PR-486

UK AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE

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

About Our Cover

Cladrastis kentukea is one of four of Kentucky's Theodore Klein Plant Award Winners for 2004. The others are *Helleborus* x *hybridus*—Lenten Rose, *Picea orientalis*—Oriental Spruce, and *Taxodium distichum* 'Mickelson' Shawnee Brave™—Shawnee Brave Bald Cypress. In addition to yellowwood being a Kentucky native *Taxodium distichum* 'Mickelson' Shawnee Brave™—Shawnee Brave Bald Cypress is a cultivar selection directly related to Kentucky natives. Kentucky's Theodore Klein Plant Award Winners are selected by plant professionals for unique ornamental characteristics and the ability to successfully perform in Kentucky.

Cladrastis kentukea Yellowwood or American Yellowwood is a medium-sized flowering tree. The fragrant 1- to 1.5-inch white flowers are found on 8- to 14-inch panicles that are a delight in May. The leaves are alternate, odd-pinnately compound. The late Buddy Hubbuch, director of horticulture at Bernheim Forest, loved this tree and planted several in the shade sun garden. He liked the yellow fall color that comes at a time when many other trees are already defoliated for winter. The bright yellow beacon of the yellowwood in the gray fall-winter scene found in most woodlands and gardens is a wonderful sight, especially when back- or side-lighted.

The infrequently found Kentucky native woody tree is tolerant of a wide variety of Kentucky environs. More common to the acid soils of Eastern Kentucky, it can also be found on the alkaline soils of southern edge of the coalfield area.

To propagate by seed, the seed coats are scarified (removed or thinned) with a sulfuric acid treatment and stored or directly sown. 'Perkin's Pink', the pink flowering yellowwood cultivar from the Arnold Arboretum originally distributed as 'Rosea', is propagated by budding to a seedling rootstock.

See Kentucky's Theodore Klein Plant Awards Web site for more information <http://www.ca.uky.edu/HLA/Dunwell/TKleinPA.html> and the Kentucky Department of Agriculture's Kentucky Grown Landscape Plant Availability Guide <http://www.kyagr.com/mkt_promo/hort/forms/plantguide/PLANT.htm> for sources of Theodore Klein Plant Award Winners.

UK Nursery and Landscape Program

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Nursery and Landscape Program

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UK Nursery and Landscape Program Overview—2003

Dewayne Ingram, Chair, Department of Horticulture

The UK Nursery and Landscape Program coordinates the efforts of faculty, staff, and students in several departments in the College of Agriculture for the benefit of the Kentucky nursery and landscape industry. Our 2003 report has been organized according to our primary areas of emphasis: production and economics, pest management, and plant evaluation. These areas reflect stated industry needs, expertise available at UK, and the nature of research projects around the world generating information applicable to Kentucky. If you have questions or suggestions about a particular research project, please do not hesitate to contact us.

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

We gratefully acknowledge the support of the Kentucky Horticulture Council's (KHC) grant that was made possible through Master Tobacco Settlement Funds and the Agricultural Development Board. These funds, along with U.S. Department of Agriculture funds through the New Crop Opportunities Center, have allowed us to expand our field research program and our Extension program to meet expanding industry needs and opportunities. The Agricultural Development Board has recently funded a second KHC grant to continue to expand our research and extension efforts in nursery crops and landscape horticulture. We will be able to continue support for the Nursery Crops Extension Associate in the western portion of the state for two more years and to hire two Extension Associates to work with nursery and greenhouse crop producers/marketers in Central Kentucky. We will also be able to expand our field research work at the Horticulture Research Farm in Lexington.

Extension Highlights

Specific, in-depth educational opportunities for garden centers, landscape contractors, nurseries, and arborists are being provided through two unique programs, the Best Management Workshops and the Integrated Pest Management Workshops.

The Best Management Practices (BMP) Workshop, a partnership between UK Cooperative Extension, KNLA, and WKNLA, is held in multiple locations and involves Extension agents, associates, specialists, and expertise from other states. The BMP program focused on weed control in 2003, utilizing the expertise of Drs. Robert McNiel and Mark Williams from UK and Dr. Larry Kuhns from Penn State. Out-of-state speakers were made possible by a grant from the UK College of Agriculture's Barnhart Fund for Excellence. The 5th Annual Best Management Practices will feature Dr. Dan Potter, UK Entomology, Dr. Dave Shetlar, Ohio State University, Kentucky Nursery Inspectors, and other UK specialists. The workshop will be offered in Louisville on February 17 and in Princeton, Kentucky, on February 18. In addition to practical information, the BMP workshop is a great way to earn pesticide and certified arborist CEUs.

The 2004 Integrated Pest Management (IPM) for Nursery Production Workshop Series will be held in June in Central Kentucky and in July in Western Kentucky. Thanks to Kentucky IPM funds, the program will feature four experts from Kentucky and beyond. IPM provides techniques that base spray decisions on pest population levels rather than guesswork. This on-location program specializes in hands-on application of IPM techniques such as resistant plants, scouting, nutrition monitoring, and economic thresholds. Featuring an IPM team with decades of experience, nursery producers, and tree care providers will be able to take home practical skills and knowledge.

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 2002-2003.

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

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 2003.

- A 14-day study tour of Great Britain and Ireland was led by Drs. McNiel, Geneve, and Dunwell involving nine students.
- Eight Horticulture students competed in the 2003 Associated Landscape Contractors of America (ALCA) Career Day competition at Hinds Community College (Mississippi) in March (Drs. Robert McNiel and Mark Williams, faculty advisors).
- Students accompanied faculty to regional/national/international meetings, including the American Society for Horticultural Science Annual Conference, the Kentucky Landscape Industries Conference and Trade Show, the Southern Nursery Association Trade Show, and the Green Industry Conference.

Graduate Program Highlights

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

Somatic Embryogenesis and Callus Induction in Willow Oak

R.L. Geneve, S.T. Kester, C. Edwards, and S. Wells, Department of Horticulture

Nature of Work

Although oaks are considered difficult to root from cuttings, it has been demonstrated that juvenile cuttings of oak root easily (2). There have been numerous attempts to manipulate the ability of oaks to root from cuttings by using etiolation (12), grafting mature scions onto seedling understocks (11), rooting epicormic shoots (5,10), and mound layering (4). These studies demonstrate that rooting in oaks can be enhanced if mature stock plants are subjected to rejuvenation. Currently, willow oak cultivars are being commercially propagated from cuttings obtained from juvenile stock plants. This demonstrates the commercial potential, but these cultivars were seedling selected rather than selected from mature hardy plants.

The objective of this research is to develop a clonal system for propagation of mature oaks by rejuvenation using a stepwise process that includes: 1) inducing somatic embryogenesis from mature acorns from which the ovules have been removed, 2) creating juvenile stock plants from germinated somatic embryos, and 3) rooting cuttings from these juvenile stock plants.

Acorn pieces from willow oak were collected in midsummer after normal ovule abortion. Disinfested acorn halves with the viable ovule removed (dates 8/5 and 8/15) or the embryo alone (dates 8/15 and 8/21) were placed on a combination of 2, 4-dichlorphenoxyacetic acid (2, 4-D) or naphthalene acetic acid (NAA) at 1, 5 and 10 μM plus benzlyadenine (BA) at 1 μM for 15 days before being moved to growth regulator-free medium for expression of somatic embryogenesis. Explants were cultured in Petri dishes containing MS medium (8) under cool white fluorescent lamps (PAR 60 $\mu mol \cdot sec^{-1} \cdot m^{-2}$) at 21°C.

Greenhouse-grown seedling willow oaks were produced in flats containing Metromix 350 for two or four months. Softwood cuttings were treated with an IBA quick dip (0, 5,000, and 10,000 ppm) and rooted under intermittent mist with bottom heat in the greenhouse. The percentage of rooted cuttings and the average number of roots per rooted cutting were evaluated after 30 days.

Results

In willow oak, pollination occurs in early spring, but fertilization of the ovule is not completed until 15 months later. There are five ovules per acorn, but only one usually remains viable in the mature fruit (Figure 1). The tissue between the outer fruit wall (pericarp) and the ovule is diploid female in origin. It is not clear if it is fruit (mesocarp) or nucellar.

Callus growth was achieved from acorn pieces treated with 5 mM 2,4-D plus 1 μM BA (Figure 2a). Callus has continued to proliferate, but to date no somatic embryos have formed.

Figure 1. Viable and aborted ovules in 15-month-old willow oak.

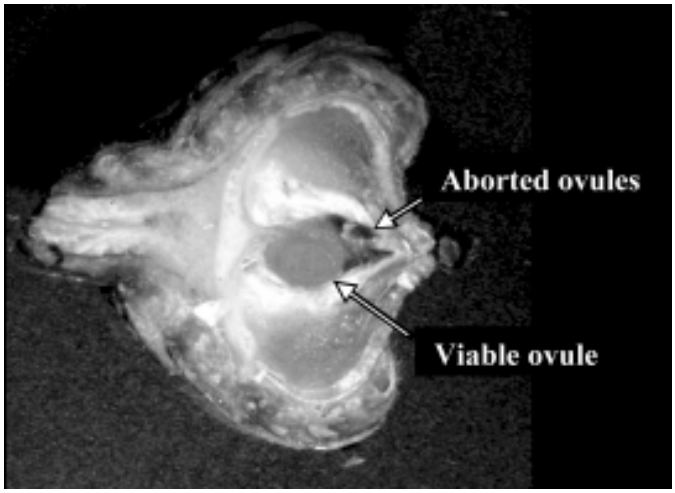
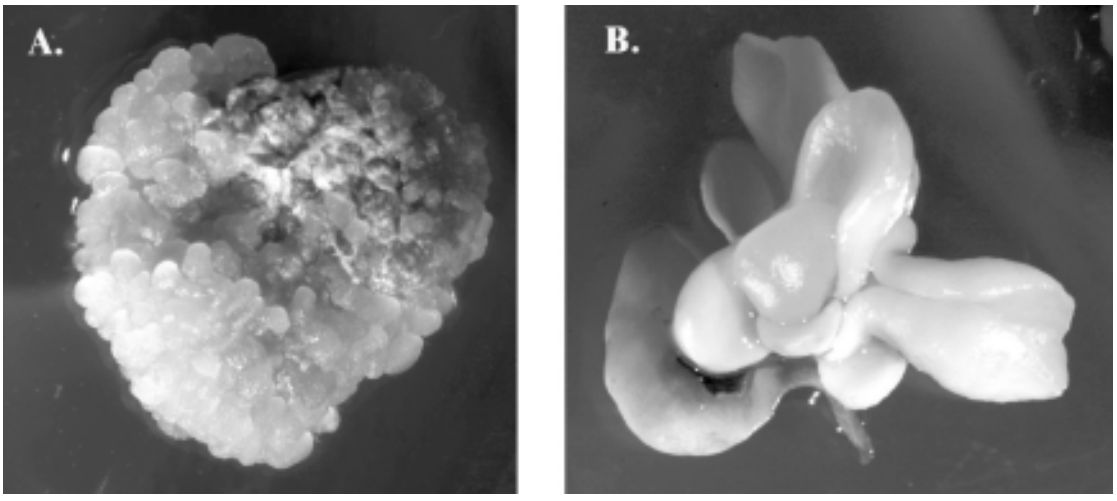


Figure 2. Callus and somatic embryogenesis in willow oak. A.) Callus production after 6 weeks in acorn tissue treated with 5 μM 2, 4-D plus 1 μM BA. B.) Somatic embryo production from zygotic embryo explants treated with 10 μM NAA plus 1 μM BA.



Embryo explants produced somatic embryos when treated with 5 or 10 µM NAA plus 1 µM BA (Figure 2b).

Cuttings taken from two- or four-month old stock plants rooted at high percentages when treated with 5,000 or 10,000 ppm IBA (Table 1). Roots per rooted cuttings increased with 10,000 ppm IBA.

Discussion

Somatic embryogenesis has been achieved in a number of oak species from either embryo or vegetative tissue (1). Most of the species evaluated to date are not hardy northern oaks, except for a preliminary report in *Q. rubra* (9) using seedling leaves and a study in *Q. bicolor* (3). The report with *Q. bicolor* is especially important because it involved somatic embryo formation from male catkins. Recently, Merkle and Battle (7), using sweet gum (*Liquidambar*), have also demonstrated that flower tissue has a high capacity to form somatic embryos. Regeneration from flower parts represents a clonal form of regeneration from mature tissue, rather than the more typical "embryo cloning" found in somatic embryogenesis from zygotic seedling tissue reported for most woody plants.

Somatic embryogenesis would create a complete reversion from a mature state to a juvenile state as is achieved during normal zygotic embryogenesis (6). Somatic embryos derived from diploid female tissue (acorn sections) after removal of the ovules would be clonal. Therefore, if somatic embryogenesis is achieved from acorn-derived callus, the resultant plantlets would form juvenile stock plants suitable for cutting propagation. Work is ongoing to this end.

Significance to the Industry

Oaks (*Quercus* spp.) are important nursery and forestry species. Most oaks are propagated by seeds because they are difficult to root from cuttings and many oaks experience delayed graft incompatibility. This severely limits availability of superior cultivars for the nursery trade. The ability to propagate superior mature clones of oak would result in increased selection and therefore profitability for oak liner and shade tree production. It would also allow growers to put existing oak cultivars on their own roots rather than attempting to graft these cultivars (i.e., *Quercus palustris* 'Crown Right'). In addition, development of the proposed somatic embryogenesis system would provide an appropriate system for attempts to transform mature oaks with novel genes (i.e., any potential genes developed for disease resistance to oak wilt or bacterial leaf scorch).

Table 1. Adventitious rooting in greenhouse-grown seedling stock plants of willow oak.

	2-month-old stock plants		4-month-old stock plants	
IBA [ppm]	Rooting %	Roots per rooted cutting	Rooting %	Roots per rooted cutting
0	37.5b[z]	1.9c	43.4b	2.6c
5,000	64.2a	3.3b	73.9a	5.8b
10,000	70.8a	9.2a	78.3a	9.5a

[z] Means within a column with the same letter were not different P≤ 0.05 by LSD.

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Pinching of *Passiflora* 'Lady Margaret' and 'Amethyst' Reduces Shoot Number and Delays Flowering

Stephen Berberich, Robert Geneve, and Mark A. Williams, Department of Horticulture

Nature of Work

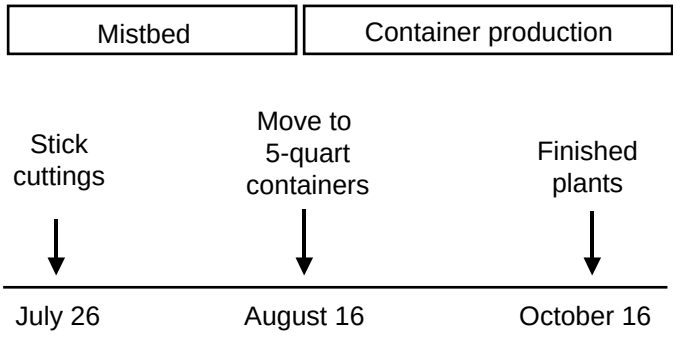
Passion flowers (*Passiflora* sp.) have good market potential as high-value container-produced plants for patio or garden use, and selected cultivars can be successfully grown in Kentucky as a single-season crop using a two-month production scheme in an outdoor nursery (Figure 1) (1). However, cultural practices that reduce the time to flowering and increase overall flower production must be developed for this condensed production schedule.

Passion flower vines can produce a flower, shoot, and tendril at each node. In the majority of these plants, each flower opens for only one day. Once the vines start blooming, developing shoots can produce a flower at each node resulting in numerous flowers per plant each day (2). It becomes apparent that the flowering potential of each plant increases by increasing the number of nodes per plant. The objective of the current research was to investigate pinching treatments on time to first flower, number of nodes, and number of flowers per plant.

Between July 26, 2002, and October 16, 2002, two passion flower cultivars (*Passiflora* 'Lady Margaret' and 'Amethyst') were evaluated for flowering response following six pinching treatments. *Passiflora* 'Lady Margaret' and 'Amethyst' were propagated from two node cuttings treated with indole-3-butyric acid (IBA) (1,000 ppm in talc) and stuck in Oasis rooting cubes. Cuttings were placed in an intermittent mist bed (5 sec. every 10 min.) with bottom heat (75°F). After 21 days, cuttings were transferred to the greenhouse in 5-quart containers (Nursery Supplies, Inc. Classic 500) in Barky Beaver (Professional Grow Mix, Moss, Tennessee 38574) southern pine bark substrate and irrigated each day with 100 ppm N (Peters 20-10-20). Day/night temperatures in the greenhouse were set at 77°F/68°F (25ºC/20ºC), and supplemental lighting (61 µmol · m^{-2} · sec^{-1} average photosynthetic photon flux density at bench top) was used to maintain 17-hour day length.

Initial pinching treatments were all performed 21 days after rooted cuttings were potted and secondary pinching treatments 42 days after cuttings were potted. The pinching treatments consisted of the following: 1) pinch the main shoot at the third node, 2) sixth node, 3) ninth node, 4) third node with all resulting shoots pinched at third node, 5) sixth node with all resulting shoots pinched at the sixth node, and 6) no pinching. Flowers were counted each day, and number of shoots, shoot length, and number of nodes were recorded 45 days after applying the first pinching treatment.

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



Results and Discussion

Both cultivars exhibited strong apical dominance and, when pinched, one of the resulting shoots assumed dominance. None of the pinching treatments increased the number of shoots, and both cultivars showed delayed flowering of approximately three weeks when pinched once and approximately four weeks when pinched twice (Figure 2).

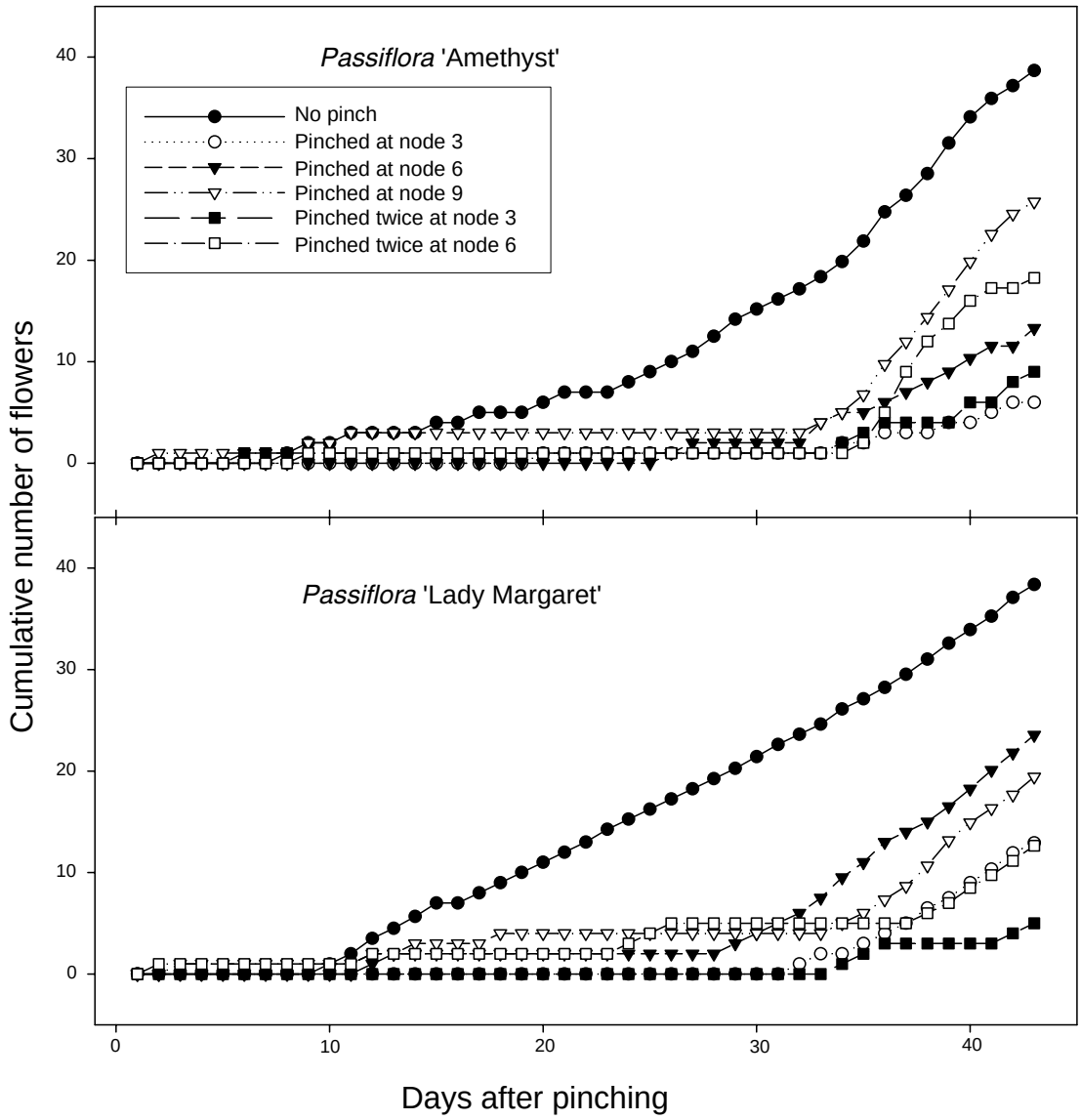
Amethyst passion flower pinched once produced 67% fewer flowers compared to non-pinched plants, and those pinched twice produced 88% fewer flowers. Lady Margaret passion flower pinched once produced 65% fewer flowers compared to non-pinched plants, and those pinched twice produced 89% fewer flowers (Table 1).

Table 1. Mean number of shoots, shoot length, number of nodes, and number of flowers for *Passiflora* 'Amethyst' and 'Lady Margaret' 45 days after applying initial pinching treatments.

	P. 'Amethyst'				*P.* 'Lady Margaret'			
Pinch Treatment	Mean number of shoots	Mean shoot length (cm)	Mean number of nodes	Mean number of flowers	Mean number of shoots	Mean shoot length (cm)	Mean number of nodes	Mean number of flowers
No pinch	10.1 a[z]	969.0 ab	177.7 a	16.5 a	7.4 a	560.9 a	113.6 a	17.9 a
Pinched at node 3	7.3 b	890.5 ab	154.8 ab	0.6 b	5.0 b	412.1 ab	70.1 b	3.3 bc
Pinched at node 6	8.3 ab	1070.0 a	193.2 a	2.9 b	5.8 ab	517.6 a	101.8 ac	8.8 b
Pinched at node 9	7.1 b	863.9 ab	163.8 ab	12.7 a	5.8 ab	559.2 a	113.0 a	6.8 bc
Pinched at node 3 & 3	6.8 b	700.4 b	120.6 b	0.9 b	4.8 b	300.1 b	54.9 b	0.6 c
Pinched at node 6 & 6	7.8 b	1048.2 a	188.8 a	3.4 b	4.9 b	410.2 ab	87.3 bc	2.8 bc

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

Figure 2. Cumulative number of flowers per day for *Passiflora* 'Amethyst' and 'Lady Margaret' beginning on the day pinching treatments were performed. For both cultivars, flowering was delayed approximately three weeks when pinched one time and four weeks when pinched two times.



For both cultivars tested, pinching resulted in fewer shoots, fewer flowers, and delayed flowering. Cytokinin treatments are currently being tested to determine if they can be used effectively to induce branching. Additionally, the use of multiple plants per container has proven to be an excellent method for increasing the number of shoots and flowers, and this method eliminates the need to overcome the strong apical dominance exhibited by these plants.

Significance to the Industry

This is the third report on studies carried out to evaluate the production of container-grown passion flowers. This study has shown that selected varieties can be successfully grown in Kentucky as a single-season crop using standard nursery practices with the two-month production schedule presented in this paper. These plants have good potential as a high-value container-produced plant for patio or garden use in a market where customers are looking for exotic, tropical vines.

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Pot-in-Pot Production Budgets, Cash Flow, and Price Sensitivity Charts

Amy Fulcher, Matt Ernst, and Robert McNiel, Departments of Horticulture and Agricultural Economics

Nature of Work

Pot-in-Pot production is growing in interest in Kentucky. Pot-in-Pot production often requires a considerable capital investment. Therefore, growers need production budgets and estimated cash flows available to them to help estimate the installation and production costs, as well as potential returns, from plants grown in Pot-in-Pot systems. This economic information is essential in order to make informed production decisions.

Red maple cultivars such as Red Sunset and October Glory are trees in demand and are commonly grown in Pot-in-Pot production systems. A trade 15 gallon is the most commonly produced size in Pot-in-Pot systems. Therefore, the budgets and price sensitivity charts were created for a red maple cultivar in a 15-gallon container.

Two sets of production budgets, 10-year cash flow estimates, and rudimentary price sensitivity analyses were developed based on two different production scenarios using cost information developed from demonstration plots. The first production scenario utilized a $15 bareroot liner (Table 1). This input would represent a very high quality liner. A high quality liner is the foundation of a high quality plant, which would receive the highest price on the wholesale market. It is difficult or impossible to grow a high quality tree from a poor-quality liner. As is expected, these estimates indicate that producing higher quality trees could be significantly more profitable in a 10-year period.

The second production scenario (Table 3) utilized a $7 bareroot liner. This liner is likely of a lower quality and may have scars or other damage on the trunk, a crooked trunk, and/or a poor branching structure. As a finished tree, this plant would not likely be saleable in the most profitable markets due to reduced quality. No price discounts are reflected in the cost of the liners because one acre of production would not be a substantial enough volume to garner significant discounts. However, an established field producer converting or adding Pot-in-Pot production may have sufficient quantity for price discounts. All other costs are the same.

The production cycle for both scenarios involves planting a 5-foot lightly branched liner in the spring of odd years and harvesting 95% (1,087) of the 1,144 trees planted in the one-acre system in even years. Finished trees are sold at 1.5 inch caliper. The budget accounts for 5% of the 1,144 trees dying during production. New growers may want to increase the percentage of loss if they have inadequate cold storage or receive poor quality liners. No trees are carried over to another year or repotted into a larger size.

Results and Discussion

Based on these estimates it is imperative that growers marketing to smaller, lower priced, wholesale markets (i.e., most local and regional markets in and around Kentucky) and control the cost of liners and other inputs to realize a profit. While $15 liners may be grown into $100 wholesale trees, new growers without sufficient production volume or established quality may not be able to sell to the larger, higher quality markets. Projected annual cash flow at various sales prices for systems with $15-liner and $7-liner inputs are provided in Tables 2 and 4, respectively. Growers who sell trees locally or regionally are likely competing with established producers from more southern climates who are able to acquire cheaper land and labor and take advantage of a longer growing season. Therefore, these growers may need to consider carefully various input costs when developing marketing plans and making purchasing decisions, such as liner quality and cost. In addition, the amount of labor spent on pruning and controlling pests will vary depending on the intended market and probable wholesale price to realize a profit.

Significance to the Industry

Producers need decision-making tools in order to make sound business decisions. These production budget estimates allow growers to consider the capital investment required to set up a Pot-in-Pot production system on a per acre basis. In addition, the cash flow estimates and price sensitivity analyses illustrate the power of growing high quality plants and selling in a more lucrative, high quality market, as well as the need to keep costs low when selling into a lower priced market. These, and any other budget estimates, are useless if the market is not analyzed and identified before a nursery system is established and production begins.

Note: These estimates represent generic estimates and should be used only as a guideline for decision making. All financial decisions should be analyzed with regard to individual production scenarios and market outlooks.

Table 1. Estimated cash flows for 1 acre of 15-gallon red maple cultivar in pot-in-pot production.*

Liners purchased for $15 each, finished trees sold for $50 each. See price sensitivity chart for other sales prices.

1,144 trees planted per acre

1,087 trees marketed per acre

EXPENSES	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
INSTALLATION EXPENSE										
1,144 sockets @$20	$22,880									
Fabric	$1,694									
Irrigation system[1]	$8,276									
Total Installation Expense	*$32,850*									
PLANTING EXPENSE										
Plant liners @$15	$17,160		$17,160		$17,160		$17,160		$17,160	
Insert pots @$3.30	$3,775		$3,775		$3,775		$3,775		$3,775	
Hired labor–10 min./tree @$10/hr	$1,907		$1,907		$1,907		$1,907		$1,907	
Media (76 cu. yd. @$20)	$1,520		$1,520		$1,520		$1,520		$1,520	
Bamboo stakes @$1.62	$1,853		$1,853		$1,853		$1,853		$1,853	
Tying ribbon	$10		$10		$10		$10		$10	
Equipment fuel, oil, repairs[2]	$18		$18		$18		$18		$18	
Total Planting Expense	*$26,244*		*$26,244*		*$26,244*		*$26,244*		*$26,244*	
ANNUAL PRODUCTION EXPENSE										
Pesticides[5]	$12	$12	$12	$12	$12	$12	$12	$12	$12	$12
Irrigation[2]	$36	$36	$36	$36	$36	$36	$36	$36	$36	$36
Hired labor										
Pruning: 30 min./tree @$10/hr	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720
Maintenance: 30 min./tree @$10/hr	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720
Equipment fuel, oil, repairs[2]	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13
Total Production Expense	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*
HARVEST EXPENSE										
Equipment fuel, oil, repairs[2]		$27		$27		$27		$27		$27
Hired labor–5 min./tree @$10/hr		$953		$953		$953		$953		$953
Marketing expense (2% of gross sales)		$2,174		$2,174		$2,174		$2,174		$2,174
Total Harvest Expense		*$3,154*		*$3,154*		*$3,154*		*$3,154*		*$3,154*
TOTAL CASH EXPENSE	**$70,595**	**$14,656**	**$37,745**	**$14,656**	**$37,745**	**$14,656**	**$37,745**	**$14,656**	**$37,745**	**$14,656**
SALES										
1,087 trees @$100		$108,700		$108,700		$108,700		$108,700		$108,700
GROSS SALES		**$108,700**		**$108,700**		**$108,700**		**$108,700**		**$108,700**
ANNUAL CASH FLOW[3]	$(70,595)	$94,044	$(37,745)	$94,044	$(37,745)	$94,044	$(37,745)	$94,044	$(37,745)	$94,044
CUMULATIVE CASH FLOW[4]	**$(70,595)**	**$23,449**	**$(14,297)**	**$79,747**	**$42,002**	**$136,046**	**$98,300**	**$192,344**	**$154,599**	**$248,643**
Cost and Return per Plant										
Installation cost	$28.72									
Planting cost	22.94									
Annual production cost	10.05									
Harvest cost	2.76									
	9%	18%	27%	34%						
Net Present Value of Cash Flows	**$132,304**	**$74,215**	**$42,470**	**$27,190**						

[1] Irrigation system is assumed to be purchased in Year 1 (new purchase price: $2,476–system controller/lines; $1,800–pump; $4,000–filters and PVC).

[2] Assumes existing ownership of 34HP tractor (new purchase price: $18,000) and wagon (new purchase price: $1,241).

[3] Annual cash flow is the amount available for loan principal and interest repayment, operator management and labor, depreciation, and other fixed costs.

[4] Cumulative cash flow is the present value of accumulated cash flows.

[5] Some cultivars will require substantially more pesticide applications.

* Check <http://www.uky.edu/Ag/HortBiz/pubs.html#budgets> for interactive budgets.

Table 3. Estimated cash flows for 1 acre of red maple cultivar pot-in-pot production.*

Liners purchased for $7 each, finished trees sold for $50 each. See price sensitivity chart for other sales prices.

1,144 trees planted per acre
1,087 trees marketed per acre (5% mortality rate)

EXPENSES	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
INSTALLATION EXPENSE										
1,144 sockets @$20	$22,880									
Fabric	$1,694									
Irrigation system[1]	$8,276									
Total Installation Expense	*$32,850*									
PLANTING EXPENSE										
Plant liners @$7	$8,008		$8,008		$8,008		$8,008		$8,008	
Insert pots @$3.30	$3,775		$3,775		$3,775		$3,775		$3,775	
Hired labor–10 min./tree @$10/hr	$1,907		$1,907		$1,907		$1,907		$1,907	
Media (76 cu. yd. @$20)	$1,520		$1,520		$1,520		$1,520		$1,520	
Bamboo stakes @$1.62	$1,853		$1,853		$1,853		$1,853		$1,853	
Tying ribbon	$10		$10		$10		$10		$10	
Equipment fuel, oil, repairs[2]	$18		$18		$18		$18		$18	
Total Planting Expense	*$17,092*		*$17,092*		*$17,092*		*$17,092*		*$17,092*	
ANNUAL PRODUCTION EXPENSE										
Pesticides[5]	$12	$12	$12	$12	$12	$12	$12	$12	$12	$12
Irrigation[2]	$36	$36	$36	$36	$36	$36	$36	$36	$36	$36
Hired labor										
Pruning: 30 min./tree @$10/hr	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720
Maintenance: 30 min./tree @$10/hr	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720	$5,720
Equipment fuel, oil, repairs[2]	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13
Total Production Expense	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*	*$11,502*
HARVEST EXPENSE										
Equipment fuel, oil, repairs[2]		$27		$27		$27		$27		$27
Hired labor–5 min./tree @$10/hr		$953		$953		$953		$953		$953
Marketing expense (2% of gross sales)		$1,087		$1,087		$1,087		$1,087		$1,087
Total Harvest Expense		*$2,067*		*$2,067*		*$2,067*		*$2,067*		*$2,067*
TOTAL CASH EXPENSE	**$61,443**	**$13,569**	**$28,593**	**$13,569**	**$28,593**	**$13,569**	**$28,593**	**$13,569**	**$28,593**	**$13,569**
SALES										
1,087 trees marketed @$50		$54,350		$54,350		$54,350		$54,350		$54,350
GROSS SALES		**$54,350**		**$54,350**		**$54,350**		**$54,350**		**$54,350**
ANNUAL CASH FLOW[3]	$(61,443)	$40,781	$(28,593)	$40,781	$(28,593)	$40,781	$(28,593)	$40,781	$(28,593)	$40,781
CUMULATIVE CASH FLOW[4]	**$(61,443)**	**$(20,662)**	**$(49,256)**	**$(8,475)**	**$(37,068)**	**$3,713**	**$(24,881)**	**$15,900**	**$(12,693)**	**$28,088**

Cost and Return per Plant	
Installation Cost	$28.72
Planting cost	14.94
Annual production cost	10.05
Harvest cost	1.81

	2%	**5%**	**7%**	**9%**
Net Present Value of Cash Flows	**$19,447**	**$9,236**	**$3,860**	**($616)**

[1] Irrigation system is assumed to be purchased in Year 1 (new purchase price: $2,476–system controller/lines; $1,800–pump; $4,000–filters and PVC).
[2] Assumes existing ownership of 34HP tractor (new purchase price: $18,000) and wagon (new purchase price: $1,241).
[3] Annual cash flow is the amount available for loan principal and interest repayment, operator management and labor, depreciation, and other fixed costs.
[4] Cumulative cash flow is the present value of accumulated cash flows.
[5] Some cultivars will require substantially more insecticide applications.
* Check <http://www.uky.edu/Ag/HortBiz/pubs.html#budgets> for interactive budgets.

Table 2. Price sensitivity chart: Annual cash flows at various prices.

Liners purchased for $15 each.

1,087 trees

	Year										Cumulative Cash Flow (Not Discounted)
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
$50	$(70,595)	$39,694	$(37,745)	$39,694	$(37,745)	$39,694	$(37,745)	$39,694	$(37,745)	$39,694	$(23,107)
$60	$(70,595)	$50,564	$(37,745)	$50,564	$(37,745)	$50,564	$(37,745)	$50,564	$(37,745)	$50,564	$31,243
$70	$(70,595)	$61,434	$(37,745)	$61,434	$(37,745)	$61,434	$(37,745)	$61,434	$(37,745)	$61,434	$85,593
$75	$(70,595)	$66,869	$(37,745)	$66,869	$(37,745)	$66,869	$(37,745)	$66,869	$(37,745)	$66,869	$112,768
$80	$(70,595)	$72,304	$(37,745)	$72,304	$(37,745)	$72,304	$(37,745)	$72,304	$(37,745)	$72,304	$139,943
$90	$(70,595)	$83,174	$(37,745)	$83,174	$(37,745)	$83,174	$(37,745)	$83,174	$(37,745)	$83,174	$194,293
$100	$(70,595)	$94,044	$(37,745)	$94,044	$(37,745)	$94,044	$(37,745)	$94,044	$(37,745)	$94,044	$248,643

Table 4. Price sensitivity chart: Annual cash flows at various prices.

Liners purchased for $7 each.

1,087 trees

	Year										Cumulative Cash Flow (Not Discounted)
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
$45	$(61,443)	$35,346	$(28,593)	$35,346	$(28,593)	$35,346	$(28,593)	$35,346	$(28,593)	$35,346	$913
$50	$(61,443)	$40,781	$(28,593)	$40,781	$(28,593)	$40,781	$(28,593)	$40,781	$(28,593)	$40,781	$28,088
$55	$(61,443)	$46,216	$(28,593)	$46,216	$(28,593)	$46,216	$(28,593)	$46,216	$(28,593)	$46,216	$55,263
$60	$(61,443)	$51,651	$(28,593)	$51,651	$(28,593)	$51,651	$(28,593)	$51,651	$(28,593)	$51,651	$82,438
$70	$(61,443)	$62,521	$(28,593)	$62,521	$(28,593)	$62,521	$(28,593)	$62,521	$(28,593)	$62,521	$136,788

Pesticide Effects on Calico Scale and Generalist Predators in the Tree Canopy

Jamee L. Hubbard and Daniel A. Potter, Department of Entomology

Nature of Work

Calico scale, *Eulecanium cerasorum*, is a pest of a variety of woody plants in urban landscapes. Calico scale was apparently introduced into the San Francisco, California, area in the early 1900s from Asia and has since spread to Kentucky and surrounding states through the transport of infested plant material. In recent years, calico scale has reached outbreak proportions in urban areas of Central Kentucky on maples, honeylocust, sweet gum, hackberries, and many other tree species. The scale encrusts the branches and covers the leaves of trees. This pest is a phloem feeder, and in large numbers, feeding can result in branch and limb dieback. Trees may be directly killed by calico scale feeding or severely weakened, consequently succumbing to woodborer attacks, drought, or other stresses. It produces copious amounts of honeydew, which may coat automobiles and other objects under infested trees. Honeydew encourages growth of sooty mold fungus that blackens foliage and bark and may interfere with photosynthesis.

During the past five years, severe outbreaks of this pest have occurred on Central Kentucky horse farms, golf courses, and street plantings. The impact of this outbreak is extensive because there has been little research on the pest's biology or management.

Earlier research determined the best management practices that would be useful in sensitive areas, such as horse farms. The focus of our research in 2003 was to determine the impact that two types of management practices—foliar sprays and systemic trunk injections—have on calico scale and generalist predators in the tree canopy.

We conducted an experiment on a local horse farm, testing three insecticides and two application methods to target first-instar settled crawlers in late spring and early summer. A pyrethroid spray (bifenthrin, Talstar® F Insecticide/Miticide) was applied with a pressurized sprayer to the entire canopy of five sweetgum trees, *Liquidambar styraciflua*, along two fencerows on 02 July 2003. The spray solution included Breakthrough® spreader/sticker at a rate of 0.31 ml per liter solution. A systemic organophosphate (bidrin, Mauget Inject-a-cide B™) was injected into the trunks of five sweetgum trees on 02 July 2003, and a systemic chloronicotinyl (imidacloprid, Mauget Imicide®) was injected into the trunks of five sweetgum trees on 28 May, 2003. Insecticides were applied at a rate listed to control scale insects. Five trees were left untreated.

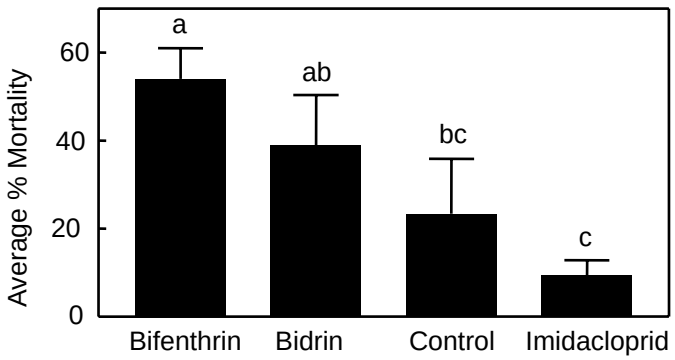
Twenty-five leaves per tree were collected on 07 August 2003 to determine the impact of insecticides on calico scale. Live and dead crawlers were counted, and percent calico scale mortality was determined by comparing number of dead crawlers with total number of crawlers. To determine the impact of the insecticides on generalist predators in the canopy, eight branch samples were taken from each tree every two weeks, starting one day before treatment and ending on 30 September 2003. To obtain branch samples, a 60- x 40-cm plastic bag was quickly slipped over the branch and cinched at the open end. Approximately 40 cm of the terminal branch was removed from the tree. The samples were frozen, and arthropods were identified to family, class, or order. Predatory arthropod groups that were analyzed included adults and larvae from the family *Coccinellidae* (ladybird beetles), adults, and larvae of the order *Neuroptera* (lacewings), members of the class *Araneae* (spiders), and adults of the family *Formicidae* (ants). Numbers of predatory arthropods were compared for each treatment across the season.

Results and Discussion

Talstar® foliar sprays yielded an average crawler mortality of 54% and was significantly different from the untreated control ($p = 0.018$), whereas bidrin trunk injections yielded an average crawler mortality of 39% and was not significantly different from the control (Figure 1). Imicide® also did not significantly control calico scale crawlers.

Both Talstar® and bidrin had a significant but short-term impact on predators in the tree canopy. Spiders were impacted the most with a significant reduction in populations for up to four weeks after the application of Talstar® foliar sprays and up to two weeks after application of bidrin trunk injections. Ants also had a significant reduction in populations for up to two weeks with both Talstar® and bidrin applications. Lacewings and ladybird beetles, both highly mobile predators, were not significantly impacted by any insecticide treatment in the experiment. The impact on predator populations was a little less severe with bidrin trunk injections than with Talstar® canopy sprays.

Figure 1. Average percent crawler mortality on sweetgum trees.



Significance to the Industry

The objective of this project was to determine the impact of three insecticide treatments, involving two application techniques, on calico scale crawlers and on generalist predators in the tree canopy. We demonstrated that two popular products used to control calico scale, Talstar® foliar sprays and bidrin trunk injections, have only a short-term impact on predators in the canopy. The efficacy data combined with the predator impact data will be valuable in helping ornamental pest managers make decisions in the management of calico scale. Additional research is currently under way to assess the impact these insecticide treatments have on the parasitoid complex associated with calico scale and rate of parasitism in calico scale.

Managing Eastern Tent Caterpillars in Landscapes and on Horse Farms in Response to Their Role in Mare Reproductive Loss Syndrome

Daniel A. Potter, Leslie Foss, and David W. Held, Department of Entomology

Nature of Work

An equine disease now known as Mare Reproductive Loss Syndrome (MRLS) struck the Ohio Valley in 2001-2002, causing thousands of foal abortions and catastrophic economic loss. Evidence that pregnant mares' exposure to eastern tent caterpillars (ETC), *Malacosoma americanum* (F.), induces MRLS created an urgent call for caterpillar control on or near horse farms. Many tree care professionals now are providing that service. We surveyed egg mass distribution and monitored ETC emergence in wild cherry trees to help guide control actions and evaluated reduced-risk treatment strategies, including foliage sprays, trunk injections, winter egg mass treatments, and barrier sprays, to intercept larvae entering pastures.

Emergence of ETC from egg masses and subsequent colony development were monitored at several field locations in central Kentucky. Sites were rows of wild cherry trees bordering pastures or fences. Twigs bearing egg masses were tagged in mid-February and checked every 1 to 2 days until mid-April, when emergence of larvae had ceased. Duration of emergence from individual egg masses was determined, as well as number of ETC per mass. Larval behavior (e.g., aggregation on egg masses, movement to twigs, size of nests) and instars predominating were noted. Distribution of egg masses within tree canopies (height, cardinal direction, open versus sheltered side of tree, distance of mass from shoot tip, diameter of twigs bearing masses) was surveyed for 10 mature wild cherry trees.

Potential for winter control of eggs was evaluated by spraying tagged egg masses with bifenthrin or permethrin formulated in a penetrating solvent, dormant oil, or oil/insecticide mixtures in December or February and then evaluating effects by dissecting some egg masses and monitoring others for larval emergence in early spring. Residual effects of such treatments were measured by placing young ETC larvae on the surface of treated egg masses.

Reduced-risk insecticides applied as contact or foliage sprays were extensively evaluated against both newly hatched and late instar ETC. Speeds of kill, residual effectiveness, and potential for repellence of larvae were tested. Treatments included horticultural oil, insecticidal soap, bifenthrin, Bacillus thuringiensis, spinosad, and tebufenozide (a molt-accelerating compound).

Trunk microinjection is a process wherein small amounts of therapeutic chemicals contained in sealed capsules are introduced into small shallow holes drilled around the base of a tree (Tattar et al. 1998). It seemingly is well suited for use on horse farms and suburban landscapes because it eliminates spray drift, reduces hazard and environmental exposure, and can be performed under most weather conditions. Effectiveness of microinjection for controlling ETC was evaluated in four separate trials conducted on horse farms, using treatment timings ranging from before egg hatch (early March) to late April, when large caterpillars were present in trees. Four systemic insecticides, bidrin, abamectin, milbemectin, and emamectin benzoate were evaluated. Nests were harvested by climbing trees, or with a pole pruner, and dissected to determine proportion of dead or live larvae.

Barrier treatments applied to pasture grass to intercept wandering late-instar larvae also were evaluated. Treatments included permethrin, malathion, and carbaryl. For permethrin, the most effective treatment, the residual effectiveness and distance larvae could crawl across treated areas also was determined.

Results and Discussion

Egg masses were concentrated in the lower canopy, on the exposed sides of trees, on twigs averaging 3.7mm diameter (range 2.1 to 5.7mm), and at mean distance of 17.9 cm (range 8.3 to 36.2 cm) from shoot tips. Larval emergence began in

mid-March in both 2002 and 2003, coinciding with about 50% bloom of *Forsythia intermedia* Zabel. Emergence was extended over three to four weeks in 2002, a year with typical March temperatures but more compressed (7 to 10 days) in 2003 due to unseasonably warm temperatures.

Winter treatment of egg masses with bifenthrin or permethrin in a penetrating solvent prevented emergence, but 3% horticultural oil was ineffective for that purpose. The pyrethroids also killed young larvae placed on treated egg masses and twigs. Therefore, neonates that manage to emerge (e.g., from egg masses that receive incomplete spray coverage) likely would be killed before they initiate a nest.

Insecticidal soap or oil gave relatively poor control even when sprayed directly on neonates. Foliage sprays with bifenthrin and spinosad were highly effective against all instars, their field-weathered residues remaining active for at least seven days. Bacillus thuringiensis controlled neonates within three days but was slower acting and less active against late instars, with shorter residual than bifenthrin or spinosad. Given its relatively short residual, several weekly applications starting a few days after first egg hatch likely would be needed for a high level of control. Insecticide residues did not repel larvae.

Microinjection of cherry trees with bidrin was highly effective against all instars, whereas injections with milbemectin or abamectin gave poor or less consistent control. Trunk injection with emamectin benzoate was effective in the one trial in which it was evaluated.

Dry residues of permethrin controlled late instars crawling in pasture grass for at least seven days, but malathion or carbaryl were ineffective for that purpose.

Significance to the Industry

The discovery in 2002 that exposure to ETC induces abortions consistent with Mare Reproductive Loss Syndrome created a climate of near-zero tolerance for ETC and an urgent call for non-hazardous control tactics. This research provides options that the arboricultural and equine industries can immediately put to use.

Bifenthrin was the fastest-acting, most effective foliage treatment we tested, field-weathered spray residues remaining active for least a week. Applied two to three weeks after first egg hatch, it can provide tree-wide control with one application. The formulation we evaluated (Talstar F®) recently was replaced by an equivalent new product, TalstarOne®, that is labeled for tree-feeding caterpillars including ETC. *Bacillus thuringiensis* (Dipel®) also was effective, although more so against young larvae than against older ones. Given its relatively short residual, several weekly applications starting a few days after first egg hatch likely would be needed for a high level of control. Both the Environmental Protection Agency's 1992 Worker Protection Standard and label grazing restrictions limit the choice of insecticides that can be applied to trees on horse farms. Labels for bifenthrin (TalstarOne®) and *B. thuringiensis* allow such use.

The bifenthrin formulation we evaluated for winter control of egg masses recently received EPA registration as Onyx® (FMC, Philadelphia, PA). Both permethrin (Astro®) and bifenthrin (Onyx®) are labeled for use on trees, permitting targeting of ETC egg masses in winter (Long, J., 2003, pers. comm). Because living and old egg masses are difficult to distinguish from the ground, treating whole trees to control egg masses likely would be less efficient than targeting nests with young larvae in early spring. Winter egg mass treatments may, however, be justified in years when ETC populations are at outbreak level and risk of MRLS is high.

Microinjection with bidrin (as Inject-a-cide B®) was highly effective in controlling ETC and is labeled for that purpose. Bidrin is a Restricted Use Pesticide due to acute oral and dermal toxicity, although microinjection allows certified applicators to use it with low hazard. Optimal timing is when small nests first appear in the trees. Bidrin also was effective against larger tents and larvae.

A 2-m sprayed band of Astro® insecticide (permethrin) just outside the fence line should be effective in intercepting wandering larvae. Some arborists and horse farm managers also reported success with permethrin applied to grass around the base of trees.

ETC outbreaks are cyclic, and populations have been declining since 2001 and 2002. Horse farm managers and arborists should remain vigilant, however, as recent research continues to implicate pregnant mares' exposure to ETC as inducing abortions and ETC will continue to be present at moderate levels every year, gradually building through to the next outbreak cycle.

Potential for Use of Nectar-Producing Plants or Sugar Sprays to Increase Parasitism of Turf-Infesting White Grubs by Tiphiid Wasps

Michael E. Rogers and Daniel A. Potter, Department of Entomology

Nature of Work

The purpose of this project is to evaluate whether providing supplemental food sources in the form of high nectar-producing plants or sugar sprays will increase parasitism of turf-infesting white grubs by tiphiid wasps. By providing such food sources, it may be possible to attract these beneficial insects to an area, leading to increased grub parasitism. Planting nectar-producing perennials might then be recommended to homeowners or golf course superintendents as a sustainable approach to help control white grubs without relying as heavily on pesticides.

Tiphiid wasps are the primary group of parasitoids that attack white grubs. These wasps spend most of their time searching for grubs in the soil and surface only to mate and obtain food in the form of honeydew or nectar from flowers. In the 1920s and '30s, *Tiphia vernalis*, a parasite of Japanese beetle grubs, was imported from Japan as a potential biological control agent. It later was observed that the locations where the wasp became established seemed to be ones with abundant nearby food sources. However, no further work was done to confirm that nectar-producing plants encourage these natural enemies. We have found *Tiphia vernalis* to be locally abundant in Kentucky, parasitizing Japanese beetle grubs from early May through mid-June. We also discovered a native Tiphia species, *Tiphia pygidialis* Allen, that attacks masked chafer grubs from August until early October.

To verify potential benefits of supplemental carbohydrates, adult females of each parasite species were maintained in the lab, and their longevity and fecundity was compared between individuals provided 10% sugar water versus water only. Gardens of spring- or fall-blooming flowering plants were established and monitored several times per week to determine if particular plant species attract *Tiphia* spp.

Two field experiments were conducted. In the first, grubs were implanted into turf plots and then those plots, or adjacent turf areas, were sprayed with 10% sugar water to attract Tiphia wasps. Grubs later were dug up to compare parasitism rates. In the second study, plantings of peonies (which were found to attract *T. vernalis*) were established in a large stand of Kentucky bluegrass, and Japanese beetle grubs were implanted at varying distances away. Numbers of wasps visiting the peonies were monitored. At the end of wasp flight, the turf was sampled and the incidence of parasitism was determined in relation to distance from the nectar source.

Results and Discussion

Survival of spring-active *Tiphia vernalis* and late summer-active *Tiphia pygidialis* was significantly increased when wasps were provided with 10% sugar water in the laboratory, confirming that access to carbohydrates benefits the wasps. Presence of a grub for host feeding (i.e., taking a blood meal) did not affect wasp longevity. *Tiphia pygidialis*, the parasite of masked chafers, was never observed feeding on flowers in the fall-blooming gardens. However, hundreds of the wasps visited turf sprayed with 10% sugar water to feed. Parasitism by *T. pygidialis* was significantly elevated (from 9% to 45%) in turf plots located near sugar-sprayed turf. Interestingly, parasitism was reduced in the turf that was directly sprayed, evidently because wasps attracted to those plots spent their time feeding rather than searching for grubs in the soil.

Tiphia vernalis, the Japanese beetle parasite, was never observed feeding on sugar-sprayed turf, nor did such treatments affect its parasitism of grubs in or near sugar-sprayed turf. Numerous *T. vernalis* were, however, observed feeding on nectar from peony (*Peonia lactiflora Pallas*). When replicated plantings of *P. lactiflora* were established in a stand of turf, parasitism of *P. japonica* was significantly higher near the peonies. We also have observed hundreds of *T. vernalis* feeding on honeydew of aphids and soft-scale insects in trees such as oaks, maples, and the tulip tree and documented parasitism rates as high as 50% in golf course roughs adjacent to such trees.

Significance to the Industry

This work suggests that incorporating peonies or similar nectar-producing flowers into home landscapes or on golf courses can help sustain populations of *Tiphia vernalis* and may increase parasitism and mortality of Japanese beetle grubs in adjacent turf. Trees (e.g., oaks and maples) that support non-harmful levels of aphids or other honeydew-producing insects also provide a food source for Tiphia populations. Incorporating such plants into home, commercial, and golf course landscapes can have benefits for conservation biological control of turf-infesting white grubs.

For full article, see Rogers, M.E. and D.A. Potter. 2004. Environ. Entomol. In Press.

Landscape Plant Disease Observations from the Plant Disease Diagnostic Laboratory—2003

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

Nature of Work

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

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

The 2003 growing season in Kentucky provided mostly cooler than normal temperatures and above normal rainfall. This season produced the second wettest April-August on record, and the second coolest June and July. January temperatures were below normal but not cold enough to cause widespread cold injuries to woody plants, although there was some injury. There were few significant late spring frosts to cause additional injury.

Results and Discussion

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

Deciduous Trees

- Birch leaf spot (*Septoria*)
- Dogwood powdery mildew (*Microsphaera*, *Phyllactinia*) and leaf spot (*Septoria*)
- Flowering crabapple scab (*Venturia*)
- Flowering plum black knot (*Apiosporina*)
- Hawthorn leaf spot (*Entomosporium*)
- Hawthorn, serviceberry, and crab apple cedar rusts (*Gymnosporangium juniperi-virginianae*, *G. clavipes*, *G. globosum*)
- Maple, ash, dogwood, oak, and sycamore anthracnose (*Kabatiella*, *Discula*, and *Apiognomonia*)
- Maple, walnut zonate leaf spots (*Cristulariella*)
- Oak bacterial leaf scorch (*Xylella*)
- Tulip poplar, maple and magnolia wilt (*Verticillium*)

Needle Evergreens

- Juniper tip blight (*Phomopsis*) and rusts (*Gymnosporangium* spp.)
- Pine tip blight (*Sphaeropsis*), needle casts (*Dothistroma*, *Lophodermium*), needle rust (*Coleosporium*), and ozone injury
- Spruce needle cast (*Rhizosphaera*) and canker (*Cytospora*)

Shrubs

- Hibiscus and spicebush zonate leaf spots (*Cristulariella*)
- Holly and inkberry black root rot (*Thielaviopsis*)
- Photinia leaf spot (*Entomosporium*)
- Rose black spot (*Diplocarpon*) and rosette (possible virus transmitted by leaf curl mites)
- Rhododendron root rot (*Phytophthora*)

Herbaceous Annuals and Perennials

- Aster web blight (*Rhizoctonia*) and rust (*Coleosporium*, *Puccinia*)
- Chrysanthemum, snapdragon, geranium, English ivy, petunia, hydrangea, and bedding plant root rots (*Pythium*, *Rhizoctonia*, *Phytophthora*)
- Chrysanthemum bacterial leaf spot (*Pseudomonas*)
- Coreopsis and foxglove downy mildews (*Plasmopara*)
- Daylily leaf streak (*Aureobasidium*)
- Geranium bacterial wilt (*Ralstonia solanacearum* race 3, biovar 2–one confirmed case)
- Geranium, vinca, peony, petunia, and annual bedding plants gray mold blight (*Botrytis*)
- Hollyhock rust (*Puccinia*)
- Pansy root rot and black root rot (*Pythium*, *Thielaviopsis*)
- Rudbeckia leaf spots (*Cercospora*, *Septoria*)
- Vinca black root rot (*Thielaviopsis*) and aerial blight (*Phytophthora*)
- Zinnia flower rot (*Choanephora*)

Significance to the Industry

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

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Survey for *Phytophthora ramorum* (Sudden Oak Death) in Kentucky, 2003

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Nature of Work

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

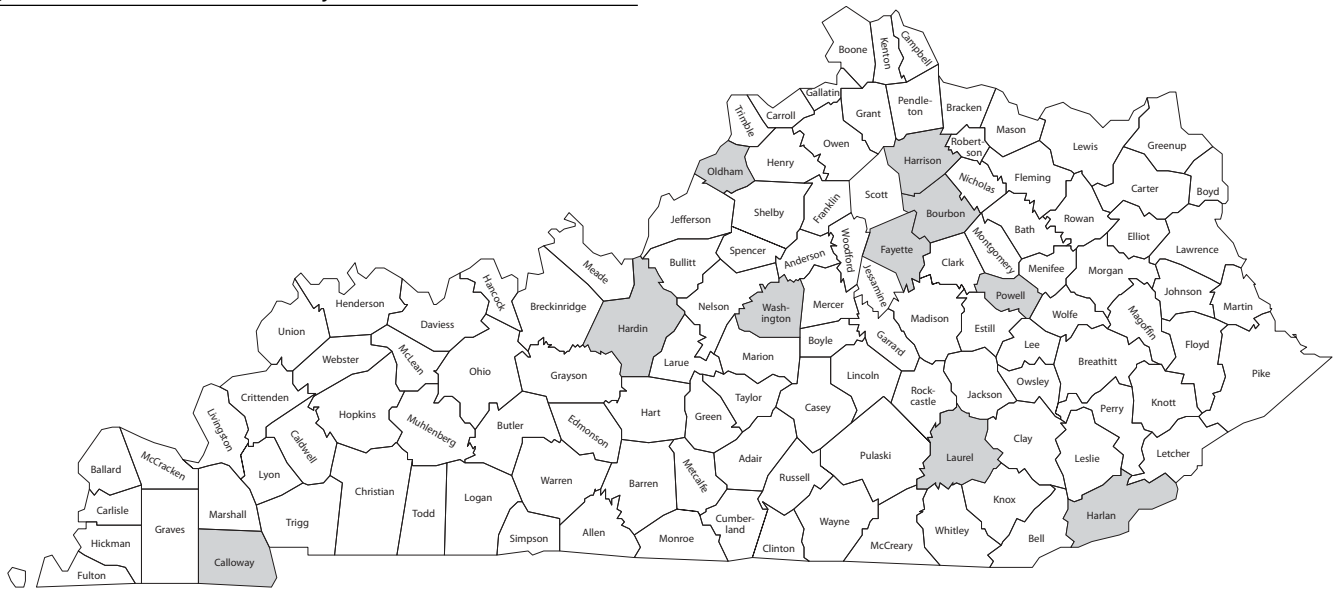
In Kentucky, our concern has been whether this disease would be similarly devastating to oaks if the pathogen were introduced into the state. The SOD disease fungus thrives in the relatively cool and moist climate of coastal California and Oregon. Because we also can have periods of cool, moist weather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

Effective February 14, 2002, a federal quarantine was imposed to prevent movement of infected plants or the pathogen from the West Coast to Kentucky and other states. However, the disease was known to be present in California for several years before the quarantine was imposed. During that time, it is possible that plants from California with *P. ramorum* were unknowingly shipped into Kentucky, possibly even through third-party commercial arrangements. Although such infected plants most likely have been sold and moved, the fungus could have escaped to vegetation surrounding the nursery or to younger plants in blocks that did not originate on the West Coast.

A survey of selected Kentucky nurseries was conducted to determine whether *P. ramorum* was present in nursery stock or in nearby vegetation. A spring survey was done during April, May, and June when the cooler weather would favor this disease. The survey was continued in September and October. Nurseries were examined for plants of all species showing abnormal symptoms including bleeding necrosis, leaf spots, blotches, and leaf tip necrosis. Nursery blocks containing oaks, rhododendrons, viburnums, and mountain laurels were especially scrutinized. Furthermore, in the woody vegetation in forest and fencerows surrounding the nurseries, plants with suspicious symptoms were also examined. The survey was further bolstered by collections of wild plants with suspicious symptoms made in Natural Bridge State Park and the Pine Mountain Settlement School. Collection locations are shown in Figure 1.

Nursery and wild plant specimens were collected, placed in plastic bags, and immediately taken to the laboratory for analysis. Small pieces of infected plant material were plated on a culture medium selective for *Phytophthora* (PARP) and were floated on water in Petrie dishes. Samples were analyzed for growth and presence of the fungus *Phytophthora*. When *Phytophthora* was found, subcultures were grown on V-8 juice agar.

Figure 1. Sudden oak death survey locations.



Results and Discussion

In spring, collections were made from eight nurseries and two natural areas in 10 counties. A total of 110 plant samples were collected for processing; 42 were from nursery blocks, and 68 were from nursery fencerows, adjacent forest edges, or natural park stands. Sampled plants included the following:

From nursery blocks:

4 or more samples each	2 samples each	1 sample each
red maple (5), pin oak (5), red oak (8), rhododendron	southern magnolia, sugar maple, white oak, viburnum	white ash, river birch, bald cypress, American elm, ginkgo, hawthorn, hornbeam, dwarf English laurel, lilac, tree lilac, sweetbay magnolia, English oak, sweetgum

From nursery fencerows, adjacent forest edges, and natural park stands:

4 or more samples each	3 samples each	2 samples each	1 sample each
American elm, sugar maple (6)	American beech, hackberry, poison ivy, mountain laurel, red maple, white oak	green ash, white ash, cat briar, American chestnut, box elder, honeysuckle, mountain laurel, chinquapin oak, red oak, sycamore	blackberry, blueberry, flowering dogwood, gray dogwood, rough-leaf dogwood, slippery elm, American holly, bitternut hickory, shellbark hickory, black locust, mulberry, chestnut oak, persimmon, rhododendron, multiflora rose, sassafras, sumac, tulip poplar, Virginia creeper

The plant specimens that were collected mostly had symptoms of spots, blotches, and leaf tip necrosis, but one white oak had symptoms of a bleeding canker, and a viburnum had a canker and shoot dieback. Although many plants had symptoms similar to those expected for plants infected with *P. ramorum*, Phytophthora was isolated from only one group of 'Eskimo' viburnums. This unknown viburnum Phytophthora was examined microscopically for presence of sporangia, zoospores, oospores, and chlamydospores. The isolate appeared to differ morphologically from *P. ramorum*. This fungus will be analyzed using a polymerase chain reaction test to further identify the fungus and clarify any possible relationship to *P. ramorum*. This survey suggests that *P. ramorum* infected plants are absent or are not easily found associated with nurseries and native plant areas in Kentucky. Nevertheless, it will be important for nursery growers to continue surveillance activity in and near their nurseries on the off chance that this fungus has somehow found its way into Kentucky.

Significance to the Industry

With increased national and international trade and movement of nursery stock, new plant diseases are always a threat to the Kentucky nursery and landscape industry. This survey suggests that *P. ramorum*, cause of Sudden Oak Death disease, is not present in Kentucky, which is good for the industry. If this disease were to be found here, disease eradication and quarantine measures would surely be imposed. These efforts, while necessary, can be costly to the nursery industry.

Evaluation of Tennessee Dogwood Selections for Powdery Mildew, 2003

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

Nature of Work

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

This test was conducted at the University of Kentucky Horticultural Research Farm and was designed to test the reaction of dogwoods to powdery mildew caused by *Microsphaera pulchra* and *Phyllactinia guttata*. This site was one of several U.S. locations for these evaluations. Having a site in Kentucky was expected to increase exposure of the dogwoods to *P. guttata*, whereas dogwoods at other sites would be exposed primarily to *M. pulchra*. The dogwoods evaluated were selections made at the Nursery Crops Research Station, Tennessee State University, McMinnville, Tennessee. Three-year-old dogwood (*Cornus florida*) seedlings were grown in 3-gallon pots containing a nursery potting mix. Four plants of each selection were transported to Kentucky and were placed in a shade structure and watered as needed with automatic overhead sprinklers. Each of the selections was replicated four times, and plants were arranged in a completely randomized design. Dogwoods were evaluated for powdery mildew by recording percent powdery mildew incidence and severity on 10 June, 16 July, and 25 August. Incidence (percentage of the plant's leaves with mildew) was recorded based on presence of both signs of the pathogen and symptoms of the disease (with pathogen signs only visible with the aid of a hand lens). Severity is a measure of fungal activity and is based on the percentage of coverage of the infected foliage with visible signs of the fungus. Percent powdery mildew values were calculated by multiplying the percent incidence by the percent severity. The data were statistically analyzed using ANOVA and Waller-Duncan k-ratio t-test, (K = 100, P = 0.05).

Results and Discussion

Powdery mildew symptoms and signs were first observed in mid-June, and by mid-July disease pressure was heavy. By the end of the experiment, powdery mildew on the dogwood selections ranged from 19 to 77%. There were significant differences in powdery mildew levels between dogwood selections (Table 1). Under Kentucky conditions, selections R-14 and R-23 and M-18 and M-19 show promise as starting material for more resistant lines.

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

Selection number	Percent powdery mildew*		
	10 June	**16 July**	**25 August**
R-23	2.0 a **	16.5 a	19.0 a
M-19	11.0 abc	15.0 a	19.3 a
R-14	3.3 a	17.0 a	28.8 a
M-18	8.0 ab	21.0 a	28.0 a
R-31	12.3 abc	45.3 b	49.0 b
R-34	16.3 bc	45.3 b	51.5 b
15	21.8 cd	40.8 b	44.0 b
R-10	31.3 de	49.3 b	52.5 b
R-25	35.8 e	52.5 bc	54.3 b
R-9	40.3 ef	67.8 cd	defoliated
R-33	51.5 f	71.0 d	77.0 c

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

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

Significance to the Industry

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

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Agrobacterium-Mediated Transformation of *Sphaeropsis sapinea*, the Causal Agent of Pine Tip Blight

Jennifer L. Flowers, John R. Hartman, and Lisa J. Vaillancourt, Department of Plant Pathology

Nature of Work

Sphaeropsis tip blight (formerly known as Diplodia tip blight) is a common disease worldwide, affecting more than 30 species of pines and other conifers. Typical symptoms of *S. sapinea* infection include stunted shoots with necrotic, stunted needles, resinous cankers, and a general decline of the tree. These symptoms lead to significant economic losses of native and exotic pines in managed plantings. Latent infections of asymptomatic pine tissues by *S. sapinea* are common. A reliable DNA-mediated transformation protocol for *S. sapinea* would allow further study of the pathogenic and latent interaction between this fungus and its hosts. Successful genetic transformation of *S. sapinea* has not been previously reported (1).

The objective of this study was to develop a transformation protocol for *S. sapinea*. Protoplasts of *S. sapinea* (cells of the fungus without cell walls) were formed using a standard procedure for digesting cell walls and re-suspending the protoplasts. Protoplasts of *S. sapinea* were determined to be sensitive to the antibiotic hygromycin B. A bacterium, *Agrobacterium tumefaciens* containing the pBM2-2 plasmid, was used for transformation experiments. The pBM2-2 plasmid carries genetic information that confers hygromycin B antibiotic resistance. The bacterium was grown in liquid culture and mixed with a suspension of *S. sapinea* protoplasts. After co-cultivation with *A. tumefaciens* and incubation, the resulting *S. sapinea* was grown on a medium containing hygromycin B. *S. sapinea* colonies that grew in the presence of the antibiotic were single-spored and examined for morphological and genetic characters.

Results and Discussion

Isolates of *S. sapinea* that once were sensitive to hygromycin B were now resistant to the antibiotic due to the resistance genes obtained from *A. tumefaciens*. These are now transformed fungal isolates. They retained their normal colony types, spore morphology, and growth rates. Thus, *S. sapinea* transformants can be obtained with this Agrobacterium-mediated transformation protocol. The hygromycin-resistance gene integration into *S. sapinea* appears to be mitotically stable because repeated subculture of the fungus did not cause the fungus to lose its antibiotic resistance. This opens the way for integration of other genes into the chromosome of *S. sapinea*.

Significance to the Industry

In future studies of this disease, it will be necessary to trace the progress of the fungus inside host pine trees. A genetically transformed version of *S. sapinea* can be created that will be easier to detect in the plant than the normal fungus. Knowing where the fungus is in the plant and whether it is in a latent or pathogenic state will enable studies on what environmental or plant factors might trigger the change from latency to pathogenicity. Identifying these events could help in devising tip blight disease control measures.

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Rudbeckia Taxa Evaluation

Amy Fulcher, Winston C. Dunwell, and Dwight Wolfe, Department of Horticulture

Nature of Work

Rudbeckia taxa comprise a group of about 30 annual, biennial, and perennial plants, all native to North America (1). Rudbeckia are in the *Asteraceae* family and display the daisy-type disc and ray flower typical of that family. They range in height from 6 inches for the smaller pot varieties to 80 inches. Many *Rudbeckia taxa,* like *R. hirta,* tolerate dry conditions, while others, such as *R. laciniata,* prefer moist conditions (2). Rudbeckia are considered easy to grow and thrive in full sun. Rudbeckia can be distinguished from other similarly shaped flowers by their alternate leaves, yellow, rust, and/or orange ray flowers, and raised disc or "eye,"

Rudbeckia species and cultivars are valued native plants. In the last five years, landscape use of *Rudbeckia fulgida* var. *sullivantii* 'Goldsturm' (1999 Perennial Plant of the Year) has become increasingly popular in residential and commercial landscapes. The focus of this study was to evaluate several less common Rudbeckia species and cultivars for landscape adaptability.

Four to eight plants of each taxa were planted at the University of Kentucky Research and Education Center in Princeton in the spring of 2002 and 2003. Preen® pre-emergent herbicide and Osmocote® 15-9-12, 5-6 month release fertilizer were applied and plants were mulched. Plants were fertilized with Miracle-Gro® 15-30-15 at 600 ppm nitrogen approximately weekly throughout the summer. The planting was irrigated at establishment, during liquid fertilizer applications, and during prolonged dry spells. The evaluation area was weeded as needed. Plants were not staked or sprayed for diseases or insects. The maintenance schedule was designed to simulate the conditions of an average home landscape.

Data were collected approximately once per week from early June through September on first bloom, bloom color, individual bloom size, and bloom coverage (percentage of the total plant covered by blooms). Bloom period (weeks in bloom), plant height, and plant width were also recorded. Observations were made on insect and disease incidence and cultural requirements.

Results and Discussion

General Summary 2002 and 2003

In 2002 *R. fulgida* var. *sullivantii* 'Goldsturm' bloomed for the longest period of time, 10 weeks (Table 1). *Rudbeckia fulgida* 'Green Wizard' did not bloom at all. In the second year of evaluation both *R. fulgida* var. *sullivantii* 'Goldsturm' and *Rubeckia triloba* bloomed for more than 11 weeks.

Rudbeckia hirta 'Autumn Colors', 'Prairie Sun', 'Goldilocks', and 'Cherokee Sunset' had the greatest flower diameter in 2002. In 2003 *Rudbeckia hirta* 'Cherokee Sunset' and 'Autumn Colors' had the largest flower diameter.

Bloom coverage was not statistically significant either year. Some variation reported may be due to the subjective nature of percent coverage data (data were reported by different people in 2002 and in 2003).

Plant height ranged from *Rudbeckia hirta* 'Toto Lemon' at slightly taller than 4 inches both years to *Rudbeckia laciniata* 'Herbstsonne' at 55.5 inches in 2002 and 103 inches in 2003.

Table 1. Results of the *Rudbeckia* taxa evaluation.

Cultivar	Weeks in Bloom 2002	Weeks in Bloom 2003	Flower Diameter 2002 (inches)	Flower Diameter 2003	Bloom Coverage 2002	Bloom Coverage 2003 (%)	Plant Height (inches)[1]	Plant Width (inches)[2]
R. fulgida var. *sullivantii* 'Goldsturm'	10.0	11.5	2.8	2.7	36	43	42.9	48.8
Rudbeckia hirta 'Autumn Colors'	8.5	6.2	4.4	4.2	46	36	16.1	19.2
Rudbeckia hirta 'Prairie Sun'	8.5	5.5	4.2	3.5	40	26	17.8	43
Rudbeckia subtomentosa	8.0	6.3	3.3	2.8	41	14	64.7	76.8
Rudbeckia hirta 'Cherokee Sunset'	7.5	8.0	3.9	4.4	46	40	26.3	39.9
Rudbeckia hirta 'Sonora'	7.3	6.8	3.1	2.9	55	30	10.9	11.3
Rudbeckia hirta 'Toto Gold'	6.7	6.0	2.6	2.3	41	43	8.0	8.8
Rudbeckia triloba	6.0	11.6	1.3	1.4	62	24	52.2	38.2
Rudbeckia hirta 'Toto Lemon'	5.7	6.5	1.9	1.7	31	31	4.0	7.1
Rudbeckia hirta 'Toto Rustic'	5.3	7.3	2.1	2.3	38	26	7.8	6.5
Rudbeckia hirta 'Goldilocks'	5.3	6.5	4.0	3.2	38	30	13	19.3
Rudbeckia laciniata 'Herbstsonne'	1.3	6.8	3.4	3.0	42	13	103	57.8
Rudbeckia fulgida 'Green Wizard'	–	–	–	–	–	–	–	–
LSD[3](P = 0.05)	2.8	3.2	0.6	0.5	NS	NS	–	–

[1] Average plant height including flower stalks taken July 28, 2003.
[2] Average plant width including flower stalks taken July 28, 2003.
[3] Least significant difference at the 0.05 probability level.
NS = not statistically significant.

Plant width varied from one year to the next, and this is possibly more a reflection of a need to stake than an accurate reflection of the space required for each taxa.

Flower Observations

2002 and 2003

Rudbeckia hirta 'Prairie Sun' began the season with butter yellow outer portions of the ray flowers and darker, golden yellow interior portions of the ray flowers. The disc flowers began as a yellow-chartreuse color. As the season progressed and seeds developed, the disc color changed to brown, altering the aesthetic qualities of the flower. *Rudbeckia hirta* 'Autumn Colors' displayed variable flower color ranging from yellow to dark orange to rust colored ray flowers. Flowering was variable in 2002 on *Rudbeckia laciniata* 'Herbstsonne' with just two of the four plants developing flower stalks and flowers. All four plants bloomed their second year. In the 2002 study *R. fulgida* var. *sullivantii* 'Goldsturm' did not have one of the highest bloom coverages, but an established planting nearby began blooming earlier and bloomed as late into the season and appeared to have greater bloom coverage than the first-year plants in the evaluation. Data from 2003 show that a more established *R. fulgida* var. *sullivantii* 'Goldsturm' does bloom for a longer period of time.

Pest Observations

2002

Shining flower beetles were identified on *Rudbeckia hirta* 'Cherokee Sunset' but did not cause damage. Japanese beetles, spittle bugs, caterpillars, and cucumber beetles were noted on occasion but did not appear to cause any noticeable damage. *Rudbeckia triloba* was the exception, sustaining noticeable, yet minor damage from Japanese beetles. Soldier beetles, a beneficial insect, were identified in large numbers on the flowers of several varieties.

In July several taxa began to display disease symptoms. On July 22 *Rudbeckia fulgida* 'Green Wizard' and *Rudbeckia hirta* 'Goldilocks' were diagnosed with rhizoctonia root and stem rot. All of the *Rudbeckia hirta* 'Goldilocks' and half of the *Rudbeckia fulgida* 'Green Wizard' died. As the season progressed, the *R. hirta* Toto series and *R. hirta* 'Sonora' also succumbed to rhizoctonia. By the end of September plants of *Rudbeckia hirta* 'Autumn Colors', 'Cherokee Sunset', and 'Prairie Sun' had also died. Powdery mildew was noted on *Rudbeckia hirta* 'Autumn Colors' and *Rudbeckia hirta* 'Cherokee Sunset' in late August. *Rudbeckia fulgida* var. *sullivantii* 'Goldsturm' was diagnosed with cercospora leaf spot in October, after several rain events. The symptoms associated with the cercospora were also present in April and May during a period of wet weather.

2003

In early July leaves and stems of one *Rudbeckia subtomentosa* plant began to die. *Sclerotinina sclerotiorum*, the causal organism of sclerotinina stem rot, was identified as the cause. No other *Rudbeckia subtomentosa* died. Later in July *Rudbeckia hirta* 'Goldilocks' was diagnosed with southern blight, *Sclerotium rolfsii*. All four plants died. In August *Rudbeckia fulgida* var. *sullivantii* 'Goldsturm' was diagnosed with cercospora leaf spot. The leaf spot did not detract from the overall aesthetic impact of the plants. Also in August *Rudbeckia hirta* 'Cherokee Sunset' and *Rudbeckia triloba* were diagnosed with a root and stem rot associated with rhizoctonia. None of the *R. triloba* died, but three out of four *R. hirta* 'Cherokee Sunset' died. During August and September nearly all plants of *Rudbeckia hirta* 'Toto Gold', *Rudbeckia hirta* 'Toto Rustic', *Rudbeckia hirta* 'Toto Lemon', *Rudbeckia hirta* 'Sonora', *Rudbeckia hirta* 'Autumn Colors', and *Rudbeckia hirta* 'Prairie Sun' succumbed to rhizoctonia stem and root rot. Leaves on the lower portion of *Rudbeckia laciniata* 'Herbstsonne' stalks turned brown and clung to the stem. No cause was determined.

Nearly all plants had holes in the leaves indicating feeding from a chewing-type insect, but no insects were found. Snout weevils were noticed in large numbers in late May feeding on the flower buds of *Rudbeckia fulgida* var. *sullivantii* 'Goldsturm'. This infestation was short-lived and did not result in any noticeable damage. Japanese beetles were present individually on *R. triloba* but did not cause noticeable damage.

Cultural and Environmental Observations

2002

Rudbeckia laciniata 'Herbstsonne', *Rudbeckia subtomentosa*, and *Rudbeckia triloba* needed to be staked, possibly due to the high rate of nitrogen applied in the liquid fertilizer. In September *R. triloba* and *R. subtomentosa* exhibited symptoms consistent with ozone damage.

2003

While some plants of *Rudbeckia laciniata* 'Herbstsonne', *Rudbeckia subtomentosa*, and *Rudbeckia triloba* needed to be staked, other plants did not.

Overall Recommendations

No plant in the study was free from problems. However, during the period of evaluation, some taxa were able to survive and flower during dry periods as well as periods of wet weather and high temperatures, while others died. Based on the number of plants dying from rhizoctonia, annual *Rudbeckia hirta* cultivars may be more susceptible to rhizoctonia than the perennial *Rudbeckia taxa*. Considering that rhizoctonia is generally considered to be ubiquitous, growers, retailers, and landscapers may wish to use these plants in clean containers filled with a sterile medium.

Barring a progression of the symptoms seen on the lower leaves in 2003, *Rudbeckia laciniata* 'Herbstsonne' is a good choice for areas requiring a tall plant. It may require staking. Preliminary observations show it may make a nice cut flower due to a long vase life.

At this time *Rudbeckia fulgida* var. *sullivantii* 'Goldsturm' continues to be a reliable bloomer and free from significant pest problems.

Rudbeckia subtomentosa and *Rudbeckia triloba* show promise as relatively trouble-free perennials, *R. subtomentosa* for midsummer bloom and *R. triloba* for season-long bloom. Their apparent ability to withstand disease pressure without significant plant death may lead to preferred use over *R. hirta* cultivars.

Significance to the Industry

Identification of adaptable, attractive, native plants can provide landscape contractors, designers, and retailers with an expanded list of plants to market to the consumer as well as a wider selection of low maintenance plants for commercial landscapes. In addition, this evaluation will serve as a basis for modeling future evaluations of Kentucky native Rudbeckia stands for landscape use.

Acknowledgments

The authors would like to recognize June Johnston, Hilda Rogers, and Julie Miller for their contributions to the *Rudbeckia taxa* Evaluation. The authors would also like to thank Dr. Robert Anderson for his assistance. Appreciation is expressed to the Kentucky Horticulture Council, the UK New Crop Opportunities Center, and Jellito Perennial Seeds.

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Perennial Garden Flower Trials—1999-2003—University of Kentucky Horticulture Research Farm

Robert G. Anderson and Kirk Ranta, Horticulture Department

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

The collection of perennials in our ongoing trials continues to expand. We have nearly 1,100 individual plants in the perennial trials with more than 175 species and cultivars in the plots at the Horticulture Research Farm in Lexington. Our trials include the Perennial Plants of the Year from the Perennial Plant Association and Kentucky native plants. We now have four years of experience with some, so our ratings have many observations. However, our ratings should be used only as a guide to determine which perennials you might sell or use in Kentucky landscapes. In general, those that have grown well for two or more seasons are marked as highly recommended (++), recommended (+), or did not perform well on our site or were not hardy (-); those unmarked need more time to determine a rating.

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

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

Russian Hollyhock
Alcea rugosa ('03)

Amsonia
Amsonia hubrectii ('01-'03) (++)
Amsonia tabernaemontana 'Blue Star' ('03) [KY NATIVE]

Artemisia
Artemisia absinthium 'Huntington Gardens' ('01) (-)
Artemisia vulgaris 'Oriental Limelight' ('03)

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

Astilbe
Astilbe 'Sprite' ('00-'03) (++)

Columbine
Aquilegia x hybrida 'Rose w/White Edge' ('02-'03), 'Songbird Cardinal' ('02-'03), 'Winky Red & White' ('02-'03)

Indigo
Baptisia leucophaea ('03) [KY NATIVE], *Baptisia pendula* ('01-'03) [KY NATIVE], *Baptisia sphaerocarpa* ('03) [KY NATIVE]

Willowleaf Oxeye
Buphthalum salicifolium 'Sun Wheels' ('00-'03) (-)

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

Feather Reed Grass
Calamagrostis acutifolia 'Karl Foerster' ('00-'03) (++), *Calamagrostis acutifolia* 'Overdam', ('02-'03) (++) - Variegated Feather Reed Grass, *Calamagrostis brachytricha*, ('03) (++) - Korean Feather Reed Grass

River Oats, Northern Sea Oats
Chasmanthium latifolium ('00-'03) (++)[KY NATIVE]

Garden Mums
Ajania pacificum 'Pink Ice' ('00-'03) (++), *Chrysanthemum* 'Hillside Pink' ('01-'03) (+), *Chrysanthemum yezoense* ('00-'03) (+), *Dendranthema rubellum* 'Clara Curtis' ('00-'03) (+), *Dendranthema rubellum* 'Mary Stoker' ('00-'03) (+)

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

Cumberland Rosemary

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

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

Montbretia
Crocosmia crocosmiifolia 'Venus' ('00-'03) (-)

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

Cone Flower
Echinacea pallida ('00-'03) (+)[KY NATIVE], *Echinacea paradoxa* ('00-'03) (+)[KY NATIVE], *Echinacea purpurea* ('00-'03) (++)[KY NATIVE], *Echinacea purpurea* 'Magnus' ('00-'03) (++), *Echinacea simulata* ('00-'03) (+)[KY NATIVE], *Echinacea tennessensis* ('00-'03) (++)

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

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

Hardy Ageratum
Eupatorium coelestinum ('01-'03) (++)[KY NATIVE]

Joe Pye Weed
Eupatorium maculatum ('00-'03) (++)[KY NATIVE], *Eupatorium maculatum* 'Carin' ('02-'03) (++), *Eupatorium maculatum* 'Gateway' ('02-'03) (++)

Spurge
Euphorbia dulchis 'Chameleon' ('03)

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

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

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

Gazania
Gazania linearis 'Colorado Gold' ('03)

Cranesbill, Hardy Geranium
Geranium 'Dusky Rose' ('00-'03), *Geranium cantabrigiense* 'Blokova' ('00-'03), *Geranium cantabrigiense* 'Karmina' ('00-'03), *Geranium cinereum* 'Ballerina' ('00-'03), *Geranium clarkei* 'Kasmir Purple' ('00-'03), *Geranium maculata* 'Claridge Druce' ('00-'03), *Geranium phaeum* 'Samobor' ('00-'03)

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

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

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

Daylily
Hemerocallis 'Stella d'Oro' ('01-'03) (++)

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

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

Crepe Myrtle
Lagerstroemia indica 'Supersonic Mix' ('02-'03) (++)

Tree Mallow
Lavatera thuringiaca 'Barnsley' ('03)

Liatris
Liatris aspera ('03) [KY NATIVE]

Acidsoil Lithodora
Lithodora diffusa 'Grace Ward' ('03)

Statice
Limonium latifolia ('00-'03) (+)

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

Maltese Cross
Lychnis coronaria 'Angel Blush' ('01-'03) (+), *Lychnis flos-jovis nana* 'Peggy' ('01-'03) (-)

Marshallia
Marshallia grandiflora ('02-'03) (+) - Barbara's buttons [KY NATIVE], *Marshallia mohrrii* ('02-'03) (+)[KY NATIVE]

Maiden Grass
Miscanthus sinensis 'Morning Light' ('01-'03) (++)

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

Catmint
Calamintha nepeta 'White Cloud' ('02-'03) (+) - Savory Calamint, *Nepeta* 'Dawn to Dusk' ('00-'03) (++), *Nepeta* 'Subsessilis' ('00-'03) (++), *Nepeta faassenii* 'Six Hills Giant' ('00-'03) (++), 'Walker's Low' ('02-'03) (++)

Evening Primrose
Oenothera macrocarpa ('03)

Ornamental Oregano
Origanum laevigatum 'Herrenhausen' ('01-'03) (++)

Wild Quinine
Parthenium integrifolium ('00-'03) (++)[KY NATIVE]

Fountain Grass
Pennisetum alopecuroides 'Hameln' ('01-'03) (++)

Beard Tongue
Penstemon barbatus 'Prairie Dusk' ('01-'03), *Penstemon digitalis* 'Husker Red' ('00-'03) (++), *Penstemon fruticosa* 'Purple Haze' ('01-'03)

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

Fleeceflower
Persicaria amplexicaule 'Firetail' ('01-'03) (+), *Persicaria bistorta* 'Superbum' ('01-'03) (-)

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

Coneflower
Ratidiba columnifera 'Mexican Hat' ('00-'03) (++), *Ratidiba pinnata* ('03) [KY NATIVE]

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

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

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

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

Sedum
Sedum spectabile 'Autumn Joy' ('00-'03) (++), 'Brilliant' ('00-'03) (++), 'Stardust' ('02-'03) (++), *Sedum spurium* 'Vera Jameson' ('00-'03) (++)

Rosinweed
Silphium integrifolium ('03) [KY NATIVE]

Cup Plant
Silphium perfoliatum ('03) [KY NATIVE]

Goldenrod
Solidago rugosa 'Fireworks' ('02-'03) (++)

Meadowsweet
Spirea latifolia ('00-'03) (++)[KY NATIVE]

Prairie Dropseed
Sporobolis heterolepis ('02-'03) (++)[KY NATIVE]

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

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

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

2003 Garden Flower Trials—Results of Annual Flower Evaluations by Kentucky Master Gardeners

Robert G. Anderson, Department of Horticulture, and Master Gardeners from McCracken, Warren, Hardin, Pulaski, Wayne, Russell, Jefferson, Fayette, Boone, and Campbell Counties

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

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

- Purchase Area Master Gardener Garden, Paducah
- UK West Kentucky Research and Education Center, Princeton
- Warren County Master Gardener Garden, Bowling Green
- Hardin County Master Gardener Garden, Elizabethtown
- Louisville Zoo, Louisville
- UK Arboretum, Lexington
- Boone County Master Gardener Garden, Burlington
- Campbell County Master Gardener Garden, Highland Heights
- Pulaski County Master Gardener Garden, Somerset
- Wayne County Master Gardener Garden, Monticello
- Russell County Master Gardener Garden, Russell Springs

We encourage you to take time to visit these trial and demonstration gardens next year.

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

A few plants performed poorly in the 2003 trials. Sunflowers and ornamental millet were too old at transplanting. We knew this was a potential problem, but learned that the seed must be sown only 20 to 25 days before transplant. The situation was somewhat similar for 'Apricot Brandy' celosia. Celosia can be one of the best flowers in Kentucky gardens, but garden performance may be reduced by transplanting older plants. This year's trial shows that plants need to be younger than six weeks at transplanting to get appropriate garden performance.

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

Vinca–'Cooler Hot Rose'	*Catharanthus roseus*	4.58
Lantana–'Weeping Lavender'	*Lantana camara*	4.40
Spreading Petunia–'Tidal Wave Purple'	*Petunia x hybrida*	4.40
Verbena–'Temari Patio Blue'	*Verbena*	4.40
Vinca–'Cooler Lavender Halo'	*Catharanthus roseus*	4.32
Zinnia–'Profusion Orange'	*Zinnia*	4.31
Lantana–'Patriot Sunburst'	*Lantana camara*	4.22
Vinca–'Cooler Deep Orchid'	*Catharanthus roseus*	4.09
Cupflower–'Summer Splash'	*Nierembergia hippomanica*	4.00
Sweet William–'Amazon Purple'	*Dianthus barbatus*	4.14
Cigar Flower–'Tiny Mice'	*Cuphea llavea*	4.00
Sweet William–'Amazon Cherry'	*Dianthus barbatus*	3.94
Bedding Begonia–'Olympia Sprint Mix'	*Begonia semperflorens-cultorum*	3.59
Zinnia–'Benary Giant Golden Yellow'	*Zinnia elegans*	3.16
Ornamental Millet–'Purple Majesty'	*Pennisetum glaucum*	3.14
Wishbone Flower–'Summer Wave Amethyst'	*Torenia fournieri*	3.04
Zinnia–'Benary Giant Deep Red'	*Zinnia elegans*	2.74
Cockscomb–'Apricot Brandy' EARLY (sown 02-27-03)	*Celosia plumosa*	2.58
Cockscomb–'Apricot Brandy' LATE (sown 03-25-03)	*Celosia plumosa*	2.28
Sunflower–'Moonbright'	*Helianthus annuus*	1.68
Sunflower–'Sunbright'	*Helianthus annuus*	1.68

Annual Flower Evaluation at the University of Kentucky Arboretum

Sharon Bale and Richard Durham, Department of Horticulture

The 2003 growing season started off with unseasonably cool and wet weather for much of May. This caused many plants to be slow to establish after transplanting. Also, heavy feeding pressure from rabbits and chipmunks affected evaluation of some species, and these are noted below. Table 1 lists plant performance for several new and/or unusual species grown at the Arboretum. Table 2 lists the recent winners from the All-America Selections (AAS) Program. The Arboretum serves as one of over 30 AAS flower trial grounds across North America. To be selected as a winner, a plant must flower during the first growing season from seed, and must perform well at a majority of trial grounds across North America. Current AAS Winners receive the Flower Award for their performance in the garden or the Bedding Plant Award for their performance in greenhouse pack trials. Evaluation comments are limited to those plants that have been selected as winners because AAS restricts release of information of plants currently being evaluated in trials. However, the trial grounds as well as the gardens containing recent AAS winners are open to the public at the UK Arboretum.

Table 1. New and unusual plants evaluated at the UK Arboretum.

Name	Flower or Foliage Color	Height	Source	Performance
Althernanthera 'Purple Knight'	purple foliage	2 ft.	Harris	Easily propagated from seed. Great color contrast plant for the garden. Low maintenance.
Amaranthus gangeticus Elephant Head Amaranth	red	4 ft.	Seeds of Change	Although the plant begins to look unsightly by mid-August, it is a great accent plant for the garden.
Argyranthemum 'Molimba and Butterfly Series	various	8-10 inches	Proven Winners	Excellent early blooms but once those fade, the plants do not rebloom. A disappointment.
Begonia rex 'Seattle Twist', Tucson Bonfire', 'Omaha', 'Houston Fiesta', 'Maui Mist', 'Escargot', 'Albuquerque Midnight Sky', Denver Lace', 'San Diego Sunset', 'Winter Sun', 'Raspberry Crush', 'Chicago Fire'	various foliage colors	12-14 inches	Donation	All cultivars are patented. Excellent for shade and also do well as house plants. A good choice.
Begonia semperflorens Olympia Sprint Series	bicolor, pink, red, rose, and white	18 inches	Benary	Tolerated sun very well. Excellent flower color and performs as well or better than the Cocktail Series.
Bidens 'Solaire Yellow'	yellow	6 inches	Proven Winners	Plants are small and blooms are dainty. Has potential, but we chose a poor location for this plant, and it couldn't compete with the neighbors.
Bracteantha Sundaze Series	bronze, yellow	10-12 inches	Proven Winners	Bloomed well all season. Required some maintenance but should be considered a good bedding plant as well as a choice for containers.
Calibrochoa 'Starlette Purple'	purple	2-3 ft.	Donation	Did very well as a bedding plant. Wonderful color.
Calibrachoa 'Superbells Series'	red, light pink	2-3 inches	PW	Performed well all season. Good color especially the 'Cherry Red'.
Catharanthus hybrida First Kiss Series	rose, pink, icy pink, coral, apricot	10 inches	Benary	**EXCELLENT.** Performs as well as any other vinca, but the flower colors make this series stand out. A shading to the bloom colors that is difficult to describe makes this series stand out, especially the coral and apricot.
Cleome 'Linde Armstrong'	pink	3-4 ft.	Donation	Distinct appearance, not invasive like other Cleome. Gets a little "out of control" in a container but excellent as a bedding plant. Performs well all season.
Delphinium grandiflorum Summer Blues and Summer Nights	blue	10 inches	Benary	No different from other delphiniums, just can't take the heat.

Table 1 continued on next page

Table 1 continued

Table 1. New and unusual plants evaluated at the UK Arboretum.

Name	Flower or Foliage Color	Height	Source	Performance
Diascia 'Flying Colors Trailing Red'	red	6-8 inches	Proven Winners	Performed well. Showed good heat tolerance. There were periods when the bloom display was reduced, but overall a good choice for the garden or container.
Dianthus 'Amazon Neon'	magenta	12-14 inches	Harris	**EXCELLENT EARLY.** Plants fade in the summer heat, but for an early display this is a beautiful cool-season flower. This is the first year at the arboretum for this plant. It doesn't appear that it will be perennial, but we will see. Would be an excellent cut flower.
Dianthus 'Bouquet Purple'	purple	12-14 inches	Harris	**EXCELLENT EARLY.** Just about as good as 'Amazon Neon' with the same potential as a cut flower and performs equally.
Graptophylum 'Tricolor', 'Chocolate'	variegated foliage	12-14 inches	Donation	Great foliage plant for full sun.
Impatiens–New Guinea Infinity Series	various	8-10 inches	Proven Winners	**GOOD PLANTS**. Excellent color range. Plants were compact, required no maintenance, and had no disease problems.
Ipomoea tricolor 'Mini Bar Rose'	variegated foliage	vine	Harris	Saw the plant at the Ball Seed Trials, and it looked interesting. Was not impressed with the performance at the arboretum.
Nemesia 'Sunsation Series.	yellow, red, white	6-8 inches	Proven Winners	Tolerated the heat and bloomed all season. Rabbits were a problem, but we will definitely try this plant again.
Petunia 'Supertunia Dark Blue', 'Supertunia Mini Blue-veined', 'Supertunia Blushing Princess'	various	8-10 inches	Donation	Performed equal to the Wave petunias.
Phlox 'Intensia Series'	rose pink, lavender	6-8 inches	Proven Winners	Performed well all season and was heat tolerant. That was a great surprise. We would have had an excellent display if the rabbits hadn't loved them as well.
Trachelium caeruleum Jemmy Series	white, violet, antique rose, royal purple	18-20 inches	Benary	Plants were too slow and didn't produce any display until late in the season. This may have been our fault; we probably needed to start the plant earlier and go to the garden with a larger plant.
Verbena 'Babylon Deep Pink', 'Babylon Neon Rose Imp'	pink, rose	6-8 inches	Proven Winners	Continuous bloom, and required no maintenance. Good choice for the garden or container.
Zinnia Zinnita Series	white, scarlet, rose, orange, yellow	12-14 inches	Benary	A low-growing zinnia with an inch diameter bloom. As good as the Profusion Series in performance. No disease problems until very late in the season. Great potential.

Table 2. All America Selection Winners for 2003 and 2004 grown at the UK Arboretum.

Name	Award	Comments
2003 Winners		
Agastache foeniculum 'Golden Jubilee'	Flower Award	Did much better in sun than in shade. Powdery mildew was a problem on shade-grown plants. Some plants were perennial after 2002 season.
Ornamental Millet 'Purple Majesty'	Gold Medal Flower Award	Did not perform as well in 2003 as when it was evaluated in earlier years. The wet spring of 2003 delayed transplanting and may have caused plants to become pot-bound. Still a very attractive plant.
Carnation 'Can Can Scarlet'	Flower Award	Good flowering even in the heat of summer with flowers produced on tall stems giving somewhat of a leggy appearance. It may be best used as part of a cut flower garden.
Dianthus 'Corona Cherry Magic'	Bedding Plant Award	Good season-long performance as it was still going strong in late August. Bicolor patterns of the flowers are attractive.
Eustoma 'Forever White'	Bedding Plant Award	Flowers produced until late summer, but plants were not overly vigorous. May be best in closer spacing or in containers.
Gaillardia pulchella 'Sundance Bicolor'	Bedding Plant Award	Did not perform well, likely due to excess moisture during the early part of the growing season.
Petunia 'Blue Wave'	Flower Award	The latest installment in the Wave series. It was slow to establish due to foraging by rabbits.
Petunia 'Merlin Blue Morn'	Flower Award	Less rabbit damage than with 'Blue Wave'. Very attractive bicolor flowers with white centers and blue edges that are especially nice when viewed at twilight.
Rudbeckia hirta 'Prarie Sun'	Flower Award	Exceptional. Peak show was in early August. Flowers have golden yellow petals and bright green centers.
Vinca 'Jaio Dark Red'	Bedding Plant	Very nice. Appeared more compact than most other vinca. Good season-long color.
2004 Winners		
Celosia plumosa 'Fresh Look Red	Gold Medal Flower Award	Excellent plant. Definitely outperformed comparisons. Held color well. Declining blooms were not removed, and the plants kept producing.
Celosia plumosa 'Fresh Look Yellow	Flower Award	Equally as good as 'Fresh Look Red'.
Gypsophila muralis 'Gypsy Deep Rose'	Bedding Plant Award	Plants looked a little stressed by early August but still useful as a novelty.
Hollyhock 'Queeny Purple'	Flower Award	A very unique growth habit. Plants are short and compact. Not a full-season bloomer but worth consideration because of the novel growth habit. Unfortunately, the rabbits seem to find it especially nice.
Petunia 'Limbo Violet'	Bedding Plant Award	Flower color is very attractive. Plants have a compact habit and may not be a desirable plant for hanging baskets, but it is excellent as a bedding plant. Held well until late summer without any special maintenance.

UKREC Daylily Cultivar Evaluation 2003

Winston Dunwell and Julie Miller, Department of Horticulture and Murray State University

Nature of Work

A collection of daylilies was established at the University of Kentucky Research and Education Center in the Plant Evaluation Plots for permanent public viewing in 1997 with plants provided by Kentucky Daylily growers and breeders: Thoroughbred Daylilies, Lexington, Kentucky, Schott Gardens, Bowling Green, Kentucky, and Swanson Daylilies (Octavian - = diploid and Milano - = tetraploid), Lexington, Kentucky (those plants in Table 1 with the Kentucky symbol were introduced by these nurseries). Julie Miller, summer intern from Murray State University, Murray, Kentucky, collected data on date of first bloom, date of last bloom, average scape length and number of blooms per scape on the 90 cultivars in the plots. Spent scapes (blooming had stopped) were inadvertently removed in August. Numbers in Table 1 in parentheses under the heading "Average Number of Blooms/Scape" represent the total number of bud scars and the number of scapes that occurred on plants that had completely stopped blooming prior to the scape removal. Blooms per scape numbers without the parentheses bracketed numbers were based on counting bud scars on approximately 10 scapes per plant. Data on total number of scapes and blooms were reported when available to give an indication of the number of blooms and scapes a 7-year-old plant will produce. This evaluation is based on a single plant per cultivar except for Black-eyed Stella.

Results and Discussion

Previous daylily evaluations at the University of Kentucky Research and Education Center had been based on first-year after division data only (Dunwell, et al, 2001, 2000, 1999, 1997, 1996, 1995, 1994). A comparison of several cultivars in this observation to the 1993 flowering dates and degree day data (Dunwell, 1994) shows little difference in date of first or last bloom for the established plants in this study versus plants the first year after division.

Acknowledgments

Our appreciation to Caldwell County Vocational Agriculture Students Sarah Baker, Bethany Brandon, and Jayme Davis for assisting with data collection.

Table 1. Daylily evaluation 2003.

Plant	First Bloom	Last Bloom	Scape Length (inches)	Average Number of Blooms/Scape
Peach Souffle	26Jun	24Aug		10.5
Siloam Red Toy	16Jun	25Jul		
Yellow Kitten	15Jun	19Jul		5.2
Sunflare[KY]	27Jun	03Aug		
Home Coming Queen	19Jun	19Jul	24.5	5.5 (127/23)
Prairie Blue Eyes	12Jun	19Jul	33.5	9.7 (532/55)
Lights of Detroit	16Jun	10Jul	21.0	6.3 (133/21)
Ribbon Candy	29Jun	04Aug		10.1
White Temptation	30Jun	19Aug		13.4
Evening Bell	19Jun	19Jul	28	4.6 (167/36)
Tangled Web[KY]	18Jun	30Jul	38	9 (403/45)
Winds of Peace	26Jun	03Aug	31	5.7 (335/59)
Jambalaya	16Jun	22Jul	32	7.2 (490/68)
Ah Youth	12Jun	19Jul		10.0
Siloam Toddler	20Jun	29Jul		
Saratoga Pinwheel	20Jun	14Jul	33	7.9 (350/44)
Granite City Toehead	20Jun	19Jul	32	7.1 (339/48)
Milady Greensleeves	27Jun	19Aug		12.1
Dune Needlepoint	28Jun	28Jul	29	10.7 (426/40)
Mad Max[KY]	28Jun	19Jul		6.8
Open Hearth	17Jun	19Aug	23.5	6.7 (240/36)
Hyperion	28Jun	03Aug		15.1
Top Honors	28Jun	04Aug		5.6
Royal Promise	28Jun	09Sep		8.4
Ruffled Apricot	5Jul	25Jul		4.1
Mary Shadow[KY]	30Jun	03Aug		4.3
Neddy Downing[KY]	08Jul	25Jul	15.5	4.4 (40/9)
Stella De Oro	01Jun	03Jul		10.5
Lullaby Baby	06Jun	24Aug		19.3
Best of Friends	20Jun	19Aug		15.6
Cha Cha Cha	27Jun	27Jul		13.1
Purple Oddity	04Jul	24Aug		21.4
Yesterday's Memories	27Jun	03Aug		
Attribution	15Jun	2Jul	21.5	3.6 (128/35)
College Try	30Jun	19Aug		
Lavender Patina	27Jun	22Jul		7.1
Dragon Lore	15Jun	10Jul	26	7.2 (179/25)
Buddha	16Jun	19Aug		
Fairy Tale Pink	26Jun	24Jul		
Atlanta Moonlight	27Jun	22Jul	29	11.0 (562/51)
Spectacular	01Jun	01Jul	37.5	8.5 (372/44)
Marse Connell	27Jun	19Jul	39.5	8.2 (343/42)
Party Queen	20Jun	19Jul	24	6.5 (319/49)
Nightgown	30Jun	04Aug		11.0
Willis & Hattie	01Jul	19Aug		
Skyland Pride	30Jun	19Aug		
Siloam Cinderella	01Jul	27Jul		9.8
Black-eyed Stella	01Jun	19Jun	26.5	5.1 (317/62)
Hawaiian Party Dress	30Jun	01Aug		9.4
Happy Returns	01Jun	09Sep		6.0
Rosella Sheridan	27Jun	05Aug		9.3
Black-eyed Stella	01Jun	23Jun	31	6.1 (307/50)
Lavender Touch	19Jun	19Jul		7.3
Ray Hammond[KY]	02Jul	19Aug		

Table 1. Daylily evaluation 2003.

Plant	First Bloom	Last Bloom	Scape Length (inches)	Average Number of Blooms/Scape
O. Marble Model	26Jun	12Jul		
O. Glow[KY]	20Jun	10Jul	24	4.5 (118/26)
O. Marble Ring[KY]	08Jun	12Jul	22	4.2 (100/24)
M. Violet Mark[KY]	16Jun	10Jul	28	7.0 (285/41)
Janice Wendell[KY]	05Jul	19Aug		16.2
Siloam Virginia Henson	28Jun	01Aug		15.9
Anzac	02Jul			
Lisa My Joy	20Jun	25Jul		11.0
Chicago Sunrise	27Jun	19Aug		11.8
Buttercurls	27Jun	03Aug	24	7.2 (267/37)
Always Afternoon	16Jun	19Jul	24	12.1 (278/23)
Angel Braid[KY]	03Jul	05Aug	21	13.5 (135/10)
Wes Kirby	30Jun	25Jul		8.3
Candie Dwyer[KY]	04Jul	26Jul	31	13.3 (199/15)
Magical Mystery[KY]	01Jul	28Jul	24	7.2 (72/10)
Upper Echelon[KY]	27Jun	23Jul	23	7.6 (168/22)
Baby Blanket[KY]	13Jul	03Aug		5.2
O. Exotic Marble[KY]	15Jun	19Aug	22	10.5 (253/24)
O. Cherry Doll[KY]	15Jun	19Jul	23	17.6 (599/34)
O. Orchid	19Jun	19Jul		10.5
Milano Rocket[KY]	28Jun	27Jul		7.4 (469/42)
Milano Maraschino[KY]	28Jun	27Jul	35	11.2 (469/42)
Cantique	26Jun	19Aug		
Pardon Me	29Jun	19Aug		18.8
Eric, Jr.	29Jun	09Sep		27.2
Barbara Mitchell	24Jun	21Jul	26	5.4 (188/35)
Juanita	28Jun	19Aug		23.4
Aten	06Jul	09Sep		13.7
Nancy Ligon[KY]	19Jun	13Jul	20	7.9 (103/13)
Dave Bowman[KY]	30Jun	27Jul	27	21.8 (262/12)
Chuck Wheeler[KY]	28Jun	30Jul	26	13.4 (107/8)
Truly Angelic[KY]	05Jul	19Aug		16.8
Mexican Siesta[KY]	02Jul	19Aug		9.2
Mystery Lover[KY]	29Jun	23Jul	30.5	8.0 (137/17)
Crown of Creation[KY]	01Jul	03Aug	24	11.7 (211/18)

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Kentucky Native Plant Evaluation

Winston Dunwell, Department of Horticulture

Nature of Work

Plants native to Kentucky are already well known in the nursery landscape industry. Dogwoods, oaks, maples, ashes, and rhododendrons are a few of the woody plants; purple coneflowers, trilliums, phlox, lilies, and black-eyed susan are a few of the many Kentucky perennial native plants used in landscapes. Kentucky native plants have characteristics that add to the aesthetics and the biodiversity of residential, industrial, institutional, and recreational landscapes. Government agencies and academics alike have called for increased use of "regionally native" plants. A Kentucky native plant evaluation program has been established at the UK Nursery Crops Development Center at Princeton, Kentucky.

Results and Discussion

Native plants are sought out and found in the wild in Kentucky, seed are collected, plants are produced from the seed, and those plants are placed into the University of Kentucky Research and Education Center Botanic Garden and/or the UK Nursery Crops Development Center research nursery for evaluation of their potential as landscape plants. Desirable characteristics include long bloom period, good clean (disease- and insect damage-free) foliage, environmental tolerance, and a commercially acceptable means of propagation.

Significance to the Industry

Indian Pink, *Spigelia marilandica*, has the greatest potential for development as a mass produced landscape plant of those tested to date because of its long bloom period and ease of propagation. The development of a source of *Quercus phellos*, willow oak, of a Kentucky provenance with tolerances of Midwest environmental conditions will be advantageous to Kentucky nurseries over currently available seed from provenances of the Deep South. *Cunila origanoides*, dittany, shows potential as a landscape plant.

Table 1 contains individual plant evaluation information. The scientific names in bold indicate native plants that show significant promise as landscape plants.

Table 1. Kentucky native plants in evaluation at the University of Kentucky Research and Education Center (UKREC), Princeton, Kentucky.

Scientific Name	Common Name	Notable Ornamental Characteristic	Evaluation Results	Current Status	Future Evaluation and Research Efforts
Ascelpias tuberosa	Butterfly Weed	bright orange bloom, attracts butterflies	native equal to cultivars	off-station[1] landscapes and butterfly garden	maintain in landscape for public viewing
Amsonia tabernaemontana	Blue-star, Amsonia, Blue Dogbane	pale blue spring flowers	easily propagated from seed or by division	UKRECBG[2]	cutting propagation and distribution
Anemonella thalictroides	Rue Anemone	fine-textured plant dainty flower	spring bloomer	UKRECBG	further evaluation in a better drained site
Cephalanthus occidentalis	Buttonbush	summer flowering woody shrub very tolerant of wet feet	attractive glossy foliage, uniquely round flower	in landscape and nursery	evaluate invasiveness
Cimicifuga racemosa	Black Snakeroot, Black Cohosh	striking tall white spike flowers in fall	prone to scorch/dieback in nursery and landscape environment	in two landscape sites and research nursery	determine best landscape environment, collect seed from plants in other sites
Cunila origanoides	Dittany	rounded small plant of 18 inches, small purple flowers in late summer/fall	attractive, divides easily	in research nursery	continue landscape evaluation, protocol for container production
Erythronium americanum	Yellow Trout-lily	aesthetic foliage and flower	very short bloom and foliage show	unable to grow bulb in container	protocol to store and plant bulbs to landscape
Hydrangea arborescens	Wild Hydrangea, Smooth Hydrangea	corymbs with few showy sterile flowers	fairly long bloom period, flushes new growth in July, leaf spot	in nursery and landscape	parent species of 'Annabelle' worth continued seedling evaluation

Table 1. Kentucky native plants in evaluation at the University of Kentucky Research and Education Center (UKREC), Princeton, Kentucky.

Scientific Name	Common Name	Notable Ornamental Characteristic	Evaluation Results	Current Status	Future Evaluation and Research Efforts
Hymenocallis occidentalis	Spider-lily	stunning white bloom in late July/early Aug	seems tolerant of landscape environment	UKRECBG landscape	expand evaluation from current shaded site
Hypericum spathulatum	Shrubby St. John's-Wort	yellow spring bloom and good foliage	vigorous, requires pruning	UKRECBG	stop evaluation, maintain in UKRECBG for public viewing
Lonicera sempervirens	Trumpet Honeysuckle	full-season red trumpet-shaped bloom	excellent bloom, foliage and habit	UKREC Vine Collection	propagate for distribution and continued evaluation
Monarda fistulosa	Monarda or Bergamot	pale blue spring flowers	susceptible to powdery mildew	UKRECBG	maintain in native plants garden
Nyssa Sylvatica	Blackgum	glossy foliage, red-orange fall foliage	great variation in seedlings	UKRECBG	develop and protect name of a selected clone with weeping habit
Passiflora incarnata	Passion-Flower	unique purple-white flower on perennial vine but considered a weed (Haragan, 1991)	attractive flower, re-seeds	UKREC Vine collection	potential as pot plant
Polygonum biflorum	Solomon's Seal	attractive habit and spring bloom	species not as vigorous as cultivars, produces fruit	UKRECBG	continue evaluation in new site
Pycnanthenum incanum	Hoary Mountain-Mint	white leaves subtend a small bloom	grows well in landscape, spreading	UKRECBG	continue evaluation
Quercus phellos	Willow Oak	tolerant of soil environments, small leaves	easy to grow from seed, seeds not consistently produced	seedlings in evaluation for selection of superior plant(s)	continue seed collection from Kentucky provenances
Rudbeckia species	Black-eyed Susan	attractive well-known summer flower	tolerates dry environments, variation in flower color/size	discontinue cultivar evaluation	continue development with seedlings from natives
Silene virginica	Fire Pink	bright red spring flower	"fleeting" in garden	dropped from evaluation	n/a
Sabatia angularis	Rose Gentian, Rose Pink	late summer pink flowering plant of uniform habit	difficult to maintain in landscape	continue to seek seed sources	re-establish in research nursery, protocol for use as an annual
Sanguinaria canadensis	Bloodroot	white spring flowering	bloom period short, foliage attractive	maintain in evaluation	examine container production potential
Spigelia marilandica	Indian Pink	bright red flower with yellow throat	long bloom period, full-season foliage	continue in UKRECBG establish stock plant bed	greatest potential as an underutilized Kentucky native
Vernonia gigantea	Tall Ironweed	fantastic purple late summer/fall flowers in a large cluster	stunning bloom frequently on attractive dark stems	extremely invasive	eliminate from evaluation site
Viola pubescens Alton	Smooth Yellow Violet	yellow spring bloom	bloom above and separate from foliage	evaluate in UKRECBG	investigate invasiveness

[1] Plants considered potentially invasive are evaluated off-station.
[2] UKRECBG – University of Kentucky Research and Education Center Botanic Garden at Princeton.

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

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

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

The Research Challenge Trust Fund was created by the Kentucky General Assembly as part of the "bucks for brains" program to provide state funds to match private contributions toward endowments to support research. Several Kentucky nursery/landscape industry leaders have seized the opportunity and made a significant and long-lasting impact on research to support our industry. Three named endowments and a general endowment have been established. All commitments to these endowments must be satisfied by October 2004. This year, income from this family of endowments provided more than $12,000 to support research for our industry.

Named endowments include:

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

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

Those individuals and companies contributing to the UK Landscape Fund in 2003 (through November 1) are listed in this report. Your support is appreciated and is an excellent investment in the future of the Kentucky nursery and landscape industries.

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

UK Nursery and Landscape Fund and Endowment Fellows

Gregory L. Ammon
Ammon Wholesale Nursery

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

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

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

Herman R.* and Mary B. Wallitsch
Wallitsch Nursery

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

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

Fred* and Jenny Wiche
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James Sanders Nursery Inc.

Robert* and Janice Corum
National Nursery Products

Herman, Jr., and Deborah Wallitsch
Wallitsch Nursery

Richard and Shirley Ammon
Ammon Landscape Inc.

*deceased

2003 Contributors to the UK Nursery/Landscape Fund and Endowments (through November 1)

Associates (> $500)
Pat Dwyer, Dwyer Landscaping Inc.
Mike Ray, Carl Ray Landscape
Bill Henkel, Henkel Denmark Inc.
John Robertson
Kit Shaughnessy, Kit Shaughnessy Inc.

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William C. Gardiner II, Gardiner Nursery & Tree Space Co.
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Daniel Tandy
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Donor (< $100)
Cindy Finneseth
Dr. Dewayne Ingram

Industry Organizations
Kentucky Landscape Industries Trade Show
Kentucky Nursery and Landscape Association

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

Ammon Wholesale Nursery, Burlington
Bernheim Aboretum and Research Forest, Clermont
Davey Tree, Kent, OH
David Leonard, Consulting Arborist, Lexington
Dow AgroSciences, Indianapolis, IN
Floralife, Walterboro, SC
Flora Novus, Denton, TX
FMC Corporation
Hillenmeyer Nurseries, Lexington
Hunter Industries, SanMarcos, CA
J. Frank Schmidt Nursery, Boring, OR
J. J. Mauget Co., Burbank, CA
Jellito Perennial Seed, Louisville
Kit Shaughnessy, Kit Shaughnessy Inc., Louisville
Larry Hanks, Consulting Arborist, Lexington
M.L. Irrigation Systems, Laurens, SC
Oaks Pavers, Cincinnati, OH
Pokon and Chrysal USA, Miami, FL
Rohm and Haas Co., Philadelphia, PA
Saunders Bros. Inc., Piney River, VA
Syndicate Sales, Kokomo, IN
The Scotts Company, Marysville, OH
UK Physical Plant Division, Grounds Department
Valent Co.
Wilson's Landscaping Nursery, Frankfort

Grants for specific projects have been provided by:

Kentucky Horticulture Council
Agricultural Development Board
Associated Landscape Contractors of America
Barnhart Fund for Excellence, UK College of Agriculture
Central Kentucky Ornamentals and Turf Association
Kentucky Nursery and Landscape Association
Kit Shaughnessy, Kit Shaughnessy, Inc.
Louisville Nursery Association
Urban and Community Forestry Program, Kentucky Division of Forestry
UK Integrated Pest Management Program
UK New Crop Opportunities Center
UK Nursery/Landscape Fund
United States Department of Agriculture

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Issued 12-2003, 1,200 copies