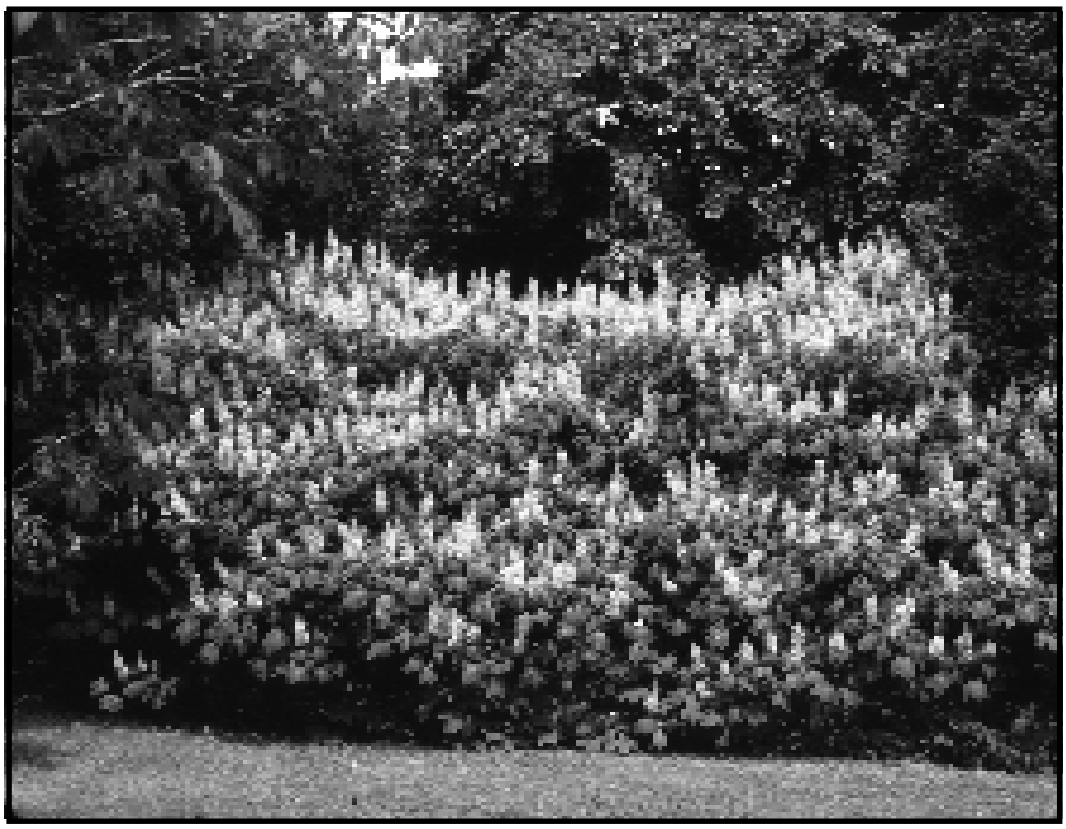
SR-96-1

Nursery and Landscape Program

1996 RESEARCH REPORT



Kentucky Agricultural Experiment Station
University of Kentucky
College of Agriculture
Department of Horticulture/Landscape Architecture
Lexington, Kentucky 40546

Nursery & Landscape Program

UK

U.K. Nursery and Landscape Program

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1996 RESEARCH REPORT

University of Kentucky

Nursery and Landscape Program

1996 UK Nursery and Landscape Program Overview

Dewayne Ingram, Chair - Department of Horticulture and Landscape Architecture

We are pleased to offer this 1996 Research Report as a means of sharing information generated from the UK Nursery/Landscape Program research program. Many faculty, staff and students from several departments have contributed to this effort. The primary areas of emphasis reported here include: production and economics, pest management, and plant evaluation. These areas reflect stated industry needs, expertise available at UK, and the nature of research projects around the world generating information applicable to Kentucky. If you have questions/suggestions about a particular research project, please do not hesitate to contact us.

Although the focus of this report is research, you will also find some highlights of educational activities through our Cooperative Extension program and an update of our undergraduate and graduate instructional program.

Extension Highlights

When you think of the UK Nursery/Landscape Program, the first things that come to mind are probably the highly visible activities such as the state and area education programs. Many activities are provided more quietly, such as contributions of articles to the *Kentucky Nursery News*, the "Nursery Notes" Newsletter, radio, television, and newspaper programs, the Plant Disease Diagnostic Clinic, soil testing and interpretative services, and monthly educational events in the Commonwealth Arboretum. Although there are many facets to the Extension program, below are three 1996 activities highlights.

Recognition and Promotion of Kentucky Landscape Plants

In an effort to promote the use of quality landscape plants in Kentucky and to increase sales of Kentucky-grown plants, Kentucky Nursery and Landscape Association and the University of Kentucky are cooperating in the establishment of Theodore Klein Plant Awards. A committee composed of industry and university representatives was formed to select woody and perennial landscape plants for this award. The primary objective of the award is to bring attention to and create excitement among consumers for new cultivars, new plants, and those plants that have been underused in the landscape. Plants nominated for this award must have excellent characteristics for landscape use; be able to be propagated and produced efficiently; be established in Kentucky with at least two good examples of the plant within driving distance of a Kentucky population center; and have no any serious pest problems. Those plants hybridized, selected, or introduced by Kentuckians will be given priority. The first six plants to receive the Theodore Klein Award will be announced to the industry in 1997 and promoted to consumers in 1999.

Bulletins and Other Printed Materials Related to Landscape Plants

You received a survey early in 1996 from the Horticulture Extension Specialists asking for availability of large trees in your nursery. The resulting publication entitled *Large Trees, The Giants for Kentucky Landscapes* was printed in June 1996. The Kentucky Division of Forestry and UK Cooperative Extension Service funded this four-color publication. Only Kentucky nurseries are listed as sources of the trees unless some plants were not available in the state. In that case, out-of-state nurseries were suggested as sources. This publication completes the three-part series; *Small Trees for Urban Spaces in Kentucky* and *Medium-sized Trees for Kentucky Landscapes* are the other two. These educational materials are used with the two-part series notebook called *Managing Trees in the Urban Environment* for urban forestry and community tree workshops conducted across the state. If you have not received copies of the publications, let us know, and we will send you a copy of each.

Landscape Plant Health Care Workshops and a Hazard Trees Workshop

Landscape plant health care workshops were presented in Lexington and Louisville in 1996. These workshops were designed to benefit beginning arborists and landscape managers by providing intensive, hands-on instruction in small groups. Topics included transplanting, pruning, insect and disease management, and landscape problem diagnostic procedures and skills. Plant Health Care Workshops are scheduled in three locations in 1997.

A Hazard Tree Workshop was also presented in 1996 to provide arborists with increased knowledge and skill in the recognition, assessment, and mitigation of hazard trees on private and public lands. UK faculty and industry leaders presented the topics and conducted field exercises with participants.

Undergraduate Program Highlights

We now offer areas of emphasis in Horticultural Enterprise Management and Horticultural Science within a Plant and Soil Science Bachelor of Science degree. This allows us to attract students who not only understand horticulture but also those students interested in plant sciences who don't yet realize that the application of plant sciences in horticulture is their real interest.

Here are a few highlights of our undergraduate program in 1996:

Enrollment

The Plant and Soil Science major currently enrolls over 110 students, of which 57 have chosen the Horticulture Enterprise Management area of emphasis. This represents a 10% increase over last year. Seven horticulture students graduated in 1996.

Scholarships

More than $10,000 in scholarships were awarded to Horticulture students. The Robert R. Scott, Laverne Scott and Elmira Scott Scholarship was added to those intended for Horticulture students.

Off-campus Learning Experiences

We believe that a significant portion of an 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. Please read the next article regarding student study tours. Additional activities include:

Two student teams competed nationally:

- The Associated Landscape Contractors of America (ALCA) Team competed in San Luis Obispo, CA (Dr. Robert McNiel, coach).
- The Floral Crop Evaluation Team competed in Utah (Dr. Jack Buxton, coach).

Two industry tours were organized:

- Horticulture enterprises and gardens in Oregon and California (March)
- Horticulture enterprises and gardens in the Chicago and Milwaukee areas (October)

Undergraduates presented research results at the Southern Nurserymen Association's Research Conference (Atlanta) and the Eastern Region International Plant Propagators Society (Cincinnati).

Students (undergraduate and graduate) accompanied faculty to the following regional/national/international meetings:

- American Society for Horticultural Science Annual Conference
- Kentucky Landscape Industries Conference and Trade Show
- Garden Centers of America/National Landscape Association Management Clinic
- International Floriculture Short Course
- Southern Nurserymen Association Trade Show
- Eastern Region, International Plant Propagators' Society

Graduate Program Highlights

The UK Horticulture faculty cooperate with faculty in other departments to offer an M.S. degree in Plant and Soil Science with an emphasis in Horticultural Science and Ph.D. degrees in Crop Science or Plant Physiology. Faculty in the UK Nursery/Landscape Program also offer M.S. and Ph.D. degrees in Entomology, Plant Pathology, Agricultural Economics, and Biosystems and Agricultural Engineering. Twelve graduate students are conducting research directly related to the Kentucky nursery and landscape industries. These are talented individuals who will contribute much to the profession upon graduation. Also, these graduate students are allowing our faculty to expand its research and provide avenues for increased multidisciplinary approaches to complex problems and opportunities.

Enhancement of Undergraduate Education in Plants, Propagation and Production Using Regional, National and International Tours

Robert McNiel and Winston Dunwell,
Department of Horticulture and Landscape Architecture

Education of undergraduate majors in horticulture can be enhanced by touring the industry related to their profession. Classroom activities of textbook, lecture and lab are limited activities when it comes to opening the eyes of a new student to the profession. The plant material classes are limited to covering 200-300 plants per semester and may be limited to a single specimen on campus. A diverse industry works with thousands of plants, and each plant has its own personality at each stage of life and season of the year. Textbooks in a way may be limited to the basics. At best, texts are revised on a five- to ten-year basis. How do students keep abreast of the current technologies and changes? Texts, lectures and labs are important parts of the education process, but each may be limited. Labs can continue to expand the knowledge put forth in the lecture. However, equipment and plants may be the limiting factors in developing laboratory activities which would cover the breadth of this industry. Local tours during labs may be limited to a single day or a single firm.

During the 1980s we started incorporating two-day or three-day tours into our program to increase exposure. In 1990 we incorporated the first week-long tour, when we toured the industry centered around Portland, Oregon. This event brought significant encouragement that it should be repeated, and the decision was made to place this tour on a three-year cycle. All students in the program should have a chance to participate while working on their degrees. Next we added international exposure with a tour to Europe to visit gardens and industry. This also is now on a three-year cycle. The other year in the three-year cycle was initiated in 1995 as a garden tour of the Northeast United States and Southeast Canada. Participation has been between 10 to 16 students for each one of these events. During the 28-month period from May 1994 to August 1995, undergraduate students at the University of Kentucky participated in five tours which were of regional, national, or international scope.

Funding for the tours has come from several sources other than from students' pockets. The Oregon tour is now partially funded by the nursery industry. In 1994 the Robert R. Scott, Laverne Scott and Elmira Scott Trust was established in the Department of Horticulture and Landscape Architecture, and a portion of its funds have been specified for travel. Our regional tours are now supported with a grant from the Scott Trust. A very active Horticulture Club has instituted fund-raising activities which have been very instrumental. Other grants and gifts have also been supportive.

A two week tour is like a semester course. It takes education beyond the classroom. Tours alter a student's scope of the industry on the regional, national and international levels and offer new information and technologies not available on campus. Thus, students have a better understanding or working knowledge of what they are exposed to in class.

UK HORT CLUB TOUR OF THE NETHERLANDS & FRANCE
MAY 9 - 21, 1994

THE NETHERLANDS
Aalsmeer Floral Auction
Aalsmeer Flori. Res. Station
Beebee Bulb Co.
Boskoop Area nurseries
Boskoop-Nursery Res. Station
Goldsmith Seed Europe
Het Loo Palace
Keukenhof Gardens
Terra Nigra bv
U. of Leiden Botanic Garden

FRANCE
Azay-le-Rideau
Bois de Boulogne - Bagatelle
Andre Briant Plants
Chenonceau Chateau
I.N.R.A. Experimental Station
LePage Perennial Nursery
Metz, France Green Space
Monet's Garden
Vaux-le-Vitcomte
Versailles
Villandry Gardens

UK HORT CLUB TOUR OF NORTHEAST U.S. & S.E. CANADA
MAY 6 - 19, 1995

Angelica Nursery
Arnold Arboretum
J. C. Bakker & Sons Nurseries
Bartrum Garden
Butler's Orchard
Centerton Nursery
Chapel Valley Landscape Co.
Conard-Pyle Co.
Dunbarton Oaks
Fairmont Park Japanese Garden
Jeffery's Greenhouse
Kendall Sculpture Garden

Kingwood Garden
Lavall Univ. Res. Gardens
Longwood Garden
Monticello
Montreal Botanic Gardens
Morris Arboretum
Mt. Cuba Center
National Arboretum
Niagara Hort. School Garden
Planting Fields
Royal Botanic Garden
Rutgers Univ. Garden
Univ. of Delaware Garden
UCONN Conifer Collection
Univ. of Maine Arboretum
URI Rhododendron Garden
John Vermeulen & Son Nursery
Wade & Gatton Nurseries
Waterloo Gardens
Wave Hill Garden
Western Maine Nursery
White Flower Farm

SCOTT GRANT TOUR OF NEW YORK, ONTARIO, & OHIO OCT. 13 - 15, 1995

Baker Farms
J.C. Bakker & Sons Limited
Brotzman's Nursery
Herman Losley & Son
Niagara Parks Greenhouse
Schenk Farm & Greenhouse
Stokes Seeds
Sunleaf Nursery
Vineland Experiment Station
Westbrook Greenhouses

UK HORT CLUB TOUR OF OREGON & CALIFORNIA MAR. 9 - 25, 1996

OREGON

Bailey's Nursery
Buchholtz & Buchholtz
Caprice Farm
Crystal Gardens
Femrite Nursery
Fisher Nursery
Gutmann Nursery
Heritage Seeds
Iseli Nursery
Japanese Garden
Klupenger's Nursery
McConkey Manuf.
A. McGill Nursery
Microplant Propagation
Moller Nursery
Monrovia Nursery
Nat'l Germ. Repos.
Northwoods Nursery
Panzer Greenhouse
Portland Rose Garden
J. F. Schmidt Nursery
SEBECO
Weeks Berry Nursery
TREECO Rootstocks
Van Bloem
Van Veen Nursery
Windflower Farm
Woodburn Nursery

CALIFORNIA

Deigaard Nurseries
Goldsmith Seed
J&P Roses
La Samida Garden Center
Monrovia Nursery
Sequoia National Park
Stewart's Orchids
Styrbling Arboretum
Yoder Bros. Greenhouse
Yosemite Nat'l Park

SCOTT GRANT TOUR OF CHICAGO/MILWAUKEE AUG. 29 - SEPT. 2, 1996

Alfred L. Boerner Bot. Garden
Ball Seed Trail Garden
Growing Systems
Hahlbeck Greenhouse
Kennicott Brothers Co.
Leider Greenhouse
Leid's Nursery Co.
Midwest Ground Covers
Midwest Trading
Mitchell Park Conservatory
Morton Arboretum
Pan American Seed
Platt Hill Garden Center
Radte Perennial Nursery
Stein's Garden Center
Tom's Farm Market
Val-Al Greenhouse

Changes in Root Length and Diameter in Plants Grown in Copper-treated Containers

Myra Stafford, Robert Geneve, and Robert McNiel
Department of Horticulture and Landscape Architecture

Nature of Work

Copper products have been successfully used to control root growth and development in container grown woody landscape plants for several years. Nurseries apply a solution of copper in latex paint to inner surfaces of containers for increased root control enabling improved field establishment and performance of woody landscape plants (*3*). Copper products control roots by eliminating circling in containers, forcing roots to branch to the center of the container (*1*). The resulting root system is more compact and evenly distributed throughout the container. Increased shoot growth and development after transplanting have also been reported in several plant species produced in copper-treated containers (*1*). In the past, researchers have relied on gravimetric measurements to evaluate root systems. Observation of roots exclusively by root dry weight can provide misleading information due to differences in allocation of root biomass in production of large and small roots. Observation of root systems with the aid of computer imaging and analysis software (MacRhizo™, Regent Inc.) provides an improved method of observing and evaluating root systems. The objective of this study is to determine how copper treatment modifies total root length and root diameter of plants grown in containers.

A fine-rooted species, redbud (*Cercis canadensis*), and a greenhouse species utilized for rapid growth, marigold (*Tagetes patula* 'Little Devil Flame') were grown in 12 cm containers. Container walls were untreated or treated with Spin Out™ (Griffen Corp., Valdosta, GA, USA) a form of cupric hydroxide in latex paint. Marigold seeds were sown directly into containers and redbud were sown into Metro Mix 360 (Scott's) in large flats (60 cm x 30 cm x 10 cm), and transplanted to containers once seedlings reached two inches. Overhead irrigation was applied as needed with Peter's 15-5-15 fertilizer in solution at 200 ppm. Plants were grown under standard greenhouse conditions.

Root length and root diameter classes were obtained from a random 2.5 cm x 2.5 cm x 6.5 cm section of the root system. Marigold plants were evaluated after 38 days, once 4-5 flower buds were visible and beginning to open. Redbud were evaluated after 114 days, once treatment effects were observed in the root system. This experiment was repeated as a time course with marigold and was evaluated on 30, 35 and 40 days.

Results and Discussion

No differences in root biomass were observed between treatments of copper and no copper; however, copper treatment effectively increased total root length in the sampled wedge of redbud and marigold by 28% and 11%, respectively. There was a significant increase in root length in the smallest diameter root class (0 - 0.50 mm) and the subsequent root diameter classes (0.50 - 1 mm and >1 mm) in both redbud and marigold when grown in copper-treated containers. MacRhizo™ enabled us to observe differences in roots from treated and non-treated copper containers that were not detected by measuring root dry weight. Shoot dry weight and leaf area of redbud and marigold were larger when subjected to copper treatments. In redbud, the leaf area and shoot dry weight increased by 14%. The results were less dramatic in marigold with only 5% and 13% increases in leaf area and shoot dry weight. These results suggest increased shoot development occurs as a result of better root development. A root system comprised of a greater proportion of small diameter roots results in increased water and nutrient uptake (*2*). Similar results were obtained when this experiment was repeated as a time course, evaluated at 30, 35 and 40 days for marigold. Again, no differences were observed in root dry weight but an increased amount of 0 - 0.50 mm diameter roots were observed in the copper treatment.

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Table 1. Leaf area, shoot and root dry weight, and root length per root class of redbud and marigold 'Little Devil Flame' plants grown in 12 cm containers treated and untreated with copper hydroxide.

Species Treatment	Leaf area (cm2)	Shoot dry wt. (g)	Root dry wt. (g)	Root length per root class		
				0 - 0.5 mm	5.0 - 1 mm	>1 mm
Redbud control	793.7	7.3	2.4	269.29	108.63	63.49
copper	925.3	9.0	2.5	388.44	146.78	79.30
Marigold control	490.15	2.5	0.8	348.30	312.99	259.53
copper	517.99	2.8	0.8	426.32	361.02	246.94

Capillary Mats Modify Media Moisture During Mist Propagation of Chrysanthemum Cuttings

Jennifer Marohnic, Robert Geneve, and Jack Buxton
Department of Horticulture and Landscape Architecture

Nature of Work

A central feature of the propagation of leafy cuttings is that lacking roots they readily develop water deficits. Slight water deficits, even though insufficient to cause any visual symptoms of distress, can result in considerable delay or reduction in the rooting response *(2)*. With the use of intermittent mist, a film of water remains on the leaf surface lowering the vapor pressure deficit and reducing transpirational water loss *(4)*. However, misting, either applied too frequently or too long at each interval, can result in excessive wetness leading to restricted aeration and reductions in root development *(3)*.

Capillary mats can be used to add or reduce the water content of growing media in containers *(1)*. In the present study, Vatex capillary mats added or removed water from Smithers-Oasis one-inch rootcubes® during mist propagation. The objective of the current study was to evaluate the efficacy of using capillary mats to maintain uniform moisture in the medium during mist propagation.

Mats placed on the surface of the propagation bench extended over the edge of the bench and downward into a water reservoir located a distance of 0 cm, 5 cm, or 10 cm below bench level. The water table established at bench level was determined by the location of the water reservoir. Oasis blocks with chrysanthemum cuttings 'Boaldi' and 'Salmon Charm' were placed on the mats under intermittent mist (ten seconds every five minutes) between 5 a.m. and 8 p.m. Leaf relative water content and quantity of water in the growing medium (ml of water/gram oasis) were measured every three days for fifteen days. After 21 days, the number of roots per cutting was evaluated.

Results and Discussion

Water content in the oasis propagation cube was significantly reduced by 47.5%, 17.9%, and 2.3% for the 10, 5, and 0 cm mat treatments, respectively. This change in water content remained uniform over time for all treatments and both cultivars. Leaf relative water content of the cuttings was not significantly different between capillary mat treatments for both cultivars. This suggests that the water status of the cuttings varied due to the environment (light levels and temperature) and that mist frequency and duration could be changed to meet this demand; capillary mats could then be used to prevent oversaturating of the medium.

Root number per cutting was greater at the 5 cm mat treatment for both cultivars compared to the 0 cm and 10 cm treatments. This suggests that a capillary mat extending 5 cm below the bench can maintain moisture content in the propagation medium for improved rooting of the two cultivars of chrysanthemums used in the study.

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Germination and Seedling Development in Pawpaw [*Asimina triloba* (L.) Dunal]

Cindy Finneseth, Desmond Layne, and Robert Geneve
Department of Horticulture and Landscape Architecture

Nature of Work

Pawpaw (*Asimina triloba*) is a small, deciduous fruit tree indigenous to most of the eastern United States. It is the only temperate member of the tropical Annonaceae or Custard Apple family. As a member of this primitive family, its large seeds have a characteristic ruminate endosperm and underdeveloped embryo.

Seed anatomy and seedling development have been outlined for a limited number in the Annonaceae family *(1,2)*. Ovule and seed development as well as seed morphology have been described in pawpaw *(4)*, but there are no descriptions of morphological changes during seed germination or seedling development. This study was designed to describe important developmental stages during germination and seedling development of pawpaw.

Seeds were extracted from ripe fruit (Keedysville Orchard, University of Maryland, Keedysville, MD), packed in moist sphagnum moss and stored in plastic bags at 4° C until planting. Cold-stratified pawpaw seeds were sown in vermiculite and placed in a growth chamber (25° C, 16 hrs of 25µmol· sec^{-1}·m^{-2} light, 8 hrs of dark and watered every 2 days).

Ten seedlings were randomly chosen and destructively harvested for length measurements (mm) and fresh and dry weight (mg) determinations. To obtain length measurements prior to radicle protrusion, the testa was removed and a 4 mm x 4 mm portion of endosperm containing the embryo was excised from the hilar end of the germinating seed. Paraffin-embedded tissue samples were sectioned using a rotary microtome and stained with safranin-fast green.

Results and Discussion

Pawpaw has an underdeveloped embryo surrounded by ruminant endosperm tissue. The embryo measured less than 2 mm at 9 days after planting. Extending from the cotyledon tips were two parallel channels of cells which stained differently than embryo or endosperm tissues. These growth channels have not been previously described. The cotyledons grow through these channels and it is possible that this facilitates absorption and translocation of materials to the developing axis.

Recognizable stages of seedling development include radicle protrusion, hypocotyl emergence, epicotyl elongation and seed coat abscission. Prior to radicle protrusion, the cotyledons and radicle grow concurrently at approximately the same rate. Cotyledons reached a maximum length after 40 days, well after hypocotyl emergence (27 days).

As the seedling developed, a reallocation of fresh and dry matter occurred. Initially, the largest proportion of fresh weight and dry weight was in endosperm tissue. This gradually decreased as storage material in the endosperm was mobilized and the seedling became autotrophic (45 days).

Pawpaw exhibits an epigeal pattern of seedling emergence. The cotyledons remain encased within the seed and are shed as one unit (day 50). Pawpaw seeds may remain subterranean, but are most often raised above the soil surface as the hypocotyl elongates. This unusual pattern may explain why pawpaw germination has been reported as hypogeal.

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Oak Seed Treatments for Weevil

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

Nature of Work

At the Eastern Region International Plant Propagators Meeting there was discussion on treating oak acorns to rid them of weevils (*Curculio* spp.). The senior author first learned of a seed treatment from the late W. D. "Army" Armstrong, UKCA Fruit Extension Specialist. His method was to put the nuts (in his case pecans) in a coffee can and set it in a cool but not freezing location. The weevils will leave the nuts and migrate to the bottom of the can. Then the seeds can be bagged up for continued storage or direct seeded into containers or the field. At the ER IPPS meeting Bill Barnes of Lorax Farms in Warrington, Pennsylvania, repeated Army's method and reported using a temperature of 35° Fahrenheit (F.). Bill Hendricks of Klyn Nurseries, Perry, Ohio, reported putting acorns in plastic bags with moth balls for three days as a weevil treatment. To test this method, we placed 25 *Quercus alba*, white oak, seeds in nine one-gallon zip-seal bags, which were treated in one of three ways: 1) 68° F., one moth ball per bag; 2) 68° F., no moth ball; or 3) 35° F., no moth ball.

Table 1. Percent Germination

Treatments	Percent Germination
68° F., one moth ball per bag	24.0
68° F., no moth ball	21.3
35° F., no moth ball	0.0
LSD (0.05)	14.1

Results and Discussion

Percent germination (as an average of three replicates) after three days is reported in Table 1. The results are as would be expected if the vapors from the moth balls did not cause damage to the acorns. The plants were placed in containers and placed outdoors for cold treatment. Unfortunately, on 18 Nov 1996 squirrels dug up all but about 25 seeds, and the experiment was terminated. There did not appear to be a squirrel protection factor related to the moth ball treatment, but data related to such a possibility was not collected.

Seed Storage Media Effects on Persimmon Germination

Winston Dunwell and Dwight Wolfe
Department of Horticulture and Landscape Architecture

Nature of Work

Common persimmon, *Diospyros virginiana*, is a medium-to-large narrow tree that produces edible fruit. Kim Tripp and J. C. Raulston *(3)* state that "*Diospyros virginiana* has a lot to offer American landscapes". Persimmon is an attractive native tree that may be a valuable landscape tree because it is tolerant of diverse environmental conditions *(1, 2, 4)*.

Persimmon seeds were collected from native trees in Caldwell County, Kentucky, on 7 December 1995. The seeds were prepared for storage by two methods: 1) Moist seed - cleaned (cap, skin and the easily removed pulp removed), and 2) Dry Seed - cleaned, dried for three days, and the remaining pulp removed. The following treatments were replicated three times: 1) moist seeds; 2) dry seeds; 3) moist seeds in dry perlite; 4) moist seeds in moist perlite; 5) dry seeds in dry perlite; 6) dry seeds in moist perlite; 7) moist seeds in dry peat moss; 8) moist seeds in moist peat moss; 9) dry seeds in dry peat moss; and 10) dry seeds in moist peat moss. Plastic one-gallon storage bags containing 25 seeds per replicate with three replicates per treatment were placed in refrigerated storage (40° Fahrenheit) immediately after treatment.

The seeds were removed from refrigerated storage and planted into a commercially prepared media (Pro-Mix BX) in 10 cubic inch, 8.25 inch long tubes (SC-10 Super Cells, Stuewe and Sons, 2290 S.E. Kiger Island Drive, Corvallis, OR 97333-9461) on 27 April 1996. Germination data was collected weekly through 10 June 1996 when maximum germination for the best treatments was repeated.

Results and Discussion

The 1 June 1996 percent germination data (Table 1) suggest that storage in moist media is beneficial regardless of the seed preparation. As moisture and cool temperatures are required for stratification of many plants, this would be expected. Dry perlite as a storage medium for moist seeds was not significantly different from using moist perlite or peat moss as a storage medium for moist seeds. It is speculated that dry peat moss removed moisture from the remaining pulp on the moist seeds to the point that their germination percent was equivalent to the dry peat moss/dry seed treatment. Therefore, stratification could not be completed in the seed stored in dried peat moss until moisture was provided at planting.

Significance to the Industry

Persimmon seed that is to be collected in the fall, refrigerated over the winter, and directly seeded in the spring should be stored in moist perlite or moist peat moss and placed in a sealed container in order to optimize germination. If a dry medium is to be used as a storage medium, perlite is the preferred medium when moist

seed is used. For convenience of handling the seed can be cleaned or cleaned and dried before storage in moist perlite or peat.

The authors would like to express their appreciation to R. June Johnston for technical assistance.

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Table 1. Percent germination for stored persimmon seed.

Storage Media / Seed Preparation	Percent Germination
Moist Perlite / Moist Seed	93.3a*
Moist Perlite / Dry Seed	89.3a
Moist Peat / Dry Seed	86.7a
Moist Peat / Moist Seed	84.0a
Dry Perlite / Moist Seed	82.7a
Dry Peat / Dry Seed	20.0b
No Media / Dry Seed	16.0b
Dry Perlite / Dry Seed	14.7b
Dry Peat / Moist Seed	12.0bc
No Media / Moist seed	4.0c

[1]*Means with the same letter are not statistically different at the 0.05 probability level using Fishers protected LSD.*

Composted Yard Trash as a Container Medium Component

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Nature of Work

Nursery managers are seeking alternative container media components to replace peat and assorted wood industry byproducts. The elimination of yard trash from landfills and the ensuing composted yard trash products have provided alternatives that should be evaluated in container production systems in the southern/midwestern region. Container medium components with suitable chemical and physical properties from local sources could reduce production costs. An increasing supply of composted yard trash is available to Kentucky nurseries, but the physical and chemical properties and suitability for blending with other components have not been studied. A study was initiated in July 1995 to evaluate several sources of leaf and yard trash compost as a container medium component in combination with pine bark for outdoor production of nursery crops. Compost from four sources was blended with pine bark to yield container media with two ranges (12% to 18% and 22% to 26%) of aeration porosity (% volume filled with air after irrigation and drainage). Compost sources were Kentucky State University, Frankfort, Kentucky, Numus (Bulk) Ag-Renew, Middletown, Ohio, Numus (Bag) Ag-Renew, Middletown, Ohio, Nea's Mushroom Compost, Ohio, and Nature's Own, Dayton, Ohio. Two irrigation regimes provided either 300 or 600 ml (10 and 20 oz) per container twice per day. *Ilex verticulata* 'Winter Red' and *Ilex crenata* 'Glory' were potted into 2-gallon (6-liter) nursery containers in July, 1995, using the blended media. Perk (micronutrients, Vigoro Industries, Chicago, IL) and dolomitic limestone were incorporated at 1.5 and 4 lb per cubic yard (0.9 kg/m^3 and 2.4 kg/m^3), respectively. Woodace fertilizer (20-4-11) was surface-applied at 23 g per container at transplanting and in April 1996. The nine media and two irrigation regimes were replicated eight times for each species. Plants were moved to a unheated, plastic-covered greenhouse the first week of November 1995 for winter protection.

Physical and chemical properties of the composted materials were determined utilizing standard procedures for container media components. Media shrinkage was determined periodically by measuring the distance from the container rim to the medium surface. Chlorosis ratings of 1 to 3, with 3 representing the greatest cholorsis, were recorded in October 1995. Shoot and root dry weights were determined at termination of the experiment in October 1996.

Results and Discussion

Treatments (% by volume) with an aeration porosity of 10-18% were: 75% pine bark:25% KSU compost, 50% pine bark:50% Numus (bulk), 100% Numus (bulk), and 100% Numus (bag). Treatments with an aeration porosity of 22-28% were: 75% pine bark:25% Numus (bag), 75% pine bark:25% Numus (bulk), 75% pine bark:25% Nature's Own, and 100% pine bark. Although there was some shrinkage of all media, the 100% Numus (bag or bulk) exhibited the greatest shrinkage. This should be expected when a medium is comprised of 100% compost with relatively small particles. Media with 100% Numus also resulted in chlorotic leaves in both test species toward the end of the first growing season, which was probably a reflection of inadequate aeration and a high pH when not blended with pine bark.

The 100% pine bark medium and the 75% pine bark blended with 25% of either compost generally produced similar plants of high marketable quality under this production system (Table 1). Neither plant species grew well in the 100% compost media. The greater irrigation volume resulted in increased shoot and root dry weight in the 'Winter Red' but did not influence shoot and root dry weight in 'Glory'.

Significance to the Industry

The physical and chemical properties of composted yard trash sources and appropriate formulation of container media in combination with other components for acceptable water holding capacity and aeration porosity must be determined before nursery operators can effectively utilize these products. Although the composted products tested differed in their physical properties, at least 25% of the compost could be blended with pine bark to yield a container medium with acceptable physical and chemical properties in central Kentucky.

Table 1. Response of liex verticulata 'Winter Red' and Ilex crenata 'Gloria' to container media comprised of various sources and ratios of composted yard trash.

Media		*Ilex verticulata 'Winter Red'*				*Ilex crenata 'Glory'*			
Treatment (%volume)	Air Space (%)	Chlorosis Rating	Media Shrinkage (cm)	Shoot Dry Weight (grams)	Root Dry Weight (grams)	Chlorosis Rating	Media Shrinkage (cm)	Shoot Dry Weight (grams)	Root Dry Weight (grams)
100% pine bark	28	1.4 cd*	4.47 ef	90.7 ab	198.5 ab	1.5 abcd	5.16 d	56.0 ab	40.0 a
75% pine bark: 25% Nature' Own	26	1.3 d	4.41 fg	93.3 ab	193.0 ab	1.3 cd	5.78 cd	64.5 a	39.8 a
75% pine bark:25% KSU compost	17	1.4 cd	3.88 g	102.4 a	211.2 a	1.7 abc	5.38 d	48.1 bc	30.1 ab
75% pine bark:25% Nea's Compost	21	1.5 cd	5.03 cde	99.1 a	178.4 ab	1.6 abcd	6.22 c	52.9 ab	32.2 ab
75% pine bark:25% Numus (bag)	23	1.8 bc	4.75 def	97.2 a	181.2 ab	1.4 bcd	6.09 c	34.6 cd	22.7 bc
75% pine bark:25% Numus (bulk)	23	1.7 cd	5.09 cd	87.2 ab	155.5 b	1.2 d	5.78 cd	48.8 b	30.5 ab
50% pine bark:50% Numus (bulk)	15	1.6 cd	5.53 c	76.8 b	101.9 c	1.8 ab	6.31 c	32.2 d	17.7 cd
100% Numus (bulk)	15	2.1 b	7.15 a	47.3 c	51.8 d	1.6 abcd	8.59 a	17.6 e	11.0 d
100% Numus (bag)	9	2.8 b	6.38 b	40.9 c	52.7 d	1.9 a	7.12 b	14.5 c	9.1 d

**Means with the same letter are not statistically different at the 0.05 probability level.*

Long-term Fertilization Study with Field-grown Nursery Crops

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Nature of Work

Nursery managers desire to maximize growth of plants under production systems with efficient fertilization practices. Fall fertilization has proven to be effective, but producers have questions regarding nutrient leaching, plant uptake, nutrient distribution in the plant, and predisposition of crop plants to winter injury *(1,2,3,4,5)*. Research was initiated in three Kentucky commercial nurseries with six genera of nursery plants to determine the effects of three fertilizer sources and rates on plant growth and development. Plots were established with *Acer rubrum* 'Red Sunset' and *Euonymus alatus* 'Compacta' at Snow Hill Nursery and *Picea abies* and *Pseudotsuga menziesii* at

Nieman's Nursery in the spring of 1994. Treatments were initiated in *Ilex x meserveae* 'China Girl' and *Picea abies* 'Nidiformis' at Ammon's Wholesale Nursery in the fall of 1994. Treatments included Woodace 29-3-8 (Vigoro Industries product with XC-IBDU), 33-3-6 (Scotts Company product with Poly S coating) and 18-3-3 (uncoated urea as the nitrogen source) applied at 100, 250 and 400 lb of N per acre per year, split into spring and fall applications. Treatments were replicated a minimum of five times in randomized complete block designs for each genus. Growth index measurements were recorded for multi-stemmed genera, and height and caliper were measured for other genera at least annually. The timing and magnitude of growth flushes were observed. Leaf samples were taken from deciduous plants in July of each year and from evergreens in November for nutrient analysis.

Results and Discussion

The experiment was recently terminated, and the soil analyses and tissue nutrient content of samples have not yet been determined. However, we will report here some general growth data and observations.

Although the general recommendation for nitrogen fertilization of woody plants in the field is about 250 lb N per acre per year, there is really not complete data on the nutrient requirements of most woody plants. The results of this three-year experiment indicate no advantage of a rate greater than 250 lb N per acre per year, with a variety of woody plants and soil types. Nutrient analyses of soil and tissue samples will be required to confirm that initial assessment.

Observations revealed no significant treatment differences in winter injury or potential injury due to early spring budbreak.

No marketable differences in plant growth due to fertilizer source or rate were noted for the Douglas fir, Norway spruce, euonymus, 'Red Sunset' maple, or 'China Girl' holly. In Bird's Nest spruce, fertilizer source did not influence growth at 250 or 400 lb N rates. However, the Woodace 29-3-8 resulted in more growth in this spruce than the other fertilizers at the 100 lb N rate. The soil and tissue nutrient content data could help us determine the reason for this difference. It appeared that the location of the maple and holly in a given row may have influenced growth during the study more than fertilizer treatments. This is particularly interesting because of the seemingly uniform soil conditions on these sites.

Significance to the Industry

There is no evidence that applications of nitrogen fertilizers applied at rates greater than 250 lbs. N per acre increases woody plant quality or growth in the field nursery. However, nitrogen application rates in nurseries commonly exceed this amount. Based on the data presented to date, the selection of a fertilizer for field production should be based on the cost of the material. One issue that was not addressed in the study was the potential advantage of controlled release fertilizers over readily soluble inorganic fertilizers on the required frequency of application. Application of controlled release fertilizers only one time per year may offset higher product costs compared to more traditional fertilizers.

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Effects of Iron Humate on 'Hinodegri' Azalea Growth and Quality

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Nature of Work

Chronic iron deficiencies can be a serious problem in some woody plants grown in containers. Iron humate is generated as a byproduct of water treatment and may be a cost-effective source of iron. It is also believed that iron humate may have a more indirect effect on plant growth by increasing the cation exchange capacity of the container medium or interacting with components of the medium to make other nutrients more available. Preliminary tests with iron humate as a cost-effective iron source have resulted in increased growth of a tropical palm *(1)* and on the yield of field-grown tomato *(2)*. An experiment was initiated in July 1995, to determine the effective rates of iron humate and fertilizer on growth of container-grown 'Hinodegri' azalea. Iron humate was incorporated at 0, 10, 20 or 30 lb/cubic yard. Azaleas were transplanted from 3-inch containers into 2-gallon containers and Woodace 20-4-11 with IBDU was surface-applied at 15, 19 or 23 g/container. The medium consisted of 100% pine bark amended with dolomitic limestone at 4 lb and Perk at 1.5 lb/cubic yard. The combinations of three fertilizer rates and four iron humate rates were replicated seven times. Plants were moved to an unheated, plastic-covered greenhouse the first week of November 1995 for winter protection. Plants were removed from the overwintering house in May and fertilized at the rates presented above. No winter damage was noted. The experiment was terminated in October 1996 when shoot dry weights and root ratings (1 to 3, with 1 being the most extensive) were recorded and analyzed.

Results and Discussion

All plants in this study were healthy and marketable. Neither the iron humate treatments nor the fertilizer rate treatments affected shoot dry weight (mean = 50 g) or root rating (mean = 1.3). There was no chlorosis observed. Under the conditions of this experiment, there was no advantage of incorporating iron humate in a pine bark medium at rates up to 30 lb/cubic yard for the growth of 'Hinodegri' azalea. There was no advantage of Woodace 20-4-11 rates above the low-end of the manufacturer's recommendation. Yeager et. al. *(3)* presented data at the 1996 SNA Research Conference showing that similar rates of iron humate did not influence the shoot and dry weight of *Ligustrum japonicum* but resulted in a higher visual rating with iron humate at 20 to 30 lb/cubic yard.

Significance to the Industry

Based on this experiment, incorporation of iron humate at rates up to 30 lb/cubic yard did not improve the growth and quality of 'Hinodegri' azalea in a 15-month production period. However, it should be stated that iron humate has benefited the plant quality in other container production systems and environments *(3)*.

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Kentucky Horticulture Survey and Database

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Nature of Work

A survey was mailed in November 1995 to horticultural businesses in Kentucky who were members of a horticultural association or were certified nurseries. Of the businesses surveyed, 979 were associated with the green industry, from which we received 543 useable responses (55% return rate). A directory of Horticultural Products and Services has been published and distributed within the diverse horticultural industries in Kentucky and to Cooperative Extension Agents and administrators and state leaders. Information from the survey was entered into a database for analysis, summary, presentation, and rapid search/retrieval.

Results and Discussion

Of the 543 firms responding, 29% of these firms classified themselves as combination wholesale/retail, 28% were retail but not wholesale, 13% were wholesale but not retail, 22% were service only, and 8% were suppliers for the green industry. Of the 71 wholesale (no retail) nursery and greenhouse firms, 30% also offered some type of landscape service. All of these firms provided landscape installation services while 80% also rendered design services and 62% provided landscape maintenance. No greenhouse wholesale operation with at least 10,000 square feet of growing space provided landscape services.

Forty-four percent of retail firms with no wholesale production also provided landscape services. Ninety-two percent of those providing landscape services indicated that installation was at least one of the services offered. Seventy-seven percent provided design services. In fact, 13 of 81 retail firms indicated that service was the most important phase of their business.

Service was an important component of Kentucky's green industry. Sixty-one percent of all green industry firms responding provided some type of landscape service. Twenty-two percent of the green industry firms responding indicated that they furnished only landscape services. Of the "service only" firms, 75% provided design or installation services, 66% rendered landscape maintenance, and 7% provided only design services.

The directory/database will be used to retrieve names and addresses of horticultural firms, by geographic location, to connect an interested clientele with services desired. Such information will also be useful in designing industry educational and development programs and in efforts to attract related support companies.

Use of Sulfentrazone (F6285) for Preemergence Weed Management in Field-grown Ornamentals

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Nature of Work

The nursery industry currently has limited options for effective season-long weed control, because relatively few soil persistent broad spectrum herbicides are registered for use in ornamentals. Sulfentrazone (F6285), a newly developed herbicide from the FMC Corporation, has shown promising results for preemergence weed control in field trials with ornamentals. Sulfentrazone provides selective control of yellow nutsedge and morningglory spp., as well as broadleaf and annual grass weeds (Weston et al., 1995). When applied at low rates in combination with other efficacious materials, the spectrum and longevity of weed suppression is enhanced (Crotser and Weston, 1995). Additional trials are needed to further evaluate the potential for registration of sulfentrazone for use in ornamentals.

Research was conducted to evaluate preemergence application of sulfentrazone and currently labeled products at different rates in ornamentals. The 17 treatments (replicated three times) included rates of sulfentrazone alone and in combinations with Gallery, Treflan, and Pennant. Within each treatment, ten tree and shrub species were planted, using three plants of each species per treatment. The plant materials included *Hemero callus*, *Liriope muscari*, *Euonymus alata* 'Compacta', *Abies concolor*, *Viburnum trilobum* 'Hahs', *Syringa vulgaris*, *Cercis canadensis*, *Crataegus viridis* 'Winter King', *Fraxinus americana* 'Skyline', and *Quercus rubra*. Plots were sprayed in June 1996, and herbicide efficacy was evaluated at 4 and 8 weeks after treatment (WAT), while phytotoxicity was evaluated at 5 and 10 WAT.

Results and Discussion

Major weeds encountered in this experiment at 4 WAT included annual grasses, yellow nutsedge, morningglory spp., honeyvine milkweed, and velvetleaf. The best overall control was provided by sulfentrazone (0.426 kg ai/ha) plus Pennant (3.409 kg ai/ha), with a 90% overall weed control rating. Also providing excellent control was sulfentrazone at 0.568 kg ai/ha (86% overall control). Sulfentrazone alone at 0.142 kg ai/ha and Gallery alone at 0.568 kg ai/ha provided the poorest overall control (32 and 55%, respectively). Sulfentrazone at higher rates and all sulfentrazone combinations provided moderate control (~80%). Major weeds encountered at 8 WAT included annual grass, morningglory spp., honeyvine milkweed, and velvetleaf. Yellow nutsedge was not apparent at 8 WAT, since it was noncompetitive with the vining weeds. The best overall control was obtained by sulfentrazone at 0.568 kg ai/ha, with a rating of 83%. Sulfentrazone (0.426 kg ai/ha) plus Pennant (3.409 kg ai/ha) also maintained good control with a 78% overall weed rating. Treatments providing the poorest control were the same at 4 and 8 WAT.

Limited phytotoxicity was observed at 5 WAT with sulfentrazone and sulfentrazone combinations. *Liriope* and *Hemero* were most sensitive to sulfentrazone, exhibiting chlorosis and bleaching of the foliage. The highest levels of phytotoxicity in these species were observed where sulfentrazone was applied at 0.568 kg ai/ha and at 0.426 kg ai/ha with Pennant (3.409 kg ai/ha). *Syringa vulgaris* exhibited slight herbicide damage due to initial foliar contact. At 10 WAT, injury to *Hemero* and *Liriope* was still evident, with chlorosis of tissue greatest when high rates of sulfentrazone were applied (> 0.426 kg ai/ha) or when sulfentrazone at 0.426 kg ai/ha was applied with Pennant. Necrosis in *Syringa* was not apparent by 10 WAT, and injury due to initial leaf contact was temporal. However, injury to *Abies* was highly visible at 10 WAT and was greater where higher rates of sulfentrazone were applied and in all sulfentrazone combinations. Chlorosis and necrosis of the foliage were likely due to postemergence contact, as evidenced by enhanced injury within the spray pattern at 10 WAT. It is not clear whether injury would be overcome with time.

Significance to the Industry

Sulfentrazone (>0.426 kg ai/ha) provided consistent and long-term weed suppression of difficult to control weeds. Combinations of sulfentrazone plus Pennant or Treflan also provided consistent control. Use of shielded applicators to prevent postemergence contact of sulfentrazone with ornamental foliage could minimize injury.

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Table 1. Weed control rating

		4 Weeks After Treatment						8 Weeks After Treatment				
TREATMENT	RATE (lb ai / A)	AG	YN	MG	HVM	VL	OVERALL	AG	MG	HVM	VL	OVERALL
1. Sulfentrazone 80WP	0.142	88.3a	100.0a	53.3b	56.7b	100.0a	31.7c	43.3d	25.0bcd	75.0ab	91.7a	40.0de
2. Sulfentrazone 80WP	0.284	95.0a	100.0a	89.3a	62.3ab	98.3a	80.0ab	85.0a	81.7a	71.7ab	95.0a	75.0ab
3. Sulfentrazone 80WP	0.426	96.3a	100.0a	91.7a	76.0ab	95.0a	84.3a	90.0a	59.3abc	75.0ab	96.7a	68.3abc
4. Sulfentrazone 80WP	0.568	91.0a	100.0a	87.3ab	80.0ab	96.7a	86.3a	89.3a	80.0a	78.3ab	93.3a	83.3a
5. Gallery 75DF	0.568	60.0b	97.7ab	53.3b	80.0ab	66.7a	55.0bc	46.7cd	59.3abc	58.3b	48.3c	33.3e
6. Sulfentrazone 80WP + Gallery 75DF	0.284 0.568	84.3a	98.3ab	86.0ab	83.3ab	100.0a	78.3ab	53.3bcd	73.3ab	81.7ab	85.0ab	55.0bcd
7. Sulfentrazone 80WP + Gallery 75DF	0.426 0.568	86.7a	100.0a	91.0a	56.7b	100.0a	78.3ab	73.3abc	76.7a	85.0a	81.7ab	66.7abcd
8. Pennant 7.8L	3.409	93.3a	100.0a	53.3b	78.3ab	66.7a	55.7bc	91.7a	45.0abcd	88.3a	58.3bc	46.7cde
9. Sulfentrazone 80WP + Pennant 7.8L	0.142 3.409	93.3a	100.0a	86.7ab	63.3ab	99.3a	76.7ab	91.7a	85.0a	88.3a	93.3a	75.0ab
10. Sulfentrazone 80WP + Pennant 7.8L	0.284 3.409	9567a	100.0a	81.7ab	65.0ab	96.0a	72.3ab	89.3a	75.0a	81.7ab	85.0ab	63.3abcd
11. Sulfentrazone 80WP + Pennant 7.8L	0.426 3.409	95.0a	99.0a	90.3a	88.3a	100.0a	90.0a	91.7a	76.7a	88.3a	96.7a	77.7ab
12. Treflan 4EC	2.272	91.7a	93.3b	68.3ab	81.7ab	98.3a	77.7ab	88.3a	55.0abc	90.0a	91.7a	46.7cde
13. Treflan 4EC	4.545	89.0a	95.0ab	89.3ab	85.0ab	100.0a	83.3a	76. 7ab	48.3abcd	80.0ab	100.0a	71.7abc
14. Sulfentrazone 80WP + Treflan 4EC	0.142 2.272	90.0a	99.0a	81.7ab	70.0ab	70.0a	80.7ab	86.7a	63.3abc	85.0a	100.0a	71.7abc
15. Sulfentrazone 80WP + Treflan 4EC	0.284 2.272	92.7a	99.0a	85.0ab	85.0ab	100.0a	70.0ab	90.0a	76.7a	88.3a	96.7a	80.0ab
16. Sulfentrazone 80WP + Treflan 4EC	0.426	91.0a	100.0a	66.7ab	60.0ab	100.0a	81.3ab	90.0a	56.7abc	82.7a	98.3a	69.3abc
17. Untreated check	---	0.0c	0.0c	0.0c	0.0c	0.0b	0.0d	0.0e	0.0d	0.0c	0.0d	0.0f
SIGNIFICANCE		<.001	<.001	<.001	**	<.001	<.001	<.001	ns	<.001	<.001	<.001
LSD 0.05	---	20.6	5.6	35.1	31.4	35.3	27.5	29.7	49.4	23.4	31.4	26.8

Table 2. Phytotoxicity ratings

		5 Weeks after Treatment			10 Weeks after Treatment		
TREATMENT	RATE (lb ai / A)	Daylily	Liriope	Syringa	Daylily	Liriope	Abies
1. Sulfentrazone 80WP	0.142	0.2de	0.3de	0.2de	2.0ab	0.3de	1.2cde
2. Sulfentrazone 80WP	0.284	1.0bcde	0.2de	0.0e	2.0ab	0.3de	2.3abcd
3. Sulfentrazone 80WP	0.426	2.0ab	1.3b	0.7abc	2.0a	1.0b	3.3ab
4. Sulfentrazone 80WP	0.568	2.3a	2.3a	0.5abcd	2.2a	2.0a	2.7abcd
5. Gallery 75DF	0.568	0.0e	0.2de	0.0e	1.3ab	0.5cd	0.0e
6. Sulfentrazone 80WP Gallery 75DF	0.284 0.568	1.3abcd	0.8bcd	0.3bcde	0.8ab	0.3de	2.0bcd
7. Sulfentrazone 80WP + Gallery 75DF	0.426 0.568	1.0bcde	0.8bcd	0.3cde	0.8ab	0.8bc	2.3abcd
8. Pennant 7.8L	3.409	0.0e	0.0e	0.0e	0.5ab	0.5cd	0.0e
9. Sulfentrazone 80WP + Pennant 7.8L	0.142 3.409	0.0e	0.8bcd	0.8ab	0.5ab	0.7bcd	3.0abc
10. Sulfentrazone 80WP + Pennant 7.8L	0.284 3.409	0.7cde	0.7bcde	0.4bcde	1.3ab	0.5cd	2.8abcd
11. Sulfentrazone 80WP + Pennant 7.8L	0.426 3.409	2.3a	1.2bc	0.8a	1.2ab	0.8bc	4.0a
12. Treflan 4EC	2.272	0.0e	0.2de	0.0e	0.5ab	0.3de	1.0de
13. Treflan 4EC	4.545	0.0e	0.2de	0.2de	0.3ab	0.5cd	1.3cde
14. Sulfentrazone 80WP + Treflan 4EC	0.142 2.272	0.5cde	0.3de	0.5abcd	1.5ab	0.5cd	3.3ab
15. Sulfentrazone 80WP + Treflan 4EC	0.284 2.272	1.5abc	0.5cde	0.5abcd	0.7ab	0.5cd	2.3abcd
16. Sulfentrazone 80WP + Treflan 4EC	0.426 2.272	1.3abcd	0.8bcd	0.8a	0.5ab	0.7bcd	1.7bcde
17. Untreated check	---	0.0e	0.0e	0.0e	0.0b	0.0e	0.0e
SIGNIFICANCE		<.001	<.001	<.001	ns	<.001	<.001
LSD 0.05	---	1.3	0.7	0.4	2.0	0.5	1.8

Preemergence Herbicides for Use in Annual Bedding Plants

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Department of Horticulture and Landscape Architecture

Nature of Work

There are many effective ornamental herbicides available for broadspectrum weed management. However, many products applied preemergence are not labeled for use on bedding plants. Researchers have evaluated efficacy for weed management over time, but phytotoxicity to annual bedding plants has not been extensively evaluated. Our past work has shown that certain herbicides offer promise for effective weed suppression, but phytotoxcity to sensitive bedding plants such as begonia (*Begonia x semperflorens-cultorum*) or impatiens (*Impatiens wallerana)* can be severe (Brown et al., 1995). Currently, metalochlor (Pennant) and oryzalin (Surflan) are labeled for use in bedding plants, but not for all commonly used species. Our objectives were to evaluate the efficacy of newly available and standard preemergence herbicides in numerous species of commonly available bedding plants.

On May 23, 1996, a variety of annual bedding plants were transplanted into the field by hand into beds. Species included:- *Begonia x semperflorens-cultorum* 'Vodka', 'Gin', *Petunia x hybrida* 'Saffrina purple', 'Purple sunset', '182 Sun Vale', *Portulaca grandiflora* 'Sundial Pink', *Tagetes erecta* 'Jamie Spry', *Impatiens wallerana* 'Peach swirl', *Catharanthus roseus* 'Grape cooler', *Pelargonium x hortorum* 'Picasso', and *Zinnia elegans* 'mixed'. Plots were irrigated after establishment and ammonium nitrate applied before planting (112 kg/ha). Each plot was 3.1 m x 6.1 m and contained 20 of each bedding plant species. Plots were arranged in a randomized complete block design with three replications.

On May 24, herbicides were applied to the plots post-transplant and over the top. The granular materials (Derby 5G, Snapshot 2.5G, and Ronstar 5G) were applied using a calibrated rotary spreader. Other materials were applied as liquids using a calibrated CO_2 pressurized backpack sprayer at 26 GPA using 8004 nozzles and 30 psi.

Plots were rated visually for herbicide efficacy (0 = no control, 100 = complete control) and phytotoxicity (0 = no injury, 5 = completely dead). Weed control ratings were taken at 4 and 8 weeks after treatment and phytotoxicity ratings were taken at 2 and 4 weeks after treatment.

Results and Discussion

Weed Control. At 4 weeks after herbicide application, weed control provided by Derby (metolachlor plus simazine), Snapshot DF (oryzalin plus isoxaben), Dimension (dithiopyr), Pendulum (all 3 formulations, pendimethalin) and Ronstar (oxadiazon) was superior. Overall weed control provided by these treatments was above 75%. The highest level of overall weed suppression was observed in the Predict (norflurazon) treatment, with overall control of 93% obtained. All Pendulum treatments provided over 87% control. Gallery provided good suppression of broadleaf weeds as expected, while Surflan and Factor controlled annual grasses effectively. At 8 weeks after herbicide application, weed suppression had declined in all treatments. However, suppression was still very acceptable in treatments containing Pendulum at all 3 formulations (G, EC, WDG) (68-77%). In addition, high levels of suppression were oberved in the Predict (77%), Ronstar (61%) and Snapshot (77%) treatments. Control of annual grasses was generally high at 8 WAT, but yellow nutsedge control was reduced and broadleaf weed control was marginal with morningglory spp. and horsenettle predominating.

Phytotoxicity to annuals. Although weed control provided by Pendulum, Snapshot and Predict treatments was highly acceptable, injury to sensitive annual spp. was observed. In particular, vinca, impatiens and begonia were most sensitive to all herbicide applications. Significant injury to vinca, impatiens, begonia and geranium was observed in Pendulum treatments, with begonia and vinca most sensitive. Zinnia and petunia spp. were least affected in all herbicide treatments. Injury to annuals was minimized when Pendulum was applied in granular formulation as opposed to WDG or EC formulations. Injury appeared as chlorosis followed by necrosis. Predict application resulted in injury to begonia, impatiens and vinca species and was severe. No injury was observed in portulaca or zinnia. Injury appeared as bleaching or chlorosis. Least phytotoxicity was observed in the Ronstar, Factor and Surflan treatments. Ronstar application resulted in good weed suppression and limited annual injury, with begonia being the only species seriously affected by application.

Significance to the Industry

Herbicide application resulted in good overall weed control with most treatments 4 weeks following application. At 8WAT, Pendulum, Predict, Ronstar and Snapshot provided reasonable weed suppression. Pendulum, Predict and Snapshot application resulted in herbicide injury to a variety of annual species, with zinnia and petunias least affected. Ronstar provided best overall weed control and least injury to annual bedding plant species.

Table 1. Herbicide Rates and Manufacturers

TREATMENT	RATE	CHEMICAL	MANUFACTURER
1. Pennant 7.8L	3.0 pt/A	metolachlor	Ciba
2. Derby 5G	60 lb/A	metolachlor + simazine 1%	Ciba
3. Snapshot 2.5G	150 lb/A	Trifluralin 2% + isoxaben 0.5%	DowElanco
4. Gallery75DF	1.0 lb/A	isoaxben	DowElanco
5. Dimension1EC	0.5 lb/A	dithiopyr	Monsanto
6. Predict 80WG	3.0 lb/A	norflurazon	Sandoz Agro, Inc.
7. Surflan 7.8L	1.0 qt/a	oryzalin	DowElanco
8. Ronstar 5G	150 lb/A	oxadiation	Chipco Ronstar Co.
9. Factor 65WG	1.0 lb/A	prodiamine	Sandoz Agro, Inc.
10. Snapshot 80DF	3.75 lb/A	isoaxben20%, oryazalin 80%	DowElanco
11. Pendulum 2G	4.0 lb/A	pendimethalin	Cyanamid
12. Pendulum 3.3EC	4.0 lb/A	pendimethalin	Cyanamid
13. Pendulum 60WDG	4.0 lb/A	pendimethalin	Cyanamid
14. Untreated Check	---	---	---

Flower species represented in each treatment:

1. Petunia 'Saffinia Purple'
2. Begonia 'Vodka', 'Gin'
3. Marigold 'Jamie Spry'
4. Impatiens 'Peach Swirl'
5. Portulaca 'Sundial Pink'
6. Geranium 'Picasso'
7. Vinca 'Pacific Punch'
8. Zinnia
9. Petunia 'Purple Sunset', '182 Sun Vale'

Table 2. Weed Control rating at 4 Weeks After Treatment

TREATMENT	AG*	MG	SD	SW	YNS	HN	RW	OVERALL
1. Pennant 7.8L	100.00 a	52.67 bcd	89.33 ab	65.67 abc	100.00 a	30.00 bc	33.33 ab	76.00 ab
2. Derby 5G	96.67 a	36.67 cde	90.00 ab	79.33 abc	100.00 a	88.33 ab	98.33 a	76.67 ab
3. Snapshot 2.5G	75.00 b	68.33 abc	72.67 ab	41.67 bcd	69.33 ab	99.33 a	98.33 a	74.33 abc
4. Gallery 75DF	76.67 b	57.67 abcd	60.67 b	54.00 abc	94.33 a	87.33 ab	100.00 a	71.67 bc
5. Dimension 1EC	93.00 a	20.00 de	98.33 a	36.67 cd	94.67 a	49.00 abc	33.33 ab	55.00 c
6. Predict 80WG	100.00 a	91.67 a	100.00 a	92.33 a	99.33 a	95.00 ab	100.00 a	92.67 a
7. Surflan 7.8L	94.33 a	60.67 abc	80.67 ab	60.33 abc	41.67 bc	30.00 bc	32.67 ab	81.00 ab
8. Ronstar 5G	87.33 ab	87.33 ab	100.00 a	93.33 a	92.00 a	60.00 abc	65.00 ab	80.33 ab
9. Factor 65WG	87.00 ab	51.00 bcd	71.67 a	87.67 ab	69.97 ab	36.67 abc	65.00 ab	75.00 ab
10. Snapshot 80DF	94.33 a	86.67 ab	86.33 ab	88.00 ab	65.00 ab	56.67 abc	100.00 a	89.33 ab
11. Pendulum 2G	94.67 a	66.00 abc	100.00 a	96.67 a	61.67 ab	30.00 bc	33.33 ab	87.67 bc
12. Pendulum 3.3EC	97.67 a	88.33 ab	100.00 a	100.00 a	74.33 ab	58.33 abc	66.67 ab	92.33 a
13. Pendulum 60WDG	94.00 a	82.67 ab	100.00 a	99.67 a	89.00 a	63.33 abc	50.00 ab	90.00 ab
14. Untreated Check	0.00 c	0.00 e	0.00 c	0.00 d	0.00 c	0.00 c	0.00 b	0.00 d
Significance	<.001	<.001	<.001	**	**	ns	ns	<.001
LSD 0.05	13.80	38.98	34.43	49.80	44.64	66.36	68.51	19.50

**AG=Annual Grass; MG=Morningglory; SD=Prickly Sida; SW=Smartweed; RW=Ragweed; HN=Horsenettle; YNS= Yellow Nutsedge*

Table 3. Weed Control rating at 8 Weeks After Treatment

TREATMENT	AG*	MG	SD	SW	YNS	HN	RW	OVERALL
1. Pennant 7.8L	97.00 a	26.67 bc	50.00 abc	51.67 ab	100.00 a	5.00 cd	92.67 a	46.00 abcd
2. Derby 5G	92.00 ab	0.00 c	64.33 ab	55.00 ab	100.00 a	61.67 abcd	66.67 ab	33.33 bcde
3. Snapshot 2.5G	10.00 e	35.00 abc	53.33 ab	30.00 bc	65.00 ab	96.00 ab	95.33 a	39.00 abcd
4. Gallery 75DF	13.33 e	3.33 c	56.00 ab	58.33 ab	100.00 a	100.00 a	97.67 a	16.67 de
5. Dimension 1EC	71.67 abc	0.00 c	95.00 a	10.00 bc	95.00 a	63.33 abcd	87.67 a	26.67 cde
6. Predict 80WG	98.00 a	65.00 ab	100.00 a	25.00 bc	93.33 a	100.00 a	88.33 a	76.67 a
7. Surflan 7.8L	68.33 bcd	39.67 abc	60.00 ab	58.33 ab	33.33 bc	59.33 abcd	81.00 a	37.67 bcde
8. Ronstar 5G	58.33 cd	71.67 a	98.33 a	93.33 a	89.33 ab	36.67 abcd	65.00 ab	61.00 abc
9. Factor 65WG	43.33 d	0.00 c	56.67 ab	81.67 a	100.00 a	58.33 abcd	33.33 ab	25.00 cde
10. Snapshot 80DF	90.67 ab	62.67 ab	36.67 bc	95.00 a	66.67 ab	66.67 abc	61.00 ab	76.67 a
11. Pendulum 2G	80.00 abc	40.00 abc	100.00 a	96.67 a	61.67 ab	32.67 bcd	67.00 ab	68.00 ab
12. Pendulum 3.3EC	80.00 abc	51.67 abc	100.00 a	98.33 a	61.67 ab	46.00 abcd	62.67 ab	76.67 a
13. Pendulum 60WDG	75.00 abc	32.67 abc	100.00 a	91.67 a	93.33 a	48.33 abcd	64.33 ab	77.00 a
14. Untreated Check	0.00 e	0.00 c	0.00 c	0.00 c	0.00 c	0.00 d	0.00 b	0.00 e
Significance	<.001	**	**	**	*	ns	ns	**
LSD 0.05	27.18	43.49	51.34	48.60	55.79	66.10	69.36	38.41

**AG=Annual Grass; MG=Morningglory; SD=Prickly Sida; SW=Smartweed; RW=Ragweed; HN=Horsenettle; YNS= Yellow Nutsedge*

Table 4. Phytotoxicity Rating at 4 Weeks After Treatment

TREATMENT	Petunia 1	Begonia	Marigold	Impatiens	Portulaca	Geranium	Vinca	Zinnia	Petunia 2
1. Pennant 7.8L	0.67abc	2.67b	1.00b	1.17ab	1.17a	0.33bc	0.83cdef	2.00a	0.50cd
2. Derby 5G	0.17bc	3.67a	0.00c	0.67abc	0.33bc	0.33bc	0.17fg	0.00c	0.00d
3. Snapshot 2.5G	0.00c	0.00e	0.17c	0.67abc	0.17bc	0.67bc	1.00bcde	0.00c	0.00d
4. Gallery 75DF	0.33abc	0.17e	0.17c	0.67abc	0.67abc	0.83b	1.33bcd	0.83b	0.00d
5. Dimension 1EC	0.67abc	0.00e	0.00c	0.17bc	0.00c	0.33bc	0.67defg	0.17c	0.67bcd
6. Predict 80WG	1.33a	1.17c	1.83a	1.67a	0.33bc	1.67a	2.33a	1.67a	1.50ab
7. Surflan 7.8L	0.67abc	0.00e	0.00c	0.83abc	0.17bc	0.00c	0.67defg	0.00c	0.17d
8. Ronstar 5G	0.00c	0.33de	0.33bc	0.50bc	0.83ab	0.00c	0.33efg	0.00c	0.33d
9. Factor 65WG	1.17ab	0.50de	0.33bc	0.50bc	0.17bc	0.17bc	1.67ab	0.17c	1.83a
10. Snapshot 80DF	0.67abc	0.50de	0.50bc	0.17bc	0.00c	0.33bc	1.50bc	0.83b	2.17a
11. Pendulum 2G	0.00c	0.00e	0.00c	0.33bc	0.00c	0.00c	0.50efg	0.00c	0.00d
12. Pendulum 3.3EC	1.17ab	0.83cd	0.67bc	1.00abc	1.17a	0.50bc	1.33bcd	0.83b	1.83a
13. Pendulum 60WDG	0.67abc	0.33de	0.00c	0.67abc	0.33bc	0.17bc	0.83cdef	0.17c	1.33abc
14. Untreated Check	0.00c	0.00e	0.00c	0.00c	0.00c	0.00c	0.00g	0.00c	0.00d
Significance	ns	<.001	**	ns	*	**	<.001	<.001	<.001
LSD 0.05	1.11	0.59	0.82	1.11	0.76	0.75	0.82	0.59	0.89

Flower species represented in each treatment:

1. Petunia 'Saffinia Purple'
2. Begonia 'Vodka', 'Gin'
3. Marigold 'Jamie Spry'
4. Impatiens 'Peach Swirl'
5. Portulaca 'Sundial Pink'
6. Geranium 'Picasso'
7. Vinca 'Pacific Punch'
8. Zinnia
9. Petunia 'Purple Sunset', '182 Sun Vale'

Table 5. Phytotoxicity Rating at 6 Weeks After Treatment

TREATMENT	Petunia 1	Begonia	Marigold	Impatiens	Portulaca	Geranium	Vinca	Zinnia	Petunia 2
1. Pennant 7.8L	0.00a	4.17a	0.33c	1.50cd	0.33de	0.33ab	1.83bcde	1.00a	0.00b
2. Derby 5G	0.00a	5.00a	0.83abc	1.33cde	0.33de	0.33ab	0.83efg	0.00b	0.00b
3. Snapshot 2.5G	0.33a	0.50d	0.33c	1.00def	0.67cde	0.33ab	1.50cdef	0.00b	0.33b
4. Gallery 75DF	0.00a	2.17b	0.83abc	1.33cde	0.83cde	0.67ab	1.67cde	0.00b	0.00b
5. Dimension 1EC	0.33a	0.33d	0.33c	0.17ef	0.00e	0.67ab	1.17defg	0.00b	0.00b
6. Predict 80WG	0.50a	4.67a	1.67ab	4.25a	0.00e	0.83ab	2.83abc	0.00b	0.33b
7. Surflan 7.8L	0.33a	0.83cd	0.67bc	0.67def	0.33de	0.00b	2.50abcd	0.00b	0.00b
8. Ronstar 5G	0.00a	2.00bc	0.33c	0.83def	0.67cde	0.00b	0.17fg	0.00b	0.00b
9. Factor 65WG	0.33a	0.67d	0.33c	0.33def	0.83cde	0.33ab	3.17ab	0.00b	0.33b
10. Snapshot 80DF	0.67a	2.00bc	1.83ab	1.50cd	1.17bcd	0.67ab	2.83abc	0.33b	2.50a
11. Pendulum 2G	0.00a	0.33d	0.17c	0.33def	1.67bc	0.33ab	2.17abcde	0.00b	0.00b
12. Pendulum 3.3EC	0.67a	2.00bc	1.83ab	3.17ab	2.83a	1.33a	3.50a	0.00b	1.83a
13. Pendulum 60WDG	0.50a	2.17b	2.00a	2.50bc	2.17ab	0.33ab	2.83abc	0.00b	0.83b
14. Untreated Check	0.00a	0.00d	0.00c	0.00f	0.00e	0.00b	0.00g	0.00b	0.00b
Significance	ns	<.001	*	<.001	<.001	ns	<.001	**	<.001
LSD 0.05	0.93	1.19	1.28	1.18	1.02	1.10	1.39	0.46	0.87

Flower species represented in each treatment:

1. Petunia 'Saffinia Purple'
2. Begonia 'Vodka', 'Gin'
3. Marigold 'Jamie Spry'
4. Impatiens 'Peach Swirl'
5. Portulaca 'Sundial Pink'
6. Geranium 'Picasso'
7. Vinca 'Pacific Punch'
8. Zinnia
9. Petunia 'Purple Sunset', '182 Sun Vale'

Factors Influencing Resistance or Susceptibility of Woody Ornamentals to the Japanese Beetle

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Nature of the Work

Adult Japanese beetles (*Popillia japonica* Newman) cause extensive damage to many landscape plants by skeletonizing the leaves. Control of Japanese beetles (JB) in the landscape is often impractical due to environmental or safety concerns. One effective control measure is to substitute resistant plants for susceptible ones. Earlier work in our laboratory *(1)* documented different levels of resistance in flowering crabapples (*Malus* spp.). Therefore, planting cultivars resistant to Japanese beetles is a way to reduce reliance on chemical insecticides while maintaining healthy plants.

Results and Discussion

Field evaluations of about 50 cultivars of roses suggested that significant resistance is unlikely to be found in *floribunda, grandiflora*, or hybrid tea roses. Ongoing work with eight varieties of lindens indicates that *Tilia tomentosa* 'Sterling', *Tilia americana* 'Wandell Legend', and *Tilia cordata* 'Glenleven' are somewhat less susceptible than other lindens.

This project will be expanded, with two main objectives in 1997. The first is to attempt to understand the basis for susceptibility or resistance to JB among cultivars of crabapples. We plan to look at surface waxes, sugars, proteins, water content, phenolics, and other leaf characteristics that may be determinants of resistance. We will also look at other insects, such as tent caterpillars, fall webworms, and mites to determine if factors that convey resistance to JB provide broad-based resistance to other pests.

Secondly, we will begin screening cultivars of other common landscape plants to discover ones that are relatively less favored by JB. We plan to evaluate cultivars of Norway maple (*Acer platanoides*), Japanese maple (*Acer palmatum*), and flowering *Prunus* spp. (cherries and plums).

Significance to the Industry

The information gained from this research will identify additional cultivars of common landscape trees that are less susceptible to JB feeding and thus better suited for use in the landscape.

Literature Cited

1. Spicer, P.G., D.A. Potter, and R.G. McNiel. 1995. Resistance of flowering crabapple cultivars to defoliation by the Japanese beetle (Coleoptera: Scarabaeidae). J. Econ. Entomol. 88: 979-985.

Response of Japanese Beetles (Coleoptera: Scarabaeidae) to Some Host Plant Volatiles in Field Trapping Experiments

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Nature of Work

Soon after the accidental introduction of Japanese beetles (JB) into New Jersey some 80 years ago, it was discovered that they are attracted to volatile oils with a floral or fruit-like character. This led to the development of a highly attractive commercial lure, a 7:3:3 mixture of geraniol, eugenol and phenethyl propionate *(1)*. The compounds actually employed by JB to locate host plants are unknown, however. The fact that JB exploit odors induced by other JB feeding on host leaves for food and mate location *(2)*, however, indicates that induced odor blends are likely to be potent JB attractants. Cultivar and species variation in induced blends may therefore be important in determining plant susceptibility to this insect. We tested JB response to 17 compounds typical of those released by undamaged and insect-damaged leaves in field trials.

Results and Discussion

While differences were noted between the relative attractiveness of the various test compounds, the two most attractive compounds, phenylacetonitrile and (*Z*)-jasmone, were only about 10% as effective as a standard geraniol lure (Table 1). Thirteen compounds lured significantly more beetles than did an unbaited trap while (*Z*)-3-hexenyl acetate, (-)-caryophyllene, indole and (S)-limonene did not. Progressive pairwise addition of less attractive volatiles to a blend of phenylacetonitrile and (*Z*)-jasmone resulted in increasing captures. The relative attractiveness of conifer, fruit and flower odor mixtures plus a complete mixture of these, was also tested. While the flower, fruit and complete mixture captured more JB than did the conifer mixture or phenylacetonitrile alone, our results indicate that this polyphagous insect is likely to be attracted to many naturally

occurring plant odors. Attractiveness to JB seems to increase as the number of components in a volatile blend increases.

Literature Cited

1 Ladd, T.L. and McGovern, T.P. 1980. Japanese beetle: a superior attractant, phenethyl propionate + eugenol + geraniol 3:7:3. J. Econ. Entomol. 73: 689-691.

2 Loughrin, J. H., D. A. Potter, and T. R. Hamilton-Kemp. 1995. Volatile compounds induced by herbivory act as aggregation kairomones for the Japanese beetle (*Popillia japonica* Newman). J. Chem. Ecol. 21: 1457-1467.

Table 1. Capture of Japanese beetles in traps baited with individual compounds

Compound	Mean number captured†	Statistical ranking††
Geraniol	275.4±46.7	a
Phenylacetonitrile	29.4±8.0	b
(Z)-Jasmone	24.2±14.3	bc
(Z)-3-Hexenyl benzoate	15.5±2.3	bc
Nerolidol	15.0±2.2	bc
(Z)-3-Hexenyl hexanoate	13.8±2.8	bc
(Z)-3-Hexenyl 2-methylbutyrate	12.0±2.7	cd
(R)-Limonene	11.4±2.5	cd
(R)- -Pinene	11.4±2.5	cd
(R/S)-Linalool	10.2±2.2	cd
(Z)-3-Hexenol	10.2±2.1	cd
(Z)-3-Hexenyl butyrate	10.0±4.3	cde
(E)-2-Hexenal	9.6±3.2	cde
Methyl jasmonate	8.8±2.6	cde
(Z)-3-Hexenyl acetate	6.0±1.6	def
(-)-Caryophyllene	5.4±1.5	def
Indole	5.4±3.2	f
(S)-Limonene	4.4±1.1	ef
Unbaited Trap	3.8±1.0	f

†Data represent the mean of 5 determinations ± SE.
†† Means followed by the same letter are not significantly different by Fisher's least significant difference test at P = 0.05.

Japanese Beetle Feeding Ecology on Preferred and Resistant Woody Angiosperms

Craig Keathley and Daniel Potter
Department of Entomology

Nature of Work

The Japanese beetle, *Popillia japonica* Newman, was first discovered in the United States at a nursery in Riverton, New Jersey in the summer of 1916. Since then it has spread throughout the eastern United States and parts of Canada. The first Japanese beetles (JB) found in Kentucky were discovered on the southern outskirts of Louisville in 1937, and beetle populations in the state proliferated during the 1950s and 1960s.

JB adults are highly polyphagous, feeding on nearly 300 plant species. There has been very little research on the feeding ecology of JB. Indeed, little is known about what factors determine host plant selection in generalist insects (i.e., those that eat a wide range of plants). In this project, we are investigating JB feeding ecology on eight species of woody angiosperms. Four highly preferred and four highly resistant species are being studied. The main question is: how do susceptible and resistant plant species differ?

Results and Discussion

Choice tests and rearing studies confirmed that sassafras, linden, purple-leaf plum, and Virginia creeper are highly preferred over Bradford pear, lilac, tuliptree, and dogwood. Longevity and fecundity were higher on the preferred species. However, there was no consistent difference between preferred and resistant plants in terms of physical and chemical leaf parameters such as leaf toughness, water or protein content, or tannins. Leaves were dipped in chloroform to remove surface waxes, and then offered to JB in choice tests. These experiments suggested that surface waxes of lilac and Bradford pear are involved in resistance of those plants. We are studying olfactory and gustatory response between preferred and resistant plants. We also determined that plants resistant to JB are not necessarily resistant to fall webworms, *Hyphantria cunea* (Drury), another insect with broad feeding habits. This suggests that different resistance mechanisms may be more or less effective against particular tree pests.

Significance to the Industry

JB adults are highly destructive pests of landscape and nursery plants. Understanding the underlying reasons why some plants are more susceptible than others is necessary if we are to fully exploit plant resistance as a management tactic.

Treehoppers (Homoptera: Membracidae) on Pin Oak in Kentucky

Monte Johnson and Paul Freytag
Department of Entomology

We determined which genera of treehoppers were present on pin oaks, *Quercus palustris* L., and followed adult population dynamics and activity patterns in relation to height in tree canopy. Ten pin oaks in Lexington, Kentucky, were monitored weekly for adult treehoppers at two or three height levels during the 1993 and 1994 growing seasons. Twelve genera were identified during this study including *Archasia* spp., *Cyrtolobus* spp., *Enchenopa binotata*, *Entylia* spp., *Glossonotus* spp., *Microcentrus caryae*, *Micrutalis calva*, *Ophiderma* spp., *Platycotis vittata*, *Smilia* spp., *Stictocephala* spp., and *Telamona* spp. Numbers of individuals from some genera captured were large enough to allow examination of population dynamics and canopy height preferences. Adults of most genera were found predominantly in mature trees, and all preferred top and/or middle levels of the canopy.

Appreciation is extended to D. Leonard for assistance in establishing sticky traps in trees.

Bacterial Leaf Scorch, Leafhoppers and Treehoppers on Pin Oak

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Nature of Work

The initiation of this project was due primarily to the increased detection of a relatively new disease called bacterial leaf scorch on pin oaks (*Quercus palustris*) and other landscape trees in Kentucky. The disease is caused by a bacterium, *Xylella fastidiosa*, which clogs water-conducting xylem cells. This bacterium has a wide host range and causes several diseases that have economic consequences. Xylem-feeding leafhoppers (*Cicadellinae*) and spittlebugs (*Cercopidae*) are known vectors for some of these diseases in other plants. However, vectors of this disease in pin oaks and other landscape trees are unknown. Consequently, the goals of this project were to determine what leafhoppers and treehoppers are found on pin oaks (note the first project mentioned in this update), to conduct ELISA (Enzyme-linked Immunosorbent Assay) tests for the bacterium on leafhoppers and treehoppers, and to conduct transmission studies if there are positive results to ELISA tests.

Results and Discussion

From studies initiated in 1992, twenty-three genera of leafhoppers (*Cicadellidae*) and ten genera of treehoppers have been identified from yellow sticky-traps placed in healthy and infected pin oaks in and near Lexington, Kentucky. Of the leafhoppers, the most numerous were *Alebra aurea*, *Empoasca* spp., *Erythroneura* spp., and *Typhlocyba* spp. Little is known about the feeding habits of these leafhoppers. Of the treehoppers, the most numerous were *Ophiderma* spp./*Cyrtolobus* spp. and *Enchenopa binotata*. *Ophiderma* spp./*Cyrtolobus* spp. utilize various oaks as host plants, but *E. binotata* does not. ELISA tests on several genera caught during 1994 have yielded positive results for the following genera/species: *Cercopidae* (spittlebugs), *Agallia constricta* (leafhopper), *Graphocephala* spp. (leafhopper), and *Oncometopia undata* (leafhopper). This discovery has triggered continued interest in this project.

Appreciation is extended to D. Leonard for assistance in establishing sticky traps in trees.

Landscape Tree Evaluations: Dogwood Borer Evaluations

Monte Johnson and Daniel Potter
Department of Entomology

In field plots where ten cultivars of dogwoods are being evaluated for insect pest and disease resistance, preliminary examinations showed that most cultivars are susceptible to dogwood borer attack. This includes several *Cornus florida* and *C. kousa* cultivars as well as the recent *C. florida/kousa* crosses. So far, only *C. mas* 'Gold Glory' (Cornelian Cherry) and *C. florida* 'Cherokee Chief' were borer free. One *C. florida* 'Cloud 9' was infested with flatheaded appletree borers. Although Johnson and Lyon indicate in the reference "Insects That Feed on Trees and Shrubs" that *C. kousa* is reported to be resistant to the dogwood borer, we are finding this not to be the case. Evaluations will continue over the next several years.

Appreciation is extended to D. Held, J. Scanell, and C. Keathley for assistance with evaluations.

Birch Evaluated for Aphids

Monte Johnson and Daniel Potter
Department of Entomology

In field plots where eight cultivars of birch are being evaluated for insect pest and disease resistance, preliminary examinations last week showed that River birch, *Betula nigra*, and the cultivar *B. nigra* 'Heritage' were susceptible to attack by aphids. Moderate to high aphid numbers and foliar damage were observed on all replicates of these two trees in late May this year. However, the aphid population crashed only after a couple of weeks, so subsequent foliage production was relatively undamaged. Several other cultivars including *B. pendula* (European White), *B. jacquemontii* (Whitebarked Himalayan), *B. platyphylla szechuanica* (Asian White), *B. p. s.* 'Purpurea', *B. papyrifera* (Paper) and *B. platyphylla japonica* 'Whitespire' had either no aphids or very low numbers with no damage. Evaluations for this pest as well as birch leafminer and bronze birch borer will continue over the next several years.

Appreciation is extended to D. Held, J. Scanell, and C. Keathley for assistance with evaluations.

Merit™ Tested Against Horned Oak Gall

Monte Johnson and S. L. Sloughfy
Department of Entomology

Nature of Work

The horned oak gall wasp, *Callirhytis cornigera* O.S., may be particularly injurious or even fatal to shade trees. Horned oak gall occurs from southern Canada to Georgia and attacks twigs of pin, scrub, black, blackjack, and water oak. Galls may be as large as 50 mm in diameter and often grow side by side to form a mass extending along the length of a small branch. They are solid and woody, with many larval cells near the center. With the horned oak gall, horn-type structures develop to the outside of the gall, with a larva developing at the base of each "horn." One adult wasp will emerge from each "horn." The biology of this insect is complicated and still not fully understood. Several professional arborists in the Lexington area have recently reported an increase in gall problems.

Results and Discussion

During the growing season of 1995, four treatments of insecticides were applied to pin oak, *Quercus palustris*, trees seriously infested with horned oak gall. Each treatment was replicated 16 times by monitoring four galls on each of four trees. This was primarily a test of Merit, a systemic insecticide manufactured by Bayer, with the active ingredient, imidacloprid. The treatments and application dates are as follows:

Merit 75WP at 0.75 g AI/inch DBH: soil injection
March 21

Merit 75WP at 1.00 g AI/inch DBH: soil injection
March 21, May 24, June 9

Imidacloprid 5% RTU (NTN 33893): basal trunk spray
March 22

Sevin 4F: foliar spray
May 11

Rainfall, which can affect the soil-injected application of Merit, was recorded in inches for each of the following months:

March 20-31	0.55 inch
April	3.39 inches
May	9.75 "
June	4.75 "
July	3.32 "
August	4.61 "
September	2.68 "
October	3.06 "

Gall diameters in millimeters (mm) were measured each month for the eight months of the test. Pre-treatment measurements were obtained the day before or on the same day of the first treatment, with the exception of the Sevin foliar spray in which the first measurements were taken four days after the application. Random samples of galls from each treatment were examined each month in the laboratory for any changes in larval development.

A statistical comparison of differences in gall diameters by treatment showed that the Sevin treatment resulted in significantly smaller galls (Table 1). Much of the gall growth occurred early in the season, and since the Sevin treatment was added later than the other treatments, lesser gall growth would be expected from that treatment. The Merit treatments did show some reduction in gall growth compared with the untreated check, but they were not significant, and no apparent effect on larval development was observed. Lower rainfall amounts immediately following soil-injection applications may have affected Merit uptake and activity.

Table 1. Four insecticide treatments and control applied to pin oak trees for assessment of effect on horned oak galls. N represents the number of gall measurements taken during the 1995 growing season. Mean diameter difference represents the growth of the galls compared to the previous measurements. SD represents the standard deviation.

Treatment	N	Mean Diameter Difference (mm)	SD
Merit 75WP 0.75	111	1.79 A	2.16
Merit 75WP 1.00	112	1.61 A	1.91
NTN 33893 5% RTU	112	1.54 A	1.80
Sevin 4F	80	0.54 B	1.47
Control	112	1.91 A	1.98

Means not followed by the same letter are significantly different (P=0.05 by Scheffe's MRT).

Appreciation is extended to B. G. Hubbs, Community Tree Care, Inc., for assistance in treating the trees and Bayer for providing the imidacloprid.

Controlled Atmosphere Anoxia Treatments as a Potential Disinfestation Technique for Greenhouse Propagules

David Held, Daniel Potter, Robert Anderson, and Richard Gates
Departments of Entomology, Horticulture, and Biosystems and Agricultural Engineering

Nature of Work

Western flower thrips and two-spotted spider mites are two severe pests in greenhouse production due to insecticide resistance, pest ecology, and a limited palette of effective pesticides. Non-chemical control tactics and new technology are needed if these pests are to be effectively managed. Controlled atmosphere (CA) storage is used extensively for fruit and vegetable crops as well as some cutflowers. Research has shown that CA conditions can control some important pests in storage. Off-shore and domestic propagule production (cuttings and plugs) involves shipping plant material over long distances and time. The objective of this project is to investigate conditions (temperature, gas mixtures, and time) that can be used before, during, or after shipping to control thrips and mites without pesticides, and without reducing plant quality.

Results and Discussion

For these experiments, mini-controlled atmosphere chambers were constructed. Nitrogen and carbon dioxide are used as test gases to create the anoxic conditions. The test gas is metered and delivered to each chamber at a set flow rate. Temperatures ranging from 60-80°F will be tested in separate trials. Exposure times vary with maximum at 48h and an ideal time of 12h.

All life stages of the Western flower thrips and two-spotted mites will be tested in separate trials. Rooted and unrooted cuttings of New Guinea Impatiens and Impatiens plugs will be used for testing effects on plant quality.

Significance to the Industry

Two years ago, nursery inspectors quarantined geranium cuttings coming from an off-shore producer. It was suspected that two pests were being shipped into the United States. The remedial response was to use methyl bromide to decontaminate most of the geranium boxes. This, in turn, caused tremendous crop loss and expense to the growers. Shipping of pest-infested propagules is a problem and any means for managing it would be an asset to growers.

Control of Powdery Mildew on Dogwoods

Jack Doney and John Hartman
Department of Plant Pathology

Nature of Work

Powdery mildew of dogwood has rapidly become a disease of major concern on ornamental dogwoods. The first indication of infection by *Microsphaera sp.* of the leaves is a chlorotic spot. As the pathogen spreads across the surface of the leaf, the leaves develop a white powdery coating and may become distorted and develop red splotches and necrotic areas. Left untreated, a predisposed *Cornus florida*, a tree planted in full sun, can be fully colonized. Trees infected with *Microsphaera sp.* are mottled with off colors, develop irregular and premature fall color, and may not be suitable as landscape ornamentals due to their poor appearance. Two important management techniques for controlling diseases of ornamentals are fungicides and resistant varieties. Experiments were conducted looking at both of these powdery mildew management strategies.

The fungicide trial consisted of a water sprayed control and five fungicides; Bayleton 25T/O, Cleary's 3336 50WP, Funginex 1.6EC, Rubigan 50WP, and, Banner 1.1EC. The first four treatments were begun on May 15, and the Banner 1.1EC treatments were begun on May 15, June 1, and June 15. These eight treatments were arranged as a randomized complete block replicated four times across four varieties of *C. florida* known to be of high susceptibility to powdery mildew (Doney et al., 1995). All treatments were applied biweekly with the last spray occurring on July 24. Each tree was sprayed to runoff with a hand-held CO_2 powered sprayer at 40 psi fitted with a Spray Systems TX6 hollow cone tip.

Powdery mildew was also evaluated in a 39 tree dogwood variety trial composed of seven *C. kousa* (two varieties), ten *C. mas* (one variety), eight hybrid trees of *C. kousa* X *C. florida* (three cultivars) and 14 *C. florida* (fourteen varieties). The *C. florida* variety Cherokee Brave (ten of 14 trees) was added to the trial this year on April 25 as a possibly powdery-mildew-resistant variety.

Disease pressure was high during the experiment, and the disease was already active on May 15, the time of the first fungicide application. Trees were evaluated approximately biweekly by visually estimating percent of leaves with any powdery mildew symptoms (incidence), and the mean proportion of affected tissues on symptomatic leaves (severity). A general index of powdery mildew was calculated as follows: arc sine (square root (incidence *(severity/100))). Trees in the fungicide trial were also evaluated for aesthetic quality on August 21.

Results and Discussion

Powdery mildew disease pressure was high throughout the growing season with ample inoculum and favorable environmental conditions for each new flush of growth to become infected. Both powdery mildew management strategies (fungicides vs. resistant varieties) produced trees with little or no powdery mildew and a high aesthetic quality (Rubigan and *C. mas*). Funginex was the only fungicide tested that did not significantly reduce disease incidence and severity (Tables 1, 2). Cleary's 3336 was highly effective in the early evaluations but by late August both incidence and severity of infections were only slightly improved over the water control. There was no consistent advantage to beginning Banner application on May 15 over June 1. Only in the August 2 and 13 evaluations were the powdery mildew indexes for the May 15 Banner start date significantly lower than that of the June 15 start date (Table 3). This was due to the relatively small increase in severity of *Microsphaera sp.* infections with the May 15 start date (Table 2).

All of the infections found on the *C. kousa* were small and did not develop into severe symptoms. The *C. florida* (possibly excepting the Cherokee Brave) were highly susceptible with nearly all leaves infected and many leaves fully covered. The hybrids of *C. kousa* and *C. florida* have less powdery mildew than does the *C. florida* while retaining most of the desirable landscape features. The Cherokee Brave trees are very small at this point with incomplete canopies that promote air movement. This combined with the very late date at which these trees leafed out makes it possible that these trees escaped the high initial inoculum and infection by the secondary inoculum. There was a strong inverse correlation between quality rating and powdery mildew index on August 21, with powdery mildew index explaining 73% of the variability in quality rating.

Significance to the Industry

Fungicide applications may be justified for controlling this disease, especially in those situations where the resistant varieties are not acceptable. It appears that an initial application of a fungicide such as Banner or Rubigan by the beginning of bract fall, and following that with applications throughout the season as needed will produce a more aesthetically pleasing plant. The need to rotate fungicides may also be indicated by the rapid loss of effectiveness of Cleary's 3336.

Literature Cited

1 Doney, J., J. Hartman, M. Johnson, B Fountain and R. McNiel. 1995. Reactions of Dogwoods to Powdery Mildew and Spot Anthracnose. UK Nursery and Landscape Program 1995 Research Report.

Table 1. Incidence (percent of leaves with one or more areas symptomatic) of powdery mildew on fungicide-treated *C. florida*.

Treatment and starting date	Rate (oz/100 gal.)	Incidence of powdery mildew*				
		Jun 25	Jul 10	Aug 2	Aug 13	Aug 21
Water check May 15	N/A	90 a	90 a	92 a	94 a	97 a
Funginex 1.6EC May 15	10.0	62 ab	60 ab	87 ab	85 ab	87 ab
Bayleton 25T/O May 15	4.0	35 bc	47 bc	50 b	50 cd	75 cd
Banner 1.1EC May 15	3.0	25 c	27 bcd	16 cd	50 cd	50 d
Banner 1.1EC Jun 1	3.0	20 c	25 cd	27 bc	30 de	60 cd
Banner 1.1EC Jun 15	3.0	35 bc	42 bc	45 b	50 cd	70 bcd
Clearys 333650WP May 15	8.0	20 c	42 bc	27 bc	65 bc	85 ab
Rubigan 50WP May 15	2.72	1 c	7 d	2 d	14 e	13 e

**Means followed by the same letter are not significantly different by Duncan's New Multiple Range test (P=0.05).*

Table 2. Severity (mean proportion of affected tissues on symptomatic leaves) of powdery mildew on fungicide-treated *C. florida*.

Treatment and starting date	Rate (oz/100 gal.)	Severity of powdery mildew*				
		Jun 25	Jul 10	Aug 2	Aug 13	Aug 21
Water check May 15	N/A	52 a	60 a	77 a	80 a	80 a
Funginex 1.6EC May 15	10.0	35 ab	50 ab	70 ab	65 ab	70 a
Bayleton 25T/O May 15	4.0	49 a	47 ab	40 b	48 c	50 b
Banner 1.1EC May 15	3.0	10 bc	27 abc	12 de	12 e	17 c
Banner 1.1EC Jun 1	3.0	18 bc	22 bc	22 bcd	22 de	40 b
Banner 1.1EC Jun 15	3.0	50 a	32 abc	35 bc	30 d	30 bc
Clearys 3336 50WP May 15	8.0	8 bc	32 abc	19 cde	20 de	42 b
Rubigan 50WP May 15	2.72	2 c	5 c	1 e	13 e	10 c

**Means followed by the same letter are not significantly different by Duncan's New Multiple Range test.*

Table 3. Powdery mildew index on fungicide treated *C.florida*.

Treatment and starting date	Rate (oz/100 gal.)	Severity of powdery mildew*					Quality rating Aug 21**
		Jun 25	Jul 10	Aug 2	Aug 13	Aug 21	
Water check May 15	N/A	76 a	82 a	101 a	106 a	108 a	3.25 c
Funginex 1.6EC May 15	10.0	48 b	62 ab	91 a	84 b	92 a	4.00 c
Bayleton 25T/O May 15	4.0	41 bc	49 bc	47 b	48 c	67 b	5.75 b
Banner 1.1EC May 15	3.0	15 cd	26 cd	13 de	16 e	30 cd	7.00 ab
Banner 1.1EC Jun 1	3.0	18 cd	22 cd	24 cd	26 cd	50 bc	6.75 ab
Banner 1.1EC Jun 15	3.0	41 bc	38 bc	48 bc	40 cd	47 bc	6.5 ab
Clearys 3336 50WP May 15	8.0	11 d	38 bc	22 cde	36 cd	63 b	4.0 c
Rubigan 50WP May 15	2.7	1 d	5 d	1 e	10 e	12 d	8.00 a

** Means followed by the same letter are not significantly different by Duncan's New Multiple Range test. Powdery mildew index = arcsine*(square root(incidence*(severity/100))).*
*** Trees were rated on a 1-9 scale where 1 = dead, 5 = minimal landscape quality and 9 = best.*

Table 4. Incidence (percent of leaves with one or more areas symptomatic) and severity (mean proportion of affected tissues on symptomatic leaves) of powdery mildew on four species of dogwood.

Species of Cornus	Incidence of powdery mildew*			Severity of powdery mildew*		
	Jun 25	Jul 10	Aug 13	Jun 25	Jul 10	Aug 13
florida	90.0 a	72.0 a	96.0 a	52.0 a	45.0 a	78.0 a
Hybrids	5.0 b	17.0 b	17.0 b	8.0 b	25.0 b	25.0 b
kousa	0.1 c	13.0 b	0.0 c	5.0 b	10.0 bc	0.0 c
mas	0.1 c	0.0 b	0.0 c	1.0 b	0.0 c	0.0 c
florida Cherokee Brave**	0.0 c	0.0 b	0.0 c	0.0 b	0.0 c	0.0 c

** Means followed by the same letter are not significantly different by Duncans New multiple Range test.*
*** Cherokee Brave trees were planted on April 25, 1996, and did not break dormancy until approximately two months after the other dogwoods. Consequently it should be considered that the trees escaped disease.*

Table 5. Powdery mildew index on four species of dogwood.

Species of Cornus	Powdery mildew index*		
	Jun 25	Jul 10	Aug 13
florida	76 a	63 a	105 a
Hybrids	6 b	20 b	17 b
kousa	1 b	13 b	0 c
mas	1 b	0 b	0 c
florida Cherokee Brave**	0 b	0 b	.0 c

** Means followed by the same letter are not significantly different by Duncans New Multiple Range test. Powdery mildew index = arc sine* (square root(incidence*(severity/100)))*.
****** Cherokee Brave trees were planted on April 25, 1996, and did not break dormancy until approximately two months after the other dogwoods. Consequently it should be considered that the trees escaped disease.

Variation in Varietal Susceptibility to Birch Anthracnose

Jack Doney and John Hartman
Department of Plant Pathology

Nature of Work

Discula betulina causes spot anthracnose of birch. Trees infected with *D. betulina* may have symptoms ranging from a minor leaf spot to large irregular necrotic patches, distortion, chlorosis and defoliation. Severely affected trees may not be suitable as landscape ornamentals due to their poor appearance. The impact of this disease on eight varieties of birch was examined.

Birch plots were established at the University of Kentucky Horticulture Research Farm in Lexington during the spring and summer of 1994. Eight cultivars of five *Betula* spp. were planted in a RCB design with ten replications. Birches were grown conventionally and mulched with wood chips. Trees were evaluated approximately biweekly by visually estimating percent of leaves with any anthracnose symptoms (incidence), and, the mean proportion of affected tissues on symptomatic leaves (severity). A general index of anthracnose was calculated as follows: arc sine (square root (incidence *(severity/100))). Trees were rated for aesthetic quality on 21 August and percent defoliation on 8 October. Data was analyzed using GLM and Duncan's new multiple range test as appropriate (P = 0.05).

Results and Discussion

Anthracnose symptoms typical of *D. betulina* developed in early May on B. *pendula* and B. *platyphylla szechuanica* (Evergreen) but no significant differences were detected until 10 July. Although there was no significant block effects detected, there was a much larger than anticipated level of variability of symptom expression within each of the cultivars. *B. platyphylla szechuanica* was the most variable; a individual tree had a disease index of <0.10 across the season, and a second individual ranged from 0.50-0.80 across the season. *B. pendula* suffered the most severe early defoliation, and B. *platyphylla szechuanica* (Evergreen) was one of three other varieties with premature defoliation. The cultivars *B. pendula, B. nigra and B. nigra* Heritage were the most susceptible. *B. jacquemontii*, *B. papyrifera* and *B. platyphylla* appeared the least susceptible.

Significance to the Industry

The birch is a popular and attractive ornamental tree. *D. betulina* is believed to be endemic to Kentucky, and any birch tree planted will likely be exposed to inoculum. The symptoms of birch anthracnose can be severe enough to limit some varieties' landscape quality.

Table 1. Spot anthracnose on eight cultivars of *Betula sp.*

Betula species (cultivar) where applicable *	Quality		Spot Anthracnose index			
	Percent defoliation Oct 8	Rating Aug 21***	Jul 10	Aug 13	Aug 21	Oct 8
pendula	54 a	6.3 c	0.31 a	0.57 a	0.56 a	0.29 a
nigra	29 b	6.0 c	0.31 a	0.36 b	0.47 ab	0.27 a
nigra (Heritage)	29 b	6.4 c	0.20 b	0.33 b	0.46 ab	0.16 a
platyphylla szechuanica	16 c	6.7 bc	0.16 b	0.25 bc	0.33 b	0.24 a
platyphylla szechuanica (Purpurea)	3 cd	8.4 a	0.04 c	0.15 cd	0.12 c	0.11 a
platyphylla japonica (Whitespire)	1 d	8.1 a	0.04 c	0.08 d	0.06 c	0.15 a
papyrifera	1 d	7.8 ab	0.01 c	0.03 d	0.08 c	0.17 a
jacquemontii**	16 c	5.4 c	0.00 c	0.01 d	0.02 c	0.31 a

**Means followed by the same letter are not significantly different by Duncan's New Multiple Range test. Spot Anthracnose index = arc sine*(square root(incidence*(severity/100))).*

***jacquemontii was severely damaged by Japanese beetles; disease data may be different without insect pressure.*

****Trees were rated on a 1-9 scale where 1 = dead 5 = minimal landscape quality and 9 = best.*

Annual Flower Trial Report

Sharon Bale
Department of Horticulture and Landscape Architecture

Annual flowers were evaluated at the UK Arboretum and Quicksand locations. Two plants were particularly outstanding. *Ipomoea batata,* Pink Potato and the 'New Look' Pentas series attracted a great deal of attention. Pink Potato requires no special maintenance and was extremely vigorous. Plants quickly filled in the bed. This plant has the same habit as Sweet Potato Blackie but the pink, white and green foliage is not quite as coarse in texture or as large as Blackie. Pentas New Look Violet, Red and Pink required more maintenance to keep the plant vigorous, but the results were worth the effort. Plants reached a height of 15 inches and bloomed continuously until frost. Declining blooms were removed to maintain vigor.

Wet weather early in the growing season caused a number of problems. Vinca, planted before the wet weather began, quickly declined. Some plants were lost to disease, while others recovered slowly. Vinca in the AAS trials was planted after the wet weather and performed quite differently. Some of the begonias and celosia never developed an extensive root system. They remained small and stunted throughout the rest of the season.

Purple Wave petunia continues to outperform all other petunias at the Arboretum.

Name	Seed Source†	Sow Date	Transplant Date	Rating††	Comments
Ageratum 'Blue Horizon'	P	3/19	4/16	5	Excellent cut flower. Bloomed until frost.
Bloodflower Asclepias currassavica	*	2/6	2/14	4	Blooms all season. Reaches a height of 4 feet. Aphids were a particular problem. (*Seed collected from previous plantings)
Basil Purple Ruffles	P	3/27	4/5	5	Good color contrast.
Begonia semperflorens 'Rio White'	SG	1/16	2/19	3.5	Plant slow to produce show.
Begonia semperflorens 'Varsity Rose'	SG	1/16	2/19	4	Small plant, but nice flower color.
Begonia semperflorens 'Victory White'	G	1/26	2/13	4	
Begonia semperflorens 'Victory Pink'	G	1/16	2/19	4.5	Small plant
Begonia semperflorens 'Victory Rose'	G	1/16	2/19	2	Lacked vigor
Calendula officinalis 'Early Nakayasu Gold'	P	1/16	1/29	5*	Great early display for cool season plant. Removed from garden in late June.
Celosia 'Pink Castle'	P	2/22	3/1	2.5	Lacked vigor. Much poorer performance than in other years.
Celosia 'Miss Nippon Scharlach'	B	2/22	3/1	1	Lacked vigor.
Celosia 'Flamingo Feather'	Gr	3/26	4/9	5	Bloomed until frost. Excellent cut flower.
Cosmos 'Ladybird Orange'	P	3/27	4/1	3	Plants remained small.
Cosmos 'Seashells Mix'	P	3/27	4/1	4.5	Continuous display until frost.

Name	Seed Source†	Sow Date	Transplant Date	Rating††	Comments
Dahlia 'Calico Mix'	CI	3/19	3/26	4	
Emilia flammea 'Scarlet Magic'	P	4/4	4/16	4	Good cut flower. Will reseed during the season.
Gaillardia 'Red Plume'	SG	3/19	3/26	3	Requires dead heading to maintain display and bloom production.
Helichrysum monstrosum 'Parks Pastel Mix'	P	3/27	4/8	3.5	Good cut flower. Height up to three feet.
Helichrysum 'Golden Beauty'				2	Plants were purchased. Lost most to root rot.
Ipomoes batatas 'Pink Potato'				5	Propagated by cuttings. The variegated pink, green and white foliage is very attractive. No pest or disease problems noted. Plants extremely vigorous.
Lisianthus (Eustoma) 'Heidi Sky Blue'	Sak	1/18	2/13	4.5	All the lisianthus did very well this season.
Lisianthus (Eustoma) 'Heidi Deep Blue'	Sak	1/18	2/19	4.5	
Lisianthus (Eustoma) 'Heidi Lilac Rose'	Sak	1/18	2/19	4.5	
Lisianthus (Eustoma) 'Echo Lilac Rose'	Sak	1/18	2/13	4.5	
Lisianthus (Eustoma) 'Heidi Orchid'	Sak	1/18	2/19	4.5	
Lisianthus (Eustoma) 'Echo Blue Picotee'	Sak	1/18	3/21	4.5	
Lisianthus (Eustoma) 'Echo Pink Picotee'	Sak	1/18	2/13	4.5	
Lobelia speciosa 'Compliment Mix'	B	1/26	2/23	3	Plants vigorous, flower colors excellent but bloom was sporadic.
Lobelia speciosa 'Fan Orchidrosa'	B	1/26	2/23	3	
Lobelia speciosa 'Fan Tiefrot'	B	1/26	2/22	3	
Lobelia speciosa 'Fan Scharlach'	B	1/26	2/22	3	
Lobelia speciosa 'Fan Zinnoberrosa'	B	1/26	3/5	3	
Pentas lanceolata 'New Look Violet'	B	1/26	3/1	5	Declining blooms should be removed to maintain vigor of the plant.
Pentas 'New Look Red'	B	1/26	3/1 3/11	5	
Pentas 'New Look Rose'	B	1/26	3/1	5	

Name	Seed Source†	Sow Date	Transplant Date	Rating††	Comments
Rudbeckia 'Z-Scape Goldie'	Gr	3/26	4/15	4	
Rudbeckia 'Indian Summer'	P	3/26	4/15	5	Powdery mildew was a problem in early August. Note: Indian Summer is supposed to be an annual. We had a 100% return of plants from 1995 at the Arboretum planting. We'll see what happens next year.
Salvia farinacea 'Reference'	B	2/22	3/1	5	Continuous display, required no special maintenance.
Vinca 'Heat Wave Mix'	Bod	3/7	3/11		It was a difficult year for Vinca. Wet weather early in the season caused a lot of problems. Plants not rated because of this.
Vinca 'Heat Wave Grape'	Bod	3/7	3/20		
Vinca 'Heat Wave Orchid'	Bod	3/7	3/20		
Vinca 'Heat Wave Peppermint'	Bod	3/7	3/18		
Vinca 'Heat Wave Pink'	Bod	3/7	3/19		Great color.
Vinca 'Heat Wave White'	Bod	3/7	3/19		
Vinca 'Pacifica Red'	P	3/20	3/20		
Vinca 'Bikini White/Eye'	Gr	3/7	4/23		
Vinca 'Bikini Deep Pink'	Gr	3/7	3/21		
Vinca 'Bikini Light Pink'	Gr	3/7	3/21		

† *Seed Sources: Bod = Bodger; B = Benary; GR = Grimes; P = Park; CP = Companion; SG = Sluis and Groot; G = Goldsmith*

†† *Flower/Plant Rating 1-5: 1=poor, 2=fair, 3=good, 4=very good, 5= excellent*

Winter Survival of Daylily Cultivars in West Kentucky

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

Nature of Work

The popularity of *Hemerocallis sp.* has increased in recent years. The demand for daylilies for landscapes, residential, institutional and roadside, has resulted in growers digging from the field and planting later in the fall than was thought acceptable in the past. Casey Schott *(2)* of Schott Gardens warned the authors that the absolute latest daylilies should be set out in the field in the fall in west Kentucky was at the autumn equinox (September 23 for 1995).

Observation and evaluation of daylilies for fall sales have been in progress since 1992 *(2)*. The evaluations are based on single year production from a single daylily fan. The primary objective was to evaluate daylilies for fall flowering and number of divisions produced from a single fan planted the previous fall.

Daylilies were transplanted to the field on Tuesday, September 25, 1995. Three plants of each cultivar being evaluated were planted. The first daylily evaluations started in 1992 had been through a complete three-season trial, and all the fans from those divisions were placed in a field nursery in order to produce adequate numbers for future cultural practice trials. At the time of planting an inventory of the plants in the evaluations and the field nursery was done. Daylilies were subjected to a "Test Winter" of repeated freezing and thawing, maximum temperatures of 60 and 70 degrees were recorded three days after minimums of -02, -06, and 00 and a low temperature of -06 degrees Fahrenheit was recorded the morning of February 4, 1996. A second inventory was taken on April 29, 1996.

Results and Discussion

The results reported here (Table 1) are observations of a Hemerocallis cultivar's winter survival in two sites. The sites are in the same field. Some of the results do not give a good indication of a cultivar's ability to survive if transplanted late in the season. The results are to be used only as a guide because the loss of one Tangled Web plant of three in the garden does not reflect the dramatic loss of 52 of 70 plants in the nursery. The fact that Top Honors had 100% survival in the garden and 100% loss in the nursery is very confusing.

The observed problem causing death of the daylilies was frost heaving. Speculation is that by transplanting very late (August-September) in the digging season the plants did not have time to develop an adequate root system to prevent frost heaving.

Most of the observations do reflect the plants' ability to survive late planting. The fact that Happy Returns had good survival in both locations may be a contributing factor to its current popularity as a excellent daylily for landscape plantings.

Significance to the Industry

Knowing which of the daylilies in the trial survived the conditions of this evaluation would be of benefit to those planting in the fall and may be of interest as some indication of a cultivar's resistance to frost heaving and freeze damage. This is not a study in which the data could be statistically analyzed; therefore, further frost heaving and freeze injury evaluations would be recommended.

Note: Additional cultivar observations were made on cultivars that occurred in one location but not both. That information is available in table form by writing the authors.

Literature Cited

1 Dunwell, Winston C., Dwight Wolfe, and June Johnson. 1995. First-year Performance of Daylilies in the Field. Nursery and Landscape Program 1994 Research Report, SR-94-1, pp. 60-64.
2 Schott, Casey. 1993. Personal Communication. Co-owner, Schott Gardens, Bowling Green, KY.

Table 1. Daylily location comparison.

Daylily Cultivar	Number planted/survivors	
	Garden	Nursery
Atlanta Moonlight	3/2	7/6
Becky Lynn	3/0	3/0
Camden Crystal Lace	4/0	2/1
Chorus Line	3/0	3/2
Dune Needlepoint	3/2	50/43
Fairytale Pink	3/3	27/23
Granite City Toehead	3/2	7/3
Happy Returns	3/3	9/7
Hawaiian Party Dress	3/1	7/5
Jambalya	3/2	24/20
Lavender Touch	3/0	3/1
Mad Max	3/3	22/17
Marse Connell	3/1	32/3
Milady Greensleeves	3/2	23/23
Nightgown	3/3	24/21
Open Hearth	3/3	6/3
Party Queen	3/1	7/4
Rosella Sheridan	3/1	5/3
Royal Promise	3/2	4/0
Ruffled Apricot	3/3	9/7
Siloam Virginia Hensen	3/2	8/5
Siloam Toddler	3/2	3/2
Siloam Cinderella	3/2	18/17
Skyland Pride	3/1	4/4
Spectacular	3/2	31/6
Tangled Web	3/2	70/18
Top Honors	3/3	3/0
Willis & Hattie	3/3	8/6

Daylilies: First-year Performance in the Field

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

Nature of Work

Continuing evaluation of *Hemerocallis* daylily cultivars at the University of Kentucky Research and Education Center at Princeton, Kentucky, is a result of the interest in daylilies. Demand is strong for information on daylily cultivars and for plants for use in the landscape and in collections. Daylily cultivars are evaluated for aesthetic appeal and favorable production characteristics during the first growing season in a field production system.

Cultivars for the trial started in 1994 were supplied by Schott Gardens of Bowling Green. Those provided for the 1995 planting were supplied by Schott Gardens and Swanson Daylilies (Octavian - =diploid and Milano - =tetraploid) of Lexington, Kentucky. Because of severe winter frost heaving (see Winter Survival of Daylily Cultivars in West Kentucky), the 1995 planting was removed from the field and transplanted into pots. The plants were returned to the field on May 23, 1996. This varied from standard daylily evaluation procedure, so the data from Table 2, 1996 Daylily Characteristics, 1995 Planting, should be used accordingly.

Biweekly observations were made to record time and color of bloom. The clumps were dug and divided on September 18, 1996, and the number of divisions recorded.

Results and Discussion

The number of divisions are reported as an average for the plants set out. In the first season two plants of each cultivar are normally placed in the evaluation garden; thereafter, three or more plants of each cultivar are planted for evaluation.

The 1994 planting (Table 1) was severely decimated by frost heaving injury with the loss of eight cultivars from the trial. For a second year, as a first-year division, 'Lavender Touch' failed to bloom. 'Happy Returns', 'Ruffled Apricot', and 'Black Eyed Stella' bloomed well with 'Black Eyed Stella' producing the most divisions. 'Royal Promise' bloomed for two months, but in the 1996 season produced less than the necessary three divisions needed to be considered commercially valuable. For the second year 'Black Eyed Stella', 'Happy Returns', and 'Royal Promise' had blooms in September.

In the 1995 planting 'Octavian Exotic Marble' (Swanson, 1997) bloomed the longest and produced the most divisions. The results from 'Octavian Glow' show a very late bloom (the division with a bud loaded scape continued to bloom until frost), but it was the only plant to be fresh dug and set out as a single fan on May 23, 1996. 'Nettie Downing' (Schott, 1994) performed well and its ivory or cream blooms were numerous during its blooming period.

Significance to the Industry

The number of nurseries producing daylilies and the number hybridizing daylilies continues to increase. Evaluations of cultivars for fall flowering and winter survival have shown that some cultivars bloom during the chrysanthemum and pumpkin harvest season, and these can be added to the fall field-grown product mix expanding the market diversity for roadside stands, adding to the productive landscape for "Entertainment Farming" as well as increasing the length of the market window for daylily growers.

Special thanks to Charles Woodlee for assisting with data collection.

Table 1: 1996 Daylily characteristic observations, 1994 planting.

Cultivar	Date of First Bloom	Date of Last Bloom	Color	Number o Divisions
Open Hearth	5 Jul	11 Jul	Rust & Yellow	7
Rosetta Sheridan	---	---	Apricot	6
Siloam Virginia Henson	5 Jul	29 Jul	Peach	5
Royal Promise	5 Jul	5 Sep	Peach Yellow	2
Happy Returns	10 Jun	16 Sep	Yellow	4
Ruffled Apricot	3 Jun	16 Sep	Apricot	3
Black Eyed Stella	3 Jun	16 Sep	Yellow w/Rust Band	10
Top Honors	8 Jul	29 Jul	Lemon Yellow	1
Lavender Touch	---	---	---	11
Melon Balls, Camden Crystal Lace, Becky Lynn, Siloam Sunburst, Hawaiian Party Dress, Classic Rose, Joyful Occasion & Chorus Line lost to winter injury.				

Table 2. 1996 Daylily Characteristic Observations, 1995 planting.

Cultivar	Color	Date of First Bloom	Date of Last Bloom	Number o Divisions
Mary Shadow	Yellow	1 Jul	25 Jul	4
Nettie Downing	Ivory	24 Jun	25 Jul	3
Janice Wendell	Yellow	NB	NB	2
Ray Hammond	Orange Red	NB	NB	1
Pagliacci	Maroon Yellow	22 Jul	25 Jul	2
Hyperion	Yellow	1 Jul	25 Jul	2
Milano Maraschino	Wine/Yellow	6 Jun	20 Jun	2
Milano Violet Mark	Wine/Yellow	3 Jun	13 Jun	5
Milano Rocket	Burnt Orange	3 Jun	1 Jul	3
Octavian Marble Ring	Peach	31 May	27 Jun	1
Octavian Marble Model	Violet	31 May	27 Jun	4
Octavian Orchid	Purple Pink w/Yellow	8 Jul	29 Jul	8
Octavian Glow	Light Cream	9 Sep	18 Sep	6
Octavian Exotic Marble	Peach w/Violet Eye	31 May	11 Sep	9
Octavian Cherry Doll	Reddish Peach	6 Jun	13 Jun	6

NB = No Bloom

University of Kentucky Nursery and Landscape Program Fund Update

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.

A Fund Development Committee established a minimum goal of $35,000 per year to support UK programs. The victory goal of $55,000 per year is certainly attainable given the size and scope of the industry. However, to reach this goal, everyone must contribute.

Over the first three years of the program (1993-95), a total of $43,368 has been given to support the UK Nursery/Landscape Program. More than $7,000 has been contributed this year through October 1996. The majority of these funds have been utilized to hire additional technical and student labor. This additional labor allowed us to initiate new research, to collect more in-depth data from existing plots, and to do a better job of maintaining research plots.

Eleven individuals/companies have committed to contribute at least $10,000 each over a ten-year period. Those contributing at this level are Nursery/Landscape Fund Fellows and can designate an individual or couple as University of Kentucky Fellows and members of the Scovell Society in the College of Agriculture.

Although larger firms are encouraged to make at least a Fellows level commitment, all nursery and landscape businesses must contribute an appropriate amount for us to make the desired impact. All contributors will be recognized by listing in the annual report and in a handsome plaque to be updated annually and displayed at the Kentucky Landscape Industry Trade Show and in the UK Agricultural Center North Building. Giving levels are designated as Donors (<$100 annual contribution), 100 Club members (≥$100 annual contribution), Associates (≥$500 annual contribution), and Fellows ($10,000 over 10 years).

The UK Nursery/Landscape Advisory Committee advises the Chair of the UK Horticulture and Landscape Architecture Department on the use of available funds to benefit the industry through research and education and assists in the continued development of the fund. The Committee members are appointed to three-year terms and represent the various segments of the industry and geographic areas. The Committee meets at least annually to review a plan submitted by UK outlining planned activities and how funds will be used. All industry personnel are welcome to attend the meetings of the Advisory Committee. The 1996 Advisory Committee includes:

Casey Schott, Leichhardt Landscape Company
Greg Ammon, Ammon Wholesale Nursery
Bob Broadbent, Broadbent Nursery
Pat Dwyer, Dwyer Landscaping Inc.
Stephen Hillenmeyer, Hillenmeyer Nursery
Bob and John Korfhage, Korfhage Landscape and Designs
Melvin Moffett, Snow Hill Nursery
Bob Ray, Bob Ray Company
Gene Ryan, Valley Hill Nursery
Lee Squires, Cave Hill Cemetery
Herman Wallitsch, Jr., Wallitsch Nursery
Charles Wilson, Wilson's Nursery

We have attempted to contact every Kentucky nursery and landscape business. If you have not received information on how to participate in this program or if you have questions about the fund and how to contribute, please contact Dr. Dewayne Ingram, (606/257-1601), one of the Advisory Committee members, or a UK Horticulture faculty member.

Those individuals and companies contributing to the UK Landscape Fund in 1996 (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.

UK NURSERY AND LANDSCAPE FUND FELLOWS

Gregory L. and Melanie G. 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 Memorial)
Lillard's Nursery

John A. Serpell and 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

Stephen and Chris Hillenmeyer
Hillenmeyer Nurseries

1996 Contributors *(through December 1)*

Associates (≥ $500)

Leroy and Venetta Squires
Charles Wilson, Wilson's Nursery

100 Club (≥ $100)

Charles Brown, Packs Nursery, Inc.
Steve King, Stonegate Gardens
David Leonard, Consulting Arborist, Inc.
Melvin Moffett, Snow Hill Nursery
Gene Ryan, Valley Hill Nurseries
Cindy and Casey Schott, Schott Gardens

Donor (< $100)

Elmer Grosser, All Season Landscaping

Industry Organizations

Kentucky Nurserymen's Association

APPRECIATION IS EXPRESSED TO THE FOLLOWING COMPANIES FOR THE DONATION OF PROJECT SUPPORT FUNDS, PLANT MATERIALS, SUPPLIES, AND OTHER MATERIALS.

American Cyanamid, Wayne, NJ
Ammon Wholesale Nursery, Burlington
BASF Corporation, Research Triangle Park, NC
Bear Creek Gardens, Medford, OR
Cape Iris Gardens, Cape Girardeau, MO
Ciba, Greensboro, NC
Cumberland Nursery, Smithville, TN
Dennis Raymond, Covington
Dow Elanco, Indianapolis, IN
Evergreen Nursery, Sturgeon Bay, WI
FMC, Philadelphia, PA
G & G Nursery, Lesage, WV
George Ball, Inc. W. Chicago, IL
Greenleaf Nursery, Park Hill, OK
Green Ridge Tree Farm, Elizabethtown
Greenwood Propagation, Hebron, IL
Griffin Corporation, Valdosta, GA
J. Frank Schmidt Nursery, Boring, OR
Jim Slatten Nursery, Rock Island, TN
Hillenmeyer's Nursery, Lexington
Hutton and Lloyd Tree Farm, Wallingford
ICI Americas, Wilmington, DE
Jansch Enterprises, Wartburg, TN
Kinsey Garden, Knoxville, TN
Larry Walker Nursery, McMinnville, TN
Leichhardt Landscape Company, Bowling Green
Marriott's Griffin Gate Resort Hotel, Lexington
Midwest Groundcovers, St. Charles, IL
Midwest Landscape Network, Florence
Mollers Nursery, Inc. Gresham, OR
Monsanto, St. Louis, MO
National Nursery Products, Louisville
Nieman Nursery, Lexington
Nursery Supplies Inc., Chambersburg, PA
Red Barn Nursery, Nicholasville
Rhone Poulenc, Research Triangle Park, NC
Roberts Irrigation Products, San Marcos, CA
Rohm and Haas, Philadelphia, PA
Sandoz, Des Plaines, IL
Scenic Hills Nursery, McMinnville, TN
Schott Gardens, Bowling Green
Smithers-Oasis, Kent, OH
Snow Hill Nursery, Shelbyville
Steve Foltz, Cincinnati, OH
Studebaker Nurseries, New Carlisle, OH
Swanson Daylilies, Lexington
Texel USA, Inc., Spartanburg, SC
The Landscape Supply, Burlington
The Scotts Company, Marysville, OH
The Wonder Company, Nashville, TN
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Vigoro Industries, Chicago, IL
Waterford Valley Nursery, Taylorsville
Wilson's Nursery, Frankfort
Yoder Brothers, Pendleton, SC

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Kentuckiana Greenhouse Association
Urban and Community Forestry Program, Kentucky Division of Forestry
UK Nursery/Landscape Fund
UK College of Agriculture Alumni Association
U.S. Department of Agriculture, National Research Initiative
Vegetation Management Association of Kentucky

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