PR-502

UK AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF KENTUCKY—COLLEGE OF AGRICULTURE

2004
Nursery and Landscape Program

Nursery and
Landscape Program

Kentucky Agricultural Experiment Station • University of Kentucky • College of Agriculture
Department of Horticulture • Lexington, Kentucky 40546

ABOUT OUR COVER

The cover photo is of one of the first winners of the Theodore Klein Plant Award in 1999; Amsonia hubrechtii, syn A. hubrichtii. <http://www.ca.uky.edu/HLA/Dunwell/amshub.html>.

Amsonia hubrechtii, syn *A. hubrichtii,* Arkansas Bluestar, is a fine-leaved plant known as much for its orange-yellow fall foliage as for its attractive spring blue flowers. The foliage creates a fine-textured, round, airy plant with full-season appeal. As its common name indicates, this plant is found native in Arkansas and surrounding states. Its native habitat is well-drained creek banks and bottomlands, but it performs admirably as a landscape plant in Kentucky. It has been observed in Kentucky landscapes growing in dry shade, moist shade, moist sunny, and dry sunny sites. There are a number of related species that are interesting as landscape plants. How the confusion in the spelling of the species name came about isn't known. The spelling *A. hubrechtii* was common to plant catalogs at the time when it was selected as a 1999 Theodore Klein Plant Award Winner. It would seem that *A. hubrichtii* is the correct spelling considering The Missouri Botanic Garden Plant Finder <http://www.mobot.org/gardeninghelp/plantfinder/codem/W810.shtml> says, "This species was named after Leslie Hubricht, who first discovered it growing in the wild in the early 1940s." Once the plant is established and flowering well, seed will result that can be collected in the fall and stored at 40°F for four to six weeks then sown in the spring. Division is another means of propagation that can be done in early spring or fall. Terminal cuttings taken in the spring root readily; rooting hormone is beneficial.

UK Nursery and Landscape Program

Faculty, Staff, and Student Cooperators

Horticulture

Faculty

Robert Anderson
Sharon Bale
Win Dunwell
Richard Durham
Bill Fountain
Robert Geneve
Dewayne Ingram
Robert McNiel
Mark Williams

Technical/Professional Staff

Shari Dutton
Amy Fulcher
Dava Hayden
June Johnston
Sharon Kester
Kirk Ranta
Hilda Rogers
Bonka Vaneva
Joe Ulrich
Dwight Wolfe

Lexington Research Farm Staff

Darrell Slone, Manager
Cortney Bobrowski
Dave Lowry
Janet Pfieffer

Students

Steve Berberich
Todd Leeson

Agricultural Economics

Faculty

Tim Woods

Professional Staff

Matt Ernst

Biosystems and Agricultural Engineering

Faculty

Richard Gates
Richard Warner

Students

Erin Wilkerson
Sergio Zolnier

Agronomy

Faculty

Tim Phillips
A. J. Powell

Entomology

Faculty

Kenneth Haynes
Daniel Potter

Students

Jamee Hubbard
Bonnie Miller

Plant Pathology

Faculty

John Hartman
Lisa Vaillancourt

Technical Staff

Bernadette Amsden
Paul A. Bachi
Julie Beale
Ed Dixon

Students

Claudia Cotton
Siriporn Dannua
Jennifer Flowers
Sabine Gruez
Stephanie Jeando
Nicki Mundellt

UK Arboretum

Marcia Farris, Director
Susan Capley
Jim Lempke

Nursery and Landscape Program

Contents

UK Nursery and Landscape Program Overview—2004 5

PRODUCTION AND ECONOMICS

Effect of Fertilizer Rate on Growth of Seven Tree Species in Pot-in-Pot Production 7

Effect of Planting Date and Protective Structures on Finishing Date for Container-Produced *Passiflora* 'Lady Margaret' 9

Effect of Fertilizer Brand, Rate, Application Technique, and June Reapplication on Growth of *Amelanchier* x 'Autumn Brilliance' in Aboveground Container Production 11

Preservative and Temperature Postharvest Treatments on *Hydrangea paniculata 'Kyushu'* 14

Using Root-Zone Temperature to Predict Rooting in Poinsettia Cuttings 16

Evaluation of Garden Mum Fertilization Programs in Central Kentucky, 2004 18

2004 Nursery Products Buyer Survey 19

PEST MANAGEMENT—INSECTS

Managing the Calico Scale Infestations with Systemic Soil Treatments or Crawler Sprays 21

Dogwood Borer Sex Pheromone Identification for Trapping and Timing Control Actions in Landscapes and Nurseries 23

New Management Approaches for Insect Pests of Nursery-Grown Maples 25

PEST MANAGEMENT—DISEASES

2004 Landscape Plant Disease Observations from the University of Kentucky Plant Disease Diagnostic Laboratory 26

Survey for *Phytophthora ramorum* (Sudden Oak Death) in Kentucky Nurseries, 2004 28

Survey for *Phytophthora ramorum* (Sudden Oak Death) in Kentucky Parks and Natural Areas, 2004 29

Preliminary Evaluation of Cambistat Treatments for Woody Plant Diseases 31

PLANT EVALUATION

Evaluation of Tennessee Dogwood Selections for Powdery Mildew, 2004 32

Evaluation of Tropical Plants as Annual Ground Covers at the UK Arboretum 33

Perennial Garden Flower Trials – 1999-2004 University of Kentucky Horticulture Research Farm 34

2004 Garden Flower Trials Results of Annual Flower Evaluations by Kentucky Master Gardeners 37

Update of Industry Support for the University of Kentucky Nursery and Landscape Program 38

UK Nursery and Landscape Fund and Endowment Fellows 41

2004 Contributors to the UK Nursery/Landscape Fund and Endowments (Through Nov. 1) 42

UK Nursery and Landscape Program Overview—2004

Dewayne Ingram, Chair, Department of Horticulture

The UK Nursery and Landscape Program is the coordinated efforts of faculty, staff, and students in several departments in the College of Agriculture for the benefit of the Kentucky nursery and landscape industry. Our 2004 report has been organized according to our primary areas of emphasis: production and economics, pest management, and plant evaluation. These areas reflect stated industry needs, expertise available at UK, and the nature of research projects around the world generating information applicable to Kentucky. If you have questions or suggestions about a particular research project, please do not hesitate to contact us.

Although the purpose of this publication is to report research results, we have also highlighted some of our Extension programs and undergraduate and graduate degree programs that are addressing the needs of the nursery and landscape industries.

Extension Highlights

Extension Associates

Although there are many facets to the Extension program conducted by the team of subject matter specialists and county agents, program expansion provided through a second Kentucky Horticulture Council grant from Agriculture Development Board (tobacco settlement) funds is highlighted this year. Although most of the initial grant was to support expanded acreage of vegetables required by the three new marketing cooperatives, we were able to create the position of Extension Associate for Nursery Crops in the western portion of the state. With the second grant we were able to continue this position in western Kentucky and add an Extension Associate for Nursery Crops and an Extension Associate for Greenhouse Crops in central Kentucky.

Amy Fulcher, who was the Extension Associate for Nursery Crops at the UK Research and Education Center in Princeton, has moved to the position in Lexington. Dava Hayden, formerly in sales with Kentucky West Nursery Cooperative and former manager with King's Gardens in Lexington, assumed the vacated position in Princeton this summer. We hired Joe Ulrich, former owner/operator of a greenhouse business in Bracken County, to fill the new Extension Associate for Greenhouse Crops position in Lexington.

Working in concert with our faculty, additional support is now available for County Agents and Nursery/Greenhouse Managers and employees statewide. They have held several workshops and demonstrations and have established a demonstration Pot-in-Pot system at the UK Research and Education Center in Princeton and are expanding the Pot-in-Pot facility in Lexington, as well as conducting field and greenhouse experiments. We are grateful for the additional funds to help us serve the nursery and greenhouse industries. These funds were obtained through the leadership of the Kentucky Horticulture Council and its member associations related to the nursery, landscape, and greenhouse industries and have made a significant difference in how UK Horticulture can serve our industries.

Virtual Arboretum

Public education about plants and their use in the human environment helps expand the market for horticultural products and services. Extension's Master Gardener program impacts market expansion. We have presented those numbers here before. However, we also address public horticulture education through the department's Web site. One element of our Internet presence is an Instructional Activities Web page at <www.uky.edu/Ag/Horticulture/teachers.html>, informally referred to as the Virtual Arboretum. The Web site is primarily meant to help teachers expose students to outdoor classrooms where students can become excited about plants and ecology. However, others involved in gardening and wishing to know more about Kentucky's ecology will find the site interesting as well. Some of the activities direct students to the on-campus arboretum, while others can be performed at any location.

The Virtual Arboretum currently involves two broad topics: Kentucky native trees and butterfly gardening. Several learning activities are available for each topic. People wanting information on Kentucky's native trees can find a listing of 64 species with links to additional information. The butterfly section provides thumbnail images of species common to Kentucky with links to specific details, including habitat and food preferences of adults and larvae. There are also design plans to construct a simple butterfly garden.

These materials have been developed by a team of faculty and staff, which includes Robert Geneve, Richard Durham, Christy Cassady, Shari Dutton, and others. Funding to support development of these materials was obtained from the Urban and Community Forestry Grant Program of the Kentucky Division of Forestry.

Undergraduate Program Highlights

The department offers areas of emphasis in Horticultural Enterprise Management and Horticultural Science within a Plant and Soil Science Bachelor of Science degree. Following are a few highlights of our undergraduate program in 2003-2004.

The Plant and Soil Science degree program has nearly 100 students in the fall semester of 2004, of which almost one-half are horticulture students and another one-third are turfgrass students. Thirteen horticulture students graduated in the 2003-2004 academic year.

We believe that a significant portion of an undergraduate education in horticulture must come outside the classroom. In addition to the local activities of the Horticulture Club and field trips during course laboratories, students have excellent off-campus learning experiences. Here are the highlights of such opportunities in 2004:

- A 13-day study tour in mid-Atlantic and northeast states was led by Drs. McNiel, Dunwell, and Geneve involving six students.
- Horticulture students competed in the 2004 Associated Landscape Contractors of America (ALCA) Career Day competition at Columbus State University in March (Drs. McNiel and Williams, faculty advisers).
- Students accompanied faculty to several regional/national/international meetings, including the American Society for Horticultural Science Annual Conference, the Kentucky Landscape Industries Conference and Trade Show, the Southern Nursery Association Trade Show, and the Green Industry Conference.

Graduate Program Highlights

The demand for graduates with master's or doctorate's in Horticulture, Entomology, Plant Pathology, Agricultural Economics, and Agricultural Engineering is high. Our master's graduates are being employed in the industry, Cooperative Extension Service, secondary and postsecondary education, and governmental agencies. Last year, there were nine graduate students in these degree programs conducting research directly related to the Kentucky nursery and landscape industry. Graduate students are active participants in the UK Nursery and Landscape research program and contribute significantly to our ability to address problems and opportunities important to the Kentucky nursery and landscape industry.

Effect of Fertilizer Rate on Growth of Seven Tree Species in Pot-in-Pot Production

Amy Fulcher,[1] Winston Dunwell,[1] Robert McNiel,[1] Dwight Wolfe,[1] and Lloyd Murdock,[2] Departments of Horticulture and Agronomy

Nature of Work

Growers strive to maximize growth each season by optimizing fertilization practices and other inputs. Overapplication can reduce plant growth, cause damage, and be expensive (3). Higher than recommended rates of fertilizer can also contribute to nutrient leaching (6). Underapplication of fertilizer results in reduced growth and/or nutrient deficiencies, leading to plant stress and possible marketing problems. Good leaf color and new growth were important aspects of plant quality as measured by retail consumers (4).

The objective of this research was to determine the effects of fertilizing at two rates of Harrell's, Inc. 18-5-10, five- to six-month release fertilizer on seven taxa in a pot-in-pot production system. Pot-in-pot production utilizes socket pots, which are permanently installed in the field, and production pots, the pots the plants actually grow in, which are placed in the socket pots during production and lifted out of the socket pot to market the plant. For pot-in-pot budgets, cash flow statements, and price sensitivity charts, see the *2003 Nursery and Landscape Research Report* at <http://www.ca.uky.edu/agc/pubs/pr/pr486/pr486.pdf>. Pot-in-pot installation and production information is available from county Extension offices by requesting a copy of the UK "Pot-in-Pot Nursery Production" video.

The taxa tested were *Acer campestre*, *Acer* x *freemanii* Autumn Blaze,® *Betula* Renaissance Reflection,™ *Malus* 'Spring Snow,' *Prunus* 'Mt. St. Helens,' *Quercus muhlenbergii*, and *Zelkova serrata*. Bareroot liners were potted into trade 15 gallon/6900 Econo-Grip™ (Nursery Supplies Inc., McMinnville, Oregon) pots in Professional Grow Mix (Barky Beaver, Moss, Tennessee) on May 13, 2002. Fertilizer was applied on May 15, 2002, and again on April 1, 2003. Two rates were used: the labeled medium rate, 100 grams (1x), and 200 grams (2x). Plants were grown in a pot-in-pot system with cyclic irrigation. The experimental design was a randomized complete block design with three replications of each treatment.

Plants of one type were pruned uniformly; if a central leader died or was damaged on one plant in the study the central leaders of the other plants of that type were headed back. If laterals were headed back they were headed back on all plants of that type. Temporary branches (branches up to 36 inches high on the trunk on ornamental trees and up to 48 inches high on shade trees) were removed as they reached 7 cm diameter. All trees, with the exception of *Malus* 'Spring Snow,' were staked the first year with bamboo stakes and the second season with the Tree-Mate-O® staking system (T-MATE-O, Charleston, Indiana). Trees of each taxa were attached to the T-MATE-O at the same height.

On June 6, 2003, a SPAD 502 (Minolta Camera Co., Japan) chlorophyll meter was used to measure chlorophyll levels. Caliper readings were taken on June 11, 2003, and again on Dec. 2, 2003. Leaf area was measured on June 13, 2003, on a LI-3100 (LI-COR Inc., Lincoln, Nebraska). Height was recorded on Dec. 2, 2003. Data were subjected to statistical analysis using ANOVA and mean separation with the PROC GLM procedure (SAS Institute, Cary, North Carolina) at a p value of 0.05 or less.

Results and Discussion

There was an interaction between plant and replication on chlorophyll level. *B.* Renaissance Reflection,™ *Q. muhlenbergii*, *A.* Autumn Blaze,® *M.* 'Spring Snow,' and *Z. serrata* had significantly higher levels of chlorophyll in the leaves from trees growing with the 2x rate of fertilizer than those growing with the 1x rate of fertilizer (Table 1). Due to plant mortality, there were not enough plants to calculate an effect of fertilizer rate on chlorophyll level for *A. campestre* and *P.* 'Mt. St. Helens.' Sibley et al. (5) found that *A.* Autumn Blaze® had a June SPAD-502 average of 37, while the average value for *A.* Autumn Blaze® at the 2x rate in this study was 28. This difference could be attributed to factors other than fertilization, such as sampling technique, local weather conditions, or yearly weather variations.

There was no difference due to fertilizer rate on caliper development whether caliper was measured in June or December of 2003 (data not shown).

The 2x fertilizer rate resulted in significantly taller trees for *A.* Autumn Blaze,® *B.* Renaissance Reflection,™ and *Z. serrata*. While the American Standards for Nursery Stock (1) acknowledges that *Betula* develop height more rapidly than some other species and may be taller for a given container size, in this experiment the increase in height for some of the *B.* Renaissance Reflection™ and *A.* Autumn Blaze® was excessive, such that additional pruning would be required during the second season to keep the central leader in proportion to the container and to encourage branching. By properly timing the pruning of these plants, the growth could be redirected into permanent lateral branches, contributing to a dense, well-branched canopy.

Although the mean of the 2x rate leaf area was lower than the 1x rate for *Z. serrata* and *M.* 'Spring Snow' (Table 1), there was no statistically significant rate by taxa interaction. Across all taxa, trees fertilized at the 2x rate averaged significantly greater leaf area than those trees fertilized at the 1x rate, 488.7 versus 354.3 cm^2, respectively. Although leaves were not larger when fertilized at the 2x rate, authors did observe longer shoot extension on the *Z. serrata* fertilized at the 2x rate, indicating that differential carbon partitioning may occur among plants in this study. There may be benefits to the 2x rate of fertilizer that were not measured in this study, such as greater root weight, shoot extension, number of shoots, number of floral buds, etc.

Growers and those who advise growers may wish to utilize the guideline of 3 grams of actual nitrogen per gallon container size as part of a plan to optimize fertilization (2). Following this guideline, a trade #15 (50.6 L) should receive approximately 45.0 grams of nitrogen. The 1x (medium) rate of 100 grams provided just 18 grams of nitrogen. The labeled high rate (not tested in this study) of 120 grams would provide 21.6 grams of nitrogen. Based on the 3 grams of actual nitrogen per gallon container size guidelines and the results of this study, the labeled medium rate and possibly the high rate are insufficient for some taxa. The additional 100 grams between the 1x and 2x rate of this experiment cost $0.18 per pot, but yielded a more desirable product in many instances.

Significance to Industry

Fertilizing with higher rates of fertilizer affected height, leaf color, and leaf size for some taxa tested but had no influence on caliper for any of the taxa tested. While plants are not sized and graded based on leaf size or color, these differences would be readily apparent, particularly when the same taxa from multiple sources are displayed or stored in close proximity.

Literature Cited

1. American Nursery and Landscape Association. 1996. American Standards for Nursery Stock. Washington, D.C.
2. Bilderback, Ted. 1999. Fertilizer choices and recommendations. Proc. N.C. State Nursery Short Course 1:28-29.
3. Cabrera, R.I. 2003. Less is more. American Nurseryman. 197(8):40-45.
4. Glasgow,T., T. Bilderback, T. Johnson, and C. Safley. 1997. Consumer perception of plant quality. Proceedings of SNA Research Conference 42:378-379.
5. Sibley, J.L., D. J. Eakes, C.H. Gilliam, G.J. Keever, W.A. Dozier, Jr., and D.G. Himelrick. 1996. Foliar SPAD-502 meter values, nitrogen levels, and extractable chlorophyll for red maples. HortScience. 31(3):468-470.
6. Yeager, T., C. Gilliam, T. Bilderback, D. Fare, A. Niemiera, K. Tilt. 2000. Best Management Practices Guide for Producing Container-Grown Plants. Southern Nursery Association. Marietta, GA.

Acknowledgments

The authors thank J. Frank Schmidt and Son Co., The Flower Potts, and Evergreen Nursery Company Inc. for plants, and June Johnston, Hilda Rogers, Jessica Haubenreich, Janet Pfieffer, and Julie Miller for their assistance.

Table 1. Chlorophyll level, leaf area, and height of 7 taxa subjected to two fertilizer rates.

Taxa	Fertilizer Rate	Chlorophyll Level[z]	Leaf Area (cm^2)	Height (inches)
Acer x freemanii Autumn Blaze®	1x	24*	556	103*
Acer x freemanii Autumn Blaze®	2x	28*	804	122*
Acer campestre	1x	29	141	96
Acer campestre	2x	NE[y]	306	90
Betula papyrifera Renaissance Reflection™	1x	28*	619	104*
Betula papyrifera Renaissance Reflection™	2x	31*	831	130*
Malus 'Spring Snow'	1x	45*	211	62
Malus 'Spring Snow'	2x	50*	206	60
Prunus 'Mt. St. Helens'	1x	NE[y]	173	79
Prunus 'Mt. St. Helens'	2x	NE[y]	214	91
Quercus muhlenbergii	1x	33*	397	84
Quercus muhlenbergii	2x	40*	804	81
Zelkova serrata	1x	11*	384	59*
Zelkova serrata	2x	46*	256	95*

* Significant difference between the 1x and 2x rate of fertilizer for the individual taxa at the P= 0.05 level, each column assessed individually.

[z] Chlorophyll levels are unitless values.

[Y] Nonestimable data.

[X] 1x treatment was the medium rate (100 grams), the 2x rate was double the medium rate (200 grams).

Effect of Planting Date and Protective Structures on Finishing Date for Container-Produced *Passiflora* 'Lady Margaret'

Steve Berberich, Robert Geneve, and Mark Williams, Department of Horticulture

Nature of Work

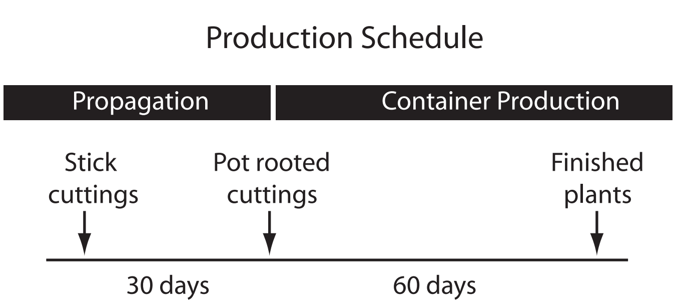
Passiflora 'Lady Margaret' is a desirable passion flower cultivar for container production in Kentucky because it is easy to propagate from cuttings, is relatively cold tolerant, and begins to flower early in the season (5). Although it is not hardy in Zone 6, it can be grown as a single-season crop using a two-month production schedule (Figure 1) (1). Currently, passion flowers sold in Kentucky are shipped from the southern United States. This demonstrates potential for local producers, but there is little information available about planting dates and time to finish.

The objective of this research was to investigate the use of heated and unheated protective structures and planting dates on growth and flowering of *P*. 'Lady Margaret.' The goal was to develop a range of finishing dates to provide growers with flexible production schedules to meet potential markets.

Materials and Methods

A randomized block design experiment with 24 replications for each treatment was carried out between Feb. 1, 2003, and June 11, 2003, and included six treatments which were combinations of three planting dates and three different growing environments (Figure 2). Plants were propagated from two node nonterminal cuttings taken from ontogenetically mature stock plants and treated with indole-3-butyric acid (IBA) (1,000 ppm in talc) and stuck in Oasis rooting cubes. Cuttings were placed in an intermittent mist bed (six seconds every 12 minutes) with 21ºC (70°F) bottom heat. After 30 days, rooted cuttings were selected for uniformity and potted three plants per 4.7-liter (5-quart) containers (Classic 500, Nursery Supplies Inc., Columbus, Ohio) in southern pine bark substrate (Barky Beaver, Professional Grow Mix, Moss, Tennessee). One emitter was placed in each container, and they were fertilized at each watering with a 150 ppm N fertilizer solution (Peter's 20-10-20 Peat-lite Special, Scotts Company, Marysville, Ohio) delivered one time per day by the automatic micro irrigation system. Thirty-six-inch tall bamboo hoop trellises were inserted into the containers, and the plants were tied as needed for support. Flowering data were collected daily, and plants were considered finished when they had produced 10 flowers per container.

Figure 1. Production schedule for single-season, container-grown passion flowers in Kentucky.



The plants were grown in either a temperature-controlled greenhouse, polyhut, outdoor container nursery, or a combination of these environments. The planting dates were March 1, April 1, or May 1. Day/night temperatures in the greenhouse were set at 25ºC/20ºC (77ºF/68°F), and supplemental lighting (61 µmol · m^{-2} · sec^{-1} average photosynthetic photon flux density at bench top) was provided with 430-watt high-pressure sodium greenhouse lights set to turn on if light levels dropped below 300 µmol · m^{-2} · sec^{-1} between 7:00 and 24:00. The polyhut was a 12-ft-by-50-ft freestanding polyethylene covered quonset hoop house with roll up side wall vents and doors at each end for ventilation. It was covered with a single layer of 6 mil translucent polyethylene greenhouse film. Doors and vents were opened and closed manually as needed to maintain suitable conditions. Two temperature data loggers (WatchDog 100, Spectrum Technologies Inc., Plainfield, Illinois) were placed with each treatment to monitor temperatures, and a mean of the two sensors was used to calculate degree hours.

Results and Discussion

Using three planting dates and combinations of heated and unheated protected cultivation, passion flower plants were finished at approximately 10-day intervals from April 19 to June 8 (Fig. 2). The plants to reach finished size in the least number of days were potted on May 1 and grown in the polyhut for 30 days before being moved to the outdoor container nursery. They reached finished size in 39 days versus those potted on April 1, which took a total of 41 days, the second shortest finish time. Of the three treatments planted on April 1, those that started in the greenhouse finished sooner, and for all treatments, the more time the plants were in the greenhouse, the earlier they finished. The plants potted on April 1 and moved directly to the polyhut, took 51 percent longer to finish than those that spent 30 days in the greenhouse and 32 percent longer than those that spent 15 days in the greenhouse. The plants potted on April 1 and moved directly to the polyhut took longer to finish than any other treatment. For the treatments that were moved directly to the polyhut without any time in the greenhouse, the plants potted on May 1 reached finished size 23 days sooner (39 days versus 62 days) than those potted on April 1.

When plants reach 10 flowers per container, they are considered ready for sale. At this time, the plants have reached a point of consistent flowering and will have between one and three flowers open each day. We were successful in producing passion flower plants for commercial sale between mid-April and mid-June. The differences in the number of days from potting to finished

Figure 2. Planting dates, number of days to finish, and time to finish for six production scenarios for container grown Passiflora 'Lady Margaret' produced as a single-season crop in Kentucky.

February	March	April	May	June	Number of Days to Finish	Finish Date
Propagation (30 days)	Greenhouse (31 days)	Greenhouse (19 days)			50	19-Apr
Propagation (30 days)	Greenhouse (31 days)	Polyhut (29 days)			60	29-Apr
	Propagation (30 days)	Greenhouse (30 days)	Polyhut (11 days)		41	11-May
	Propagation (30 days)	Greenhouse (15 days); Polyhut (30 days)	Nursery (2 days)		47	17-May
	Propagation (30 days)	Polyhut (30 days)	Nursery (32 days)		62	1-Jun
		Propagation (30 days)	Polyhut (31 days)	Nursery (8 days)	39	8-Jun

plants appear to be a function of light levels and temperature. For plants potted in March, low light levels delay consistent flowering and plants required between 50 and 60 days to reach a salable size. Low solar radiation can suppress the formation of new flower buds until carbohydrate status is favorable (2), and we have observed that flower abortion is common during winter growing conditions.

Plants took the least time to reach salable size when they were potted in April and grown at relatively consistent temperatures. For most passion flower species, there is a strong relationship between rate of vegetative growth and the production of flowers because flowers are produced on the new vegetative growth at the leaf axil. If the plants are stressed by environmental factors, the shoots may fail to elongate or may elongate without producing flowers (2). When grown in air temperatures between 20°C and 30°C, there is an increase in the number of flower buds on passion fruit (*P. edulis*) (3, 4). There is a significant reduction in number of flowers below 20°C and above 30°C. Additionally, when grown within this temperature range, the plants flower two weeks earlier. Temperature is the one environmental factor most likely to impact growth and flowering in passion flower (3, 4).

Significance to Industry

Passion flowers are a high-value crop and have good potential as an alternative nursery crop in Kentucky. Recommended cultural practices include:

1. Early flowering, cold-tolerant cultivars should be selected for early season production in a two-month period. 'Lady Margaret' and 'Amethyst' have proven to work well in this system. Later-flowering cultivars can have larger flowers but will finish in July or later. These would be suitable for production to meet southern markets, while early flowering cultivars are most suited for Kentucky and other Midwest states.
2. Plant three cuttings per container. Passion flowers have strong apical dominance and do not produce secondary branches until late in the growing season. Since passion flower produces one flower per node and these open for only one day, three plants per container increase the potential for consistent early flowering in the garden center.
3. Passion flower plants are relatively heavy feeders. They require more fertilizer than typical greenhouse and nursery plants. Therefore, a constant feed system that provides 150 ppm N per irrigation is recommended.
4. Planting dates and protective cover should be planned according to desired finish date.

Literature Cited

1. Berberich, S., M. Williams, and R, Geneve. 2002. Evaluation of cultural practices for container production of passion flowers. Proceedings of Southern Nursery Association Research Conference 47:111-114.
2. Menzel, C. M., D. R. Simpson and C.W. Winks. 1986. Effects of foliar-applied nitrogen during winter on growth, nitrogen content and production of passion fruit (*Passiflora edulis* f. *edulis X Passiflora edulis* f. *flavicarpa*). Scientia Horticulturae 28:339-346.
3. Menzel, C. M., D. R. Simpson and C.W. Winks. 1987. Effect of temperature on growth, flowering and nutrient uptake of three passion fruit cultivars under low irradiance. Scientia Horticulturae 31:259-268.
4. Simon, P. and A. Karnatz. 1983. Effect of soil and air temperature on growth and flower formation of purple passion fruit (*Passiflora edulis* Sims. var. *edulis*). Acta Horticulturae 139:83-90.
5. Vanderplank, J. 1996. Passion Flowers. Cassell Pub. Ltd., London.

Effect of Fertilizer Brand, Rate, Application Technique, and June Reapplication on Growth of *Amelanchier* x 'Autumn Brilliance' in Aboveground Container Production

Amy Fulcher, Winston Dunwell, Dwight Wolfe, and Robert McNiel, Department of Horticulture

Nature of Work

Optimum fertilization practices are a critical component to profitable nursery crop production. Underfertilization can reduce growth, lower quality, and cause unmarketable plants (2). Overfertilization is wasteful and can cause plant damage (1). In addition, excess fertilizer can contaminate surface and ground water (3). Developing optimal fertilization regimes will allow growers to maximize growth in the most cost-efficient manner.

The objective of this research was to examine the effect of fertilizer brand, fertilizer rate, method of application, and summer reapplication on the height, caliper, and number of branches of *Amelanchier* x 'Autumn Brilliance' grown in aboveground containers. On March 20, 2003, uniform *A.* 'Autumn Brilliance' whips were potted into trade 7 gallon, EG 2800 (24.6 L) containers (Nursery Supplies Inc., McMinnville, Oregon) with a 5/8-inch locally available, aged, bark-based substrate (pH 6.5, EC 0.16 mmho/cm, and 35 ppm calcium, at time of planting) and fertilizer treatments were applied. Polyon® (a polyurethane coated fertilizer) 18-4-8 with minors, eight- to nine-month release and Osmocote Plus® (an alkyd resin coated fertilizer) N&S 15-9-12, eight- to nine-month release fertilizers were tested. Fertilizer treatments in March were the high and medium labeled rate and top-applying or incorporating each of the two fertilizers. Fertilizer applications were based on the labeled topdress rate and the entire rate was applied (Table 1). On June 6, 2003, summer reapplications were made. One-half of the of medium rate and one-half of the high rate of Polyon® 19-4-8 with minors, five- to six-month release and Osmocote Plus® 15-9-12, five- to six-month release were topdressed to the containers with corresponding March applications of medium and high rate applications of Polyon® or Osmocote Plus® for the equivalent of 1.5x rates of total fertilizer. The control treatments received no fertilizer, neither the initial March application nor the June reapplication. On June 6, 2003, the central leaders were pruned to 7 feet and lateral branches were pruned to 12 inches. The experiment was located on a gravel pad in Kirksey, Kentucky. The 2003 growing season brought above average rainfall and an early spring with several days in early May in the 80s followed by several days 10 to 15 degrees below normal. Temperatures in June averaged below normal (Table 2).

Electrical conductivity (EC) and pH were measured monthly with HI 9811 Portable pH/EC/TDS meter (Hanna Instruments Inc., Woonsocket, Rhode Island) on leachate collected using the Virginia Tech Extraction Method (3). Caliper, height, and branch number were recorded on Nov. 20, 2003. The experiment, a 2x2x2x2 factorial, was arranged in a randomized block design with six single plant replications. Data were subjected to statistical analysis using ANOVA and a mean separation with the PROC GLM procedure in SAS (SAS Institute, Cary, North Carolina) at a p value of 0.05 or less.

Results and Discussion

Whether or not the trees received a summer reapplication (topdress) had no significant effect on the number of branches, caliper, or height (data not shown).

No treatment had any impact on height (data not shown). This likely reflects the heading back pruning.

The number of branches was statistically related to fertilizer treatment, confirming visual observations (Table 3). The Osmocote Plus® treatments had significantly more branches than the control. There were no significant differences between the Polyon® treatments and the control. There was a rate by fertilizer brand interaction with regard to number of branches. There were significantly more branches with the high rate of Osmocote Plus® than the high rate of Polyon.® There was no difference at the medium rate.

There was a method of application by fertilizer brand interaction on the number of branches. Method of application significantly affected the Osmocote Plus® treated trees with topdressing resulting in the greatest number of branches (11.9 versus 9.7 branches). Method of application had no effect on the number of branches for the Polyon® treated trees.

There was a method of application by fertilizer rate interaction on the number of branches. Method of application had a significant effect on those trees treated with the high rate of fertilization. Topdressing resulted in more branches than incorporating (10.6 versus 8.5) when plants were fertilized at the high rate. There were no significant differences observed for trees treated with the medium rate of fertilization.

Trees treated with the high rate of Osmocote Plus® had significantly greater caliper than those treated with the high or medium rate of Polyon® or the control (Table 4).

There was a fertilizer brand by method of application interaction for caliper. Incorporating the fertilizer significantly increased the caliper for the Polyon® treated trees, 1.7 cm compared to 1.5 cm for the topdressed, while topdressing significantly increased the caliper for the Osmocote Plus® treated trees, 1.8 inches compared to 1.6 inches for the incorporated treatment.

All treatments led to EC levels that were high (> 0.5 mmhos/cm) during the summer (4) (Figures 1-4). These excess nutrients, when leached in rainfall and/or irrigation, can endanger water quality.

Table 1. Nitrogen applied in each treatment.

Fertilizer Technology	Rate	Nitrogen Applied (Grams)		Total Nitrogen Applied(Grams)	Deviation from Recommended Nitrogen for 7- Gallon Container (28 Grams)
		Initial Application	June Reapplication		
Osmocote Plus®	High	27.2	11.7	38.9	10.9+
Osmocote Plus®	High	27.2	0	27.2	0.8-
Osmocote Plus®	Medium	19.5	7.8	27.3	0.7-
Osmocote Plus®	Medium	19.5	0	19.5	8.5-
Polyon®	High	27.5	9.1	36.6	8.6+
Polyon®	High	27.5	0	27.5	0.5-
Polyon®	Medium	22.5	7.4	29.9	1.9+
Polyon®	Medium	22.5	0	22.5	5.5-
Control		0	0	0	28-

Table 2. The 2003 growing season rainfall and temperature averages and departures from averages for Kentucky.

Month	2003 Temperature (°F)	2003 Rainfall (Inches)	Departure from Average Temperature (°F)	Departure from Average Rainfall (Inches)
March	48.7	2.24	2.2 +	2.32 -
April	57.8	6.06	2.2 +	1.96 +
May	64.5	7.35	0	2.36 +
June	69.0	6.40	3.4 -	2.14 +
July	75.6	5.38	0.8 -	0.98 +
August	76.3	5.23	1.3 +	1.63 +
September	66.0	6.22	1.6 -	2.62 +
October	57.0	2.42	0	0.49 -
November	50.5	5.88	3.9 +	1.84 +

Table 3. Matrix of significance: number of branches on *A.* 'Autumn Brilliance.'

	Osmocote Plus® High (12.1)[z]	Osmocote Plus® Medium (9.7)	Polyon® High (7.1)	Polyon® Medium (8.8)	Control (6.0)
Osmocote Plus® High (12.1)		*	*	*	*
Osmocote Plus® Medium (9.7)	*		*	NS	*
Polyon® High (7.1)	*	*		NS	NS
Polyon® Medium (8.8)	*	NS	NS		NS
Control (6.0)	*	*	NS	NS	

* Indicates significant differences between compared means at 0.05 probability level.
[z] Branch means in parentheses correspond with treatment listed in same cell.
NS indicates no significant difference between compared means at the 0.05 probability level.

Table 4. Caliper of *A.* 'Autumn Brilliance.'

Fertilizer Brand	Rate	Caliper (cm)
Osmocote Plus®	High	1.79a[z]
Osmocote Plus®	Medium	1.65ab
Polyon®	High	1.63b
Polyon®	Medium	1.59b
Control		1.38c

[z] Means with the same letter were not significantly different P<0.05 by LSD.

Figure 1. Electrical conductivity for Osmocote Plus® incorporated treatments.

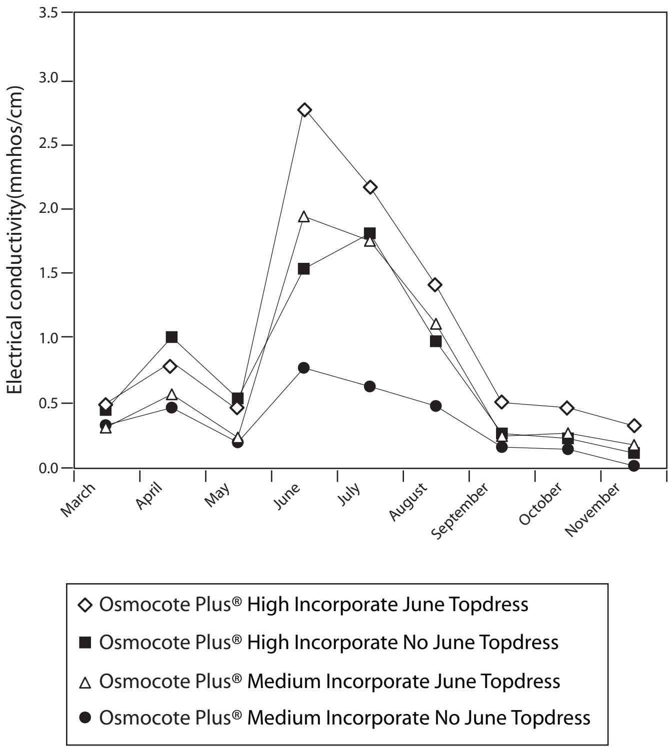


Figure 3. Electrical conductivity for Osmocote Plus® top applied treatments.

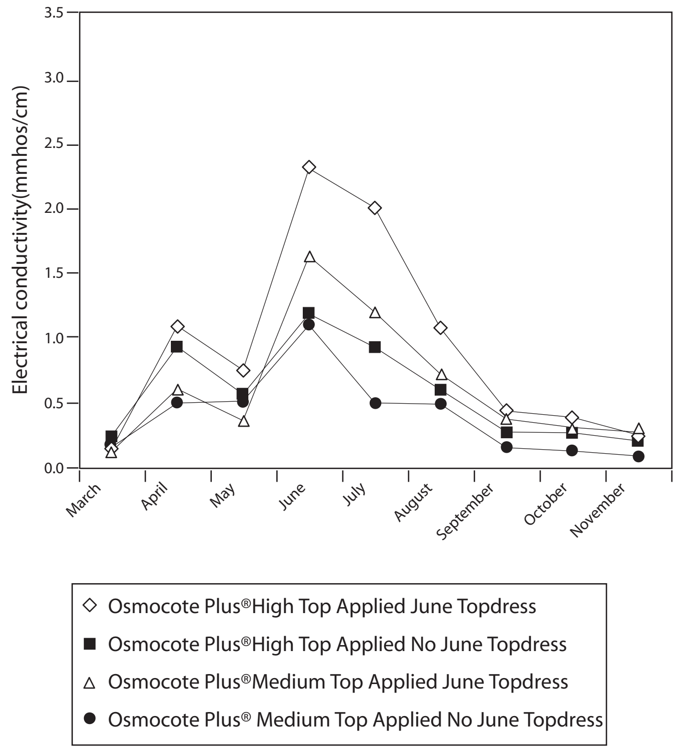


Figure 2. Electrical conductivity for POLYON® incorporated treatments.

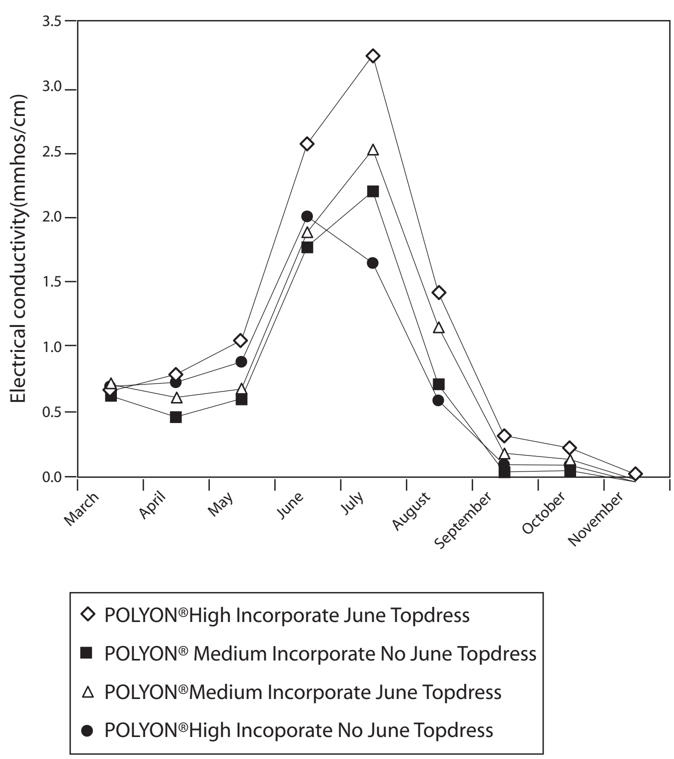
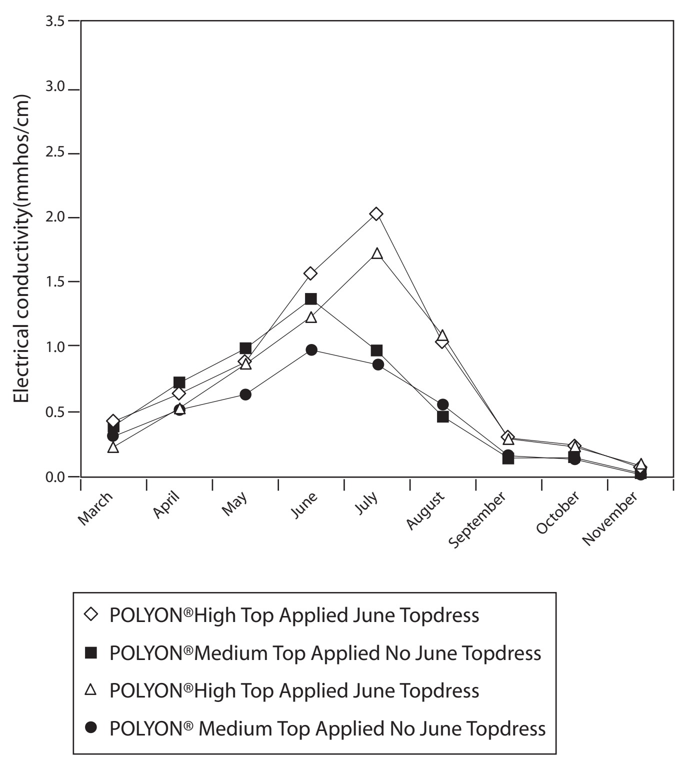


Figure 4. Electrical conductivity for POLYON® top applied treatments.



Significance to the Industry

Precise fertilization practices can help producers maximize plant growth without wasting fertilizer or labor. While these data reflect just one study, growers may be able to fine-tune their fertilizer regime and create optimal fertilizer systems by experimenting with the following points: Growers using an eight- to nine-month controlled-release fertilizer may not realize any growth benefits to a summer reapplication. Growers using Polyon® may wish to incorporate to maximize caliper; growers using Osmocote Plus® may wish to top apply in order to maximize caliper. Growers may wish to fertilize with the high rate of Osmocote Plus® to achieve maximum caliper. Growers may wish to experiment with Osmocote Plus,® top-applied to increase branching.

Literature Cited

1. Cabrera, R.I. 2003. Less is more. American Nurseryman. 197(8):40-45.
2. Glasgow,T., T. Bilderback, T. Johnson, and C. Safley. 1997. Consumer perception of plant quality. Proceedings of SNA Research Conference 42:378-379.
3. Wright, R.D. 1986. The pour-through nutrient extraction procedure. HortScience 21:227-229.
4. Yeager, T., C. Gilliam, T. Bilderback, D. Fare, A. Niemiera, K. Tilt. 2000. Best Management Practices Guide for Producing Container-Grown Plants. Southern Nursery Association. Marietta, GA.

The authors thank Jamie Potts, Dava Hayden, and Todd Powell for assistance and The Flower Potts for plant material and supplies.

Preservative and Temperature Postharvest Treatments on *Hydrangea paniculata 'Kyushu'*

Todd Leeson, Robert McNiel, and Sharon Bale, Department of Horticulture

Nature of Work

Hydrangea paniculata is available wholesale as a cut stem from the Holland market. Some *H. paniculata* are available in this country as a cut stem through farmers' markets. A national commercial wholesale source of this stem is not readily available. *H. macrophylla* cultivars are the flowers that are usually grown for the cut flower market. The other hydrangea species—*H. arborescens*, smooth hydrangea; *H. paniculata*, panicled hydrangea; and *H. quercifolia*, oakleaf hydrangea—have been grown for landscape plants (1). Therefore, the ability to produce quality field-grown cut stems of the *H. paniculata* flower may offer an alternative income source to Kentucky farmers.

In 1999, a hydrangea cut-flower cultivar trial was established at the University of Kentucky Research and Education Center at Quicksand, Kentucky (2). In 2001, preliminary studies were conducted at the University of Kentucky to determine the effects of irrigation and pruning influence on hydrangea for fresh cut flower production (2). Cutting the existing *H. paniculata* shrubs back in the fall produced strong straight stems the next season that definitely had potential for the cut stem market. In the summer and fall of 2002, a preliminary study was conducted to see if *H. paniculata* cultivars had the potential to become a specialty cut flower. The results were reported at the 2003 SNA Conference and showed an average vase life of five to six days in 2002. The overall objectives of this experiment were to observe *H. paniculata 'Kyushu'* to see if it has a reasonable vase life, to observe interactions with the floral preservatives and extender, and to see if the stems responded differently to cold treatments.

No information could be found on the best floral preservative to be used on these plants, nor was there any information on the effects cold, wet storage would have on these stems. Cold storage could mimic the effects of shipping time as well as the ability of a wholesale florist to "hold" the plant material.

The study was initiated when 150 stems were harvested on Sept. 16, 2003, at 9:00 EST. Stems were harvested when the first and second row of sterile florets were fully developed. Dry stems were transported to the lab and cut to a 36-inch length. Stems were then placed into a hydrating solution (Pokon Professional #2) for one and one-half hours. The 'Kyushu' blooms were then divided into two 75-stem lots to be placed into their no cold storage treatment and cold storage treatment. The 75 stems for the cold storage treatment were placed into Prokona containers for wet storage at 35°F and 90 percent relative humidity(RH) for seven days. The other 75 stems were then placed directly into their randomized treatments in a storage facility with a temperature of 73°F and 90 percent RH. The eight treatments (per package directions) were:

1. Control using tap water with a pH of 7.5
2. Floralife Original Flower Food
3. Pokon & Chrysal Professional #3
4. Aquaplus
5. Floralife + Flora Novus XL
6. Pokon & Chrysal Professional #3 + Flora Novus XL
7. Aquaplus + Flora Novus XL
8. Flora Novus XL

A floral extender (Flora Novus XL), which claims to add days of life to flowers, was added to the floral preservatives in treatments 5 through 8.

Stems remained in the treatments until the stem tips wilted or the sterile florets showed the first brown color and the flowers were no longer of commercial value. For example, if the stem in vase 3 failed to rehydrate and remained wilted after initial treatment, the vase life was considered 0 days. If the sterile florets started browning on the third day, vase life was over and considered to be three days. The stems that remained in cold storage for seven days were then taken out of the cooler and were placed into their designated treatments as described with no cold treatments.

Results and Discussion

The experiment was set up as a factorial experiment with eight replications using an ANOVA to determine the main effects and interactions that occurred with a P value <.05. The independent variable was the vase life. The three factors involved were the cold storage, preservative treatments, and extender. Wet, cold storage for seven days did seem to have a negative effect on the vase life of 'Kyushu,' as vase life was decreased by two days. Stems with no cold storage treatments had a mean vase life of 7.9 days, and stems in cold storage treatments had a vase life of 5.8 days (Figure 1).

The results with floral preservative treatments back up the idea that the cultivar would react differently with the different floral preservative treatments. Floralife treatment with no cold storage treatment was significantly better than either of the other two preservatives or the control (Figure 2). There was no difference between preservatives when stems were stored in cold prior to treatment; although all three preservatives were better than the control (Figure 3). The extender actually decreased the vase life by one to two days (Figure 4), but the extender + preservative interaction was not significant.

Questions to be addressed by future research to determine the maximum vase life of *H. paniculata* include: How long can these flowers remain in wet, cold storage before their quality/longevity is adversely affected? Does shipping and storage in a solution versus dry cold storage make a significant difference in vase life?

Significance to Industry

Results of this study indicate that *H. paniculata 'Kyushu'* has the potential to be a fresh cut flower. Implementation could potentially develop a supply of *H. paniculata* for the wholesale fresh cut flower market. Controlling production practices, storage methods, and preservation solutions can result in a hydrangea fresh cut flower market crop for growers interested in alternative farm incomes.

Literature Cited

1. Armitage, A.M and Judy Laushman. 2003. Specialty cut flowers. 2nd Ed. Timber Press, Portland Ore.
2. Dunwell Winston, Dwight Wolfe, and June Johnston.2001. Hydrangeas for cut flowers: 2000 observations. UK Nursery and LandscapeProgram 2001 Research Report, PR-450:8-9.

Figure 1: Treatments with the same letter are not significantly different. The P value for this graph was <0.05.

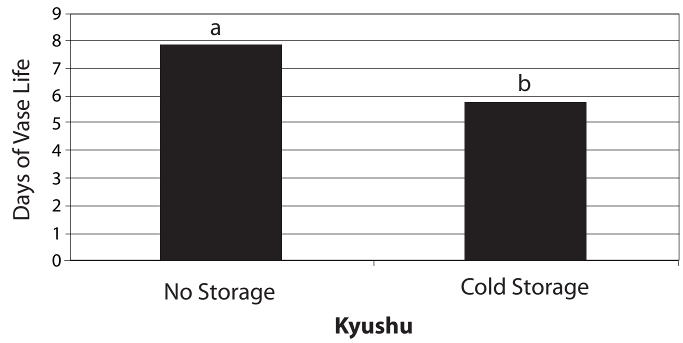


Figure 2: Treatments with the same letter are not significantly different. This graph showed a P value <0.05.

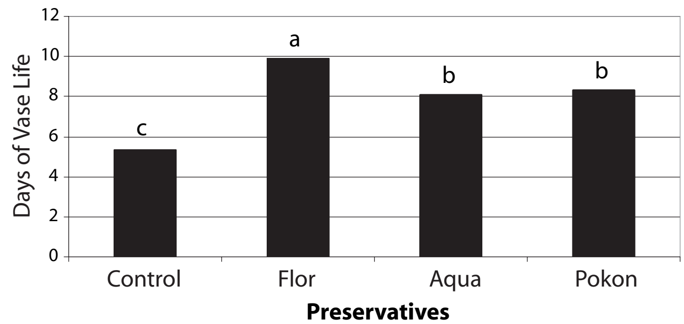


Figure 3: Treatments with the same letter are not significantly different. This graph showed a P value <0.05.

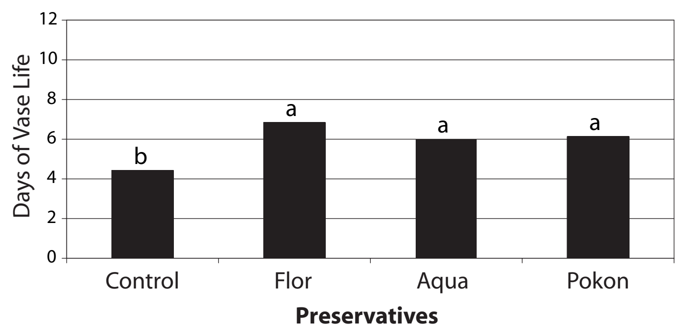
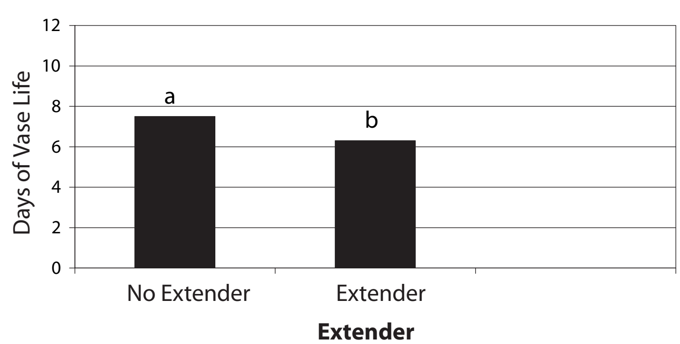


Figure 4: Treatments with the same letter are not significantly different. This graph showed a P value <0.05.



Using Root-Zone Temperature to Predict Rooting in Poinsettia Cuttings

Robert Geneve, Richard Gates, Erin Wilkerson, Sérgio Zolnier, and Sharon Kester,
Departments of Horticulture and Biosystems and Agricultural Engineering

Nature of Work

Temperature-based models have been developed to predict many aspects of growth and development, including flowering, fruit ripening, dormancy, and seed germination (4). Currently, there are no temperature-based models that predict the stages of root formation in cuttings under different environments. Optimal root-zone temperatures are between 18°C and 30°C, depending on the species (3). In general, warmer temperatures tend to reduce the time to visible root formation and increase the number of roots per cutting up to a species-dependent temperature maximum. Temperatures above this maximum, typically about 30°C, tend to have a deleterious impact on rooting. Being able to predict the rooting stage in cuttings will allow the propagator to better manage mist intervals and acclimate cuttings prior to removal from the cutting mist bench.

The objective of this research was to use root-zone temperature-based mathematical models to predict time to visible rooting and postemergent root length in poinsettia cuttings and to relate these stages to cutting transpiration capacity.

Three-greenhouse mist chambers were constructed as described by Geneve et al. (1). Mist intervals were controlled by a personal computer running the evapotranspiration-based misting model developed by Zolnier et al. (7). Each mist burst lasted five seconds and delivered water at 1200-ml·h^{-1}·m^{-2}. The computer recorded root-zone temperature from three thermal couples per chamber inserted in random containers at a depth equal to the cutting base. Data were recorded every five minutes and summed to provide a daily mean root-zone temperature. Experiments were conducted approximately monthly from April to October. During June, July, and August, greenhouse mist chambers received 60 percent shade; otherwise, cuttings were in full sun. This provided a range of daily root-zone temperatures from approximately 22°C to 26°C. Mathematical models developed for time to visible rooting and postemergent root elongation were used to compute stages of rooting. The observed versus predicted data obtained from six greenhouse experiments were compared as described by Wilkerson et al. (6).

Postemergent root length was measured using MacRhizo (Régent Instruments Inc., Quebec, Canada) software of digital images taken using a flat-bed scanner (2). Transpiration was measured in cuttings according to Wilkerson et al. (5).

Results

Using a root-zone temperature model, the observed versus predicted time to visible root emergence over the six greenhouse experiments was highly correlated ($r^2 = 0.95$) with a mean prediction error of 1.6 days (Figure 1). Time to rooting was faster during July and August when the root-zone temperatures averaged closer to the optimal temperature for rooting (~ 26°C).

Observed versus predicted postemergent root length was also compared for six greenhouse experiments (Figure 2). There was a high correlation ($r^2 = 0.82$) between observed and predicted root length following root emergence. The mean prediction error was 14.8 cm for the six experiments.

There is a linear relationship between total root length and cutting transpiration (Figure 3). Very little transpiration took place prior to visible rooting, and cuttings could not withstand a moderate desiccation stress (no mist) until the root system has reached approximately 80 cm in length.

Significance to Industry

Based on the temperature models and transpiration data, the key rooting stages were established for cuttings grown at a root-zone temperature of 26°C (Table 1). This would be the temperature that most closely approximates a shaded cutting environment during July, which is a typical time for propagating poinsettia cuttings for a Christmas crop. Each rooting stage represents a step-wise increase in the transpiration capacity of the cuttings. Depending on the system a grower employs for intermittent mist control, identification of these stages could indicate appropriate times to reduce misting frequency towards eventually acclimatizing the cuttings to a nonmisted condition. The only environmental parameter needed to predict these stages is the daily root-zone temperature calculated as the average of 24-hourly readings. The mathematical models for time to rooting and postemergent root length based on root-zone temperatures are published in Wilkerson et al. (6).

Literature Cited

1. Geneve, R. L., S. T. Kester, and J. W. Buxton. 2003. Capillary mats alter the water content in medium during mist propagation of Dendranthema. HortScience39:584-587.
2. Geneve, R.L., R.S. Gates, S. Zolnier, E. Wilkerson, and S. T. Kester. 2004. Environmental control systems for mist propagation of cuttings. Acta Horticulturae 630:297-303.
3. Hartmann, H. T., D. E. Kester, F. T. Davies, Jr., and R. L. Geneve. 2002. Hartmann and Kester's Plant Propagation: Principles and Practices, Seventh ed. Prentice Hall, Upper Saddle River, N.J.
4. Thornley, J.H.M. and I.R. Johnson. 1990. Plant and crop modeling—a mathematical approach to plant and crop physiology. Clarendon Press, Oxford.
5. Wilkerson, E.G., R.S. Gates, S. Zolnier, S.T. Kester, and R.L. Geneve. 2005. Predicting rooting stages in poinsettia cuttings using a root-zone temperature-based model. Journal of the American Society for Horticultural Science 130:in press.

6. Wilkerson, E.G., R.S. Gates, S. Zolnier, S.T. Kester, and R.L. Geneve. 2005a. Transpiration capacity in poinsettia cuttings at different rooting stages and the development of a cutting coefficient for scheduling mist. J. Amer. Soc. Hort. Sci. 130:in press.
7. Zolnier, S., R. S. Gates, R. L. Geneve, and J. W. Buxton. 2003. Evapotranspiration model-based mist control for poinsettia propagation. Trans. ASAE 46:135-145.

Figure 1. Deviation between observed and predicted time to visible root formation in poinsettia cuttings. The mean predicted error for estimating time to rooting was 1.6 days averaged over the six experiments. Values in parentheses above the month were the observed number of days to visible root formation.

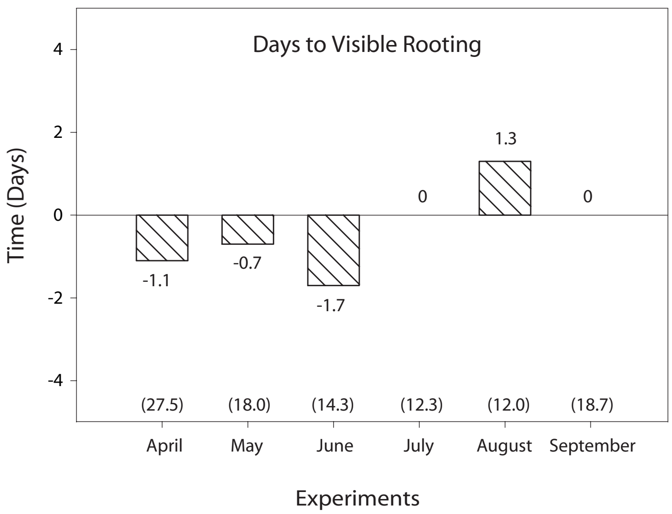


Table 1. Key rooting stages for poinsettia cuttings grown at a root-zone temperature of 26ºC, which approximates root-zone temperature averages in July and August.

Rooting Stage	Cutting Condition	Time (d) to Reach Each Stage After Sticking
Stage 0	Prior to visible root emergence.	< 12
Stage 1	Visible root emergence.	12
Stage 2	Initially rooted; root length between 20 and 50 cm.	14
Stage 3	Partially rooted; root length between 80 and 100 cm.	18
Stage 4	Fully rooted; root length > 100 cm.	21

Figure 2. The observed versus predicted postemergent root elongation in poinsettia cuttings. The mean predicted error for estimating root length was 14.8 days averaged over the six experiments.

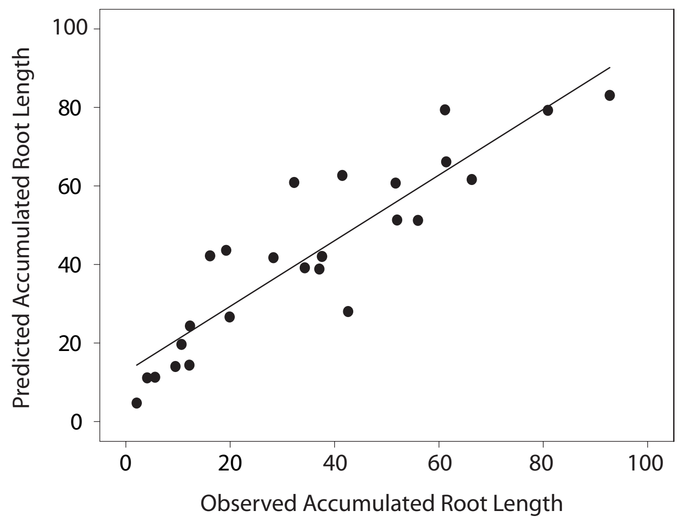
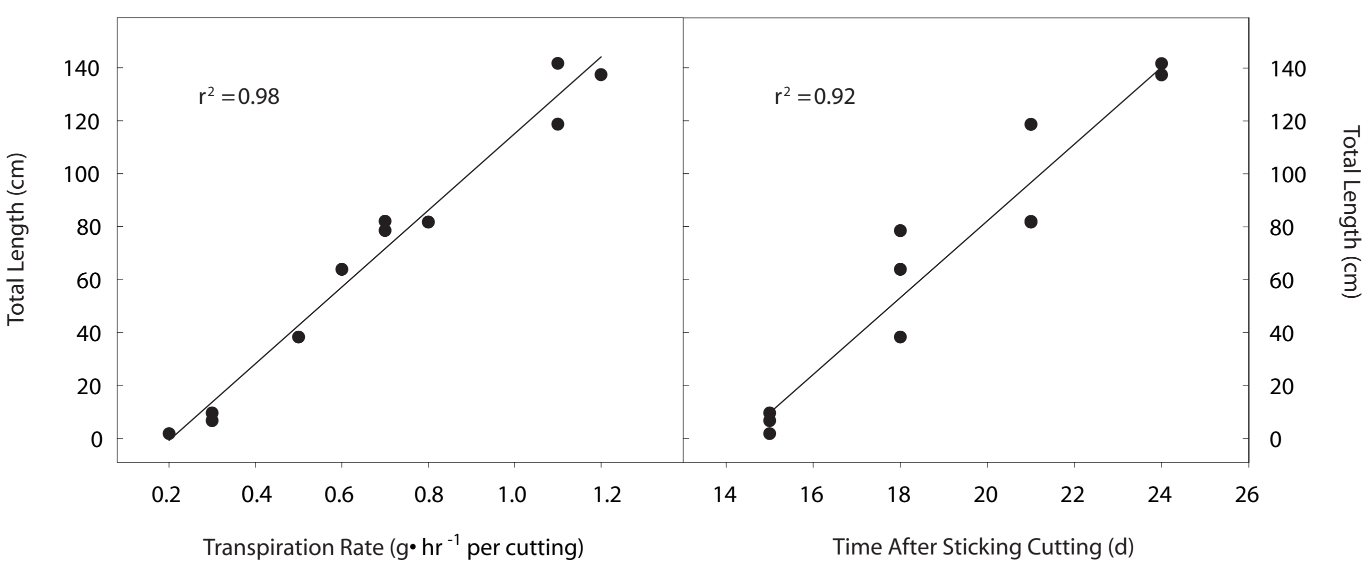


Figure 3. The correlation between transpiration rate and root length in poinsettia cuttings rooted at 26ºC. Cuttings can remain turgid under a moderate environmental stress after root length has reached approximately 80 cm.



Evaluation of Garden Mum Fertilization Programs in Central Kentucky, 2004

Joe Ulrich, Department of Horticulture

Nature of Work

Garden mums, or *Chrysanthemums*, are the No. 1 summer floriculture crop grown in Kentucky by greenhouse operators. Mums are a relatively easy crop to grow and are popular with consumers in the fall. Many growers either raise or buy pumpkins, corn fodder, gourds, straw, and other decorative items to sell with their garden mums.

Fertilizer management is important to the appearance and quality of garden mums. Fertilizer programs were evaluated to help growers improve plant quality by managing their fertility program correctly. The Pour-Thru method of soil testing was used for the collection of this data in this study. In addition, the goal was to help growers understand how to test their mums themselves and how to manage the crop using the EC (Electrical Conductivity) and pH data. Another component of the program was to look at the quality of the irrigation water and to see its impact on the fertilization program.

Twelve grower/cooperators were selected in Fleming, Madison, Mason, Mercer, Montgomery, Pulaski, Rowan, and Spencer counties. The size of the mum crops ranged from 500 to 5,000 plants and most were planted in 8-inch or 9-inch mum pots. Planting dates varied from May 20 to July 25. Normally two to four visits per grower were made to collect fertigation data. The mums were usually grown outside on landscape fabric. The irrigation methods varied from hand watering to drip systems with and without spaghetti tubes. Several growers initially topdressed with time-release fertilizer, such as Osmocote® 14-14-14, followed by irrigation with a soluble fertilizer. Typically, 20-10-20 fertilizers were used, and 20-20-20 was used occasionally. Fertilizer solution EC readings usually were in the 150 to 325 ppm range. Most growers fertilized continuously, but some fertilized once or twice a week. In some cases, calcium nitrate or 15-0-15 were used along with Epsom salts (magnesium sulfate) later in the crop schedule. Insecticides were occasionally sprayed for leafminers, aphids, and caterpillars.

Results and Discussion

Several growers had smaller than desired garden mum crops in 2004. This was balanced by very few pest problems and the good appearance of the crop from a color standpoint. The crop also flowered earlier than in most years. This wasn't a problem as consumer demand started earlier as well.

Garden mums should have growing media EC readings of 2.6-4.6 mS/cm based on the Pour-Thru method (Table 1). Rarely was this value achieved in the mum crops surveyed. This was due to several factors. First, many growers had high amounts of rain, so they watered and fertilized less frequently. Second, the high amount of precipitation leached nutrients from the growing media causing lower EC values. A third factor was improper calibration of the fertilizer injectors. Some growers were putting on less than 100 ppm when they thought they were applying 200 to 300 ppm nitrogen. Growers that started their garden mums in May and early June generally had closer to desired size than growers that started their mums in late June and July. Starting garden mums in Kentucky in late June can be accomplished as long as enough fertilizer is provided to the plant, especially the first six to eight weeks after planting rooted cuttings.

Table 1. The average electrical conductivity (EC) and pH, using the PourThru method of soil testing, for growing media for garden mums at 12 central Kentucky growers in the summer of 2004.

Month	Measured EC (mS/cm)	Recommended EC	Measured Media pH	Recommended pH
June	0.97	1.9-2.6	6.7	5.6-6.4
July	1.29	2.6-4.6	6.5	5.6-6.4
August	0.85	2.6-4.6	6.6	5.6-6.4
September	0.49	1.9-2.6	6.6	5.6-6.4

Another factor that caused smaller garden mums was that August temperatures were cooler than normal. Usually garden mums flower later in the season because of "heat delay," but this wasn't the case in 2004. The switch from vegetative growth to reproductive growth occurred on time but early compared to previous years. This reduced the amount of time growers expected to have for vegetative growth. Low fertility and earlier than expected flowering were the two main causes of smaller garden mums.

The foliage color of the garden mums was good for most crops despite low fertility readings. Iron deficiency, yellowing of the newer growth was observed in a few crops. This occurs when the media pH values reach 7.0 or higher depending on the variety. A group of growers kept their mum crops above the recommended pH range but below the 7.0 threshold (Table 1). However, three growers had problems with high pH (above 7.0) and had iron deficiency in the upper leaves. The main solution was to use a fertilizer that had a high potential acidity. This rating is the pounds of calcium carbonate it would take to neutralize one ton of the fertilizer selected. The recommended fertilizer to use was 21-7-7, which has a potential acidity of 1700. The normal fertilizer used by most growers, 20-10-20, has a potential acidity of 422.

The use of a highly acid fertilizer is one way to manage media pH. However, the most common method is simply using recommended amounts of fertilizer. When the growing media had a higher EC value, the pH value was much lower and in the desirable range (Table 2).

Table 2. The effect of more versus less fertilizer on growing media pH of garden mums in the summer of 2004.

Growing Media Samples	Growing Media pH Values
EC (mS/cm) >1.0	6.1
EC <1.0	6.8

The quality of the irrigation water source is another factor in the maintenance of desirable growing media pH. High growing media pH was more of a problem for growers with high water alkalinity. Alkalinity is a measure of the water's ability to neutralize acids. It is measured in parts per million bicarbonate (Table 3). Perhaps alkalinity can be best understood as liquid lime. As alkalinity increases, it has a larger effect on raising the growing media pH. Well water is most likely to have high alkalinity compared to municipal and pond water (Table 3). Alkalinity over 300 ppm is difficult to handle without adding acid to the water to bring the water pH down.

Table 3. Evaluation of water used for irrigation purposes.

Water Source	Number of Growers	pH	EC(ms/cm)	Alkalinity(ppm)
Municipal Water	9	7.5	0.34	90
Well Water	1	7.4	0.60	320
Pond Water	2	7.3	0.28	136
Desirable Levels		< 7.5	<1.5	<150

It was clear from this soil testing program that the main impact on garden mum foliage color was keeping the growing media pH below 7. This was accomplished by choice of an acidic fertilizer, applying correct amounts of fertilizer, and managing alkalinity if necessary.

Significance to Industry

Garden mums will be one crop that will be considered by farmers diversifying their enterprises. They are relatively easy to grow for beginners if they manage fertigation properly. This evaluation demonstrates that new growers are less likely to apply adequate fertilizer to garden mums. Additionally, new growers have not adopted soil testing to confirm that their fertigation program is appropriate throughout the growing season. This summer-long program showed growers how to check their fertilizer injectors, test their irrigation water, and sample their garden mums' growing media. These demonstrations allowed growers the ability to see, firsthand, and use all the different factors that contribute to a good fertilization program.

Acknowledgments

The author would like to thank Robert Anderson, Ph.D., and Kirk Ranta as well as all of the greenhouse operators in this evaluation for their help and information.

2004 Nursery Products Buyer Survey

Andrea Basham, Tim Woods, and Matt Ernst, Department of Agricultural Economics

Nature of Work

A survey of the nursery industry in Kentucky's seven-state area was conducted to assess regional industry trends during the summer of 2004. Approximately 500 retailers, landscapers, and wholesalers from the nursery industry in Kentucky, Tennessee, Ohio, Indiana, Missouri, Illinois, and West Virginia were questioned by mail. Over 30 percent (150) of the surveys were returned; of these, 126 surveys (25 percent) were complete and available for analysis.

Firms surveyed are operating primarily as retailers or landscapers. Approximately 56 percent of businesses reported some retailing activity while 75 percent reported landscaping services contributing to gross sales. While 52 percent of those surveyed reported wholesaling activity, the average sales volume from wholesaling was only 20 percent of a firm's gross sales. Thus, "wholesaler" trends cannot be properly identified from this sample set, which is most representative of nursery businesses whose primary functions are retailing and/or landscaping.

Results/Discussion

Evergreen trees, evergreen shrubs, and flowering shrubs accounted for the largest sale volumes by retailers and landscapers. Flowering, ornamental, and shade trees accounted for relatively low sales volumes (less than 1,000 units annually). Three main trends are identified from the survey results:

- Demand for specific cultivars
- Demand for specific plant size
- Importance of characteristics in wholesale purchases

1. Demand for Plant Varieties

The survey asked respondents to rate the demand for 12 tree cultivars. Respondents rated demand as decreasing, stable, or increasing on a three-point scale. Both retailers and landscapers noted stable to decreasing demand for sweetgum, honey locust, and ash (Table 1). Stable to increasing demand was indicated for magnolia (retailer), oak (landscaper), and maple (both).

Table 1. Demand table for selected trees.

	Decreasing to Stable	Stable	Stable to Increasing
Retailers	Sweetgum	Birch	Maple
	Honey Locust	Oak	Magnolia
	Ash	Serviceberry	
	Flowering Pear	Dogwood	
	Flowering Cherry	Flowering Crabapple	
Landscapers	Sweetgum	Birch	Oak
	Honey Locust	Magnolia	Maple
	Ash	Dogwood	
	Serviceberry	Flowering Cherry	
	Flowering Pear	Flowering Crabapple	

2. Demand for Plant Sizes

The study focused on trends in balled and burlap sales as well as container plants. Among B&B sizes, there were increases in quantity demanded for larger sizes (Figure 1). For example, landscapers showed a stable or increasing demand for 1.75-inch to 3-inch B&B plants. Both retailers and landscapers expected decreasing demand for smaller sizes (1 inch to 1.5 inch).

Container plants also followed the larger size/larger quantity demanded rule. Landscapers indicated stable to increasing demand for 10- and 15-gallon sizes and an increasing demand for 25-gallon container plants. Retailers indicated an increasing demand for 10-gallon containers and stable demand for 15- and 25-gallon sizes. The significance of this trend is reinforced by comments from many respondents that they have difficulty locating 1-inch to 3-inch B&B as well as 10- and 15-gallon container plants.

3. Characteristics of Wholesale Purchases

The survey attempted to determine which characteristic of a purchase between wholesalers and retailers/landscapers is most important. Retailers and landscapers, in general, reported product quality as the most important factor in a transaction (Figure 2). Other important factors were: 1) variety/selection/volume; and 2) ease/speed/cost of delivery. Price was least important to landscapers, while relationship with the wholesaler was least important to retailers.

Figure 2. Importance of characteristics in wholesale purchases.

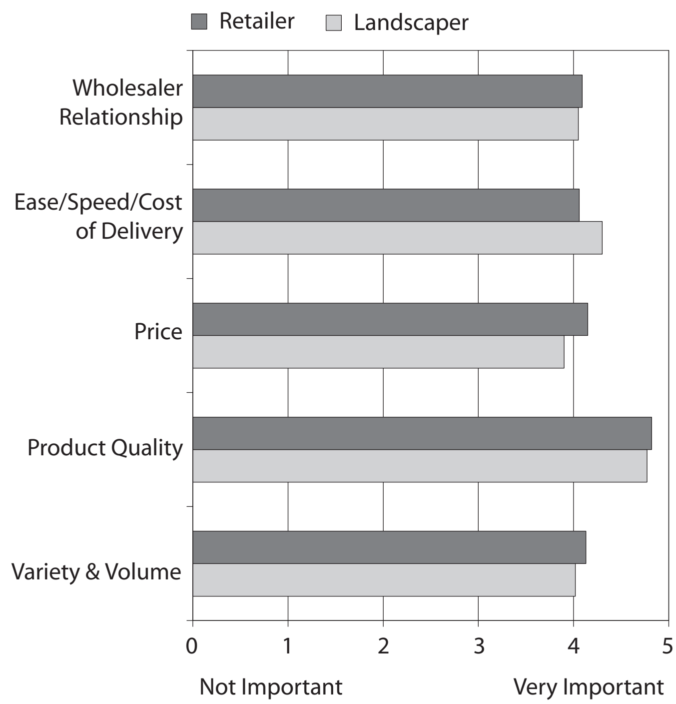
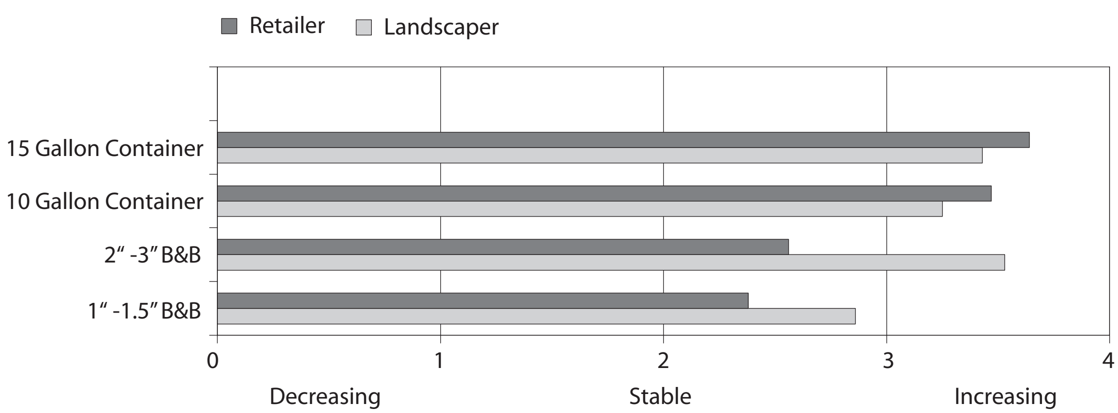


Figure 1. Demand outlook for container sizes.



Kentucky Responses

In addition to the three trends above, some observations can be made about Kentucky businesses that responded to this survey. There were 33 businesses from Kentucky returning completed surveys, representing one-quarter of all respondents. On average, operations in Kentucky conducted 38 percent of their gross sales from retailing, 47 percent from landscaping, and 15 percent from wholesaling. Other highlights from Kentucky's respondents included:

- 20 percent to 50 percent of nursery stock sold by Kentucky businesses was grown in Kentucky
- Highest sales volumes are from evergreen shrubs, flowering shrubs, and shade trees
- Respondents expected the quantity demand to increase for magnolia and maple trees
- Respondents expected the quantity demand to decrease for flowering crabapple, ash, and honey locust

Kentucky respondents expected increases in demand for larger B&B sizes (2-inch to 3-inch), as well as 15-gallon container plants. Decreases were expected for 1-inch and 1.5-inch B&B plants. Lastly, in wholesale purchases, Kentucky businesses reported that the most important characteristic is product quality. Least important are the ease/speed/cost of delivery. This was similar to trends noted across all respondents.

Significance to Industry

This survey indicates that consistently high product quality is most important in the minds of the buyers surveyed. Growers should therefore pay careful attention to market products of the highest quality. Although Kentucky nursery stock is not currently regarded as the lowest price stock in our region, Kentucky growers may be able to capitalize on buyer preferences for high quality stock. Exactly how much more buyers are willing to pay for higher quality stock from Kentucky is yet to be determined and will be key to developing successful regional markets for Kentucky nursery producers.

Managing the Calico Scale Infestations with Systemic Soil Treatments or Crawler Sprays

Jamee Hubbard and Daniel Potter, Department of Entomology

Nature of Work

Calico scale, *Eulecanium cerasorum* (Cockerell), (Homoptera: Coccidae) is a widespread and destructive scale insect pest of woody landscape plants. It was apparently introduced into the San Francisco, California, area in the early 1900s from Asia and has since spread to Kentucky and surrounding states through the transport of infested plant material. During the past five years, severe outbreaks of this pest have occurred on central Kentucky horse farms, golf courses, and street plantings. The impact of this outbreak is extensive because there has been little research on the pest's biology or management. Calico scale adults encrust the branches, and nymphs cover the leaves of trees. This pest is a phloem feeder, and in large numbers, feeding can result in branch and limb dieback. Trees may be directly killed or severely weakened by calico scale feeding, consequently succumbing to woodborer attacks, drought, or other stresses. Adults produce profuse amounts of honeydew, which may coat automobiles and other objects under infested trees. Honeydew encourages growth of sooty mold fungus that blackens foliage and bark and may interfere with photosynthesis.

Calico scale has one generation per year with late instars overwintering on the bark. Adults are noticeable as large, round, black and white scales from March until June. They begin to senesce, turning brown and black, as the eggs underneath them reach full maturity. Individual females produce about 3,700 to 4,700 eggs. After emergence from underneath females, newly hatched crawlers disperse to leaves over about a 19-d period from late May until mid-June beginning at a mean accumulation of 818 DDC (1473 DDF) calculated from a base temperature of 4.4°C (40°F), with Jan. 1 as a starting date. These crawlers settle primarily along veins on the undersides of leaves where they feed on plant sap. They molt to second instars in mid-July and then remain on the foliage until just before leaf senescence in autumn, at which time the crawlers remove their mouthparts from the leaves and crawl to the bark to overwinter.

Recent studies (Hubbard and Potter, in review) showed that certain reduced-risk insecticides, including pyrethroids and pyriproxifen (an insect growth regulator), give excellent control of settled calico scale crawlers so long as there is sufficient coverage. In reality, however, the logistical difficulty of spraying tall trees and the crawlers' proclivity to settle along leaf veins makes it difficult to achieve more than about 66 percent control. So far we have targeted crawlers in mid- to late June, some weeks after they have settled on the leaves, the rationale having been to wait until hatching was complete. As this project evolved, it became apparent that earlier treatment (just *before* egg hatch) likely would be more effective because the crawlers would expose themselves to residues as they venture from beneath the overwintered females on trunks and branches and make their way to their summer feeding sites on leaves.

Trunk and soil injections with systemic insecticides (bidrin and imidacloprid) during the growing season to target crawlers that have settled on leaves and begun feeding were also tested in those studies. Bidrin was moderately effective, but it is a Restricted Use Pesticide. Also, it must be delivered by trunk injection, a technique not suited for production nurseries or smaller trees. Imidacloprid was not effective against settled crawlers when applied as trunk injections in spring or as soil injections with the Kioritz® soil injector in winter or spring. However, recent literature suggests that imidacloprid soil injections done in the *preceding* autumn can be highly effective against sucking insects the following growing season. Imidacloprid has extended residual and evidently the expanding leaves serve as a sink.

We conducted an experiment in 2004 to test the effectiveness of applying bifenthrin or pyriproxyfen to branches and leaves of sweetgum trees at the beginning of crawler hatch. The study site was a planting of 18 sweetgum trees (about 18 cm diameter) on a grassy road median in Lexington, Kentucky. Three lower branches, each about 1 m long, were tagged in each of six heavily infested trees. Branches were accessed using a 3-m ladder and blocked on the basis of density of adult female scales. The site was monitored daily for egg hatch which began May 20. That same day, one marked branch on each tree was sprayed with either bifenthrin (Talstar F) at 0.14 g (AI) per liter, pyriproxyfen (Esteem 35 WP) at 0.13 g (AI) per liter, or left untreated. Treatments were applied with a Solo® backpack sprayer to thoroughly wet the bark and leaf surfaces. The remainder of the tree was not sprayed. Percentage mortality was evaluated Aug. 3-4, 2004, by harvesting each treated branch, removing 10 representative leaves along its length, and counting living crawlers on the left half of the abaxial leaf.

A second experiment was conducted from autumn 2003 to summer 2004 to test the effectiveness of autumn soil applications of imidacloprid against settled crawlers feeding on leaves the following summer. The test site was two rows of infested red maples along a horse farm roadside. Twelve trees, about 10 cm trunk diameter, were paired according to previous year's infestation level (i.e., dead females on branches). On Nov. 25, 2003, the soil around one tree of each pair was treated with imidacloprid (Merit 75 WP) at 1.9 g product per 2.54 cm of trunk diameter, the highest label rate. A high-pressure injection system was used to apply 1.92 liters per tree, with 147.9 ml applied per injection point and 13 injection points located 25.4 to 30.5 cm from the trunk and evenly spaced around the tree. Injection pressure was 4.23 kg per cm^2. Efficacy against the overwintering generation of scales, nymphs of which had been on the trees when the injections were done, was evaluated on May 10, 2004, by counting live adult females on the main trunk to 2.21 m height and 42.5 cm up four main branches from where they joined the trunk. Counts were totaled per tree and compared between treatments by paired *t*-test. Control of subsequent settled crawlers on leaves was evaluated on Aug. 10, 2004. For those samples, a pole pruner was used to harvest 16 woody twigs with foliage throughout the lower and middle canopy of each tree. Live settled crawlers were counted on the left half of the abaxial surface of one leaf per shoot using a binocular microscope.

Results and Discussion

Treating foliage with either pyriproxyfen or bifenthrin at first egg hatch significantly reduced numbers of live settled crawlers on leaves ($P = 0.01$). Mean (± SE) number of crawlers per leaf sample averaged 1142 ± 273, 425 ± 140, and 85 ± 106 for untreated, pyriproxyfen-, and bifenthrin-treated branches, representing reductions of 63 percent and 83 percent, respectively, from the two treatments. High-volume, basal soil injection with imidacloprid in autumn of 2003 did not control calico scales in the following growing season. On May 10, 2004, treated trees had an average of 318 ± 86 adult females per sample, versus 118 ± 45 for controls ($P = 0.15$). In August, live settled crawlers on leaves averaged 677 ± 189 per sample for treated trees, versus 603.2 ± 239.0 per sample for controls ($P = 0.79$).

Levels of control with preventive applications of pyriproxyfen or bifenthrin likely would have been greater had the whole canopy been treated. Spraying only the tagged shoots left a reservoir of untreated crawlers in the trees that could infest the treated branches until the end of the crawler hatch period. With contact insecticides, treating at first hatch would force active crawlers to traverse residues as they move from hatching sites on woody tissue to feeding sites on leaves, likely providing better control than targeting settled crawlers on leaf undersides

Soil injections with imidacloprid seemed a likely candidate for managing calico scale because such treatments have been shown to control a range of tree insect pest species. However, soil-injected imidacloprid applied in autumn did not significantly control post-overwintered adults or the subsequent generation of crawlers. Tree species, size, and vigor, climatic conditions that might inhibit uptake of imidacloprid through the xylem, timing of application, location of injection points in relation to the trunk or drip line, and other factors could affect systemic uptake of pesticides and result in low concentrations in the leaves. Much more research is needed to understand how these factors may affect efficacy and consistency of trunk- or soil-injected systemic insecticides against scale insects in trees.

In conclusion, treatments with bifenthrin or pyriproxyfen canopy sprays at or just before crawler hatch may be the best method for controlling calico scale in most situations. The use of degree days can help target scouting for adults to better time these applications. Imidacloprid soil injection is not a good choice for controlling calico scale, but scales can still be suppressed in sensitive areas where drift must be eliminated, such as horse farms, with the use of bidrin trunk injections applied by a certified applicator just before crawler hatch.

Significance to Nursery Industry

Calico scale (*Eulecanium cerasorum*) is an invasive soft scale that encrusts the leaves and branches of maples, honey locust, dogwoods, sweet gum, hackberry, and other tree species, causing dieback and death of heavily-infested trees. The scales produce profuse amounts of honeydew that coats the leaves and bark, promoting growth of unsightly sooty mold, as well as any objects (e.g., parked vehicles) beneath infested trees. Calico scale has reached outbreak status in commercial and residential landscapes, on horse farms, and in production nurseries (e.g., Snow Hill Nursery in Shelbyville, Kentucky, in 2004). The objective of this project was to evaluate application timing of reduced-risk foliar insecticides to intercept crawlers before they reach summer feeding sites, and also autumn soil with imidacloprid for season-long systemic control. This research compliments earlier studies that determined appropriate management practices for calico scale in urban and rural areas of Kentucky.

Dogwood Borer Sex Pheromone Identification for Trapping and Timing Control Actions in Landscapes and Nurseries

Kenneth Haynes and Daniel Potter, Department of Entomology

Nature of Work

Dogwood borer [DWB], *Synanthedon scitula* (Harris), is the major insect pest of flowering dogwoods in landscapes and nurseries (1) and increasingly important in high density apple orchards where it infests burr knots near the graft union (2). Management of DWB has been hindered by ineffectiveness of commercial pheromone lures (2, 3). The true sex pheromone has not been identified, rather an attractant based on field screening has been used for many years. The variability of trapping results with this attractant suggests that a systematic approach to pheromone identification could provide a tool that would be more useful for timing control actions.

Many species of clearwing moths (Sesiidae) use isomers of 3, 13-octadecadien-1-ol acetate (ODDA) in their sex pheromone blend (4). Commercial pheromone lures marketed for trapping clearwing moths tend to be somewhat generic and often catch several species of moths. Many investigators have reported poor response of DWB to commercial lures. Such lures contain (Z, Z)-3, 13-ODDA as their main component but vary in purity and concentration of other ODDA isomers. Sympatric species of closely related moths often rely upon subtle difference in pheromone blend for species isolation, so slight deviation from the true blend can completely shut down males' response.

Several hundred mature woody horned oak galls with exuded frass indicative of DWB infestation (5) were collected from pin oak trees in spring and autumn preceding the bimodal flight peaks of DWB adults. Gland extracts from virgin females reared from those galls were analyzed using gas chromatography coupled to mass spectroscopy (GC/MS) and electroantennogram analyses (GC/EAG). Based on results from these analyses, lures were formulated containing the major pheromone component Z,Z-ODDA and variable quantities of a potential trace compound EZ-ODDA. Pherocon sticky traps were baited with these lures and hung from trees in six locations around Lexington during both June and August.

Results and Discussion

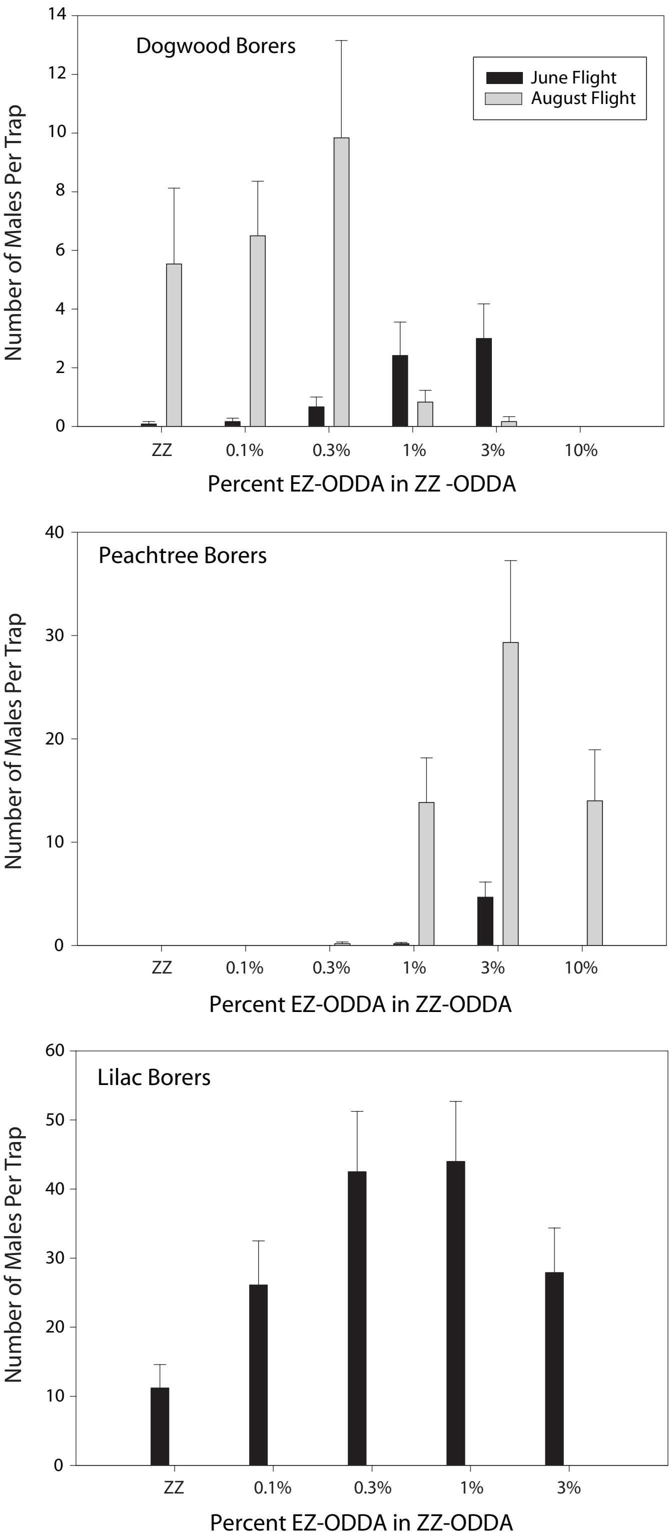
Through GC/EAD and GC/MS analyses we determined that ZZ-ODDA was present in the female DWB's sex pheromone gland during the daily period when they attract males. These analyses suggested the possibility that a trace amount of EZ-ODDA was also present. During the June flight, a 3-percent blend of EZ –ODDA (in ZZ-ODDA) was over 30 times more effective than ZZ-ODDA alone (Figure 1). However in the August flight this blend was 30-fold less effective than ZZ-ODDA alone. At this time a 0.3-percent blend of EZ-ODDA in ZZ-ODDA was most effective. Many of these traps also caught peachtree borers and lilac borers. A 3-percent blend was most effective for peachtree borers during both June and August. The lilac borer was not present during the second test period (August), but during June, blends with 0.3 and 1 percent were most effective.

The results with the DWB indicate that EZ-ODDA is an effective synergist for the sex attractant that is currently available. However, the observation that the most effective quantity of this synergist was different in June and August requires more study. Three possible explanations for this pattern are the following: 1) the insects caught in June and August are genetically distinct (i.e., different species or subspecies); 2) the environment influences the lures or the moths in different ways during these periods; or 3) missing additional components would make the trapping results more consistent.

Significance to Industry

Control of wood-boring larvae with insecticidal sprays requires that residues be on the bark to intercept newly hatched larvae before or as they chew into the tree. Traditionally, this has been accomplished by applying a larvicide, either chlorpyrifos (Dursban) or lindane, 10 to 14 days after first male capture in pheromone traps, followed by another application if flight continues for six more weeks. That timing coincides with the

Figure 1. Mean number (+SE) of male dogwood borers (upper graph), peachtree borers (middle graph), and lilac borers (lower graph) caught in sticky traps baited with the indicated blend of EZ and ZZ-ODDA. The quantity of ZZ-ODDA was held constant at 250 µg, while the quantity of EZ-ODDA was varied from 0 percent to 10 percent of this amount. The 10 percent treatment was not included in the experiment conducted in June.



two-week incubation period of eggs. With the recent cancellation of these traditional borer insecticides, shorter-lived pyrethroids must be used. That makes timing even more critical. An effective synthetic lure used in inexpensive cardboard sticky traps can help pinpoint optimal spray timing. We have identified a pheromone blend that is much more effective during the June flight than the commercially available lure.

Literature Cited

1. Potter, D.A. and G.M. Timmons. 1981. Factors affecting predisposition of flowering dogwoods to attack by the dogwood borer. HortScience 16: 677-679.
2. Bergh, J.C. and T.C. Leskey. 2003. Biology, ecology, and management of dogwood borer in eastern apple orchards. Can. Entomol. 135: 615-635.
3. Potter, D.A. and G.M. Timmons. 1983. Flight phenology of the dogwood borer (Lepidoptera: Sessiidae) and implications for control in *Cornus florida* L. J. Econ. Entomol. 76: 1069-1074.
4. Tumlinson, J.H. 1979. The chemistry of Sesiidae pheromones. In *Pheromones of the Sesiidae*. USDA, Agricultural Research Results (ARR-NE-6).
5. Eliason, E. and D.A. Potter. 2000 Dogwood borer (Leidoptera: Sesiidae) infestation of stem galls induced by *Callirhytis cornigera* (Hymenoptera: Cynipidae) on pin oak. Environ. Entomol. J. Econ. Entomol. 93: 757-762.

New Management Approaches for Insect Pests of Nursery-Grown Maples

Bonny Miller, Daniel Potter, Amy Fulcher, and Robert McNiel, Departments of Entomology and Horticulture

Nature of Work

This new project for 2005-2006 will evaluate tree cultivar resistance and other reduced-risk tactics for managing insect pests of nursery-grown maples. Maples are among the top nursery crops in Kentucky and likely will remain so given emerging problems afflicting other tree species (e.g., sudden oak death/decline, emerald ash borer). Maples, however, have their own pest problems. Flatheaded apple tree borer (FHATB) and potato leafhopper (PLH) are especially damaging to red maples (2, 3), and growers presently apply multiple cover sprays for each species. FHATB control is complicated by recent cancellation of traditional borer insecticides (e.g., lindane, chlorpyrifos). Growers also report increased problems with calico scale, maple spider mites, and shoot borers that often destroy the terminal leader, affecting tree symmetry. Little is known about biology or management of the latter three pests in production nurseries. Several large growers asked that we investigate these problems.

Host plant resistance ideally is the first line of defense against insects and pathogens both in nurseries and landscapes. This project will evaluate relative resistance of many newer maple cultivars, versus the old standbys, to multiple insect pests. Cultivars to be evaluated include:

Acer rubrum: Autumn flame, Burgundy Belle, October Glory, Red Sunset, Somerset, Sun Valley
Acer freemanii: Autumn Blaze, Autumn Fantasy, Pacific Sunset, Sienna Glen
Acer saccharum: Crescendo, Commemoration, Green Mountain, Legacy, Sugar Queen
Acer truncatum: Pacific Sunset
Acer compestre: Hedge maple

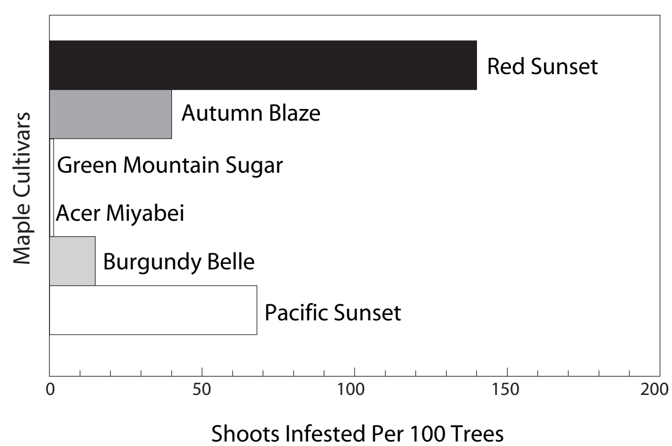
Trees will be planted in replicated field plots at two production nurseries and at the UK South Farm, and they will be evaluated twice monthly for density of pests and/or severity of pest symptoms. South Farm trees will be inoculated with calico scale and maple mites to ensure adequate infestations.

We also are studying whether trunk coatings of particle film (Surround® Crop Protectant) can protect trees from borers. This new technology involves spraying a suspension of kaolin, a biodegradable clay-like material, on plant surfaces to disrupt insect feeding and egg laying (1). Particle film may have potential for nontoxic, preventive borer control in nurseries and landscapes. Newly planted trees would have their trunks "whitewashed" to protect them following transplant when they are most vulnerable to borer attack. Evaluations were carried out in 2004 against FHATB in a block of nursery-grown red maples, 60 trees each being treated with particle film (three times at two-week intervals), permethrin (Astro®), or untreated as controls. In addition, Surround® was applied to trunks of red maples, green ash, and thornless honeylocust (six trees per species, about 4-inch trunk diameter) at the UK South farm and the whitewash-like residues were visually rated to determine how long they last under field conditions. Further evaluations against FHATB and bronze birch borer are planned for 2005. We also will evaluate two systemic soil insecticides, Discus® (imidacloprid) and Flagship® (thiamethoxam), for season-long preventive control of major maple pests (especially FHATB and PLH) from a single early-spring soil treatment.

Results and Discussion

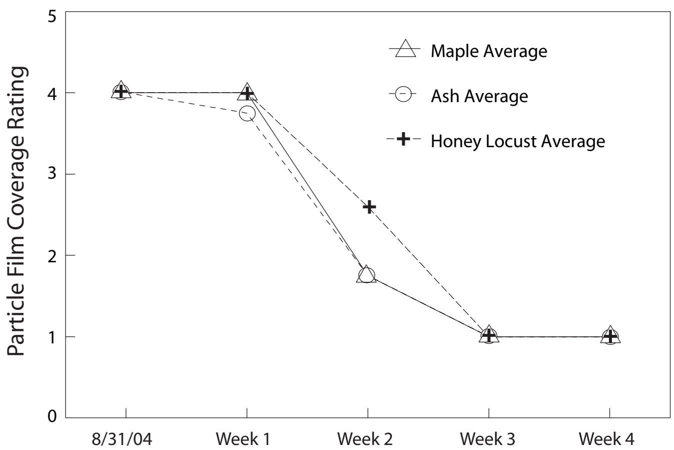
Preliminary data collected in 2004 indicate that the shoot borer problem in Kentucky nurseries is caused by caterpillars of one species of tortricid moth, *Proteoterus aesculana*. Moths were reared from infested shoots, and their ID was confirmed by sending moths to a specialist. Large larvae were present in flagged shoots in late May, and moths emerged in late June. Surveys of selected maple species indicated significant variation in susceptibility to shoot borers (Figure 1). Studies of the shoot borer's biology will continue in 2005.

Figure 1. Relative susceptibility of selected nursery-grown maples to shoot borer infestation in Shelbyville, Kentucky, Spring 2004.



None of the trees in the plot comparing Surround® particle film versus Astro® insecticide showed symptoms of borer infestation, including the untreated controls. High rainfall in summer 2004 probably reduced tree stress and borer infestations. The experiment will be repeated in 2005. Under heavy rainfall, the particle film trunk treatments lasted two to three weeks (Figure 2).

Figure 2. Persistence of field-weathered Surround® particle film residues on trunks of selected borer-susceptible tree species.



Significance to Industry

Flatheaded apple tree borer and potato leafhopper are the two worst insect pests of Kentucky's production nursery industry. Growers presently apply several cover sprays for each pest. Problems with shoot borers, calico scale, and maple mites seem to be on the rise. This project will provide:

- multiple pest resistance ratings for newer maple varieties being favored by Kentucky growers;
- new information on maple shoot borers leading to more focused control; and
- new chemical and nonchemical options by which nursery growers can reduce the frequency of insecticide applications

References:

1. Glenn, D.M., G.J. Puterka, T. Vanderzwet, R.E. Byers, and C. Feldhake. 1999. Hydrophobic particle films: a new paradigm for suppression of arthropod pests and plant diseases. J. Econ. Entomol. 92: 759-771.
2. Potter. D.A., G.M. Timmons, and F.C. Gordon. 1988. Flatheaded apple tree borer in nursery-grown red maples: Phenology of emergence, treatment timing, and response to stressed trees. J. Environ. Hort. 6: 18-22.
3. Potter, D. A. and P.G. Spicer. 1993. Seasonal phenology, management, and host preferences of potato leafhopper on nursery-grown maples. J. Environ. Hort. 11: 101-106.

2004 Landscape Plant Disease Observations from the University of Kentucky Plant Disease Diagnostic Laboratory

Julie Beale, Paul Bachi, and John Hartman, Department of Plant Pathology

Nature of Work

Plant disease diagnosis is an ongoing educational and research activity of the UK Department of Plant Pathology. We maintain two branches of the Plant Disease Diagnostic Laboratory, one on the UK campus in Lexington and one at the UK Research and Education Center in Princeton. Of the more than 4,000 plant specimens examined annually, about 40 percent are landscape plant specimens (1).

Making a diagnosis involves a great deal of research into the possible causes of the plant problem. Most visual diagnoses involve microscopy to determine what plant parts are affected and to identify the microbe involved. In addition, many specimens require special tests such as moist chamber incubation, culturing, enzyme-linked immunosorbent assay (ELISA), electron microscopy, nematode extraction, or soil pH and soluble salts tests. This year, the laboratory is using polymerase-chain-reaction (PCR) testing which, although very expensive, will allow more precise and accurate diagnoses. Computer-based laboratory records are maintained to provide information used for conducting plant disease surveys, identifying new disease outbreaks, and formulating educational programs. In addition, information from the laboratory forms the basis for timely news of landscape disease problems through the *Kentucky Pest News* newsletter, radio and television tapes, and plant health care workshops.

To assist county Extension agents in dealing with plant disease issues, we also operate a Web-based digital consulting system utilizing photographic images. When the system is used to provide a diagnostic assist, the images can be used to help determine where best to collect samples for submission to the laboratory. The digital consulting system is especially useful in providing advice about landscape tree and shrub diseases and disorders because whole plants are difficult to send to the laboratory. Of almost 700 digital consulting cases, 30 to 35 percent dealt with landscape and nursery plants.

The 2004 growing season in Kentucky provided mostly cooler than normal temperatures and above normal rainfall, however these observations varied by location. The coldest temperatures occurred in January and ranged from -12°F in northern Kentucky to 4°F in the west. There were few significant late spring frosts. In central Kentucky, normal temperatures prevailed most months except for above normal temperatures in March and May and cooler than normal in July and August. Indeed, in this region, there were no days with 90°F or greater temperatures (normal is 17 days). Rainfall in central Kentucky was normal during most months, but was above normal during May through August. In western Kentucky, except for a wet May, rainfall was mostly normal but turned dry at the end of the summer and very dry into the fall. In eastern Kentucky, May, June, and September were wet, but July and August were dry. With wetness affecting disease development, the percentage of days with rain in Kentucky averaged about 35 percent statewide during April (43 percent in some regions), 45 percent in May (52 percent), 38 percent in June (60 percent), and 38 percent in July (58 percent). Thus, there were ample opportunities for rain-based plant disease development.

This year the following important diseases, as well as the diseases that were unusual or increased due to the wet weather, were observed:

Deciduous trees

- Dogwood powdery mildew (*Microsphaera, Phyllactinia*), spot anthracnose (*Elsinoe*)
- Flowering crabapple scab (*Venturia*)
- Hawthorn, serviceberry, and crabapple cedar rusts (*Gymnosporangium juniperi-virginianae, G. clavipes, G. globosum*)
- Magnolia, maple, and smoke tree wilt (*Verticillium*)
- Maple, ash, dogwood, oak redbud and sycamore anthracnose (*Kabatiella, Discula*, and *Apiognomonia*)
- Maple leaf spot (*Phyllosticta*)
- Oak bacterial leaf scorch (*Xylella*), Actinopelte leaf spot (*Tubakia*), and leaf blister (*Taphrina*)
- Willow leaf spot (*Cercospora*)

Needle Evergreens

- Juniper tip blight (*Phomopsis, Kabatina*) and rusts (*Gymnosporangium*)
- Pine tip blight (*Sphaeropsis*) and needle rust (*Coleosporium*)
- Spruce needle cast (*Rhizosphaera*)

Shrubs

- Azalea leaf and flower gall (*Exobasidium*)
- Crepe myrtle powdery mildew (*Erysiphe*)
- Holly black root rot (*Thielaviopsis*)
- Photinia leaf spot (*Entomosporium*)
- Rose black spot (*Diplocarpon*) and rosette (possible virus, leaf curl mite-transmitted)
- Rhododendron dieback (*Phytophthora*)

Herbaceous Annuals and Perennials

- Asiatic lily, chrysanthemum, daylily, geranium, petunia, rudbeckia, vinca, and bedding plants root rots (*Pythium, Rhizoctonia, Phytophthora*)
- Daylily leaf streak (*Aureobasidium*)
- Impatiens virus (Impatiens Necrotic Spot Virus)
- Downy mildew of helleborus (*Peronospora*) and coreopsis (*Plasmopara*)
- Hosta southern blight (*Sclerotium*)
- Pansy, petunia, geranium, and vinca black root rot (*Thielaviopsis*)
- Vinca aerial blight (*Phytophthora*)

Significance to Industry

Plant diseases play a significant role in production and maintenance of landscape plants in Kentucky. The first step in appropriate pest management in the landscape and nursery industry is an accurate diagnosis of the problem. The UK Plant Disease Diagnostic Laboratory assists the landscape industry of Kentucky in this effort. To serve their clients effectively, landscape industry professionals, such as arborists, nursery operators, and landscape installation and maintenance organizations, need to be aware of recent plant disease history and the implications for landscape maintenance. This report is a synopsis of the useful information about plant disease provided for landscape professionals.

Literature Cited

1. Bachi, P., J. Beale, J. Hartman, D. Hershman, W. Nesmith, and P. Vincelli. 2005. Plant Diseases in Kentucky—Plant Disease Diagnostic Laboratory Summary, 2004. UK Department of Plant Pathology (in press).

Survey for *Phytophthora ramorum* (Sudden Oak Death) in Kentucky Nurseries, 2004

John Hartman, Joe Collins, Carl Harper, Bernadette Amsden, Siriporn Dannua, Claudia Cotton, and Paul Vincelli, Departments of Plant Pathology and Entomology

Nature of Work

During recent years, sudden oak death (SOD) caused by a fungus new to the United States, *Phytophthora ramorum*, has appeared in the coastal regions of northern California and Oregon. The fungus causes bleeding necrosis on the trunks and limbs of affected oak and tanoak trees and can girdle and kill infected trees. The fungus also infects foliage, causing spots, blotches, or leaf tip necrosis of many kinds of plants without much notice or harm to the plants. These infected "carriers" of SOD may include rhododendrons, camellias, bay laurels, maples, viburnums, honeysuckles, buckeyes, and many other trees and shrubs.

In Kentucky, we are concerned about whether this disease would be similarly devastating to oaks if the pathogen were introduced into the state. The SOD disease fungus thrives in the relatively cool and moist climate of coastal California and Oregon. Since we also can have periods of cool, moist weather in spring and sometimes in fall, the disease might thrive here, too. The wide host range of the fungus in nature and in greenhouse inoculations includes Kentucky native woody plants such as red oaks, rhododendrons, viburnums, and mountain laurels.

Thus, effective February 2002, a federal quarantine was imposed to prevent movement of infected plants or the pathogen from the West Coast to Kentucky and other states. Despite the quarantine, during the 2003 growing season, infected amellias were shipped from a California nursery outside the quarantine zone to eastern states, mostly in the southeast. In 2004, as part of a national nursery survey, all nurseries and garden centers in Kentucky were examined for plants with symptoms of *P. ramorum* infections.

The nursery survey was done primarily during May, June, and July. Nursery collections were done by USDA-APHIS personnel and nursery inspectors operating from the Office of State Entomologist. Nurseries were examined for plants showing abnormal symptoms including bleeding necrosis, leaf spots, blotches, and leaf tip necrosis. Nursery blocks and garden center sales areas containing oaks, rhododendrons, viburnums, camellias, lilacs, and mountain laurels were especially scrutinized.

Nursery specimens were collected, labeled, placed in plastic bags, double bagged, and immediately taken to the laboratory for analysis. Small pieces of infected plant material were tested for presence of Phytophthora using an enzyme-linked immunosorbant assay (ELISA) test. Samples were also plated on a culture medium selective for Phytophthora (PARP) and were floated on water in Petrie dishes. Samples testing positive with the ELISA test were further tested for Phytophthora fungi closely related to *P. ramorum* with a polymerase chain reaction (PCR) test. ELISA- and PCR-positive samples were considered "presumed positives" and were sent to the USDA-APHIS in Beltsville, Maryland, for confirmation. None of our ELISA and PCR "suspect positive: plants yielded "confirmed positive" results by the USDA-APHIS laboratories.

Results and Discussion

Examinations were made of 126 nurseries in 28 counties statewide (Figure 1), and collections were made from 231 nursery plants showing disease symptoms. The survey data are summarized in Table 1.

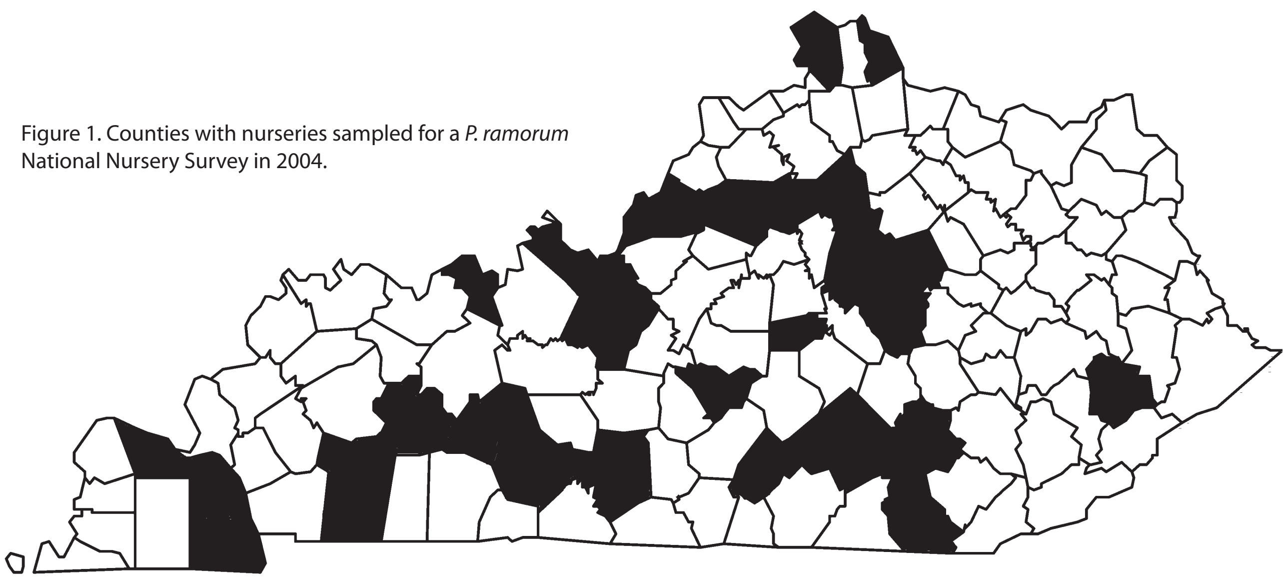


Figure 1. Counties with nurseries sampled for a *P. ramorum* National Nursery Survey in 2004.

Table 1. Diagnoses of diseases of plants collected for the *P. ramorum* National Nursery Survey in 2004.

Host Plants	Number of Samples Examined	Number of Samples ELISA (+)	Diagnoses
Rhododendron	80	35	Phytophthora dieback (27), Pestalotia blight (18), Botryosphaeria canker (8), Sunscald (8), Edema (5) Insect injury (5), Phyllosticta leaf spot (3), anthracnose (3), Septoria blight (3), fungal leaf spots and blight (5), insect injury (5), abiotic disorders (6), undiagnosed disorders (4)
Viburnum	36	2	Anthracnose (7), Sunscald/scorch (6) Phyllosticta leaf blight (4), Ascochyta leaf spot (3), fungal and bacterial leaf spots (7), undiagnosed disorders (4), arthropod damage, abiotic disorders (3)
Lilac	18	13	Heterosporium leaf blight (3) fungal leaf spots (5), abiotic disorders (3), bacterial spot (1)
Pieris japonica	11	5	Phytophthora dieback (3), fungal leaf spots and blights (5) abiotic and undiagnosed disorders (3)
Camellia	11	3	Anthracnose (5), fungal leaf spots (3), abiotic and undiagnosed disorders (3)
Magnolia	7	4	Fungal leaf spots (5), aboitic disorders (2)
Rose	7	1	Fungal leaf spots (4), abiotic disorders (3), mite damage (1)
Mandevilla	6	3	Anthracnose (3), undiagnosed disorders (3)
Azalea	6	1	Rhizoctonia web blight (2), fungal leaf spots (3), undiagnosed (1)
Various Hosts (<5 plants each)	46	4	Fungal leaf spots and abiotic disorders from the following plants: Cherry Laurel, Holly, Mahonia (4 each); Canna, Clematis, Fern, Mt. Laurel, Leucothoe, (3 each); Hamamelis, Hydrangea, Maple, Weigela (2 each); Aesculus, Carpinus, Lily, Liriope, Mt. Laurel, Oak, Pin Oak, Red Oak, Pulmonaria, Pyracantha, Spirea, Taxus, Wisteria (1 each)

None of our ELISA and PCR suspect positive plants were confirmed as positive by the USDA-APHIS laboratories. Although some cultures yielded species of *Phytophthora*, none of the cultures had morphological characters resembling those of *P. ramorum*. This nursery survey suggests that *P. ramorum* infected plants are absent from or are not easily found associated with Kentucky nurseries.

Significance to Industry

This disease of West Coast forests has greatly impacted the nursery industry in the United States with potential ramifications to Kentucky. The Kentucky landscape and nursery industry needs to be made aware of the status of SOD in Kentucky and of the great potential risk this disease is to Kentucky's forest and nursery industries should the disease be found endemic in the forest.

Survey for *Phytophthora ramorum* (Sudden Oak Death) in Kentucky Parks and Natural Areas, 2004

John Hartman, Bernadette Amsden, Siriporn Dannua, Brenda Coe, and Paul Vincelli, Department of Plant Pathology

Nature of Work

During recent years, sudden oak death (SOD) caused by a fungus new to the United States, *Phytophthora ramorum*, has appeared in the coastal regions of northern California and Oregon. The fungus causes bleeding necrosis on the trunks and limbs of affected oak and tanoak trees and can girdle and kill infected trees. The fungus also infects foliage, causing spots, blotches, or leaf tip necrosis of many kinds of plants without much notice or harm to the plants. These infected "carriers" of SOD may include rhododendrons, camellias, bay laurels, maples, viburnums, honeysuckles, buckeyes, and many other trees and shrubs.

In Kentucky, we are concerned about whether this disease would be similarly devastating to oaks if the pathogen were introduced into the state. The SOD disease fungus thrives in the relatively cool and moist climate of coastal California and Oregon. Since we also can have periods of cool, moist weather in spring and sometimes in fall, the disease might thrive here, too. The wide host range of the fungus in nature and in greenhouse inoculations includes Kentucky native woody plants such as red oaks, rhododendrons, viburnums, and mountain laurels.

Despite a federal quarantine during the 2003 growing season, infected camellias were shipped from a California nursery outside the quarantine zone to eastern states, mostly in the southeast. In addition, *P. ramorum* is known to be capable of being moved in soil, such as that stuck to hiking boots and to automobile tires. On the chance that *P. ramorum* has already been introduced, selected Kentucky state and national parks and natural areas were surveyed in 2004 for presence of *P. ramorum*.

The park and natural areas survey was done primarily during September and October when relatively cool temperatures would favor *P. ramorum* diseases. Collections were made from plants growing primarily along well-traveled trails. Trail-side vegetation was examined for plants showing abnormal symptoms including bleeding necrosis, leaf spots, blotches, and leaf tip necrosis. Species such as oaks, rhododendrons, viburnums, and mountain laurels were especially scrutinized.

Plant specimens were collected, labeled, placed in plastic bags, double bagged, and immediately taken to the laboratory for analysis. Small pieces of infected plant material were tested for presence of Phytophthora using an enzyme-linked immunosorbant assay (ELISA) test. Samples were also plated on a culture medium selective for Phytophthora (PARP) and were floated on water in Petrie dishes. Samples testing positive with the ELISA test were further tested for Phytophthora fungi closely related to *P. ramorum* with a polymerase chain reaction (PCR) test. ELISA- and PCR-positive samples were considered "presumed positives" and were sent to the USDA-APHIS in Beltsville, Maryland, for confirmation. DNA from the ELISA and PCR "suspect positive" awaits confirmation by the USDA-APHIS laboratories.

Results and Discussion

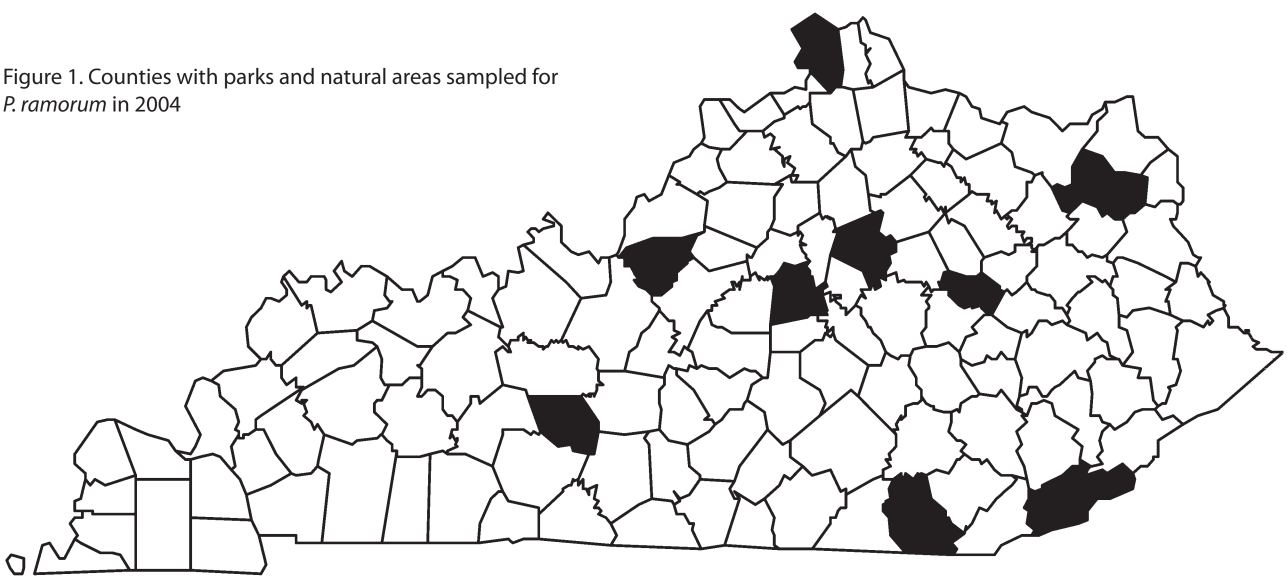
Park and natural area collections were made at the following 11 locations: Bernheim Forest, Big Bone Lick State Park, Carter Caves State Park, Cumberland Falls State Park, Kentucky Horse Park, Mammoth Cave National Park, Natural Bridge State Park, Pine Mountain Settlement School, Shaker Village of Pleasant Hill, Tygart State Forest, and University of Kentucky in nine counties, primarily in central and eastern Kentucky (Figure 1). Collections were made from 51 indigenous plants showing disease symptoms.

In this survey, the following specimens were collected and tested: nine rhododendrons; eight red oaks; five pin oaks; four European beech; three shingle oaks; two each of American beech, azalea, elm, lilac, magnolia, and mountain laurel; and one each of bottlebrush buckeye, chestnut, chestnut oak, chinquapin oak, filbert, hickory, maple, redbud, viburnum, and witch hazel. Of the 51 plant samples taken, three rhododendrons tested positive using the ELISA test and one of those tested positive with PCR. DNA from the ELISA and PCR suspect positive sample awaits confirmation by the USDA-APHIS laboratories. It is likely that this sample, like those in the nursery survey, will also test negative for the disease. No isolates of *P. ramorum* were cultured. This survey suggests that for now, *P. ramorum* infected plants are absent from or are not easily found associated with Kentucky parks and natural areas.

Significance to Industry

This disease of West Coast nurseries could greatly impact the forest industry in Kentucky with broad implications for the Kentucky nursery industry. The Kentucky landscape and nursery industry needs to be made aware of the status of SOD in Kentucky and of the great potential risk this disease is to Kentucky's forest and tourist industry and also to Kentucky's nursery industry.

Figure 1. Counties with parks and natural areas sampled for *P. ramorum* in 2004



Preliminary Evaluation of Cambistat Treatments for Woody Plant Diseases

John Hartman, Jen Flowers, Ed Dixon, and Nicki Mundell, Department of Plant Pathology

Nature of the Work

Landscape tree bacterial leaf scorch (*Xylella fastidiosa*), pine tip blight (*Sphaeropsis sapinea*), and dogwood powdery mildew (*Microsphaera pulchra & Phyllactinia guttata*) are serious diseases of woody landscape plants in Kentucky (1). Cambistat (paclobutrazole) is a plant growth regulator chemical which inhibits synthesis of the plant hormone gibberellin. The chemical is also a weak fungicide. Preliminary evidence suggests that application of Cambistat may improve tree health and reduce the effects of plant disease. Cambistat is applied as a soil drench around the base of the tree and is taken up into the tree systemically. Cambistat effects may not appear until the year after the treatments, but its beneficial effects are thought to last for three years. The objectives of these experiments were to test the efficacy of Cambistat treatments against bacterial leaf scorch, pine tip blight, and dogwood powdery mildew.

Cambistat was applied at labeled rates to the base of mature, disease-susceptible pin oaks (*Quercus palustris*) (20 trees) and red oaks (*Quercus rubra*) (five trees). Each tree was paired with a tree of similar age, placement, and condition which was treated only with water. Both street trees and golf course trees were used in the experiment.

Cambistat treatments were made at labeled rates to 20 mature Austrian pines (*Pinus nigra*) growing in a screen planting. Pines were infected with varying levels of tip blight disease, and matching experimental controls were treated with water.

Sixteen flowering dogwoods (*Cornus florida*) were treated with labeled rates of Cambistat in replicated trials with an equal number of water-treated controls. All applications were made in July 2003.

Results and Discussion

Oaks and bacterial leaf scorch. Oaks were evaluated in October 2003 and in May, July, September, and October 2004. Trees were evaluated for dieback symptoms and for leaf scorch symptoms and assigned a percentage for each. Photographs were also taken. Tree scorch symptoms are highly variable from tree to tree. Some trees are 100 percent scorched while others are showing no scorch. Although the results are not statistically significant, some trends may be occurring. Bacterial leaf scorch symptoms generally increased from 2003 to 2004. Cambistat-treated golf course pin oaks may be increasing in symptom severity more slowly than water-treated trees. Otherwise, trees with bacterial leaf scorch and resultant dieback are not noticeably changing as a result of treatments with Cambistat or water. Although there are no statistical differences in changes in tree condition resulting from bacterial leaf scorch, it may be too early to tell. Data comparing October 2003 ratings with October 2004 are presented in Table 1.

Table 1. Effect of Cambistat treatments on bacterial leaf scorch of pin oaks and red oaks growing as open-field golf course specimens and as street trees.

Species and Number of Trees	Treatment	Range of Symptoms Observed in 2004		Average 1-Year Symptom Increase *	
		Scorch	Dieback	Scorch	Dieback
Oaks Growing in a Golf Course Environment					
Pin Oak - 10	Cambistat	0 - 60%	0 - 10%	1%	1%
Pin Oak - 11	Water	0 - 90%	0 - 30%	8%	2%
Red Oak - 4	Cambistat	0 - 90%	0 - 10%	7%	1%
Red Oak - 4	Water	0 - 75%	0 - 30%	7%	2%
Oaks Growing as Street Trees					
Pin Oak - 10	Cambistat	15 - 100%	5 - 45%	34%	2%
Pin Oak - 10	Water	5 - 100%	5 - 40%	22%	4%
Red Oak - 1	Cambistat	0%	0%	- 4%	0%
Red Oak - 1	Water	0%	15%	- 3%	2%

* Results are not significantly different due to high variability of symptom changes.

Pines and tip blight. Pines were evaluated in July for levels of tip blight disease and for detection of the causal fungus in healthy tissues using PCR assays. Many of the pines continued to deteriorate since 2003, whether treated with Cambistat or not, and several have had to be removed. Average tip blight levels in the remaining trees are not different between Cambistat and water-treated trees. The causal fungus was detected equally in symptomless tissues for both treatments.

Dogwoods and powdery mildew. Dogwoods were evaluated in May and July for effects of treatments on the trees and for powdery mildew. All Cambistat-treated dogwoods showed noticeable phytotoxicity. Bracts did not fully expand in spring, so the trees were noticeably impaired aesthetically. Leaves never did fully expand, but they remained green and presumably functional throughout the season. Water-treated trees did not show any growth abnormalities. Powdery mildew appeared in early summer and reached high levels by midsummer. Cambistat-treated trees showed significantly less powdery mildew.

Significance to Industry

Cambistat treatments are being used for landscape tree disease management by some arborists in Kentucky. There are few data to suggest that the chemical will make an impact on disease. The results of this study will be useful to the Kentucky landscape industry.

Literature Cited

1. Bachi, P.R., J.W. Beale, J.R. Hartman, D.E. Hershman, W.C. Nesmith, and P.C. Vincelli. 2005. Plant Diseases in Kentucky—Plant Disease Diagnostic Laboratory Summary, 2004. UK Department of Plant Pathology (in press).

Evaluation of Tennessee Dogwood Selections for Powdery Mildew, 2004

John Hartman and Edward Dixon, Department of Plant Pathology, UK; and Margaret Mmbaga, Nursery Crops Research Station, Tennessee State University, McMinnville

Nature of Work

Powdery mildew continues to be a problem in Kentucky Landscapes (1). There are several effective fungicides available for use in nurseries and landscapes; there are also some promising resistant varieties becoming available as well.

This test was conducted at the University of Kentucky Horticultural Research Farm and was designed to test the reaction of dogwoods to powdery mildew caused by *Microsphaera pulchra* and *Phyllactinia guttata*. This site was one of several U.S. locations for these evaluations. Having a site in Kentucky was expected to increase exposure of the dogwoods to *P. guttata,* whereas dogwoods at other sites would be exposed primarily to *M. pulchra*. The dogwoods evaluated were selections made at the Nursery Crops Research Station, Tennessee State University, McMinnville, Tennessee. Three-year-old dogwood (*Cornus florida*) seedlings were grown in 3-gallon pots containing a nursery potting mix. Four plants of each selection were transported to Kentucky and were placed in a shade structure and watered as needed with automatic overhead sprinklers. Each of the selections was replicated four times, and plants were arranged in a completely randomized design. Dogwoods were evaluated for powdery mildew by recording percent powdery mildew incidence and severity on Aug. 17 and Oct. 7, 2004. Incidence (percent of the plant's leaves with mildew) was recorded based on presence of both signs of the pathogen and symptoms of the disease (with pathogen signs only visible with the aid of a hand lens). Severity is a measure of fungal activity and is based on percent coverage of the infected foliage with visible signs of the fungus. Percent powdery mildew values were calculated by multiplying the percent incidence by the percent severity. The data were statistically analyzed using ANOVA and Waller-Duncan k-ratio t-test, (K = 100, P = 0.05).

Results and Discussion

In 2004, powdery mildew symptoms and signs were first observed in late June and by August disease pressure was moderately heavy. By the last evaluation, powdery mildew on the dogwood selections ranged from 3 to 43 percent, a level of infection somewhat lower than that found in 2003 (19 to 77 percent). There were significant differences in powdery mildew levels between dogwood selections in both 2003 and 2004 (Table 1). Under Kentucky conditions, selections R-14, 15, 23, and 31 and M-18 and 19 show promise as starting material for more resistant lines.

Table 1. Reactions of Tennessee dogwood selections to powdery mildew.

	Percent Powdery Mildew ** (Incidence x Severity)				
Selection	**10 June 2003**	**16 July 2003**	**25 Aug 2003**	**17 Aug 2004**	**7 Oct 2004**
R-9	40.3 ab***	67.8 ab	defoliated	1.0 c *	43.0 a
R-10	31.3 bc	49.3 c	52.5 b	24.0 a *	3.5 d*
R-14	3.3 f	17.0 d	28.8 c	5.0 bc	16.7 bcd
R-15	21.8 cd	40.8 c	44.0 b	- *	5.0 d*
M-18	8.0 ef	21.0 d	28.0 c	7.5 bc	7.4 d
M-19	11.0 def	15.0 d	19.3 c	5.8 bc	2.7 d
R-23	2.0 f	16.5 d	19.0 c	8.3 bc	10.7 cd
R-25	35.8 b	52.5 bc	54.3 b	4.0 bc*	35.0 ab*
R-31	12.3 def	45.3 c	49.0 b	6.0 bc*	2.9 d
R-33	51.5 a	71.0 a	77.0 a	15.0 ab*	35.3 ab*
R-34	16.3 de	45.3 c	51.5 b	6.0 bc*	33.0 abc*

* Powdery mildew data from 2004 taken on reduced replication (2 or less) for some cultivars due to overwinter damage and death caused by animal pests.

** Percent powdery mildew = % incidence (% of leaves with symptoms and signs of disease) x % severity (% average percent of leaf area with symptoms and signs of powdery mildew).

*** In a column, means bearing the same letter are not significantly different (Waller-Duncan K-ratio test, P = 0.05).

Significance to Industry

With landscape industry concerns about the long-term health of flowering dogwoods during the current powdery mildew epidemic and consumer concerns about the use of fungicides in the landscape, there is a need to evaluate dogwood selections that are less prone to powdery mildew disease. Landscape managers, arborists, and nursery operators will have an interest in knowing if dogwood lines can be found to withstand powdery mildew in Kentucky.

Literature Cited

1. Bachi, P.R., J.W. Beale, J.R. Hartman, D.E. Hershman, W.C. Nesmith, and P.C. Vincelli. 2005. Plant Diseases in Kentucky—Plant Disease Diagnostic Laboratory Summary, 2004. UK Department of Plant Pathology (in press).

Evaluation of Tropical Plants as Annual Ground Covers at the UK Arboretum

Richard Durham and Shari Dutton, Department of Horticulture

The use of tropical plants as annual ground covers has been investigated for several years at the UK-Lexington Fayette Urban County Arboretum. Such plants are being promoted for their rapid establishment, temporary nature, and lower cost for short-term establishment. As mentioned below, under the comments with *Plectranthus*, very vigorous annual ground covers might also be useful in the landscape to compete with undesirable, invasive perennials.

Much of the 2004 growing season was characterized by cooler than normal temperatures and above average rainfall. This led to many plants becoming quickly established after transplanting. Transplants were started from cuttings from stock plants grown in the Department of Horticulture's tropical plant collection. Cuttings were rooted and grown in 3-inch pots prior to transplanting. Most transplanting to the arboretum occurred on May 13 and 14, with plants placed on 8- to 10-inches centers. Plants were evaluated in light shade to sunny conditions. Some of these plants have been evaluated for several years (see Durham and Dutton, 2001, 2002) while others were first evaluated in 2004. Plant evaluations are summarized in the following table.

Literature Cited

1. Durham, R. and S. Dutton. 2001. Evaluation of ground covers at the UK Arboretum. 2001 Nursery and landscape Program Research Report, pages 27-28.

2. Durham, R. and S. Dutton. 2002. Evaluation of tropical foliage and flowering plants as annual ground covers at the UK Arboretum. 2002 Nursery and Landscape Program Research Report, pages 30-31.

Plant Name	**Comments**
Cissus rhombifolia— Grape Ivy	Evaluated over several years with very consistent performance. A bit slow to get started, but once established will quickly grow, spread, and fill. Very glossy foliage to about 10 inches high, no flowers.
Cissus striata— Miniature Grape Ivy	First evaluated in 2004. Much smaller than *C. rhombifolia*, reaching only 2 to 3 inches tall. It did have a tendency to climb up tree trunks but was not competitive with the established plants. Formed a nice, low-growing cover but somewhat slow to fill between plants.
Gibasis pellucida— Tahitian Bridal Veil	Evaluated for several years with consistent growth but inconsistent flowering. Abundant flowers were produced during this season. Plants quickly spread and filled in with a height of 12 to 15 inches.
Mikania ternate—Plush Vine	First evaluated in 2004. These plants were low growing with velvety maroon to purple leaves. No flowers were observed. Plants were slow to spread and did not fill between plants.
Pellionia daveanana— Trailing Watermelon Begonia	First evaluated in 2004. Variegated gray-green foliage was attractive but plants did not spread well.
Pilea depressa—Depressed Clearweed, Babytears	First evaluated in 2004. Small-leafed, creeping plant with light green foliage that formed extremely dense growth, especially in full sun. Height to 3 to 4 inches. Inconspicuous flowers were also produced. Appears promising as an annual ground cover.
Pilea nummularifolia— Creeping Charlie	First evaluated in 2004. Similar to *P. depressa*, perhaps better. Foliage was a little larger and hid the inconspicuous flowers that were produced. Very vigorous, rapid spread and fill. Foliage was 4 to 5 inches tall.
Plectranthus australis —Swedish Ivy	First evaluated in 2003. Very attractive light green foliage, no flowers produced. Plants were very vigorous and quickly spread and filled in. Plants grew to 12 to 15 inches tall. These plants were planted over existing *Houttuynia cordata*—Chameleon Plant (which many consider invasive) and competed very well with it.
Tradescantia albiflora albo-vitta—Giant White Inch Plant	First evaluated in 2004. The green and white variegated foliage was attractive early in the season, but older foliage died and turned brown, which detracted from the plant's appearance. Spread and fill was very good with plants reaching a height of about 5 inches.
Tradescantia navicularis —Chain Plant	First evaluated in 2004. Vigorous, but growth remained viney with little branching so plant did not fill in as well as other species.
Tradescantia sillamontana—Teddy Bear Vine	First evaluated in 2004. Compact but viney growth with hairy, silvery leaves and attractive pink flowers. Plants filled in well and reached a height of 8 to 10 inches. Similar problem as with *T. albiflora albo-vitta* in that older leaves browned. Pink flowers improved attractiveness.
Zebrina 'Red Hill'—Flowering Inch Plant	First evaluated in 2004. Very attractive. Greenish-purple foliage with clusters of light pink to purple flowers produced summer long atop plants 12 to 15 inches tall. Very promising. Also very easy to propagate.

Perennial Garden Flower Trials – 1999-2004
University of Kentucky Horticulture Research Farm

Robert Anderson, Kirk Ranta, and Joe Ulrich, Department of Horticulture

Annual and perennial garden flowers have been evaluated for many years at the University of Kentucky. Trials have occurred at the University of Kentucky Arboretum since 1993. These trials were expanded at the Horticulture Research Farm in 1999 and 2000 with grants from the Kentucky Department of Agriculture and the Kentuckiana Greenhouse Association. Grants from the USDA New Crop Opportunities Center allowed expansion of the trials to more than 20,000 square feet of trial gardens in Lexington that have been used from 1999 to 2004.

The collection of perennials in our ongoing trials continues to expand. We have nearly 1,200 individual plants in the perennial trials with more than 225 species and cultivars in the plots at the Horticulture Research Farm in Lexington. Our trials include the Perennial Plants of the Year from the Perennial Plant Association and Kentucky native plants. We now have five years experience with some so our ratings have many observations. However, our ratings should be used only as a guide to determine which perennials you might sell or use in Kentucky landscapes. In general, those that have grown well for two or more seasons are marked as highly recommended (++), recommended (+), or did not perform well on our site or were not hardy (-). Those unmarked need more time to determine a rating.

Photos and details about plant performance are continually added to the Kentucky Garden Flowers Web site at <http://www.uky.edu/Ag/Horticulture/gardenflowers>. You can also go to the UK home page at <http://www.uky.edu> and search for a plant name; you will be directed to the Kentucky Garden Flowers location.

Mexican Hyssop

Agastache 'Tutti Frutti' ('01-'02) (-)

Russian Hollyhock

Alcea rugosa ('03-'04)

Amsonia

Amsonia hubrectii ('01-'04) (**++**)

Amsonia tabernaemontana 'Blue Star' ('03-'04) (**++**) [Ky Native]

Artemisia

Artemisia absinthium 'Huntington Gardens' ('01) (**-**)

Artemisia vulgaris 'Oriental Limelight' ('03-'04)

Aster

Aster apellus 'Triumph' ('00-'03) (**-**), *Aster azureus* ('03-'04) - Sky Blue Aster [Ky Native], *Aster laevis* 'Bluebird' ('00-'04) (**++**), *Aster latiflorus* 'Prince' ('00-'03) (-), *Aster novi-belgii* 'Celeste' ('01-'03)(-), *Aster novi-belgii* 'Purple Monarch' ('01-'03) (-), *Aster novi-belgii* 'Snow Cushion' ('00-'02) (-), *Aster novi-belgii* 'White Swan' ('00-'03) (**+**), *Aster novi-belgii* 'Winston Churchill' ('01-'03) (-), *Aster novi-belgii* 'Woods Purple' ('00-'03) (+), *Aster x frikarti* 'Monch' ('00-'03) (+), *Aster oblongifolius* ('03-'04) [Ky Native], *Aster oblongifolius* 'Raydon's Favorite' ('02 -'04) (++), *Aster simplex* ('03-'04) – Panicled Aster [Ky Native], *Aster tongolensis* 'Wartburg Star' ('03 -'04)

Boltonia asteroides ('00-'04) (+), - Star Flower

Kalimeris mongolica ('01-'04) (**++**) - Star Aster, *Kalimeris mongolica* 'Variegata' ('00-'04) (++) - Star Aster

Astilbe

Astilbe 'Sprite' ('00-'04) (++)

Columbine

Aquilegia x hybrida 'Rose w/White Edge' ('02 -'04), 'Songbird Cardinal' ('02-'04), 'Winky Red & White' ('02-'04)

Indigo

Baptisia leucophaea ('03-'04) [Ky Native], *Baptisia pendula* ('01-'04) [Ky Native], *Baptisia sphaerocarpa* ('03-'04) [Ky Native]

Willowleaf Oxeye

Buphthalum salicifolium 'Sun Wheels' ('00-'03) (**-**)

English Daisy

Bellis perennis 'Galaxy Rose' ('02-'03), 'Rose Border' ('02-'03), 'Tasso Strawberry & Cream' ('02-'03)

Feather Reed Grass

Calamagrostis acutifolia 'Karl Foerster' ('00-'04) (**++**), *Calamagrostis acutifolia* 'Overdam', ('02 -'04) (++) - Variegated Feather Reed Grass, *Calamagrostis brachytricha*, ('02-'04) (++) - Korean Feather Reed Grass

River Oats, Northern Sea Oats

Chasmanthium latifolium ('00-'04) (**++**)[Ky Native]

Garden Mums

Ajania pacificum 'Pink Ice' ('00-'04) (**++**), *Chrysanthemum* 'Hillside Pink' ('01-'04) (+), *Chrysanthemum yezoense* ('00-'04) (+),

Dendranthema grandiflora

Prophet Series – 'Beth' ('04), 'Brandi'('04), 'Dark Triumph'('04), 'Dazzling Stacy'('04), 'Debonair'('04), 'Ginger'('04), 'Golden Helga'('04), 'Golden Spotlight'('04), 'Gretchen'('04), 'Harmony'('04), 'Heidi'('04), 'Helen'('04), 'Helga'('04), 'Janice'('04), 'Jennifer'('04), 'Jessica'('04), 'Linda'('04), 'Legend'('04), 'Marilyn' ('04), 'Natalie'('04), 'Natasha'('04), 'Nichole'('04), 'Okra'('04), 'Patricia'('04), 'Rhapsody'('04), 'Soft Lynn'('04), 'Spotlight'('04), 'Sunny Gretchen'('04), 'Sunny Robin'('04), 'Sunny Ursala'('04), 'Symphony'('04), 'Tabitha'('04), 'Yellow Ginger'('04), 'Yellow Triumph'('04), 'Zesty Barbara'('04),

Showmaker Series – 'Amata Purple'('04), 'Amour Pink'('04), 'Amour White'('04), 'Amour Spider White'('04), 'Argos Orange'('04), 'Caster Yellow'('04), 'Firecracker Yellow'('04), 'Goldfinch Yellow'('04), 'Gothic Purple'('04), 'Iduna Bronze'('04), 'Jason White'('04), 'Minerva White'('04), 'Pluto Red'('04), 'Rio Dark Purple'('04), *Dendranthema rubellum* 'Clara Curtis' ('00-'04) (+), *Dendranthema rubellum* 'Mary Stoker' ('00-'04) (+)

Shasta Daisy

Chrysanthemum (Leucanthemum) x superbum 'Becky' ('02 -'04)(++), 'Thomas Killen' ('03-'04) (++)

Cumberland Rosemary

Conradina verticillata ('02 -'03) [KY NATIVE]

Coreopsis

Coreopsis 'Tequila Sunrise' ('01-'04), *Coreopsis grandiflora* 'Domino' ('02 -'04) (+), *Coreopsis grandiflora* ' Early Sunrise' ('02 -'04) (+), *Coreopsis lanceolata* 'Baby Sun' ('02 -'04) (+) - Lanceleaf Coreopsis *Coreopsis rosea* 'American Dream' ('01-'04) (+), 'Sweet Dreams' ('03-'04), 'Limerock Ruby' ('03)(-), *Coreopsis tripteris* ('03-'04) – Tall Coreopsis [KY NATIVE], *Coreopsis verticillata* 'Moonbeam' ('00-'04) (++), 'Zagreb ('03-'04) (++) – Threadleaf Coreopsis

Montbretia

Crocosmia crocosmiifolia 'Venus' ('00-'02) (-)

Pinks

Dianthus 'Brilliant Star' ('03-'04), 'Sarah' ('03), *Dianthus allwoodii* 'Doris' ('02 -'04), 'Frosty Fire' ('02), 'Helen' ('03) - Allwood Pink, Dianthus caryophyllus 'Rosie Cheeks' ('03), 'Ruby's Tuesday' ('03), *Dianthus deltoides* 'Brilliant' ('01-'04) (++), 'Zing Rose ('03) - Maiden Pink, *Dianthus gratianopolitanus* 'Bath's Pink' ('02-'04) (++), 'Spotty' ('03) - Cheddar Pink

Cone Flower

Echinacea pallida ('00-'04) (+)[KY NATIVE], *Echinacea paradoxa* ('00-'04) (+)[KY NATIVE], *Echinacea purpurea* ('00-'04) (++)[KY NATIVE], *Echinacea purpurea* 'Magnus' ('00-'04) (++), 'Primadonna Deep Rose ('02-'04) (++), *Echinacea simulata* ('00-'04) (+)[KY NATIVE], *Echinacea tennessensis* ('00-'04) (++)

Silver Prairie Grass

Erianthus alopecuroides ('00-'03) [KY NATIVE]

Oregon Fleabane

Erigeron 'Azure Fairy' ('00-'03) (-)

Hardy Ageratum

Eupatorium coelestinum ('01-'04) (++)[KY NATIVE]

Joe Pye Weed

Eupatorium maculatum ('00-'04) (++)[KY NATIVE], *Eupatorium maculatum* 'Carin' ('02-'04) (++), *Eupatorium maculatum* 'Gateway' ('02-'04) (++)

Spurge

Euphorbia dulchis 'Chameleon' ('03-'04)

Hardy Fuchsia

Fuchsia magellanica 'Ricartonii' ('02) (-)

Blanket Flower

Gaillardia grandiflora 'Summer's Kiss' ('03)

Wand Flower

Gaura lindheimeri 'Siskiyou Pink' ('01-'02) (-)

Gazania

Gazania linearis 'Colorado Gold' ('03) (-)

Cranesbill, Hardy Geranium

Geranium 'Dusky Rose' ('00-'02), *Geranium cantabrigiense* 'Blokova' ('00-'02), *Geranium cantabrigiense* 'Karmina' ('00-'04) (++), *Geranium cinereum* 'Ballerina' ('00-'02), *Geranium clarkei* 'Kasmir Purple' ('00-'02), *Geranium maculata* 'Claridge Druce' ('00-'02) (++), *Geranium phaeum* 'Samobor' ('00-'04) (++)

Sneezeweed

Helenium 'Blutentisch' ('03), 'Coppella' ('00-'04) (+), *Helenium autumnale* ('03-'04) [KY NATIVE]

Sun Rose

Helianthemum 'Annabel' ('01-'04) (++), *Helianthemum nummularium* 'Dazzler' ('03-'04) (++), 'Double Red' ('01-'04)

Sunflower

Helianthus angustifolius ('03-'04) [KY NATIVE], 'Gold Lace' ('02-'04) (++) - Swamp Sunflower, Helianthus helianthoides ('03-'04) – Oxeyed Sunflower [KY NATIVE], *Helianthus mollis* ('00-'04) (+) - Downy Sunflower [KY NATIVE], Helianthus occidentalis ('03-'04) – Western Sunflower [KY NATIVE], *Heliopsis* 'Loraine Sunshine' ('00-'04) (++) - False Sunflower

Daylily

Hemerocallis 'Stella d'Oro' ('01-'04) (++)

Alum Root, Coral Bells

Heuchera 'Amber Waves' ('03) (-), 'Amethyst Mist' ('03-'04) (++), 'Purple Petticoats' ('03-'04), *Heuchera x brizoides* 'Bressingham Hybrid' ('01-'04) (+), *Heuchera micrantha* 'Palace Purple' (++) ('00-'04), *Heuchera sanguinea* 'Canyon Pink' ('03-'04), Splendens' ('03-'04) (++)

Garden Hibiscus

Hibiscus moscheutos 'Disco Bell Pink' ('00-'04) (++), 'Disco White' ('00-'04) (++), 'Kilimanjaro Red' ('01-'04) (++), 'Lord Baltimore ('03), 'Ranier Red' ('01-'04) (++), 'Mauna Kea' ('01-'04) (++), 'Etna Pink' ('01-'04) (++), 'Matterhorn' ('01-'04) (++),'Luna Blush' ('04), 'Luna Red' ('04),

Hosta

Hosta 'Francee' ('04), 'Golden Tiara' ('04), 'Patriot' ('04), Pizaz' ('04)

Siberian Iris

Iris sibirica 'White Swirl' ('00-'04) (+)

Crepe Myrtle

Lagerstroemia indica 'Supersonic Mix' ('02-'04) (++)

Tree Mallow

Lavatera thuringiaca 'Barnsley' ('03-'04)

Liatris

Liatris aspera ('03-'04) [KY NATIVE]

Acidsoil Lithodora

Lithodora diffusa 'Grace Ward' ('03)

Statice

Limonium latifolia ('00-'04) (+)

Lobelia

Lobelia speciosa 'Fan Burgundy' ('01-'03) (+)

Maltese Cross

Lychnis coronaria 'Angel Blush' ('01-'04) (+), *Lychnis flosjovis nana* 'Peggy' ('01-'03) (-)

Marshallia

Marshallia grandiflora ('02-'04) (+) - Barbara's buttons [Ky Native], *Marshallia mohrrii* ('02-'04) (+)[Ky Native]

Maiden Grass

Miscanthus sinensis 'Morning Light' ('01-'04) (++)

Bee Balm

Monarda didyma 'Fireball' ('02-'04) - Petite Bee Balm, 'Jacob Cline' ('01-'04), 'Marshall's Delight' ('01-'04), 'Pink Supreme' ('02-'04) - Petite Bee Balm, 'Prairie Night' ('03-'04) (All cultivars severely infected with powdery mildew)

Catmint

Calamintha nepeta 'White Cloud' ('02-'04) (+) - Savory Calamint, *Nepeta* 'Dawn to Dusk' ('00-'04) (++), *Nepeta* 'Subsessilis' ('00-'04) (++), *Nepeta faassenii* 'Six Hills Giant' ('00-'04) (++), 'Walker's Low' ('02-'04) (++)

Evening Primrose

Oenothera macrocarpa ('03-'04)

Ornamental Oregano

Origanum laevigatum 'Herrenhausen' ('01-'04) (++)

Wild Quinine

Parthenium integrifolium ('00-'04) (++)[Ky Native]

Fountain Grass

Pennisetum alopecuroides 'Hameln' ('01-'04) (++)

Beard Tongue

Penstemon barbatus 'Prairie Dusk' ('01-'04), *Penstemon digitalis* 'Husker Red' ('00-'04) (++), *Penstemon fruticosa* 'Purple Haze' ('01-'04)

Russian Sage

Perovskia atriplicifolia ('00-'04) (++), 'Filagran' ('03-'04), 'Little Spire' ('02-'04) (++), 'Longin' ('03-'04)

Fleeceflower

Persicaria amplexicaule 'Firetail' ('01-'04) (+), *Persicaria bistorta* 'Superbum' ('01-'04) (-)

Garden Phlox

Phlox maculata 'Miss Lingard' ('00-'04) (++), 'Natasha' ('00-'04) (++), *Phlox paniculata* 'Becky Towe' ('03-'04), 'David' ('02-'04) (++), 'Jill' ('02-'04) (++), 'Margie' ('02-'04) (++), 'Nicky' ('02-'04) (++), 'Robert Poore' ('02-'04) (++), *Phlox pilosa* 'Eco Happy Traveller' ('02-'03) (-) - Downy Phlox

Painted Daisy

Pyrethrum coccineum 'Giant Red' ('02-'04)

Coneflower

Ratidiba columnifera 'Mexican Hat' ('00-'03) (++), *Ratidiba pinnata* ('03-'04) (++) [Ky Native]

Black Eye Susan, Cone Flower

Rudbeckia fulgida var. *fulgida* ('02-'04) (++), *Rudbeckia fulgida* var. *sullivanti* 'Goldsturm' ('00-'04) (++),*Rudbeckia hirta* ('03) - Black Eye Susan [Ky Native], 'Autumn Colors' ('03), 'Cordoba' ('03), 'Goldilocks' ('03), 'Indian Summer' ('03), 'Prairie Sun' ('03), 'Sonora' ('03), 'Toto Gold' ('03), 'Toto Lemon' ('03), 'Toto Rustic' ('03), (all cultivars of *Rudbeckia hirta* are best considered annuals) *Rudbeckia laciniata* 'Herbstonne' ('02-'04) (++) - Cutleaf Cone Flower, *Rudbeckia occidentalis* 'Black Beauty' ('02-'04) (+), *Rudbeckia subtomentosa* ('00-'04) (++) - Sweet Black Eye Susan [Ky Native], *Rudbeckia triloba* ('00-'04) (++) - Brown Eye Susan [Ky Native]

Meadow Sage

Salvia 'Blue Hill' ('00-'04) (+), 'Blue Queen' ('00-'04) (+), 'May Night' ('00-'04) (++), 'Blue Hill' ('00-'04) (+), 'Snow Hill' ('00-'04) (+), *Salvia lyrata* 'Burgundy Bliss' ('00-'03) (-)

Pincushion Flower

Scabiosa caucasica 'Perfecta Alba' ('00-'04) (+), *Scabiosa columbaria* 'Butterfly Blue' ('00-'02), 'Pink Mist' ('00-'03) (+)

Kaffir Lily

Schizostylis coccinea ('00-'03) (-)

Sedum

Sedum spectabile 'Autumn Joy' ('00-'04) (++), 'Brilliant' ('00-'04) (++), 'Stardust' ('02-'04) (++), *Sedum spurium* 'Vera Jameson' ('00-'04) (++)

Rosinweed

Silphium integrifolium ('03-'04) (++) [Ky Native]

Cup Plant

Silphium perfoliatum ('03-'04) (++) [Ky Native]

Goldenrod

Solidago rugosa 'Fireworks' ('02-'04) (+)

Meadowsweet

Spirea latifolia ('00-'04) (++)[Ky Native]

Prairie Dropseed

Sporobolis heterolepis ('02-'04) (++)[Ky Native]

Stokes Aster

Stokesia laevis 'Blue Danube' ('00-'02) (-), 'Klaus Jellito' ('00-'04), 'Mary Gregory' ('00-'04) (-), 'Omega Skyrocket' ('03), 'Purple Parasols' ('00-'03), 'Silver Moon' (-) ('00-'03)

Mulleins

Verbascum 'Helen Johnson' ('00-'02) (-), *Verbascum* 'Jackie' ('00-'03) (-)

Speedwells

Veronica 'Fascination' ('00-'04) (++), *Veronica* 'Giles van Hess' ('00-'04), *Veronica* 'Goodness Grows' ('00-'04) (+), *Veronica* 'Royal Candles' ('03-'04), *Veronica* 'Spring Dew' ('02-'04), *Veronica* 'Waterperry' ('01-'04) (+), *Veronica* 'White Jolanda' ('00-'04) (++), *Veronica alpinia* 'Alba' ('01-'04) (++), *Veronica austriaca* 'Crater Lake Blue' ('00-'04), 'Trehane' ('03-'04) *Veronica longifolia* 'Sunny Border Blue' ('00-'04) (++), *Veronica peduncularis* 'Georgia Blue' ('01-'04) (+), *Veronica spicata* 'Blue Carpet' ('02-'04) (+), 'Icicle' ('00-'04) (+), 'Noah Williams' ('00-'04), 'Red Fox' ('00-'04) (+), 'Rose' ('02-'04) (+), 'Sightseeing' ('02-'04) (+)

2004 Garden Flower Trials Results of Annual Flower Evaluations by Kentucky Master Gardeners

Robert Anderson, Department of Horticulture, and Master Gardeners from McCracken, Marshall, Warren, Allen, Hardin, Pulaski, Jefferson, Fayette, Boone, and Campbell Counties

Annual and perennial garden flowers have been evaluated for many years at the University of Kentucky. Trials have occurred at the University of Kentucky Arboretum since 1993. These trials were expanded at the Horticulture Research Farm in 1999 and 2000 with grants from the Kentucky Department of Agriculture, the Kentuckiana Greenhouse Association, and the USDA New Crop Opportunities Center.

Demonstration gardens have been established at eight locations across the state. We wish to thank the Extension agents and Master Gardeners at these garden locations for planting, maintaining, and evaluating the annual flowers in these trials.

Purchase Area Master Gardener Garden, Paducah
Marshall Co. Master Gardener Garden, Benton
Warren Co. Master Gardener Garden, Bowling Green
Allen Co. Master Gardener Garden, Scottsville
Hardin Co. Master Gardener Garden, Elizabethtown
Louisville Zoo, Louisville
UK Arboretum, Lexington
Boone Co. Master Gardener Garden, Burlington
Campbell Co. Master Gardener Garden, Highland Heights
Pulaski Co. Master Gardener Garden, Somerset
Wayne Co. Master Gardener Garden, Monticello
Russell Co. Master Gardener Garden, Russell Springs

Selected annual flowers were grown in Lexington and distributed to the demonstration gardens in May. The Master Gardeners and Extension agents planted the flowers in their trial gardens and evaluated them four times during the summer (mid-July, early August, late August, mid-September). All gardens were mulched with wood chip mulch; drip irrigation was used throughout the summer, and plants were fertilized during the summer. Plant performance was evaluated on a 1-to-5 scale with 1 = poor and 5 = excellent. The evaluation was based only on the individual gardener's determination of the quality of the plants. Although personal tastes are reflected in individual evaluations, the overall evaluation was accurate for the plant performance in each garden. The demonstration gardens seem to be a good educational activity for the Master Garden educational program. It is the goal of this program to allow Master Gardeners to see new flowers and compare them to the reliable annual flowers seen in Kentucky gardens.

A few plants performed poorly in the 2004 trials. Some plants of trailing petunia and spreading petunia were infected with stem and root disease at transplanting.

Photos and details about plant performance are continually added to the Kentucky Garden Flowers Web site at <http://www.uky.edu/Ag/Horticulture/gardenflowers>. You can also go to the UK home page at <http://www.uky.edu> and search for a plant name; you will be directed to the Kentucky Garden Flowers location.

Common Name	Scientific Name	Rating
Perilla - 'Magilla'	Perilla hybrida	5.0
Petunia - 'Easy Wave Blue'	Petunia hybrida	4.8
Vinca - 'Titan Polka Dot'	Catharanthus roseus	4.7
Vinca - 'Titan Blush'	Catharanthus roseus	4.7
Vinca - 'Pacifica Magenta Halo'	Catharanthus roseus	4.6
Vinca - 'Pacifica Punch Halo'	Catharanthus roseus	4.6
Vinca - 'Titan Burgundy'	Catharanthus roseus	4.6
Lantana - 'Patriot Dove Wings'	Lantana camara	4.6
Bedding Begonia - 'Harmony Scarlet'	Begonia semperflorens-cultorum	4.6
Bedding Begonia - 'Harmony White'	Begonia semperflorens-cultorum	4.6
Vinca - 'Pacifica Halo Orchid'	Catharanthus roseus	4.5
Vinca - 'Titan Lilac'	Catharanthus roseus	4.5
Bedding Begonia - 'Prelude Pink'	Begonia semperflorens-cultorum	4.5
Bedding Begonia - 'Prelude Scarlet'	Begonia semperflorens-cultorum	4.5
Petunia - 'Easy Wave Red'	Petunia hybrida	4.4
Coleus - 'Lifelime'	Solenostemon scutellarioides	4.4
Coleus - 'Sedona'	Solenostemon scutellarioides	4.4
Petunia - 'Double Cascade Blue'	Petunia hybrida	4.0
Bedding Begonia - 'Hot Tip Pink'	Begonia semperflorens-cultorum	4.0
Nicoletta - 'Nicoletta'	Plectranthus coleoides	4.0
Petunia - 'Dreams Burgundy Picotee'	Petunia hybrida	3.8
Petunia - 'Dreams Rose Picotee'	Petunia hybrida	3.8
Petunia - 'Dreams Sky Blue'	Petunia hybrida	3.6
Heliotrope - 'Atlantis'	Heliotropium arborescens	3.6
Trailing Petunia - 'Superbells Coral Pink'	Calibrachoa hybrida	3.5
Trailing Petunia - 'Superbells Pink'	Calibrachoa hybrida	3.5
Moss Rose - 'Rose Samba'	Portulaca grandflora	3.5
Daisy - 'Comet White'	Argyranthemum frutescens	3.5
Trailing Petunia - 'Million Bells Yellow'	Calibrachoa hybrida	3.4
Daisy - 'Comet Pink'	Argyranthemum frutescens	3.4
Trailing Petunia - 'Superbells Blue'	Calibrachoa hybrida	3.3
Trailing Petunia - 'Superbells Red'	Calibrachoa hybrida	3.3
Trailing Petunia - 'Million Bells Terra Cotta'	Calibrachoa hybrida	3.1

Update of Industry Support for the University of Kentucky Nursery and Landscape Program

The UK Nursery/Landscape Fund provides an avenue for companies and individuals to invest financial resources to support research and educational activities of the University of Kentucky to benefit the industry. The majority of UK Nursery/Landscape Fund contributions are used for student labor and specialized materials and equipment. These investments have allowed us to initiate new research and to collect more in-depth data than possible before.

All contributors are recognized by listing in the annual report and in a handsome plaque that is updated annually and displayed at the Kentucky Landscape Industry Trade Show and in the UK Agricultural Center North Building. Giving levels are designated as Fellows ($10,000 over 10 years), Associates (>$500 annual contribution), 100 Club members (≥$100 annual contribution), and Donors (<$100 annual contribution). Fifteen individuals and companies have contributed or pledged at least $10,000 each over a 10-year period. Those contributing at this level are Nursery/Landscape Fund/Endowment Fellows and can designate an individual or couple as University of Kentucky Fellows and members of the Scovell Society in the College of Agriculture.

The Research Challenge Trust Fund was created by the Kentucky General Assembly as part of the "bucks for brains" program to provide state funds to match private contributions toward endowments to support research. Several Kentucky nursery/landscape industry leaders have seized the opportunity and made a significant and long-lasting impact on research to support our industry. Three named endowments and a general endowment have been established. This year, income from this family of endowments provided more than $12,000 to support research for our industry. Results from many of the research projects in this report were partially supported by these funds.

Named endowments include:

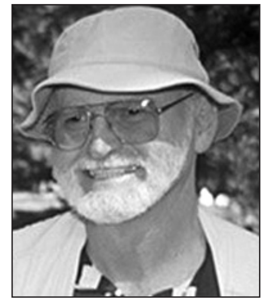
- James and Cora Sanders Nursery/Landscape Research Endowment, provided by the Sanders Family and friends
- Don Corum and National Nursery Products Endowment, funded by Bob Corum
- Ammon Nursery/Landscape Research Endowment, established by Richard and Greg Ammon

The General UK Nursery/Landscape Research Endowment was established with donations from several individuals and companies totaling $34,000, which was matched with state funds.

The Robert E. McNiel Horticulture Enrichment Fund is being endowed to honor Dr. McNiel and to provide support for faculty and student travel on our study tours and for national student competitions. We began in November 2004 the final phase of the campaign to raise the remaining $16,000 required to meet the goal and to secure the $50,000 match from state funds by early 2005. *See a more complete description of this opportunity on the following page, which highlights Dr. McNiel's dedication and years of service with UK Extention.*

Those individuals and companies contributing to the UK Landscape Fund in 2004 (through Nov. 1) are listed in this report. Your support is appreciated and is an excellent investment in the future of the Kentucky nursery and landscape industries.

Contributions to support the UK Nursery/Landscape Program can be made to the annual gift account for immediate expenditure in the program or may be made to any one of the currently established endowments. Also, the Research Challenge Trust Fund is available to provide the 1:1 match for additional endowments. It is possible for several individuals and companies to pool their commitments to be contributed over five years to reach the $50,000 minimum required for a match. For more information on how to contribute to an endowment or the annual giving program, please contact Dewayne Ingram at (859) 257-1758 or the UK College of Agriculture Development Office at (859) 257-7200.



After 28 years of dedicated service as a UK Extension Specialist for Nursery Crops, Robert E. McNiel, Ph.D., will be retiring from UK Cooperative Extension on Jan. 31, 2004. Dr. McNiel has been instrumental in the establishment and continued success of the winter conference (now named the Kentucky Landscape Industries Conference and Trade Show) and the Kentucky Certified Nursery Professional program.

Fortunately, we will not completely lose the talents and dedication of Dr. McNiel in UK Horticulture this year. He has agreed to a part-time, post-retirement appointment for the next three years to conduct research and to advise the Horticulture Club and ALCA Team. However, he will not continue his responsibilities in Extension.

Dr. McNiel's research has focused on pest and weed management related to woody plants and production technologies. His research on economic characteristics of nursery production and the industry in general have been valuable contributions not only to Kentucky but to the cooperating states in a regional project for which he currently serves as chair.

Dr. McNiel has taught courses in plant identification, nursery production, bidding and contracting, and landscape management. He has advised or co-advised the UK Horticulture Club since 1983. He coordinates the club's trips, has organized national and international study tours, and has coached our Associated Landscape Contractors of America student competition teams. During the 1990s, the team hosted two National ALCS Student Career Days.

Since the early 1980s, Dr. McNiel has coordinated educational tours of industry and gardens for Horticulture students. Over 140 students have participated in study tours throughout the United States, Northwest Europe, New Zealand, and China. These activities have advanced Kentucky's nursery and landscape industries, invigorated faculty research program objectives, and broadened students' perspectives through interaction with industry professionals around the world. These study tours allow students to compare technology development at leading horticultural sites and research centers with application to horticulture in Kentucky and to determine the applicability of this technology to the Kentucky horticultural industries. For trip itineraries and details, visit the UK Horticulture Club Web site at <http://www.uky.edu/StudentOrgs/Horticulture>. It is important to note that, often, the travel expenses for Dr. McNiel and other Horticulture faculty who lead these activities have at least been augmented from their personal funds.

To honor Dr. McNiel and his efforts to enhance horticulture education through courses, study tours, and the Horticulture Club, a special enrichment fund has been created. The ***Robert E. McNiel Horticulture Enrichment Fund*** will be endowed to make sure that future students have an opportunity to participate in such study tours and national competitions. Annual proceeds from the endowment will be used to help offset student and faculty travel expenses for these activities. From contributions we have already received and from funds allocated from proceeds from the last ALCA Student Career Days we hosted, the endowment contains $34,000 as of Nov. 1, 2004. Donations totaling $16,000 are needed to secure a match from Kentucky's "Bucks for Brains" program to endow a total of $100,000 for this fund. For ways you can contribute to this fund, please contact Dewayne Ingram at (859) 257-1758 or the UK College of Agriculture Development Office at (859) 257-7200. Join us in this opportunity to honor Dr. McNiel and to support future students wishing to participate in educational tours and activities.

UK Nursery and Landscape Fund and Endowment Fellows

Gregory L. Ammon
Ammon Wholesale Nursery

Patrick A. and Janet S. Dwyer
Dwyer Landscaping Inc.

Robert C. and Charlotte R. Korfhage
Korfhage Landscape and Designs

L. John and Vivian L. Korfhage
Korfhage Landscape and Designs

Herman R.* and Mary B. Wallitsch
Wallitsch Nursery

Lillie M. Lillard and Noble Lillard (In Memoriam)
Lillard's Nursery

Daniel S.* and Saundra G. Gardiner
Boone Gardiner Garden Center

Bob and Tee Ray
Bob Ray Company

Stephen and Chris Hillenmeyer
Hillenmeyer Nurseries

Larry and Carolyn Sanders
James Sanders Nursery Inc.

Robert* and Janice Corum
National Nursery Products

Herman, Jr., and Deborah Wallitsch
Wallitsch Nursery

Richard and Shirley Ammon
Ammon Landscape Inc.

**deceased*

2004 Contributors to the UK Nursery/Landscape Fund and Endowments (Through Nov. 1)

Associates (≥ $500)

Pat Dwyer, Dwyer Landscaping Inc.
Mike Ray, Carl Ray Landscape Nursery
Kit Shaughnessy, Kit Shaughnessy Inc.

100 Club (≥$100)

Joe Calhoun
James J. Eason, Eason Horticultural Resources
Dan R. Ezell
William C. Gardiner II, Gardiner Nursery & Tree Space Co.
Bill Henkel, Henkel Denmark Inc.
Scott Maddox
Frank M. Melton
Glenn Yost

Donor (< $100)

Anthony M. Aulbach
Jerry P. Hart
Dr. Dewayne Ingram

Industry Organizations

Kentucky Landscape Industries Trade Show
Kentucky Nursery and Landscape Association

Appreciation is expressed to the following companies for the donation of plants, supplies, and other materials or project support funds:

Ammon Wholesale Nursery, Burlington
Ball Seed Company, W. Chicago, IL
David Leonard, Consulting Arborist, Lexington
Deibel's Greenhouses, Crestwood
Dow AgroSciences, Indianapolis, IN
DeVroomen Holland, Morrow, GA
Flora Novus, Denton, TX
Friends of the UKREC, Princeton
Everygreen Nursery Company, Inc. Sturgeon Bay, WI
FMC Corporation
Harrell's Fertilizer, Inc, Lakeland, FL
Hillenmeyer Nurseries, Lexington
J. Frank Schmidt Nursery, Boring, OR
Jelitto Perennial Seed, Louisville
Kit Shaughnessy, Kit Shaughnessy, Inc., Louisville
Larry Hanks, Consulting Arborist, Lexington
Oaks Pavers, Cincinnati, OH
Tony and Shelly Nold, Plant Kingdom, ???
Pokon and Chrysal USA, Miami, FL
Rainbow Treecare Scientific Advancements, where?
Song Sparrow, Avalou, WS
Southerland Greenhouses, Paris
Syndicate Sales, Kokomo, IN
The Flower Potts, Kirksey
The Scotts Company, Marysville, OH
Ann Trimble, Trimble's Flowers, Princeton
Jim and Mary Wallitsch, Wallitch Garden Center, Louisville

Grants for specific projects have been provided by:

Kentucky Horticulture Council Inc.
The KentuckyAgricultural Development Board
Central Kentucky Ornamentals and Turf Association
Kentucky Nursery and Landscape Association
Kit Shaughnessy, Kit Shaughnessy Inc.
Louisville Nursery Association
Rainbow Treecare Scientific Advancements
Urban and Community Forestry Program, Kentucky Division of Forestry
UK Integrated Pest Management Program
UK New Crop Opportunities Center
UK Nursery/Landscape Fund
USDA Animal and Plant Health Inspection Service
USDA Cooperative Agricultural Pest Survey

UNIVERSITY
OF KENTUCKY

The College of Agriculture is an Equal Opportunity Organization
Issued 12-2004, 1,200 copies