14	2.5 gal	16.7						R/nr						
Pristine 38 WG	$3.90	oz	12.5-18.5	oz	$49-72	120 oz	6.5-9.6											nr	
Procure 480 SC	$113.69	qt	4-8	fl oz	$14-28	1 qt	4.0-8.0											R	
Proline 480 SC	$655.94	gal	5.7	fl oz	$29	2.5 gal	56.1							R	R			R	
Prolivo	$4.40	oz	4-5	fl oz	$18-22	32 oz	6.4-8.0											nr	
Quintec 2.08 SC	$4.46	oz	4-6	fl oz	$18-27	30 oz	5-7.5											R	
Rally 40 WSP	$3.93	oz	2.5-5	oz	$10-20	20 oz	4-8											nr	
Ranman 400 SC	$1,180.93	gal	2.1-2.75	fl oz	$19-25	1 qt	11.6-15.2						R			R			
Revus	$505	gal	8	fl oz	$32	1 gal	16.0						R/nr			R			
Rhyme 2.08 SC	$3.46	oz	5-7	fl oz	$17-24	50 oz	7.1-10.0								R			R	
Switch	$6.96	oz	11-14	oz	$77-97	28 oz	2-2.5	R	R						R			L	
Tanos 50 DF	$57.65	lb	8	oz	$29	7.5 lb	15						nr						
Torino 0.85 SC	$8.94	oz	3.4	oz	$30	34 oz	10.0											nr	
Vivando 2.5 SC	$311.87	gal	15.4	fl oz	$38	1 gal	8.3											R	
Zampro 525SC	$3.30	oz	14	fl oz	$46	140 oz	10.0						R			R			
Zing! 4.9 SC	$97.91	gal	36	fl oz	$28	2.5 gal	8.9						R			R			
PROTECTANT Fungicides:																			
Chlorothalonil 720	$51.47	gal	1.5-3	pt	$10-19	1 gal	6.7-13.3	R	R	R			R		R			R	R
Microthiol Disperss	$1.13	lb	2-10	lb	$2-11	30 lb	3-15											R	
Kocide 3000	$8.16	lb	0.5-1.25	lb	$4-10				L	L	R		nr		L			nr	

Disease name abbreviations: Alternaria blight (AB), Alternaria leaf spot (AL), angular leaf spot (ALS), anthracnose (A), bacterial leaf spot (BLS), downy mildew (DM), Fusarium blight aka Fusarium crown rot and fruit rot (F), gummy stem blight (GSB), Phytophthora blight (PhB), Plectosporium blight (PlB), powdery mildew (PM), scab (S)

R = recommended, nr = not recommended, L = labeled. Some fungicides not recommended for DM on some crops because of resistance.

Session 21

General Vegetables I

Session Chairs:

Andy Wyenandt / Tom Orton

Rutgers NJAES

BACTERIAL LEAF SPOT POPULATIONS AND COPPER RESISTANCE DEVELOPMENT IN VEGETABLE AND TREE FRUIT CROPS IN NEW JERSEY.

Nrupali Patel[1], Radhika Patel[1] Andrew Wyenandt,[2] and Donald Kobayashi[1]
[1]Department of Plant Biology,
Rutgers University,
59 Dudley Road, New Brunswick, NJ
npatel@sebs.rutgers.edu
[2]Department of Plant Biology, Rutgers University,
Rutgers Agricultural Research and Extension Center (RAREC),
121 Northville Road, Bridgeton, NJ 08302
wyenandt@njaes.rutgers.edu

Bacterial Leaf Spot diseases caused by Xanthomonas species on vegetable and tree fruit crops have been problematic in New Jersey for decades. Copper-based chemical products are among the most widely used methods to manage bacterial diseases worldwide and has been used extensively in New Jersey to reduce bacterial leaf spot diseases. However, the overuse of copper to reduce disease can be problematic because Xanthomonas species are known to acquire resistance to copper once the genetic resistance is introduced into local bacterial populations. Despite persistence of leaf spot disease and the associated threat of copper resistance among pathogen populations, a comprehensive evaluation of Xanthomonas leaf spotting diseases or a survey of copper resistance among Xanthomonas in New Jersey fields has not been conducted. As a result, we initiated a study at the end of the 2019 growing season with two objectives: 1) to gain a better understanding of Xanthomonas species causing leaf spot diseases among vegetable and fruit crops, and 2) to assess the level of copper resistance among Xanthomonas populations throughout the state.

Only two of the four major Xanthomonas species known to cause leaf spot on tomatoes and peppers, (*X. euvesicatoria, X. gardneri, X. perforans*, and *X. vesicatoria*) were identified in New Jersey during our survey in 2019 and 2020. *X. euvesicatoria* was the only species obtained from pepper leaf spot diseased tissue. In contrast, both *X. perforans* and *X. euvesicatoria* were isolated disease from leaf spot on tomato. Ongoing characterization of the causal agent for bacterial leaf spot of peach in 2020 indicates *X. arboricola pv. pruni* as the sole pathogenic agent responsible for the disease throughout the state.

Since copper is used broadly to control bacterial leaf spot of vegetable and fruit crops, we have begun to evaluate resistance to the compound among Xanthomonas populations causing bacterial leaf spot on tomatoes, peppers, and peach. Preliminary results to date indicate copper resistance was detected among more than 50% of *X. euvesicatoria* isolates obtained from commercial fields of tomato and pepper when grown on a laboratory agar medium supplemented with copper. In contrast, no resistance was observed among isolates recovered from non-commercial research fields. Similarly, copper resistance was not detected among *X. arboricola pv. pruni* isolates recovered from diseased peach samples, regardless of whether they were obtained from commercial or research fields. Copper evaluation of all Xanthomonas populations collected during the 2019 and 2020 growing season will continue and include a more robust verification through molecular characterization.

UPDATE ON X10R BELL PEPPER VARIETIES IN NEW JERSEY

Wesley Kline, PhD[1] and Andy Wyenandt, PhD[2]

[1]Cooperative Extension Agent
Rutgers Cooperative Extension of Cumberland County
291 Morton Ave., Millville, NJ 08332
wkline@njaes.rutgers.edu

[2]Extension Specialist in Vegetable Pathology
Rutgers Agricultural Research and Extension Center
121 Northville Rd., Bridgeton, NJ 08302
wyenandt@njaes.rutgers.edu

Introduction:
Bacterial leaf spot (BLS) is caused by the pathogens, *Xanthomonas euvesicatoria*, *X. vesicatoria*, *X. perforans*, and *X. gardneri,* and is the second most important disease on bell and non-bell peppers in New Jersey. BLS has become more of a concern in New Jersey over the last ten to fifteen years. Early survey results from 2019 suggest *Xanthomonas euvesicatoria* is the most prevalent species found in pepper and tomato fields in the state. There are eleven (0-10) races of BLS identified in the United States; and past research has shown that all races are present in New Jersey. The pathogens are favored by high humidity, hard driving rains, vigorous plant growth, infested stakes, and working in the field when plants are wet.

Materials and Methods:
Since 2016, we have screened cultivars and advanced breeding lines with resistance to all races (often referred to as X10R resistance) of bacterial leaf spot. In 2020, Two 128 cell trays were seeded on March 19th and the plants were set by hand on June 2nd . The trial was established in a grower's field in Vineland, New Jersey on black plastic mulch with one drip line between double rows with distance between plants at 18 inches in double rows and 64 inches between beds center to center. The plots (18 plants/plot) were transplanted June 2nd. Plots were arranged in a randomized complete block design with four replications.
All cultural practices such as staking/tying, fertilization and pest management were carried out by the grower. Plots were sprayed weekly for BLS control.

Table 1 summarizes the monthly minimum, maximum and average temperatures, and rainfall for the season. Entries, seed company and reported disease resistance are listed in Table 2.

Discussion:
The trial was evaluated weekly for BLS with the first observed BLS symptoms on July 13 in all four plots of the variety (Paladin) and one plot of Camelot. By July 27, all plots of Camelot showed symptoms. Plots were rated on September 18 after the last harvest. Varieties that showed no symptoms were 'Antebellum', '3255', 'Labelle', 'FPP 2862', 'Shogun' and 'Outsider'. The varieties with the most severe BLS symptoms were 'Paladin', 'Camelot' X3R, '3964', '1819', 'Turnpike', and 'Aristotle' X3R. Plots continued

to be observed through November 6th with no changes to the varieties that were infected or the severity of the infections. Plants were sampled for bacterial leaf spot on July 28th and the laboratory identified the pathogen as *Xanthomonas euvesicatoria* which was also isolated from other pepper fields in South Jersey.

A closed plant canopy is important to protect the fruit from sunburn. Plots were evaluated the day prior to the first harvest. The varieties with the most up right plant and closed canopy were 'Antebellum', '1819', '3964', 'Labelle', 'FPP 2862', and 'Outsider'.

The entries were harvested 4 times starting 66 days after transplanting from August 7 to September 14. Peppers were graded based on weight (extra-large >0.49 lbs., large 0.33 – 0.49 lbs., medium 0.25 – 0.32 lbs., commercials, and culls <0.25 lbs.). Harvest data is summarized for total harvest in table 3. Yield data was analyzed for the first three harvests since at harvest 4 anthracnose *Colletotrichum spp.* severely impacted the trial.

The cultivar '1819' had the highest extra-large, large, and total marketable yield for the first harvest, but was not statistically different from 'Mercer', 'Labelle', '3255', 'Turnpike' or 'Aristotle' for the first harvest. 'Paladin' had the lowest yield and was significantly lower than all other entries. At the second harvest, 'Prowler' had the high extra-large, large, medium, and total marketable yield, but for total marketable yield it was not statistically significant from 'Nitro', 'Shogun', 'Camelot', '3964' or 'Antebellum'. As in the first harvest 'Paladin' had the lowest total marketable yield, but in contrast to the first harvest "Outside', 'Turnpike', 'Mercer', '2862' and '3255' were not statistically different from it. At the third harvest '3964' had the highest yield, but it was not statistically different than "Tarpon', '1819', 'Labella', '3255', 'Aristotle' or 'Turnpike'. There was no yield for the variety 'Paladin' since BLS had completely defoliated the plants. However, 'Shogun', 'Camelot' and '2862' were not significantly different from it. For the combined yield, '1819' had the highest yield for extra-large, large, and medium fruit percent marketable and total marketable yield. There were several varieties which were not statistically different from its 'Labelle', '3964', 'Mercer', 'Prowler', '3255', 'Antebellum', 'Tarpon', 'Aristotle', and 'Turnpike'. 'Paladin' had the lowest total marketable yield.

The results from 2020 are similar to 2019. The varieties that had the highest yield in 2019 were '2964', '1819', 'Antebellum', 'Turnpike', 'Tarpon', 'Prowler', and 'Aristotle' X3R. Based on these two years growers have several varieties from which to select. One-point growers need to remember is not spraying is not a possibility especially in areas where other disease maybe prevalent. In New Jersey, anthracnose is becoming more of a problem, especially in the South. This relates to poor rotations and possibly not starting spray programs in a timely matter. For anthracnose management the first applications should be applied at first bloom and continued weekly throughout the harvest period. Once anthracnose is in the field it is difficult to control. Missing one spray could allow anthracnose to become established in a field.

Table 1. Summary of average, minimum and maximum temperatures (°F), and total rainfall, Vineland, New Jersey May-September 2020.

Month	Average	Minimum	Maximum	Rainfall (inches)
May	60.0	34.7	84.8	1.13
June	72.6	42.5	90.6	2.44
July	78.8	64.1	96.2	10.92
August	75.5	59.8	92.0	10.42
September	67.1	41.7	88.7	4.36

Table 2. Seed sources and disease resistance as report by the company.

Variety	**Company**	**Disease Resistance**
1819	Seminis	HR: Xcv: 0-5; IR: Pc
3255	Seminis	HR: Tm: 0; IR: Xcv: 1-10
3964	Seminis	HR: Xcv: 0-4, 7-9; Tm: 0; IR: CMV
Antebellum	Seminis	HR: Tm: 0, IR: TSWV, Xcv 1-10
Aristotle X3R	Seminis	HR: PVY: 0, Tm: 0; Xcv: 0-3, 7, 8
Camelot X3R	Seminis	Xcv 1-3
FPP 2862	Sakata	
Labelle	Seedway	IR: Xcv 1-10
Mercer	Sakata	HR: TMV:0; Xcv 0-3, 7-8; IR: Pc
Nitro S10	Sakata	HR: TMV:0, IR: Xcv 0-10
Outsider	Syngenta	HR: TSWV; Xcv: 1-10
Paladin	Syngenta	HR: Pc
Prowler	HM Clause	IR: TSWV: 0; IR: Xcv 1-10
Shogun S10	Sakata	HR: TMV:0, IR: TSWV, Xcv 0-10
Tarpon	Seminis	HR:Tm:0, Xcv: 0-10; Pc
Turnpike	Seminis	HR: Tm; Xcv: 0-5, 7-9; IR: Pc

[a]PVY = Potato virus Y; TMV = Tobacco Mosaic Virus; TSWV = Tomato Spotted Wilt Virus; Tm = Tobamovirus; Xcv = Bacterial leaf spot race resistance; CMV = Cucumber mosaic virus; Pc = *Phytophthora capsici*, with HR = Highly resistant; IR = Intermediate resistance

Table 3. Extra-Large, Large, and Medium Sized Fruit, Percent Marketable Yield, and Total Marketable for Three Harvests. (28 Lb. Boxes per Acre); 2020, Vineland, NJ.

Variety/Line	XL		L		M		% Marketable		Total Marketable	
1819	407.13	a	689.42	ab	99.80	ab	97.11	a	1196.30	a
Labelle	316.94	ab	754.95	a	50.30	abc	94.65	a	1122.20	ab
3964	410.70	a	566.09	a-d	80.24	abc	94.88	a	1056.90	abc
Mercer	196.73	bc	719.68	a	100.18	ab	96.76	a	1016.60	a-d
Prowler	222.42	bc	691.59	ab	92.82	abc	91.57	ab	1006.80	a-d
3255	313.50	ab	639.73	a-d	49.59	abc	98.23	a	1002.80	a-d
Antebellum	330.66	ab	582.07	a-d	54.50	abc	94.64	a	967.20	a-e
Tarpon	155.57	cd	704.60	ab	95.70	abc	91.85	ab	955.90	a-e
Aristotle	367.90	a	525.08	bcd	52.75	abc	95.79	a	945.70	a-e
Turnpike	411.70	a	476.14	d	50.11	abc	98.24	a	938.00	a-e
Nitro	106.31	cd	668.58	abc	51.53	abc	96.38	a	826.40	b-e
Outsider	299.55	ab	479.30	cd	33.61	c	95.37	a	812.50	cde
Shogun	153.69	cd	582.40	a-d	38.28	bc	96.71	a	774.40	cde
FPP2862	54.73	d	588.53	a-d	110.08	a	95.22	a	753.30	de
Camelot	32.74	d	593.62	a-d	68.40	abc	93.80	a	699.30	e
Paladin	14.52	d	60.25	e	41.91	bc	75.00	b	116.70	f
LSD	**141.19**		**192.19**		**63.325**		**18.008**		**296.19**	

[x]Within columns, means followed by different letters are significantly different.

XL = Extra-Large; L = Large; M = Medium

Session 22

Grapes II

Session Chair:

Hemant Gohil

Rutgers Cooperative Extension

NO ARTICLES SUBMITTED

Session 23

Technology

Session Chair:

Richard VanVranken

Rutgers Cooperative Extension

FROM THE HORIZON TO THE FAR OUT – AG PRODUCTION ENHANCING TECHNOLOGIES

Gene A. Giacomelli, PhD
Professor Biosystems Engineering Dept
Former and Founding Director, Controlled Environment Agriculture Center (CEAC)
The University of Arizona, Tucson, Arizona 85719
giacomel@ag.arizona.edu https://ceac.arizona.edu

This presentation is dedicated to the extension specialist Professor Bill Roberts, who succumbed to the COVID-19 virus in May 2020. In 1973, as an undergraduate student, I met him, then built my first greenhouse from his extension design plan in 1975. Later I became a member of the Cook College faculty from 1980 – 2000 in the Biological & Agricultural Engineering Dept which he chaired. I owe much of my professional opportunities from the mentorship that he provided.

The presentation will focus on the procedures and technologies of vegetable crop production that will range from the recently developed (on the 'horizon'), to what may be next (potentially 'far out').

Current topics and terminologies for modern production agriculture producers and growers:

Resources Utilization of Solar Radiation, Energy, Water, Genetics, Labor
Production Efficiency and Quality
Irrigation Scheduling and Fertigation
Agrivoltaics - Photovoltaics (PV) fields and Greenhouses
Mechanization, Automation and Robotics
Controlled Precision Agriculture – CEA+
Intelligent Farming - Data and Information Management
CRISPR technology – genetics for crop improvement
Urban Agriculture – food production migration toward the cities
Webinars – university and technical education in your home
Risk Mitigation – all of the above

Some are described below, while all are within the PowerPoint slide show.

But first, some fundamentals, or just reminders of what you already know but sometimes overlook for effective and quality crop production using Genetics, Environment, Management and Sustainable practices. It should be every grower's goal to:

> *Apply the proper **Environment** to achieve the **Genetic** potential of the plant, within a well-**Managed** and properly designed (outdoor or indoor) food production system that provides for greater operational **Sustainability** (economically, environmentally and socially) by enhancing product market value to improve the quality of life with more nutritious and available foods, while reducing the environmental impact.*

Best of continued success!

Farmers support the growth of crops that transfer solar energy into food energy for people. They are driven (yet beholden) by the sun and its plant production capability. **Agrivoltaics** is sharing the sunlight to generate electric power and crops in the field or for crops from under cover of a greenhouse. The University of Arizona has studied crops grown under photovoltaic panels in the field, as well as crops grown hydroponically under greenhouse glazing with PV-imbedded flexible film.

Production efficiency requires judicious use of water, fertilizer, pest control and labor that when combined meets the needs of the crop, while limiting excess resources that become wastes. With the expertise of the grower in knowing the scheduling, planting, watering, fertilization and harvest needs of the crop, plants for food are evaluated and cared for through the human sense of vision. However, electronic sensors with monitoring, alarm and control systems are now more elaborate, accurate, information-filled and cost-effective. **Irrigation and fertigation** scheduling already monitoring soil moisture can now directly monitor plant water status to determine water and nutritional needs. Wireless remote and distributed sensors can provide soil moisture conditions throughout a field at an instant, and drone transported non-contact sensors will automatically indicate general plant conditions of the field. Such real-time knowledge from robotic equipment will save resources and expenses but only if utilized by the grower to enhance plant growth. **Mechanization** for labor-saving and task easing continues to develop and requires that plant-to-plant variability be reduced where possible. **Robotic** harvesting by mimicking the human capabilities remains challenging but electronic, tactile and computation speed improvements are achieving improvements.

Controlled environments (CEA+) and **Controlled precision agriculture** production (CEA) offer a great advancement in yield, quality and predictability of product. Greenhouse (sunlit), grow rooms (electrical lighted), Vertical Farms (multi-level, electrically lighted) all target resource use efficiency and production quality to demand a premium price point with desired market properties (pesticide-free, non-GMO, locally-grown). CEA facilities can also allow moving the farm to non-traditional locations and operate in alternative harvest time periods and even year round, providing products for the high market demands in concentrated consumer markets.

Technologies to improve the light availability (greater intensity, longer durations) and quality (specific wavelengths of color) have recently enhanced plant production as LED lamps have become cost-effective. LED lighting remains the focus of a rapidly improving efficiency of converting electricity into light for plant growth. Sunlight, too, has been improved for crops within the traditional greenhouse with new films made of ETFE (ethylene tetrafluoroethylene) and providing plants inside with ultra-violet wavelengths transmitted from the outside environment. A future greenhouse film product containing non-contaminating nanotechnology quantum dots, shifts blue sunlight to more plant growth efficient orange and red sunlight and increases plant yields.

Genetic manipulation whether by traditional breeding programs or with assist by **CRISPR technology** now provides a significant improvement in plant value, either by yield, quality or as a new cultivar. Expanding traits such as disease resistance, flavor

and nutrition will benefit field vegetable crops and the rapidly expanding CEA industry within greenhouse, high tunnels, Vertical Farms, and Urban Agriculture.

CEA allows for true plant-based environmental control because of the sensors (wireless non-contact), complex control decisions (based on many types of real-time and historical plant data), and the environmental control hardware systems for heating, cooling, fertigating, pest control and lighting. Informed decision-making leads to **intelligent farming** practices, allowing for even greater **risk mitigation** unavailable until this century.

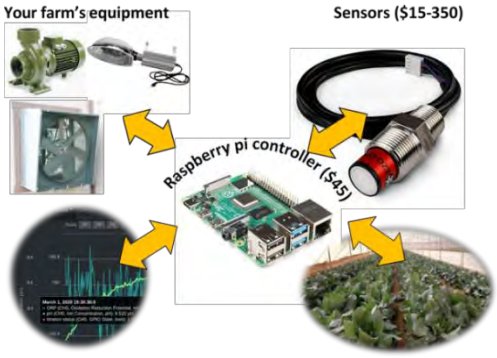
Urban Agriculture production installations have recently been meeting risk mitigation of crop production, and although many establishments remain untested for profitability, their presence and promotions have been creating a renewed interest in food production for the non-farm community. Consumers are being introduced to the challenges as well as the rewards of plant production. Although most people still will not produce their own vegetables, they will gain an education about the process, something that had been diminished for the past generation or two. UAg may vary in complexity and productivity from community gardens in empty lots, to high tunnels and even to CEA rooftop greenhouses. Such new options have created companies (Agritecture.com) that advise a new, non-experienced in agriculture business community wanting to establish production facilities with limited-experienced growers. A challenge for sure, with the current lack of experience growers. In addition, high-tech, multi-disciplinary companies (AutoGrow.com; LetsGrow.com) now exist to advise the high-tech grower with CEA+ strategies such as ‘Growing by Plant Empowerment’ within information-rich, real-time autonomous greenhouse production systems.

Education by seminar, short course, conference and remote experiences such as **webinars** on production technology and problem-solving of growing plants have increased in frequency and number in recent years. Universities, technical schools and K-12 schools have established educational program on food production. These are valuable for learning the technology, terminology, expectations and basic difficulties of crop production, but remain in critical need for providing hands-on experiences which are difficult to obtain.

The future of food production in the open field will not be dominated by greenhouses and Vertical Farms, but it will be supplemented by them in locations for special reasons such as extreme climate, limited resources, promotional flair to enhance supermarket sales, or the drive by markets and local foods enthusiasts to serve their community. In return, they will help to educate a much larger amount of the public about the realities of vegetable food production, and that will be very beneficial.

FARM-IT, COST EFFECTIVE AND OPEN-SOURCE MANAGEMENT SOLUTIONS FOR SMALL FARM OPERATIONS

Alon Rabinovich
PhD Candidate
Department of Earth and Environmental Sciences, Rutgers University, 101 Warren Street, Newark, New Jersey, 07102, U.S.A
ar1152@newark.rutgers.edu



Greenhouse, vegetable and livestock farm production often relies on farm automation and management solutions to meet productivity and sustainability goals. Until recent year, the high cost of these systems made them less cost effective for small farm operations. Currently, microcontroller systems such as Raspberry-pi and MyCodo software can support farm automation using a reliable and lower cost hardware.

Raspberry Pi is a single board computer that suitable for field application as it can operate at -10 to 120 F with ready to use connections to relays, Wi-Fi, sensors and more. MyCodo is a public software for farm applications that cover the needs of vegetable growers, nurseries, livestock, mushroom growers and agricultural research. The unique nature if the Raspberry controller and Mycodo system allows farmers to control most farm stationary machinery and has an integrated data logging and precision farming functions. Open-source software means that this method can utilize most of the existing infostructure (i.e. readers, controllers, motors, etc.) so that an overhaul of facility is not needed.

Current existing applications covers: a. growing space climate control with gas (CO_2, CH_4, O_2), moisture (Air, Soil), aeration flow rate and light (Photon flux) control. b. animal feeder automation, animal behavior monitoring, chemical dosing. c. process automation with PID d. security and customer service with remote cashier. e. research application and data processing. F. mechanical control of equipment, switches, levers and more with precise stepper motors. Training input needed to operate this system and customize it to an individual farm needs varies based on familiarity with such systems, however a 6-12 h training program was found to be sufficient for gaining basic capabilities without prior experience.

Cost of installation and operations are mostly affected by the quality of sensor input equipment needed, where software use is open source (free) and an average raspberry + wiring / housing cost ~$50-$100. Sensors can be as low cost as ≤$10 for (soil moisture, power on/off status, water level etc.) or >$500 for higher and or more durable

applications (High temp liquids chemistry, N_2O sensors, etc.). This is to say that through consultation, this system can be tailored to the user budget and needs.

Session 24

General Vegetables II

Session Chairs:

Andy Wyenandt / Tom Orton
Rutgers NJAES

NO ARTICLES SUBMITTED