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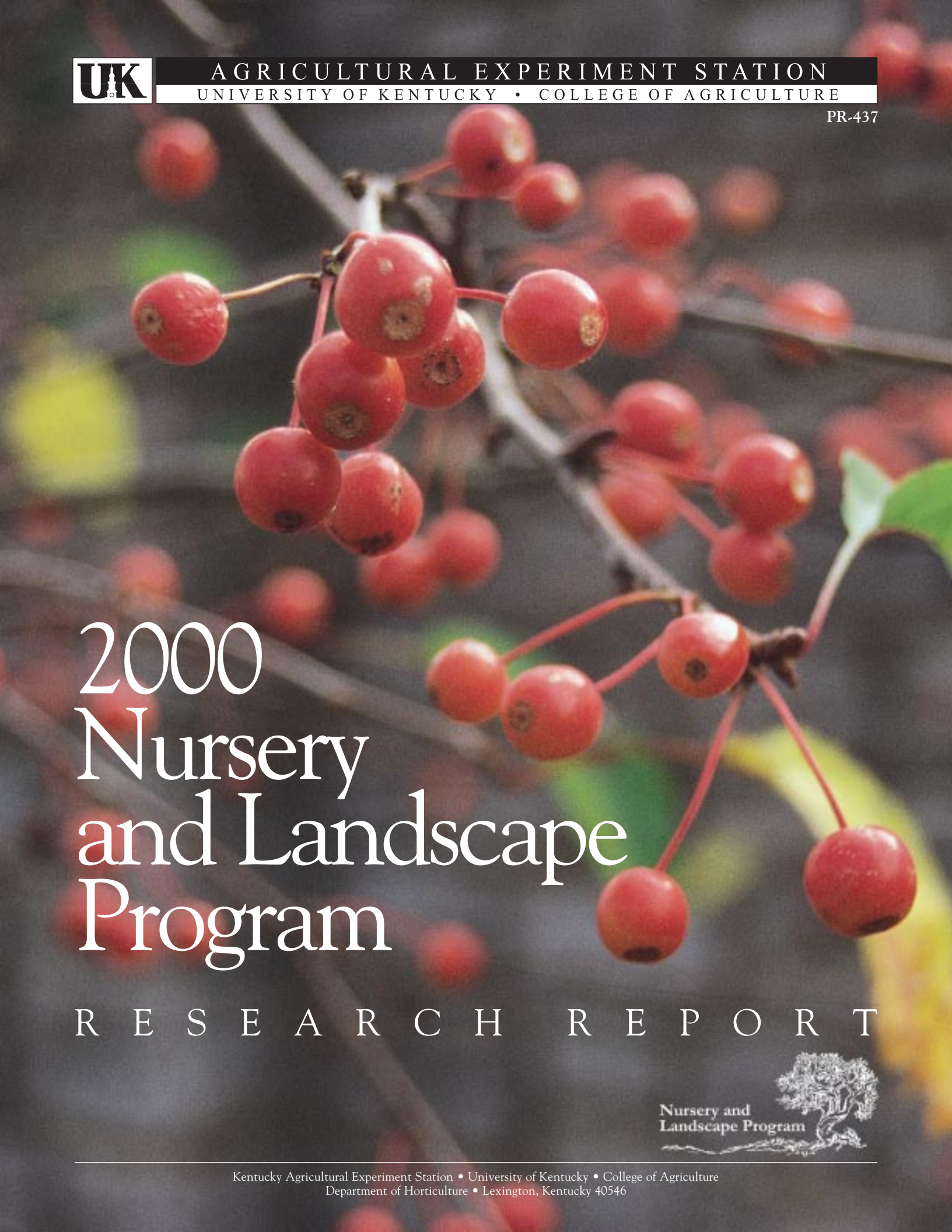

2000 Nursery and Landscape Program

RESEARCH REPORT

Nursery and Landscape Program

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

ABOUT OUR COVER
Large persistent fruit is only one positive attribute of *Malus* x 'Donald Wyman', a Theodore Klein Plant Award Winner for 2001. It is one of the most floriferous of all the crabapples. The plant is impressive in every season with great, 1-inch or larger, single flowers and excellent dark green foliage. This crabapple was named in honor of the late plantsman, author, and Arnold Arboretum horticulturist, Dr. Donald Wyman. The plant has a rounded form frequently found to be slightly wider than tall. A 20-year-old specimen at the University of Kentucky Research and Education Center at Princeton is 18 feet tall by 20 feet wide. UK evaluations have found it to have good resistance to diseases common to crabapples (see Extension publication ID-68, *The Flowering Crabapple* <http://www.ca.uky.edu/agc/pubs/id/id68/id68.pdf>).

UK Nursery and Landscape Program

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Nursery and Landscape Program

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2000 UK Nursery and Landscape Program Overview

Dewayne Ingram, Chair

Department of Horticulture

The faculty, staff, and students in the UK Nursery/Landscape Program are pleased to offer this 2000 Research Report. This is one way we share information generated from a coordinated research program involving contributions from several departments in the College of Agriculture. The 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 programs in neighboring states and around the world generating information applicable to Kentucky. If you have questions and/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 below some of our Extension program and undergraduate and graduate degree programs that are addressing the needs of the nursery/landscape industries.

Extension Highlights

Extension programs targeted to Kentucky's nursery/landscape industry include highly visible activities and some more subtle ones. The statewide and area educational conferences and seminars are probably the most visible. Publications, videos, slide sets, newsletters, articles in state and national industry magazines, newspaper articles, radio spots, and television programs are important, visible elements of our Extension program. However, training for county Extension agents so they can more effectively serve our clientele, the Plant Disease Diagnostic Clinic, soil-testing and interpretative services, and problem diagnosis and solving services are more subtle activities. We are delighted to see that the outreach capacity of the Arboretum on the UK campus increases each year for the industry and consumers.

Although there are many facets of the Extension program conducted by the team of subject matter specialists and county agents, our Home Landscape IPM Program and County Extension Agents for Horticulture are highlighted this year.

A home landscape integrated pest management (IPM) Extension program has been initiated by Richard Durham and William Fountain, Department of Horticulture, John Hartman, Department of Plant Pathology, and Monte Johnson, Department of Entomology, with funding from the Kentucky IPM Program and the UK Nursery/Landscape Fund. The overall goal of this project is to increase awareness in the general public regarding integrated pest management practices appropriate for the home landscape. During the first year, radio scripts have been developed and are being released to county agents for use in local radio programming or modified for release in newspaper columns or as factsheets. An Internet site <http://www.uky.edu/Ag/Horticulture/landipm/index.htm> was developed to highlight the program. An instructional video will be released in January 2001 for use in county and multi-county meetings and in Master Gardener training. The initial emphasis for this program has been trees and shrubs but will be expanded to encompass other aspects of the home landscape, including herbaceous plants, fruits and vegetables, and turf. This IPM Extension program has the potential to draw favorable attention to Kentucky landscape industries and help expand the market through consumer education.

The number of **County Extension Agents for Horticulture** has increased from three to 17 in the last decade due to the significant demand for horticulture educational programs at the county level. Each of the 120 counties has Extension agents for Agriculture, Family and Consumer Sciences and 4-H/Youth Development who are cooperatively funded by state, county, and federal funds. Several of the general agriculture county agents are excellent horticulturists and have served our industries well for many years. Additional agents, such as those specializing in horticulture, are funded entirely by the county. The horticulture agents are primarily located in counties with a large population center, and they target a major portion of their programming to consumers, primarily homeowners. A portion of their time is invested in the educational programs and service support for commercial horticultural industries. Although educational opportunities and the size of each horticultural commodity differ among counties, the commercial landscape horticulture industry is important in each of these counties.

It is important to note that the County Extension Agents for Horticulture are part of the team of faculty, staff, agents, and students addressing horticultural opportunities through education and research. You see many of them working at the KLI Conference and Trade Show and other events. However, I wanted to introduce them to you again here. They are:

Boone County—Michael Klahr
Campbell County—David Koester
Daviess County—Annette Meyer
Fayette County—Candace Harker
Franklin County—Edie Greer
Hardin County—Amy Aldenderfer
Henderson County—Thomas Brass
Hopkins County—Amy Fulcher
Jefferson County—Donna Michael (KSU)
Jefferson County—Vacant
Kenton County—Don Smyers
McCracken County—Kathleen Keeney
Nelson County—Robbie Smith
Pulaski County—Beth Galloway
Shelby County—Tim McClure
Warren County—Michelle Johnson
Woodford County—Patricia Savage

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 2000:

The Plant and Soil Science degree program has more than 110 students in the Fall Semester of 2000, of whom almost one-half are Horticulture students and another one-third are turfgrass students. Six Horticulture students graduated in 2000.

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 2000.

- A three-week study tour of western Europe was led by Drs. McNiel, Dunwell, Geneve, and Buxton involving eight students.
- Horticulture students competed in the 2000 Associated Landscape Contractors of America (ALCA) Student Career Days competition at Mississippi State University in March (Dr. Robert McNiel, faculty advisor).
- Students accompanied faculty to the following regional/national/international meetings, including Southern Region of the American Society for Horticultural Science Annual Conference, Kentucky Landscape Industries Conference and Trade Show, the Southern Nurserymen Association Trade Show, and the Green Industry Expo.

A complete list of students and student activities can be viewed at <www.uky.edu/StudentOrgs/Horticulture>.

Graduate Program Highlights

The demand for graduates with a M.S. or Ph.D. in Horticulture, Entomology, Plant Pathology, Agricultural Economics, or Agricultural Engineering is high. Our M.S. graduates are being employed in the industry, the Cooperative Extension Service, secondary and postsecondary education, and governmental agencies. Last year, there were seven graduate students in these degree programs conducting research directly related to the Kentucky nursery/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. For example, graduate students as well as undergraduates presented research results at the Southern Nursery Association's Research Conference in Atlanta, and several will present posters summarizing their work at the 2001 Kentucky Landscape Industry Conference and Trade Show.

Height Reduction in Container-Grown Passion Flowers Using Bonzi

Bailey Hale, Robert Geneve, Robert Anderson, and Sharon Kester, Department of Horticulture

Nature of Work

Passion flowers, members of the genus *Passiflora*, are among the most beautiful and exotic flowers in cultivation. They are rarely grown outside of botanic gardens and arboreta. Species and hybrids of passion flower range in size from less than ½ inch to more than 6 inches in diameter and come in every color (2). Although a couple of selections of passion flower reach the commercial markets in the United States on occasion (usually *P. x alto-caerulea* or *P. vitifolia*), many attractive species and hybrids have commercial potential to be marketed in a fashion similar to other tropical vines like *Bougainvillea* and *Mandevilla*. Most passion flower hybrids and cultivars are easily grown from cuttings. The limitation to commercial container production of passion flower is controlling the vigorous growth of the vines that can grow a foot or more per week.

There has been limited research on height control in passion flower. Sanderson et al. (1) evaluated several chemicals as foliar sprays and drenches for height control in *Passiflora edulis* and *P. caerulea*. They found significant reduction in height with several materials especially ancymidol on *P. edulis*, but no height control on the more vigorous vines of *P. caerulea*. Bonzi (Paclobutazol, Uniroyal Chemical Co. Middlebury, CT) can be an effective chemical used to control height in a wide range of container-grown plants. The objective of the current study was to evaluate height control in container-grown passion flowers (all with *P. caerulea* parentage) using Bonzi as a container drench.

In the summer of 1999, a variety trial with more than 50 species, hybrids and cultivars of passion flower was conducted at the University of Kentucky Arboretum in Lexington. Among the best performers based on plant habit, flower number, and quality were *P.* 'Blue Bouquet' (*P. caerulea x P. amythestina*), *P.* 'Sapphire' (*P. caerulea x P. edulis*) and *P. x violacea* (*P. caerulea x P. racemosa*). These plants were selected for further evaluation for container production.

In late February, two-node cuttings of each selection were treated with IBA (1,000 ppm in talc) and stuck in Oasis rooting cubes. Cuttings were placed in an intermittent mist bed (5 sec. every 10 min.) with bottom heat (75°C). After two weeks, cuttings were well rooted and moved to 6-inch plastic containers with a peat/bark medium (Scott's 360 Metro mix). Bonzi treatments were applied two weeks after transplanting at 0, 2.5, 5.0, 10.0, 25.0, and 50.0 ppm. Solutions were prepared according to label specifications, and 4 ounces were applied per container. Plants were evaluated after 0, 7, 14, and 21 days for total vine length and number of nodes. Greenhouse conditions were maintained with day/night temperatures of 65/55°F and fertilized with a 100-ppm fertilizer solution (Peter's 20-10-20) at each watering.

Table 1. Mean height (cm) of *Passiflora* 'Blue Bouquet' and *P.* 'Sapphire' treated with six concentrations of Bonzi evaluated at 0, 7, 14, and 21 days after treatment.

Cultivar	Bonzi [ppm]	Days after treatment 0	7	14	21
'Blue Bouquet'	0	38a	60a	93a	125a
	2.5	37a	55a	86a	122a
	5	37a	56a	87a	120a
	10	40a	59a	88a	122a
	25	37a	55a	77b	104b
	50	35a	50b	68c	91c
'Sapphire'	0	20a	31a	50a	69a
	2.5	19a	29a	49a	70a
	5	20a	28a	50a	73a
	10	17a	28a	47a	71a
	25	19a	27a	43b	60b
	50	18a	26a	35c	46c

Means within a column for each cultivar followed by the same letter are not significantly different as determined by Tukey's test at P = 0.05.

Results and Discussion

Significant height reduction was attained with Bonzi at 25 and 50 ppm, with greatest control at the higher concentration (Table 1). At 21 days after treatment with 50 ppm, there was a 28 and 33% reduction in height for *P.* 'Blue Bouquet' and *P.* 'Sapphire', respectively, compared to untreated plants. Regardless of concentration, no reduction in plant height was observed with *P. x violacea* (data not shown).

These data are the first to indicate that height reduction can be achieved in passion flower plants derived from *P. caerulea*. In the study by Sanderson et al. (1), there were no treatments that reduced plant height in *P. caerulea*. Bonzi was not used in their study, but flurprimidol, which has a similar mode of action to Bonzi (paclobutrazol), failed to impact plant height in *P. caerulea* at the concentrations tested (2 and 4 ppm). In the current study, similar concentrations of Bonzi also showed no effect on plant height, but concentrations above 25 ppm did reduce plant height in two of the passion flower selections with *P. caerulea* parentage. However, *P. x violacea* plants were not affected by concentrations of Bonzi up to 50 ppm.

It should be noted that passion flowers bloom on new growth at each node. For this reason, height reduction as a result of fewer nodes would be undesirable. Bonzi treatment had no affect on the number of nodes produced in any of the passion flower selections (data not shown).

Plants of *P.* 'Blue Bouquet' and *P.* 'Sapphire' showed slight to moderate leaf cupping at all concentrations of Bonzi evaluated. The leaves were not unattractive or necrotic. All plants grew out of the height control and leaf cupping after approximately one month after Bonzi treatment. No floral buds were observed during the 21 days of examination, but all plants initiated flower buds in the month following treatment.

Significance to the Industry

Although 28 and 33% height reduction was significant in this study, plants were still larger than would ideally be desired for greenhouse or nursery production. Perhaps multiple Bonzi treatments possibly at higher concentrations, or Bonzi coupled with cultural practices such as reduced fertilization or pruning, could be used to further reduce plant height. Although not all cultivars were responsive to Bonzi at the rates tested, it does suggest that height reduction is possible and that, when Bonzi is used as a cultural tool, a wide variety of passion flower selections could become profitable nursery plants.

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PRODUCTION AND ECONOMICS

Propagation of Pawpaw (*Asimina triloba*)

Cynthia Finneseth, Sharon Kester, Robert Geneve, Kirk Pomper, and Desmond Layne, Department of Horticulture

Nature of Work

The North American pawpaw is a temperate member of the mostly tropical Annonaceae or Custard Apple family. Pawpaw has commercial value both as a small landscape tree and as an orchard fruit crop (4). It is also the source of several novel botanical and medicinal extracts (5). Nurseries commonly propagate pawpaw from seed or chip budding. Seed propagation of pawpaw is important to the nursery industry as a source of seedlings for both ornamental and understock production. Currently, chip budding is used to propagate superior fruiting cultivars. One problem with budding is the propensity for pawpaw understocks to sucker and potentially compete with the desired cultivar. Cutting or tissue culture propagation would be a desirable way to establish pawpaw cultivars on their own roots. The objective of our research program in pawpaw is to develop propagation methods for seedling and clonal establishment of plants for commercial production.

Seed Propagation

Fruits were collected from six sites in Kentucky during the fall of 1996. Seeds were cleaned and combined into one seed lot. Stratification of seeds occurred in rolls of moistened germination paper at 5°C in darkness. At 7-day intervals for 14 weeks, one set of 50 seeds was moved from stratification to germination conditions and germination percentage determined after 14 days.

To determine the pawpaw seeds' ability to withstand drying, 50 fresh seeds were slowly dried at approximately 25°C. At 3-day intervals, seeds were weighed to calculate the approximate change in seed moisture content. Seeds at various moisture contents were stratified for 120 days at 5°C as previously described.

Storage life was determined in seeds extracted from fruits after macerating the pulp and floating off the fruit flesh. Seeds were washed, surface sterilized using a bleach solution, rinsed, and stored in hydrated Terrasorb™ (hydrophilic polymer) at 5°C. Seeds were not permitted to dry out prior to storage. At various times during storage, stratified seeds were surface-sterilized with 10% bleach solution and rinsed three times with sterile deionized water prior to germination testing.

In all germination experiments, seeds were placed in three sheets of germination paper (30 x 38 cm, Anchor Paper Co., St. Paul, MN) moistened with approximately 250 ml of deionized water. Ten seeds were placed between the second and third sheet of rolled paper. Rolls of seeds were placed in 0.5 mil polyethylene bags. Germination was conducted in a 25°C growth chamber in darkness. Fifty to 100 seeds were evaluated per treatment.

Cutting Propagation

Softwood cuttings were taken from either mature or seedling stock plants. Cuttings were stuck in a peat-lite medium and placed under intermittent mist (5 sec every 10 min) with bottom heat 75°F (25°C). Cuttings were treated with a quick dip using IBA at 0, 1000, 5000, or 10000 PPM dissolved in 50% ethanol.

Tissue Culture Propagation

Establishment of tissue cultures was attempted from seedling, mature, or rejuvenated explants. Mature explants were taken from new growth on established, fruiting trees. Rejuvenated explants were from root suckers from mature plants. Tissue culture conditions were MS medium with 5 to 10 μM BA and 1 to 3 μM NAA. Photoperiod was 16 hr at 20 μmol$\times$ sec$^{-1}\times$m^{-2} of light provided by cool white fluorescent bulbs. Culture room temperature was 25°C.

Results and Discussion

Pawpaw seeds have a small rudimentary embryo embedded in a large ruminant endosperm (3). A small proportion (12%) of the seed population used in this study germinated after removal from the fruit. The remaining seeds required 8 weeks of chilling stratification to satisfy dormancy (Figure 1). In addition, pawpaw seeds displayed a moderate form of recalcitrance. Seeds lost 50% viability when dried from their initial 37 to 25% moisture. Total loss in viability was between 15 and 5% moisture. There was no significant effect of light on germination. For germination, pawpaw seeds should be stratified for 100 days at 5°C. Seeds stored cold (above freezing) and moist retain good viability for two years (Figure 2).

Anatomical studies of pawpaw seed revealed a small, linear embryo that does not change in length during cold or warm stratification (2). Cotyledons grew through a specialized channel of cells extending above the cotyledon tips but never emerged from the seed. The time required for the development of the cotyledons delayed seedling emergence more than 50 days. The cotyledons appear to be haustorial and translocate storage material from the endosperm to the growing embryo. Seedling development could be divided into four distinct stages, including radicle protrusion, hypocotyl emergence, epicotyl elongation, and seedcoat abscission.

Cutting Propagation

More than 1,000 softwood cuttings were taken from mature flowering trees throughout the spring and summer. All failed to form adventitious roots. However, seedlings up to 2 months old showed a capacity to root. Cuttings treated with IBA (10,000 ppm) rooted at 75% and averaged two roots per cutting (Figure 3). Seedlings beyond 2 months old lost the capacity to form roots. These data suggest that strategies to revert stock plants to a more juvenile state (like tissue culture or mound layering) will be required before a reliable method for cutting propagation can be obtained.

Micropropagation

The effect of juvenility on explant performance was seen with the inability of explants from 26 mature sources to respond in culture. Of the 551 mature explants, 72% were successfully disinfested, but only 4% survived in the culture environment (1). Most of the mature explants turned black and lost tissue integrity. The explants that were alive did not respond in culture and produce axillary shoots or adventitious buds. Only the small percentage of explants from mature sources that survived showed some tissue proliferation after approximately 7 months in culture.

In contrast, 88% of seedling explants showed expanded shoots (> 3 cm) and were suitable for subculture after 6 weeks (Figure 4). For explants from root suckers, axillary shoot elongation began in 42% of the explants after eight weeks. Although explants from root suckers did not respond as rapidly or at the high percentages of the seedling explants, these explants did respond in culture and would produce clones of the donor plant.

Figure 1. Germination percentage of pawpaw seeds after stratification at 5°C.

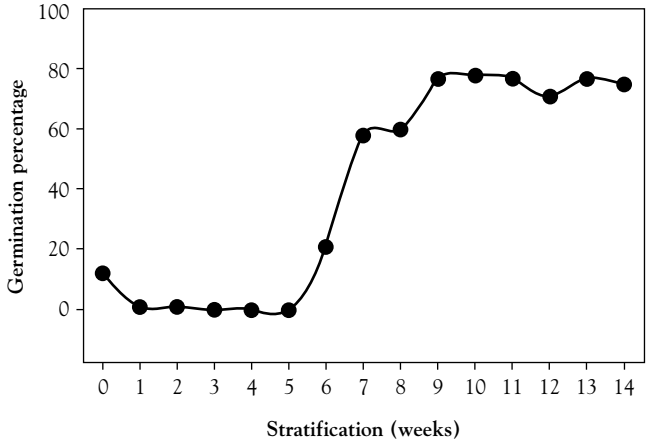


Figure 2. Germination percentage in two seed lots of pawpaw after storage.

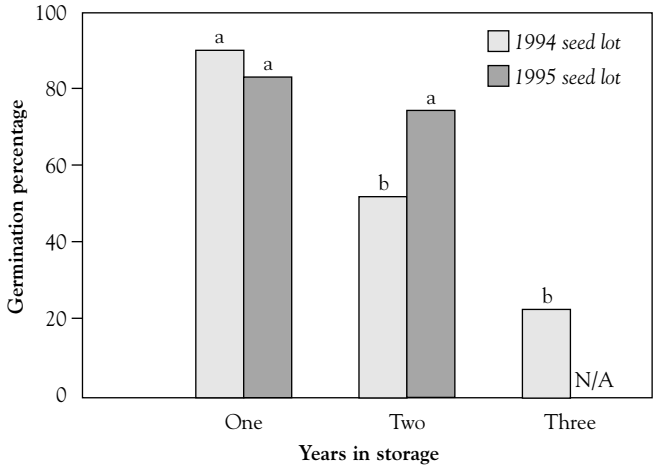


Figure 3. Root formation in seedling cuttings treated with 10,000 ppm IBA.

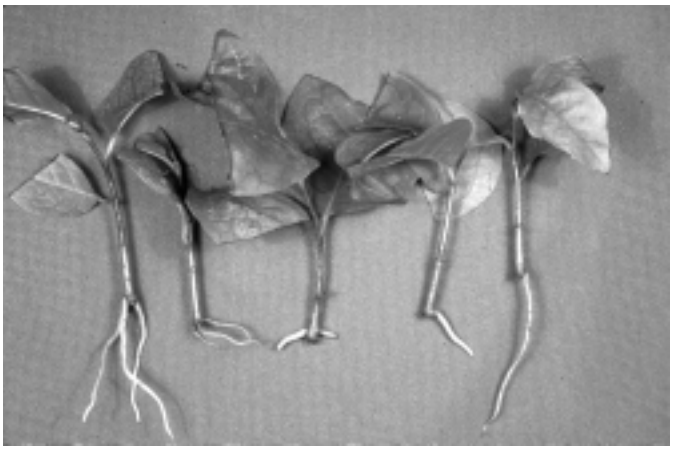
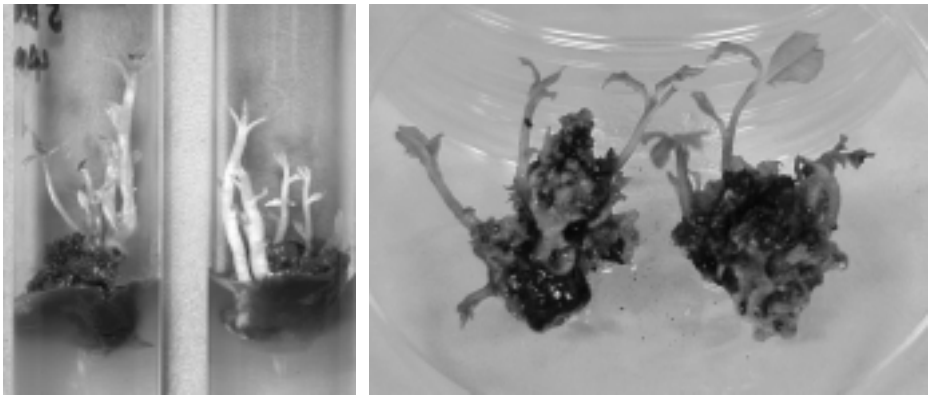


Figure 4. Shoot formation from seedling and rejuvenated explants of pawpaw.



Seedling explants *Explants from suckers*

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PRODUCTION AND ECONOMICS

Rooting of *Aesculus parviflora* by Layering

Robert McNiel and Steve Elkins, Department of Horticulture

Nature of Work

Bottlebrush Buckeyes are under investigation for rootability in a layering propagation system. Forty plants were planted during 1995 and were mistakenly bushhogged during the fall of 1998. Many new stems arose from each initial plant. During the summer of 2000, the plant rows were mounded to a depth of 18 inches with aged sawdust. The rows are on drip irrigation with daily application.

Each month 10 random plants are being chosen for propagation. Three branches are selected on each plant. The sawdust is removed to within an inch or two of the ground. A lateral slit about 1 inch long is cut about halfway through the branch. No. 3 Hormex rooting hormone is introduced into the slit. The branch is then re-covered with sawdust. Plants will be treated monthly for nine months over a period of one year. During the months of December, January, and February, no treatments will be made because of weather. Initial response after 60 days is that rooting is occurring at the point of treatment. More information will be available after the year-long cycle is complete.

Does Imidacloprid Pose a Hazard to Endemic Pollinators?

Jerome Gels and Daniel Potter, Department of Entomology

Nature of Work

According to the U.S. Department of Agriculture (USDA), we are facing an "impending pollination crisis." Both wild and managed pollinators are disappearing at alarming rates, due to habitat loss, pesticides, and parasites such as tracheal mites. As one of the objectives aimed at solving this problem, the USDA and other concerned scientists have highlighted the importance of evaluating the potential hazards of certain insecticides that are applied in areas frequented by pollinators. Such sites include nurseries and landscapes in which flowering plants or weeds are grown.

Merit (imidacloprid) is a persistent, systemic insecticide that is widely used to control pests of woody and herbaceous ornamentals, as well as white grubs in turf. Because imidacloprid is inherently toxic to bees, it could potentially harm pollinators if translocated to the nectar or pollen of flowering ornamentals in plant beds or within flowering weeds between nursery rows. The same exposure is important for nectar-producing plants sold for butterfly gardening. However, hazards of an insecticide to a nontarget organism are determined by degree of exposure, as well as inherent toxicity of the pesticide. We investigated the possible nontarget effects of imidacloprid on bumblebees that foraged on flowering clover in turf.

Fifteen field plots containing flowering white clover were grouped by initial clover density in five replicates. A pair of plots were sprayed with the wettable powder formulation of imidacloprid, one receiving post-treatment irrigation and the other not. A third plot was left untreated without irrigation as the control. After treatment, field cages were placed over each plot, and a commercially acquired hive of bumblebees was placed into each. Bumblebee foraging was monitored daily for 28 days after treatment. At the end of that period the hives were collected and frozen. Each hive was dissected, and hive health was measured by comparing the weight of the hive, the total bee biomass, and the queen. Also the numbers of brood chambers, adult workers, and honey pots were counted. Experiments regarding the hazards imidacloprid poses to butterflies are still in progress.

Results and Discussion

Wettable powder applications of imidacloprid that were not irrigated into the soil had an adverse effect on hive health. The numbers of brood chambers, workers, and honey pots, as well as the worker biomass and hive weights, were significantly reduced on nonirrigated imidacloprid treated plots relative to control plots. However, there were no differences between those treated plots receiving post-treatment irrigation and control plots. This work suggests that following applications of imidacloprid with irrigation will greatly reduce the exposure to the bumblebees. Moreover, the rate at which imidacloprid is translocated to either the nectar or pollen of a flowering plant is in too low a concentration to have any toxic effects.

Significance to the Industry

Understanding ways to better reduce the hazards of pesticides to pollinators lends itself to more environmentally friendly management practices in nurseries. This work indicates that bumblebees that feed on the nectar or pollen of an imidacloprid-treated plant are at a lesser risk of insecticide poisoning if treatments are followed with adequate irrigation. These data reiterate the need for post-treatment irrigation, not only for increased efficacy against grubs but also for reducing exposure to pollinators. This knowledge helps protect a useful tool for nursery pest control against potential claims of post-treatment pollinator poisoning.

Table 1. Mean comparisons between irrigated and nonirrigated imidacloprid-treated plots and control plots.

		Control	Irrigated	Nonirrigated	F-stat	P-value
Weight (g)	hive	86.44 ± 13.72	80.61 ± 5.29	39.60 ± 26.80	11.81	0.0041
	workers	7.22 ± 2.02	7.97 ± 0.86	3.25 ± 1.30	18.63	0.0010
	queen	0.71± 0.09	0.70 ± 0.13	0.70 ± 0.06	0	0.9995
Numbers	adults	55.40 ± 14.04	48.60 ± 8.76	21.80 ± 4.71	13.23	0.0029
	brood chambers	28.60 ± 8.53	25.00 ± 7.35	3.60 ± 1.52	18.65	0.0010
	honey pots	24.00 ± 5.87	24.20 ± 9.55	6.80 ± 9.42	6.37	0.0222
	dead bees	0.0 ± 0.0	1.00 ± 1.41	13.20 ± 4.71	15.52	0.0018

Evaluating Repellent or Masking Odors from Non-Host Plants for Protecting Roses from Japanese Beetles

Philip Gonsiska, David Held, and Daniel Potter, Departments of Entomology and Horticulture

Nature of Work

Since its accidental introduction around 1916, the Japanese beetle, *Popillia japonica* Newman, has become the most destructive pest of landscape plants in the eastern United States. The adults feed on about 300 plant species in 79 families, including woody ornamentals, herbaceous perennials, and field and garden crops with annual control costs amounting to hundreds of millions of dollars.

Associational resistance occurs when a plant is protected from herbivory through being associated with (e.g., growing near) other plant species that may produce masking or repellent odors that interfere with a pest's host location behaviors. For example, potato beetles, which orient upwind to the odor of solanaceous plants, are repelled by some non-host plants. Perhaps the most familiar application of this concept is companion planting in gardens.

Osage orange is a native species with a long history of economic use and a rich folklore concerning its alleged pharmacological properties. The fruits, or hedge apples, contain natural compounds that prevent spoilage and are reportedly toxic to herbivores. Also, the fruits are allegedly repellent to cockroaches and other household pests. Ginkgo, a deciduous gymnosperm native to eastern China, is notably resistant to diseases and insect pests, including the Japanese beetle. The fruits, which are actually tan, plum-like, naked seeds, have a fleshy covering that is distinctively pungent. Hedge apples and ginkgo seeds are both present in July, during peak flight activity of adult Japanese beetles. Red cedar (*Juniperus* spp.) shavings, commonly sold as animal bedding to control animal odors, are alleged to be nontoxic repellents for German cockroaches and fleas. There have been few evaluations of the use of cedar volatiles against insect pests that do not readily feed on cedar.

Our objective was to evaluate whether the volatiles from ginkgo and hedge apple fruit or from cedar shavings could protect flowers and leaves of roses and perennial hibiscus from attack by Japanese beetles. On 19 July, fresh hedge apples and ginkgo fruit were collected by hand from plantings around Lexington. Cedar shavings used for animal bedding (Premiere Pet™ Aromatic Red Cedar shavings) were purchased. In the laboratory, an average weight of a single hedge apple fruit was calculated and then an equivalent mass of cedar and ginkgo was determined to standardize each treatment by weight. In an attempt to simulate bruising and increase volatility, the fruit treatments were placed in a -20°C freezer for 2 hours before beginning the test. All treatments were placed separately in nylon mesh bags as follows: 1 hedge apple fruit per bag; 4 ginkgo fruit per bag, and approximately 430 g of cedar shavings per bag.

On 20 July, we placed potted flowering rose, *Rosa* 'Ultimate Pink', and rose mallow, *Hibiscus moscheutos* 'Hinpink' plants on the old driving range at the University Club of Kentucky (Lexington), an area with a high population of Japanese beetles. Plants were placed parallel to the prevailing winds and spaced about 1.5 m apart to reduce interactions among treatments. To ensure similarity among plants in a replicate, the plants were graded by number of open blooms and then assigned to the replicates. Four separate areas of the driving range were used, one for each replicate. Each plant was bordered by four plastic fenceposts set at cardinal directions. Each plant received four total bags of each treatment, one per post. Bags for a particular treatment were tied to the posts at bloom height. Empty nylon bags were tied at bloom height to posts that were surrounding control plants. Each treatment was replicated in four separate locations on roses and only three locations for the hibiscus treatments.

During the afternoon and evening of 20 July, the number of Japanese beetles on each plant was counted by a single observer. Additional counts were made during the morning and afternoon of 21 July, with the final count in the morning on 24 July.

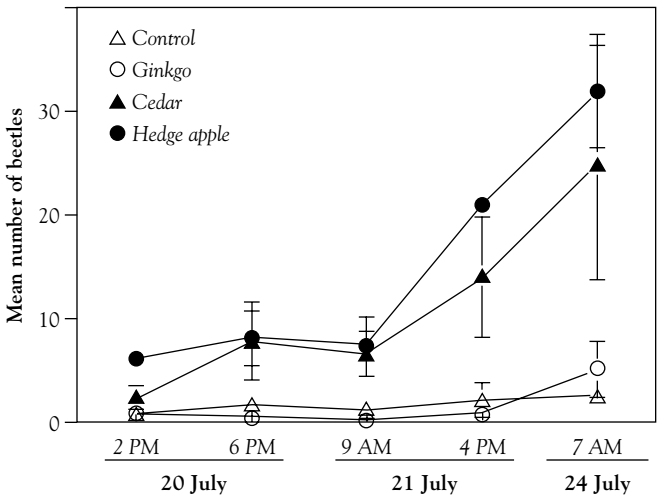
Results and Discussion

Although beetles were present on most of the rose plants, there were not enough beetles for comparison on hibiscus plants at any observation period. Therefore, only data from the rose evaluations are presented. Roses bordered by hedge apples had significantly more beetles than control rose plants during all observation periods except for 6 p.m. on 20 July (see Figure 1). Plants bordered by cedar shavings also had high numbers of beetles. After only one day in the field, those plants with cedar shavings were not significantly different from those with hedge apples. However, plants with cedar were only significantly different from controls during the last two observations. Plants bordered with ginkgo fruit were never significantly different from control plants.

The rose plants bordered by hedge apple and cedar also had the most foliar and floral damage at the end of the study. Across all four replicates, the rose plants bordered by cedar had 1 to 15% defoliation, and two of the four plants had no blooms. Similarly, the roses bordered by hedge apples had 5 to 15% defoliation with no intact blooms on any plant. The control and ginkgo-bordered roses had little to no defoliation or flower feeding.

Past work has demonstrated that Japanese beetles exploit feeding-induced plant volatiles as kairomones, which accounts for aggregative behavior within trees. In addition,

Figure 1. Number of beetles present over time on blooming rose plants surrounded either by fruit of ginkgo or hedge apples, or by cedar shavings.



blend complexity generally increases beetle response. Therefore, the increased attraction to the cedar and the hedge apple may be a response to an increase in the complexity of the volatile blend. The increased beetle number over time is typical of the response of the beetles recorded in other studies where beetles respond to kairomones produced by plants with fresh beetle damage.

Significance to the Industry

The use of non-host odors to mask or repel insects has been used for some pests as an exclusionary control method. Our objective was to identify potential non-host odors that would protect susceptible plants from attack by the Japanese beetle. However, we found that the use of non-host fruit or plant parts increased the number of beetles recruited and the overall damage of roses that were to be protected. This study suggests that the use of masking odors may not be a viable means of protecting plants and may even increase a plant's susceptibility to Japanese beetles.

PEST MANAGEMENT—INSECTS

Biology of *Tiphia* Wasps, Natural Enemies of White Grubs

Michael Rogers and Daniel Potter, Department of Entomology

Nature of Work

Tiphia wasps are the dominant group of parasitic insects that attack white grubs. This wasp burrows into the soil, where it locates a host grub. The wasp then stings the grub and attaches an egg. Upon hatching, the wasp larva consumes the host grub and then spins a cocoon in the soil where it will overwinter and emerge the next year as an adult. In certain areas, up to 60% of the white grub population may be parasitized, while in other areas, very little parasitism occurs. Little work has been done on the biology and conservation of these wasps. The focus of our research is to study the biology of *Tiphia* wasps and then apply this information to conserve and increase the benefits received from these wasps.

Results and Discussion

During 2000, we determined that two species of *Tiphia* are common on golf courses in Kentucky. Adults of *Tiphia vernalis*, a species introduced for control of Japanese beetles, were active from May 4 to June 1. *Tiphia pygidialis*, a native species that attacks masked chafer grubs, were active from August 1 to September 14. Yellow pan traps were effective for monitoring early-season activity of *T. vernalis*, whereas both species could be monitored by spraying a 10% sugar water solution on the turf. Weekly sampling of the natural grub population showed that both *Tiphia* species parasitized primarily third instars. Parasitism of masked chafers averaged 15% at two golf courses but was as high as 37% at some sites.

Cues used by *Tiphia* to locate grubs below ground were examined by use of an "ant farm," positioned horizontally to allow observation of wasp behavior in the soil. Wasps were found to locate their victims by following species-specific scent trails left by the grub as it moves through the soil. Wasps showed an even stronger response to frass from their host grubs. This is the first study to show how *Tiphia* wasps locate grubs underground. Ovipositional behavior of each wasp species was also characterized. Both *T. vernalis* and *T. pygidialis* deliver a paralyzing sting and then manipulate the body of the grub in preparation for oviposition. Then, the female laboriously scrapes the grub to thin the cuticle where the egg will be laid. *T. vernalis* lays its egg on the underside of the grub, whereas *T. pygidialis* lays its egg on the back of the host grub. Eggs hatch in 3 to 5 days. Larval development is completed in about 21 days, after which a cocoon is spun. No-choice tests were conducted with several grub species to study the range of grubs that each wasp will attack. When offered Japanese beetle, masked chafer, or May beetle grubs, *T. vernalis* parasitized only Japanese beetles. *Tiphia pygidialis* were tested with the aforementioned grub species, plus two additional exotic species, European chafer and Oriental beetle. In general, only masked chafer grubs were attacked. In one case, however, *T. pygidialis* parasitized and completed larval development on a third-instar European chafer.

The relationship between the developing larval *Tiphia* and its host grub was examined in the lab. Shortly after being para-

sitized, grubs quit feeding on grass roots and will move down into the soil profile to depths as much as 20 cm. We speculate that *Tiphia* wasps manipulate juvenile hormone levels in parasitized grubs, causing them to prematurely descend. Hemolymph was collected from normal and parasitized grubs to test this hypothesis. Our experiments show that once parasitized, grubs may no longer contribute to turf damage. Persons monitoring for the presence of parasitized grubs should look deeper in the soil where parasitized grubs will be found.

Dilute sugar water sprays were applied to turf in an attempt to attract *Tiphia* wasps and increase parasitism of grubs. Although large numbers of wasps were observed feeding on the sprayed grass blades, no grubs were parasitized in the sprayed turf. In the surrounding, unsprayed turf, however, up to 37% of the grub population was parasitized. This indicates that sugar sprays applied near, but not directly on, grub-infested turf may increase the rate of parasitism. Floral resources have been shown to enhance performance of parasitoids; therefore, 20 species of flowering perennials were planted and monitored to determine if they attract *Tiphia* wasps. No wasps were found on these plantings. Since sugar water sprays did not attract any wasps when applied around these floral resources, it is believed that no wasps were present in this area.

Significance to the Industry

We will continue to study the basic biology of these two wasp species in 2001. Additional tests will be conducted to determine if planting of wildflowers, use of sugar sprays, or other tactics can increase parasitism by *Tiphia*. Studies on the impact of turfgrass insecticides, including newer chemistries, on the performance of these wasps will be undertaken. Such information, together with our studies of the wasps' seasonal activity, will increase awareness of the benefits of *Tiphia* wasps in golf-course IPM programs.

PEST MANAGEMENT—DISEASES

Landscape Plant Disease Observations from the 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% 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. Computer-based laboratory records are maintained to provide information used for conducting plant disease surveys, identifying new disease outbreaks, and formulating educational programs.

After the hot and dry 1999 growing season and a relatively mild winter, the 2000 growing season in Kentucky reverted to near-normal precipitation and temperature levels. Although soil moisture levels were still short from the previous drought, normal to above-normal rain in spring and early summer eased the drought. Indeed, July was characterized by below-normal temperatures and above-normal rainfall. This trend continued into the late summer in eastern Kentucky regions, but hot, dry weather returned in the western parts of the state.

Thus, with mostly normal rainfall, much of the 2000 growing season was favorable for foliar diseases of landscape plants. Drought still influenced plant health, however, because some vascular wilts, canker diseases, and tip blights began the year before during the drought stress.

Results and Discussion

Deciduous tree diseases. Above-normal rainfall in April got foliar diseases off to a good start. Cedar rust (*Gymnosporangium juniperi-virginianae, G. clavipes, G. globosum*) infections were widespread. Rust-susceptible crabapple leaves showed significant cedar-apple rust spots, and hawthorn fruits and shoots were heavily infected with cedar-quince rust. Flowering crabapple scab (*Venturia inaequalis*) was very active, and most susceptible flowering crabapples were defoliated from scab by mid-summer. The maple, dogwood, ash, and sycamore anthracnose fungi (*Kabatiella, Discula*, and *Apiognomonia*) were also very active because of the early wetness. Dogwood anthracnose was confirmed from Harrison County for the first time. An apparently new anthracnose disease of yellowwood was found on trees in several Kentucky landscapes. Sourwood leaf spot (*Cercospora oxydendri*) was serious in some locations. Dogwood powdery mildew (*Microsphaera, Phyllactinia* spp.), a disease which has become important in recent years, was fairly serious in many landscapes. Crabapple powdery mildew (*Podosphaera leucotricha*) was widely evident. Bacterial leaf scorch (*Xylella fastidiosa*) was easily detected visually on red and pin oaks in late summer. Drought stress the previous season appeared to

have made this disease much worse. Previously infected trees seemed to show accelerated rates of decline. In addition to branch dieback, increased numbers of large, mature pin oaks in most Kentucky urban areas are dying from bacterial leaf scorch. Bacterial leaf scorch was also diagnosed in sugar maple and London plane. Botryosphaeria canker (*Botryosphaeria dothidea*) of various woody plants and Hypoxylon canker (*Hypoxylon atropunctatum*) of oak, probably exacerbated by the previous year's drought, were more noticed. Verticillium wilt (*Verticillium dahliae*) appeared on maple, redbud, smoke-tree, and magnolia; in the latter case, symptoms were visible in previous years' wood on young, recently planted trees. Ash yellows, a phytoplasma-caused disease, was more observable in landscapes this year.

Needle evergreen tree diseases. Maturing Austrian and Scots pines continue to die from tip blight (*Sphaeropsis sapinea*) and pine wilt nematode (*Bursaphelenchus xylophilus*). The drought of the previous year seemed to exacerbate these diseases. Although the drought occurred in summer last year, many needle evergreens such as pines and spruces retained their foliage and did not turn brown and die until winter or spring this year. White pine decline (linked to high pH, compacted soils with high clay content, or with root disturbance) continues to take its toll.

Shrub diseases. Black root rot (*Thielaviopsis basicola*) of holly, inkberry, Japanese holly, and boxwood remains a problem. In addition to the usual outbreaks of black spot (*Diplocarpon rosae*) and powdery mildew (*Sphaerotheca pannosa*), roses this year had additional problems with rose mosaic virus and with the devastating rose rosette disease.

Perennial and annual plant diseases. Black root rot (*Thielaviopsis basicola*) of annuals such as petunia, lavender, and pansy was a problem in many flower beds in spring and again in fall. Southern blight (*Sclerotium rolfsii*) was more commonly observed this year on hosta, phlox, and echinacea. Stem rot (*Rhizoctonia solani*) also affected many landscape flowers, especially impatiens, vinca, lily, and petunia. Peony, especially tree peony, was afflicted with leaf spot and blight (*Cladosporium paeoniae*) and iris with leaf spot (*Heterosporium iridis*). Bacterial blights (*Pseudomonas* and *Xanthomonas spp.*) were observed on chrysanthemum, impatiens, geranium, and several other flowers. Poinsettia scab (*Sphaceloma poinsettiae*) outbreaks were noted.

Landscape lawn diseases. The usual spectrum of turfgrass diseases appeared throughout the growing season. Perennial ryegrass gray leaf spot (*Pyricularia grisea*) was fairly serious this year.

Significance to the Industry

The first step in appropriate pest management in the landscape 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 provides useful information for landscape professionals.

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PEST MANAGEMENT—DISEASES

Latent Infections of Austrian and Scots Pines by *Sphaeropsis sapinea*

Jennifer Flowers, Lisa Vaillancourt, Etta Nuckles, and John Hartman, Department of Plant Pathology

Nature of Work

Sphaeropsis tip blight (formerly known as Diplodia tip blight) is a common, worldwide disease of more than 30 pine species and other conifers. Newly infected shoots stop growing and quickly die. Typical symptoms of *Sphaeropsis sapinea* infection include stunted shoots with necrotic, stunted needles, resinous cankers, and a general decline of the tree (1). In Kentucky, the disease is severe enough that trees infected for several successive years are often removed from the landscape long before they become mature (80 years in their native environment) (2). A survey was made in the region to determine if the pathogen is present in asymptomatic shoots and needles of Austrian and Scots Pine. Asymptomatic shoots were tested from diseased trees and from asymptomatic, apparently healthy trees.

Diseased and asymptomatic shoots were collected from diseased and healthy trees growing mainly in Kentucky, but also from Illinois, Indiana, and Ohio. Pine tissues were surface disinfested and plated onto acidified potato dextrose agar using standard fungal isolation techniques. *Sphaeropsis* isolations were confirmed by subculturing the fungus on water agar with sterilized pine needles and observing development of pycnidia on these needles. For sample collections made locally, the fungus was also isolated from different surface-disinfested tissues dissected from asymptomatic Austrian pine shoots. Fungal isolates were tested for pathogenicity on 3-year-old Austrian pines in the greenhouse.

Results and Discussion

Asymptomatic Austrian and Scots pines were frequently latently infected with *S. sapinea* (Table 1). The pathogen could be recovered from all parts of asymptomatic shoots, including needles; stems; buds; first-, second-, and third-year cones (not asymptomatic); and male flowers. Latent infections were localized in the outermost tissues of the shoots and branches (Figure 1).

S. sapinea isolates from latently infected tissues of Austrian and Scots pines were pathogenic. Fungal isolates derived from either diseased or asymptomatic tissue caused typical tip blight symptoms within two weeks of inoculation; 74% of inoculated trees showed symptoms while the control trees remained healthy throughout. The causal fungus was recovered from all diseased tissue. Of the 26% of inoculated trees which failed to show symptoms, 10 trees were sacrificed for isolations and from nine of the 10, *S. sapinea* was recovered from needles and stem tissue at least 5 cm beyond the point of inoculation. These latently infected trees represented fungal isolates from both latent and outwardly diseased samples.

In summary, the results of this work show that:

- Asymptomatic pine tissues are frequently latently infected with *S. sapinea*.
- In asymptomatic shoots and branches, the fungus is most often found in bark and phloem tissues.
- The fungus is also readily isolated from asymptomatic needles, terminal buds, male flowers, first-year conelets, second-year cones, and from dead scales of old cones.
- *S. sapinea* isolates from both diseased and asymptomatic tissues were capable of infecting potted pines in the greenhouse.
- Greenhouse inoculations may also result in no symptoms (26% of the time), but in most cases (90% of the time) the fungus can be recovered 5 cm beyond the inoculation site. It is not known why some inoculations result in latent infections while others do not.

From: Flowers, J.L., et al., APS Annual Meeting poster presentation, Aug. 2000.

Significance to the Industry

Information on Austrian pine tip blight identification, disease progress, and prognosis made in Lexington can be extended to Austrian pines in other regions of the state. This knowledge may assist landscape architects and managers in deciding whether to use Austrian pine in the landscape. Indeed, for longevity and ease of maintenance, Austrian pines may not be a good choice for Kentucky landscapes. The finding that the fungus already exists in the tree or parts of the tree before symptoms develop will have an enormous impact on tip blight disease management decisions, should the work be expanded.

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Figure 1. Current year shoot tissues where S. sapinea could be recovered from diseased Austrian pines.

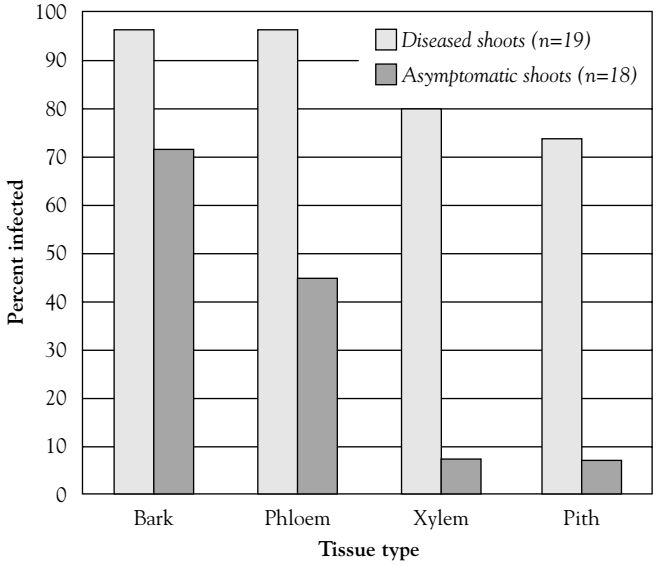

Table 1. Isolation of *S. sapinea* from diseased and asymptomatic Austrian and Scots pines.

				Percent recovery of *Sphaeropsis sapinea* from:			
				Diseased shoots		Asymptomatic shoots	
	Number of shoots sampled			Previous year's	Current year's	Previous year's	Current year's
Tree species and health	Diseased	Asymptomatic	Trees	stem	shoot	stem	shoot
Asymptomatic Austrian pine	0	68	17	-	-	8	4
Diseased Austrian pine	46	97	100	87	100	73	70
Asymptomatic Scots pine	0	28	17	-	-	4	30
Diseased Scots pine	33	36	100	82	100	42	80

Injections with Fungicides for Management of Pine Tip Blight—Preliminary Results of a New Long-Term Study

John Hartman, Jennifer Flowers, Lisa Vaillancourt, Fanny Moine, Jerry Hart, and Larry Hanks, Department of Plant Pathology

Nature of Work

Tip blight disease, caused by the fungus *Sphaeropsis sapinea*, is a major problem of Austrian pine (*Pinus nigra*) in the landscape (1). Control by pruning or spraying is difficult and usually ineffective; most affected trees eventually die or are removed (2). Young trees that are not yet producing cones are rarely affected by tip blight. It has been suggested that a primary source of inoculum may be old infected cones and that young trees escape due to lack of locally produced infective propagules. However, we have found that the tip blight fungus is present in healthy parts of trees (found in more than 70% of symptomless twigs), or in healthy young trees (17%), living as a latent pathogen or possibly as an endophyte within the twigs (3,4). This study is intended to determine whether fungicide injection can prevent new infections and further spread of tip blight disease. We hope to determine also whether injection of pines with fungicides can eradicate *S. sapinea* from within infected/infested pines and the impact of fungal eradication on disease.

Two distinct groups of Austrian pines on the UK campus were selected for injection treatments as described below: Experiment 1, mature diseased (1 to 50% tip blight) Austrian pines (six replicates) and Experiment 2, maturing, mostly non-diseased Austrian pines (10 replicates). Disease symptoms were evaluated in mid- to late summer each year by estimating the percent of diseased shoot tips per tree. Diseased branches previously removed for sanitation purposes were included in the estimate. During July 2000, shoot and needle samples (two each) from asymptomatic and diseased shoots were collected from each treated tree and the pathogen cultured on acidified PDA using standard microbiological techniques. The fungal cultures were identified and confirmed microscopically following inoculation of autoclaved pine needles.

Experiment 1. Sixteen 22-year-old diseased Austrian pines located on traffic islands on the UK campus received one of four treatments. Treatments, arranged in a randomized complete block design and replicated on four individual trees, consisted of injections at labeled rates of a) oxycarboxin (Carboject), b) debacarb (Fungisol), c) tebuconazole (Tebuject), and d) water used as controls. Treatments were made 8 May 1999 (capsules removed 12 May; water controls injected 18-22 May), when the candles of the pines were partly elongated, and again 6-9 May 2000 (capsules removed 16 May), with future injections to be made in spring 2001. Due to the demise of several of the traffic-island trees in the first year, eight additional 20-year-old trees located around the perimeter of a UK campus parking lot nearby were injected in May 2000. Trees have been grouped into randomized complete blocks, and each treatment is now replicated five or six times with each replicate being an individual tree.

Experiment 2. From a group of 71 mostly disease-free 13- to 14-year-old Austrian pines forming a screen planting on the UK campus, 40 trees were injected in 1999 and again in 2000 as described above. The experiment was designed as a randomized complete block experiment with 10 replicates.

Results and Discussion

Experiment 1. Disease levels in the mature trees were quite variable (1 to 50%) when treatments were initiated in 1999. In addition, 1999 was a year of extreme drought with watering restrictions placed on Lexington residents and the UK campus. By mid-summer, when disease ratings were made, disease levels were much higher. Drought stress caused several of the severely diseased trees in the experiment to die. Consequently, another group of less diseased trees were added to the experiment in 2000, but they have gone through only one injection treatment. Thus, it is difficult to assess the effects of two years of fungicide injections on disease levels in this group of trees (Table 1). There were no significant differences in recovery of the pathogen from diseased or healthy shoots of the trees in this experiment (Table 2). During the injection process, it was noticed that some of the capsules soon filled with pitch from the tree. Thus, it is difficult to know whether all capsules were actually emptied into the injection site.

Experiment 2. The younger, minimally diseased trees showed very little evidence of disease (Table 1), but the potential for future disease development is present because an occasional diseased shoot was found and harvested for fungal isolations. These diseased shoots yielded significantly higher levels of the pathogen in culture than did asymptomatic shoots from the same trees. *S. sapinea* was isolated from all trees with a diseased shoot, whereas the fungus was isolated from only one in 10 asymptomatic shoots of Fungisol-treated trees compared with five of 10 water- or Tebuject-treated and seven of 10 Carboject-treated trees. Injections will be made again in spring 2001, so there will be an opportunity next summer to see if this trend continues.

Significance to the Industry

Information on injections as a management tool for Austrian pine tip blight may provide insights on the biology of the fungus and its host and potential control of the disease. This knowledge may assist landscape architects and managers in deciding whether to use Austrian pine in the landscape. Indeed, unless efficient control measures are developed, for longevity and ease of maintenance, Austrian pines may not be a good choice for Kentucky landscapes. If treatments can eradicate the fungus that already exists in the tree or parts of the tree before symptoms develop, this informa-

Table 1. Summer 1999 and 2000 disease ratings (percent blighted shoot tips) for Experiment 1, mature diseased (1 to 95% tip blight) Austrian pines (six replicates) and for Experiment 2, maturing, mostly non-diseased (less than 1% tip blight) Austrian pines (10 replicates).

UK Austrian pines		Experiment 1 trees				Experiment 2 trees
Treatment	Rating year	Range	Average *	Average for original trees	Original trees' disease percent in 2000 vs. 1999	Range
1 - Fungisol	1999	1-85	28	08		0
	2000	1-25	07	10	125	0 - <1
2 - Tebuject	1999	1-90	51	38		0
	2000	1-95	28	49	129	0 - <1
3 - Carboject	1999	9-52	34	34		0
	2000	5-70	31	49	144	0 - <1
4 - Water	1999	23-35	29	29		0
	2000	5-60	33	46	159	0 - <1

* Percent disease changed substantially from year to year if one heavily diseased tree died or if new, less diseased trees were added after the first year.

tion will have an enormous impact on tip blight disease management.

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Table 2. Isolation of *Sphaeropsis sapinea* from UK campus pines: Experiment 1, mature diseased (1 to 95% tip blight) Austrian pines (six replicates). Experiment 2, maturing, mostly non-diseased (less than 1% tip blight) Austrian pines (10 replicates) treated with fungicides via trunk injections. Percent needles and shoots yielding *S. sapinea* in culture (four samples per tree).

UK Austrian pines	Experiment 1 trees	Experiment 2 trees	
Treatment and sample health status	Percent recovery of *S. sapinea*	Percent recovery of *S. sapinea*	Proportion of trees with *S. sapinea*
1 - Fungisol, symptomless shoot	55.0 a *	7.5 a	(1:10)
3 - Tebuject, symptomless shoot	40.0 a	17.5 a	(5:10)
7 - Water, symptomless shoot	66.7 a	22.5 a	(5:10)
5 - Carboject, symptomless shoot	45.8 a	25.0 a	(7:10)
4 - Tebuject, diseased shoot	75.0 a	68.8 b	(8:8)
8 - Water, diseased shoot	79.2 a	75.0 bc	(6:6)
2 - Fungisol, diseased shoot	80.0 a	79.2 bc	(6:6)
6 - Carboject, diseased shoot	66.7 a	87.5 c	(6:6)

* Means in a column followed by the same letter are not significantly different; Waller-Duncan K-ratio t-test (K = 100, p = 0.05).
Fungisol = debacarb
Carboject = oxycarboxin
Tebuject = tebuconazole

PEST MANAGEMENT—DISEASES

Reactions of Flowering Crabapples to Application of Heritage Fungicide—2000

John Hartman and Edward Dixon, Department of Plant Pathology

Nature of Work

Heritage fungicide (azoxystrobin), one of a new class of fungicides known as strobilurins, has many registrations for ornamental crops. Another form of azoxystrobin, called Abound, is used in the fruit industry, but is not recommended for apples because of phytotoxicity to the variety McIntosh and to apples genetically related to McIntosh. The effect is so pronounced that grape growers using azoxystrobin are warned not to use the fungicide if they also grow apples (1). This research was done to determine if a selection of flowering crabapples would be similarly affected.

This trial was conducted on a planting of fully mature flowering crabapple (*Malus* spp.) cultivars established in 1992 on the UK Agricultural Research Farm north of Lexington. Plots are located on a fertile, well-drained Maury silt loam soil. The trees were arranged in a randomized complete block design with five replications. For this experiment, half-trees received treatment while the other half of each tree remained untreated. Trees in replicates 1, 3, and 5 were treated on their north side while trees in replicates 2 and 4 were treated on their south side. Treated parts of all trees were sprayed with the fungicide Heritage (8.0 oz/100 gal) to run-off using a Solo hand-pumped backpack sprayer. Four applications were made on April 26, May 9 and 24, and June 7 at two-week intervals beginning at bloom. These dates coincide with normal times of fungicide application for control of scab, powdery mildew, and rust diseases. Eastern tent caterpillar infestations were noticed in the plots and webbed "nests" were removed from the trees and destroyed. Crabapples were watched for fungicide reactions during May and June and evaluated for their reaction to the fungicide treatment on July 27 by examining all leaves for appearance and color on at least 10 shoots on each half of each tree.

Results and Discussion

Sprays were applied in a timely way, and typical Lexington, Kentucky, weather with favorable rainfall prevailed throughout the trial. Not all cultivars were fully replicated because this was a fairly old planting, and several of the trees had been destroyed due to mower damage or drought stress from previous years. In any case, none of the crabapple cultivars in the experiment showed any symptoms of phytotoxicity resulting from treatments with Heritage. The 25 cultivars used in this test (numbers of trees in parentheses) are: Adirondack (2), Beverly (1), Brandywine (1), Candymint 'Sargent' (3), Centurion (4), Coralburst (2), David (3), Dolgo (3), Doubloons (2), Edna Mullins (2), Floribunda (3), Harvest Gold (5), Indian Summer (2), Jewelberry (2), *Malus baccata* 'Jackii' (1), Naragansett (3), Pink Princess (3), Purple Prince (2), Radiant (1), Red Splendor (4), Sinai Fire (1), Snow Magic (3), Tina (2), Velvet Pillar (3), Zumi 'Winter Gem' (2).

Significance to the Industry

Although many more flowering crabapples need to be tested, landscape managers, arborists, and nursery operators may rest a little easier when Heritage sprays are applied nearby to nursery blocks with crabapples or when their sprayer is contaminated with Heritage.

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PEST MANAGEMENT—DISEASES

Evaluation of Fungicides for Control of Cedar Rusts of Hawthorn—2000

John Hartman and Edward Dixon, Department of Plant Pathology

Nature of Work

The experiment was established to compare the efficacy of different rates of the fungicide Lynx with standard fungicides for control of cedar-quince (*Gymnosporangium clavipes*) and cedar-hawthorn (*G. globosum*) rust of hawthorn (*Crateagus laevigata*). Cedar-quince rust was the main target because it normally is more prevalent and damaging in landscape hawthorns (1); a prominent indicator of cedar-quince rust is numbers of flower (fruit) infections, but it can also cause twig cankers. Cedar-hawthorn rust causes leaf spots on hawthorns. Plots were established on mature hawthorn trees growing in landscape beds on the University of Kentucky campus. Treatments were applied to trees experimentally grouped in a randomized complete block design and replicated four times as single tree replicates. Treatments were applied with a Solo hand-pumped backpack sprayer. Spray applications were made March 26 (tree phenology–green tip to tight flower cluster), April 9 (tight flower cluster to open flower cluster), April 23 ("popcorn" flowers to full bloom), and May 7 (flower petal fall, leaves fully expanded). These applications coincided with fungal telia production on cedars (junipers).

Results and Discussion

Rust spores were abundant on nearby cedar trees, and weather was generally favorable for several infection periods to occur during the weeks of fungicide application. The major indicator of infections actually occurring, however, are infected flowers and fruit, and due to a drought in 1999, there were few flowers produced in 2000. Thus, due to a lack of flowers, fruit infection levels were extremely low, much lower than normal. Leaf infections were at their normal and twig cankers were infrequent. Evaluations of fruit (cedar-quince rust) and leaf (cedar-hawthorn rust) infection levels were made July 27. Most trees had few fruit and some had none, but where there were fruit, up to 200 fruit were examined, and the number of infected fruits was recorded. Similarly, 500 to 1000 leaves were examined per tree, and the number of infected leaves was recorded. Fruit and leaf infection levels on water-treated trees

Table 1. Effect of fungicides on cedar rusts of hawthorn.

Treatment and rate/100 gal.	Percent fruit infection	Percent leaf infection
Lynx, 3.3 oz	0.000 a *	0.000 a
Lynx, 4.4 oz	0.000 a	0.000 a
Banner MAXX, 5.0 oz	0.000 a	0.025 a
Lynx, 2.2 oz	0.167 a	0.000 a
Heritage, 4.0 oz	1.043 ab	0.200 a
Water check	4.250 b	1.050 b

* Means in a column followed by the same letter are not significantly different, Waller-Duncan K-ratio t-test (K = 100, P = 0.05).

(check) were only 4.25 and 1.05%, respectively. Although infection levels were low, all fungicide treatments provided significant control of rust on hawthorn (Table 1).

Significance to the Industry

During wet spring weather, cedar rusts are very infective and by late summer can cause significant damage to susceptible hawthorn shoots and twigs. Fungicides provide landscape managers, arborists, and nursery operators an additional tool for managing cedar-rust diseases.

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PEST MANAGEMENT—DISEASES

Evaluation of Fungicides for Control of Dogwood Powdery Mildew—2000

John Hartman and Edward Dixon, Department of Plant Pathology

Nature of Work

Powdery mildew is increasingly becoming a problem in Kentucky landscapes (1). There are several effective fungicides available for use in nurseries and landscapes; there are some promising biological control materials becoming available as well.

This test was conducted at the University of Kentucky Horticultural Research Farm and was designed to test the efficacy of MT-2000, a biocontrol fungicide, at different application regimens in comparison to standard treatments for control of dogwood powdery mildew (*Microsphaera* sp.). Four-year-old dogwood (*Cornus florida*) seedlings were grown in 3-gallon pots containing Barky Beaver nursery potting mix. The plants were placed in a shade structure and were watered as needed with automatic overhead sprinklers. Dogwoods were fertilized with 9 g of 14-14-14 fertilizer/pot on June 19. Fungicides were prepared in small quantities and were applied using a hand-held atomizer/sprayer. Treatments were replicated five times, and treated plants were arranged in a completely randomized design. Most treatments were initiated on June 2; however, weekly treatments of the biocontrol fungicide MT 2000 did not begin until June 30. Fungicide rates and application dates are presented in Table 1. Percent powdery mildew incidence and severity were recorded August 29. Incidence was recorded for 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 coverage of the foliage with visible signs of the fungus. The data were statistically analyzed using ANOVA and Waller-Duncan K-ratio t-test, (K = 100, P = 0.05).

Table 1. Efficacy of a biocontrol fungicide treatment and application timing compared to standard fungicides on powdery mildew of flowering dogwood. First applications were made 2 June (weekly applications began 30 June), and last applications were made 25 August.

Treatment	rate/100 gal.	application frequency	Percent powdery mildew*	
			Incidence	Severity
Banner Maxx 1.24MEC	8.0 oz	triweekly	4 a**	7 a
Heritage 50WG	8.0 oz	triweekly	28 ab	7 a
MT 2000 1AS	1.5 gal	biweekly	42 b	19 ab
MT 2000 1AS	1.0 gal	biweekly	44 b	25 abc
MT 2000 1AS	1. 5 gal	triweekly	49 b	27 abc
MT 2000 1AS	0.5 gal	biweekly	76 c	39 bcd
MT 2000 1AS	1.0 gal	triweekly	89 c	28 abc
MT 2000 1AS	1.0 gal	weekly	83 c	59 de
Check (water)		triweekly	85 c	52 cde
MT 2000 1AS	0.5 gal	triweekly	80 c	61 de
MT 2000 1AS	0.5 gal	weekly	92 c	60 de
MT 2000 1AS	1.5 gal	weekly	94 c	72 e

* Percent powdery mildew: Incidence = % foliage with symptoms and signs of disease; Severity = % foliage with visible signs of powdery mildew.
** In a column, means bearing the same letter are not significantly different (Waller-Duncan K-ratio test, P = 0.05).

Results and Discussion

Powdery mildew symptoms and signs were first observed in mid-July, and by mid-August disease pressure was heavy. By the date of the evaluation, untreated plants showed an incidence of 94 and severity of 72% powdery mildew, while stan-

dard fungicide treatments held the disease levels much lower (Table 1). As formulated, the MT 2000 1AS (1% aqueous suspension), when applied early and at the highest rate, showed some efficacy for powdery mildew management. Given the high disease pressure, Banner Maxx and Heritage were effective in suppressing powdery mildew.

Significance to the Industry

With consumer concerns about the use of fungicides in the landscape, there is a need to evaluate biological control alternatives to standard fungicides. Landscape managers, arborists, and nursery operators will have an interest in knowing which fungicides will be capable of managing dogwood powdery mildew.

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PEST MANAGEMENT—DISEASES

Distribution of Bacterial Leaf Scorch on Landscape Trees in Kentucky

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

Nature of Work

Landscape trees have long been afflicted with leaf scorch symptoms caused by environmental factors such as root damage, road salt, and drought and by wilt diseases caused by fungi (2). The association of xylem-limited bacteria with shade tree leaf scorch symptoms was first made in 1980 (7). In 1987, the bacterium associated with leaf scorch was described as a new species, *Xylella fastidiosa* (11). Bacterial leaf scorch has been reported in coastal U.S. states from New York to Texas and in Kentucky in bur, pin, red, and shingle oak; sycamore; sugar maple; and sweetgum (1,3,4,5,6,9,10). The disease is now being detected in southern Indiana and southern Ohio and has been diagnosed in Tennessee; thus, it is found throughout the eastern United States.

In oak, scorch symptoms first appear in late summer in individual branches where leaves show dead margins with green tissues near the main veins and leaf petiole. Often there is a fine yellow or reddish zone between brown and green tissues. Many affected leaves drop prematurely. In succeeding years, the late summer leaf scorch progresses to all parts of the tree. Gradually, infected trees suffer a chronic decline with branch dieback affecting more of the tree each year. Secondary factors can contribute to the tree demise, and eventually the tree needs to be removed. Tree decline, from first discovery of the disease to removal, may take place over a period of five to 10 or more years. It is not known how *X. fastidiosa* causes leaf scorch and defoliation of landscape trees, but water stress due to xylem occlusion seems to be the most likely cause (8).

In the Plant Pathology Department's Plant Disease Diagnostic Laboratory, we used an enzyme-linked immunosorbent assay (ELISA) developed for *X. fastidiosa* ("Pathoscreen-Xf," Agdia, Inc., Elkhart, IN) to detect the bacterium. When positive ELISA results are obtained from a new host or new geographic location, we confirm our findings by using electron microscopy to observe occluded xylem tissues and to observe the causal agent with its typical scalloped or undulating cell walls. The objective of this continuing research is to confirm the presence of *Xylella* in new locations on hosts showing symptoms of bacterial leaf scorch disease in Kentucky.

Results and Discussion

In 1987, we reported that bacterial leaf scorch was found in the following 17 Kentucky counties: Boyle, Caldwell, Campbell, Christian, Daviess, Fayette, Garrard, Hardin, Henderson, Hopkins, Jefferson, Jessamine, McCracken, Oldham, Pulaski, Union, and Warren. By 2000, an additional six counties are now on the list: Barren, Boone, Green, Marshall, Scott, and Taylor. The following landscape trees are now known to be hosts of bacterial leaf scorch in Kentucky:

a) oaks, including the following types: bur, pin, red, shingle, and white.
b) maples, including the following types: red, silver, Norway, and sugar
c) other deciduous trees, including sweetgum, sycamore, and London plane.

The disease is most serious and widespread on oaks, especially pin oaks. In some urban areas, mature pin oaks with bacterial leaf scorch have declined to such a great extent that they are now being removed. But the disease is by no means confined to older trees. We have diagnosed the disease on nursery trees and landscape "saplings" dying from bacterial leaf scorch. The disease is not widespread on maples and sweetgums in Kentucky, and bacterial leaf scorch-infected elms and mulberries, confirmed hosts in other states, have not been found in Kentucky.

Significance to the Industry

Bacterial leaf scorch, exacerbated by last year's drought, is a major concern for arborists, nursery operators, and landscape managers because it is a very destructive disease. It is important for the industry to recognize the importance of bacterial leaf scorch and where it might be found in Kentucky.

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PLANT EVALUATION

Annual and Perennial Garden Flower Evaluations—2000

Sharon Bale and Bob Anderson, 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 in 1999 and 2000 with grants from the Kentucky Department of Agriculture and the Kentuckiana Greenhouse Association. In 2000, 8000 square feet of trial gardens were initiated at the Horticulture Research Farm in Lexington, and 500-square-foot demonstration gardens were established at the Louisville Zoo, the Research and Education Center in Princeton, and the Purchase Area Master Gardeners Garden in Paducah. We plan to add demonstration gardens in other areas of the state in 2001.

We wish to thank the staff gardeners at all our garden locations for all their help with these trials. We are pleased to work with such knowledgeable and hard-working horticulturists across the state. Please take some time next year to visit these trial and demonstration gardens.

Perennial Plant Performance after Three Years

The following plants have been observed for at least three years. Those that are noted as not hardy were replanted each season just in case their performance over one season was not indicative of overall performance. The past several winters have been relatively mild, and the hardiness may be affected by a severe winter. Plants that did not survive the initial growing season are not listed. It is our feeling that perennial performance should be evaluated over a period of at least three years. When replacement plants were not available, any comment will be withheld until such time that these plants can be re-evaluated.

Perennial Plants

Name	Flower Color	Height	Season	Performance
Amsonia hubrichtii Narrow Leaf Amsonia	blue	2-3 ft	early summer	Habit compact and more suitable for most border plantings. Not as invasive as *Amsonia tabernaemontana*
Crocosmia 'Jenny Bloom'	yellow	28"	mid summer	Period of bloom not extensive but still desirable for the garden. Plant not invasive.
Cuphea glutinosa Mexican Heather	light purple	8-10"	mid summer	Blooms are not that conspicuous. Good as a front-of-the-border plant or sunny ground cover.
Echinacea angustifolia Narrow-leafed Coneflower	lavender	18-24"	summer	Lighter color than *Echinacea purpurea* with petals longer and more narrow. Not as vigorous. May be more difficult to establish.
Echinacea paradoxa Yellow Coneflower	yellow	24-28"	summer	Not a common garden plant but has potential. Removal of spent blooms promotes rebloom. A change of pace from *Rudbeckia*.

Perennial Plants

Name	Flower Color	Height	Season	Performance
Echinacea tennessensis Tennessee Coneflower	lavender	18-24"	summer	Has great potential. Finer texture than *Echinacea purpurea*. Removal of spent blooms promotes rebloom. Considered an endangered species, but seed and plants are available from reputable sources.
Eupatorium rugosum 'Chocolate' Chocolate Leaf Snakeroot	white	3-4 ft	late summer	Dark foliage is attractive even while the plants are not in bloom. Nice addition for the "native look." As blooms decline, plants become a little ragged looking.
Hibiscus coccineus Scarlet Mallow	red	7-10 ft	summer	Dies back to the ground but very quick growing. Very exotic looking with 5" blooms. Great for a garden accent and tolerates wet locations.
Knautia 'Melon Pastels'	various	18-24"	summer	Nice addition for the front of the border. Potential as a cut flower.
Lysimachia nummularia 'Aurea' Gold Moneywort	golden yellow foliage	2-3"	summer	A low-growing ground cover. Good to brighten an area of the garden or front of the border. Not that invasive.
Monarda 'Petite Delight' PPAF Dwarf Bee Balm	pink	12-14"	late summer	Not invasive, doesn't lodge, and appears resistant to powdery mildew. Nice plant.
Salvia madrensis 'Dunham'	yellow	5-6 ft	late fall	Plants are not hardy. Blooms too late in the season to be useful. Often killed by frost before blooms completely show color.
Salvia 'Maraschino' Cherry Sage	red	3-4 ft	summer	Small red blooms all summer. Not showy from a distance. Attracts hummingbirds.
Salvia gregii 'Sierra San Antonio' Yellow Texas Sage	yellow	12-14"	summer	Not hardy. Bloomed most of the season but not as vigorous as other salvias.
Salvia microphylla 'Wild Watermelon'	red	18-24"	summer	Not reliably hardy. Similar habit to S. 'Maraschino'
Salvia puberula 'Hidalgo' Hidalgo Mexican Sage	deep pink	36-48"	late summer	Not hardy. Plants lodge and may require staking to maintain habit. Although not hardy, the striking distinct blooms are a welcome addition to the late summer garden.
Salvia 'Raspberry Royale'	deep pink	3-4 ft	summer	Similar to 'Maraschino' but blooms a deep pink.
Salvia regla 'Jame' Orange Mountain Sage	orange	18-24"	early fall	Not hardy. Blooms relatively large and attractive, but plants bloom too late in the season to be effective even as an annual.
Salvia uglinosa Bog Sage	blue	5-6 ft	summer	Blooms all season. Habit rather rank. Can reseed and become invasive. Great for the "wild" look. Unpleasant foliage odor.
Tovara virginiana 'Painter's Palette'		12-14"	all season	Grown for the effect of the variegated foliage. Prefers shade; slow growing; has potential as ground cover.
Verbena 'Abbeyville'	light blue	6-8"	summer	Begins bloom early but must be cut back to promote rebloom.
Verbena 'Appleblossom'	pink	6-8"	summer	Blooms later in the spring than others. Must be cut back to promote rebloom.
Verbena 'Blue Prince'	blue	6-8"	summer	Not hardy. Still has great potential as an annual. Great in containers.
Verbena canadensis 'Greystone Daphne'	lavender	6-8"	summer	Not has hardy as some others. Probably not the best choice.
Verbena 'Fiesta'	pink/red	6-8"	summer	Mottled blooms are very attractive. Like others, must be cut back after bloom to promote rebloom.
Verbena canadensis 'Lilac Time'	lilac	6-8"	summer	Was in full bloom April 15, 2000. The earliest blooming of all the verbenas. Like others, must be cut back after bloom to promote rebloom.
Verbena peruviana	red	2-3"	summer	Mat-like habit makes this one rather unusual. Consider for a very low ground cover. Must be cut back to promote rebloom.
Verbena 'Snowflurry'	white	6-8"	summer	Not reliably hardy. Some plants did overwinter, but this is not a vigorous plant for us. There are better choices.
Veronica puduncularis 'Georgia Blue' Creeping Veronica	blue	1-2"	early summer	Hardy and cute. Very bright and attractive when in bloom. Not invasive and could be a very attractive ground cover. Foliage persists through the winter.

These perennials have been observed for only one summer:

- Asters—*Aster apellus* 'Triumph', *Aster laevis* 'Bluebird', *Aster latiflorus* 'Prince', *Aster novae-angliae* New England Aster, *Aster novi-belgii* 'Snow Cushion' and 'Woods Purple' New York Aster, Aster x frikarti 'Monch'
- Catmints—*Nepeta* 'Dawn to Dusk', *Nepeta* 'Subsessilis', *Nepeta faassenii* 'Six Hills Giant'
- Cone Flowers—*Echinacea pallida, Echinacea paradoxa, Echinacea purpurea, Echinacea simulata, Echinacea tennessensis*, *Ratidiba columnifera* 'Mexican Hat' Prairie Coneflower

- *Crocosmia* 'Venus'
- Daisies—*Buphthalum salicifolium* 'Sun Wheels' Willowleaf Oxeye, *Erigeron* 'Azure Fairy' Oregon Fleabane, *Helenium* 'Coppella' Sneezeweed, *Heliopsis* 'Loraine Sunshine' False Sunflower
- Geraniums, Cranesbill—*Geranium* 'Dusky Rose', *Geranium cantabrigiense* 'Karmina', *Geranium cinereum* 'Ballerina', *Geranium clarkei* 'Kasmir Purple', *Geranium maculata* 'Claridge Druce', *Geranium phaeum* 'Samobor'
- *Heuchera x brizoides* 'Bressingham Hybrid Coral Bells
- *Hibiscus moscheutos* 'Disco Bell Pink' and 'Disco White'
- Kentucky Native Plants—*Baptisia leucophaea* Cream False Indigo, *Chasmanthium latifolium* River Oats, *Erianthus alopecuroides* Silver Prairie Grass, *Helianthus mollis* Downy Sunflower, *Parthenium integrifolium* Wild Quinine, *Rudbeckia triloba* Thin-leaved Cone Flower, Brown Eye Susan, *Spirea alba*, *Limonium latifolia* Statice
- Mullein—*Verbascum* 'Helen Johnson' and 'Jackie'
- Perennial Garden Mums—*Ajania pacificum* 'Pink Ice', *Chrysanthemum yezoense*, *Dendranthema rubellum* 'Clara Curtis' and 'Mary Stoker'
- Perennial Plant Association—Plants of the Year—*Astilbe* 'Sprite', *Coreopsis verticillata* 'Moonbeam' Threadleaf Coreopsis, *Echinacea purpurea* 'Magnus' Purple Cone Flower, *Heuchera micrantha* 'Palace Purple', *Perovskia atriplicifolia* Russian Sage, *Rudbeckia fulgida* 'Goldsturm' Cone Flower, *Salvia nemorosa* 'May Night' Meadow Sage, *Veronica longifolia* 'Sunny Border Blue' Speedwell
- *Phlox maculata* 'Miss Lingard' and 'Natasha'
- Sages—*Salvia lyrata* 'Burgundy Bliss', *Salvia superba* 'Blue Hill', 'Blue Queen', 'Snow Hill', Meadow Sage
- *Schizostylis coccinea* Kaffir Lily
- *Sedum spectabile* 'Autumn Joy' and 'Brilliant', *Sedum spurium* 'Vera Jameson'
- Speedwells—*Veronica* 'Fascination', 'Giles van Hess', 'Goodness Grows', 'Spring Dew', 'White Jolanda', *Veronica austriaca* 'Crater Lake Blue', *Veronica spicata* 'Noah Williams' and 'Red Fox'
- Stokes Asters—*Stokesia laevis* 'Blue Danube', 'Klaus Jellito', 'Mary Gregory', 'Purple Parasols', 'Silver Moon'

Annual Plant Performance

Many annual flowers are grown each year in our trials and have a well-known performance record. The following plants were "new" this season in our trials or just deserved to be mentioned again. None had intensive maintenance requirements or exhibited any problems with diseases or pests. No information regarding this season's AAS trials is released until the judging process is complete and winners are designated.

Annual Bedding Plants

Name	Flower Color	Height	Season	Performance
Floss Flower *Ageratum houstonianum* 'Blue Horizon'	blue	24-28"	summer	Although not new to the garden, this ageratum continues to be one of the best performers. Better than other ageratums with the added benefit of being a great cut flower.
Opal Cup *Anoda*	lavender	24-28"	summer	Similar habit to a hollyhock. More of a novelty but useful for something different. No apparent pest or disease problems. Required no special maintenance.
Snapdragon *Antirrhinum majus* 'LaBella Mix', 'Light Pink Ribbon'	various	18-24"	summer	Although they heat checked somewhat, these plants appeared fairly heat tolerant and produced blooms all summer.
Begonia 'Dragon Wing'	rose red	18-24"	summer	Great performance from a large size begonia. Needs plenty of water and fertilizer for best performance.
Million Bells *Calibrachoa* 'Cherry Red', 'Terra Cotta'	rose red, salmon	12-15"	summer	Commonly used for hanging baskets but excellent performance in ground beds. Flowered uniformly all summer.
Calibrachoa 'Liricashower Blue', 'Liricashower Rose', 'Trailing Pink', 'Trailing White'	blue, rose, pink, white	4-6"	summer	Commonly used for hanging baskets but excellent performance in ground beds. Flowered uniformly all summer.
Vinca *Catharanthus roseus* 'Stardust Orchid'	lilac with white center	12-14"	summer	2000 AAS Winner. Unique color. Performance similar to other vinca.
Angel Trumpet *Datura meteloides*	white	3-4 ft	summer	Fast growing. Three plants covered a 6' x 8' portion of a flower bed. Large, showy white blooms. Good as a specimen plant. Plant parts poisonous.
Dianthus 'Melody Pink'	pink	16-18"	summer	2000 AAS Winner. Grass pink type of habit. Blooms were produced consistently all summer. Plan to observe for hardiness.
Gazania rigins Daybreak Series - 'Bright Orange', 'Bronze', ' Garden Sun', ' Pink Shades', ' Red Stripe', ' White', 'Yellow'	mixed	12-14"	summer	Overall performance was mixed. The plants grew well and flowered well in early summer and fall, but they seemed to struggle more in the heat of summer. Self-sowed dramatically, probably not a good characteristic.
New Guinea Impatiens *Impatiens hawkeri* 'Java Mix'	mixed	16-18"	summer	A New Guinea produced from seed that performed similarly to others.

Annual Bedding Plants

Name	Flower Color	Height	Season	Performance
Lantana camara 'Rainbow'	red and orange	12"	summer	Common landscape plants in the South; heat and drought tolerant. This variety seems too small and too slow growing for garden use in Kentucky.
Lantana camara 'Cowboy', 'Tangerine', 'Weeping Lavender', 'White'	mixed	12-18"	summer	Common landscape plants in the South; heat and drought tolerant. These varieties are easy to grow and perform well.
Lantana camara 'Confetti', 'Dallas Red', 'Irene', 'Patriot Hot Country', 'Patriot Sunburst' , 'Pink Caprice', 'Radiation', 'Rainbow', 'Samantha',	mixed	18-24"	summer	Common landscape plants in the South; heat and drought tolerant. These varieties are easy to grow and perform well. 'Radiation' is our favorite because of bright red/orange flowers.
Lantana camara 'Dove Wing', 'Golden Plume', 'Lady Olivia', 'Miss Huff', 'New Red', 'Patriot Hallelujah'	mixed	24-36"	summer	Common landscape plants in the South; heat and drought tolerant. These varieties are easy to grow and perform well but may be too large for many gardens. 'Miss Huff' may be hardy.
Blue Stars *Laurentia axillaris*	blue	8-10"	summer	Small blue blooms were produced all summer. Has potential; will try again. No apparent pest or diseases, and no particular maintenance requirements.
Osteospermum 'Passion Mix'	various	12-18"	early and late summer	Plants became leggy and floppy. Early bloom is very showy. Late bloom not as showy. Better in a mixed border because show is not consistent. AAS Winner.
California Bluebell *Phacelia campanularia*	blue	3-5"		Plants burned out early. Bright blue blooms are very attractive, but the plants don't seem to tolerate our climate.
Plumbago capensis 'Escapade Blue', 'Escapade White'	blue, white	18-24"	summer	A common landscape flower in the South with good heat and drought tolerance. Seemed too slow growing and flowering for the Kentucky landscape.
Portulaca grandiflora 'Radiance Bicolor', 'Radiance Fuchsia'	fuchsia, fuchsia and white	3-5"	summer	A large-flowered moss rose from cuttings. The fuchsia-colored flowers were spectacular in the landscape.
Castor Bean *Ricinus communis* 'Carmencita Pink', 'Carmencita Red'	seed heads pink or red	8-10 ft	summer	Although seed set isn't apparent until later in the summer, these plants produce a quick annual hedge. Both could be very effective additions to the garden.
Fan Flower *Scaevola aemula* 'New Wonder'	blue	8-12"	summer	Typically used in hanging baskets but an outstanding spreading plant with blue flowers in the landscape.
Bacopa *Sutera cordata* 'African Sunset', 'Lavender Storm', 'Snowstorm'	white, red, lavender	2-4"	summer	Cool-season plants from cuttings generally used in containers. Did not tolerate our summer garden conditions well.
Mexican Sunflower *Tithonia rotundifolia* 'Fiesta Del Sol'	orange	3-4 ft	summer	Past AAS Winner. Plants have a more compact habit and do not lodge late in the season but decline in late summer. Better choice than 'Torch' for this reason.
Verbena *Verbena canadensis* 'Abbyville', 'Batesville Rose', 'Blue Princess', 'Pink Sunrise', 'Temari Bright Red', Cherry Blossom Pink', 'Patio Blue', 'Violet', 'Tortuga Double Purple', 'Hot Pink', 'Peach', 'Red', 'White', 'Wildfire Dark Lavender'	various	10-24"	summer	These verbenas have larger, less divided leaves. Temari and Tortuga verbenas flowered all summer and fall, while the others flowered sparsely in mid-summer. Tortugas seemed more susceptible to disease. Temari Patio Blue was the best of all verbenas in 2000. It flowered well all summer and produced a large mass of plants 24" tall. The other Temari verbenas performed well and remained a vigorous ground cover at 10 to 12". The Temari varieties remain our favorite after three years of trials. The unique or strong colors of Tortuga White, Red, and Hot Pink were attractive in the garden, but the plants did not perform as well as the others.
Verbena *Verbena tenuisecta* 'Aztec Lavender, 'Pink Magic', 'Babylon Lilac', 'Neon Rose', 'Silver', 'Tapien Blue Violet', 'Tapien Rose Pink'	various	6-12"	summer	These verbenas have smaller leaves that are finely cut. In general, these plants do not flower well in mid-summer but flower profusely in spring, early summer, and fall. Plus, they are frost tolerant. Tapien verbenas were somewhat better in our trials.
Zinnia 'Profusion White, Cherry, Orange'	white, rose, orange	14-24"	summer	AAS Winners. These disease-resistant zinnias should be in many commercial and residential gardens. Orange is somewhat better than White which is better than Cherry. No disease or maintenance problems. Great plants!
Swiss Chard 'Bright Lights'	yellow & red stems	16-18"	summer	Great for the edible landscape. Foliage texture and stem color contrast well with many other plants.

Evaluation of Ground Covers at the UK Arboretum

Richard Durham, Department of Horticulture

A ground cover evaluation has begun at the University of Kentucky/Lexington Fayette Urban County Arboretum. Installation of plants occurred in May 2000.

Annuals

A few tropical species were planted to see whether they would provide fast enough cover to be recommended as temporary or annual ground covers. Because of their lack of hardiness, these species would be treated as annuals in the landscape.

- *Cissus rhombifolia*—Grape Ivy was installed as rooted cuttings in 1-inch plugs on approximately 8-inch centers in a fairly sunny location. Although most plants survived in the landscape, the plants did not spread sufficiently to fill between plants. Toward the end of the season, the plants were becoming more vigorous, but growth ceased with the first frost. Installing a larger transplant and increasing fertilization may have given these plants an extra boost in getting established.
- *Setcreasea purpurea*—Purple Heart Ivy was planted as a companion to *Lavender* (see below).The transplant size and spacing were similar to *Cissus* except the planting was made in full sun. As with *Cissus*, the plants survived installation well but were slow to establish and spread. A larger transplant and increased fertilization may have been beneficial in getting these plants to fill their allotted space.
- *Zebrina pendula*—Wandering Jew was installed essentially the same as *Cissus* except in a shady area. The expectation was that these plants would rapidly fill in the allotted area, but this was not the case. As with *Cissus*, these plants may have performed better with additional fertilizer applications and may have responded to increased watering.

We believe these species may have potential as annual ground covers and will repeat this evaluation with increased fertilization and, in the case of *Cissus* and *Setcreasea,* with larger transplants.

Perennials

Several perennials were added to the existing ground cover display at the Arboretum including several cultivars of *Hedera helix* and *Sedum spp*. These were evaluated for rate of establishment and initial spread. Hardiness will be evaluated in future years.

- *Fragaria vesca* 'Alexandria'—Alpine strawberry performed very well from 1-inch plug transplants established from seed. The plants were installed 8 to 10 inches apart in part shade. The plants completely filled in within about two months. Flowers and fruit were evident from the end of July until well beyond the first frost.
- *Hedera helix*—Several cultivars of English ivy were installed either from 2-inch pots or 1-inch plugs and were planted 12 inches apart. Most survived well following transplant, but these differed greatly in the amount of spread during the first season of growth. Some of these cultivars may lack sufficient hardiness to be recommended for Kentucky landscapes. Therefore, readers are cautioned to use these varieties sparingly in the landscape until their hardiness under Kentucky conditions can be evaluated.
- 'Baltica'—has replaced 'Thorndale' as the industry standard. The plants appeared to be fairly vigorous in that by the end of the season, vines 4 to 5 feet long were evident on several plants. However, the plants had not filled in very well. This cultivar did have the longest vines following one season of growth.
- 'Duck Foot'—exhibited very dense compact growth but did not fill in between plants. Had the plants been spaced at 6 to 8 inches rather than 12 inches, nearly complete fill would have occurred during the first year. The fine texture and compact spread of this cultivar might make it especially well suited to rock gardens.
- 'Gold Baby Plus'—similar to 'Baltica'. Some plants produced very long vines, but there was generally fairly poor fill between plants during the first growing season.
- 'Hermania Plus'—a little more vigorous than 'Duck Foot' with about equal spread. The foliage on these is noteworthy. The leaves are more elongate or linear than the typically lobed ivy leaf.
- 'King's Choice Plus'—This gave the best cover of all the English ivies and almost completely filled the space between plants.
- 'Spetchley'—This cultivar established poorly, as many of the plants failed to survive after installation. Those that survived were moderate in vigor, but fill between plants was extremely poor due to missing plants.
- 'Silver Lace Plus'—similar but perhaps not quite as vigorous as 'King's Choice Plus,' but 'Silver Lace Plus' still exhibited good vigor and filled in well between plants.
- *Hypericum perforatum* 'Topaz'—Saint John's Wort was transplanted from 1-inch plugs that were established from seed. The plants gave excellent coverage after about two months; however, the habit was somewhat inconsistent. Some plants were more upright in growth, reaching a height of 14 to 18 inches, while other plants were more compact and stayed below about 10 inches in height. This probably reflects the variable nature of the species when propagated from seed. Nevertheless, the plants provided a very quick and effective ground cover.
- *Lavender dentata*—Fringed Green Lavender was established from 3-inch pots and grew to about 18 inches tall. The plants were spaced 8 inches and filled the space between

plants the first year.

- *Lavender angustifolia*—English Lavender was established similar to *L. dentata*. *L. angustifolia* was more compact and reached a height of about 12 inches. This species did not completely fill in between plants during the first season of growth. Both lavenders made great companion plants to Purple Heart Ivy.
- *Rubus calcynoides*—Dwarf raspberry was established from 3-inch pots, 18 inches apart, in a partly shady location. The plants have not filled in but show excellent promise as a ground cover. The small foliage has a very soft, fine texture. The compact plants would be an excellent addition to a rock garden. The spread during the first season was around 10 to 12 inches with some longer trailing vines. This will definitely be one to watch during the coming years.
- *Sedum spp*.—Five new cultivars of *Sedum* were installed at the UK Arboretum. All were established from 3-inch pots, spaced 12 inches apart, in an area with full afternoon sun. Not all plants flowered the first season so only their rate of spread will be reported. All plants survived transplanting and, although their initial growth was slow, most ended up at least doubling their size after the first growing season.
- *Sedum* 'John Creech'—coverage about 10 inches.
- *Sedum kamtchaticum*—coverage about 6 to 8 inches.
- *Sedum reflexum*—coverage to about 8 to 10 inches.
- *Sedum* 'Rosy Glow'—poorest coverage of all; very little spread during the first year, but it did produce the best show of flowers.
- *Sedum spurium* 'Fuldaglut'—best coverage at about 12 inches.

Several other perennials were planted for evaluation as ground covers. Among these were Albretia *deltoidea* 'Whitewell Gem', *Aurina sacatilis* 'Compacta', several cultivars of *Phlox subulata*, and several cultivars of hardy *Geranium*. These are slower to establish than those listed above, and their performance will be reported in future years.

PLANT EVALUATION

Daylily Evaluations

Winston Dunwell, Dwight Wolfe, and June Johnston, Department of Horticulture

Nature of Work

Evaluation of *Hemerocallis* daylily cultivars at the University of Kentucky Research and Education Center (UKREC) at Princeton is a result of the interest in daylilies that has created strong demand for plants and information on daylily cultivars. Daylily cultivars supplied by Kentucky hybridizers were evaluated for aesthetic appeal and favorable production characteristics.

Kentucky daylily cultivars for the 2000 trial were supplied by Thoroughbred Daylilies (T), Paris, KY; Schott Gardens (S) (for more on Schott Gardens cultivars see previous Research Reports), Bowling Green, KY; and Swanson Daylilies (Octavian = diploid and Milano = tetraploid), Lexington, KY.

Weekly observations were made on all cultivars in the evaluations to record time and color of bloom for the 2000 season. Daylilies were dug and divided on October 2, 2000 (Table 1). The divisions were replanted for further evaluation. Selected cultivars were distributed by the UKREC Nursery Crops Development Center (NCDC), Princeton, to the Floriculture Display Gardens at the UK Horticultural Research Farm in Lexington.

Results and Discussion

The bloom dates are reported as the first bud and the first bloom observed for any of the plants in the planting and the last bloom on any of the plants of a particular cultivar. The height of the scape is reported in inches. Irrigation was provided. The length of the bloom period can be influenced by the production system.

Significance to the Industry

There continues to be an increase in the number of Kentucky nurseries producing daylilies and the number hybridizing daylilies. New cultivars with exciting characteristics such as John Rice's "white line" and "ruffled" edges in combination with watermarks, eye zones, and bands help maintain high levels of daylily sales to daylily collectors, gardeners, and landscapers. Evaluations of cultivars for time of flowering and number of divisions are important to a cultivar's economic survival. Three divisions per original plant is considered the absolute minimum in order for a cultivar to be considered commercially viable, and then only if the bloom characteristics are exceptional.

Knowledge of a cultivar's special bloom characteristics, i.e., early bloom, continuous bloom, or fall bloom, has been used to tailor marketing strategies. For example, a cultivar that bloomed during the fall festival season could expand the marketing diversity for roadside stands and entertainment farms as well as increase the length of the market window for daylily growers. Cultivars that bloom early and could be displayed in bloom during peak retail sales in the spring would also enhance sales.

Note: A single plant of each cultivar evaluated since the first daylily evaluation trial in 1992 has been planted in a display garden available for public viewing at the University of Kentucky Research and Education Center in Princeton. Some cultivars have been planted at the UK Arboretum in Lexington.

Table 1. 2000 Kentucky daylily characteristic[1] observations.

Cultivar	Date of First Bud	Date of First Bloom	Date of Last Bloom	Height (in.)	Color	Number of Divisions (proliferations)
Angel's Braid (T)	15Jun	30Jun	5Oct	15.0	Yellow-lavender blush	NH
Baby Blanket (T)	15Jun	30Jun	13Jul	13.7	Pink	4 (1)
Candie Dwyer (T)	07Jun	26Jun	02Aug	17.5	lavender	4
Chuck Wheeler (T)	26Jun	13Jul	13Jul	12.9	Purple	5
Crown of Creation (T)	02Jun	05Jun	24Jul	17.8	Gold-Orange	3
Dave Bowman (T)	15Jun	13Jul	24Jul	10.9	Mauve w/ Burgundy eye	4
Magical Mystery(T)	02Jun	22Jul	02Aug	15.8	Pale Burgundy	3
Mexican Siesta (T)	02Jun	05Jul	13Jul	12.0	Dark Rose w/Yellow	3
Mystery Lover (T)	02Jun	26Jun	05Jul	21.2	Purple Red	6 (1)
Nancy Ligon (T)	02Jun	26Jun	03Jul	11.9	Yellow Peach	2
Truly Angelic (T)	16Jun	05Jul	07Jul	18.4	Pink-Lavender	5 (1)
Wes Kirby (T)	07Jun	24Jul	24Jul	11.8	Lavender	4
Upper Echelon (T)	2Jun	13Jul	24Jul	14.5	Violet	5
Classic Rose	na	na	na	na	Pink	9
Neddie Downing(S)	na	na	na	na	Ivory	4
Ray Hammond (S)	na	na	na	na	Rust/Yellow	4
Mary Shadow (S)	na	na	na	na	Yellow/blush blush	5
Janice Wendell (S)	02Jun	26Jun	02Aug	25.7	Yellow	6
Milano Maraschino	02Jun	15Jun	05Jul	26.8	Wine/Yellow	NH
Milano Violet Mark	02Jun	20Jun	05Jul	23.9	Violet	6
Milano Rocket	02Jun	15Jun	13Jun	23.8	Burnt Orange	2
Octavian Marble Ring	02Jun	15Jun	5Jul	26.1	Peach	3
Octavian Marble Model	02Jun	07Jun	05Jul	25.0	Violet	9
Octavian Orchid	02Jun	07Jun	05Oct	25.1	Purple Pink w/Yellow	17
Octavian Glow	02Jun	07Jun	20Jun	10.2	Light Cream	8
Octavian Exotic Marble	02Jun	15Jun	02Aug	21.5	Peach w/Violet Eye	9
Octavian Cherry Doll	na	02Jun	30Jun	18.4	Reddish Peach	6

[1] Color descriptions are limited and do not include throat colors, ruffling of edges, or edge color. See grower's catalog for more thorough descriptions.
NB–no bloom observed
NH–not harvested

Table 2. 1999 non-Kentucky daylily characteristic observations.

Cultivar	Date of First Bud	Date of First Bloom	Date of Last Bloom	Ht. (in.)	Color	Number of Divisions (proliferation)
Barbara Mitchell	02Jun	15Jun	13Jul	27.0	Pink	NH
Siloam Virginia Henson	07Jun	26Jun	05Oct	21.2	Pink w/Red Eye	6
Hyperion	na	na	na	na	Yellow	6
Happy Returns	na	na	na	na	Pale Yellow	9
Always Afternoon	02Jun	15Jun	02Aug	13.5	Lavender/purple eye	5
Open Hearth	na	na	na	na	Yellow/red blush	9
Ruffled Apricot	na	na	2Oct	na	Apricot	4
Buttercurls	02Jun	15Jun	5Oct	26.8	Yellow	12
Chicago Sunrise[1]	02Jun	20Jun	02Aug	28.0	Orange	na
Eric Jr.	02Jun	26Jun	28Jul	29.4	na	39
Lisa My Joy	07Jun	20Jun	13Jul	18.8	off white/ purple eye	na
Anzac	07Jun	26Jun	05Oct	20.4	orange	10
Pardon Me	15Jun	26Jun	13Jul	10.8	red	5
Cantique	07Jun	20Jun	30Jun	9.3	pink	4 (1)
Juanita	07Jun	26Jun	02Aug	29.3	Orange	13
Always Afternoon	02Jun	15Jun	02Aug	13.5	mauve/purple eye	NH
Aten	07Jun	05Jul	23Aug	32.4	Orange	10

[1] Chicago Sunrise had a fasciated scape.
NH—Not harvested

PLANT EVALUATION

Buddleia Cultivar Landscape Evaluation

Winston Dunwell and Paul Cappiello, Department of Horticulture

Nature of Work

This is the first year of a study at the UK Research and Education Center at Princeton evaluating *Buddleia* species and cultivars. Buddleia, or butterfly bush, is an attractive long-flowering shrub known for its long spiked flowers that attract butterflies. Plants grown from cuttings and averaging 6 to 8 inches tall were planted April 27, 2000.

Results and Discussion

Size of the plant at the end of the growing season is reported as spread, which is an in-the- row width measurement plus an across-the-row width measurement divided by two, and a height measurement (Table 1). Measurements were taken November 9, 2000, and are reported in inches.

Table 1. *Buddleia* spread and height measurements.[1]

Species/Cultivar	Spread	Height	Species/Cultivar	Spread	Height
'Pink Delight'	44"	25.5"	'Flaming Violet'	43"	44"
'Fair Maiden'	58.5"	36"	'Golden Glow'	63"	62"
'Deep Lavender'	55.5"	40"	'Orchid'	58"	37"
'Pink Charmer'	54"	38"	'Fascination'	52.5"	36"
'Centennial Purple'	68"	39"	'Lavender Beauty'	44"	35"
B. longifolia	63.5"	45"	'Fascinating'	49"	43"
B. salvifolia	15.5"	32"	*B. hemsleyana*	45"	36"
'Windy Hill Farm'	35"	27"	'Harlequin'	41"	28"
'Lavender Ice Cream'	64.5"	54"	'Dudley White'	50"	44"
'Hever Castle'	63"	47"	'Black Knight'	34"	26"
'Excellent Blue'	63"	45"	'Dubonnet'	55"	42"
B. x weyeriana 'Sungold'	85"	46"	'Morgaine'	46"	25"
'Royal Red'	45"	34"	'Nano White'	51"	38"
'White Cloud'	45"	30"	*B. japonica*	dead	-
B. lindleyana 'Gloster'	19.5"	15"	*B. yunnanensis*	43"	42"
'Honeycomb' x *B. lindleyana*	75"	50"	'Ile de France'	44"	36"
'Ellen's Blue'	44"	33"	'Golden Crown'	72.5"	46"
'Honeycomb' x *B. lindleyana*	59"	36"	'Niche's Choice'	50"	30"
'White Bouquet'	43.5'	34"	'Compact Lavender'	43"	28"
'Fortune'	49.5"	33"	'Nano Indigo'	56.5"	34"

[1] Names listed in the table as with cultivar name only are *Buddleia davidii*.

Significance to the Industry

The long season of flowering makes Buddleia an attractive landscape plant. It has been speculated that there is interest in new and underutilized Buddleia cultivars for use in landscapes and butterfly gardens. Buddleias may also be used for cut flowers. Following being cut to the ground, straight stems are produced with multiple flowers on each. It would appear that *B. davidii* 'Flaming Violet' and *B. yunnanensis* offer potential as dried flowers. *B. davidii* 'Flaming Violet' has dark stems and attractive seed heads. *B. yunnanensis* does not have colorful flowers but has silvery gray foliage and flower heads. Future evaluations will include cutting back the plants and evaluating their landscape characteristics and cut and dried flower potential.

Appreciation is expressed to Dwight Wolfe, June Johnston, and Hilda Rogers for assistance with this project.

PLANT EVALUATION

Observations from the UK Arboretum Rose Garden

Timothy Phillips, Department of Agronomy

A rose garden was established in the UK Arboretum to demonstrate the use of roses in the landscape, to exhibit the range of rose cultivars available in the industry, and to educate the public on the selection, planting, and care of roses. In 1998, 144 bushes were planted, with 450 more added in 1999 and over 100 more in 2000. Very few rose cultivars are represented in this garden by more than a single plant, so performance observations should be taken with a grain of salt. Often microclimate effects are stronger than plant genetic effect for disease susceptibility and winterhardiness. However, we thought the following observations might be of value to the Kentucky nursery and landscape industry.

- The best winterhardiness and disease resistance from the 1998 planting: Sea Foam, The Fairy, Iceberg, Polarstern, Rio Samba, and Golden Celebration.
- The best winterhardiness and disease resistance from the 1999 planting: Ballerina, Oranges and Lemons, Sevillana, Prairie Fire, Purple Heart, Kaleidoscope, Fourth of July, Rubaiyat, Kentucky Derby, Pixie Hat, Abraham Darby, Heritage, Dublin Bay, Well's Pink and White Climber, Climbing Rainbow's End, Dortmund, and New Dawn.

- The following roses have been killed back to the soil line during one or more of the past two winters: Color Magic, Stephen's Big Purple, and Playgirl.
- The following roses consistently have been heavily attacked by powdery mildew and/or blackspot: Permanent Wave, Stainless Steel, Folksinger, Raphaela, and Soleil d'Or.
- The 2000 growing season was much milder and had better rainfall than the 1999 season. Consequently, most rose plants grew and flowered much better this year compared to last year.
- Nearly all of the 700+ rose plants will be relocated to a new rose garden at the Arboretum over the winter. Monthly ratings for flower production and pest susceptibility will be made next summer in order to obtain more detailed data for rose performance in the Bluegrass of Kentucky.

For additional performance ratings, the American Rose Society has a rating system for most rose cultivars that have been on the market for several years.

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

The UK Nursery/Landscape Fund was initiated in 1993 to provide an avenue for companies and individuals to invest financial resources to support research and educational activities of UK to benefit the industry. Many industry personnel recognized that a dependable, consistent supply of support funds would allow faculty to increase research and education programs addressing industry needs. Such an investment by the industry is wise and essential.

The majority of UK Nursery/Landscape Fund support has been used for student labor and specialized materials/equipment. These investments have allowed us to initiate new research and to collect more in-depth data from existing plots.

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/companies have committed to contribute 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 goal of the initial advisory committee was to develop annual giving to a level that we could endow a fund from which the interest could be used to support this program. That goal became a reality in 1999 -2000 through the encouragement of a state match, dollar for dollar, of private contributions to support research at UK. The Research Challenge Trust Fund was created by the Kentucky General Assembly at the recommendation of Governor Paul Patton to assist the University in reaching the goal of becoming a top-20 public research institution by 2020. This program was funded again in the General Assembly for 2000-2001. The minimum amount to be matched in this phase of the program is $50,000, committed over five years. As was true last year, the commitments of state funds for this match will go fast, and we must move quickly with any additional endowment contributions this spring and summer.

A Family of Endowments Established to Support Nursery/Landscape Research at the University of Kentucky

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 that will total more than $250,000 within five years have been established at the University of Kentucky to support nursery and landscape research through the Department of Horticulture.

Named endowments were established by a minimum commitment of $25,000 over five years. The 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, and
- **Ammon Nursery/Landscape Research Endowment**, established by Richard and Greg Ammon.

UK Nursery/Landscape Research Endowment

The general UK Nursery/Landscape Research Endowment was established with cash and pledges over three years totaling $34,000, which was matched with state funds. These funds were provided by continuing Fellows-level commitments redirected to the endowment, one new Fellows-level contribution, and two one-time contributions.

James and Cora Sanders Nursery/Landscape Research Endowment

Larry and Carolyn Sanders, of the James Sanders Nursery in Paducah, created the James and Cora Sanders Nursery/Landscape Research Endowment at the University of Kentucky. The Sanders have committed $25,000 that was matched by the state through its Research Challenge Trust Fund. Contributions were also made by Paducah area residents to honor James and Cora Sanders. Funds appropriated by the Kentucky General Assembly established the Research Challenge Trust Fund that provided a 1:1 match of contributions to this endowment.

The endowment fund honors Larry's parents, James and Cora Sanders. The family have been active business owners and leaders in Paducah for more than 40 years.

The James Sanders Nursery is a multi-faceted organization with a complete lawn and garden center, equipment sales, and landscape contracting services. The business serves customers in western Kentucky and throughout the midwestern United States.

Don Corum and National Nursery Products Endowment

Bob Corum, before his death in 1999, created the Don Corum and National Nursery Products Endowment. The Corums contributed $50,000, which was matched by the state through its Research Challenge Trust Fund. The endowment is a memorial to Bob's brother, Don, who worked with him in the nursery business.

National Nursery Products, Inc. was founded in 1971. It has grown into a national supplier of nursery plants with offices in Louisville, Baltimore, Chicago, Detroit, Kansas City, Seattle, St. Louis, and St. Paul.

Ammon Nursery/Landscape Research Endowment

Richard and Greg Ammon of Ammon Wholesale Nursery created the Ammon Nursery/Landscape Research Endowment at the University of Kentucky. The Ammons have committed $25,000, which has been matched by the state through its Research Challenge Trust Fund. The Ammon family began its landscape business in 1950. Today it is the largest nursery and landscape business in northern Kentucky with 127 greenhouses on 18 acres and 230 acres of field stock.

UK Nursery/Landscape Advisory Committee

The UK Nursery/Landscape Advisory Committee consists of contributors to the fund and advises the chair of the UK Horticulture Department on the use of available funds to benefit the industry through research and education and assists in the continued development of the fund. Those individuals and companies contributing to the UK Landscape Fund in 2000 (through December 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.

Summary

The contributions of these industry leaders and the matching state funds will result in a family of endowments approaching a quarter of million dollars within three years. Through the generosity and commitment of these leaders, we were able to take advantage of available state funds to make a real and lasting impact on our ability to serve the industry. Annual contributions will continue to be an important mechanism for the industry to support this program. Without industry support, it is simply not possible for us to provide the quality research, extension, and teaching programs we all want.

The Research Challenge Trust Fund, which provides the 1:1 match for endowments to support research at UK, is the greatest opportunity afforded the industry to develop long-term support for the programs designed to support the industry. As was true last year, it is possible for several individuals and companies to pool their commitments to be contributed over the next five years to reach the $50,000 minimum required for the 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.

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. Gardiner
Watch Us Grow of Kentucky

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

Fred and Jenny Wiche
Fred Wiche Lawn and Garden Expo

Bob and Tee Ray
Bob Ray Company

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Hillenmeyer Nurseries

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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.

2000 Contributors to the UK Nursery/Landscape Fund and Endowments (through December 1)

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Mike Ray, Carl Ray Landscape

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Anthony Aulbach
David E. Cornett
Mark Horman
Dr. Dewayne Ingram
Jerry Pullen, God's Green Earth

Industry Organizations
Kentucky Nursery and Landscape Association

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Bernheim Aboretum and Research Forest, Bardstown
Bunton Seed Co., Louisville
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Griffin Industries, Falmouth
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Novartis Crop Protection, Greensboro, NC
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