PR-409

UNIVERSITY OF KENTUCKY

Nursery and Landscape Program

1998 RESEARCH REPORT

Nursery and Landscape Program

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

UK Nursery and Landscape Program

Faculty, Staff, and Student Cooperators

ABOUT OUR COVER

Hydrangea quercifolia is a Theodore Klein Plant Award Winner for 1999. This native of the southeastern United States has been in cultivation since 1803. Oakleaf hydrangea is a stoloniferous 4- to 6-foot-tall shrub with handsome, coarse foliage. Fall color can vary, but generally is a flamboyant mix of red, orange, and purple. The showy, white sterile flowers conceal the small fertile flowers that occur in 4- to 12-inch-long erect panicles. The June blooms are long lasting, slowly fading from white to a purplish-pink and finally, in the fall, to a brownish tan that can be used in dried flower arrangements. Cultivars known for erect, showy flowers are 'Alice', 'Alison', 'Snowflake', and 'Snow Queen'. Theodore Klein Plant Award Winners are selected by plant professionals for unique ornamental characteristics and the ability to successfully perform in Kentucky.

Horticulture and Landscape Architecture

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Nursery and Landscape Program

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1998 UK Nursery and Landscape Program Overview

Dewayne Ingram, Chair
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The faculty, staff, and students in the UK Nursery/Landscape Program are pleased to offer this 1998 Research Report. It is a means of sharing information generated from a coordinated research program involving contributions from several departments in the College of Agriculture. This report has been organized according to our primary areas of emphasis: production and economics, pest management, and plant evaluation. These areas reflect stated industry needs, expertise available at UK, and the nature of research projects around the world generating information applicable to Kentucky. If you have questions and/or suggestions about a particular research project, please do not hesitate to contact us.

Although the purpose of this publication is to report research results, please find below some 1998 highlights of our Extension program and Undergraduate and Graduate degree programs addressing the needs of the nursery/landscape industries.

Extension Highlights

In addition to the more visible activities, such as the state and area educational programs, the Nursery/Landscape Extension Program addresses the needs of the commercial industry and consumers of our products and services in more subtle ways. We provide training for county Extension agents so they can more effectively serve our clientele. Publications, videos, slide sets, newsletters, articles in state and national industry magazines, newspaper articles, radio spots, and television programs are important elements of our Extension program. Services such as the Plant Disease Diagnostic Clinic, soil testing and interpretative services, and problem-diagnosis and solving services are other activities. The outreach capacity of the Arboretum on the UK campus increases each year. Although there are many facets to the Extension program conducted by the team of subject-matter specialists and county agents, our program directed to provide horticultural education to youth and to utilize horticultural subject matter in youth development is highlighted this year.

Kentucky's Cooperative Extension Service's Youth Horticulture Program involves more than 500 youth, 120 county 4-H Agents, 15 county horticulture agents, and countless volunteer leaders annually. Local training and contests are followed by area training and contests. Area winners compete at the state level at the Kentucky State Fair. From the winners at the state level, a state team is formed to participate in the National Junior Horticultural Association (NJHA) annual conference and competition.

NJHA is a 64-year-old organization and remains the only organization in the world dedicated solely to youth and horticulture. NJHA programs are designed to help young people obtain a basic understanding of and develop skills in the ever-expanding art and science of horticulture. These programs help the horticultural industry by training and recruiting youth in many specialized fields of horticulture. NJHA also develops citizen appreciation for the industry by emphasizing positive programs for building producer-consumer understanding. The University of Kentucky, through the efforts of Dr. William Fountain, has helped mold NJHA's current program activities. Dr. Fountain serves as national program chair, a position that brings Kentucky to the forefront of national recognition as he coordinates programs and activities for youth across the nation.

The NJHA Annual Conference is held the last week of October or early November. Youth who attend the convention participate in one or many competitive activities. In addition to the large number of project reports and contests, youth and their leaders participate in workshops, tours, and presentations of local cultures.

Undergraduate Program Highlights

The Department offers areas of emphasis in Horticultural Enterprise Management and Horticultural Science within a Plant and Soil Science Bachelor of Science degree. Following are a few highlights of our undergraduate program in 1998:

The Plant and Soil Science degree program has more than 100 students in the Fall Semester of 1998, of which almost one-half are Horticulture students and another one-third are turfgrass students. Ten Horticulture students graduated in 1998.

We believe that a significant portion of an undergraduate education in horticulture must come outside the classroom. In addition to the local activities of the Horticulture Club and field trips during course laboratories, students have excellent off-campus learning experiences. Here are the highlights of such opportunities in 1998:

- A two-week study tour of the northeastern U.S. and southeastern Canada was led by Drs. McNiel, Dunwell, and Geneve.
- Horticulture students competed in the 1998 Associated Landscape Contractors of America (ALCA) Career Day competition in Raleigh, N.C., in March (Dr. Robert McNiel, faculty advisor).
- Students visited horticulture enterprises and gardens in northern Kentucky (October).
- Students accompanied faculty to regional/national/international meetings, including American Society for Horticultural Science Annual Conference, Kentucky Landscape Industries Conference and Trade Show, and the Southern Nurserymen Association Trade Show.

Graduate Program Highlights

The demand for graduates with an M.S. or Ph.D. in Horticulture, Entomology, Plant Pathology, Agricultural Economics, or Agricultural Engineering is high. Our M.S. graduates are being employed in the industry, Cooperative Extension, secondary and post-secondary education, and governmental agencies. Last year, there were 14 graduate students in these degree programs conducting research directly related to the Kentucky nursery/landscape industry.

Graduate students are active participants in the UK Nursery and Landscape research program and contribute significantly to our ability to address problems and opportunities important to the Kentucky nursery/landscape industry. For example, three graduate students presented research results at the Southern Nurserymen Association's Research Conference in Atlanta, and several will present posters summarizing their work at the 1999 Kentucky Landscape Industry Conference and Trade Show.

UK to Host the 1999 Associated Landscape Contractors of America (ALCA) Student Field Days

The ALCA Student Career Days is an annual three-day competition which attracts hundreds of students enrolled in interior/exterior, horticulture/landscape contracting programs from more than three dozen colleges and universities across the country. Student Career Days feature 20 to 25 landscape-related events which are led by sponsoring landscape contractors. The events are equally distributed among those covering identification, design, business, equipment operation, and construction. Student Career Days feature the best skilled landscape contracting students who are comparing their skills to other students while at the same time demonstrating those skills for potential employers. More information is available at <www.alca.org/html/SCD/index.html>.

The University of Kentucky has been participating in ALCA Student Career Days since 1985. Many UK students have shown very competitive skills with high placings including first place in a number of events over the years.

The University of Kentucky will be host to the 1999 ALCA Student Career Days March 18-21. For more information about the event and ways you can assist, consult this website <www.uky.edu/StudentOrgs/Horticulture/welcome.html>, or contact Dr. Robert McNiel.

Root and Shoot Development after Early Radicle Pruning in Red Oak

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Nature of Work

Quercus is among the most important hardwoods found in North America. It is very popular as an ornamental and is used for timber, shade, and fuel. Container nursery production has many advantages when compared with other forms of nursery production. Oaks produced in containers are, however, very susceptible to root deformation, because the dominant tap root can grow in circles and produce a poor root system (4). Root system malformation due to restricted root volume in containers leads to kinked, circling, and matted roots forming at the medium container wall interface. Following transplanting, this root deformation has been reported to increase mortality or reduce initial transplant growth (1,7), increase mechanical instability (6), and cause other undesirable symptoms. Several methods of root pruning have been used to avoid root malformation, such as chemical and air pruning. The objective of this work was to determine how the method and timing of root pruning in oak seedlings affect root and shoot development before and after transplanting.

Acorns were collected from the University of Kentucky campus during fall 1997, and hot water bath treatment was applied (45ºC for 50 minutes) in order to kill weevils. Then the seeds were stratified in plastic bags containing moist vermiculite (2 acorn:1 vermiculite) at 4ºC for 3 months, in order to break dormancy. Only acorns that started to crack were used to ensure 100% germination. Anderson-band containers (Anderson Die & Manufacturing Co., Portland, Oregon) with dimensions of 7.3 x 7.3 x 14 cm were used. One acorn was sown in each container, and the following treatments were applied: 1) chemical pruning, where the bottom of containers were covered with weed barrier painted with a commercial solution of copper hydroxide and latex paint (Spin Out, Griffin Co., Valdosta, Georgia); 2) no pruning, which was the same as chemical treatment, but weed barrier was painted with latex paint only; 3) air pruning, with containers that were open on the bottom to kill root tips that exit the container. Control plants were grown in deeper containers, dimensions 10 x 10 x 35 cm. MetroMix 510 (Scott's) was used as the growing medium. Irrigation was applied as needed, and fertilization (200 ppm of Peters 20-10-20) was included in the irrigation water every other time. The experiment was located in the Department of Horticulture greenhouse. Temperature was 20ºC at night and 22ºC to 30ºC during the day, and the photoperiod was 14 hours. The experiment was set on the first week of January 1998. Experimental design was completely randomized, and 16 plants were assigned for each treatment. Plants were harvested 30, 45, and 60 days after sowing, and the dry weight of roots and shoots was collected. The remaining plants were transplanted at the day of harvesting to deeper containers measuring 10 x 10 x 35 cm (the same size as the control containers), and the data were collected after 75 days cumulative.

Results and Discussion

Before transplanting, oak seedling biomass and root length were lower in small-volume containers. Also, seedlings showed a linear increase in growth in all treatments over a 60-day period (Figure 1), but copper-treated plants were heavier than others. Mean dry weight of copper-treated plants was 5.6 g, while mean dry weight of control plants was 9.8 g, no-prune was 3.8 g, and air was 3.9 g. Mean dry weight of copper-treated plants was 47% higher than no-prune treatment and 41% higher than air treatment. However, seedlings grown without root pruning in 32-cm-deep containers showed increased growth when compared to seedlings exposed to root pruning treatments and grown in smaller 14-cm-deep containers. Hanson et al. (3) also found that northern red oak seedling biomass was reduced as the volume of the container medium was reduced. Root length was statistically equal for all treatments until 60 days; after that, container volume restricted root length. There was no difference in biomass accumulation in the pruning treatments until day 60, when seedlings in copper-treated containers showed increased growth (Figure 1). Burdett and Martin (2) grew conifer seedlings in copper-treated containers and also found a reduction in height and dry weight, especially of roots, when compared to plants grown in non-treated containers.

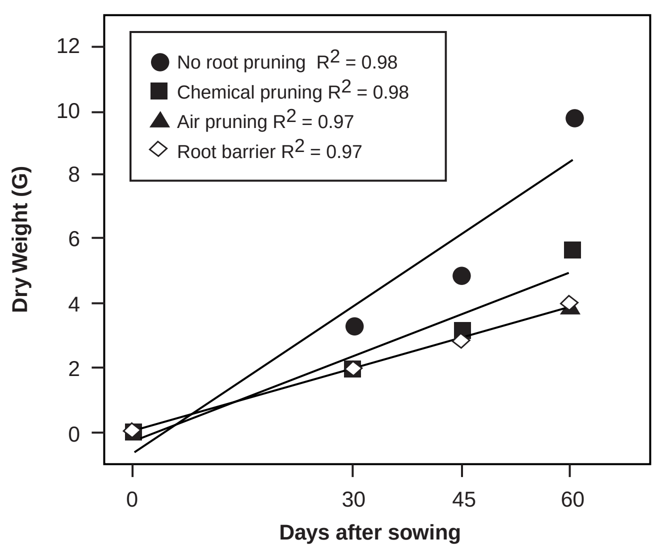

Figure 1: Root and shoot dry weight (g) in Northern red oak seedlings either non-root pruned in 32-cm-deep containers (control) or root pruned by air or chemical (copper) means grown with a root barrier in 14-cm-deep containers for 30, 45, or 60 days.

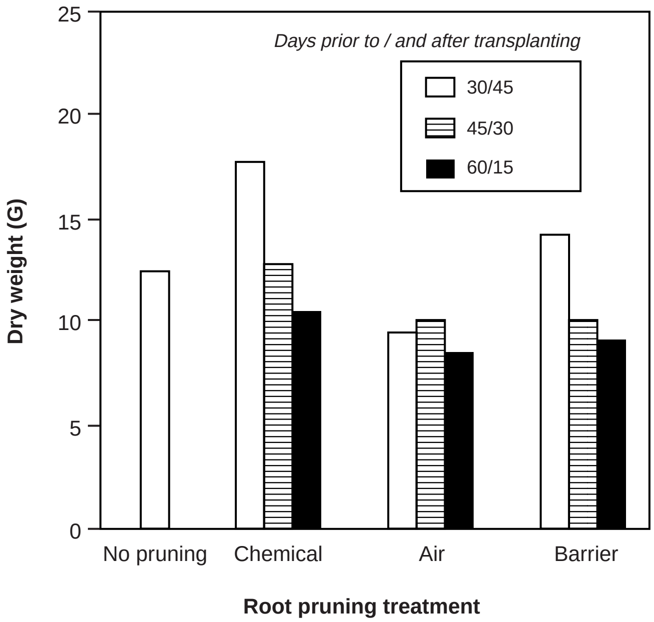

Figure 2: Root and shoot dry weight (g) in Northern red oak seedlings grown in root-pruning or restricting 14-cm-deep containers for 30, 45, or 60 days prior to transplanting or in 32-cm-deep containers. Non-root-pruned controls were grown in 32-cm-deep containers for the entire 75 days.

Following transplanting, all treatments had similar biomass to non-pruned control plants (Figure 2). However, seedlings grown for 30 days in copper-treated containers prior to transplanting showed a significant increase in root and shoot growth. Mean dry weight of copper-treated plants was 17.6 g, and mean dry weight of control plants was 12.4 g. Copper-treated plants were 42% heavier than control plants. Latimer and Baden (5) found a reduction in root dry weight in tomato seedlings planted in copper-treated flats, but after transplanting, total dry weight of roots was 4% greater than untreated tomato transplants. For root length, all treatments were the same.

Significance to the Industry

Chemical root pruning using $CuCO_3$ has been shown to be effective in pruning roots in several plants. Liners produced in $CuCO_3$-treated containers have a better-distributed root system, and girdling and kinking are avoided. These data suggest that early chemical root pruning improves root and shoot dry weight in oaks grown in 14 cm deep containers. Further research is needed to verify the factors that make chemical pruning better than other methods of root pruning.

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Effects of Controlled-release Fertilizers on Growth and Nutrient Content of 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). The industry is also seeking more genera-specific fertilizer recommendations. 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* 'Compactus' at Snow Hill Nursery (Shelbyville, Kentucky) and *Picea abies* (Norway spruce) and *Pseudotsuga menziesii* (Douglas fir) at Nieman's Nursery (Lexington, Kentucky) in the spring of 1994. Treatments were initiated in *Ilex x meserveae* 'China

Girl' and *Picea abies* 'Nidiformis' (bird's nest spruce) at Ammon Wholesale Nursery (Burlington, Kentucky) 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 lbs of N/A/yr, split into spring and fall applications. Treatments were replicated a minimum of five times in randomized complete block designs for each genus. Plant size parameters were measured at least annually. Growth index measurements (volume = maximum width x minimum width x height) were recorded for multi-stemmed genera, and height and caliper were measured for single-stemmed genera. The timing and magnitude of growth flushes were observed. Leaf samples were taken from the maple and euonymus in July and from the holly and spruce in November for nutrient analysis in July, 1996. Soil samples were taken at the initiation of the experiment and again in August, 1996.

Results and Discussion

Although the general recommendation for nitrogen fertilization of woody plants in the field is about 250 lbs N/A/yr, there are few woody plants for which we have comprehensive nutrient requirement guidelines. The results of this three-year experiment indicate that the 250 lbs N/A/yr is an appropriate recommendation for a wide variety of woody plants and soil types. However, there were differences among the test plants in this study in their responses to fertilizer source and rate. Observations revealed no significant treatment differences in winter injury or potential injury due to early spring budbreak.

Acer rubrum **'Red Sunset'** caliper growth was not influenced by fertilizer source in either year or for the 3-year total (mean= 1.2 inches). Change in caliper between years 1 and 2 was greater for the 400 lbs N/A/yr rate than the lower rates, although rate had no effect on caliper growth in subsequent years or cumulatively over the experiment. 'Red Sunset' maple growth in height (3-year mean = 5.2 ft) was not affected by treatments. Soil NO_3 content after 3 years of treatments increased significantly with increasing fertilizer rate (8.1, 14.5, and 37.1 ppm, respectfully). However, the higher soil NO_3 content did not result in greater N tissue content or growth parameters. Mean tissue N across treatments increased from 1.8% in year 1 to 2.7% in year 3.

Euonymus alatus **'Compactus'** caliper growth was not influenced by treatments on any measurement dates. There was a fertilizer x rate interactive effect on growth in height between years 1 and 2 (p=0.05) with 18-3-3 at the 100 lbs N/A/yr rate, resulting in greater height growth than the higher rates. The highest rate of the Woodace and Scotts products resulted in a slightly greater growth the second year, but by the third year there were no differences. The Woodace and Scotts fertilizers resulted in greater N (1.9%), K (0.67%), and P (0.2%) foliar content than the 18-3-3 after three years. The two higher rates resulted in greater foliar N, P, and K than the 100 lbs N/A/yr rate. This correlates with the higher soil NO_3 content in year 3 at the 400 (39 ppm) and 250 (32 ppm) lbs N/A/yr rates than at the 100 lbs N/A/yr rate (14 ppm).

There was a fertilizer x rate interaction on ***Picea abies*** **'Nidiformis'** growth expressed as the change in plant volume. Growth was greatest when fertilized with Woodace at the 100 rate compared to the 250 and 400 lbs N rates. An opposite, nonsignificant trend was noted in the 18-3-3 fertilizer treatments. There was no statistical difference in growth due to rate of the Scotts fertilizer. Foliar tissue analysis for this species is not currently available. The soil NO_3 content (95 ppm) was not affected by treatments, although NH_4 content increased (9, 21, and 34 ppm for the 100, 250, and 400 lbs N/A/yr rates, respectively) with increasing fertilizer rate.

Growth of ***Ilex x meserveae*** **'China Girl'** was not affected by treatments. Growth the second year was more than twice the measured growth the first year, which is probably a function of the relative change in size over this period. The initial soil nutrient content of this block was moderate to high. However, soil NO_3 content was greater with the 400 (104 ppm) than the 250 (52 ppm) and 100 (32 ppm) lb N/A/yr rates. Soil NH_4 content followed a similar trend. Foliar N (2.1% mean), P (0.20% mean), and K (0.93% mean) levels were not affected by treatments.

Picea abies caliper was not influenced by treatments. A trend (p=0.10) was noted for the effect of fertilizer rate on change in plant height. The general trend was for greater growth at the 100 and 250 lbs N/A/yr rate of Woodace than at the 400 lb N/A/yr rate. There was also a trend for increased height with increasing rate of 18-3-3. There were no differences in growth response to the different rates of the Scotts product.

Pseudotsuga menziesii caliper in years 1 and 3 and cumulatively over the experiment was greatest at the 100 lbs N/A/yr rate compared to the 250 and 400 rates across fertilizers. The same trend (p=0.08) was noted for height increase. Height increase in year 3 was greater with 18-3-3 than with the Scotts product, while Woodace's effect was intermediate. Total height over the 3 years revealed a trend (p=0.08) of Woodace and 18-3-3 resulting in more shoot growth than Scotts.

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.

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. The optimum fertilizer rate for bird's nest spruce was dependent upon fertilizer source.

Significance to the Industry

There is little evidence that applications of nitrogen fertilizers applied at rates greater than 250 lbs N/A/yr increases quality or growth of the plants in the field study. However, nitrogen application rates in nurseries commonly exceed this amount. Based on the data presented here, the selection of a fertilizer for field production should be based on the total cost and compatibility with other cultural practices. One issue that was not addressed in the study was the potential advantage of controlled-release fertilizers over readily-soluble inorganic fertilizers with regard to the required frequency of application. Application of controlled-release fertilizers only one time per year may offset higher product costs compared to multiple applications of readily-available, inorganic fertilizers.

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Acknowledgment: The authors would like to thank Ammon Wholesale Nursery, Snow Hill Nursery, and Nieman's Nursery for cooperating in this research at their nurseries by providing land and plants and maintaining the plots.

Use of Digital Analysis of Radicle Extension of Marigold Seedlings as an Early Indicator of Seed Vigor

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Nature of Work

Radicle extension has been shown to be an accurate, early predictor of vigor in several horticultural crops (1). Digital imaging of the radicle has potential to meet the criteria for an ideal vigor indicator; several seed producers and seed testing laboratories are presently using or exploring this technology. In this study, MacRhizo® software was used to analyze digital images of the radicle captured on a flatbed scanner. This study attempts to correlate the computer-generated marigold vigor data with results from commonly used vigor tests.

In order to examine the correlation between radicle length and the standard tests which predict seed vigor, seed from a single, high-vigor lot was mildly (24 hours AA) and moderately (72 hours AA) deteriorated by artificial aging in a high-temperature and relative-humidity environment (2). Once significant differences in vigor between groups of seed were achieved, several measurements which are commonly used as vigor indicators were taken.

If a positive correlation exists between computer-generated radicle length analysis and the Association of Official Seed Analysts vigor test results, the use of digital images of radicles may be a reliable predictor of seed vigor.

Results and Discussion

Seed moisture content of the control seed was 15.23%, 40.77% for mildly aged seed, and 52.85% for moderately aged seed and showed significant differences (at P# .05) between levels of deterioration in all but one case. Standard germination also had significant differences between levels of deterioration (at P# .05), with 84.5% germination for controls, 49.5% germination for mildly aged seed, and 9.72% for moderately aged seed.

Digitally analyzed radicles also revealed significant differences (at P# .05) in length between each vigor level. Average radicle length for control seed was 2.10 cm, 1.91 cm for mildly aged seed, and 1.27 cm for moderately aged seed.

Using radicle length, seedling emergence test, and AA vigor test results as predictors of seed vigor, radicle length was regressed against percent standard germination (R^2=0.797) and percent seedling emergence (R^2=0.995), and a positive correlation was found in each case (Table 1). Correlation coefficients (r) based on the prediction variable means also showed a positive correlation of prediction accuracy. The r value for radicle length and seedling emergence (r=0.997) suggests radicle length may be a better predictor of future performance in the plug tray than the AA-standard germination test (r=0.893).

Significance to the Industry

It has been established that radicle length can be used for marigold as an accurate, economical, reproducible seed vigor indicator. When the petri dish assay protocol is established, using digital analysis as a indicator of seed vigor will meet all the criteria for a reliable and efficient test, and the potential for this technology in the seed industry can be fully realized.

Table 1. Correlation coefficients (r) for *Tagetes patula* 'Little Devil Flame' using means of variables that indicate seed vigor level.

Treatment	Radicle Length (mm)	Germination (%)	Emergence (%)
Radicle Length	1.000	0.893	0.997
Germination*	0.893	1.000	0.924
Emergence**	0.997	0.924	1.000

*R^2 = 0.797 where y = 1.02 + 0.01x when radicle length is regressed against germination.
**R^2 = 0.995 where y=1.17 + 0.01x when radicle length is regressed against seedling emergence.

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Physical and Economic Requirements for Pot-in-pot Nursery Production

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Chris C. Montgomery, Buffalo Co. Inc., Charlotte, NC

Nature of Work

The pot-in-pot production system has been increasing in acres steadily during the 1990s in the eastern two-thirds of the United States. The system is centered around the production of caliper-sized shade and flowering trees and large shrubs in containers which are placed in the ground. A permanent container (socket pot) is placed in the ground, where it may last for a decade or longer. A production container (insert pot), with plant, is inserted into the socket pot. The time a plant is in a production container can be from six to nine months but not more than two years. Unit sizes have varied from 3 to 30 gallons. On an acre basis, more units in the 7, 10, and 15 gallon sizes appear to be in production today. The trend is away from smaller sizes and into larger sizes. The socket pot and production pot need to be two distinctly manufactured units. Compatible units during the past few years have been manufactured only in the mid-range to large sizes. Container media consists of the common bark-based media existing in the industry.

Holes are augered using a size related to the size of the container when installed on well-drained soils, such as sandy soils. When well-drained soils (most others) are not available, a trench is formed. Tile is usually laid in the bottom of the trench just below the bottom of the socket container. Insufficient drainage is the reason for plant loss in most early established pot-in-pot sites.

Spacing is dependent upon the size of the canopy at harvest time. Common spacing in both directions has been 4, 5, or 6 feet. The socket pot is inserted into the augered hole and leveled. It should rest on firm soil. The socket pot determines the orientation of the plant in production, and new plant growth needs to continue the axis formed by the trunk. A spacer is set in the bottom of the socket pot. The spacer should be ½ inch taller than the height of the air gap between the bottoms of the two containers. This prevents the weight of the production container and plant from becoming wedged into the socket container. Once the plant is placed in the production container, it can be transported to the production site and inserted into the socket container. Weed control and fertilization practices are similar to those existing in container production.

Micro irrigation nozzles are used, and the nozzle should be one which sprays water across the entire media surface. Plant growth can be maximized and plant stress can be reduced by making multiple water applications per day.

Escaped roots destroy the socket pot and thus disrupt the value of the system. Copper-treated paper or fabric is placed on the bottom of the socket pot to cover the drain holes in order to keep roots from escaping. The production pot is treated on its inner surface with copper in order to reduce circling roots and root escapes.

The industry may or may not place fabric over the entire production area. Fabric (landscape fabric) appears to be more common in the southeastern United States. An X is cut in the fabric above each socket container it covers. The fabric reduces erosion, eliminates weed maintenance, allows movement around the area at all times with a dry surface, and keeps UV light from reaching the socket pot.

Most acreage in the northeast and central parts of the United States has been left uncovered. Weeds or turf are allowed to grow between containers and then maintained on an as-needed basis.

Results and Discussion

Production costs were synthesized for a hypothetical 15-acre nursery with 10 acres in crop production. An economic comparison was made as to whether this nursery was producing the crop in the field, as aboveground container plants, or as pot-in-pot container plants. In-field production based on19 ft^2 per plant yielded 18,990 salable plants. Aboveground container production based on 18.6 ft^2 per plant yielded 21,430 salable plants. Pot-in-pot production based on 16.8 ft^2 per plant yielded 23,338 salable plants. Capital requirements and annualized fixed and variable costs were determined for each system. Table 1 summarizes these costs and illustrates the total cost per salable plant for each production system.

Table 1. Capital requirements and cost comparisons for crapemyrtle production using alternative production systems, 15-acre nursery with 10-acre production area, 3-year production cycle with 1 year in liner development, USDA hardiness zone 8, 1996.

	Production System ($)		
Item	IF[z]	AGC[y]	PNP[x]
Capital requirement	210,840	223,170	224,260
Machinery/equipment operation	26,370	15,650	15,700
Fixed Cost	352,880	350,450	374,525
Per plant	18.58	16.35	16.05
Variable Cost	97,790	157,650	127,680
Per plant	5.15	7.36	5.47
Total Cost	450,670	508,100	502,205
Per plant	23.73	23.71	21.52

[z]In-field.
[y]Aboveground container.
[x]Pot-in-pot.

Significance to the Industry

There are more plants per acre in the pot-in-pot system than in field production. Plants can be harvested any day of the year. The system produces a container-grown plant that should not be root-bound. Plants have the advantage that they are anchored in the ground and do not blow over in the wind, as compared to aboveground container production. Pot-in-pot uses the natural ground temperature, like in-field, without the need to heal-in or move plants to a structure for overwintering or to shade the container wall from summer sun. Moisture and nutrients can be monitored better than in a field situation. Total cost of production per salable plant was similar between in-field ($23.73), aboveground container ($23.71), and pot-in-pot ($21.52).

Changes in the Cost of Production of Field-grown Nursery Plants in USDA Plant Hardiness Zones 5 and 6 since 1985

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Nature of Work

The cost of production for five nursery crops that were field grown was tracked during the 1990s. The budgeted costs were integrated into the budget for USDA Hardiness Zones 5 and 6 field production developed by Taylor et al. (1) The intent was to determine if any trends were developing that influenced inputs and resources. The final per-plant cost of production could then be compared to the per-plant sale price.

Using 1985 production costs, Taylor et al. (1) developed a budget for field-produced nursery plants being grown in USDA Hardiness Zones 5 and 6. Their model consisted of budgeting costs and analysis for five common crops using representative genera being grown throughout the north-central part of the United States, which includes hardiness zones 5 and 6. The five plants budgeted in 1985 (*Taxus*, *Juniperus*, *Viburnum*, *Acer rubrum*, and *Malus*) continue to be mainstays of field production in the 1990s. The synthesis of their model centered on the typical field-production nursery of the region and used the best management practices of the period. Excluding specialty crop or niche nurseries, this production model still is realistic for these five crops in the North Central Region. The Taylor et al. (1) enterprise budget framework was used to examine changing costs during the 1990s.

Using the 1985 model, cost inputs were obtained in 1991 and 1997 from wholesale nurseries across the United States and nursery suppliers throughout the Ohio River Valley. The costs used are new product values published by the suppliers through catalogs. Taylor et al. (1) found that a nursery of at least 200 acres was required to use the facilities and equipment in an economically efficient manner. The analysis developed for the 1990s data is for a 200-acre nursery which would have 175 acres in field production and 25 acres in production facilities, holding areas, etc. Each plant genera was considered for size of liner and spacing (Table 1) and for planting and harvesting requirements (Table 2).

Results and Discussion

Capital Requirements and Annualized Fixed Costs

Capital costs for land, buildings, and equipment for 1991 and 1997 were compared to the 1985 costs (Table 3). Over the two 6-year periods several changes occurred; however, most items could be properly identified and priced in each time slot. Examples of change included: 1) buildings in 1985 and 1991 were constructed of concrete blocks, while in 1997 buildings were of metal construction; 2) the firm manufacturing the articulated loader specified in 1985 was no longer in business in 1991, nor was the firm manufacturing the 1991 model in business in 1997; and 3) increased cost of tiling was the most significant increase to the cost of land improvements in 1997. Land costs were unchanged over the 12-year period when considering a firm located in a rural setting and marketing in a multi-state territory. Table 4 illustrates the method of determining annualized fixed costs using only the 1997 data.

Variable Costs

The determination of variable costs for all five crops was based on the specific production requirements for the crop. Each crop was assumed to be handled in approximately the same manner during each of the three years. As an example of variable costs, data for only *Acer rubrum* are reported in Table 5. The significant variable cost from materials (50% of total variable costs) was with the liner. This was followed by the packaging material at harvest (burlap and wire basket). Tractors, trucks, and loaders were the most significant equipment contributing to variable costs. Hourly labor during the three years was based on a wage of $5.25, $5.50, and $6.50 respectively. Interest rates by 1997 had declined to 10%, compared to 12% in the previous years.

Total Costs per Salable Plant

Total costs from fixed and variable costs are summarized for the five genera for the three years in Table 6. For the 7-year crop (*Taxus*), fixed costs exceed variable costs. For the 4- and 5-year crops of *Viburnum* and *Juniperus*, variable costs slightly exceed fixed costs. With the tree genera of *Acer* and *Malus*, variable costs exceed fixed costs approximately 2:1. For the three shrubs, the 1991 total cost per salable plant was 107% of the 1985 total cost per salable plant. *Acer* and *Malus* increased 118% and 114% respectively between 1985 and 1991. The increase in total cost per salable plant between 1991 and 1997 ranged from 121% for *Acer* to 135% for *Viburnum*.

Budget Costs Compared to Catalog Prices

The total cost per salable plant from the enterprise budget was compared to the price listed in nursery catalogs for an individual plant (Table 7). The catalog price was the average of prices obtained from nursery catalogs. The catalogs were from ten nurseries of at least 200 acres in size and were distributed over a five-state area in USDA Hardiness Zones 5 and 6. A 1997 firm's profit would have a significant contribution from tree genera as compared to shrub genera.

The 1985 catalog price averaged 146% of the budgeted cost across the five species. The 1991 catalog price increased to an average of 227% of the 1991 budgeted cost across the five species. Demand was exceeding supply during the late 1980s and into the 1990s. The industry responded with increased production in order to meet demand. The 1997 catalog price dropped to an average of 156% of the 1997 budgeted cost. Catalog price dropped as cost increased. This indicates that the supply is currently more competitive.

Significance to the Industry

Production costs increased during the 1990s. 1997 production costs ranged from 139% to145% above their level 12 years earlier. Whether it was buildings, equipment, materials, or labor, there were constants and changes occurring in the production costs for field-produced nursery crops. 1997 total costs per salable plant were $13.09 for *Taxus*, $10.05 for *Juniperus*, $10.24 for *Viburnum*, $50.88 for *Acer rubrum*, and $34.92 for *Malus*. High valued inputs, whether the liner or labor, should be monitored for their contribution to the total cost. Where applicable, different buying plans or labor savings techniques should be implemented in order to keep profits high. A number of these opportunities exist in the industry, but they are not uniformly employed.

Literature Cited

1. Taylor, R.D., H.H. Kneen, E.M. Smith, D.E. Hahn, and S. Uchida. 1986. Costs of Establishing and Operating Field Nurseries Differentiated by Size of Firm and Species of Plant in USDA Plant Hardiness Zones 5 and 6. Res. Bull. 1177. The Ohio State Univ., Wooster, OH.

Acknowledgments:

Assistance in data collection was provided by Joe Brown, Jim Owen, and Robbie Smith.

Table 1. Plant Densities and Losses for Field Production of Nursery Plants, USDA Plant Hardiness Zones 5 and 6.

Plant Group	Description		Size of Salable Plant	Years in Rotation	Spacing Between Rows	Spacing in Rows	Sq Ft per Plant[1]	Plants per Acre	Estimated Percent Shrink
I	Slow-growing Evergreens —	*Taxus*	18 - 24”	7	44”	28”	10.2	4,272	15
II	Fast-growing Evergreens —	*Juniperus*	18 - 24”	5	44”	28”	10.2	4,272	15
III	Deciduous Shrubs —	*Viburnum*	3 - 4'	4	48”	30”	11.90	3,652	15
IV	Shade Trees —	*Acer rubrum*	2.0 ” diameter	5	96”	42”	33.68	1,298	10
V	Ornamental Trees —	*Malus*	5-6' (1 - 1½”)	4	96”	36”	28.7	1,518	10

[1]Sq. ft. per plant includes necessary perimeter roads.

Table 2. Planting and Harvesting Requirements for a 200-acre[a] Field Nursery, USDA Plant Hardiness Zones 5 and 6.

			Propagation[b]	Bedding Area[c]	Field Planting			
Plant Group			Units Struck	Rooted Cuttings Planted	Acres	Acres Planted per Year	Units Planted per year	Units Harvested per Year
I	Slow-growing Evergreens —	*Taxus*	34,710	26,700	35	5.00	21,360	18,156
II	Fast-growing Evergreens —	*Juniperus*	48,594	37,380	35	7.00	29,904	25,418
III	Deciduous Shrubs —	*Viburnum*	51,927	39,944	35	8.75	31,955	27,162
IV	Shade Trees —	*Acer rubrum*[d]	—	—	35	7.00	9,086	8,177
V	Ornamental Trees —	*Malus*[d]	—	—	35	8.75	13,283	11,954
	TOTAL		**135,231**	**104,024**	**175**	**36.50**	**105,588**	**90,867**

[a]Total of 200 acres, with 175 acres in field growing space and 25 acres in production facilities, holding area, field bed area, roads, etc.
[b]For each plant available for transplanting as a rooted cutting into the bedding area, it is estimated that 1.3 cuttings would need to be stuck in the propagation facility.
[c]For each plant available for transplanting into the field, it is estimated that 1.25 rooted cuttings would need to be planted in the bedding area.
[d]Shade and ornamental trees would be purchased as bare-root liners for planting directly into the field.

Table 3. Capital Requirements for a 200-acre Field Nursery, USDA Plant Hardiness Zones 5 and 6, for 1985, 1991, and 1997.

Item	Description	1985 Total Cost ($)	1991 Total Cost ($)	% Change From 1985	1997 Total Cost ($)	% Change From 1985
Land	Unimproved land	400,000	400,000	0	400,000	0
Land Improvements	Grading, tiling, graveling, pond	284,210	308,065	108	433,432	152
Buildings	Office, equipment storage, polyhouses	165,981	195,347	118	176,326	106
Machinery and Equipment		529,045	577,997	109	689,766	130
TOTAL		**1,379,236**	**1,481,409**	**107**	**1,699,524**	**121**

Table 4. Annualized Fixed Costs ($) for 200-acre Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1997.

Item	Description	Depreciation [a]	Interest [b]	Insurance and Taxes	Total
Land	Unimproved land		48,000	8,000	56,000
Land Improvements	Grading, tiling, graveling, pond	19,504	52,012	8,669	80,185
Buildings		11,853	21,159	4,313	37,325
Machinery and Equipment		80,886	82,771	2,607	166,264
Total for Depreciation, Interest, Insurance, and Taxes		112,243	203,942	23,589	339,774
General Overhead					
Utilities	Telephone, electric, gas heat				17,500
Licenses and bonds					850
General repairs and maintenance	Buildings, grounds, roads				23,800
Advertising and printing					2,500
Insurance, personnel[c]	Worker's compensation, FICA, health, unemployment				52,800
Travel and professional fees					7,255
Administrative and management[d]	Clerical, operator, supervisory labor, and office supplies				165,000
Miscellaneous					3,900
Subtotal					273,605
Interest on General Overhead, Insurance, and Taxes: 10% per annum for 6 months on a total of $297,194					14,860
Total Annualized Fixed Costs					**628,239**

[a]Depreciation was estimated by dividing initial cost (adjusted for a 10% salvage value) by the years of useful life.
[b]Interest costs were estimated by multiplying the initial value of land, buildings, equipment, and machinery by the interest rate, 10% per annum.
[c]Insurance for personnel was estimated at 32% of salaries for owner/operator, supervisor, and clerical.
[d]Owner/operator = $75,000, two supervisors @$30,000 each = $60,000, two clerical @$15,000 each = $30,000, supplies 10% or $16,500. Total = $136,400.

Table 5. Variable Costs ($) for Group IV Plants (*Acer rubrum*) for a 200-acre Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1997.

Item	Description	Unit	Cost per Unit ($)	Quantity	Total Variable Cost ($)
Materials					186,597
Machinery and Equipment					24,932
Labor	Labor hours	hr	8.58[a]	6,320	54,226
	Related labor hours, 20%	hr	8.58[a]	1,264	10,845
Subtotal					65,071
Interest Charge On Operating Capital	Computed at 10% on an annual basis for six months	%	5.0 (.05)	276,600	13,830
Total Variable Costs					**290,430**
Variable Cost per Salable Plant (5 cm Caliper)	**Units available for sale in a given year**	**ea**		**8,177**	**36**

[a]Average basic wage before withholding taxes and fringe benefits=$6.50; taxes and fringe benefits add 32%, or $2.08, for a total of $8.58.

Table 6. Summary of Fixed, Variable, and Total Costs ($) per Salable Plant of Operating a 200-acre Field Nursery, USDA Plant Hardiness Zones 5 and 6, for 1985, 1991, and 1997.

	Group I (*Taxus*)			Group II (*Juniperus*)			Group III (*Viburnum*)			Group IV (*Acer rubrum*)			Group V (*Malus*)		
Item	1985 Cost per Plant	1991 Cost per Plant	1997 Cost per Plant	1985 Cost per Plant	1991 Cost per Plant	1997 Cost per Plant	1985 Cost per Plant	1991 Cost per Plant	1997 Cost per Plant	1985 Cost per Plant	1991 Cost per Plant	1997 Cost per Plant	1985 Cost per Plant	1991 Cost per Plant	1997 Cost per Plant
Fixed Cost Items															
Land and Improvements	1.20	1.24	1.50	0.85	0.89	1.07	0.80	0.83	1.00	2.66	2.76	3.33	1.82	1.89	2.28
Buildings	0.38	0.44	0.41	0.27	0.32	0.29	0.25	0.29	0.27	0.83	0.98	0.91	0.57	0.67	0.62
Machinery and Equipment	1.40	1.49	1.83	1.00	1.07	1.31	0.94	1.00	1.22	3.11	3.32	4.07	2.13	2.27	2.78
General Overhead	1.80	2.35	3.01	1.28	1.68	2.15	1.20	1.57	2.01	4.00	5.23	6.69	2.73	3.57	4.58
Interest on General Overhead, Insurance, and Taxes	0.12	0.16	0.16	0.08	0.11	0.12	0.08	0.10	0.11	0.27	0.34	0.36	0.18	0.24	0.25
Subtotal	**4.90**	**5.68**	**6.91**	**3.48**	**4.07**	**4.94**	**3.27**	**3.79**	**4.61**	**10.87**	**12.63**	**15.36**	**7.43**	**8.64**	**10.51**
Variable Cost Items															
Propagation	0.20	0.21	0.25	0.11	0.12	0.14	0.10	0.12	0.13	xx[1]	xx[1]	xx[1]	xx[1]	xx[1]	xx[1]
Materials	0.94	0.81	2.14	0.77	0.67	1.90	0.77	0.66	2.10	13.88	18.35	22.82	9.02	11.10	14.65
Machinery and Equipment	0.65	0.59	0.46	0.47	0.44	0.29	0.52	0.49	0.41	3.03	2.67	3.05	2.51	2.37	1.57
Labor	2.45	2.55	3.04	2.05	2.15	2.54	2.19	2.30	2.72	6.43	6.73	7.96	4.79	5.02	5.93
Interest on Operating Capital	0.25	0.25	0.29	0.21	0.20	0.24	0.22	0.21	0.27	1.40	1.67	1.69	0.98	1.11	1.16
Subtotal	**4.49**	**4.43**	**6.18**	**3.61**	**3.58**	**5.11**	**3.80**	**3.78**	**5.63**	**24.74**	**29.42**	**35.52**	**17.30**	**19.60**	**24.41**
Total Costs per Salable Plant	**9.39**	**10.11**	**13.09**	**7.09**	**7.65**	**10.05**	**7.07**	**7.57**	**10.24**	**35.61**	**42.05**	**50.88**	**24.73**	**28.24**	**34.92**

[1]Tree liners were purchased rather than propagated. Liner costs were included under materials.

Table 7. Budget Costs per Salable Plant Compared to Catalog-listed Prices for Field Production of Nursery Plants, USDA Plant Hardiness Zones 5 and 6, for 1985, 1991, and 1997.

Plant Group	Description		Size of Salable Plant	1985 Budget Cost per Salable Plant	1985 Catalog-listed Sale Price	1991 Budget Cost per Salable Plant	1991 Catalog-listed Sale Price	1997 Budget Cost per Salable Plant	1997 Catalog-listed Sale Price
I	Slow-growing Evergreens —	*Taxus*	18 - 24"	9.39	10.75	10.11	23.04	13.19	19.19
II	Fast-growing Evergreens —	*Juniperus*	18 - 24"	7.09	8.25	7.65	14.18	10.12	14.30
III	Deciduous Shrubs —	*Viburnum*	3 - 4'	7.07	10.35	7.57	17.93	10.31	15.57
IV	Shade Trees —	*Acer rubrum*	2.0" diameter	35.61	75.75	42.05	119.30	50.88	96.63
V	Ornamental Trees —	*Malus*	5 - 6' (1 - 1½")	24.73	36.25	28.24	57.95	34.92	53.50

Weed Control in Commercial Nurseries with EC and Granule Formulations of Thiazopyr

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Nature of Work

The experimental preemergent herbicide thiazopyr (1) was evaluated for weed control in six field-grown ground covers. In addition, tolerance of these ground covers to thiazopyr was evaluated.

1997: On May 9, 1997, at the University of Kentucky's Horticultural Research Farm, six plant species (Table 1) were transplanted into a cultivated test plot. Treatments were applied on May 21, 1997. Granulars were applied with a Gandy® drop spreader calibrated to deliver the correct amount of product per treatment. Sprayables were applied with a CO_2 pressurized backpack sprayer using 8004 spray tips calibrated to deliver 26 GPA. See Table 2 for a list of 1997 treatments.

1998: The 1998 experiment was applied to the same area on which the 1997 test was performed. Treatments were applied on May 15, 1998. Granulars were applied with a Scotts drop spreader calibrated to deliver the correct amount of product per treatment area. Sprayables were applied with a CO_2 pressurized backpack sprayer using 8004 spray tips calibrated to deliver 26 GPA. See Table 3 for a list of 1998 treatments.

Treatments were rated visually both for weed control and injury to the ground covers. Weed control ratings were on a 0-100 scale (0=no control, 100=complete control). Injury ratings were taken on a 0-100 scale (0=no injury, 100=completely dead plant). Due to limitation of publication size, only the 8 WAT (weeks after treatment) weed control ratings are presented. Data were analyzed using PRM® (Pesticide Research Manager) by Gilling Data Management, Brookings, South Dakota. All data were subjected to analysis of variance, and means were subjected to Duncan's New Multiple Range test with p=0.05.

Table 1. List of ground-cover plant species tested.

Common Name:	Scientific Name:
Daylily	*Hemerocallis species*
Hosta	*Hosta plantaginea*
Ajuga	*Ajuga repens*
English Ivy	*Hedera helix*
Common Periwinkle	*Vinca minor*
Wintercreeper	*Euonymus fortunei*

Table 2. Treatments 1997

Treatment #	Herbicide	Formulation	Rate applied (lb ai/A)
1	thiazopyr	2 EC	0.5
2	thiazopyr	2 EC	1.0
3	thiazopyr	0.5 G	0.5
4	thiazopyr	1.0 G	1.0
5	thiazopyr (0.5 %) / oxyfluorfen (1.5 %)	2.0 G	1.5 (0.375 / 1.125)
6	thiazopyr (1.0 %) / oxyfluorfen (1.5 %)	2.5 G	2.5 (1.0 / 1.5)
7	thiazopyr (0.5 %) / oxyfluorfen (2.0 %)	2.5 G	2.5 (0.5 / 2.0)
8	thiazopyr (1.0 %) / oxyfluorfen (2.0 %)	3.0 G	3.0 (1.0 / 2.0)
9	Rout (oxyfluorfen (2.0 %) / oryzalin (1.0 %))	3.0 G	4.0 (2.67 / 1.33)
10	Gallery (isoxaben)	75 DF	1.0
11	Control		

Table 3. Treatments 1998

Treatment #	Herbicide	Formulation	Rate applied (lb ai/A)
1	thiazopyr	2 EC	0.5
2	thiazopyr	2 EC	1.0
3	oxyfluorfen (2.0%) / thiazopyr (0.5 %)	2.5 G	2.5 (2.0 / 0.5)
4	oxyfluorfen (2.0%) / thiazopyr (0.5 %)	2.5 G	5.0(4.0 / 1.0)
5	oxyfluorfen (2.0 %) / thiazopyr (1.0 %)	3.0 G	1.5(1.0 / 0.5)
6	oxyfluorfen (2.0 %) / thiazopyr (1.0 %)	3.0 G	3.0 (2.0 / 1.0)
7	thiazopyr	2 EC	0.5
7	dithiopyr	1 EC	0.5
8	thiazopyr	2 EC	1.0
8	dithiopyr	1 EC	0.5
9	OH2 (oxyfluorfen 2.0 % +pendimethalin 1.0 %)	3.0 G	3.0 (1.0 / 2.0)
10	Gallery (isoxaben)	75 DF	1.0
10	Pennant (metolachlor)	7.8 L	4.0
11	Control		

Results and Discussion

Weed Control

Please refer to Table 4 for a complete list of weeds rated in 1997 and 1998.

1997: Only the 8 WAT is represented here (Table 5). Annual grass control was excellent (> 90) with all herbicide treatments. The 1.0 lb ai/A (pounds active ingredient/Acre) rate of thiazopyr in both the EC and G formulations (including those formulated with oxyflurofen) provided good yellow nutsedge control (78 to 91). All other treatments provided poor yellow nutsedge control. Furthermore, at a later rating date (12 WAT), thiazopyr 1.0 lb ai/A (EC formulation) was the only treatment providing any favorable degree of yellow nutsedge control (data not included). Fair to good control of morningglories was ob-

Table 4. Weeds rated in 1997 and 1998.

Common Name	Scientific Name	Abbreviation
Annual Grass species	**Main representatives:** *Seteria faberi, Echinochloa crus-galli,* and *Panicum dichotomiflorum*	ANGR
Yellow nutsedge	*Cyperus esculentus*	CYES
Morningglory species	**Main representatives:** *Ipomoea lacunosa* and *I. hederacea*	IPSP
Ladysthumb	*Polygonum persicaria*	POPE
Common Lambsquarters	*Chenopodium album*	CHAL
Pigweed species	**Species represented:** *Amaranthus hybridus* and *Amaranthus retroflexus*	AMSP
Honeyvine milkweed	*Ampelamus albidus*	AMAL
Hairy galinsoga	*Galinsoga ciliata*	GASCI

served with all but the Gallery herbicide treatment. All but the 0.5 lb/ai rate of the thiazopyr granular provided excellent control (>88) of common lambsquarters. All herbicide treatments provided fair to good control of ladysthumb, honeyvine milkweed, and pigweed. Treatments that provided 1.0 lb ai/A of thiazopyr were yielding good overall weed control ratings at 8 WAT. However, these ratings declined to fair or poor with all herbicide treatments at 12 WAT (data not included). The overall weed control ratings were skewed low because of a johnsongrass infestation. None of these herbicides was expected to control johnsongrass; however, the EC formulation of thiazopyr did provide suppression of johnsongrass, and this is reflected in the higher overall control ratings (data not presented).

1998: As with the 1997 data, only the 8 WAT weed control data are presented (Table 6). As expected, the Gallery/Pennant combination provided complete yellow nutsedge control (2). The EC formulation of thiazopyr at 1.0 lb ai/A, by itself and in combination with dithiopyr, provided fair control of yellow nutsedge, but all other treatments provided poor control (<46.7). All treatments, except Gallery/Pennant, provided fair to excel-

Table 5. Weed control ratings 1997 (8 WAT)[a]

Treatments[b]	Rate lb/ai	ANGR	CYES	IPSP	POPE	CHAL	AMSP	AMAL	OVERALL
thia 2EC	0.5	100 a	75 abc	88.3 a	90 ab	94.3 a	91.7 a	97.7 a	73.3 abc
thia 2EC	1.0	100 a	91.7 a	90 a	96.7 ab	100 a	99.3 a	99.3 a	92.3 a
thia 0.5 G	0.5	100 a	60 bcd	85 a	56.7 e	20 b	68.3 b	91.7 ab	46.7 d
thia 1.0 G	1.0	98.3 ab	81.7 abc	85 a	86.7 cd	91.7 a	93.3 a	90 ab	83.3 ab
thia (0.5%) + oxy (1.5%) 2.0 G	1.5	98.3 ab	53.3 cd	71.7 a	98.3 a	91 a	96 a	73.3 bc	53.3 cd
thia (1.0%) + oxy (1.5%) 2.5 G	2.5	100 a	83.3 ab	88.3 a	100 a	100 a	99.3 a	94.3 ab	86.7 a
thia (0.5%) + oxy (2.0%) 2.5 G	2.5	100 a	61.7 bc	85 a	98.3 a	94.3 a	97.7 a	91.7 ab	68.3 a-d
thia (1.0%) + oxy (2.0%) 3.0 G	3.0	100 a	78.3 abc	86.7 a	100 a	100 a	100 a	91.7 ab	79.3 ab
Rout 3.0 G	4.0	98.3 ab	55 bcd	76.7 a	100 a	100 a	100 a	61.7 c	60 bcd
Gallery 75 DF	1.0	95.0 b	31.7 d	26.7 b	81.7 d	100 a	97.7 a	90 ab	20 e
Control		0 c	0 e	0 c	0 f	0 c	0 c	0 d	0 e

[a]Means within a column followed by the same letter are not significantly different at p=0.05 as determined by Duncan's multiple range test
[b]thia=thiazopyr, oxy=oxyfluorfen

Table 6. Weed control ratings 1998 (8 WAT)[a]

Treatments[b]	Rate lb/ai	CYES	IPSP	POPE	GASCI	AMSP	AMAL	OVERALL
thia 2EC	0.5	36.7 c	80 a	73.3 a	70 bc	60 c	96.7 a	55 bcd
thia 2EC	1.0	70 ab	93.3 a	78.3 a	86.7 ab	80 c	93.3 a	75 ab
oxy (2.0%) / thia (0.5%)	2.5	36.7 c	76.7 a	66.7 a	56.7 c	93.3 ab	80 ab	56.7 bcd
oxy (2.0%) / thia (0.5%)	5.0	46.7 bc	85 a	83.3 a	86.7 ab	100 a	93.3 a	63.3 abc
oxy (2.0%) / thia (1.0%)	1.5	23.3 cd	95 a	66.7 a	76.7 abc	100 a	100 a	46.7 cd
oxy (2.0%) / thia (1.0%)	3.0	43.3 bc	90 a	78.3 a	86 ab	100 a	100 a	63.3 abc
thia /dithio	0.5 / 0.5	40 bc	86.7 a	90.0 a	86.7 ab	78.3 b	93.3 a	56.7 bcd
thia /dithio	1.0 / 0.5	68.3 b	86.7 a	81.7 a	88.3 ab	86.7 ab	80 ab	83.3 a
OH2 (oxy 2.0% +pendi 1.0%)	3.0	0 d	76.7a	86.7 a	96.7 a	100 a	56.7 b	36.7 d
Gallery / Pennant	1.0 / 4.0	100 a	40 b	36.7 b	100 a	100 a	66.7 ab	56.7 bcd
Control		0 d	0 c	0 c	0 d	0 d	0 c	0 e

[a]Means within a column followed by the same letter are not significantly different at p=0.05 as determined by Duncan's multiple range test
[b]thia=thiazopyr, oxy=oxyfluorfen, pendi=pendimethalin

lent control of Pennsylvania smartweed and morningglory species. The Gallery/Pennant and the OH2 treatments provided the best overall control of hairy galinsoga. All other treatments, except the 0.5 lb ai/A EC formulation of thiazopyr and the 0.5 lb ai/A thiazopyr in the 2.5 G, provided fair to good control of hairy galinsoga. Fair to excellent control of pigweed was attained with all treatments except the 0.5 lb ai/A EC formulation of thiazopyr. Thiazopyr and all thiazopyr combinations provide good to excellent control of honeyvine milkweed. However, honeyvine milkweed control with OH2 and Gallery/Pennant was poor. The best overall control (83.3) was provided by the tank mix of thiazopyr and dithiopyr (1.0 lb ai/ 0.5 lb ai). However, this treatment was not significantly different from any treatments that contained 1.0 lb ai/A of thiazopyr.

Ground Cover Injury 1997/1998

In 1997 and 1998, injury to English ivy, periwinkle, and winter creeper was minimal, if at all noticeable, in most of the treatments. The granular combinations that contained oxyflurofen caused the most injury. At 4 WAT the highest injury to these plant species was 40 in 1997 and 16.7 in 1998. Injury to the daylilies, hostas, and ajuga was more severe in 1997 and 1998, particularly with the granular formulations containing oxyflurofen. In 1997 and 1998, the worst injury symptoms appeared on the daylilies and hostas. Injury ranged between 20 and 53 at 4 WAT. Injury to the ajuga was highly variable between 1997 and 1998. As with the other treatments, injury was most severe with the granulars containing oxyflurofen. At 4 WAT, injury ranged from 13 to 53 in 1997 and 0 to 6.7 in 1998. However, injury declined to near-acceptable levels (10 to 20) by 8 WAT in the 1997 experiment. It was apparent that the granular formulations containing thiazopyr and oxyflurofen caused unacceptable damage to daylilies, hostas, and ajuga from 1 to 4 WAT. These plants were able to recover from the damage, but this injury most certainly would not be tolerated by the nursery industry.

Significance to the Industry

Thiazopyr, a new experimental preemergent herbicide, provided good weed control of annual grasses and most broadleaves, while providing a minimum of injury to most of the ground covers. It is possible that this herbicide alone or in combination with other herbicides may be marketed in the near future to wholesale nurseries.

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Does Endophytic Perennial Ryegrass Enhance the Efficacy of Biorational Insecticides for Cutworms and White Grubs?

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Nature of Work

Endophytes are symbiotic fungi that grow intracellularly within leaves and stems of certain turfgrasses, including perennial ryegrass and tall fescue. Endophyte infection is beneficial to the grass plant because the fungus produces alkaloids (toxins) that enhance resistance to certain insect pests. Feeding on endophytic turfgrass is lethal for some pests (e.g., chinch bugs, greenbugs). For black cutworms and white grubs, however, the effects, if any, are usually less severe, consisting of slightly delayed development or reduced weight. We sought to determine if insects experiencing such sublethal effects might be more vulnerable to microbially-based insecticides. If so, endophytic grasses might enhance the efficacy of biorational products to levels formerly possible only with standard insecticides.

We compared the effectiveness of the microbially-based insecticides *Bacillus thuringiensis* (Bt) and spinosad (Conserve®) against black cutworms feeding on endophyte-infected (EI) or endophyte-free (EF) grasses. Bt is a bacterial pathogen labeled for control of caterpillars, including black cutworm, on various plants, including turfgrass. Two formulations of Bt were tested, Thuricide® and DiPel® DF, at labeled rates for turf. Conserve was also used but applied at 0, 0.25x, 0.5x, or 1x labeled rate. The sprays were applied to the EI and EF ryegrasses, and when residues had dried, the cutworms were fed the treated clippings. The cutworms were evaluated daily for mortality and survival.

With Japanese beetle grubs, we evaluated possible synergism between EI perennial ryegrass and *Bacillus popilliae,* bacteria which cause milky disease. Milky disease spore powder has been marketed as a biological control agent for Japanese beetle grubs for many years. Commercial spore powder was mixed with autoclaved field soil and placed into a 32-cell greenhouse flat at four rates. For each rate, flats were sown with either EI or EF perennial ryegrass and allowed 12 weeks to establish before introduction of the grubs. Beginning 16 days later, grubs were checked weekly for survival, weighed, rated for milky disease symptoms, and then returned to their respective cells. Grubs that showed full symptoms of milky disease were removed and bled to confirm infection. Rates of infection were compared among EI and EF grass.

Results and Discussion

Even at full label rate, neither formulation of Bt provided significant mortality of black cutworms on either EI or EF grass. Spinosad (Conserve®), in contrast, resulted in 100% mortality of cutworms, regardless of grass type. Feeding on endophytic grass alone, without either insecticide, did not adversely affect the cutworms.

High concentrations of spore powder resulted in significant infection by milky disease; however, rates of infection were independent of whether grubs were feeding in EI or EF ryegrass. In other words, endophytic grass did not render the grubs any more, or less, susceptible to milky disease. As with cutworms, the endophyte itself had little impact on the grubs.

Significance to the Industry

With increased public concern about pesticide usage in the urban landscape, interest in alternatives to chemical controls, such as host-plant resistance and biorational insecticides, has increased. Although endophytic turfgrasses are widely available for use, their effectiveness in pest management has been variable. We found no evidence to suggest that black cutworms or Japanese beetle grubs are negatively affected by perennial ryegrass endophyte, or that sublethal effects of EI perennial ryegrass synergize the effects of biorational insecticides. Although we failed to demonstrate enhanced control, such “negative” data from careful research on alternative tactics can be important in protecting registrations for conventional insecticides.

Evaluation of Controlled Atmosphere Anoxia Treatments as a Potential IPM Tool for Greenhouses

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Nature of Work

The floriculture industry is a billion-dollar-a-year sector of U.S. agriculture. Because of the labor-intensive production cycles, employees frequently contact plants through daily chores. This can also increase their exposure to pesticides and/or pesticide residues. Greenhouse production is unique because it is protected cultivation within a closed environment. This means that pest entry must occur via immigration through unrestricted air flow or introduction on propagules. Controlled atmosphere anoxia treatments are one tactic that could address employee safety as well as pest introduction issues.

Anoxia is the use of low-oxygen atmospheres for controlling pests. Anoxia has its origins in stored-product commodities but more recently has been applied to a more diverse set of plants and pests of horticultural commodities. Our work evaluates this technology for a new application for greenhouse crops. These treatments would target disinfesting propagules when they are at high densities prior to entering the production cycle.

Results and Discussion

Early work with this system indicated that several factors could potentially influence treatment effectiveness, such as pest species, life stage, gas type, and the presence of plant material. Variability due to pest species has been noted for two of the test species, aphids and thrips. In a 100%-nitrogen atmosphere, aphids require only 6 h exposure to produce 100% mortality, whereas thrips require 12 h under the same conditions. Twospotted spider mites were used to evaluate life stage variability among treatments. Mite eggs and adults treated in 100% nitrogen had reduced survival after 12 h, and 100% mortality after 24 h of exposure. The same was true in a 100%-carbon dioxide atmosphere; there was 0% survival of both mites and mite eggs after 24 h. Some plant species react negatively to elevated-nitrogen atmospheres. For example, treating impatiens for 12 and 24 h in 100% nitrogen had slight effects on percent flowering and days to first flower. Begonias, however, were killed by this same treatment. Because of these variable adverse effects, we sought to determine if a different gas, carbon dioxide, would be as effective as nitrogen for killing the pests. We found that 100% carbon dioxide and 100% nitrogen were similarly effective for controlling thrips, mites, and mite eggs.

All of the above experiments were done without plant material in the treatment chamber. We expected that plant material in the chamber during treatment would increase insect or mite survival. Thrips and mite adults were tested in chambers with and without impatiens plugs both in the light and in the dark. All chambers were exposed to 100% nitrogen for 12 hours. Lighting did not affect effectiveness of the anoxia treatment. Presence of plants during anoxic treatment further reduced survival of mites, perhaps because of elevated humidity within the chamber.

Significance to the Industry

Governmental restrictions for environmental and worker safety issues are widespread. The Worker Protection Standard and the Food Quality Protection Act are encouraging greater interest in reduced-risk pest control methods. Development of alternative technology such as anoxia has potential for providing effective control of pests in shipping or upon receiving so that each production cycle can be started with as few pests as possible. This could greatly reduce the amount of insecticide usage on crops produced in greenhouses.

Management of an Outbreaking Gall Wasp on Pin Oak Trees

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Nature of Work

Gall-inducing insects rarely cause significant damage to landscape plants, but occasionally certain species reach outbreak levels on susceptible trees. The horned oak gall wasp, *Callirhytis cornigera*, is such a pest on pin oak in Kentucky. The large twig galls formed by this species may be so abundant that they seriously reduce the aesthetic quality of infested trees, and galls remain on twigs for years. One generation of *Callirhytis cornigera* develops in twig galls for about 22 months, and another generation develops in tiny leaf galls for 2 to 3 months. Females emerge from twig galls in late March and lay eggs in swelling buds. Eggs hatch, and tiny galls form along veins on the lower side of leaves. Males and females emerge from leaf galls in early summer, mate, and lay eggs in young twigs.

We are studying the biology and management of this pest on pin oaks planted on horse farms and as street trees in central Kentucky. Given the complex life cycle of *C. cornigera*, we considered several approaches to reduce gall density on heavily infested trees. The first approach targeted females emerging from twig galls using whole-canopy sprays of Talstar Lawn and Tree Flowable and Dursban Pro. The second approach involved injecting concentrated solutions (Abacide, Imicide, and Bidrin) from pressurized containers into tree sapwood to control the generation that develops in leaf galls. The third approach targeted leaf galls on expanding leaves by spraying leaf-systemic insecticides (Cygon 2-E, Orthene Turf, Tree, & Ornamental Spray, Avid 0.15 EC, and Merit 75 WP). To study the importance of timing, the systemic insecticides were applied to different shoots on May 2 and May 17. Treatment effectiveness was evaluated by counting numbers of leaf and twig galls and percentages of galled leaves. Impact of the treatments on gall wasps and beneficial parasitic wasps (parasitoids) was also determined by rearing a subset of galls from each tree.

Results and Discussion

Whole-canopy treatment with Talstar at bud-break significantly reduced the numbers of leaf galls compared to untreated controls. Dursban, applied in the same manner, was not as effective as Talstar in reducing numbers of leaf galls. Unfortunately, Talstar also killed the beneficial parasitoids that attack the gall wasp, so parasitism was reduced and more *C. cornigera* adults emerged from leaf galls on Talstar-treated trees than on the other trees.

Trunk injections of Bidrin and Abacide killed a significantly greater percentage of leaf galls than did Imicide or control treatments. Bidrin acted quickly and killed newly initiated and young leaf galls. On the downside, Bidrin and Abacide also had a severe impact on the beneficial parasitoids attacking gall wasp larvae within the leaf galls.

The timing of the foliar sprays in the spring was critical to achieve good control. Significantly more leaf galls were killed by Avid than by any of the other systemic treatments sprayed on May 2. However, the foliar sprays also killed some beneficial parasitoids. Sprays applied on May 17 did not significantly differ in either the percentage of leaf galls killed or parasitoid and gall wasp emergence.

Significance to the Industry

The horned oak gall wasp, *Callirhytis cornigera*, induces large, unsightly galls on pin oak. These galls also reduce photosynthesis and acorn production, result in twig death, and likely contribute to tree stress. Based on this 1-year study, we suggest one of two alternatives if treatment is necessary. Trees could either be sprayed with Talstar at bud break, followed by an Avid spray during early leaf expansion (leaves < 50% of full size). Or else, trees could be injected with Bidrin without any need for follow-up sprays. Adequate control may require at least 2 successive years of treatment.

Does Early Season Defoliation of Crabapple by Eastern Tent Caterpillar Induce Resistance to Japanese Beetles?

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Nature of Work

The Japanese beetle (JB), *Popillia japonica* Newman, is among the most destructive pests of urban landscape plants. Chemical control of adults is often impractical, especially when preferred plants are growing close to homes, schools, and other public areas. Alternative methods of control need to be considered to reduce the need for insecticides. We also seek to understand why JB frequently attack certain trees more heavily than others. One factor that could affect JB response is whether or not a potential host plant has sustained damage from early-season defoliators. Such damage could induce changes in a preferred plant in such a way that JB feeding will be reduced.

We studied whether early-season defoliation by eastern tent caterpillars (ETC) alters susceptibility of crabapples (*Malus* sp.) to Japanese beetles. This question is relevant because, in a given growing season, both of these pests may attack the same Rosaceous plants in urban landscapes.

Results and Discussion

The study was conducted in a block of Candymint Sargent crabapples, planted in 1989, at Hillenmeyer Nurseries, Lexington, Kentucky. Sixteen trees were divided into eight pairs. One tree within each pair, destined for early-season defoliation, was purposefully infested with ETC egg masses, whereas the other tree served as a non-defoliated control. ETC egg masses were collected from wild cherry and crabapple trees in late February, 1998. Six egg masses were placed on each “defoliated” tree in early March. When the ETC hatched, they established nests and caused severe defoliation, leaving only a small number of intact first-flush leaves and some ETC-damaged leaves. These ETC-damaged trees flushed new leaves before JB flight began. We compared physical leaf parameters between ETC-damaged and control trees and, later in July, conducted a series of preference tests and non-choice tests to determine the acceptability of leaves from ETC-damaged or control trees to JB. We also compared natural damage by JB between the two sets of trees in the field.

Physical leaf parameters, including leaf thickness, relative toughness, water content, and area, did not differ significantly between ETC-damaged and control trees. JB did not discriminate between intact first-flush leaves from defoliated trees (i.e., leaves that had escaped injury from ETC), and intact leaves from control trees. They did, however, feed less on those leaves that had been partially consumed by ETC. In all comparisons, the beetles tended to avoid young, second-flush leaves. This was true irrespective of whether the trees had been damaged by ETC earlier in the spring. Young leaves of crabapple contain relatively high levels of certain alkaloids (e.g., phloretin) that have been shown to deter JB. However, we found no evidence for tree-wide or systemic induction of resistance following the early-season defoliation. Similarly, natural Japanese beetle populations caused similar damage to ETC-defoliated and control trees in the field.

Significance to the Industry

This work increases understanding of factors that affect severity of feeding by Japanese beetles in landscapes and nurseries. We hypothesized that early-season defoliation by eastern tent caterpillar might cause elevated levels of defenses in second-flush leaves, resulting in tree-wide (systemic) induced resistance to feeding by Japanese beetles later in the season. This phenomenon, however, did not occur. Japanese beetles fed equally, regardless of whether the trees had sustained earlier damage. Early-season damage by eastern tent caterpillar neither increases nor decreases susceptibility of the same trees to Japanese beetle. We did find that the beetles avoid feeding on young crabapple leaves. Characterization of the specific compounds responsible for this avoidance may point to new ways that resistant crabapples can be developed.

What Factors Affect Twospotted Spider Mite Populations on Winged Euonymus?

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Nature of Work

Winged euonymus, *Euonymus alata*, also called burning bush, is commonly planted for its brilliant red fall foliage. Unfortunately, it often suffers outbreaks of twospotted spider mite, *Tetranychus urticae* Koch, which cause chlorosis and premature leaf abscission at high population densities. We studied how cultural factors such as planting site (degree of shading, or proximity to a structure), water availability, and fertilization affect susceptibility of winged euonymus to mites. We hypothesized that certain conditions may favor buildup of mites by providing them with a more suitable food plant or environment.

Shading effects were tested using two shading levels, 30% and 60%, and full sun. A plot of 18 *E. alata* was planted in pot-in-pot production. Shade huts (1.07 m high, 1.5 m wide at the base) were placed over the plants. The plants were allowed to break bud under their respective treatments and then were infested with 50 female mites in July. Mite populations were allowed to build and were sampled in September via whole-leaf counts on 50 leaves per plant.

To test whether plants close to a structure are more vulnerable to mite outbreaks, 24 *E. alata* were planted next to (0.6 m distance) or remote from (6.1 m distance) a 9.75 m cinder-block wall. The wall was constructed on an east/west line and was painted black. Six replicates were planted both adjacent to and away from the wall on the north and south sides. Plants were infested in July and were subsequently sampled in September, as discussed above. Temperature differences in the plant canopies also were monitored.

To study the effects of water stress and plant nutrition, 36 plants were planted in pot-in-pot production, and fertility and watering regimes were manipulated. The two fertility regimes were no fertilizer added and fertilized with Osmocote 18-6-12 at 68g per 11.4L. Watering regimes consisted of well-watered (watered three times daily), cyclic drought (watered once every other day), and chronic drought (watered upon wilting point). Soil moisture and plant water potential were monitored with tensiometers and a pressure chamber respectively, and foliar nitrogen levels were determined by Kjeldahl analysis. Natural rainfall was excluded from the plants by covering the plot with plastic. The plot was mulched to prevent excess heat from affecting the plants. Plants were infested and sampled as before.

Results and Discussion

Sun vs. Shade. Plants growing in full sun had greater leaf water content and thicker leaves than did shaded plants. However, total mite populations and total number of leaves infested did not differ significantly between the three treatments.

Proximity to a Structure. Mite populations were significantly higher by the wall and on the south side (Figure 1). Temperature readings were also significantly higher on the south side, near the wall, than away from the wall or on the north side near the wall. There was significant interaction of direction and wall on mite densities. However, none of the leaf parameters differed significantly among planting sites, implicating temperature as the main cause for the differences in mite populations.

Water Stress and Nutrition. Well-watered plants had significantly more total mites and total infested leaves than did cyclic or chronic drought-stressed plants (Figure 2). However, fertilization had no effect on mite populations. Pressure bomb readings confirmed that well-watered plants were under the

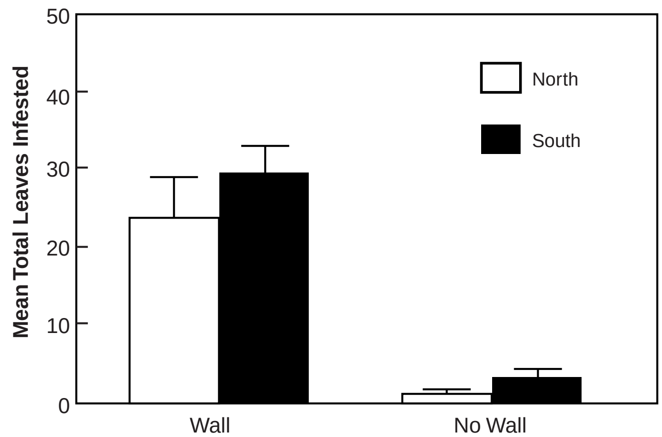

Figure 1. Average number of mite-infested leaves (out of 50-leaf samples) on winged euonymus grown close to the north or south side of a concrete block wall (to simulate a building foundation), or in the open, away from the wall.

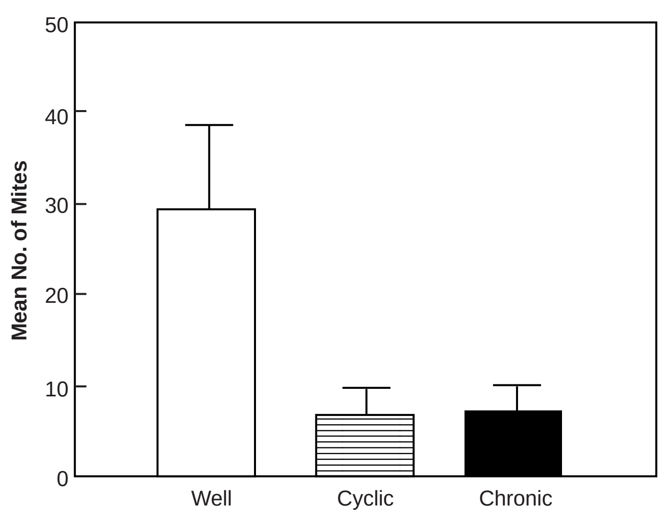

Figure 2. Average number of mites on 50-leaf samples from winged euonymus grown under three different watering regimes.

least amount of moisture stress, followed by cyclic and chronically drought-stressed plants. Well-watered plants had significantly thicker, more succulent leaves than did drought-stressed plants. Visual color rating showed that well-watered and unfertilized plants had the best red fall color, whereas chronic drought and fertilized plants had the least amount of fall color.

Significance to the Industry

Characterizing how planting site affects twospotted spider mite populations will be helpful in managing mite problems on *E. alata*. This work suggests that well-watered winged euonymus planted on the south side of and close to homes or other structures may be especially prone to mite outbreaks. These locations should be scouted first when inspecting for mites on *E. alata* in home or commercial landscapes. Early detection is a key to timely control, which can prevent rapid growth and spread of mite populations. Planting *E. alata* in cooler, less severe locations (e.g., the north side of structures) may reduce their susceptibility to mites.

Cicada Damage to *Cornus florida*

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Nature of Work

Periodic cicada, *Magicicada septendecim,* Brood XIX of the 13-year cycle, the largest brood of the 13-year cicadas (3,4,5), struck southern parts of western Kentucky and caused significant damage in nurseries and landscapes. *Cornus florida* (or flowering dogwood) plants that had been in the field 3 to 4 years seemed to be particularly susceptible to damage. Branches up to 24 inches long had to be removed in order to prune out the damage caused by the female cicada egg laying. In a western Kentucky nursery, few genera suffered the amount of damage found on dogwood.

All dogwoods in the nursery had to be pruned. It was estimated at the time of pruning that the branches removed averaged 18 inches long and represented 2 years of growth. It seemed at the time of pruning that the branches that were damaged but did not break were larger than the stems that broke causing limbs to wilt and die (flags).

Fifty cicada-damaged stems that had broken over, causing flags, and fifty stems that had been damaged but not broken were collected. The diameter of the stems was measured at the break and at the midpoint of the damage on the unbroken stems.

Results and Discussion

There was a difference (LSD=0.02 inches) between the diameter of the stems that broke and those that were damaged but not broken. The average diameter of the damaged unbroken stems was 0.246 inches (approximately pencil diameter). The broken stems averaged 0.196 inches. While rare, branches up to 0.291 inches were found broken. No branches damaged by female cicada egg laying that were collected from dogwood in the nursery studied were larger in diameter than 0.298 inches.

Significance to the Industry

The cicadas attack young, vigorously growing trees (3,4). Protection efforts, physical (2) or chemical (1), for dogwoods should concentrate on protecting branches with a diameter of less than 0.298 inches. The loss of branches in that diameter range adds at least a year to the production cycle. The next major cicada outbreak to affect west Kentucky will be Brood XXIII of the 13-year cycle in 2002 (3).

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Effect of Dogwood Powdery Mildew Incidence on Flower Bud Set

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Nature of Work

Dogwood powdery mildew, associated with ascocarps of *Microsphaera* and *Phyllactinia* spp., is damaging to the health and aesthetic qualities of *Cornus florida* (1). Although powdery mildew has been reported on dogwoods for many years, the disease has only become a serious problem in Kentucky landscapes during the past 5 years. The disease causes leaf symptoms which include distortion, reddish splotches, premature mottling, premature yellowing, dead patches, and marginal necrosis. Powdery mildew mycelium and spores are readily observed on the surface of some affected leaves, especially the newest growth; however, many leaves with symptoms show few fungal signs. Landscape dogwoods may be especially vulnerable to powdery mildew when the scorch and discoloration are enhanced by exposure to sunlight and dry soil conditions.

We evaluated the effects of fungicide applications on powdery mildew in 1997 on research plots at the University of Kentucky Horticultural Research farm near Lexington (2). The following fungicide treatments were applied either biweekly or monthly beginning in May and ending in mid-August: Banner MAXX, Rubigan AS, Bayleton 25TO, Cleary's 3336, and a water check. Powdery mildew was evaluated biweekly by estimating the percentage of leaves with powdery mildew symptoms (incidence) and the mean percentage of leaf area affected on infected leaves (severity). Disease pressure in the plots was high, and untreated *C. florida* were severely affected by the fungus. Fungicide effectiveness varied, providing trees with varying levels of disease. The influence of powdery mildew on next year's flowering was examined. Powdery mildew disease levels for September 4, 1997, were compared, using regression analysis, with flower bud set recorded on March 5, 1998.

Results and Discussion

The first signs of powdery mildew were detected on May 30 on *C. florida*. Powdery mildew incidence increased, especially in early July, reaching 100% by July 9 on susceptible trees. Cleistothecia were observed attached directly to fungal powdery mildew mats on fresh, infected dogwood leaves in September, and they were determined microscopically to be *Microsphaera*. Leaves with powdery mildew and no cleistothecia were harvested on October 22 and incubated under dry laboratory conditions. Cleistothecia developed on the leaves in about a month and proved microscopically to be those of *Phyllactinia*. Similarly, cleistothecia of *Phyllactinia* were observed embedded in fungal mats on fallen leaves collected from the field on November 25. Many of these leaves had cleistothecia of both *Microsphaera* and *Phyllactinia*.

Significant negative correlations for powdery mildew and flower bud set were found (Table 1). There was no correlation between specific fungicide treatments and flower bud set (3). Results were similar in a 1998 test that compared pairs of landscape dogwood trees in Lexington, Kentucky. One member of the pair was treated with Eagle (myclobutanil) at 3-week intervals from May through August. Flower bud set was measured in October. The fungicide-treated member of the pair set flower buds on 94% of its twig terminals while the untreated counterpart set flower buds on 35% of its terminals. These data suggest that where there is high disease pressure, using fungicides to reduce powdery mildew on landscape dogwoods can improve flowering. The long-term effects of fungicides and disease development on tree health are not known.

Significance to the Industry

This report confirms the concept that for those landscape plants that set buds for spring flowers the summer before, the health of the plant foliage is important to the profusion of blooms the following spring. The same phenomenon was observed a number of years ago in flowering crabapple infected and not infected with scab disease. To better serve their clients, landscape maintenance managers are being made aware of the importance of complete plant health care for optimum landscape aesthetics.

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Table 1. Effect of powdery mildew incidence in 1997 on flower bud set in 1998 in the fungicide efficacy trial at the UK Horticultural Research Farm.

Percent powdery mildew 9/4/97	Percent flower bud set 3/5/98	Predicted flower bud set (linear regression model)
0 - 15	93.0	98.6
15 - 35	90.0	90.0
35 - 65	85.4	74.3
65 - 85	48.5	65.3
85 - 100	68.5	55.4

Evaluation of Fungicides for Dogwood Powdery Mildew

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Nature of Work

Powdery mildew (*Microsphaera* and/or *Phyllactinia* spp.) is damaging to the health and aesthetic qualities of dogwood *(Cornus florida)* (1). The first observable symptom is a small whitish-to-chlorotic leaf spot. Growth of the pathogen causes the leaves to become distorted and develop reddish splotches and interveinal and marginal necrosis or leaf scorch. Landscape dogwoods are often especially prone to powdery mildew, because the scorch and discoloration symptoms may be enhanced by exposure to sunlight and dry soil conditions. Premature mottling and yellowing may also develop. This disease can be managed by the use of fungicides (2,3).

This test was conducted at the University of Kentucky Horticultural Research Farm and was designed to test the efficacy of several different fungicides and different application regimes for control of dogwood powdery mildew. A new strobilurin fungicide, Heritage, which we had not evaluated in previous years, was included in the test. Dormant, 2-year-old bare root dogwood liners were planted into three-gallon pots containing Barky Beaver nursery potting mix in May, 1998. The plants were placed in a shade structure and were watered as needed with automatic overhead sprinklers. Dogwoods were fertilized with 9 grams of 14-14-14 fertilizer/pot on June 19. Fungicides were prepared in small quantities and were applied using a hand-held sprayer. Fungicide rates and application dates are presented in Table 1. Percent powdery mildew incidence and severity were recorded on July 31 and August 21, expressed as incidence multiplied by severity, and statistically analyzed using a means comparison test.

Results and Discussion

On the first treatment day, June 18, the level of powdery mildew infection present on all plants was already between 1 and 2%. By the date of the last treatment, and three weeks later, untreated plants were recorded as having 58 and 84% powdery mildew, while several of the fungicide treatments held the disease levels to 1 or 2%. All fungicides at all treatment regimes were effective (Table 1). It appears that the new strobilurin fungicide, Heritage, is as effective as previously tested fungicides such as Cleary's 3336, Banner Maxx, and Eagle.

Significance to the Industry

In order to maintain optimal health of established dogwoods, the landscape industry needs to be aware of the relative efficacy of selected fungicide treatments. This report provides useful information to that end and, furthermore, should alert industry managers and workers about the seriousness of dogwood powdery mildew.

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Table 1. Efficacy of fungicides for control of dogwood powdery mildew, 1998.

Treatment and date of application	Percent powdery mildew[ab]	
	Jul 31	Aug 21
Cleary's 3336, 8.0 oz/100 gal, triweekly - June 18, July 10, July 31	2 a	1 a
Banner Maxx, 8.0 oz/100 gal, triweekly - June 18, July 10, July 31	2 a	1 a
Heritage, 8.0 oz/100 gal, weekly - June 18, 26; July 2, 10, 17, 24, 31	2 a	2 a
Eagle, 6.0 oz/100 gal, triweekly - June 18, July 10, July 31	2 a	3 ab
Heritage, 4.0 oz/100 gal, weekly - June 18, 26; July 2, 10, 17, 24, 31	2 a	6 ab
Heritage, 8.0 oz/100 gal, triweekly - June 18, July 10, July 31	2 a	6 ab
Heritage, 8.0 oz/100 gal, biweekly - June 18; July 2, 17, 31	1 a	7 ab
Heritage, 4.0 oz/100 gal, biweekly - June 18; July 2, 17, 31	7 a	7 b
Heritage, 4.0 oz/100 gal, triweekly - June 18, July 10, July 31	5 a	9 b
Check (untreated)	58 b	84 c

[a]In a column, means bearing the same letter are not significantly different (P = 0.05).
[b]Percent powdery mildew = (% incidence x % severity).

Evaluation of Fungicide Application Timing for Dogwood Powdery Mildew Control

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Nature of Work

Dogwood (*Cornus florida*) is adversely affected by powdery mildew (*Microsphaera* and/or *Phyllactinia* spp.) (1). The disease begins as a small whitish-to-chlorotic leaf spot. Growth of the pathogen causes the leaves to become distorted and develop reddish splotches and interveinal and marginal necrosis or leaf scorch. Premature mottling, yellowing, and defoliation may also develop. Landscape dogwoods are often especially prone to powdery mildew, because the scorch and discoloration symptoms may be enhanced by exposure to sunlight and dry soil conditions. This disease can be managed by the use of fungicides (2, 3).

The test was conducted in a home landscape with a history of dogwood powdery mildew. Located in Woodford County, Kentucky, the landscape contained more than 40 dogwoods ranging in size from 1 to 10 inches in diameter at the base. The trees were identified by size and location relative to shade, and assignments were made such that each treatment would appear across trees of all sizes and locations. The effect of fungicide application timing was tested by assigning certain trees one of a series of eight spray schedules, which permitted comparison of applications made at different times in the season (Table 1.)

The fungicide Banner Maxx was used for this evaluation and was applied at the labeled rate of 8.0 oz/100 gal. The fungicide was applied at 3-week intervals using a hand-pumped Solo backpack sprayer operating at about 25 psi. Trees were evaluated for powdery mildew at 3-week intervals from July 10 to October 3. The percent incidence and severity of disease symptoms and signs were recorded. Percent powdery mildew ratings were expressed as percent incidence multiplied by percent severity. Results were statistically analyzed using a means comparison test.

Results and Discussion

Treatment designations and results are presented in Table 1. The dogwoods were in full flower on April 17, the first spray application date, and three weeks later, all the bracts had fallen. The first signs of powdery mildew were detected on June 19. Disease pressure was fairly heavy in July, but lessened when dry weather occurred later. From August 1 through October 2 only a trace of rain fell at this site, and the homeowner did not water the trees. Thus, drought caused scorching, premature leaf color, and defoliation that obscured disease symptoms on September 11 and October 3. These latter ratings only took into account signs of powdery mildew and not symptoms such as reddish splotches, premature mottling, premature yellowing, dead patches, and marginal necrosis. Although unsprayed dogwoods were easy to detect in these later evaluations, the drought masked differences between the different fungicide treatments.

By August 21, unsprayed trees averaged 59% powdery mildew. The disease varied greatly between trees within the same treatments; nevertheless, all treatments had significantly less disease than the controls. Full-season fungicide treatment provided better control of powdery mildew than part-season treatments. It appeared that fairly good control might be obtained with as few as four fungicide applications made 3 weeks apart.

Table 1. Effect of fungicide application timing on powdery mildew disease development in the landscape dogwoods of Ms. S. Thompson, Woodford Co., KY, 1998.

Treatment Date	Treatment with Banner Maxx fungicide 8.0 oz/100 gal							
April 17 (bloom)	yes	yes	yes	no	no	no	no	no
May 8 (bract fall)	yes	yes	yes	no	no	no	no	yes
May 29	yes	yes	yes	yes	no	yes	no	yes
June 19 (first p.m.)	yes	yes	yes	yes	no	yes	no	yes
July 10	yes	yes	no	yes	yes	yes	no	yes
July 31	yes	yes	no	yes	yes	yes	no	yes
August 21	yes	no	no	no	yes	yes	no	yes
September 11	yes	no	no	no	yes	yes	no	no
Evaluation Date	**Percent powdery mildew (% incidence x % severity)[a]**							
July 10	10 a	6 a	10 ab	20 b	30 b	11 ab	24 b	8 a
July 31	8 a	9 a	10 a	5 a	15 a	9 a	48 b	15 a
August 21	1 a	10 b	14 bc	10 bc	16 c	5 ab	59 d	6 ab
September 11 (dry)	0 a	0 a	0 a	0 a	13 b	0 a	61 c	0 a
October 2 (dry)	0 a	0 a	0 a	0 a	0 a	0 a	24 b	0 a

[a]In a column, means bearing the same letter are not significantly different (P = 0.05).

Significance to the Industry

With dogwood powdery mildew being a relatively new disease, little is known of the most effective timing of fungicide applications. This report is useful to the landscape industry because it suggests that, although powdery mildew is nearly a season-long disease, it may not be necessary to apply fungicides through the whole season. In addition, 3-week intervals between applications may work well for disease management.

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Preliminary Results on Isolation of *Spheropsis sapinea* from Landscape Austrian Pines

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Nature of Work

Austrian pines (*Pinus nigra*) growing in the landscape are subject to tip blight disease caused by the fungus *Sphaeropsis sapinea* (*Diplodia pinea*) (1). In Kentucky, the disease is severe enough that trees infected for several successive years are often removed from the landscape long before they become mature (80 years in their native environment). Despite spraying and pruning efforts, Austrian pines continue to die in many landscapes. We had made a survey of Austrian pines on the University of Kentucky campus in 1992-1994 and found that of the 563 pines ranging in age from 7 to 30 years, the disease was nearly absent in pines under 13 years, and became progressively worse as pines aged (2). Onset of disease was associated with production of cones. Cones of Austrian pines are retained for 3 years, appearing as small brown conelets the first season after spring pollination, elongating into green cones with tight scales the second year, and finally into typical brown cones with open scales the third year.

We re-surveyed the same trees in 1998, recording their health status. In the laboratory, isolations were made of the causal fungus from cones of different ages and from infected and healthy branches. Pine tissues were surface-sterilized and plated onto acidified potato dextrose agar using standard fungal isolation techniques.

Table 1. Percent of Austrian pines with varying levels of tip blight on the UK campus (539 trees evaluated).

Tree health category	Percent
Healthy trees	37
0 - 10% tip blight	24
10 - 50% tip blight	19
50 - 90% tip blight	7
>90% tip blight	2
Removed in last 3 yr.	12

Table 2. Isolation of *S. sapinea* from Austrian pine needles.

Live needles	Percent	Dead needles	Percent
tip	0	tip	42
middle	37	middle	49
base	42	base	83

Table 3. Isolation of *S. sapinea* from Austrian pine cones.

First year cones	Percent	Cone scales	Percent
tip	34	2nd year	50
near tip	27	3rd year	94
middle	23		
near base	31		
base	67		

Results and Discussion

Evaluation of the 539 Austrian pines in 1998 reveals a continuing decline in the health of the population, despite the addition of new individuals in recent years (Table 1). Within the population, 37% remain healthy and, since the previous survey, 12% of the trees have been removed. Between the time of the survey and the writing of this report, an additional 2-3% have been removed.

The tip blight fungus, *Sphaeropsis sapinea*, was isolated from both diseased and healthy pine needles (Table 2), from apparently healthy first- and second-year cones as well as diseased third-year cones (Table 3), and from symptomless twigs and buds, mostly from trees having tip blight in another part of the tree (Table 4). Isolation of *S. sapinea* as an endophyte from green, healthy cones of Monterey and Mexican yellow pines in South Africa has been demonstrated (3). Our studies support the concept that *S. sapinea* may live as an endophyte inside symptomless tissues of Austrian pines. Additional work is needed to determine the extent to which this phenomenon occurs and the potential implications for maintenance of the health of Austrian pines.

Table 4. Isolation of *S. sapinea* from Austrian pine twigs and buds.

Branches, 12 in	Percent	Shoot buds	Percent
shoot tip	83	tip	17
middle (6 in)	61	middle	12
base (12 in)	69	near base	27
		base	69

Significance to the Industry

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

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Landscape Plant Disease Observations from the Plant Disease Diagnostic Laboratory

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Nature of Work

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

Making a diagnosis involves a great deal of research into the possible causes of the plant problem. Most visual diagnoses involve microscopy to determine what plant parts are affected and to identify the microbe involved. In addition, many specimens require special tests, such as moist chamber incubation, culturing, enzyme-linked immunosorbent assay (ELISA), electron microscopy, nematode extraction, or soil pH and soluble salts tests.

Computer-based laboratory records are maintained to provide information used for conducting plant disease surveys, identifying new disease outbreaks, and formulating educational programs. Much of the 1998 growing season was very favorable for landscape plant diseases. Kentucky landscapes experienced fluctuating, but mild, winter temperatures, an early-spring freeze, heavy late-spring and early-summer rains, and dry late-summer and fall weather, each of which contributes to the development of different kinds of diseases.

Results and Discussion

A widely observed abiotic weather-related problem of crabapples, callery pears, junipers, arbor vitaes, and other woody plants was the sudden collapse of shoots and foliage at the first onset of warm spring weather. This dieback could be attributed to temperatures below 10°F on March 12, at which time most plants had broken dormancy; flowering crabapples were at the stage of pink bud, and callery pears were in bloom. Browning of phloem tissues was observed in injured plants. A variety of canker diseases could later be found on many of these same cold-injured woody plants.

Deciduous Tree Diseases

Mild winter temperatures and wet spring weather resulted in high levels of peach leaf curl (*Taphrina deformans*). Rainy spring weather favored flowering crabapple scab (*Venturia inaequalis*) and cedar-apple rust (*Gymnosporangium juniperi-virginianae*). Rust-susceptible apples showed significant leaf spots, while scab-susceptible crabapples were practically defoliated by August. Following a dry period, many of these same crabapples produced blooms in October. The various anthracnose fungi were very active on ash (*Discula*), maple (*Kabatiella* and *Discula*), and sycamore (*Apiognomonia*). At one point in late spring, most sycamores only had a few tufts of green leaves in the top of the tree. Dogwood powdery mildew (*Microsphaera, Phyllactinia* spp.), a disease which has become important in recent years, continues to be very serious in many landscapes. Oak leaf spot (*Tubakia* sp.), along with oak anthracnose, is severely affecting some established, but young, red oaks, causing twig and branch dieback. Bacterial leaf scorch (*Xylella fastidiosa*) was detected by ELISA in a callery pear, but the causal agent could not be found microscopically. Branch dieback continues to follow many years of bacterial leaf scorch symptoms in large, mature pin oaks.

Needle Evergreen Tree Diseases

Early spring 1998 defoliation of landscape Japanese black pines was noted due to infections of brown spot (*Mycosphaerella dearnesii*) that occurred in 1997. Spring 1998 rains, and apparently favorable infection conditions in the summer of 1996, resulted in unusually high levels of telia production by cedar rusts (*Gymnosporangium* spp.) on junipers. White pine root decline (*Verticicladiella procera*), usually only a Christmas tree problem, has been found in several landscapes. In groups of white pines approximately 15 to 20 years old, the disease appears to move from tree to tree, killing individuals in one season. Maturing Austrian and Scots pines continue to die from tip blight (*Sphaeropsis sapinea*) and pine wilt nematode (*Bursaphelenchus xylophilus*). White pine decline (associated with root disturbance or with soils having high clay content, high pH levels, or heavy compaction) continues to take its toll.

Shrub Diseases

Black root rot (*Chalara elegans*) of hollies remains a problem. Taxus, junipers, and other shrubs suffered root rot (most likely *Phytophthora* spp.), worsened by high soil moisture levels. Rhododendrons facing environmental stresses such as cold, heat, drought, or poor soils showed cankers (*Botryosphaeria dothidea* and others) that caused wilt and branch dieback. Azalea leaf and flower gall (*Exobasidium vaccinii*) was common.

Perennial and Annual Plant Diseases

Rhizoctonia root and stem rot in annual and perennial beds was common.

Landscape Lawn Diseases

Perennial ryegrasses suffered a devastating attack of gray leaf spot (*Pyricularia grisea*) in late summer.

Significance to the Industry

To serve their clients effectively, landscape industry professionals, such as arborists, nurserymen, and landscape installation and maintenance organizations, need to be aware of recent plant disease history and the implications for landscape maintenance. This report provides useful information for landscape professionals.

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Daylily Evaluation: Two Years in the Field

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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, for use in the landscape and in collections, that has created strong demand for plants and information on daylily cultivars. Daylily cultivars were evaluated for aesthetic appeal and favorable production characteristics after 2 years in a field production system.

Cultivars for the trial were supplied by Schott Gardens, Bowling Green, and Swanson Daylilies, Lexington, Kentucky.

Weekly observations were made to record time and color of bloom in 1998. The clumps were dug and divided on September 22, 1998, and the number of divisions recorded.

Results and Discussion

The bloom dates are reported as the first bud, first bloom, and last bud observed for any replicate plant of the cultivars in the study. The number of divisions are reported as the average of three plants in the field unless otherwise noted. The number of proliferations is the actual number that occurred for the number of plants reported. Of the plants shown to still be in bloom on the harvest date, September 22, 1998, most had additional buds and would have continued to bloom.

Significance to the Industry

There continues to be an increase in the number of Kentucky nurseries producing daylilies and the number hybridizing daylilies. Evaluations of cultivars for time of flowering and number of divisions are important to a cultivar's economic survival. Three divisions per original plant is considered the absolute minimum in order for a cultivar to be considered commercially viable, and then only if the bloom characteristics are exceptional. Knowledge of a cultivar's special bloom characteristics, i.e., early bloom, continuous bloom, or fall bloom, can be used to tailor marketing strategies. For example, a cultivar that bloomed during the fall festival season could expand the marketing diversity for roadside stands and entertainment farms, as well as increase the length of the market window for daylily growers.

Note: Since the first daylily evaluation trial in 1992, a single plant of each cultivar evaluated has been planted in a display garden available for public viewing at the UKREC, Princeton, Kentucky. Most of the cultivars have also been planted at the UK Arboretum, Lexington, Kentucky.

Table 1. 1998 Daylily characteristic observations of two-year-old plants.

Cultivar	Color	Date of First Bud	Date of First Bloom	Date of Last Bloom	Number of Divisions (proliferation)
Open Hearth	Rust & Yellow	26 May	18 Jun	29 Jul	7
Rosetta Sheridan	Apricot	29 May	18 Jun	14 Aug	12 (32)
Siloam Virginia Henson	Peach	9 Jun	18 Jun	27 Jul	12
Royal Promise	Peach Yellow	9 Jun	18 Jun	22 Sep	9 (1)
Happy Returns	Yellow	7 May	26 May	14 Aug	19
Ruffled Apricot	Apricot	9 Jun	10 Jul	22 Sep	9
Black Eyed Stella	Yellow w/Rust Band	4 May	11 May	22 Sep	27
Top Honors	Lemon Yellow	1 Jun	18 Jun	14 Sep	7
Lavender Touch	Lavender	9 Jun	26 Jun	10 Jul	12
Buttercurls*					6
Barbara Mitchell*	Pink				6
Chicago Sunrise*	Orange				5
Eric Jr.*					54
Lisa My Joy*	Off White/Purple Eye				6 (5)
Anzac*	Orange				2
Pardon Me*	Red				14
Cantique*	Pink				8
Juanita*					7
Always Afternoon*	Mauve/ Purple Eye				9
Aten*	Orange				19
Mary Shadow	Yellow	1 Jun	18 Jun	12 Aug	8 (10)

continued

Table 1. 1998 Daylily characteristic observations of two-year-old plants, continued.

Cultivar	Color	Date of First Bud	Date of First Bloom	Date of Last Bloom	Number of Divisions (proliferation)
Nettie Downing	Ivory	1 Jun	18 Jun	27 Jul	8 (2)
Janice Wendell	Yellow	9 Jun	10 Jul	20 Aug	8 (2)
Ray Hammond	Orange Red	18 Jun	29 Jun	12 Aug	7
[1]Pagliacci	Maroon Yellow				
Hyperion	Yellow	1 Jun	22 Jun	10 Jul	9
Milano[2] Maraschino	Wine/Yellow	1 Jun	18 Jun	31 Jul	10
Milano Violet Mark	Violet	26 May	5 Jun	11 Jun	11
Milano Rocket	Burnt Orange	26 May	18 Jun	10 Jul	8
Octavian[2] Marble Ring	Peach	26 May	18 Jun	27 Jul	19
Octavian Marble Model	Violet	26 May	1 Jun	20 Aug	12 (1)
Octavian Orchid	Purple Pink w/Yellow	26 May	1 Jun	11 Sep	31 (7)
Octavian Glow	Light Cream	1 Jun	22 Jun	22 Sep	5
Octavian Exotic Marble	Peach w/Violet Eye	26 May	18 Jun	12 Aug	13 (7)
Octavian Cherry Doll	Reddish Peach	26 May	1 Jun	27 Jul	21

[1] Eliminated from the evaluation.
[2] Octavian - =diploid and Milano - =tetraploid
* Single plants for which no bloom data were collected

Landscape Tree Evaluations for Host Plant Resistance

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Nature of Work

Although biological reasons are not fully understood, various cultivars within plant species may be especially prone to attack by arthropod pests and diseases. Even relatively small biochemical and/or phenological differences between plants may affect the feeding preferences, survival, and population growth of pests using them as a food source.

Results of a case study of Urban IPM in Kentucky (1) indicated that for many of the pest and disease problems encountered, selection of resistant or tolerant cultivars could have reduced plant damage. Furthermore, in urban settings where pesticide use is often inappropriate, lack of reliable information prevented IPM practitioners from making insect pest- and disease-control suggestions based on cultivar differences. Experience with the National Crabapple Evaluation Program in Kentucky has demonstrated the feasibility of obtaining consistent disease-resistance information from blocks of different cultivars in the field (2, 3, 4).

Historically, breeding programs for woody ornamentals have been more concerned with desirable horticultural or aesthetic characteristics than with resistance to pests. Cultivar resistance evaluations have been made for very few plant species, and there has been almost no research in this area in the southeastern United States. Resistance in woody plants is strongly related to general vigor, so regional differences in host susceptibility are likely to be important. Nonetheless, cultivars do exist that are resistant to certain arthropod pests and diseases, and selection of these genotypes can potentially reduce future pest problems (5, 6, 7).

The objective of this study is to determine levels of insect and disease resistance among cultivars of dogwoods and birches, ornamental plants that are commonly used in Kentucky landscapes. These species are also important to landscapes of the midwestern and mid-southern regions of the United States. Separate plots have been established for insect and disease assessments at the South Farm Horticulture Experiment Station, Lexington, Kentucky. Cultivars are replicated 10 times for each assessment plot (except for *B. nigra*, of which we could only obtain five plants) and have been planted in a randomized complete block design. Dogwood plots were established in 1991 and birch in 1994. The dogwood cultivars assessed include *Cornus florida* (white), *C. f.* 'Cherokee Chief', *C. f.* 'Barton White', *C. f.* 'Cloud 9', *C. kousa* 'Milky Way', *C. k.* 'National', *C. f.* x *k* 'Galaxy', *C. f.* x *k.* 'Constellation', *C. f.* x *k.* 'Star Dust', and *C. mas* 'Gold Glory'. The birch cultivars evaluated include *Betula pendula* (European White), *B. jacquemontii* (Whitebarked Himalayan), *B. platyphylla szechuanica* (Asian White), *B. p. s.* 'Purpurea', *B. populifolia* 'Whitespire', *B. papyrifera* (Paper), *B. nigra* (River), and *B. n.* 'Heritage'.

Results and Discussion

Evaluations of insect pest damage on dogwood and birch cultivars were done in 1996 and 1998. The primary dogwood pest evaluated was the dogwood borer, *Synanthedon scitula*. Birch pests evaluated included the birch leafminer, *Fenusa pusilla*; Japanese beetle, *Popillia japonica*; aphids, *Hamamelistes spinosus*; and the bronze birch borer, *Agrilus* *anxius*. Additional evaluations will be done in the future to assess damage by these pests as the trees age. The following tables show the results of these evaluations.

Significance to the Industry

The results of this study are providing a basis for Integrated Pest Management (IPM) and Plant Health Care (PHC) programs with potential reductions in pesticide usage while managing pest populations at acceptable levels.

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1998 Dogwood Evaluations (Lexington, KY)

Rating System:

0=No pest activity (0% damage) OR Pest absent
1=Low pest activity (1 - 33% damage or 1 borer)
2=Moderate pest activity (34 - 66% damage or 2 borers)
3=Severe pest activity (67 - 100% damage or 3 or more borers)

Dogwood Borer (*Synanthedon scitula*) Assessment

Cultivar	Average Ratings	Comments
Cornus florida (white)	2.0	
C. florida 'Cherokee Chief'	1.5	
C. florida 'Barton White'	1.4	
C. florida 'Cloud 9'	1.1	
C. kousa 'Milky Way'	2.1	3 plants dead out of 10: 2 to borers
C. kousa 'National'	2.9	3 plants dead out of 10: all to borers
C. kousa x florida 'Galaxy'	2.1	4 plants dead out of 10: 2 to borers
C. kousa x florida 'Constellation'	2.2	4 plants dead out of 10: 0 to borers
C. kousa x florida 'Star Dust'	1.8	6 plants dead out of 10: 1 to borers
C. mas 'Gold Glory'	0.2	1 plant with moderate infestation

Comments:

Date of assessment was May 28. Notable that all the plants (10) of the *Cornus florida* cultivars are surviving, with relatively low borer activity.

The *C. kousa* cultivars and the *C. kousa x florida* crosses experienced notable mortality, with the most severe borer activity on *C. kousa* 'National' and *C. kousa x florida* 'Constellation'.

Lowest borer activity was on *C. mas* 'Gold Glory' (Cornelian Cherry), which has characteristics quite different from the other dogwoods.

1998 Birch Evaluations (Lexington, KY)
Rating System:
- 0=No pest activity (0% damage) OR Pest absent
- 1=Low pest activity (1 - 33% damage or 1 borer)
- 2=Moderate pest activity (34 - 66% damage or 2 borers)
- 3=Severe pest activity (67 - 100% damage or 3 or more borers)

Bronze Birch Borer (*Agrilus anxius*) Assessment

Cultivar	Average Ratings	Comments
Betula pendula (European White)	0.3	1 plant infested out of 10 (>100 holes)
B. jacquemontii (Whitebarked Himalayan)	0.0	5 plants dead out of 10 (stressed by Japanese beetles?)
B. platyphylla szechuanica (Asian White)	0.1	1 plant infested out of 10 (1 hole); 1 plant dead out of 10
B. p. s. 'Purpurea'	3.0	2 plants dead/removed; remaining 8 plants averaged 32.7 holes/tree
B. populifolia 'Whitespire'	0.0	
B. papyrifera (Paper)	0.0	1 plant dead out of 10
B. nigra (River)	0.0	5 plants
B. n. 'Heritage'	0.3	2 plants dead out of 10: 1 to borers

Comments:
Date of assessment was May 28. Cultivars with no borers: *Betula jacquemontii, B. papyrifera, B. populifolia* 'Whitespire', and *B. nigra*.
B. platyphylla szechuanica 'Purpurea' was extremely susceptible. Borer emergence holes are predominantly on the south/southwest side of trees. One tree had 2 larger holes, possibly flatheaded appletree borer.
Borers in *B. nigra* 'Heritage' were larger, possibly flatheaded appletree borers.
B. jacquemontii was seriously defoliated by Japanese beetles.

1996 Birch Evaluations (Lexington, KY)
Rating System:
- 0=No pest present (0% damage)
- 1=Low pest numbers (1 - 33% damage)
- 2=Moderate pest numbers (34 - 66% damage)
- 3=High pest numbers (67 - 100% damage)

Aphids (*Hamamelistes spinosus* and others) Assessment

Cultivar	Average Ratings	Comments
Betula pendula (European White)	0.4	4 plants out of 10: low numbers
B. jacquemontii (Whitebarked Himalayan)	0.1	1 plant out of 10: low numbers
B. platyphylla szechuanica (Asian White)	0.2	1 plant dead/removed; 2 plants out of 9: low numbers
B. p. s. 'Purpurea'	0.6	6 plants out of 10: low numbers
B. populifolia 'Whitespire'	0.2	2 plants out of 10: low numbers
B. papyrifera (Paper)	0.0	
B. nigra (River)	2.0	5 plants: moderate numbers
B. n. 'Heritage'	2.4	moderate to high numbers

Comments:
Date of assessment was May 16. Aphid numbers generally low on all cultivars except *Betula nigra* and *B. n.* 'Heritage'. Most aphids noted on these two cultivars were *Hamamelistes spinosus*, causing characteristic corrugated leaves with eventual leaf death and drop. Noticed several Coccinelids (*Harmonia*) attracted to infested leaves.

1998 Birch Evaluations (Lexington, KY)

Rating System:

0=No pest present (0% damage)
1=Low pest numbers (1 - 33% damage)
2=Moderate pest numbers (34 - 66% damage)
3=High pest numbers (67 - 100% damage)

Aphids (*Hamamelistes spinosus*) Assessment

Cultivar	Average Ratings	Comments
Betula pendula (European White)	0.0	1 plant dead out of 10 (borers)
B. jacquemontii (Whitebarked Himalayan)	0.0	5 plants dead out of 10 (stressed by Japanese beetles?)
B. platyphylla szechuanica (Asian White)	0.0	1 plant dead out of 10
B. p. s. 'Purpurea'	0.0	4 plants dead out of 10
B. populifolia 'Whitespire'	0.0	
B. papyrifera (Paper)	0.0	1 plant dead out of 10
B. nigra (River)	1.0	5 replicates
B. n. 'Heritage'	1.0	2 plants dead out of 10

Comments:

Date of assessment was May 28. Only plants infested were *Betula nigra* and *B. n.* 'Heritage'. This evaluation was done later than in 1996, possibly resulting in lower pest activity. Johnson and Lyon state that, at least in New York, activity on birch is completed by the end of June. *Hamamelistes spinosus* utilizes witch-hazel as an alternate host.

1996 Birch Evaluations (Lexington, KY)

Rating System:

0=No pest present (0% damage)
1=Low pest numbers (1 - 33% damage)
2=Moderate pest numbers (34 - 66% damage)
3=High pest numbers (67 - 100% damage)

Birch Leafminer (*Fenusa pusilla)* Assessment

Cultivar	Average Ratings	Comments
Betula pendula (European White)	0.1	
B. jacquemontii (Whitebarked Himalayan)	0.3	
B. platyphylla szechuanica (Asian White)	0.4	
B. p. s. 'Purpurea'	0.0	
B. populifolia 'Whitespire'	0.3	
B. papyrifera (Paper)	0.4	
B. nigra (River)	0.2	
B. n. 'Heritage'	0.1	

Comments:

Date of assessment was July 9. No major problems with leafminer. *Betula platyphylla szechuanica* 'Purpurea' was only cultivar with no leafminers noted.

1998 Birch Evaluations (Lexington, KY)

Rating System:

0=No pest present (0% damage)
1=Low pest numbers (1 - 33% damage)
2=Moderate pest numbers (34 - 66% damage)
3=High pest numbers (67 - 100% damage)

Birch Leafminer (*Fenusa pusilla)* Assessment

Cultivar	Average Ratings	Comments
Betula pendula (European White)	0.0	
B. jacquemontii (Whitebarked Himalayan)	0.0	
B. platyphylla szechuanica (Asian White)	0.0	
B. p. s. 'Purpurea'	0.0	
B. populifolia 'Whitespire'	0.0	
B. papyrifera (Paper)	0.1	1 out of 9 with low damage
B. nigra (River)	0.0	
B. n. 'Heritage'	0.0	

Comments:

Date of assessment was July 24. On May 28, two *B. platyphylla szechuanica* and two *B. populifolia* 'Whitespire' were noted to have low leafminer activity but none observed at the time of this assessment. Johnson and Lyon state that the birch leafminer is common on gray birch, *B. populifolia*, and *B. papyrifera* but rarely feeds on black, yellow, European white, or river birch.

1996 Birch Evaluations (Lexington, KY)

Rating System:

0=No pest present (0% damage)
1=Low pest numbers (1 - 33% damage)
2=Moderate pest numbers (34 - 66% damage)
3=High pest numbers (67 - 100% damage)

Japanese Beetle (*Popillia japonica)* Defoliation Assessment

Cultivar	Average Ratings	Comments
Betula pendula (European White)	0.1	
B. jacquemontii (Whitebarked Himalayan)	1.9	9 of 10 plants with moderate damage
B. platyphylla szechuanica (Asian White)	0.8	
B. p. s. 'Purpurea'	0.9	
B. populifolia 'Whitespire'	1.0	
B. papyrifera (Paper)	1.0	
B. nigra (River)	1.0	
B. n. 'Heritage'	1.0	

Comments:

Date of assessment was August 21. Notable that *Betula jacquemontii* received the most damage from adult Japanese beetle feeding. *B. pendula* showed the most resistance to feeding damage; only 1 plant out of 10 had low level of damage.

1998 Birch Evaluations (Lexington, KY)

Rating System:

0=No pest present (0% damage)
1=Low pest numbers (1 - 33% damage)
2=Moderate pest numbers (34 - 66% damage)
3=High pest numbers (67 - 100% damage)

Japanese Beetle (*Popillia japonica*) Defoliation Assessment

Cultivar	Average Ratings	Comments
Betula pendula (European White)	0.3	3 plants out of 9: low numbers
B. jacquemontii (Whitebarked Himalayan)	2.8	Only 5 plants alive; plants are very small, 5-6' tall (stressed?)
B. platyphylla szechuanica (Asian White)	0.3	3 plants out of 9: low numbers
B. p. s. 'Purpurea'	0.4	Only 5 plants alive; 2 with damage
B. populifolia 'Whitespire'	1.0	
B. papyrifera (Paper)	1.7	6 out of 9 had moderate damage
B. nigra (River)	0.2	1 out of 5 with low damage
B. n. 'Heritage'	0.4	3 out of 8 with low damage

Comments:

Date of assessment was July 24. *B. jacquemontii* again received the most damage from adult Japanese beetle feeding. It is notable that these trees have remained quite small (5-6') compared to all other cultivars that typically are 12 - 20' tall. Leaf spot noted on *B. p. szechuanica, B. p. s.* 'Purpurea', *B. pendula, B. nigra, and B. n.* 'Heritage'. *B. pendula* has sparse foliage. A few bagworms on all cultivars and one *B. populifolia* 'Whitespire' with yellownecks.

Hydrangeas for Cut Flowers: Early Observations

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

In April 1998 *Hydrangeas* (planted as rooted cuttings in October 1996) were dug, pruned to the ground, and planted into a cut flower trial. The plants were spaced at 12 feet between rows and 10 feet between plants in the row. No fertilizer or irrigation was provided. Throughout the growing season, the plots were observed weekly to record the date of first bloom. At the end of the flowering season, data were collected on the number of stems that had bloomed and the length of the stems with blooms (18 inches would be a salable Hydrangea stem with bloom, personal communication, Sharon Bale). There were 12 plants per cultivar (except for 'Boskoop', which was missing one plant, and 'Alice', which was missing two plants). Averages in Table 1 were calculated using the total number of plants even if some had no blooms. 'Pee Wee' had 3 plants without blooms. 'Annabelle', 'Tardiva', and 'Boskoop' each had one plant without blooms.

Table 1. Flowering characteristics of Hydrangea cultivars, 1998.

Cultivar	Date of First Bloom	Average number of stems per plant	Average length (inches) of stems
Hydrangea aborescens 'Annabelle'	June 8, 1998	2.67	17.82
Hydrangea quercifolia 'Alice'	no bloom	----	----
Hydrangea paniculata 'Boskoop'	June 26, 1998	2.55[1]	18.75[1]
Hydrangea paniculata 'Kyushu'	June 19, 1998	7.58	22.12
Hydrangea paniculata 'Pee Wee'	July 14, 1998	3.25	19.04
Hydrangea paniculata 'Pink Diamond'	July 14, 1998	9.42	17.68
Hydrangea paniculata 'Tardiva'	July 14, 1998	3.75	21.12
Hydrangea paniculata 'Unique'	June 14, 1998	7.67	20.60
Hydrangea paniculata 'White Moth'	no bloom	----	----

[1] Averages calculated using 11 plants

Notes From the Arboretum: Annual and Perennial Plant Performance

Sharon Bale
Department of Horticulture and Landscape Architecture

The All America Trials, located at the University of Kentucky Arboretum, are the focus of my effort to evaluate new and different herbaceous plant materials for Kentucky. In addition to those trials, I try to grow some plants that are new or unfamiliar to me or the Arboretum staff. While it is a goal to have something new each season, some of the tried-and-true cultivars are usually grown for class purposes as well as the enjoyment of the general public.

The following are some comments on how a number of plants fared this season.

All America Selection Winners

Zinnias 'Profusion Orange' and 'Profusion Cherry'—GOLD MEDAL WINNERS—This distinction is reserved for a breeding breakthrough. These two plants have earned this distinction for their foliar disease tolerance. Everything printed about these plants in the press or trade magazines is true of their performance in Kentucky. These are *great plants!* Visitors to the Arboretum have made many favorable comments. The plants produce mounds of single blooms that require no deadheading.

Begonia 'Pin-up-Flame'—A tuberous rooted begonia with bicolor blooms. It requires shade for best performance, and since we still do not have a great deal of shade at the Arboretum, the performance in our garden may not be completely up to par. Bloom size is 2 to 4 inches in diameter, and plants reach a height of 10 to12 inches.

Tritoma 'Flamenco'—This perennial plant's claim to fame is that it will bloom the first season from seed. It did. Garden performance after that has been equal to other Tritomas.

Marigold 'Bonanza Bolero'—Touted as unique because of its irregular gold-and-red bicolor pattern.

Osteospermum 'Passion Mix'—Press information states flower size is 2 to 2½ inches, and the plant reaches a height of 12 to 18 inches. Plants are drought tolerant. When scored in the Kentucky trials, the plants did not survive the season. This year they lasted all season and looked great. Plants were 8 to 10 inches. Although it did not rate high on my list the first season, this plant is worth another look.

Portulaca 'Sundial Peach'—Great color and large blooms. Garden performance is equal to other portulacas.

Verbena 'Quartz Burgundy'—It is a very nice verbena. The problem with many of the "garden verbenas" was all the deadheading that was necessary to keep them vigorous. 'Quartz Burgundy' does not require that maintenance.

Proven Winners

(Donated by Pleasant View Gardens)

Cobbity Daisies 'Summer Angel', 'Butterfly', and 'Sugar n'Ice'—These were somewhat of a disappointment. Plants were set out with flowers in full bloom and additional buds set. After the first flush of bloom, 'Summer Angel' and 'Sugar n'Ice' never produced any additional blooms. 'Butterfly' did flower again in late August but was not prolific.

Diascia 'Elliot's Variety'—We have tried to grow Diascia before. We were not successful then, and we were not successful with this cultivar. With the loss of these plants, Diascia now has two strikes against it in my book.

Anagallis 'Skylover'—A very prostrate plant with blue blooms. This plant was not very exciting, but I am not sure we did not have this in an unfavorable location. It is on the list to try again.

Petunia 'Million Bells', 'Trailing Pink', 'Cherry Pink', and 'Trailing Blue'—All were great in containers but were slow to grow and produce bloom in our ground beds. All began to produce a great show late in the season, so the problem with this plant may have been the gardeners rather than the plant. We will evaluate these plants again next year.

Verbena 'Temari Violet', 'Temari Bright Pink', 'Temari Red'—*Great! Pick a color and grow lots.* No need to deadhead, and they bloomed all season. Generally 6 to 8 inches, with a wide spread.

Odd Lots

Salvia 'Coral Nymph'—This plant was grown in the Arboretum two years ago and got a lot of attention. Plants produce light-pink spike blooms all season. There was some reseeding, but germination was too late the following season to either be an advantage or a problem. Plants were 18 to 20 inches.

Salvia 'White Nymph'—Since 'Coral Nymph' was so attractive, it made sense to try 'White Nymph'. It blooms all season and is more robust than 'Coral Nymph'. Plants may reach 48 inches in height. It was in the wrong location to show it to its best advantage, but it looks like a plant worthy of attention. 'White Nymph' will be a "back of the border" or an annual hedge in the Arboretum next year.

Cuphea x purpurea 'Firefly'—Not really showy from a distance, but this plant produced blooms all season. Plants were 18 to 24 inches tall. The bloom color is hard to describe. Depending on the light, they were pink to red with a blue or purple tinge. Plants were grown in a location where they were overwhelmed by the Salvia leucantha planted behind them. 'Firefly' needs to be grown again in a less crowded location to be adequately evaluated.

Lobelia 'Fan Scharlach' and 'Fan Tiefrosa'—Think in terms of Lobelia cardinalis in various shades. Plants appear to be quite hardy here and offer a range of colors. They bloom around mid-season and could be quite popular in a perennial border. They tolerate full sun and do not seem to have any special moisture requirements.

What to Look for Next Season

The following plants are being evaluated for their annual garden performance as well as their potential as perennial plants in this area. Since this is the first season, I have provided brief catalog descriptions, but I will reserve judgment about performance in this area until next season.

Salvia greggii 'Raspberry Royale' (Zone 6)—A hybrid of S. greggii x S. lemmonii. Blooms heavily in spring, sporadically during the summer, and heavily in the fall. It was 18 to 20 inches this season.

Salvia guaranitica (Zone 7)—Dark blue flowers on 36-inch plants. Begins show mid-season.

Salvia guaranitica 'Black and Blue' (Zone 7)—Very similar to Salvia guaranitica, but the calyx is black. Growth habit and performance are similar. Drew attention because of the touch of black on the bloom.

Salvia leucantha—Not hardy and blooms very late in the season. When in bloom the display is spectacular. Can get extremely tall (4 to 5 feet), and may require staking.

Salvia 'Maraschino' (Zone 6)—A hybrid between S. grahamii and S. microphylla, it is supposed to be one of the hardiest. Cherry-red blooms are produced sporadically through summer and then heavily in the fall.

Salvia microphylla 'Wild Watermelon' (Zone 7)—Produces large pink flowers in spring and fall. May be more cold hardy.

Salvia puberula 'Hidalgo' (Zone 7)—The 3-foot-tall, 3-foot-wide bushy sage sprawls in the garden. Bright-pink fuzzy flowers are produced late in the season.

Salvia uliginosa (Zone 6)—Up to 55 inches. An upright plant that produces sky-blue flowers from spring through fall. Foliage has a rather strong aroma, but that can be overlooked because of the display. *Quite a show.*

All of the following are being compared to Verbena 'Homestead' for garden performance.

Verbena 'Abbeville' (Zone 7b)—Consistent violet blooms throughout season.

Verbena 'Batesville Rose' (Zone 7b)—Magenta blooms, very vigorous.

Verbena canadensis 'Greystone Daphne' (Zone 5)—Pink, lavender blooms that may not produce a continuous show.

Verbena canadensis 'Lilac Time' (Zone 5)—Very light lilac color. Produced continuous show.

Verbena peruviana (Zone 6)—Brilliant red blooms from spring through summer.

Verbena 'Snowflurry' (Zone 5)—Heavy flowering in spring and fall.

Verbena tenera 'Sissinghurst' (Zone 7b)—Coral pink flowers. Produces continuous show.

Wildlife Favorites

Rabbits' Choice

Surfinia Petunias—Surfinia 'Blue Vein' and 'Pink Vein' were safe in containers but gone in a flash from the ground beds. They must be more flavorful than 'Purple Wave'—the surfinias didn't last 24 hours, but 'Purple Wave' never had a nibble.

Gazanias—There were six different cultivars in the AAS trials. Not one plant survived the feeding frenzy.

Chipmunks' Choice

Geraniums—Chipmunks like the roots, and they don't care which cultivar they get. They pull the plants out of the ground and munch away. I don't think I would have believed it if I hadn't watched them do it.

If you are interested in expanding your product line, be sure to visit the University of Kentucky Arboretum each season. The All America Trials change each season. Potential winners from the 1998 trials may not be introduced for several years. Viewing the trials each season may help you determine future plant trends.

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 that address industry needs. Such an investment by the industry is wise and essential. Broad participation by Kentucky nursery and landscape firms in this program would help a dedicated, hard-working faculty and staff accomplish more for you.

More than $12,800 were given in 1997. More than $8,500 have been contributed this year through November, 1998. The majority of these funds have been utilized for student labor and specialized materials/equipment. These investments have allowed us to initiate new research and to collect more in-depth data from existing plots.

Twelve individuals/companies have committed to contribute at least $10,000 each over a 10-year period. Those contributing at this level are Nursery/Landscape Fund 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 should 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 Fellows ($10,000 over 10 years), Associates (annual contribution of more than $500), 100 Club members (annual contribution of more than $100), and Donors (annual contribution of less than $100).

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 3-year terms and represent the various segments of the industry and geographic areas. The Committee meets at least annually to review planned activities and to advise how funds will be used. All industry personnel are welcome to attend the meetings of the Advisory Committee. The 1998 Advisory Committee included: Greg Ammon (Ammon Wholesale Nursery), Bob Corum (National Nursery Products), Pat Dwyer (Dwyer Landscaping Inc.), Stephen Hillenmeyer (Hillenmeyer Nursery), Bob and John Korfhage (Korfhage Landscape and Designs), Mike Land (Hillcrest Nursery), David Leonard (Consulting Arborist), Shelly Nold, Gary Phelps (Green Ridge Tree Farm), Bob Ray (Bob Ray Company), Larry Sanders (James Sanders Nursery), Casey Schott (Leichhardt Landscape Company), Lee Squires (Cave Hill Cemetery), Herman Wallitsch Jr. (Wallitsch Nursery), and Charles Wilson (Wilson's Nursery).

We attempt to contact every Kentucky nursery and landscape business annually. 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 1998 (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

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Herman R. and Mary B. Wallitsch
Wallitsch Nursery

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

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Dr. Dewayne Ingram

Peaches Scearce
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Michael E. Webb
Estate Tree Service

Industry Organizations

Kentucky Nursery and Landscape Association

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

AgroEvo, Wilmington, DE
Ammon Wholesale Nursery, Burlington
B&R Spray Systems, Lexington
Berryhill Nursery, Springfield, OH
Boone Gardiner Landscape Co, Louisville
Bunton Co., Louisville
Century Equipment-Toro, Cincinnati and Hilliard, OH
David Leonard, Consulting Arborist, Lexington
Dow AgroSciences, Indianapolis, IN
Evergreen Nursery Co., Sturgeon Bay, WI
Flowerwood Nursery, Loxley, AL
FMC, Philadelphia, PA
Gilbert Nursery, Chesnee, SC
Goldsmith Seeds, Gilroy, CA
Greenleaf Nursery, Park Hill, OK
Green Ridge Tree Farm, Elizabethtown
J. Frank Schmidt Nursery, Boring, OR
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Kearney Hills Golf Course, Lexington
Kentucky Kingdom, Louisville
Kyn Nursery, Perry, OH
Larry Martin Nursery & Greenhouse, McMinnville, TN
Larry Walker Nursery, McMinnville, TN
Leichhardt Landscape Company
Louis' Flower Power Shops, Lexington
Marriott's Griffin Gate Resort Hotel, Lexington
Mike Brown Wholesale Nursery, Hustonville
Monsanto, St. Louis, MO
Hal Mumme
Natrop Landscape Supply
Nieman Nursery, Lexington
Novartis Corp., Greensboro, NC
Nursery Supplies Inc., Chambersburg, PA
Pleasant View Gardens, Loudon, NH
Red Barn Nursery, Nicholasville
Ridge Wholesale
Snow Hill Nursery, Shelbyville
Sakata Seeds, Japan
Tubby Smith
Stinson Nursery, Shelbyville
Studebaker Nurseries, Carlisle, OH
Taylor Horticultural
The Scotts Company, Marysville, OH
UK Agriculture Alumni Association
Vigoro Industries, Chicago, IL
Villa Luz Greenhouse, Beattyville
Wight Nursery, Inc., Westlake, OH
Wilson's Nursery, Frankfort
Wolf Creek Co, Dayton, OH
Wurth Farms, Paducah
Zeneca Professional Products, Wilmington, DE

Special grants have been provided by:
Bedding Plants Foundation, Inc.
FMC, Philadelphia, PA
Gloeckner Foundation
Kentucky Arborists Association
Kentucky Nursery and Landscape Association
International Plant Propagators Society
Kentuckiana Greenhouse Association
Urban and Community Forestry Program, Kentucky Division of Forestry
UK Nursery/Landscape Fund

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