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UK UNIVERSITY OF KENTUCKY College of Agriculture

PR-571

2008 Research Report of Nursery and Landscape Program

UKAg RESEARCH

Nursery and Landscape Program

Department of Horticulture

UK Nursery and Landscape Program

Faculty, Staff, and Student Cooperators

About Our Cover

Cercis canadensis 'Silver Cloud'—Silver Cloud redbud is an outstanding Theodore Klein selection found in his nursery field of seedling redbuds. The white-on-green foliage is striking and holds up reasonably well through the summer.

The variegation observed in Silver Cloud redbud is most likely the result of a "jumping gene" caused by a transposon. Transposons are pieces of DNA that move from one location to another on a chromosome. If the transposon moves into a gene important for pigment production, that cell is unable to produce that pigment. The resultant irregular patterns show up as blotches, dots, irregular lines, and streaks. Dr. Barbara McClintock won the 1983 Nobel Prize for describing this pigment variegation in corn grains.

This plant is a favorite of all who know it and a particular favorite of J. C. Raulston, which he showed to every visitor he took on tour of the J.C. Raulston Arboretum, Raleigh, NC. In Harrison Flint's book, *Landscape Plants for Eastern North America*, he states that "J.C. Raulston has pointed out that the white-variegated foliage is most effective on vigorous plants under full sun but cool conditions," while Michael Dirr says "best grown in some shade." A number of years ago Bonnie Appleton and others at the Virginia Tech's Hampton Roads Agricultural Research and Extension Center carried out an under-powerlines plant evaluation. 'Silver Cloud' redbud performed well in full sun under what could only be deemed harsh conditions. At the UK Research and Education Center Botanic Gardens in Princeton, KY, it is being grown in full sun on compacted disturbed clay soils, and it has performed well there. Its tolerance of soils and heat is matched by its hardiness, having survived the -24°F of several Kentucky winters. The very old declining original plant at Yew Dell Gardens, Louisville KY, was replaced in 2007. Because of the continuing interest in this plant, once impossible to find, it is now readily available thanks to tissue-culture propagation.

Images can be viewed at http://www.ca.uky.edu/HLA/Dunwell/CerciscanadensisSilverCloudTKPA08.html

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UK Nursery and Landscape Program Overview—2008

Dewayne Ingram, Chair, Department of Horticulture

The UK Nursery and Landscape Program coordinates the efforts of faculty, staff, and students in several departments within the College of Agriculture for the benefit of the Kentucky nursery and landscape industry. Our 2008 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 that generate information applicable to Kentucky. The number of articles in our report this year is less than normal due to three vacant faculty positions in nursery and greenhouse crops and landscape horticulture. 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 we have also highlighted some of our extension programs and undergraduate and graduate student activities that are addressing the needs of the nursery and landscape industries.

Extension Highlights

We have chosen to highlight the Nursery Crops Integrated Pest Management (IPM) Program this year. In 2003, the UK Department of Horticulture began an IPM program for nursery crops in Western Kentucky, led by Amy Fulcher and Win Dunwell. Since 2003 the Nursery Crops Group has received more than $55,000 in IPM grant money, and its work has grown into a statewide program. The goal of the nursery crops IPM program is to provide growers with the information necessary for effective pest control delivered in a precise, sustainable, and environmentally sound manner. The program uses educational programs, nursery scouting, electronic media, and a trap distribution and monitoring program to reach this goal.

Programming—Diverse educational programs were conducted yearly on topics ranging from scouting techniques and pruning to modeling disease incidence. Workshops were often a combination of inside classroom-style sessions and outdoor hands-on sessions. Presenters from nine states representing multiple universities, agencies, nurseries, and consulting firms delivered information on their areas of expertise. This programming afforded Kentucky growers access to the best nursery crop researchers and educators and the most up-to-date information in the country.

Scouting—The nursery crops scouting program began in 2005. Scouting techniques were developed in the initial year and refined over the next three years to include monitoring for soluble salts and pH levels for container crops. Between two and four nurseries per year were scouted on a weekly basis. Nurseries ranged from 5 to 500 acres and spanned 10 counties in Kentucky. The scouts were students from the UK College of Agriculture. The scouting program served a dual purpose: nurseries had an additional means of detecting pest problems as a complement to their own staff and received a weekly report of current pest populations and control recommendations. At the same time, students received hands-on experience identifying pests and using scouting and monitoring techniques and were exposed to the day-to-day operations of the nursery industry.

Information Development—The scouting program generated current trap counts, pest population levels, and damage levels for a range of nursery pests. Pest information from the weekly scouting sessions formed the basis of the *Kentucky Nursery Update* newsletter. This newsletter shared the benefit of timely information generated from scouting visits to all Kentucky producers. A manual on IPM for nursery production was developed and included basic IPM information, scouting techniques and thresholds, pest identification, and pest control information. Additionally, a calendar on IPM for deciduous tree production was developed. The calendar features specific IPM techniques for pests in addition to pesticide recommendations.

Impacts—Through the nursery crops scouting program, two emerging exotic pests, granulate ambrosia beetle and Japanese maple scale, were monitored, in addition to traditional nursery crop pests. Granulate ambrosia beetle has been trapped for three consecutive seasons, including a statewide trapping collaboration with county extension agents in 2008. These data are used to alert growers to the presence of granulate ambrosia beetle in their counties so they may accurately schedule pesticide applications to prevent an infestation. Growers at three nurseries estimated that they protected $34,500 in redbud sales through precisely timed applications in just one season of the scouting program. Due to information disseminated in the *Kentucky Nursery Update*, individual growers not in the scouting program calculated savings at as much as $5,750 per redbud crop per year due to control of this pest.

From 2003 to 2008, attendance at nursery crop IPM programs exceeded 900. Impacts from 2004-2007 include improved plant quality through pest and nutrient management and pruning techniques and reduced pesticide applications. Total economic impact for the state, as estimated by growers, was $1,330,364 ($245,429 in 2004, $363,848 in 2005, $401,780 in 2006, and $319,307 in 2007). Environmental quality at the nurseries also increased. Additionally, improved plant quality in the nursery translates to better plant establishment in the landscape, reduced pesticide use and plant health care costs, and related environmental benefits in landscapes.

Continued IPM funding is only possible through the testimony of growers. Please contact Amy Fulcher afulcher@uky.edu 859-257-1273 or Win Dunwell wdunwell@uky.edu 270-365-7541 ext. 209 to share the benefits you've experienced from an IPM-funded educational program or nursery crops scouting or to document your support for continued programming.

Acknowledgments

The program was modeled after the nationally recognized program initiated by Craig Adkins, area specialized agent, North Carolina State University, and uses *Developing an Integrated Pest Management Program for Nurseries*, publication E-213, from Purdue University.

Undergraduate Program Highlights

The department offers areas of emphasis in horticultural enterprise management and horticultural science within a Horticulture, Plant and Soil Science Bachelor of Science degree. Following are a few highlights of our undergraduate program in 2007-2008.

The plant and soil science degree program had 75 students in the fall semester of 2008, of which one-half were horticulture students and another one-third were turfgrass students. Eleven horticulture students graduated in the 2007-2008 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 UK Horticulture Club and field trips during course laboratories, students have excellent off-campus learning experiences. Here are the highlights of such opportunities in 2008:

- Five students participated in a12-day study tour in the northeastern United States in May, led by Dr. Robert Geneve.
- Horticulture students competed in the 2008 Professional Landcare Network (PLANET) Career Day competition in Atlanta, GA., in March (Dr. Robert Geneve, faculty advisor).
- Students accompanied faculty to the following regional/national/international meetings: the joint Eastern Region/Western Region of the International Plant Propagators' Society; the Kentucky Landscape Industries Conference; the Mid-States Horticultural Expo; the short course sponsored by OFA, Ohio's association for florist professionals; and the summer outing of the Kentucky Nursery and Landscape Association.

Graduate Program Highlights

The demand for graduates with master's degrees or doctorates in horticulture, entomology, plant pathology, and agricultural economics is high. Our master's graduates are being employed in the industry, the 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**.** The excellence of our students is illustrated by Amy Fulcher winning the graduate student competition at the Southern Nursery Association Research Conference.

The Relationship Between Photosynthetic Activity, Container Moisture, and Growth in *Hibiscus rosa-sinensis* L.

Amy Fulcher, Robert Geneve, Jack Buxton, Department of Horticulture, and Richard S. Gates, Department of Biosystems and Agricultural Engineering

Nature of the Work

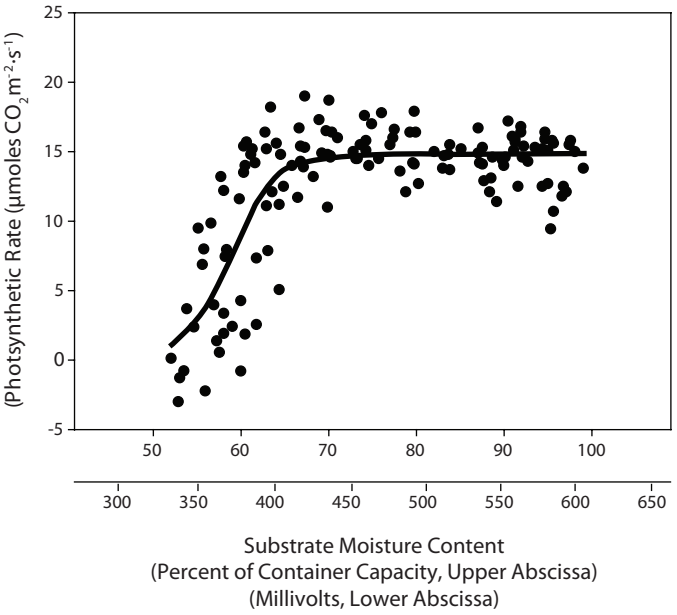
Water is critical to plant survival as a carrier for nutrients and plant hormones, as a substrate in reactions, and as the hydraulic force behind growth. Without sufficient water, photosynthesis, vegetative biomass, and yield are reduced (4). Recently, the nursery industry has been severely impacted by drought (3). Regulations have restricted container irrigation in many major nursery production states, and scientists and nursery producers predict a reduction in water availability for nursery crop production (1).

Various methods can be used to model crop water use. The Penman-Monteith equation, stem heat balance, gravimetric techniques, soil moisture sensors, leaf temperature, and modeling based on empirically-derived plant characteristics have all been used to gauge water loss. However, irrigation technology based on crop models has not been adopted on a large scale by the nursery industry (1). This lack of use is in part due to the diversity of nursery crops and the need to develop individual crop coefficients**.** An irrigation model based on photosynthetic rates as an indicator of plant water status would require a minimum of data collection for model development and could easily be modified for use with other species. The objectives of this study were to develop and evaluate a photosynthesis-based irrigation model for *Hibiscus rosa-sinensis*.

Hibiscus is a readily propagated, fast-growing woody plant that can be grown throughout the year in a controlled environment in Kentucky. Hibiscus has a typical response to decreasing moisture (Figure 1); photosynthetic rates remain high as plant water potentials decline until a critical point where stomates close (2). For these reasons, hibiscus is a good crop for nursery crop irrigation modeling.

Uniform cuttings of *H. rosa-sinensis* 'Cashmere Wind' were potted into trade 1-gallon (3.7 liter) containers (Nursery Supplies, McMinnville, OR) with MetroMix 280 (Sun Gro Horticulture, Bellevue, WA) one month prior to imposing treatments**.** Substrate moisture levels were measured and controlled using ECHO-5 dielectric probes (Decagon Devices Inc, Pullman, WA) connected to a CR1000 datalogger (Campbell Scientific Inc., Logan, UT). Probes were installed perpendicular to the substrate surface, 1.96 inches (5 cm) from the sidewall, with the sensor overmold just below the substrate surface. Plants were watered then allowed to drain to container capacity. To determine the relationship between substrate water content and photosynthetic rate, photosynthesis was measured over a range of increasingly drier substrate moisture contents (100 to 45 % of container capacity) by withholding irrigation. Single leaf gas exchange measurements were taken between 10 a.m. and 3 p.m. with a LI-COR 6400 infrared gas analyzer (LI-COR, Lincoln, NE). Irrigation treatments were selected based on set points for container water content that corresponded to between 100 and 69 % of maximum photosynthetic rates (Table 1). Irrigation valves were triggered when the average probe millivolt reading decreased below the set point. The irrigation valve remained open to deliver the volume of water necessary to return the container to container capacity.

Figure 1. Relationship between substrate moisture content and photosynthetic rate in container-grown Hibiscus. Line is predicted from 136 photosynthetic measurements taken over a range of container water contents. Photosynthesis=14.6844/(1+exp (-(millivolts-361.9237)/15.4806)).



Photosynthesis and leaf water potential were measured three times for each treatment, just prior to an irrigation event. Biomass was determined after 10 weeks, and water use efficiency was calculated as the amount of water used per dry mass accumulation. The experiment used a completely randomized design with four irrigation treatments and eight plants per treatment.

Results and Discussion

The photosynthetic rate remained relatively constant between approximately 11 and 18 µmoles of CO_2 m^{-2}·s^{-1} until plants dried below 60% of container capacity (Figure 1). Sixty percent of container capacity corresponded to a leaf water potential of approximately -1.0 MPa. It is common for photosynthetic rates to remain high as plant water potentials decline until a critical point where stomates close (2).

Table 1. Evaluation of a photosynthesis-based irrigation model.

Setpoint *(percentage of container capacity)*	**Predicted photosynthetic rate** *(μmoles CO_2 m^{-2}·s^{-1})*	**Percentage of predicted maximum photosynthesis**	**Actual photosynthetic rate** *(μmoles CO_2 m^{-2}·s^{-1})*	**Percentage of actual maximum photosynthesis**	**Water use efficiency** *(dry matter/ water applied)*	
					g/l	**lbs/gal**
89	14.7	100	13.9±0.66[z]	100	1.62a[y]	0.014a[y]
81	14.7	100	14.0±0.43	100	2.18b	0.018b
69	14.4	98	13.6±0.52	98	2.32b	0.019b
61	10.3	69	8.17±0.90	58	2.13b	0.018b

[z] mean prediction error is the square root of the summation of squared residuals divided by sample size.
[y] means within a column followed by the same letter were not significantly different (Tukey's HSD a = 0.05).

Four irrigation set points between 89 and 61 % of container capacity were established to evaluate the hypothesis that plant growth would not be affected by reduced substrate moisture until photosynthesis also declined. A photosynthesis-based irrigation model assumes that photosynthetic rate is a sensitive indicator of the water status of the plant, that growth would not be compromised due to a transient reduction in plant water potential, and osmotic adjustment, if it occurred, would only benefit plants grown under the model. A sigmoidal curve (r^2 = 0.62) was used to predict photosynthetic rates at each set point (Figure 1). The greatest variability occurred in the steepest part of the curve. For example, a range of substrate water contents from 58 to 63 % corresponded with a range of predicted photosynthetic rates from 6.9 to 12.6 μmoles of CO_2 m^{-2} ·sec^{-1}; however, a 20% span in the flat portion of the curve—for example, 69 to 89 % of substrate water content—corresponded with a range of just 14.4-14.7 μmoles of CO_2 m^{-2} ·sec^{-1}. The actual photosynthetic rates followed the predicted trends as indicated by percentage of maximum photosynthesis and mean prediction error (Table 1). However, the driest treatment did show a lower photosynthetic rate than was predicted, as might be expected, because this set point corresponds to the variable portion of the photosynthetic rate curve.

Photosynthetic rate, stomatal conductance, transpiration rate, and leaf water potential were not different for plants in the three wettest irrigation treatments but were reduced in the driest treatment (data not shown). Plants grown under the wetter treatments used 1.4, 1.2, and 1.05 times more water during the course of the experiment than plants in the driest treatment. Average total dry mass accumulation was 20.5, 22.3, 21.2, and 18.7 grams for the plants at the 89, 81, 69, and 61 % of container capacity treatments, respectively. It is possible that a more severe reduction in dry mass did not occur for the driest treatment because plants were not subjected to a constant water deficit but rather maintained a container moisture content comparable with the other treatments for most of each irrigation cycle. Water use efficiency was significantly greater for the three driest treatments compared to the wettest treatment (Table 1). These data show that conservative irrigation schedules are possible without incurring a growth "penalty."

A photosynthesis-based irrigation model was developed and evaluated for container-grown *Hibiscus rosa-sinensis*. Substantial water savings without a significant decrease in growth was achieved by selecting irrigation regimes for efficient water use. This research demonstrates a novel basis for irrigation that could be adopted by the nursery industry with minimal development of species-specific prerequisite data and with the potential for considerable water savings.

Significance to the Industry

Water is a crucial resource in nursery crop production. Recent water shortages have made production difficult for horticultural enterprises. Identifying an irrigation model that uses water efficiently and that would be readily adoptable by growers would reduce excess water use, avoid nutrient leaching, and allow growers to better cope with drought. The proposed irrigation model uses photosynthesis as a sensitive gauge of plant water use. It is derived with a minimum of empirical data and uses a simple system to evaluate the use of container water content to trigger irrigation valves. It was determined that irrigating at the point prior to photosynthetic rate reduction decreased water usage without reducing hibiscus growth.

Acknowledgment

The authors wish to acknowledge Leah Dougherty, Sharon Kester, Amy Poston, and Sarah Stolz for their assistance.

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Effect of Physical Manipulation and Plant Growth Regulator Application on Branching of Oak, Linden, and Kentucky Coffeetree

E. Michelle Senn, Amy Fulcher, and Robert Geneve, Department of Horticulture

Nature of the Work

Red oak (*Quercus rubra*), littleleaf linden Shamrock® (*Tilia cordata*), and Kentucky coffeetree (*Gymnocladus dioicus*) are trees currently produced by the nursery industry. However, training these tree species to a high quality canopy can be challenging. Nursery producers have identified species-specific challenges to developing ideal canopy characteristics and branch structure. For example, growers often experience difficulty developing well-spaced branches on red oaks. Oaks have multiple lateral buds immediately subtending the terminal bud, which develop into clusters of branches. These branch clusters alternate with unbranched sections of the central leader. In lindens, the primary branches are often a mix of very short, somewhat stunted branches and very long, vigorous branches, which creates an unbalanced, asymmetrical appearance. Coffeetree is a particularly challenging species because few branches develop on young trees in production, making it difficult to develop a full canopy.

A naturally occurring hormone in plants, auxin, is known to inhibit branching. Auxin moves downward from the stem apex through the plant, repressing lateral bud break (1). This process is termed *apical dominance*. In order to decrease the amount of auxin and thus stimulate branching, nursery growers head back (prune out) the central leader of trees, removing the primary source of auxin. Another hormone involved in branching is cytokinin. Cytokinin stimulates cell division and branching. The auxin-to-cytokinin ratio is important in regulating shoot and root growth and, as such, plays an important role in branch development.

Plant growth regulators (synthetic plant hormones or inhibitors of naturally occurring plant hormones) have been used on woody plants. They are used on fruit trees to increase budbreak (6). Some plant growth regulators are also used to increase compactness and increase shoot growth (4). Plant growth regulators have also been used to stimulate flushes of growth (5). However, using plant growth regulators has not been widely adopted by the nursery industry.

Nursery producers often use labor-intensive pruning techniques to manipulate branch architecture. Heading back cuts are commonly made to increase branch number (3). Pruning is frequently used during shrub production to control size and create more dense plants. However, labor is increasingly expensive and the effectiveness of heading back cuts in ornamental tree production has not been researched thoroughly. In addition, less common training techniques, such as whipping and notching, have been tried on a very limited basis (2).

The objective of this study was to determine the effectiveness of heading back cuts, other physical manipulations, and a plant growth regulator on branch architecture of three trees in pot-in-pot production.

All plants were received as bareroot liners. The oaks and lindens were potted into 15- and 7-gallon containers, respectively, in the spring of 2007, and the coffeetrees were potted into 7-gallon containers in spring of 2008. All plants were potted with Barky Beaver Professional Grow Mix (Barky Beaver Mulch and Soil Mix, Inc., Moss, TN), a pine bark-based substrate. The trees were placed into pot-in-pot production the year of potting. Plants were fertilized with 19-4-8, five-to-six month release fertilizer (Harrell's Fertilizer Inc., Lakeland, FL). The plants in 7-gallon containers received 100 grams per plant and those in 15-gallon containers received 200 grams per plant. Trees were irrigated as needed with micro-irrigation emitters.

The initial caliper and branch number were taken on April 3, 2008. On April 18, 2008, all treatments were imposed except for the application of Maxcel®, a synthetic cytokinin, (Valent Corp., Richardson, TX), which was applied on May 23, 2008, at a concentration of 2,500 parts per million. All species were subjected to MaxCel®, heading back (pruning out the top 4" of the central leader to a healthy, lateral bud), and untreated control. Additional treatments were assigned to each species based on addressing the particular challenges for that species: the oaks were subjected to rubbing out the subtending buds, the lindens to whipping, and the Kentucky coffeetrees to sanding and notching.

The oaks tend to have well developed branches. However, the branches tend to be unevenly spaced and grow in clusters. Other research has shown that rubbing out the lateral buds subtending the terminal bud can enhance branch development on oak trees (Dan Struve, personal communication). On lindens, there is disparity in branch length and vigor. By removing all branches (whipping), the canopy will be composed entirely of new branches that will develop with the support of a relatively large root system. Kentucky coffeetrees often develop few branches during production. Notching interrupts auxin flow, relieving the lateral buds from apical dominance. In the notching technique, a small cut is made above the lateral buds. It is important not to cut so deeply that the xylem is severed. Sanding was recommended by a nurseryman as a technique to stimulate budbreak on coffeetrees (Gary Phelps, personal communication). The sanding treatment involved rubbing sand paper (100A grit) over the buds while the trees were dormant. Swollen buds were not sanded due to the risk of damaging them.

On May 30, the MaxCel® treated plants were rated on a scale of 1-5 for phytotoxicity (data not shown). On June 10, the trees received a treatment of Snapshot® to reduce the germination

of weed seeds. The final branch count was conducted on July 29, 2008. The quality of the canopy was rated on a scale of 1 to 3. A rating of 1 was given when a tree had an asymmetric, light canopy. A tree was rated as a 3 when the canopy was very dense and had branches that were evenly spaced. The final caliper was taken on August 15, 2008.

Results and Discussion

No treatment significantly increased the gain in primary branches or the final number of primary branches. For red oaks the increase in branch number was variable, ranging from 0 for heading-back cuts to 4.9 for rubbing out the subtending buds. For Shamrock® linden, the increase in branch number ranged from 2.2 for the whipping treatment to 4.4 for untreated control and the heading-back treatments. As might be expected, few branches developed on Kentucky coffeetree, regardless of treatment. The average increase in branch number ranged from 1.2 for headed back and MaxCel®-treated plants to 1.7 for notched plants.

There was no significant difference in final caliper or gain in caliper for any species. Additionally, the initial caliper measurements were highly uniform within each species. The average initial caliper was 16.7, 19.0, and 18.7 mm, and the average increase in caliper was 5.25, 6.3, and 2.6 mm, for red oak, Shamrock® linden, and Kentucky coffeetree, respectively.

The time to apply each treatment and general lack of a significant effect on branch number and/or quality suggests that these techniques are not a useful tool for nursery producers on these species. However, in the case of notching and sanding, the technique may not have been performed correctly, and further refinement of the technique could be effective in stimulating branching. The application of MaxCel® plant growth regulator caused significant phytotoxicity on the lindens. The oaks were much less affected, and the coffeetrees were not affected (data not shown). On lindens, the leaves appeared to be scorched and had dark spots on the underside of the leaves. Eventually many of the leaves abscised. At the end of the season, headed-back and MaxCel®-treated plants had a significantly better quality than the whipped plants (Table 1). Additionally, the growth that occurred on the whipped plants consisted of non-typical foliar shape and size for the cultivar, possibly due to juvenility. For this reason, the lindens could not have been sold as true to type. Interestingly, plants that were whipped had the same number of primary branches by the end of the summer as plants subjected to the other treatments.

Table 1. Canopy quality ratings (1-3; 3 being the highest quality) for three tree species subjected to branch-inducing treatments.

Treatment	Oak	Linden	Coffeetree
Untreated	2.1	1.8ab[z]	2.4
Head Back	2.0	2.2b	1.6
MaxCel	2.0	2.3b	2.2
Notch	-	-	2.5
Rub Out	2.1	-	-
Sand	-	-	1.9
Whip	-	1.3a	–
ANOVA P Value	0.9479	0.0123	0.0507

[z] means followed by the same letter were not significantly different (Tukey's HSD α=0.05)

There was no increase in branch number due to any treatment. With the exception of the lindens, treatments did not significantly influence tree quality. These data suggest that the common practice of heading back trees to stimulate branching and/or increase quality may not be consistently effective on red oak and coffeetree and warrants a more thorough examination on other species.

Significance to the Industry

Deciduous shade trees are an important segment of the nursery crop industry in Kentucky. Developing high quality trees efficiently could increase profits. Heading back and other more novel techniques to control branching were determined to be ineffective at stimulating branching on these recalcitrant species. Growers may want to examine the costs and benefits of these techniques on certain species.

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Natural Season, Container-Grown Garden Mum Production

Stephen Berberich and Rebecca Schnelle, Department of Horticulture

Nature of the Work

An on-farm, container-grown garden mum production demonstration was conducted in Lincoln County in 2008. The grower/cooperator produced 500 garden mums to be marketed through the Lincoln County Produce Auction. On-farm demonstrations are conducted to help new and existing growers understand and apply technologies of profitable production systems. The purpose of this natural season mum plot was to demonstrate cultural practices necessary for successful outdoor garden mum production using drip irrigation and proportional fertilizer injectors.

For this demonstration, labor and daily management of the crop was provided by the cooperator. Since this small grower used unpaid family labor for production of this crop, it is not included in the budget. The extension associate made regular visits to the plot to assess progress of the crop and make recommendations. The county extension agent scheduled and coordinated a field day at the site.

In preparation for the demonstration, a sample of irrigation water was analyzed at the UK Regulatory Services lab and the fertigation program was devised. The alkalinity and conductivity was determined to be acceptable for production of container-grown plants. However, calcium and magnesium were extremely low and needed to be supplemented.

A 30 x 100 ft. plot adjacent to the greenhouse was covered with black woven polypropylene ground cover (DeWitt Company, Sikeston, MO 63801) and drip irrigation lines with pressure compensating emitters (Netafim USA, Fresno, CA 93727) were installed for 30-inch center distance spacing of pots. A 1:100 ratio proportional fertilizer injector (Chemilizer Products, Inc., Largo, FL 33770), along with appropriate filters, regulators, and valves, was installed.

Liners of four garden mum cultivars, *Chrysanthemum x morifolium* 'Urano Orange', 'Camino', 'Novare Yellow', and 'Terano Yellow', were received in 144 cell trays. On June 1 the liners were transferred to 12-inch mum pans (Nursery Supplies, Inc. Classic 1200S) in SunGro Metro-Mix 560 Coir (SunGro Horticulture Distribution Inc., Bellevue, WA 98008). On June 4, the plants received Banrot drench (Scotts Company LLC, Marysville, OH 43041) at label rate as a preventative treatment for root rot diseases.

20-10-20 plus micros water soluble fertilizer (Miller Chemical & Fertilizer Corp., Hanover, PA 17331) was used as the primary fertilizer for the continuous liquid feed program. The plants were fertigated as needed throughout the growing season. Fertilizer concentration was 150 ppm N for weeks one and two, 400 ppm N for weeks three through six, and 325 ppm N for weeks six through ten. For the remainder of the growing season, the plants were fertigated every third day with potassium nitrate at 200 ppm N. Calcium and magnesium were provided by weekly applications of calcium nitrate at 1 pound per 100 gallons water and biweekly applications of magnesium sulfate at 1 pound per 100 gallons of water. The EC of the container media was checked regularly by pour-through media analysis in an attempt to maintain an EC value between 1.5 and 2.0 mS/cm. Media samples were sent to the lab for analysis the second week of each month.

Results and Discussion

This was a successful crop for the grower/cooperator, and he intends to grow a similar quantity next year. The average price for garden mums sold at the Lincoln County Auction was down slightly in 2008 compared to 2007, but this appeared to be from oversupply, not poor quality. Even though garden mums are not a high value crop, they have the potential to be profitable. They are a very important fall flower crop for greenhouse growers selling at the produce auction, so growers generally try to differentiate their product by producing larger, better quality mums. Although production costs may vary considerably from grower to grower, a new grower can use the costs listed below as a good estimate of the typical costs associated with mum production (Table 1, page 12).

Acknowledgements

We would like to thank Lloyd Schrock, Lincoln County Produce Auction manager, and Dan Grigson, Lincoln County agriculture extension agent, for supporting this demonstration and Darrell Slone for logistical support.

Table 1. Production budget for 500 natural-season, container-grown garden mums in 2008.

	Qty	Unit	Price per unit	Total
Sales				
12-inch	500	each	$4.30	$2,150.00
Total sales				**$2,150.00**
Expenses - Variable				
Liners (144 trays)	500	each	$0.33	$165.50
12-inch mum pan (Nursery Supplies C1200S)	500	each	$0.55	$274.04
Media (2.8 cu. ft. Metro Mix 540 coir)	51	bags	$7.30	$372.30
Fertilizer (20-10-20, 15-5-15, calcium nitrate, magnesium sulfate, potassium nitrate)	58.2	pounds	$1.02	$59.38
Fuel	17	gallons	$4.00	$68.00
Marketing fees (10%)				$215.00
Total Variable Expenses			$1.25	**$1154.21**
Expenses - Fixed (prorated over five years)				
Woven ground cover	3000	ft^2	$0.05	$30.00
Fertilizer injector (Chemilizer 11GPM)	2	each	$195.00	$78.00
Misc. PVC fittings, filters, regulators, etc.		each	$100.00	$20.00
Irrigation supplies (lines, emitters, spray stakes)	125	4-way assembly	$2.00	$50.00
Backpack sprayer	1		$110.00	$22.00
pH, EC meters	1		$140.00	$28.00
Total Fixed Expenses				**$228.00**
			Total expenses	**$1382.21**
			Profit (total sales – total expenses)	$767.79
			Profit per plant (profit ÷ total plants sold)	$1.54
			Labor (hours)	
			Installation of outdoor growing area (prorated over 5 years)	2.9
			Production	64.0
			Total labor	**66.9**
			Return per hour (profit ÷ total labor)	**$11.48**

Natural Season, Container-Grown Garden Aster Production

Stephen Berberich and Rebecca Schnelle, Department of Horticulture

Nature of the Work

An on-farm, container-grown garden aster production demonstration was conducted in Lincoln County in 2008. The grower/cooperator produced 750 garden asters to be marketed through the Lincoln County Produce Auction. Asters, like garden mums, are less capital intensive than most floricultural crops, as they can be produced without a heated structure. Although there are many new garden mum cultivars introduced every year, there still are none available with blue flowers, so the true blue color of asters creates interest and enhances fall sales.

On-farm demonstrations are conducted to help new and existing growers understand and apply technologies of profitable production systems. The purpose of this natural-season aster demonstration plot was to show that, with the correct cultural practices, asters can be successfully produced and marketed as a companion to garden mums. This demonstration addressed production issues that had the potential to cause a reduction in sales due to poor quality.

At the onset of this demonstration, the grower's primary concerns were control of powdery mildew and rust diseases, root rot diseases, proper fertilization and plant size, and crop timing. These issues were addressed by closely monitoring plant nutrient status and regular preventative applications of appropriate fungicide. Production of quality garden asters depends on proper cultural practices and control of production costs.

For this demonstration, labor and daily management of the crop was provided by the cooperator. Since this small grower used unpaid family labor for production of this crop, it is not included in the budget. The extension associate made regular visits to the plot to assess progress of the crop and make recommendations. The county extension agent scheduled and coordinated a field day at the site.

In preparation for the demonstration, the irrigation water was analyzed at the UK Regulatory Services lab, and the fertigation program was devised. The alkalinity and conductivity were determined to be acceptable for production of container-grown plants. However, calcium and magnesium were extremely low and needed to be supplemented.

A 40 ft. x 80 ft. plot was covered with black woven polypropylene ground cover (DeWitt Company, Sikeston, MO 63801) and drip irrigation lines with pressure compensating emitters (Netafim USA, Fresno, CA 93727) were installed for 24-inch center distance spacing of pots. A 1:100 ratio proportional fertilizer injector (Chemilizer Products Inc., Largo, FL 33770), along with appropriate filters, regulators, and valves, was installed.

Liners of six garden aster cultivars, *Aster novi-belgii* 'Ballad', 'Celeste', 'Dragon', 'Sloopy', 'Twist', and 'Hazy', were received in 144 cell trays. On June 1 the liners were transferred to 9-inch mum pans (Nursery Supplies, Inc. Classic 550) in SunGro Metro-Mix 560 Coir (SunGro Horticulture Distribution Inc., Bellevue, WA 98008). On June 4 the plants received Banrot drench (Scotts Company LLC, Marysville, OH 43041) at label rate as a preventative treatment for root rot diseases. The plants were treated biweekly throughout the growing season with a foliar fungicide spray of Eagle 20EW or Cleary 3336F at label rate for prevention of powdery mildew and rust diseases.

20-10-20 plus micros water soluble fertilizer (Miller Chemical & Fertilizer Corp., Hanover, PA 17331) was used as the primary fertilizer for the continuous liquid feed program. The plants were fertigated as needed throughout the growing season. Fertilizer concentration was 150 ppm N for weeks one and two and 250 ppm N for weeks three through nine. For the remainder of the growing season, the plants were fertigated every third day with potassium nitrate at 200 ppm N. Calcium and magnesium were provided with weekly applications of calcium nitrate at 1 pound per 100 gallons water and biweekly applications of magnesium sulfate at 1 pound per 100 gallons of water. The EC of the container media was checked regularly by pour-through media analysis in an attempt to maintain an EC value between 1.5 and 2.0 mS/cm. Media samples were sent to the lab for analysis the second week of each month.

Results and Discussion

Overall, this was a very successful aster crop for the grower/cooperator. There was keen interest from buyers at the auction, and asters sold for a higher price than garden mums of similar size. Although there may not be demand for large quantities of asters at the produce auction, returns for a small plot can be attractive (Table 1, page 14). The outdoor production area is relatively inexpensive to install, has a usable life of approximately five years, and can be used for other crops, such as natural-season garden mums.

Armed with the knowledge from this demonstration plot, the grower intends to produce a comparable number of asters next year. The grower did express interest in later flowering cultivars and may incorporate them into the 2009 crop. Additionally, several other growers have expressed interest in producing an aster crop for fall sales after seeing that asters can be produced on a schedule similar to garden mums.

Acknowledgements

We would like to thank Ben Troyer for willingly participating in this demonstration; Lloyd Schrock, Lincoln County Produce Auction manager, and Dan Grigson, Lincoln County agriculture extension agent, for their continuous support of educational programs at the auction and Darrell Slone for logistical support.

Table 1. Production budget for 750 natural-season, container-grown garden asters in 2008.

	Qty	Unit	Price per unit	Total
Sales				
9-inch	750	each	$4.67	$3,502.50
Total sales				**$3,502.50**
Expenses - Variable				
Liners (144 trays)	750	each	$0.40	$297.75
9-inch mum pan (Nursery Supplies C550)	750	each	$0.20	$150.00
Media (2.8 cu. ft. Metro Mix 540 coir)	47	bags	$7.30	$342.19
Fertilizer (20-10-20, 15-5-15, calcium nitrate, magnesium sulfate, potassium nitrate)	87.3	pounds	$1.02	$89.06
Chemicals (Eagle, Cleary 3336)	1.3	fl. oz.	$4.20	$5.38
Marketing fees				$350.25
Fuel	15	gallons	$4.00	$60.00
Total Variable Expenses			$1.25	**$1294.63**
Expenses - Fixed (prorated over five years)				
Woven ground cover	3200	ft^2	$0.05	$30.27
Fertilizer injector (Chemilizer 11 GPM)	2		$195.00	$78.00
Misc. PVC fittings, filters, regulators, etc.			$100.00	$20.00
Irrigation supplies (lines, emitters, spray stakes)	188	4-way assembly	$2.00	$75.00
Backpack sprayer	1		$110.00	$22.00
pH, EC meters	1		$140.00	$28.00
Total Fixed Expenses				**$253.27**
			Total expenses	**$1547.90**
			Profit (total sales – total expenses)	$1954.60
			Profit per plant (profit ÷ total plants sold)	$2.61
			Labor (hours)	
Initial installation of outdoor growing area (prorated over 5 years)				3.3
Production				77.5
Total labor				**80.8**
Return per hour (profit ÷ total labor)				**$24.19**

Resistance of Landscape-Suitable Elm (*Ulmus* spp.) Cultivars to Japanese Beetle, Leaf Miners, and Gall Makers

Cristina Brady, Jennie Condra, and Daniel A. Potter, Department of Entomology

Nature of the Work

The University of Kentucky is one of 15 locations participating in the National Elm Trial to evaluate pest resistance and horticultural characteristics of landscape-suitable elms. We evaluated 20 elm species/cultivars of different provenance for resistance to Japanese beetle, leaf-miners, and gall-makers. We also report a new state record for the invasive European elm flea weevil (EEFW), Orchestes alni (L.), its cultivar preferences, and observations on its seasonal biology.

Twenty elm cultivars were planted in a randomized complete block with five replications. Japanese beetle (JB) defoliation was visually estimated (nearest 10%) by two independent observers in late July, 2006-2008. The number of leaf galls and leaf mines per 100 leaves were counted in 2006 and 2008. An April freeze damaged the first flush of leaves of many cultivars and decimated populations of those pests in 2007. Gall contents were sent to S. Halbert (Florida Dept. of Agric.) for identification. Leafminers were reared for identification. One of the main species appeared to be EEFW, which had not previously been reported in Kentucky. Specimens were sent to R. Anderson (Canadian Museum of Natural History), who confirmed that identification. Observations on life history of EEFW were conducted in 2008.

Results: Cultivar Evaluations

Elms with Japanese provenance, U. *parvifolia* and *U. propinqua*, are relatively resistant to JB, whereas a number of the hybrid cultivars are highly susceptible. Hybrid *U. pumila* × *japonica* are especially susceptible to aphid (*Tetraneura s*p.) pouch galls. American elms as a group are highly susceptible to the agromyzid leafminer, *A. aristata*. All types of elms are susceptible to EEFW (Table 1, page 16).

Observations on *Orchestes alni*

European Elm Flea Weevil was first found in the United States in 2003 and previously reported only from Illinois and Wisconsin (1). Adult EEFW feeding injury and leaf mines made by its larvae were abundant on many of our study trees in 2008 (Table 1). This finding is a new state record for EEFW in Kentucky. The following life history information is based on our 2008 observations.

EEFW probably overwintered as an adult. Weevils appeared in early spring and laid eggs in the mid-vein of young leaves. The mines were serpentine at first but enlarged by later instars to a blotch at the leaf tip. Larvae are legless and cream-colored with a brown head capsule. All mines we dissected (n = 200) contained only one larva. Pupation occurred in the mine; pupae are yellowish with an obvious snout. Adults began emerging from mined leaves in early May. They are usually reddish brown with black spots on the elytra (wing covers), and about 3mm (⅛ inch) long. They are active jumpers. The weevils fed mainly from the underside of leaves, chewing numerous small round "shot holes." Adult damage was greatest on trees with the most mines. Adults were still observed feeding into July. There was only one leaf-mining generation per year. The mines and adult feeding damage were abundant enough to compromise aesthetic quality of susceptible trees.

The hybrid 'Homestead' elm was particularly susceptible to EEFW (and also highly susceptible to JB). Hybrid elms with *U. japonica*, *U. wilsoniana*, or *U. glabra* × *carpinifolia* as a group were the most susceptible to EEFW, although all species of elms were vulnerable.

Significance to the Industry

Our data will help nursery growers, landscapers, and homeowners to choose Dutch elm disease-resistant elms that are also relatively resistant to insect pests. This project revealed that a new invasive pest, EEFW, has become established in Kentucky. Our data set is the first documenting elm cultivar resistance for EEFW and for aphid pouch galls and is the most complete data set for elm resistance to Japanese beetles in the field. Results of this undergraduate research project will be submitted to *Arboriculture* and *Urban Forestry* for publication.

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Table 1. Japanese beetle defoliation and abundance of aphid pouch galls and three species of leaf miners on elm cultivars, 2006–2008.

Species or parentage *(provenance)*	**Cultivar**	**Mean** *(±SE) % JB defoliation*			**Mean** *(±SE) pouch galls per 100 leaves*		**Mean** *(± SE) mines per 100 leaves*			
							A. aristata		**K. ulmi**	**O. alni**
		2006a	**2007**	**2008**	**2006**	**2008**	**2006**	**2008**	**2006**	**2008**
U. Americana	Valley Forge	27±3	28±9	17±13	0	0.2±0.2	77±5	3.8±2.0	0	4.0±1.3
(North America)	Princeton	44±9	25±12	24±12	0	0		2.8±1.5	0	5.4±2.1
	Jefferson	NP	33±34	46±31	NP	0		1.8±1.0	0	0
	New Harmony	22±5	23±7	11±9	2±2	0		3.8±1.9	0	2.0±1.5
	Prairie Expedition	NP	73±14	22±22	NP	0		0	0	5.3±3.5
U.parvifolia	Emer II Allee	7±2	2±2	8±3	0	0.7±0.7	0	0	3.7±3.7	8.7±2.2
(Japan, China, Korea)	Athena	NP[1]	15±7	8±6	NP	0	NP	0	NP	1.0±0.4
	Everclear	NP	13±3	5±6	NP	0	NP	0	NP	5.8±3.8
U.propiqua (Japan)	JFS Bieberich	8±1	18±10	13±10		0.7±0.7		0	0	7.8±1.9
U.wilsoniana (China)	Prospector	32±5	37±30	40±7		1.4±1.4	24±14	0	0	11.6±3.1
Hybrid Cultivars										
U.pumila × *japonica*	Morton Plainsman Vanguard	51±9	71±20	68±35	8.2±3.4	4.8±2.6	2±2	0	9.2±4.2	11.6±6.0
	New Horizon	33±4	20±4	23±5	3.2±0.9	9.4±2.4	12±2.0	0	1.8±1.8	18.4±4.9
U.japonica × *wilsoniana*	Morton Red Tip Danada Charm	43±3	43±8	45±18	1.2±0.7	0.2±0.2	0	0	4.4±2.7	11.2±3.0
	Morton Accolade	42±2	73±8	59±22	0	0	0	0.8±0.4	0	2.4±1.6
U.glabra × *carpinifolia*	Pioneer	63±9	37±9	65±24	0.6±0.4	1.0±0.3	1±1	0	1.6±1.4	13.2±4.3
U.glab × *U.carp* × *U.pumila*	Homestead	69±8	87±10a	66±27	0.4±0.4	1.3±0.6	1±1	0	8.0±5.8	22.8±5.6
U.pumila × *japonica* × *wilsoniana*	Morton Glossy Triumph	46±12	60±7	47±24	2.6±1.9	0.4±0.3	0	0	0	5.2±1.6
U.carpinifolia × *pumila* × *wilsoniana*	Morton Stalwort Commendation	41±4	46±21	60±15	0.3±0.3	0	0	0	0	11.5±5.5
U.glab × *carp* × *pum* × *wil*	Patriot	69±8	41±14	43±7	0.2±0.2	1.5±1.5	13±4	0	1.2±1.2	6.5±1.0
U.carp × *U.parv*	Frontier	22±4	13±5	29±14	0	0	0	0	0	7.8±3.7
2-way ANOVA: (P-value)		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001
Contrast between groups (P-value)										
U.parvifolia + *propiqua* versus *americana*		<0.001	<0.001	<0.001			<0.001	<0.001	ns	<0.01
U.parvifolia + propiqua <wilsoniana		<0.001	<0.001	<0.001						
U.parvifolia + *propiqua* <all hybrids		<0.001	<0.001	<0.001						
U.americana <all hybrids		<0.001	<0.001	<0.001			<0.001	<0.001	0.02	<0.01

[1] NP = Not planted until a subsequent year

Sustainable Management of Soft Scale Outbreaks Using Ant Exclusion

Sarah J. Vanek and Daniel A. Potter, Department of Entomology

Nature of the Work

Soft scale insects (Coccidae) are major pests of trees and shrubs in the urban landscape and an increasing problem in production nurseries. More than a dozen species of soft scales infest Kentucky landscapes, causing severe damage by sucking sap to remove photosynthates and nutrients and by inducing cell necrosis with their phytotoxic saliva. Infestations result in twig dieback, plant stress, and foliar chlorosis.

These insects also excrete copious amounts of sugary honeydew that can accumulate under trees. Removal of such trees is sometimes required to prevent dripping honeydew from damaging vehicles and other structures. Honeydew is also detrimental to plants as a medium for growth of sooty molds. These molds blacken leaves, branches, and trunks and reduce photosynthetic ability (5) as well as the aesthetic value of plants. Honeydew also attracts flies and stinging insects, creating a nuisance and hazard in some settings.

Current treatment methods for scale insects include the use of insecticidal sprays and injections as well as horticultural oils (4). However, these methods are not consistently effective, may be impractical, and have potential drawbacks including high cost, hazard from spray drift, and impact on beneficial insects that may lead to secondary pest outbreaks.

It has long been known that mutually dependent relationships exist between ants and honeydew-producing insects. Ants use honeydew as a source of sugar and nutrients, and in turn, aggressively protect the honeydew producers from predators and parasitoids (2, 6). A number of studies have shown that ant exclusion has a significant negative effect on honeydew-producing pest populations. For example, when toxic bait was used to suppress ant activity in a rain forest facing widespread scale outbreaks, within 12 months there was 100% decline in scale densities where ants had been excluded (1). In comparison, control plots showed higher scale densities for two of the four tree species being monitored. Ant exclusion is used to suppress soft scales in orchards (3) but has not been evaluated for nursery or landscape trees. Our objective was to evaluate ant exclusion as a means of suppressing calico scale, *Eulecanium cerasorum* (Cockerell), on established and recently-transplanted trees.

Large sugar maple trees (12-14 cm trunk diameter) with established calico scale infestations and extensive ant (*Formica* sp.) activity were located at a horse farm near Midway, KY and paired according to levels of infestation. Within each of six pairs, a physical barrier was used to exclude ants from one of the two trees. These barriers were applied to the tree trunks at 1 m height and consisted of burlap, duct tape, and an adhesive substance (Tanglefoot®). Bands were applied May 4, 2008, prior to heavy honeydew production by adult scales. Control trees were not banded. To further ensure ant exclusion, the lower 0.5 m of trunk of each banded tree was sprayed to runoff with bifenthrin (Talstar®), a pyrethroid insecticide. Effectiveness of ant exclusion was evaluated by counting the number of ants that crossed a line on each tree trunk during a five-minute period. Each line was 1.5 m from the ground or 0.5 m above the bands. Ant activity was evaluated on three dates (May 13, June 12, and August 13).

Samples of potential scale predators were collected from each tree by beating branches over a sheet. Eight branches per tree were each struck eight times. Predators were collected from the sheet with an aspirator and stored in alcohol until they could be identified and counted. Green lacewing larvae (Neuroptera: Chrysopidae) were some of the most abundant. To determine whether they prey upon calico scale nymphs, six lacewing larvae were collected from the study site and brought to the laboratory. Eight petri dishes were set up, each with a leaf containing a known number (20-71) of settled scale nymphs and a moist tissue. The six lacewing larvae were each placed in a separate dish, and the remaining two dishes served as controls. The dishes were kept in a growth chamber for two days, and all remaining scale nymphs were then counted.

Scale populations were estimated by counting nymphs on 50 leaves from each tree on October 1. Leaves were selected by first collecting 10 twigs from each tree. Five leaves with minimal physical damage were then selected from each twig. To minimize variability caused by leaf size, scales were only counted within a circular area of 7.1 cm^2 at the base of the leaves. All comparisons between banded and non-banded trees were evaluated using a paired t-test.

Results and Discussion

Evaluation of ant activity on three separate dates (May 13, June 12, and August 13) showed that our exclusion methods were highly effective. Trees with bands had means (± SE) of 0, 1.5 ± 0.7, and 0 ants counted on each date respectively, whereas trees without bands had means of 40 ±11, 18 ± 6, and 33 ± 8, respectively.

Beat sheet samples showed significantly more lacewing larvae and spiders in the absence of ants. Banded trees had an average of 5.5 ± 1.0 lacewing larvae and 6.5 ± 1.5 spiders while non-banded trees had means of 0.3 ± 0.2 and 1.8 ± 0.4, respectively. On average, 67 ± 14% of the scale crawlers were missing from petri dishes with a lacewing larva versus 0% missing from the controls, confirming that larval lacewings prey on calico scale nymphs. Predation of scales by lacewing larvae also was directly observed. Finally, scale populations in the fall were 54% lower in banded trees than non-banded trees (560 ± 172 versus 1206 ± 167, respectively; t = -6.32, df = 5, $P < 0.001$).

Based on our results, we believe that *Formica* sp. ants protect calico scale nymphs from natural enemies such as lacewing larvae, and that ant exclusion can reduce soft scale infestations by allowing increased predation upon scale nymphs. Further research will be conducted to test this conclusion and to identify other natural enemies that might be influenced by scale-tending ants.

Significance to the Industry

This research supports the use of a new and sustainable approach for managing soft scales in the urban landscape. Application of a simple trunk band to exclude ants has potential to increase scale insect mortality from natural enemies and suppress infestations below economic thresholds. This would provide a safe, convenient, and inexpensive management option for landscape managers and homeowners. In nurseries, where banding individual trees might not be practical, the scales' ant bodyguards might be eliminated using broadcast baits.

Acknowledgments

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2008 Landscape Plant Disease Observations from the University of Kentucky Plant Disease Diagnostic Laboratory

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

Nature of the 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 campus in Lexington and one at the Research and Education Center in Princeton. Of the nearly 3,000 plant specimens examined annually, about 40% are landscape ornamentals (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. The laboratory is also using polymerase-chain reaction (PCR) testing which, although very expensive, allows 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 assist in diagnosis, 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. In 2008, approximately 25% of digital consulting cases dealt with landscape and nursery plants.

The 2008 growing season was kinder than the 2007 season, but not by a lot. January had slightly lower-than-normal temperatures and precipitation. February began with destructive severe weather that produced one of the highest tornado totals from a single weather event that the Commonwealth has experienced. A couple of winter weather systems that created an icy situation across the state caused significant branch breakage to many trees and large shrubs. In March there were several heavy rainfall events that created periodic flooding across the Commonwealth, especially along the Ohio River. The first part of April continued with above-average rainfall (the period from October 1, 2007, through April 19, 2008, was the wettest ever recorded during that time in Louisville, with 41.28 inches of rain), but the latter half of the month was relatively dry. Temperatures for April were average. May saw below-normal temperatures and normal rainfall. In June temperatures were above normal and rainfall below normal. Temperatures were below normal and rainfall was above normal in July, but the end of the month saw the beginning of a significant dry period across the state, which has continued through October. The period of August 1 to September 30, 2008, was the second driest for that time frame in the past 114 years.

The abundant rainfall at budbreak and beyond provided optimum conditions for many diseases like scab, anthracnose, black spot of rose, cedar/apple and cedar/quince rusts to be widespread. Bark cracking was also noted in some woody trees and shrubs, due to the 2007 spring freeze and summer-long drought.

Landscape plant diseases were common this year and included those favored by wet spring weather (e.g., leaf spot diseases) and those enhanced by drought conditions in 2007 and 2008 (e.g., cankers, wilts). The following important or unusual diseases were observed:

Deciduous trees

- Ash, buckeye, chestnut, maple oak and sycamore anthracnose (*Discula, Glomerella, Kabatiella, Apiognomonia*) and dogwood spot anthracnose (*Elsinoe*).
- Crabapple scab (*Venturia*)
- Honeylocust and redbud leaf spot (*Cercospora*); birch leaf spot (*Gloeosporium*)
- Dogwood, oak, and crapemyrtle powdery mildew (*Microsphaera, Phyllactinia*)
- Witchhazel leaf blotch(*Phyllosticta*)
- Serviceberry rust (*Gymnosporangium*)
- Oak leaf blister (*Taphrina*) and Actinopelte leaf spot (*Tubakia*)
- Flowering pear, serviceberry, and flowering crabapple fire blight (*Erwinia*)
- Birch, elm, maple, oak, redbud and willow cankers (*Botryosphaeria, Cytospora, Phompsis*)
- Maple and oak bacterial leaf scorch (*Xylella*)
- Redbud and yellowwood wilt (*Verticillium*)
- Dutch elm disease (*Ophiostoma*)
- Dogwood root/crown rot (*Phytophthora*)
- Serviceberry root rot (*Armillaria*)

Needle Evergreens

- Leyland cypress blight (*Seridium*) and canker (*Botryosphaeria*)
- Pine tip blight (*Diplodia*) and needle spot (*Mycosphaerella*)
- Spruce needle cast/blight (*Rhiozsphaeria* and *Stigmina*)
- Taxus root rot (*Phytophthora*)
- White pine and spruce root and collar rot (*Phytophthora*)
- White pine and spruce canker (*Cytospora*)
- White pine decline (physiological)

Shrubs

- Boxwood canker (*Pseudonectria*)
- Euonymus powdery mildew (*Erysiphe*)
- Holly black root rot (*Thielaviopsis*) and canker *(Botryosphaeria*)
- Hydrangea bacterial leaf spot (*Xanthomonas*) and fungal leaf spot (*Cercospora*)
- Hazelnut [filbert] blight (*Anisogramma*)
- Cherrylaurel root rot (*Phytophthora*)
- Tree peony root rot (*Armillaria*)
- Hibiscus Southern blight (*Sclerotium*)
- Rose black spot (*Diplocarpon*), blight (*Botrytis*), spot anthracnose (*Sphaceloma*) and rosette (possible virus, leaf curl mite-transmitted)

Herbaceous Annuals and Perennials

- Hollyhock rust (*Puccinia*)
- Chrysanthemum, petunia, and snapdragon root rots (*Pythium*)
- Coreopsis, impatiens, vinca, and petunia root/crown rots (*Rhizoctonia*)
- Daylily leaf streak (*Aureobasidium*) and thrips injury
- Petunia black root rot (*Thielaviopsis*)
- Pachysandra stem canker and blight (*Volutella*)
- Phlox crown rot (*Fusarium*)
- Hosta root rot (*Phytophthora*) and foliar nematodes (*Aphelenchoides*)
- Osteospermum and zinnia blights (*Botrytis*)
- Geranium bacterial blight (*Xanthomonas*)
- Vinca canker (*Phoma*)
- Portulaca virus symptoms from the papaya mosaic virus
- Peony blight (*Phytophthora*)

Significance to the 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 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 useful information about plant disease provided for landscape professionals.

Literature Cited

1. Bachi, P., J. Beale, J. Hartman, D. Hershman, S. Long, K. Seebold, and P. Vincelli. 2009. Plant Diseases in Kentucky - Plant Disease Diagnostic Laboratory Summary, 2008. UK Department of Plant Pathology (in press).

National Nursery Survey for *Phytophthora ramorum* in Kentucky, 2008

Julie Beale and Sara Long, Department of Plant Pathology; Janet Lensing, Katie Kittrell, and John Obrycki, Department of Entomology

Nature of the Work

Phytophthora ramorum, the cause of Ramorum blight and sudden oak death, continues to be a problem on the West Coast in California and Oregon. This disease, first observed in California in the mid 1990s, causes the widespread death of many oak and tanoak species. Other hosts for this pathogen include camellia, rhododendron, viburnum, lilac, and mountain laurel. Regulations and quarantines have been established to limit the spread of this pathogen, but concerns still remain about potential movement in contaminated nursery stock. Methods of long distance spread of the pathogen include moving plants, plant parts, soil, and water. *P. ramorum* infection and symptom expression takes place when the leaves, shoots, and stems are wet for 12 hours a day for 10 days or more at temperatures between 37-82°F. The Appalachian region is considered to be a high risk area for the establishment of *P. ramorum* because appropriate weather conditions often occur and because several native plant species in the region are identified as hosts.

The National Nursery Survey for *P. ramorum* in Kentucky was continued through the 2008 growing season. This survey, a collaborative effort between the Department of Plant Pathology and the Office of the State Entomologist (Department of Entomology) at the University of Kentucky, and the USDA-APHIS, has been ongoing each year since 2004 (1). Procedures for collecting and testing followed protocols established by the USDA-APHIS-PPQ. Twenty nurseries in Central and Western Kentucky were inspected. Ninety-one samples with foliar symptoms suggestive of general *Phytophthora* infection were collected from 10 counties: Calloway, Daviess, Graves, Hancock, Hardin, Henderson, Hopkins, Jefferson, Oldham, and Union. These samples were double-bagged and sent to the Plant Disease Diagnostic Lab (PDDL) in Lexington for testing. An immunological assay (ELISA) was used to detect the presence of proteins typical of several species of *Phytophthora* as an initial screen of these samples at the PDDL. DNA was then extracted from samples testing positive for general *Phytophthora* infection and were sent to USDA-APHIS approved testing laboratories for further identification via polymerase chain reaction (PCR).

Results and Discussion

Of the 91 total samples collected throughout the state, 22 tested positive for infection by *Phytophthora* species. Extracted DNA from these samples was sent to the USDA-APHIS approved laboratory in Florida or Maryland for further testing via polymerase chain reaction (PCR). The *P. ramorum* PCR test for each of these samples was negative. *Phytophthora ramorum* was not found in the state of Kentucky this growing season. Results are summarized in Table 1.

Table 1. Number and type of plants sampled and results of ELISA assays for *Phytophthora* in general and PCR for *Phytophthora ramorum* during the National Nursery Survey for *Phytophthora ramorum* in Kentucky in 2008.

Plant Species	Number of Samples	ELISA positive-*Phytophthora sp.*	PCR positive-*P. ramorum*
Rhododendron	44	20	0
Viburnum	47	2	0
Total	91	22	0

Literature Cited

1. De Sa, P.B., J. Hartman, J. Lensing, J. Collins, C. Harper, J. Obrycki. 2007. National Nursery Survey for *Phytophthora ramorum* in Kentucky. Research Report of the Nursery and Landscape Program. Agricultural Experiment Station. University of Kentucky. PR-554. P26-27.

National Elm Trial - Kentucky Data, 2008

John Hartman and Ed Dixon, Department of Plant Pathology; Dan Potter, Department of Entomology; Jerry Hart, Physical Plant Department-Grounds; and William Fountain, Department of Horticulture

Nature of the Work

The National Elm Trial was established to evaluate landscape-suitable elm cultivars for disease and insect tolerance and for horticultural characteristics at 15 locations nationwide from California to Vermont and south to Kentucky. Locally, 14 elm cultivars were planted April 13-15, 2005, in a grassy area on the University of Kentucky campus in Lexington. An additional three cultivars were planted in April 2006 and three more cultivars in April 2007. Plots were located south and east of the sports complex across from the The Arboretum entrance along Alumni Drive (North 38 deg, 1 min; West 84 deg, 30 min, elev. 990 ft). The site had been graded for construction some years before and consisted of a mixture of topsoil, subsoil, and construction debris. In the planting, a double-allée, each cultivar was replicated five times and arranged in a randomized complete block design. Additional randomized space was left in each block for elm cultivars to be planted in future years. Trees were staked as needed, watered during dry periods, and all trees were mulched over grass that had been killed with an application of Roundup herbicide.

The 20 elm cultivars planted for this study include the following:

1. 'JFS Bieberich' Emerald Sunshine - *Ulmus propinqua*
2. 'Emer II' Allee - *U. parvifolia*
3. 'Frontier' - *U. carpinifolia X U. parvifolia*
4. 'Homestead' - *U. glabra* X *U. carpinifolia* X *U. pumila*
5. 'Morton Glossy' Triumph - *U. pumila X U. japonica X U. wilsoniana*
6. 'Morton Plainsman' Vanguard - *U. pumila X U. japonica*
7. 'Morton Red Tip' Danada Charm - *U. japonica X U. wilsoniana*
8. 'Morton Stalwart' Commendation - *U. carpinifolia X U. pumila X U. wilsoniana*
9. 'Morton' Accolade - *U. japonica X U. wilsoniana*
10. 'New Horizon' - *U. pumila X U. japonica*
11. 'Patriot' - (*U. glabra X U. carpinifolia X U. pumila*) *X U. wilsoniana*
12. 'Pioneer' - *U. glabra X U. carpinifolia*
13. 'Prospector' - *U. wilsoniana*
14. 'Valley Forge' - *U. americana*
15. 'Princeton' - *U. americana*
16. 'Jefferson' - *U. americana*
17. 'New Harmony' - *U. americana*
18. 'Athena' - *U. parvifolia*
19. 'Everclear' - *U. parvifolia*
20. 'Prairie Expedition' - *U. americana*

Trees came from the nursery in 2005, 2006, and 2007 as bare root transplants about 5-8 ft tall (except 'Jefferson', which was much smaller). Elms in all plots were pruned in early spring of 2008 to eliminate crossing and broken branches and to establish a central leader. In the plots, new mulch was added to existing mulch in early summer, and trees were provided with supplemental water in late summer during a period of drought. In Summer 2008, tree trunk diameters were measured with calipers, and tree height and width were determined. Japanese beetle damage and leaf miner infestations were assessed by entomologist collaborators, and these results are reported elsewhere.

Results and Discussion

Results from the elm plots are presented in Table 1. All of the elm cultivars are increasing in height and/or trunk diameter. Some of the 2008 height observations may have been affected by spring pruning.

Table 1. Size of elms, 2008.

Cultivar number and name from list above	Average trunk diameter, inches dbh*; *(increase from 2007)*	Average height in feet *(increase from 2007)*	Average crown width *(ft)*
1. JFS Bieberich	1.38 (0.05)	12.4 (0.3)	4.8
2. Emer II Allee	1.10 (0.20)	9.8 (1.3)	7.3
3. Frontier	1.00 (0.09)	11.6 (1.0)	5.4
4. Homestead	1.50 (0.16)	10.9 (0.0)	7.1
5. Morton Glossy	1.20 (0.14)	10.3 (0.7)	4.7
6. Morton Plainsman	1.58 (0.16)	11.0 (0.2)	6.7
7. Morton Red Tip	2.02 (0.20)	12.2 (0.8)	7.3
8. Morton Stalwart	1.70 (0.10)	11.6 (0.0)	6.1
9. Morton Accolade	1.36 (0.10)	11.0 (0.5)	5.5
10. New Horizon	1.52 (0.08)	11.9 (1.0)	5.9
11. Patriot	1.55 (0.15)	14.1 (1.5)	6.9
12. Pioneer	1.36 (0.12)	11.3 (0.5)	6.4
13. Prospector	1.52 (0.08)	8.6 (0.0)	6.1
14. Valley Forge	1.38 (0.22)	12.1 (1.6)	6.7
15. Princeton	1.36 (0.18)	14.6 (1.0)	3.9
16. Jefferson	0.78 (0.23)	6.4 (2.2)	2.3
17. New Harmony	1.06 (0.14)	11.3 (0.2)	3.5
18. Athena	0.80 (0.30)	5.3 (1.2)	2.1
19. Everclear	0.55 (0.20)	7.1 (2.3)	1.7
20. Prairie Expedition	0.78 (0.33)	6.3 (1.0)	2.9

* Trunk diameter taken at 4.5 ft except Jefferson, Athena Classic, and Everclear, which are shorter than 4.5 ft and were measured at 0.5 ft.

Significance to the Industry

The widespread use of elms in the landscape has been lost largely due to Dutch elm disease. Knowledge of how elms perform in Kentucky in the face of diseases such as Dutch elm disease, elm yellows, and bacterial leaf scorch and to Japanese beetles, elm leaf miners, and other insect pests will benefit arborists and the landscape maintenance and nursery industries.

Landscape Performance of *Hydrangea macrophylla* Cultivars

Sharon Bale, Department of Horticulture

Over a period of years, six plants of various *Hydrangea macrophylla* cultivars were established in replicated plots in Lexington at the University of Kentucky Horticulture Research Farm and at Quicksand, a University of Kentucky, College of Agriculture substation located in Jackson County. Plants were transplanted when well established in 1-gallon containers. The plots were mulched and watered when needed, using drip irrigation. Plants were fertilized in the spring using Harrell's 18-2-14, a custom formulation for hydrangea, at the recommended rate. The total number of blooms produced by each plant was recorded during the growing season. Plants were grown in full sun.

The following cultivars are those that can be expected to bloom. Number of blooms per plant and number of years that plants are in bloom production are both inconsistent, but some bloom is reliably produced. In 2007 a late freeze severely damaged the plants. In 2008 David Ramsey, Decatur Blue, and Endless Summer 'Bailimer' produced a few buds in the spring and began to set a significant number of buds at the end of October. Although the bloom production was reduced in 2008, these cultivars are still some of the best for the landscape. "Fuji Waterfall' showed a great deal of potential for bloom in 2007 but was damaged by the late freeze and did not produce as well in 2008. Hopefully, the plants will recover.

Expected to bloom in Kentucky

- All Summer Beauty
- David Ramsey
- Decatur Blue
- Domotoi
- Endless Summer™ 'Bailimer'
- Fuji Waterfall
- Nikko Blue
- Oak Hill
- Penny Mac

Inconsistent, Cannot Be Considered Reliable Bloomers, and Hardiness May Also Be an Issue

- Amy Pasquir
- Ayesha
- Bodensee Rose
- Brunette
- Goliath
- Kurohimi
- Lanarth White
- Le Marne
- Madame Emily Mouillère
- Nightingale Purple
- Paris
- Parzival
- Souvenir du President Paul Doumer
- Teller Red
- Tovelit

Plants Viable But No Blooms Produced

- Akishno-Temari
- Benegaku
- Blauer Prinz
- Blue Deckle
- Diadem
- Enziandom
- Fasan
- Frillibet
- Générale Viciomtesse de Vibrayé
- Gertrude Glahn
- Greyswood
- Goliath
- Harlequin
- Holtsein
- Hornli
- Izu No Hana
- Masja
- Midoriboshi-Temari
- Miranda
- Miyama-Yae-Murskie
- Mousmée
- Otaska
- Rotdrössel
- Teller White
- Tödi
- Variegata

Plants That May Not Be Considered Hardy in This Area

- Brestenburg
- Cardinal Red
- Westfalen
- Jogasaki
- Kyosumi
- Altona
- Lilacina

Cultivars That Will Be Evaluated In a New Study

- Big Daddy
- CityLine™ series
  - -Berlin Rabe
  - -Paris Rapa
  - -Venice Raven
  - -Vienna Rawi
- Claudie ppaf
- Endless Summer™ 'BlushingBride'
- Royal Purple
- Sadie Ray
- Sonmarie
- Queen of Pearls™
- Shamrock™
- Shirofuji

Notes from The Arboretum Annual Flower Performance

Sharon Bale, Department of Horticulture

Proven Winners

Each year Proven Winners, a commercial plant grower, supplies The Arboretum with a variety of annual plants for evaluation. We are happy to have these plants and would welcome other brands of plants if offered.

Begonia 'Bellagio Pink' and 'Bellagio Blush'—Unique blooms. Both performed well. We trialed this plant in full sun, which was probably a mistake. I suspect both would have performed better in partial shade. Both are very attractive and deserve a second look, but in a different location.

Chrysocephalum apiculatum 'Flambe Orange' and 'Flambe Yellow'—Plants are low to the ground with small button-type blooms at an effective height of 6-8". Plants do quite well, bloom all season, and tolerate cool weather and drought situations. Not a big show from a distance, but a unique addition to the garden. (Rabbits find them tasty.)

Cleome 'Senorita Rosalita'—Approximately 3 ft in height, this plant is a nice addition to the garden. Plants are uniform in height and bloom consistently throughout the season. They maintain vigor and are still attractive late in the season, while more common cleomes become leggy and unattractive. This is the second year for this plant at The Arboretum, and reseeding does not appear to be a problem.

Euphorbia hypericifolia 'DiamondFrost'—This is the third year for this plant at The Arboretum. It is a consistent bloomer, shows no disease or pest problems, and is simply one of the best. The small white blooms produce an overall good show. I personally don't like the plant in containers because it can get leggy and almost overpower other plants, but as a bedding plant it is hard to beat.

Impatiens Rockapulco 'Apple Blossom', 'Dark Orange', 'Orchid', 'Purple', 'Red', 'Rose', 'White'—Double impatiens that are quite nice. Uniform plants that tolerate full sun. They were a little slow to take off in full sun, but were very nice for most of the season. They would be a group of plants that anyone would like to have as repeat for the garden. Approximately 14" in height, low maintenance, and very florific.

Lantana camara Luscious 'Grape', 'Lemonade', 'Citrus Blend', 'Tropical Fruit'—If you like lantana, any of these plants would be desirable. Just pick your favorite color. 'Grape' is not as vigorous as the others, but still nice.

Petunia Supertunia 'Vista Bubblegum', 'Vista Silverberry', 'Vista Fuchsia', 'Raspberry Blast'—All are very nice, but 'Raspberry Blast' is the star of this group. The bicolor blooms really attract attention. Even though the blooms of this group are smaller in diameter than some petunias, they produce consistent bloom throughout the season. They do not require cutting back or other types of maintenance, and they tolerate some frost. Still in bloom in early November 2008.

Various seed companies supply seed for plants they wish to trial in this area. This is often a way to try new cultivars of plants that generally perform well in this area as well as a way of trying something completely new.

Sakata Seed Company

Ipomoea 'Sunsmile Violet', 'Sun Smile Pink', 'Sun Smile Red', 'Sun Smile Blue'—When the package arrived from Sakata and morning glory seed was a major component, it was scary. There are some morning glories at The Arboretum for class purposes, but they are also a significant weed problem. The thought of planting more morning glory seed with the potential of further increasing the weed population was something to ponder. However, these morning glories are different. They do not vine, the plants are low to the ground, they have variegated foliage, and they appear to be rather tame. I was not aware of this difference in growth habit. These seeds were not planted in a location that would demonstrate their suitability to the garden. We need to try these again, without the fear.

Zinnia 'Profusion Apricot, 'Deep Apricot', 'Orange', 'Fire', 'Cherry', 'White', 'Double Cherry'—They may not be the "cut-and-come-again" type of zinnia, but they are an excellent addition to the garden. They have good bloom production, they grow up and over declining blooms, and disease resistance is excellent.

Benary Seed Company

Begonia x benariensis 'Big Red'—The name is very descriptive. Blooms are at least 1½" in diameter, and the plants are 14-16" in height. These plants are extremely showy and an excellent choice. Other begonia cultivars sent by Benary included 'Lotto Red', also an excellent begonia with large blooms, and 'Sprint Pink' and Sprint White', which were both good begonias. 'Big Red' was the standout, however.

Impatiens wallerana 'Sweetie White', 'Violet', 'Lavender', 'Rose', 'Soft Pink', 'Red', and 'Orange'—Nice impatiens but no better than other cultivars we have tried.

Pentas 'Kaleidoscope Deep Rose' and 'Pink'—12-14" in height, good colors. Require maintenance, as do other pentas.

Ptilotus exaltatus 'Joey'—This was a new plant for us. Looked good in the flat but did not perform well in the garden. It died out early in the season. When we do not have success with a new plant, it is good to try it again to determine that the plant will not grow well in this area or that we did something wrong the first time.

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 in order to benefit the industry. The majority of 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 has been 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 Science Center. 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 to at least $10,000 each over a 10-year period. Those contributing at this level are Nursery/Landscape Fund/Endowment Fellows and may designate an individual or couple as University of Kentucky Fellows and as members of the Scovell & Erikson Society in the College of Agriculture.

A family of five endowments has been established to support the UK Nursery/Landscape program. Four of these are named endowments. 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 the National Nursery Products Endowmen**t, funded by Bob Corum
- **Ammon Nursery/Landscape Research Endowment**, established by Richard and Greg Ammon
- **Robert E. McNiel Horticulture Enrichment Fund**

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

Those individuals and companies contributing to the UK Landscape Fund in 2008 (through November 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 and Landscape Program may 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. Matching funds are available from the state for establishing new endowments or significantly increasing existing ones. 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.

UK Nursery and Landscape Fund and Endowment Fellows

Gregory L. Ammon
Ammon Wholesale Nursery

Richard and Shirley Ammon
Ammon Landscape Inc.

Robert* and Janice Corum
National Nursery Products

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

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

Stephen and Chris Hillenmeyer
Hillenmeyer Nurseries

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

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

Bob and Tee Ray
Bob Ray Company

Larry and Carolyn Sanders
James Sanders Nursery Inc.

Herman R.* and Mary B.* Wallitsch
Wallitsch Nursery

Herman Jr. and Deborah Wallitsch
Wallitsch Nursery

**deceased*

2008 Contributors to the UK Nursery/Landscape Fund and Endowments

(through November 1)

100 Club ($100 or more)

Dr. Jack W. Buxton

Etter Lane Gardens

Lexington Lawn and Landscape LLC

Donors (less than $100)

Dewayne and Pat Ingram

Scott R. Maddox

Earl Thieneman's Green House & Nursery

Industry Organizations

Kentuckiana Greenhouse Association

Kentucky Nursery and Landscape Association

Mid-States Horticulture Expo

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

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Friends of the UK Arboretum

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A. McGill and Son Nursery, Hubbard, OR

Rennerwood, Inc., Tennessee Colony, TX

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Sunny Ray Nursery, Elizabethtown, KY

UK Physical Plant Division, Grounds Department

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Kentucky Agricultural Development Board

Kentucky Horticulture Council Inc.

Kentucky Nursery and Landscape Association

UK Integrated Pest Management Program

UK New Crop Opportunities Center

UK Nursery/Landscape Fund

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