SECTION 10
LANDSCAPE

Mr. Will Corley
Section Chairman and Moderator

Establishment and Maintenance of Wildflowers on Erodible Sites

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Georgia

Nature of Work: Stabilization of an erodible site is usually accomplished by seeding a nurse grass and/or companion legume (3). This nurse grass is seeded, fertilized, mulched, and managed or maintained to prevent erosion and sedimentation of down stream areas, and to improve wildlife habitat and visual resources. Since wildflowers are often desired to add low maintenance color for Improved visual and environmental enhancement effects (1,2) research was Initiated in 1988 to determine optimum seeding rates of appropriate nurse grasses and wildflowers and to determine fertilizer regimes for rapid establishment of a nurse grass while maintaining cost efficient wildflower color.

Two infertile test sites were chosen: a loamy sand in extreme southwest Georgia and a heterogeneous clay subsoil in northcentral Georgia. Main plots were seeded spring and fall, according to requirements of the nurse grass. A typical southeastern wildflower mix was seeded at 10 Ibs./ac. (5 oz/K Ft^2) into lightly tilled soil which had been oversprayed with Roundup to reduce competition from existing vegetation. Subplots consisted of the following grasses seeded simultaneously: tall fescue @ 35 Ibs./ac., Pensacola bahia @ 40 Ibs/ac., hulled common bermuda @ 7 Ibs./ac., and weeping lovegrass @ 3 Ibs./ac. Previous unpublished research had indicated that a 25 percent reduction in the nurse grass seeding rate was satisfactory to combine with usual wildflower seeding rates. Subplots were further divided into biannual fertilizer applications of granular 16-4-8 and Osmocote 18-6-12 at 500 and 1,000 Ibs./ac. All plantings were cultipacked and mulched lightly with clean wheat straw. Supplemental irrigation was not utilized. Data were collected over two years for nurse grass establishment, plant growth rates, and flowering or color effect of wildflowers.

Results and Discussion: Detailed data are not presented but are available in publications cited. The following recommendations are submitted as guides to establish and maintaln wildflower color in grass plantings on erodible sites:

1) A seeding combination of 75 percent usual grass seeding rate + 10 lbs./ac. wildflower seed mix is recommended for all grasses except bahia. Wildflowers have failed to persist in all bahia seedings.

2) A typical southeastern wildflower mix will perform satisfactorily. Superior performance of a special mix for nurse grass compatibility is presented in Table 1. This mix can be custom blended by most wholesale wildflower seedsmen.

3) Fertilizer rates of 500 to 1,000 Ibs./ac. will enhance seedling establishment. Maintenance applications of 500 Ibs./ac. are usually sufficient.

4) Control of broadleaf weeds can be accomplished by mowing, spot spraying, or overspraying of appropriate herbicides.

5) Aggressive grasses can be checked by diluted sprays of grass specific herbicides, after soil erosion is not a problem.

Significance to Industry: Low maintenance or conservascape color can be provided by wildflowers. When critical or erodible sites are seeded with grasses for erosion control, wildflowers can be economically added to the grassing specification. Management of wildflower meadows in these sites plays an important role in the durability and visual impact of a wildflower meadow for the Southeast.

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Table 1. Custom wildflower mix for nurse grass companion plantings on erodible sites.

Taxa	Common Name	Bloom Season	Color	%
Achillea millefolium	White Yarrow	Summer	White	5
Centaurea cyanus	Cornflower	Spring	Blue	10
Chamaecrista fasiculata	Partridge Pea	Fall	Yellow	15
Chrysanthemum leucanthemum	Oxeye Daisy	Spring-Summer	White	15
Coreopsis lanceolata	Lance Coreopsis	Summer	Yellow	20
Gaillardia pulchella	Annual Gaillardia	Summer-Fall	Yellow/Red	25
Rudbeckia hirta	Blackeye Susan	Summer-Fall	Yellow	10

Seedbed Preparation Alternatives for Establishment of Wildflower Meadows and Beauty Spots

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Nature of Work: Interest in wildflowers continue to grow in tandem with environmental and resource conservation concerns. Active and planned establishment of wildflowers on both public and private lands have served as query origins for proper establishment practices for wildflowers, whereby the goal of cost efficient landscape color can be successful for vegetation managers of public lands, landscape contractors, and backyard gardeners. A test was initiated to determine optimal soil preparation for wildflower seedling establishment while minimizing competition from weed seedlings.

A test site was selected in clay loam subsoil with little inherent fertility and pH of 5.8. During late summer and fall the following seedbed preparation treatments were implemented on a site containing common bermuda grass and miscellaneous weeds: (1) mow + Roundup overspray, (2) mow + Roundup + shallow till, (3) mow + Roundup and Treflan tank mix + shallow till, (4) multiple deep tillage, (5) solarization, and (6) fumigation with Basamid. Light tillage disturbed the soil only 1 to 2 inches deep, while conventional tillage penetrated 6 to 8 inches. Multiple deep tillages were necessary to suppress weed seedlings stimulated by the previous tillage. Fumigation consisted of deep tillage, incorporation of fumigant granules, and sealing under plastic for several weeks prior to planting. Solarization was accomplished by all the procedures for fumigation except no fumigant was applied. A landscape color southeastern wildflower mix was seeded at 15 pounds per acre during early winter. Wheat straw mulch was applied at approximately one-half inch depth over all treatments. Ratings for wildflower establishment, flowering effect, and weed competition were recorded monthly during the growing season. The monocot specific herbicide, Poast, was oversprayed during April and June to reduce competition from grassy weeds.

Results and Discussion: Table 1 shows that the practice of drill seeding wildflowers into dormant turf during winter months can produce good results. However, timing for adequate soil moisture is critical since a straw mulch is not used. Dormant turf can serve as a partial mulch for seedling establishment. When shallow tilling is utilized, weed seedling population can seriously compete with wildflower stands. A short term preemergent herbicide such as Treflan can significantly reduce weed seedling competition. Herbicide application should be made 4 to 6 weeks prior to planting. Incorporation by rainfall or irrigation is necessary. Multiple tillage produced a good seedbed. Both solarization and fumigation treatments resulted in excellent wildflower establishment and weed suppression. These two seedbed preparation techniques require warm soils for effectiveness, thus implementation by late summer is necessary.

Significance to Industry: Cost efficient landscape color can be provided by wildflower meadows and beauty spots. Several methods for seedbed preparation are optimal for landscape managers, according to landscape maintenance budgets and desired effects of the wildflower plantings. Where low costs (pennies per square foot) are desired or critical, multiple tillings or the use of short term preemergent herbicides are viable options in seedbed preparation. Both solarization and fumigation produce good results where resources are available.

Table 1. Effects of tillage methods on wildflower species establishment and weed suppression, 1989-1990.

Tillage method	Wildflower Establishment[1]	Weed Suppression[2]
Mow + Roundup	Good	Good
Mow + Roundup + Shallow Till	Fair	Poor
Mow + Roundup + Treflan + Shallow Till	Excellent	Good
DeepTill Twice	Excellent	Good
Solarization	Excellent	Good
Fumigation	Excellent	Good

[1] Rated subjectively at seeding rate of 15 Ibs/ac.

[2] Rated subjectively on winter, spring and summer weed emergence.

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Cold Hardiness Potential of Four Selections of Raphiolepis umbellata

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Nature of Work: Yeddo raphiolepis or Indian Hawthorn (Raphiolepis umbellata Makino.) is a popular plant throughout USDA hardiness zones 8 through 10 (Dirr, 1990). To increase its geographic range of adaptability it is necessary to increase its cold tolerance. Twenty species and cultivars of raphiolepis were evaluated by Corley (1984,1985) at the Georgia Experiment Station in Griffin, Ga. He found 'Ovata' and an unnamed Plant Introduction (PI 277653) to be the most hardy after exposure to -19 C (-3 F) in 1983.

In an attempt to find other cold hardy raphiolepis plants, crosses were made between the PI and 'Ovata'. Four of approximately 2000 seedlings have been selected for desirable horticultural characteristics, cold hardiness, and leaf spot resistance. However, the degree of cold hardiness of these selections throughout the winter season is not known since extremely cold winters do not occur regularly in middle Georgia. Therefore, the objective of this paper is to evaluate the cold hardiness of leaves and stems of the cold hardy raphiolepis parent and crosses ('Ovata' x Pl) at various times throughout the fall, winter, and spring over two winter seasons.

Seedlings of the cold hardy PI were planted into field plots at the Georgia Experiment Station in 1963. Cross between the PI and 'Ovata' was made in 1973 and selected plants were planted into the field in 1975. Four selections from the above mentioned cross were used in this study. The plants were sampled six times for cold hardiness estimates in 1989-90 and three times in 1991. To estimate cold hardiness on each test date, thirty-six, uniform, 10 cm long stem segments were removed from each plant. In the first year only stem tips were used since they are freeze damaged the most easily. In the second year, however, 20 cm of stem tissue was removed to allow testing of both stem tips from the past season's growth and stem segments from the second year growth. In either case, the leaves were removed from the stems. Samples, wrapped in wet paper towels, were put in plastic bags then placed on ice for transport to the lab. Within 2 hours of the collection the stems and leaves were prepared for freezing as described by Lindstrom and Dirr, 1989. The number of stems or leaves killed at each temperature was recorded and the lowest survival temperature (LST) was determined from the data. The LST was the lowest temperature at which little or no injury was observed.

Results and Discussion: The four selections of raphiolepis were, in general, as cold hardy or more so in both the stems and leaves as the cold hardy parent (PI 277653) on all dates tested over two winter seasons (Table 1 and 2). During the first year of testing, when only leaves and stem tips were used, the four selections acclimated at a similar rate as the PI (Table 1). The stem tips of all the selections were generally less cold hardy than the leaves at -6 C (21 F) but were as cold hardy

as those of the PI. Stem tips were injured by an outdoor freeze on 23 and 24 Dec, 1989, therefore, there is no estimate of cold hardiness on the 22 Jan sampling date. Due to the injury of the stem tips, stem sections from the second year growth were used on 20 Feb and 26 Mar sampling dates. The older stems had nearly the same cold hardiness as the leaves on these dates indicating that in turn they are more cold hardy than the stem tips. This is substantiated by the fact that they survived the exposure to the minimum temperatures experienced on 23 and 24 Dec. On the 26 Mar 1990 sampling date, both the leaves and the stems of all the plant selections were more cold hardy than the PI (Table 1).

On the second year of testing, stem tips, stem sections from second year's growth, and leaves were evaluated for cold hardiness on three different dates. On all dates the stem tips were less cold hardy than the older stem sections or leaves (Table 2) and there was little difference between the cold hardiness of the stem tips of the plant selections and the PI. Leaf and old stem cold hardiness closely parallelled each other on 29 Jan and 27 Feb sampling dates, but, on 27 Mar the leaves had deacclimated and were less cold hardy than the stems. On 27 Mar 1991, as in the first year of the experiment both the leaves and old stems of the plant selections were more cold hardy than those of the PI (Table 2).

Significance to Industry: The four raphiolepis selections in this study, considering the data collected over two years, are as cold hardy as the parent PI. In fact, they appear to have more cold hardiness in the spring (March) than does the PI. This indicates that the selections may be more able to survive late spring frosts than the PI and that the selections could be grown in areas where the PI is injured or killed.

Table 1. The lowest survival temperatures (C ± SD) of 4 selections of Raphiolepis umbellata to their cold hardy parent (PI 277653) from 30 Oct 89 through 26 March 1990.

	Date collected											
Plant	10-30-89		11-20-89		12-18-89		01-22-90		02-20-90		03-26-90	
selection	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem
1	-9	-6	-12	- 7±4	-15	-9±l2	-15	C[z]	-15	-ll±2	-12	-9
2	-9	-6	- 9	-6	-15	-9	-15	C[z]	-15	-14±2	-14±2	-9
3	-9	-6	-12	-6	-15	-9	-15	C[z]	-12	-12	- 12	-9
4	-9	-6	-12	-9	-18	-9	-15	C[z]	-15	-12	-11± 2	-9
PI	-9	-6	- 9	-6	-15	-9	-15	C[z]	-12	-12	- 9	-6

[z] Non-frozen control dead.

Table 2. The lowest survival temperatures (C±SD) of old and new stem segments and leaves of 4 selections of Raphiolepis umbellata to their cold hardy parent (PI277653) from 29 Jan through 27 Mar 1991.

	Date collected								
	1-29-91			2-27-91			3-27-91		
Plant selection	Leaf	Stem (new)	Stem (old)	Leaf	Stem (new)	Stem (old)	Leaf	Stem (new)	Stem (old)
1	-18	-12	-18	-18	-12	-18	-11+2	-6	-18
2	-18	-11+3	-18	-18	-15	-18	-12	-8+2	-18
3	-18	-12	-21	-18	-12	-14+3	-11+2	-6	-18
4	-18	-14+4	-18	-18	-12	-18	-12	-6	-18
PI	-15	-12	-18	-15	-12	-15	- 9	-6	-12

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An Economic Analysis of Xeriscaping

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Nature of Work: Xeriscaping is a term coined in Colorado in 1981 to describe a seven-step approach to water conservation in the landscape; 1. Proper planning and design; 2. Practical turf areas; 3. Efficient irrigation; 4. Soil improvements; 5. Mulching; 6. Appropriate plant selection; and 7. Maintenance to reduce water needs. The environmental and aesthetic benefits of Xeriscaping are well-documented in the literature (3,6,7,8). However, there is little information available on the economic benefits of Xeriscaping when renovating an existing landscape to make it more water efficient.

In this study, a residential landscape model was utilized to compare water use and costs of water, sewage (a cost relative to water usage) and maintenance before and after a Xeriscape renovation (Figure 1). Note the changes in water-use zones. In addition, the following assumptions were made: (1) the high water-use zone would receive 1-inch of supplemental water three times per month from April to October, then 1-inch of irrigation once a month from November to March; (2) the medium water-use zone would receive 1-inch of irrigation once a month from April to October and no supplemental water from November to March; (3) the low water-use zone would receive no supplemental water once the plants were established. These assumptions were based on Georgia Cooperative Extension Service recommendations (5).

To compare water and sewage costs, residential water rates and sewage rates for nine cities in Metro Atlanta during 1990 were obtained from the Atlanta Regional Commission (1). Average monthly water costs for these cities were $6.53 for the first 2,000 gallons consumed and $2.41 for each additional 1,000 gallons. Sewage costs, assessed according to water consumption, were $5.04 for the first 2,000 gallons and $1.69 for each additional 1,000 gallons. A computerized cost estimator (2) was utilized to estimate equipment, labor and material costs of landscape maintenance before and after the renovation. Labor cost was charged at a rate of $10/hour.

Average retail prices of plants and materials were used to estimate installation costs. Labor costs were not included because it was assumed that the client would install the landscape himself. These costs were then compared to the combined savings in water costs, sewage costs and maintenance costs to project a return on investment.

Results and Discussion: As a result of the Xeriscape renovation, total irrigated area was reduced by 3,403 square feet (Table 1). This factor, combined with the change in water use within the designated zones, resulted in a projected annual water savings of 27,437 gallons. The Xeriscape renovation resulted in $66.12 savings on annual water cost and $46.36 savings on sewage cost.

Renovation reduced the turf area by 3551 square feet, increased the ornamental area by 1001 square feet, and diverted 2200 square feet of irrigated to non-irrigated mulch (Table 2). Less supplemental irrigation, combined with less frequent fertilization and conservative pruning, resulted in a substantial reduction in maintenance requirements of the Xeriscape and a projected annual savings of $237 in maintenance costs.

Although this landscape renovation required an investment of $1245 (Table 3), the com-bined annual savings ($66.12 (water) + $46.36 (sewage) + $237 (maintenance) = $349.48) helped justify the expense. The model showed a complete return on investment in three years (Table 4). A comparable bank return on $1245 investment at 8% interest would require approximately nine years.

Significance to the Industry: The economic benefits of Xeriscaping can be a powerful marketing tool for landscape professionals. Landscape architects are encouraged to conduct a similar analysis of their designs to convince their clients that Xeriscapes not only save water... they save money.

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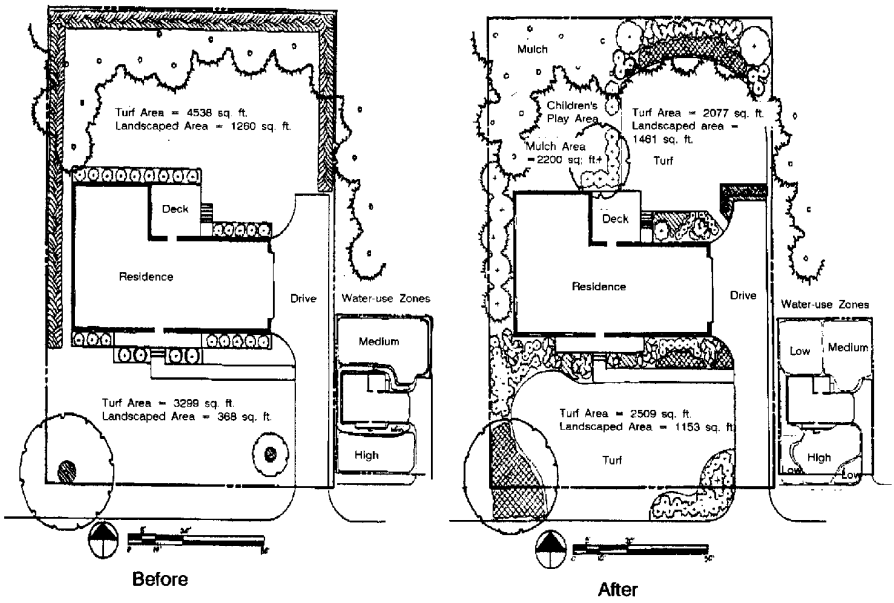

Figure 1. Before and after Xeriscape renovation.

Table 1. Surface Area, Estimated Annual Water Use, Projected Annual Water Cost, and Annual Sewage Costs by Water-use Zone Before and After Xeriscape Renovation.

	Square feet		Annual water use (gallons)			Projected Annual Water Cost			Projected Annual Sewage Cost		
Zone	Before	After	Before	After	Change	Before	After	Change	Before	After	Change
Low	0	3403	0	0							
Mod.	5788	3538	24310	14860	-9450	$60.29	$37.52	-$22.77	$42.74	$26.77	-$15.97
High	3662	2509	57127	39140	-17987	$139.39	$96.04	-$43.35	$98.20	$67.81	-$30.39
Total			81437	51723	-27437	$199.68	$133.56	-$66.12	$140.94	$94.54	-$46.36

Table 2. Areas Serviced and Estimated Annual Maintenance Costs of Xeriscape Renovation.

Areas Serviced	Square feet Before	After	Change
Turf	7837	4586	-3351
Ornamentals	1613	2614	+ 1001
Totals	9450	7200	-2250
Direct Costs	**Estimated Costs**		
Equipment	$52	$23	-$29
Labor	$530	$323	-$207
Materials	$78	$77	-$1
Totals	$660	$423	-$237

Table 3. Estimated Plant and Material Costs for Model Xeriscape Renovation.

Item	Quantity	Unit Cost	Total Cost
1 gal. plt.	47	$4.50	$212
3 gal. plt.	37	$8.00	$297
5 gal. plt.	9	$14.00	$126
Grnd Cover	430	$0.80	$344
Annuals	300	$0.30	$90
Mulch	44	$4.00	$176
		Total:	$1 245

Table 4. Projected Time for Return on Investment on Xeriscape Renovation

	Savings/yr. [1]	Cost
Installation		$1 245.00
Year 1	$384.43	$860.57
Year 2	$422.87	$437.70
Year 3	$465.16	$0.00

[1] Assumption: 10% increase in water rates and maintenance costs per year.

Operation and Management of the Trial Garden System at the University of Tennessee

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Nature of Work: Each year new varieties of flowering plants are developed by breeders and are introduced into the trade by commercial seed companies. The list of available annual flower varieties becomes longer as improvements in flower color, plant form, and plant durability in the landscape are bred into each flower type. The purpose of the annual variety testing program at the University of Tennessee is to compare these newly introduced flower varieties with some of the older, better known varieties that are commonly grown in Tennessee.

Our program at the University of Tennessee is one of thirty All American Selection trial gardens. We are also one of thirty-six worldwide public gardens which displays Fleuroselect Trials. We have perennial trials along with herbs, daylilies, daffodils, irises, ornamental grasses, pansies, and chrysanthemum trials. We have organized a winter garden where we evaluate flowers that can survive the winter.

The test gardens used for these trials are located in three different regions of Tennessee. The east Tennessee region garden is located at the University of Tennessee's Agriculture Campus in Knoxville. The middle Tennessee region garden in located at the University of Tennessee's Highland Rim Experiment Station in Springfield. The west Tennessee region garden is located at the University of Tennessee Experiment Station located in Jackson. All varieties tested were grown in cell packs containing a peat-lite growing media mix. Plants were set out in the first half of May.

Data were recorded for each plant variety at peak flowering. Data presented in the tables include plant name, variety, location (see code), flower color (see code), seed source (see code), average height (HT) (inches), average spread (WD) (inches) (M = Massed if plant crowns had grown together), and observational comments (see code). All plants were set on 12 inch centers and performance rates as (5.0 = excellent, 4.0 = very good, 3.0 = good, 2.0 = fair, 1.0 = poor, and 0 = died).

Perennials were over-wintered in the garden for one winter only and then evaluated at peak flowering times following spring, summer and fall bloom. New varieties are added to the trials each year. As evaluations are completed, they are then added to the comprehensive yearly report. Data presented in the tables include scientific plant names, common name, variety, flower color, blooming period, average height and spread, trialing location, overall evaluation of performance and observational comments.

Each year we try to do a special theme for our gardens. One year we tried to look at all of the different periwinkles or annual vinca and determine the best to use in Tennessee. One year it was a large selection of geraniums. This time we have the year of the cosmos. We have tried to get cosmos seed from all of the seed growers over the world. We hope to have a special leaflet or article on the cosmos for next year.

The purpose of our program here at the University of Tennessee is: (1) to promote interest in plant materials, not just flowers but all types of plant materials; (2) to test new varieties of plants; (3) to test the new All American Selection varieties and be a part of a nation wide group judging the new varieties; (4) to compare new varieties with some of the standard or older varieties that have been out for some period of time.

We not only test flowers for the All American Selection garden but we are also an official Fleuroselect Display Garden where we trial the new varieties from Europe. Fleuroselect is the European equivalent to the All American Selections Award. Thus we have the new varieties from Europe in our trial gardens here at the University of Tennessee. Through this testing program we can evaluate Europe's best to see how they tolerate Tennessee's climatic conditions.

Our evaluations of the trial garden our developed on five different criteria:

1) We look at the growth and growth habit of each of the different plants within the garden. We take physical measurements of height, width, and spread. Also taken are first flowering along with the total flowering period of that plant material and the total time that the plant is in good condition.

2) We look at the flower and foliage integrity throughout the growing season.

3) We look at diseases and insect resistance.

4) Heat and cold tolerance, we leave the gardens in until late fall so that we get at least one frost on the gardens before they are destroyed.

5) Flower and foliage characteristic. We look not only at color but for size of the flowers and foliage. Whether it is a large lanky one or dwarf and compact, and also any differences that may occur within the trial.

From all of this evaluation criteria, we judge these plants from Excellent to Poor so that the homeowner and landscaper can determine which are the better performing varieties within the state or region. They can also look at the individual characteristics of a particular plant. These are included with all of the varieties and their overall evaluation.

Results and Discussion: The trial gardens are very helpful for more than just getting information out about new plant materials. These gardens are used by our teaching program, not only for our students but for Short Courses with different groups that have their meetings here. We have also found that many of our other departments here at the Institute of Agriculture at the University of Tennessee use our trail gardens as part of their programs to give tours through the gardens. We found that the trial gardens are also a big hit at our annual Ag Day in September which is the day that all of the agricultural alumni come for special programs and tours of the trial gardens. They enjoy riding the trolley or the horse and carriages down to the trial garden for a guided tour.

At the entrance to our trial garden we have a path leading to the gardens. Dr. Will Witte of our department has installed a woody plant trial garden along this path which has many different types of trees and shrubs planted and labeled. Thus, a homeowner can view some unusual woody plant material on the way to the trial garden.

Funding and support for the garden can be a real problem. We have found that the attraction that the garden has given to the Agricultural Campus and to our department has been the biggest plus. As far as support and funding for the garden, we have received a letter from the president of the University each year complimenting the Department on the Garden and how he receives letters from the Alumni and other supporters across the state on how beautiful the campus looks and how well the gardens looked when they were on campus. This type of support has been able to help us with funding for the garden through the Agriculture Experiment Station. Our experiment station crew along with our greenhouse crew maintains the gardens and we have had funding to maintain this over the years. Even for the coming year with a drastic cut in funding, we still are planning our trial garden at the normal rate, and it looks like we will have the support for this garden, even though we did not cut back on the size of it at all.

The Annual Bedding Plant Variety Trial Gardens are open to the public from the first of May to the end of October, during daylight hours. Free brochures are available at the gardens for self-guided tours. Between three and four hundred varieties of annuals are trialed annually in the East and West Tennessee trial gardens and two hundred at the Springfield garden with evaluations printed in the research report. Additional information about the garden is available through the Department of Ornamental Horticulture and Landscape Design, University of Tennessee, Knoxville; the Highland Rim Experiment Station, Springfield; or the West Tennessee Experiment Station, Jackson.

Significance To Industry: An advantage that our trial gardens have is that we are in the transition zone. The transition zone means that we can grow some of the plant materials that require cooler temperatures along with some that prefer warmer climates. Therefore the results of our trials should be accurate and acceptable for all of the neighboring states to the North and South of Tennessee. By

looking at the different sections of the state where we have three distinct climatic zones, more accurate determination of plant performance in neighboring states can be made.

After all of this information is gathered the data is published in a Research Report for each of the different gardens, such as: Herbaceous perennials, Annual bedding plants, Pansy, Chrysanthemum, etc. In these publications we list the ranking along with some of the distinguishing characteristics of each plant.

The Woody Ornamentals Research/Teaching Garden at the University of Tennessee

Willard T. Witte
Tennessee

Nature of Work: In the loosely connected landscape industry (propagation, production, design, installation, and maintenance), most research is on production techniques due to the interest and support of a well organized nursery industry seeking assistance in solving problems. Little research information is available on long term landscape plant adaptation in Tennessee. Research programs have not been organized to accumulate objective data on long term growth and performance of living collections. The large number of species and cultivars available in the trade tends to limit information on each to anecdotal observation and opinion.

New plants are introduced every year. During the last three decades, botanical authorities have registered over 300 new cultivars in about a hundred genera of ornamental plants. Although some well-organized landscape plant performance evaluations are conducted at various arboreta, gardens, and institutions throughout the U.S., the majority of this research has limited application to Tennessee soils and climates, unless performed in USDA plant hardiness zones 6a, 6b, and 7a. None of the gardens and arboreta in Tennessee conduct organized woody plant evaluation programs. Therefore a research project was undertaken at the University of Tennessee to implement a controlled system to collect, maintain, evaluate, document, propagate and distribute superior woody ornamental plant cultivars and selections with potential to become commercial Tennessee nursery crops and landscape plants. The major part of the research plan involves replicated trials of cultivars in selected commercially important genera. The part of the research reported in this paper involves the collection of new or uncommon plants for observation in an evaluation garden that is easily accessible to faculty, students, nurserymen, and the public.

The woody ornamentals research/teaching (WOR/T) garden was begun spring 1990 in support of research and teaching programs in the Dept. of Ornamental Horticulture and Landscape Design at the University of Tennessee. The WOR/T garden is located on the edge of the Agricultural Campus on a one acre strip adjacent to the annual and perennial trial beds. This site is convenient to parking and accessible from Neyland Drive, a main thoroughfare bounding the river side of campus. A simple entrance structure, brick path, rock retaining walls, footbridge, and sitting plaza were class projects (spring 1990) in landscape construction taught hy Dr. Don Williams. Design of the path and bed layout was by Garry Menendez and graduate student Al Hill. Bed preparation on the upper half of the site, planting and labelling was begun in spring 1990 under the direction of Dr. Witte and research associate Hermon Dickerson. The irrigation system installed on the left hand side of the walkway was a class project (fall 1990) involving irrigation design taught by Garry Menendez. The garden will be used for future class projects in landscape construction, irrigation design and of course plant identification. Maintenance assistance is provided by the Agricultural Experiment Station plot crew. Initial plantings consisted of about 250 cultivars that had been collected from such sources as Bernheim Forest arboretum, NCSU arboretum, Holly Society of America, UT Arboretum Society, and various individuals, nurseries and institutions. Another 250 cultivars, mainly from nurseries, were planted in spring 1991. Current collections are strongest in Ilex, Viburnum, Rhododendron, Kalmia, Pieris, and assorted small flowering trees. Collection and planting will continue at this pace for two or three more years.

Each plant, or in some cases a group of the same plants, is identified by a numbered plastic tag welded to a plexiglass stake. ID tags are weather resistant plastic laminate in a cocoa brown color with white engraved numbers, and are supposed to last for ten years. A mailbox at the entrance to the garden contains about 50 copies of a numerical list that gives the ID number, the scientific name of the plant, a source code, and estimated height and spread in feet. An alphabetical list by genus, species, and cultivar is included to aid searches for specific plant(s). Both lists are updated every six months or after completion of each major planting.

A detailed maintenance plan for the WOR/T garden has been drafted and is currently under review by faculty in the OHLD Dept. and the Agricultural Experiment Station superintendent. It is very important to efficiently utilize available resources, labor and equipment in an undertaking of this sort. Beds are mulched with hardwood bark and plants are fertilized the first few years to obtain good growth and color. Weeds are largely controlled with pre-emergence and contact herbicides but in some cases hand weeding is more efficient. Thus far we have been successful in maintaining a presentable appearance nearly all the time.

Results and Discussion: It is anticipated that periodic research reports on the growth and performance of selected groups of plants in the WOR/T garden will be published. Thus far, very few plants have failed to become established. The winter of 1990/91 was mild, and the only plants suffering winter injury were

Quercus suber, Itea ilicifolia, Arctostaphylos uva-ursi 'Woods Red', and a supposedly hardy selection of Sabal minor. A bad test winter will result in injury to many more plants.

We have not done any surveys or counts on visitor numbers, but from casual observation and the number of ID lists needed, over one hundred visitors per week are using the garden. Few nurserymen have utilized the garden thus far to obtain propagation material, but they can easily gain permission to collect cuttings, scions, or budwood with a phone call (615/974-7324) to Dr. Witte. We do ask that seed or plant parts not be removed without permission. In this respect we are supporting the policy followed by Dr. J. C. Raulston at the North Carolina State University arboretum. We hope this will encourage the adoption of some new plant materials by the nursery and landscape industry.

Donations from individuals or organizations to support the garden are gratefully accepted and a fund has been set up to receive contributions. Some unsolicited donations have already been received, and some local nurseries have been very generous with donations of plant materials.

Significance to Industry: With increasing interest and awareness of the functional and esthetic values of landscape plants in public, business, and private sectors it should be beneficial to have better knowledge of landscape plant adaptability and performance. Nurserymen would benefit through improved plant performance and productivity and by access to proven plants to upgrade their product line, thus improving market competitiveness. Consumers would ultimately benefit through improved plant performance, increased landscape value, fewer losses, reduced maintenance cost, and better landscape appearance.

With the establishment and continued plantings at the WOR/T garden at UT, nurserymen and landscape designers from Tennessee and adjoining areas have a readily accessible and reliable woody ornamental plant collection available for observation of new and uncommon cultivars. Commercial nurserymen can easily obtain permission to collect propagation material of any plants they wish to try out for commercial production. Students and faculty will use the garden as part of the ornamental horticulture and landscape design teaching program. Researchers will collect data on growth and performance of plants under Tennessee conditions. Extension will use this data in making recommendations. Though not meant to be a "show" garden per se, the site and bed layout is attractive. The garden is open during daylight hours for the public to enjoy and learn about woody ornamental plant materials. The ID labels and plant list enable any nurseryman or visitor to identify any plant that catches their interest. Gardens of this sort can have a multitude of beneficial influences on the nursery and landscape industry and on the public perception of landscape plants, both locally and regionally.

Allelopathic Potential of Landscape Mulches to Control Weeds

D.B.Williams, K.K.Stein, and J.B.Walsh
Tennessee

Nature of Work: Allelopathy is well defined and extensively reported by Rice in 1984 (2) and Putnam in 1985 (1) but scarcely any research has been done in horticultural situations. No research had been found regarding mulches and weed control in the landscape until two Master of Science graduate students at The University of Tennessee examined the subject. Their work resulted in two reports in the Proceedings of SNA's Research Conference (4,6) and an MS thesis for each student (3,5). This report is a synopsis of their work and comments on the relevancy of allelopathy as a method of weed control in the landscape.

Experiments conducted from 1986 to 1991 included mulches of decomposable materials like bark, wood chips, straws, and foliage of various plants. Most tests included the effect of the mulch and/or leachate derived from the mulch on the germination of seed of plants normally considered weeds. Some tests included the effect of the mulch and/or leachate on the growth of ornamental plants. Studies included determining how water moves through mulch layers. The tests with the greatest control over variables involved soaking mulches in distilled water and testing this leachate on seed germination .

Results and Discussion: Whenever a decomposable mulch lies upon the surface of the soil, it is difficult to determine if any weed control obtained is due to the physical presence of the mulch, chemicals derived from the mulch, or a combination of both. In tests by Walsh (5) it was determined that water does not move uniformly downward through the mulch and therefore may pick up varying amounts of chemicals depending on how much of the mulch is contacted by water. In some tests most of the mulch was not wet at all and in other cases water percolated through the mulch but in a very erratic pattern (Figure 1). This means that if the water picks up chemicals capable of controlling weeds, it is not applied uniformly to the soil below. This could account for the erratic results of field studies of Stein (3). It was for this reason that most studies that followed used leachates derived from soaking mulches in distilled water and then applying the leachate to various seed during germination tests. The tests did not always reveal reproducible results meaning a mulch might have controlled germination in one test but not another. As expected, some mulches controlled the germination of certain kinds of seed but not others. Never-the-less some significant statements can now be drawn from the work of Stein (3) and Walsh (5).

1. Stein found that leachates of mulches derived from foliage of trees was more likely to prevent germination of morningglory, large crabgrass, and pigweed than leachates derived from mulches of bark or sawdust.

2. Stein found that among the most reactive of the foliage mulches, leachates derived from eastern hemlock, eastern red cedar, red maple, and sassafras controlled up to 100% of the pigweed and crabgrass and up to 95% of the

morningglory. Leachates from fresh white pine needles controlled germination of these weeds better than leachates from old (brown) white pine needles.

3. Stein found leachates of eastern red cedar wood chips controlled 80% or more of morningglory, crabgrass, and pigweed and this was more control than was obtained from sawdust or bark of red oak or white oak or shavings of black walnut, although black walnut gave 75% control of pigweed.

4. Walsh found that leachate from eastern red cedar gave moderate control of weed germination. In tests using pigweed and tall fescue, leachates from red chips gave better control than leachates from the white (sapwood) chips. However, for clasping coneflower germination, leachates from both colors of cedar chips gave the same results.

5. Walsh tested leachates derived by percolating water through mulches and found leachates from fresh sawdust of red maple and redwood, and fresh shavings of black walnut gave significant control of annual ryegrass.

6. In tests using leachates derived from soaking mulches in distilled water, Walsh found that fresh shavings of tulip poplar and black walnut, chips of eastern red cedar, and fresh sawdust of red maple and redwood gave significant control of sowthistle. The tulip poplar and black walnut prevented essentially all germination. Leachates from the same mulches except cedar also gave significant control of wild carrot with black walnut preventing germination entirely. Leachate from cocoa bean hulls also gave nearly complete control.

7. Walsh found leachates from white oak bark, black walnut shavings and red maple sawdust killed all duckweeds in a bioassay but leachates from oats and eastern red cedar stimulated growth of duckweed.

8. Walsh found leachates from four monocot mulches (rye, oat, barley, and wheat) stimulated germination of monocot seed when annual ryegrass and tall fescue were tested.

9. In tests using leachates from white oak sawdust and wheat straw, Walsh obtained significant control of dandelion seed germination but both mulches stimulated the germination of mung beans.

10. Both Stein and Walsh were aware that soluble salts and pH of leachates might influence germination but Walsh did not find a significant correlation between germination percentages and the soluble salts or pH of the leachates. Stein did not test for this correlation. There is reason to believe that allelo-chemicals were responsible for most results in the various tests where germination was inhibited.

Significance to Industry: Altogether in these studies more questions have been raised than have been answered but it has been shown that landscape mulches do have allelopathic potential for control of some weeds in the landscape. Of course this phenomenon has been present for as long as decomposable mulches have been used but it is exciting to find the specific relationships between certain mulches and control of certain weeds.

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				32	79
127					127
					62
				348	
			103	348	
			32		32

Shredded Oak Bark

71	221				
95	47				
	364	174		190	47
364	229	166		95	150
	16		47	221	
32	119	127		40	62

Rye Straw

Figure 1. Milliliters of water from continuous misting percolating through approximately 2.5 inches of mulch and caught in 2 1/4 inch square containers showing the uneven distribution of leachate. Containers without numbers did not catch measurable amounts of leachates. Total leachate between oak bark and rye straw should not be compared since tests were not run at same time.

Pools and Aquatic Plants in the Garden

M.A. Powell
North Carolina

Nature of Work: One of the most popular additions to recent landscapes is the water garden. Home gardeners, landscape designers, contractors, and horticulturists have become interested and involved for numerous reasons. A water feature can be as simple as a lily-filled tub or a more complex design featuring water cascading over rocks, surrounded by numerous moisture loving plants and exotic fish.

Results and Discussion: Aesthetically, water offers an immediate focal point. Ones' attention is automatically drawn to the views, reflections, and sounds of a water garden. These areas lend themselves very well to low-voltage lighting along with an opportunity to use plants which actually require high-moisture levels. The season of interest can be extended to 8-9 months in most of the South.

The most important consideration for a successful water garden is the location. The pool should receive as much direct sunlight as possible. Nearby trees or overhanging limbs will cause obvious maintenance problems, as fallen leaves and decaying organic material will be undesirable and unsightly. The pool should have water and electrical sources readily available.

The size and shape of the pool is also very important. The pool sides should not be sloped, thus offering less surface area for algae growth. The depth is typically 24-30 inches deep, with a shelf along the outside edge at 18 inches, for potted aquatic plants. The bottom of the pool should be slightly sloped to one end, to allow for easier cleaning. Contrary to popular belief, a small pool is more difficult to maintain than a larger one.

There are numerous approaches to designing and building a garden pool. One of the best things to happen in recent years has been the introduction of pool liners and sealers. Traditionally, pools were constructed from masonry materials. Now one can have an almost instant pool without forming and pouring concrete. Vinyl or rubberized liners along with pre-molded plastic liners are readily available. Listed below are the basic components, along with a general price.

Synthetic Rubber Liner	$.68 - $.75/sq. ft.
Polyethylene Liner	$.37- $.44/sq. ft.
Underlayment Liner	$.20 sq. ft.
Pump (submersible)	
30 gallon/hr. 3/8" outlet	$ 30.00
2400 GPH 1 1/4" outlet	$232.00

Biological Water Treatment filter	$100 $500
Low Profile Foam Filter	$ 10 - $ 50

Aquatic nurseries typically classify their plants into the following categories:

1. Hardy water lilies	5. Floating plants
2. Lily-like aquatics	6. Oxygenators
3. Lotus	7. Moisture loving perennials
4. Hardy shallow water plants	8. Moisture loving grasses

Significance to Industry: There are numerous moisture loving plants that can be grown in or around a pool feature. Many are adapted to withstand wet soils while others are actually submersed in the pool water. Just as any other plant decision, one should find out how aggressive or invasive the particular plant is, and plant accordingly.

Illicium Evaluations in the NCSU Arboretum

P. R. Fantz, J. C. Raulston, and Robert McCartney
North Carolina/South Carolina

Nature of Work: About 40 species of Illicium (anise tree) in the Illiciaceae (or Magnoliaceae) family exist as broadleaf evergreen shrubs or trees native to temperate and subtropical regions of southeast Asia and the southeastern United States and West Indies (2,4, 8, 9). The strong aromatic fragrance of the leaves "allures" and "entices" one, attributes that became translated into the Latinized name Illicium (1, 2, 3, 7, 8, 9). The aromatic fragrance is often cited as a "strong anise" odor (1, 2, 9), but not all species have an anise aroma (3). The genus is underutilized as one of superior ornamental landscape plants (1) noted for their aromatic, glossy, evergreen floiage, showy flowers, hardiness, and lack of serious pest problems (1, 2, 3, 6, 9). The species are reported to prefer moist, well-drained soils with high organic matter (2, 6), but all are growing well in heavy clay soils at The NCSU Arboretum. The species are reported as shade tolerant (2, 6) and a common industry perception exists that only I. parviflorum is sun tolerant. However, once established, all will grow well in full sun with more compact growth and more profuse flowering than in shade. All are easily propagated from cuttings under mist at most any time of year when mature wood is available. Native species are reported easy from seed with no special treatment required (2) . No serious biological problems commonly

exist. Illicium taxa are under evaluation in The NCSU Arboretum for cultural and ornamental characteristics in USDA zone 7.

Results and Discussion: The following list summarizes taxa in U. S. cultivation and their ornamental attributes. Invalid synonyms are presented in parentheses. Plants in The NCSU Arboretum collection are followed by an asterisk (*). The accompanying table provides a quick overview of some identification characteristics.

Illicium anisatum (I. japonicum, I. religiosum) * - Anise Tree. A 6-25' shrub/tree native to China, Japan, Korea, Ryukyus and Taiwan with medium-textured, broadleaf leaves with an anise aroma when crushed. The mid-spring flowers are showy, whitish with a creamy-yellow hue as they mature, 1-2 inches in diameter, with 17-24 petaloid segments. Many plants currently sold in commercial trade in the southeast U. S. under this name are actually I. parviflorum with which it is often confused. (1,3, 7). Possibly the least hardy of the five species discussed here with probable adaptability to USDA zones 7-9 with periodic injury in severe atypical winters of zone 7.

Illicium anisatum 'Pink Stars' * - A seedling variant selected at The NCSU Arboretum for increased anthocyanin pigment in the plant. New shoot growth is crimson and fades to green. Flowers are pink in the bud stage, and gradually fade to white as the flower opens. This clone is being evaluated as a potential NCSU Arboretum cultivar release.

Illicium anisatum 'Variegata' * - Two similar Japanese clones bear this name and both have irregular white stripes through the leaves. Small cuttings of these clones recently received from Japan do not yet show distinctive features to enable one to separate them.

Illicium floridanum * - Florida Anise Tree: A 6-15' shrub/tree native to the Florida panhandle, southwest Georgia, and westward through Alabama, Mississippi and into Louisana (5) ranging from 6-15' high. Leaves are pointed and lanceolate, heavy textured, often drooping, and bear a strong rank odor with a weak anise odor in the background. The late spring flowers are showy, maroon/purple, 1-2 inches wide, with 21-33 petaloid segments and the aroma of decaying fish. This species often reblooms in autumn following drought stress. Has withstood -10F in N. C. without injury and is probably adapted to USDA zone 6-9.

Illicium floridanum 'Alba' * - A chance seedling selected by Chris Early in the wild in Mississippi in 1982. Attractive clone with white flowers in contrast with the dark green foliage. Dirr (2) quotes a report that white and pink flowered forms are found intermixed with the red flowered type in the wild.

Illicium floridanum 'Compactum' * - A clone listed by one southern nursery but observation at The NCSU Arboretum shows no dramatic diffences from the normal species in growth rate or size. The foliage does seem somewhat shorter and wider. Needs further observation.

Illicium floridanum 'Halley's Comet' * - A chance seedling selected by John Allen Smith of Magnolia Nursery, Chunchula, AL in the wild near De Funiak Springs, FL, and formally named by the nursery in 1986 when Halley's Comet appeared. It is reported to have larger flowers, more flowers per inflorescence, and heavier summer and fall rebloom than typical for the species.

Illicium floridanum (Unnamed Pink Selection) * - A chance seedling selected by Chuck Salter of Salter Tree Farm, Madison, FL in the wild in northwest Florida in 1987. First otfered for sale by Woodlander's Nursery, Aiken, SC in 1991.

Illicium floridanum (Unnamed Variegated Selection) - A chance selection made by Steve Riefler of Green Images Nursery, Christmas, FL in the wild in northwest Florida about 1984. In build-up stage at several nurseries, but not yet offered for sale. The variegation is reportedly a yellow random striping/banding on a green background.

Illicium henryi * - Henry's Anise Tree: A 6-20' shrub/tree from western China with glossy green leaves. The late spring flowers are showy with color ranging from pink to deep crimson in the wild, but only the pink form is in U. S. commerce at present, with 1/2 to 1 inch flowers with 10-14 segments. Very rare in cultivation in the U. S. and those in the southeast U. S. probably all originated from a plant brought to the U. S. in 1972 from Hillier's Nursery in England. Hardiness unknown - probably adapted to USDA zones 7-9. A beautiful, dense conical plant.

Illicium mexicanum * - Mexico Anise Tree: A rare shrub native to Mexico. Those presently in southeast U. S. trade probably all originated from a single plant brought to this country by Harold Hopkins of Washington, DC and given to the U. S. National Arboretum. Woodlander's Nursery obtained cuttings from this plant and were the first to offer it for commercial sale. It is very similar in appearance to I. floridanum, and probably evolved as an ecotype variant of that species as did many other woody plants of southeastern America (e.g. Cercis mexicana as a variant of Cercis canadensis) - in fact, a published distribution map of I. floridanum (5) shows an isolated Mexico population. It is noted to flower almost continuously through the summer and into the fall in contrast to the more focused spring bloom period of I. floridanum. The NCSU Arboretum recently obtained wild-collected Mexican seed of this species from Yucca Do and Peckerwood Gardens Nursery in Waller, TX and now has 45 seedlings for future observation on variability and performance. An outstanding ornamental plant. Probable adaptability to USDA zones 7-9.

Illicium parviflorum* - Small-Flowered Anise: A north-central to central Florida (5) native shrub/tree 10-20' high with ascending obtuse foliage with a strong anise aroma. The early summer (June-July) flowers are small, inconspicuous, greenish-yellow, with 1/2 inch flowers of 12-15 segments and appear long after all other species flower. It is currently in rapid increase in popularity in the nursery trade as a replacement for "red-tip" photinia, Photinia X fraseri for use in hedges and screening. It is often mistakenly sold as I. anisatum and has been published as being native to Japan (6). Probable adaptability to USDA zones 6-9.

Significance to Industry: Use of I. floridanum and I. parviflorum is rapidly increasing in the southeast U. S. nursery trade with the discovery of greater hardiness than expected following the record winter of 1985 when many other broadleaved evergreen shrubs were severely injured or killed in the south. Both species are excellent ornamentals deserving of greater use, and new cultivars and other existing species also offer much potential for trial and production. There is great need for nurseries to correctly identify and name the plants they are offering to eliminate the widespread existing I. anisatum vs. I. parviflorum confusion which exists.

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Table 1. Comparisons of Illicium species cultivated in the southeastern United States.

Species	Foliage	Flowers	Fruits
	Leaf Apex Shape Number Lateral Veins Odor	Season (Raleigh, NC) Color Petal Number Petal Length	Diameter SegmentNumber Segment Length
I. anisatum	Obtuse/Short-Acuminate 4-6 Pairs Anise Odor	Spring (April) White toYellowish 17-24 Petals 11-23 mm. Long	24-30 mm. 8 Segments 12-15 mm.
I. floridanum	Acuminate 6-10 Pairs Rank, Weak Anise Odor	Spring (April) Maroon (White, Pink*) 21-33 Petals 15-27 mm. Long	26-36 mm. 10-15 Segments 13-18 mm.
I. henryi	Acuminate 5-8 Pairs Weak Anise Odor	Spring (April) Pink(Crimson*) 10-14 Petals 6-10 mm. Long	24-40 mm. (6-7) 8 Segments 12-20 mm.
I. mexicanum	Acuminate 6-9 Pairs Weak Anise Odor	Spring (April) to Fall Maroon 24-33 Petals 15-20 mm. Long	Unknown 19-21 Segments Unknown
I. parviflorum	Obtuse 4-7 Pairs Strong Anise Odor	Summer(June/July) Dull Yellowish 12-15 Petals	20-30 mm. 10-13 Segments 10-15 mm.

* Other color form(s) existing within species or as selected cultivars.

Styrax Evaluations in the NCSU Arboretum

J. C. Raulston
North Carolina

Nature of Work: There are ca. 130 species and cultivars of Styrax in the Styracaceae Family in tropical and temperate Asia, southeastern Europe, and North America with many superb white-flowered shrubs and trees useful for their ornamental characteristics. Unfortunately, they are rarely cultivated in the nursery and landscape industry of the southeastern U. S. although many are well adapted and the genus includes several excellent native species.

Results and Discussion: The following compilation lists Styrax taxa discussed in available literature, with those plants which have been grown in The NCSU Arboretum underlined. Those plants adapted for production and utilization in the southeast are followed by an asterisk (*). Invalid synonyms are presented in parentheses. Brief origin and use comments are given for each. The literature is quite confused on many species names with both "a" and "us" endings used (e.g. americana and americanus; japonica and japonicus; etc.) by different authors going back to various taxonomic treatments of the genera name as being either feminine, masculine or neuter (1) which then alters name endings.

Styrax americanus (S. laevigata) * - Southeast U. S. native from Virginia to Missouri, Florida to Louisana; Europe introduction 1765. Shrub 3-9', can be trained tree-form, hardy to zone 5. Good plant shape and profuse showy flowers when brought from woodland native habitat to landscape setting with better light.

Styrax americanus var. pulverulentus (S. pulverulentus) * - Botanical variety of above, more densely hairy and less hardy to zone 6. Good plant shape and showy flowers in garden use.

Styrax benzoin - Indonesia, used to produce medicinal balsamic resins, zone 9-10?

Styrax calvescens - China, characteristics unknown, plant from Chinese seed still in nursery. Styrax confusa - China, characteristics unknown.

Styrax dasyanthus - China (Hupeh Prov.), 10-25' shrub/tree, introduced by Ernest Wilson in 1900, Krussman lists as zone 9 but likely hardier, plant from Chinese seed still in nursery. Styrax dasyanthus var. cinerascens - China, botanical variety of above with undersides of leaves more densely downy.

Styrax grandifolius * - Southeast U. S. native from Virginia to Florida, shrub/small tree 6-12' (to 25'), hardy in zone 6, much showier in landscape setting than in native habitat.

Styrax hemsleyana - Central and west China, showy tree to 30' (46' in England), introduced by Ernest Wilson in 1900, zone 6, large foliage and flowers much like S. obassia, sensitive to root rot in southeast heat/heavy soils - solve by possible grafting on S. japonica?

Styrax huanus - China (Szechwan Prov.), 20-45' tree not yet in cultivation, described as very floriferous and notable for beauty, possible zone 6, should be a very high priority taxa to attempt to acquire for adaptation trial and industry use.

Styrax japonica (S. serrulata) * - China, Korea, Japan, Philippines, Ryukyus, and Taiwan, introduced by Richard Oldham in 1862, quite variable species in both morphology and ecotypic physiology through provenance of widely varying native habitats, zone 5-8 depending on provenance, many selections by Japanese horticulturists (Dirr reports double-flowered and variegated forms exist in addition to the cultivars listed below), the only species currently grown commercially to any extent in the southeast and deserving greater use of superior cultivars as a superb ornamental small tree with great stress tolerance and few pests.

Styrax japonica 'Angyo Dwarf' - Selection reported to remain compact with age, grew rapidly in early years of trial at The NCSU Arboretum creating doubt about the name - but size has remained essentially stable since the plant reached 8' in height, collected by Barry Yinger in Japan in 1978 and formally introduced by Brookside Gardens, Wheaton, MD.

Styrax japonica 'Carillon' (S. japonica 'Shidare', S. japonica 'Pendula') * - A graceful weeping growth habit selection collected by Barry Yinger in Japan. Named and formally introduced by Brookside Gardens, Wheaton, MD. Can be cutting grown and trained up stake to get height, but probably more cost effective when budded or grafted as a standard on seedling understock for faster production, about a 1:3 height:width ratio to potential10' height? The plant should only be propagated asexually if sold under the cultivar name, but self-pollinated seed will produce progeny with some seedlings having varying degrees of weeping habit.

Styrax japonica 'Crystal' * - A NCSU Arboretum selection from Korean provenance seed collected in 1985 by the U. S. National Arboretum collection expedition, has very dark black/green foliage and purple pedicels which highlight the crisp, small, pure white flowers, striking appearance noted favorably by many arboretum visitors since reaching blooming age, somewhat upright fastigate growth, flower petal number is variable from 2 to 9 petals, for potential release and distribution in 1992.

Styrax japonica 'Issai' * - A fast growing and free flowering selection with somewhat larger than normal foliage with good green color, collected by Barry Yinger in Japan in 1982 and distributed by Brookside Gardens, Wheaton, MD.

Styrax japonica 'Kusan' - A selection discovered by Dr. Robert Ticknor in Oregon. Listed by Roslyn Nursery, Dix Hills, NY as a slower-growing, compact globe form reaching 10', zone 5.

Styrax japonica 'Pink Chimes' (S. japonica 'Benibana', S. japonica 'Rosea') * - The only pink flowered taxa in the entire genera, deeper and bener pink than one would expect and showing good flower color in the heat of the south, good fragrance, outstanding ornamental plant collected by Barry Yinger in Japan in 1977 and formally introduced by Brookside Gardens, Wheaton, MD.

Styrax japonica 'Sohuksan' * - Korea (Sohuksan Island off southwest coast), discovered as a single tree variant in the wild by the author during the 1985 U. S. National Arboretum collection expedition and clonally preserved by a single successful graft. Foliage is thick and leathery, dark green and 2-4 times the size of normal species leaves, flowers are 2-3 times the size of normal species and unusual in that petal number varies from 2 to 8 on various flowers in a single inflorescence (versus normal 5 for the species) - both of which indicate the possibility of it being a naturally occurring polyploid seedling. Has a pungent spicy-lemon fragrance. Predicted to be zone 6-7 hardiness and to attain 20' in height. Outstanding ornamental value for commercial production. Limited budwood now available from The NCSU Arboretum.

Styrax japonica var. fargesii (S. fargesii) - China (Northwest Szechwan Prov.), introduced by Pere Farges in 1898, more tree-like with larger leaves, zone 6.

Styrax japonica var. jippei-kawamurae - Honshu Island, Japan, larger plants with larger flowers and foliage. (Listed in Flora of Japan)

Styrax langkongensis - China (Yunnan Prov.) and Burma, introduced by George Forrest in 1 91 7,1 -4' shrub, zone 8-9?, doubtful for southeastern U.S. heat and moisture.

Styrax megalocarpus - Asian, no further information.

Styrax obassia - China, Japan, and Korea, introduced by Charles Maries in 1879, tree to 30' (52' in England), zone 6, fragrant flowers, the second most commonly grown species in the U. S. with considerable use in the mid-Atlantic region of Maryland-New York, although it grows well in container production in N. C. many trials at The NCSU Arboretum have failed with plants susceptible to root rots in summer on heavy soils - potential to graft on S. iaponica for better tolerance?

Styrax odoratissima - Asian, no further information available.

Styrax officinalis - Southeast Europe and Asia Minor, cultivated since antiquity and contributed name of genera from the term "Storax" - a fragrant resin product of many uses obtained from the plant, 15-20' tree, zone 7, likely problems of root rot in southeast - graft on S. japonica?

Styrax officinalis var. californicus (S. californicus) - Northern California, a remarkable botanical geographic distribution mystery with this California species so identical to the only European species that some botanists say they cannot be distinguished, 6-12' shrub, likely problems of root rot in southeast.

Styrax officinalis var. fulvescens - Southern California form of the above.

Styrax officinalis var. officinalis - Southeast Europe, botanical variety differing from species by presence of densely stellate-pubescent hairs on under surface of foliage.

Styrax philadelphoides (S. serrulata) - Himalayas, shrub/small tree to 10', likely zone 8-9 and probably not heat tolerant or summer moisture tolerant in southeast U. S..

Styrax platanifolia - Central and west Texas, shrub/small tree to 12', zone 7?, likely problems with summer root rot in southeast - graft on S. jaeonica?

Styrax platanifolia var. stellata - Texas, botanical variety of above with densely tomentose under surface of foliage, as above also likely not tolerant to hot, humid southeast U. S. soils.

Styrax ramirezii - Mexico, no further information available.

Styrax shiraiana - Japan and Korea, introduced 1915, 15' tree, very distinct species with broad ends and deep toothing of foliage resembling Hamamelis japonica, should be well adapted to southeast U. S., seedling plants still in nursery.

Styrax shiraiana var. discolor - In Flora of Korea, unknown how it differs from species.

Styrax shweliensis - China (Yunnan Prov.) and Burma, introduced by George Forrest in 1919, 14-24' tree, zone 9.

Styrax texana - Central Texas (Edwards Plateau), rare shrub/small tree to 15', zone 6-7?, likely problems with summer root rot in southeast - graft on S. japonica?

Styrax tonkinensis - Thailand, used to produce medicinal balsamic resins, zone 9-10?

Styrax veitchiorum - Central China (Hupeh Prov.), introduced by Ernest Wilson in 1900, 15-30' tree, zone 6, large foliaged tree allied to S. obassia and hemsleyana but less common.

Styrax wilsonii - West China, introduced by Ernest Wilson in 1908, normally small shrub under 4' but reaching 6-9', zone 8-9?, small foliage and flowers, blooms profusely when young.

Styrax youngae - Texas, extremely rare endemic from Davis Mts. and recently rediscovered also in Mexico, shrub/small tree 6-10', zone 7?, likely root rot in southeast - graft on S. japonica? In commercial production, Styrax species are propagated by seed with most American species requiring 3 months cold stratification. Asian species are reported to have double dormancy in seeds and require 3 to 5 months warm stratification followed by 3 months cold. Summer softwood cuttings root quickly and easily under mist and are the best way to produce named cultivars.

Significance to Industry: Twenty-one taxa of Styrax have been grown at The NCSU Arboretum and the living collection currently contains 15 taxa. From these trials the following 4 taxa are at present the most highly recommended for commercial production and landscape use in USDA zones 7-9 of the southeastern U. S.: S. grandifolius, S. japonica 'Carillon', 'Pink Chimes', and 'Sohuksan'.

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Effects of the 1989 Advective Freeze on Landscape Palms in the New Orleans Area

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Louisiana

Nature of Work: Palms are basically tropical plants by nature, but a few are native and others are hardy enough to withstand normal winters in the Gulf South region of the United States. However, in severe winters cold damage and death may be experienced. Such an episode occurred in December of 1989.

According to the National Weather Service (1) the advective freeze of 1989 was by far the most significant of this century in New Orleans. Eighty one of 82 hours, beginning on December 22, and ending on December 25, 1989, were below 32°F. Temperatures were at or below freezing for a consecutive 64 hours from December 22 through December 24. Perhaps more significant was the fact that of the three coldest outbreaks ever recorded in New Orleans, this was the worst, with 15 hours of 15°F or less occurring, and a record low of 11°F on December 23. 1989.

Not only was the cold a factor but also high winds contributed markedly to palm damage. The cold drying winds desiccated plant tissues and produced obviously more damage to exposed plants than to ones protected from the wind.

It was decided by the authors that a systematic and accurate survey be conducted to determine the extent of damage palms received in and around New Orleans. There are accounts of various species of palms surveyed after cold episodes in Georgia (4), Dallas, TX (2), Daytona Beach, FL (6) and more recently at Fairchild Tropical Gardens in Miami, FL (3). Other accounts of various palms surviving cold temperatures can be reviewed in John Popenoe's 'The Hardiest Palms' (5). However, none of these references counted the total number of palms reported in this study.

The survey began on August 16 and ended on October 30, 1990. Metro-politan New Orleans was divided into 15 geographic regions. Randomly selected streets both with a known high concentration of existing palms present and an unknown population were surveyed. A total of 57.25 hours was spent traveling approximately 1125 miles.

Twenty two species of palms comprising 14 genera were found on both private and public property and were assigned to one of seven condition categories. The first category included palms that showed no visible freezed related injury. Category 2 palms lost their foliage but replaced them with vigorous new growth. Category 3 palms lost foliage but replaced them slowly with new possibly half sized leaves and category 4 lost foliage but barely resprouted new growth. In category 5 palms lost all of their foliage, resprouted but new growth died again. Category 6 palms lost their foliage but did not resprout. In the last category palms lost their foliage, did not resprout and their trunks were either broken or had fallen over which indicated death.

Results and Discussion: The hardiest palms appeared to be Rhapidophyllum hystrix and Sabal minor with 71% and 60%, respectively, falling into category 1 (Table 1)**.** Only one R. hystrix was badly damaged while no S. minor was found in any condition below category 3.

Other palms which fared well included Sabal mexicana, Phoenix canarie- nsis, Trachycarpus fortunei and Sabal palmetto. Sabal 5pp. in Table 1 also survived well but the authors are having difficulty with positive identification. So until it is accurately identified, no recommendations can be given.

A few other species may do well but insufficient population numbers were present to make a favorable recommendation at this time. They include Arenaa engleri, Brahea armata, Chamaedorea microspadix, and Phoenix reclinata, Phoenix dactylifera showed favorable cold hardiness in Table 1.

However, past experience and very low population numbers prevent a favor-able recommendation. Serenoa repens is native to Louisiana but is on the critically endangered species list for the state. It is suspected that this species also would be a good candidate for recommendation.

Palms not recommended for reliable open landscape planting along the northern Gulf Coast include Syagrus romanzoffiana, Washingtonia robusta, Washingtonia filifera, Rhapis excelsa, Livistona chinensis, Butia capitata and Chamaerops humilis.

Significance to Industry: Nurserymen and landscape contractors can feel relatively safe in producing or installing such palms as Rhapidophyllum hystrix, Sabal minor, S. mexicana, S. palmetto, Phoenix canariensis and Trachycarpus fortunei along the northern Gulf Coast region. However, only two species, R. hystrix and S. minor, showed very hardy resistance to cold temperatures experienced in December of 1989 in New Orleans.

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Table 1. Survey and condition of palm species found 10 months after the 1989 severe advective freeze in New Orleans

SPECIES	1 No foliage damage; vigorous and healthy		2 Lost foliage but replaced it w/vigorous new foliage		3 Lost foliage but replaced it with slow new foliage		4 Lost foliage but barely re-sprouted with new foliage		5 Lost foliage Resprouted but foliage died		6 Lost foliage but did not resprout		7 Lost foliage. Did not re-sprout. Trunk broken or fallen. Palm dead.		TOTALS	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1. Arenga engleri (Arenga Palm)					3	100									3	< 1
2. Brahea armata (Blue Hesper or Windmill Palm)			6	100											6	< 1
3. Butia capitata (Jelly or Pindo Palm)			276	43	124	19	10	2	31	5	107	17	88	14	636	7
4. Chamaedorea microspadix (Parlor Palm)			28	82	6	18									34	< 1
5. Chamaerops humilis (Mediterranian Fan Palm)			48	42	53	47	6	5	5	4	1	< 1			113	1
6. Livistona chinensis (Chinese Fan Palm)			32	19	30	18	17	10	13	8	74	44	3	2	169	2
7. Phoenix canariensis (Canary Island Date Palm)			916	74	179	14	16	1	36	3	73	6	19	2	1239	14
8. Phoenix dactylifera (Date Palm)			2	67	1	33									3	< 1
9. Phoenix reclinata (Senegal Date Palm)			7	47	8	53									15	< 1
10. Phoenix sp.			3	43	2	29					2	29			7	< 1
11. Rhapidophyllum hystrix (Needle Palm)	17	71	4	17	2	8			1	4					24	< 1

Table 1. Survey and condition of palm species found 10 months after the 1989 severe advective freeze in New Orleans

SPECIES	1 No foliage damage; vigorous and healthy		2 Lost foliage but replaced it w/vigorous new foliage		3 Lost foliage but replaced it with slow new foliage		4 Lost foliage but barely re-sprouted with new foliage		5 Lost foliage Resprouted but foliage died		6 Lost foliage but did not resprout		7 Lost foliage. Did not re-sprout. Trunk broken or fallen. Palm dead.		TOTALS	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
12. Rhapis excelsa (Lady Palm)					8	89	1	11							9	<1
13. Sabal mexicana (Texas Palmetto)	20	3	549	75	83	11	15	2	10	1	58	8	1	<1	736	8
14. Sabal minor (Dwarf Palmetto)	140	60	93	39	4	2									237	3
15. Sabal palmetto (Cabbage Palm)	113	4	1562	54	482	17	70	2	148	5	527	18	13	<1	2915	32
16. Sabal spp. - quadrilogy S. bermudana or S. blackburniana or S. domingensis or S. umbraculifera	7	3	195	82	20	8			1	<1	15	6	1	<1	239	3
17. Sabal spp seedlings	17	2	712	95	11	1			1	<1	4	<1	6	<1	751	8
18. Serenoa repens (Saw Palmetto)			1	100											1	<1
19. Syagrus romanzoffiana (Queen Palm)									1	17	5	83			6	<1
20. Trachycarpus fortunei (Windmill Palm)	40	2	1171	71	337	20	18	1	11	1	71	4	2	<1	1650	18
21. Washingtonia filifera (Petticoat Palm)			23	17	10	7	3	2	4	3	86	62	13	9	139	2
22. Washingtonia robusta (Washington Palm)									1	<1	108	91	10	8	119	1
TOTALS	354	4	5628	62	1363	15	156	2	263	3	1131	12	156	2	9051	100

Evaluation of U.S. National Arboretum Crape Myrtle Selections

Adolph J. Laiche
Mississippi

Nature of Work: Sixteen advanced generation Lagerstroemia (Crape Myrtle) seedling selections, obtained from the National Arboretum, were evaluated for cold hardiness and flower quality in south Mississippi. These selections are promoted to be mildew resistant with tall, intermediate and dwarf types with flower colors that range from white, pale pink, dark pink and lavender (1).

Lagerstroemia (indica x fauriei) selections 'Wichita', 'Miami', 'Biloxi', 'Tuskegee', 'Natchez', 'Muskogee', 'Yuma', 'Comanche', 'Lipan', 'Apalachee', 'Osage', 'Pecos', 'Zuni', IAcoma' and 'Hopi' grown in 1 qt containers and a Laqerstroemia (indica x indica) selection 'Seminole' grown in 3 qt containers were field planted in a Ruston fine sandy loam soil on a 12' x 12' spacing on October 10, 1985. The selections were arranged in a randomized complete block design with 4 replications. One plant represented an experimental unit.

Planting holes were dug with a 24 inch diameter auger, 14 inches deep. Three gallons of peat moss was incorporated with the back-fill soil at planting. Dolomitic limestone was broadcast in a 1.5 foot radius around each plant at the rate of 8 ounces per plant. All plants were fertilized annually with a complete fertilizer of 13-13-13 or 20-5-10 in the spring and mid summer at the rate of 1 ounce per plant per application.

Flower quality ratings were recorded at peak flowering in 1988 and 1990. Visual flower quality ratings were on a scale of 3 - excellent to good, 2 - poor, 1 - no flowering. Low temperatures of 12°, 5°, 5°, and 6°F were recorded on December 22, 23, 24, and 25, 1989, respectively. Visual cold damage ratings were taken on April 20, 1990 on a scale of 5 - none, 4 - slight, 3 - moderate, 2 - severe, 1 - all above ground shoots dead, 0 -plant completely dead.

Results and Discussion: Poor cold hardiness was observed with 'Wichita', 'Seminole' and 'Pecos', Table 1. Over all, best resistance to damage from low temperatures and best flowering were obtained with 'Miami', 'Natchez', 'Yuma', 'Lipan', 'Apalachee', and 'Hopi', Table 1.

Significance to Industry: The sixteen Lagerstroemia (indica x fauriei) selections evaluated in this report have been widely distributed by the U.S. Arboretum. The cold hardiness and flowering characteristics of these selections, as reported in this study, will be very helpful to growers and home owners to effectively select superior crape myrtle cultivars for production and use.

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Table 1. Cold damage and flower quality evaluation of sixteen (16) cultivars of Crape Myrtle (Lagerstroemia).

Cultivar	Growth[1] habit	Flower color	Cold[2] hardiness 1990	Flower[3] quality 1988	1990
'Wichita'	tall	light pink	0.50d[4]	2.50abc	3.00a
'Miami'	tall	dark pink	4.50a	2.50abc	2.25bc
'Biloxi'	tall	pale pink	3.88ab	2.00c	2.13bc
'Tuskegee'	tall	dark pink	4.50a	2.13c	2.25bc
'Natchez'	tall	white	4.88a	2.25bc	2.50abc
'Muskogee'	tall	light lavender	4.50a	2.25bc	1.88c
'Yuma'	intermediate	medium lavender	4.25a	2.75ab	2.75ab
'Comanche'	intermediate	coral pink	5.00a	2.00c	2.00c
'Lipan'	intermediate	medium lavender	4.75a	2.75ab	2.75ab
'Apalachee'	intermediate	light lavender	3.75ab	2.75ab	2.50abc
'Osage'	intermediate	light pink	4.50a	2.13c	2.00c
'Seminole'	intermediate	medium pink	1.38cd	2.50abc	2.50abc
'Pecos'	semidwarf	medium pink	1.25d	2.13c	2.38abc
'zuni'	semidwarf	medium lavender	2.63bc	2.25bc	3.00a
'Acoma'	semidwarf	white	4.63a	2.00c	2.13bc
'Hopi'	semidwarf	medium pink	3.88ab	3.00a	2.38abc
LSD			1.26	.61	.65

[1] Growth habit, approximate height range: tall - 23 - 33 feet, intermediate - 13 - 20 feet, and semidwarf - under 10 feet.

[2] Cold damage rating: 5 - none, 4 - slight, 3 - moderate, 2 - severe, 1 -all above ground shoots dead, 0 - plant completely dead.

[3] Flower quality rating = 3 - excellent to good, 2 - poor, 1 - no flowering.

[4] Means within columns not followed by the same letter differ at the 5% level according to Fisher's protected LSD.

Evaluation of Landscape Fabrics with Organic vs Inorganic Mulches

Bonnie Appleton, Jeffrey Derr and Susan French
Virginia

Nature of Work: The use of porous synthetic fabric barriers as a component of landscape weed control is increasing. In comparative trials a range of weed suppression has been obtained depending upon the particular fabrics used, the weed species tested, and the type and depth of mulches used (1, 3, 4, 5, 6). No adverse effects on soil moisture or temperature have been reported thus far when using fabrics beneath mulches (2, 6) as opposed to problems reported when using nonporous plastic (7).

To date most landscape fabric trials have been restricted to the use of organic materials such as shredded and chunk (nugget) pine bark, hardwood bark and pine needles as the mulches atop the fabrics. In many parts of the United States, sizeable quantities of inorganic mulches such as marble (limestone) and volcanic (lava) rock are used as mulches. The objectives of this on-going research are to: 1. - compare weed suppression using organic vs. inorganic mulches, 2. - to compare the effect on soil moisture and soil temperature of organic vs. inorganic mulches (1 & 2 combined with various physical barriers), and 3. - to determine whether the use of herbicide-treated organic mulch is justified.

In May, 1990, 144 plots measuring 6'x12' were installed representing a factorial arrangement of 6 ground coverings by 6 mulches in a randomized complete block design with 4 replications (see reference #2 for method). The 6 ground coverings were: bare soil, black plastic (solid polyethylene), Dalen's Weed-X (nonwoven black polyethylene/polyester), DeWitt's Weed Barrier (woven black polypropylene), a woven white polypropylene, and a light blue nonwoven polypropylene. The 6 mulches were shredded pine bark, herbicide-treated shredded pine bark (Surflan @ 3 lb ai/A), chunk (nugget) pine bark, white marble rock, and Colorado Aggregate's Red FloweRock (large particle volcanic stone) and Red Mite-T-Lite (small particle volcanic stone). All mulches were applied to a uniform 2" depth.

One concentric electrode gypsum block for soil moisture determination, and one thermocouple for soil temperature monitoring were installed at a 2" soil depth in the center of each plot. Readings were taken biweekly between 1:00 and 3:00 pm. The readings taken from May, 1990 to May, 1991, were individually subjected to analysis of variance. Natural weed growth was allowed to occur in all plots. Weed growth was visually rated twice, and total weed weights were taken in December, 1990, and all data subjected to analysis of variance.

Results and Discussion: Only one significant covering-mulch interaction occurred during the reading dates, therefore only main effects of mulch and

fabric are reported. Differences among mulches and coverings occurred more frequently for soil temperature than for soil moisture. Significant differences in soil temperature among coverings occurred on 16 of 26 dates; for mulches on 23 of 26 dates. Significant differences in soil moisture among coverings occurred on 6 of 27 dates; for mulches on 9 of 27 dates.

For the specific coverings and mulches the following rankings occurred:

	Mulch	Covering
Wettest	#1 - HTSPB[1]; #2 - SPB	#1 - plastic; #2 - WW
Driest	#1 - marble; #2 - RFR	#1 - bare; #2 - BW
Coolest	#1 - CPB; #2 - RFR	#1 - WW; #2 - WB
Warmest	#1 - RMTL; #2 - marble	#1 - bare; #2 - plastic
Weed Control	#1 - marble; #2 - RFR	#1 - plastic; #2 - Weed-X

[1] HTPB = herbicide-treated shredded pine bark; SPB = shredded pine bark; RFR = red FloweRock; CPB = chunk pine bark; RMTL = red Mite-T-Lite; WW = white woven; BW = blue woven; WB = Weed Barrier.

The plots were planted with two each containerized red maples, Acer rubrum, to look for any potential problems that might arise from the use of any of the mulch-fabric combinations. The research site is in an open field where wind speed can be considerable, and one problem that developed early was tree trunk abrasion from the volcanic rocks.

Significance to Industry: The selection of ground covering or mulch type can significantly influence soil moisture and temperature. Mulch selection influenced soil moisture and temperature more often than covering selection. Among the mulches, shredded pine bark kept the soil wettest, with the greatest soil drying occurring under the rocks of larger particle size (marble and FloweRock). The coolest temperatures occurred under the mulches of largest particle size (chunk pine bark and FloweRock -probably due in part to evaporative cooling), and the warmest under the remaining rocks (Mite-T-Lite and marble). Though effective for weed suppression, marble proved the least desirable of the mulches relative to the soil environment it created. Treating the shredded pine bark with herbicide did not greatly increase weed control.

Among the soil coverings, black plastic kept the ground the wettest, with the driest ground occurring where no soil covering was used. Moisture differences among the various fabrics were minor. The coolest temperatures occurred under the woven fabrics, the warmest under first bare soil, then black plastic. Plots without a soil covering (bare soil) under a mulch had the poorest weed control, hottest temperatures and lowest moisture contents. Though black plastic gave the best weed control, the hot, moist soil environment it created could increase problems with soil-borne pathogens.

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Root Growth During Recovery of Transplanted River Birch Trees

Dan Milbocker
Virginia

Nature of Work: Two of the advantages of growing trees in low profile containers is their easy transplanting and quick recovery. River Birch, Betula nigra trees were grown for two years (from one year seedlings) in the field, conventional 25 gallon containers and in low profile containers (8 inches high, 33 inches diameter, 25 gallons) and transplanted to a Tall Fescue, Festuca arundinacea covered field and a cultivated field. After one growing season in the field, all trees were dug and tops and roots were measured as indicators of survival and recovery.

Results and Discussion: The confinement of container culture produced smaller trees than field culture. Low profile container grown trees were largest after the first growing season but were 57% smaller and conventional container grown trees were 71% smaller than field grown trees after the second growing season as determined by trunk cross-sectional area.

Trees planted in Tall Fescue sod recovered poorly as compared to those planted in cultivated soil. Top dieback was the best indicator of tree survival. Dieback was more severe on trees transplanted in fescue sod from field culture (54% of the top weight died) than on either conventional container grown trees (31% of the top weight died) or the low profile container grown trees (26% of the top weight died). No dieback occurred on trees transplanted in cultivated soil. Fescue sod competition greatly reduced the surviving top weight of trees.

Increases in top and root growth during the year of transplanting were the best indicators of tree recovery. Field grown transplanted trees recovered poorly in fescue sod. Trunk cross-sectional area, a measure of top size, increased only 2% and weights of roots grown since transplanting averaged 61 grams per tree. The top to root ratio was 36 to 1, a large amount of top to support very few roots. The trunk cross-sectional areas of low profile and conventional container grown trees increased 20 and 13% respectively, a barely significant statistical difference. Container grown trees recovered quicker than field grown trees with low profile container grown trees recovering more quickly under stress than conventional container grown trees. Root weights of container grown trees were nearly equal (92 and 96 grams per tree) and 50% heavier than the roots of trees transplanted from field culture but top weights were still too high in proportion to the root weights (16 to 1 and 12 to 1 respectively) for complete recovery.

Field grown transplanted trees recovered much better in cultivated soil with a cross-sectional trunk area increase during the year of transplanting of 10%. The cross-sectional trunk area of low profile and conventional container grown

trees increased 57 and 65%, respectively. Only the difference between field and container grown trees was statistically significant showing that container grown trees recover easier than field grown trees whether under grass sod induced stress or not. The recovery of trees from the two types of containers did not differ in the absence of stress. Root lengths were measured at monthly intervals on trees planted in cultivated soil. By mid-summer, four foot lengths of root began intermingling with neighboring trees which made further measurements difficult. By contrast, roots on the trees planted in sod were only two feet long at the end of the growing season. The top-to-root ratio of trees planted in cultivated soil averaged 6 to 1 with non-significant differences between them. These trees were fully recovered from transplanting.

These results show that fescue sod is an effective competitor during the year following transplanting. Under stressful conditions, container grown trees survive best, particularly low profile container grown trees.

Significance to Industry: Most trees are now marketed as field or conventional container grown stock. A certain amount of failure is accepted in landscaping as being inevitable when planting with this nursery stock. According to my research, survival of trees can be improved by planting in cultivated soil and delaying the establishment of a lawn until trees are established. When trees must be planted in lawns or other stressful situations, trees previously grown in containers, particularly low profile containers, survive and establish themselves easiest. Because trees are not currently grown in low profile containers the production of such trees presents a new opportunity for nurserymen.

Flowering Herbaceous Perennials For Zone 8

David W. Marshall
Florida

Nature of Work: Sales of flowering herbaceous perennials have grown steadily in recent years. Considering the present general interest in color in the landscape, there seems to be considerable potential for further increases in sales of flowering perennials in the coming years. However, one of the limiting factors in the South, particularly the deep South, is the public's lack of knowledge about which perennials are reliable in our climate.

Some perennials such as *Achillea, Agapanthus, Asclepias, Chrysanthemum morifolium, Chrysanthemum x superbum, Coreopsis, Crocosmia, Hemerocallis, Lantana, Phlox, Plumbago, Rudbeckia, Solidago,* and *Stokesia* are known to grow well in the deep South (1,2). However, the performance of many other perennials is more questionable.

The purpose of this work is to evaluate the performance of various flowering perennials in Tallahassee, Florida, which is in U.S.D.A. climatic zone 8. In 1984 the first perennials in these trials were planted. By 1991 there have been over 100

different perennials in the trials, new ones being added each year from different sources. In most cases, three plants of each perennial were planted, though sometimes, because of expense, only one of each kind was planted. The plots are in an Orangeburg fine sandy loam soil amended with spent mushroom compost. They are mostly in full sun with the exception of one plot which is shaded by lattice which also casts late afternoon shade on the adjacent plot. The plants are watered by an overhead system with impact heads on an "as needed" basis. They are fertilized on as "as needed" basis also, with most types receiving a spring application of fertilizer such as 16-4-8 or 13-6-6 with half of the nitrogen in a slow-release form. Because pest tolerance is a major factor being examined in the trials, no pesticides are used other than slug bait and fire ant insecticides. The trials are planted and maintained by Master Gardener volunteers from the Leon County Extension Service.

Results and Discussion: Plants were evaluated on a visual basis by Master Gardeners and the author. Floriferousness, vigor, low grooming requirements, the ability to overwinter as well as tolerate summer conditions, and absence of intolerable pest problems were factors considered desirable. On the basis of these desirable characteristics, the perennials listed in Table 1 are considered of value for landscape use in zone 8. Still, it should not be inferred that only the perennials listed in Table 1 are worthy of growing in the deep South as the list is by no means a definitive list of what will and will not grow in zone 8.

Table 1. Some perennials of value for zone 8.

Name	Characteristics & Performance Notes
Artemisia ludoviciana, 'Silver King'	Grown for loose, silver foliage rather than flowers. About 2 ft. tall.
Aster laevis	Though not overly showy, is more reliable in our tests than A. *frikartii.* Small blue flowers throughout spring, summer, and fall. 1 ft. A. *frikartii 'Monch'* hasn't made it through our late summer and winter.
Buddleia spp.	Shrubby perennial, reaching 10 ft. or so if allowed. Depending on type, flower spikes of purple, blue, or pink. Very attractive to butterflies.
Caryopteris x clandonensis	Flowers late summer to fall with small 'Blue Mist' clusters of light blue flowers. 3 ft.
Chrysanthemum x 'Mei-kyo'	Very floriferous fall-blooming mum with lots of small purplish-pink flowers. Rapid spreader. 1.5-2 ft.

Echinacea purpurea	Purple coneflower produces its purplish pink flowers from June until late fall. 3 ft.
Gaura lindheimeri	Small, spidery pinkish-white flowers on long slender stems give an airy effect in the garden. Prefers good drainage. 3 ft.
Hosta spp.	Hostas will work in our area on shaded, moist, but well-drained sites. Grown as much for foliage as flowers. 1-1.5 ft.
Jacobinia carnea	Terminal clusters of tropical-looking pink flowers on plants up to 2 ft. tall all spring and summer. For shade or filtered sunlight.
Lythrum salicaria	Spectacular magenta flower spikes cover the 2-3 ft. plants in June-July. Full sun. Not invasive at all in our trials.
Miscanthus sinensis	Though an ornamental grass rather than a flowering perennial, Miscanthus sinensis cultivars ('Sieberfeder', 'Morning Light', gracillimus, and variegatus) have done well in our trials, better than most other ornamental grasses tried.
Perovskia atriplicifolia	Silvery, gray aromatic foliage with spikes of pale blue flowers borne from late spring through summer. Leggy. 3 ft.
Phlomis fruticosa	2-3 ft. healthy plant with bright yellow flowers in mid to late spring.
Salvia elegans	Small bright red flowers are most numerous in the fall. Foliage has pineapple fragrance. Flowers attractive to hummingbirds. 3 ft.
Salvia farinacea	The very common blue perennial salvia. Must be cut back occasionally to keep growing well. 1.5 ft.
Salvia greggii	Very drought-tolerant, attractive salvia with small red, pink, white, or coral flowers. Does very well if it has good drainage. 1.5-2 ft.

Salvia leucantha	Primarily a fall-blooming sage with purple-and-white or purple flowers. Very drought tolerant. Needs frequent pruning to keep bushy. 3 ft.
Verbena canadensis	Pink or lavender forms, flowers heaviest in spring before summer's heat and mites slow it. Very drought tolerant but not as durable as V. tenuisecta. Six inches to a foot.
Verbena tenuisecta	Violet flowers heaviest in spring. White form not as vigorous. Extremely drought tolerant. Six inches.
Veronica 'Blue Charm'	Plants remain healthy and vigorous after several years. Blue flowers in May-June. 1 ft.

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ELM - Environmental Landscape Management A "Systems" Approach to Florida Landscapes

Sydney Park Brown and Gary W. Knox
Florida

Nature of Work: ELM - Environmental Landscape Management is a new Extension educational program developed by the University of Florida, IFAS. ELM regards the landscape as an integrated "system" composed of plants, organisms and environmental influences. Unlike a natural ecosystem, the landscape contains an additional component— man. Therefore, the landscape designer, installer and/or manager should strive to understand how landscape practices affect natural processes and vice versa.

A nationwide search of Extension programs and research was conducted. This information was compiled into an educational program aimed at horticulture professionals and homeowners. A ELM guide, three slide sets, and several videos were produced; much of the information is also available through CDROM technology. The program is now being delivered statewide by Extension horticulture agents.

Results and Discussion: ELM proposes a comprehensive, packaged strategy for landscape design, installation and maintenance. Horticulture professionals and homeowners alike gain from this "big picture" approach which allows them to produce landscapes which are beautiful, easily maintained and environmentally sound. Emphasis is placed on the integrated nature of landscape design and maintenance practices. Common pitfalls are detailed:

— How construction practices create hazardous trees;
— How an unwise mix of plants in the same bed leads to to water wastage;
— How untimely applications of soluble nitrogen can increase insect and disease problems;
— How mowing too short reduces the water absorbing ability of turfgrass;
— How pesticides impact beneficial organisms, and so on.

ELM complements the principles of Xeriscape™ and IPM-Integrated Pest Management. These programs are tied into the program along with other environmentally sensitive issues like solid waste management in the landscape.

Significance to Industry: The horticultural industry in Florida is under severe pressures from regulatory agencies who are beginning to question traditional landscape practices. Recent droughts have resulted in restrictions which, in some parts of the state, limit irrigation to one day a week. Recently passed legislation requires government landscapes to adhere to Xeriscape™ principles. Pesticide regulations now mandate that information be posted in landscapes which are sprayed and that "pesticide-sensitive" people be notified when sprays are

scheduled. As of January, 1992, Florida's Solid Waste legislation will prohibit the disposal of yard wastes into Class I landfills. These environmental regulations are obviously impacting the way landscapes are designed and managed.

In addition, clients and consumers are rapidly becoming environmentally sensitized. Homeowners, office managers and condominium associations, to name just a few, are beginning to demand "alternative landscapes".

ELM offers the industry a way to cope with these increasing regulatory pressures and trends. It allows the industry to set itself on an environmental path as leaders rather than followers.

Furthermore, ELM guidelines lead to labor savings, reduced costs and fewer headaches. Environmental Landscape Management is a valuable landscape tool for the 1990's and beyond.

Nitrogen Rapidly Leaches from Cypress Wood Chip Mulch

Tom Yeager, Ed Gilman and Diane Weigle
Florida

Nature of Work: Cypress-mulched landscape plants are commonly fertilized by broadcasting over the surface of the mulch. However, the extent of nitrogen (N) leached from the cypress mulch is unknown. Previous research revealed that nitrate nitrogen leached rapidly when surface-applied to pine bark, whereas ammonium nitrogen leached only after exchange sites were saturated (Foster et al., 1983). The purpose of this research was to compare rates of nitrogen leaching from cypress wood chips using various nitrogen carriers, nitrogen application rates and rates of water application. The following experiments were carried out under laboratory conditions using 1.5 x 6 inch polyvinyl chloride columns that were filled with cypress wood chips.

For the first experiment, the equivalent of 56 Ib of N per 1000 square feet from NH_4NO_3, or 28 Ib of N from KNO_3 or $(NH_4)_2SO_4$ were evenly distributed on the mulch surface. The columns of mulch were leached the first day with the equivalent of 1.5 inches of deionized water to thoroughly wet the cypress wood chips. Thereafter, daily each column received the equivalent of 0.5 inch of water until termination of the experiment after 25 days. In the second experiment, the equivalent of 56 lb N per 1000 square feet per column from NH_4NO_3 was evenly distributed on the surface of the cypress wood chips. Deionized water was applied to columns at either 0.5, 1.0, 1.5, or 2.0 inches per day for 50 days. Leachate from each column was periodically collected for 50 days. For the third experiment, columns received NH_4NO_3 at either 0, 7, 14, 28, or 56 Ib of N per 1000 square feet. Each column was leached the first day with 1.5 inches of deionized water

to thoroughly wet the cypress wood chips. Thereafter, each column received 0.5 inch of deionized water daily for 50 days. Leachates were collected every fifth day until day 50.

Results and Discussion: Sixty-five percent of applied nitrate nitrogen and approximately 60% of applied ammonium nitrogen had been leached from the cypress wood chips after five days. Ninety-two and 85% of applied nitrate and ammonium nitrogen, respectively, were leached by day ten. This is similar to pine bark, from which more than 95% of the nitrogen from NH_4NO_3 had been leached after eight days (Foster et al., 1983). Total ammonium nitrogen leached from NH_4NO_3 and $(NH_4)_2SO_4$ was slightly less than that applied indicating only limited sorption by the wood chips and/or volatilization of nitrogen. Nitrification, conversion of ammonium to nitrate by microorganisms, may also have occurred since more nitrate nitrogen leached than was applied. However, negligible nitrate nitrogen was recovered for the $(NH_4)_2SO_4$ treatment and leachate pH was similar for all carriers (6.2). Nitrate nitrogen leached from KNO_3 was similar to that applied.

Results from the second experiment indicated that more water was required to leach a given amount of nitrogen at the higher water rates than at the lower rates. For example, an equivalent of 8 inches of water applied by day 4 at the 2 inch per day rate leached 86% of the nitrate nitrogen; whereas, only 5.5 inches applied by day 11 was required to leach this amount at the 0.5 inch per day rate. Regardless of water rate, more nitrate nitrogen leached than was applied, indicating nitrification had occurred.

The nitrate and ammonium nitrogen concentrations in the leachate during this experiment decreased rapidly at each water rate and were lowest at the higher water application rates due to the dilution effect of the greater water volume. Total N (nitrate plus ammonium) concentration for the 0.5 inch per day irrigation treatment on day 25 was less than 80 ppm, an optimal level for container-grown Ilex crenata 'Helleri' (Niemiera and Wright, 1982; Wright and Niemiera, 1985). Combined nitrate and ammonium nitrogen concentrations in the leachate of the third experiment for the 56 lb N per 1000 square feet rate were less than 80 ppm by day 20. Nitrate and ammonium concentrations on day 50 ranged from 5 to 7 ppm for the 56 lb N per 1000 square feet treatment and from 7 to 4 ppm for the 7 lb N per 1000 square feet treatment, respectively.

Data from these experiments revealed that more than 92% of the nitrate nitrogen and 85% of the ammonium nitrogen leached through cypress wood chips from a surface-application of NH_4NO_3, KNO_3 or $(NH_4)_2SO_4$ after applying 6 inches of water during a ten day period. Leaching was faster at the higher water application rates. Therefore, nitrate and ammonium nitrogen broadcast over cypress wood chips in the landscape would leach rapidly into the soil. Leaching would be slower from water insoluble nitrogen fertilizers or slow-release fertilizers that are sometimes used to fertilize landscape plants. The concentration of N leached,

when 0.5 inch of irrigation water was applied daily, from cypress wood chips which received 7 lb of N per 1000 square feet was above 80 ppm only for the flrst 10 days after fertilizer application. Since generally landscapes do not receive water at this rapid rate, application of soluble N fertilizer at 7 lb per 1000 square feet would result in leachate concentrations greater than 80 ppm for longer than 10 days. The best growth for woody plants in container media occurs at about 80 ppm N, but the optimum concentration for plants growing in the landscape is not known. The 7 lb of N per 1000 square feet is about three times the recommended minimum yearly fertilizer rate for landscape plants, and the fertilizer should be divided into three applications per year, not in one application as was done in this study.

Significance to Industry: The rapid leaching of nitrogen from cypress wood chip mulch emphasizes the need for frequent applications of small amounts of water soluble fertilizer or fertilizing landscape plants with slow-release fertilizers. Cypress mulch does not appear to tie up significant quantities of nitrogen and most of the nitrogen leaches quickly into the soil.

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Effects of High-Salt Irrigation on the Elemental Tissue Analysis ofThree Maple Species

Marvin D. Hatter and David L. Morgan
Texas

Nature of Work: Many municipal water sources in the Texas High Plains contain high concentrations of soluble salts. These salts may limit the successful use of certain maples *(Acer* spp.) as landscape plants in the region (1,3,4,5). We are reporting elsewhere (2) that salty irrigation water diminished height and caliper increase and visual appearances of 3 maple species. In this paper we report the effects of application of that water source on the concentrations of selected elements in leaf tissues of the 3 maples.

Maples included in the study were: Drummond red maple, *Acer rubrum* var. *drummondii* (Hook. and Arn.) (Sarg.), from Alexander State Forest, LA; 'Caddo' sugar maple, *A. saccharum* Marsh. subsp. *saccharum,* from the canyons of Caddo and Canadian counties of West Central, OK; and bigtooth maple, *A. grandidentatum* Nutt., from the canyons on the Ft. Hood military reservation, Coryell County, TX.

The study was conducted in a field plot at Texas Tech University. Sixty, 2-year-old seedlings averaging 12-15 inches in height were grown in buried containers from July 1988 until October 1989. The bottomless containers were constructed of 10-inch diameter PVC pipe cut to 40-inch lengths and filled with sandy clay loam soil (Table 1).

Thirty trees of each species were irrigated with Lubbock city water (Table 2) and 30 with collected rainwater. The ions presented in Table 2 were undetected in the rainwater analysis. To evaluate the effects of irrigation frequency, half (15) of the trees in each water source treatment received 0.53 gallons (2 liters) of water in one application and the other half received the same total volume in two equal applications (1 liter). Intervals between applications varied according to rainfall and dryness of the growing medium and ranged from 7-14 days. A total of 13.4 inches of rain fell during the 15-month study.

The experimental design was a completely randomized split plot with species as the main plot treatment. The subplot was a factorial combination of water source and irrigation frequency. Treatments were replicated 15 times with one tree per replication. Tissue analyses were conducted on 5 replications. All data were subjected to analysis of variance.

Results and Discussion: Concentrations of selected elements are shown in Table 3. The 3 species were similar in responses to the treatments, with the exception that red maple leaves were higher in concentrations of magnesium (Mg) and chloride (CI) than the other species. There were no significant differences

in levels of phosphorus (P), potassium (K),iron (Fe) or copper (Cu) between the treatments. Irrigation with city water caused higher levels of manganese (Mn), Mg, Na and CI to occur in the leaves. Na and CI in high concentrations were responsible for tree damage elsewhere (1,3,4,5). Only where Ca is reported to be greater in the split irrigation treatment did frequency of irrigation affect a foliar element. Compared with the levels in the native stands (Table 4), Na and Cl ions are demonstrably high in all treatments, which suggests that these elemental ions originated in the city water (Table 2) and the soil (Table 1). Leaching of these elements through the soil profile likely was limited by the low rainfall and modest irrigation rates during the study.

Significance to Industry: The presence of of some ions in high concentrations in the leaves of the 3 species in our study suggests growers may consider foliar analysis as a tool for determining potential salt problems where irrigation water is poor. We would hope that the foliar analyses presented here may be useful references for such screening.

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Table 1. Elemental analysis of sandy clay loam soil used in the study.

P	K	Mg	Ca	Na	Mn	Fe	Cu	Cl	Soluble salts
				ppm					dSm-1
32	455	380	1890	87	11	14	0.9	80	0.5

Table 2. Chemical analysis of city of Lubbock water supply from May, 1988 through September, 1989[y].

Parameter	Low	High	Average
Conductivity[z]	1.36	1.71	1.51
Ca	46	59	53
Mg	25	34	29
Na	244	334	293
K	7	15	9
Cl	349	412	372

All figures reported in mg/l except as noted

[z] dSm-1

[y] Monthly water analyses by the City of Lubbock Water Treatment Laboratory

Table 3. Foliar analyses of 3 species of maples irrigated with municipal water and rainwater for 15 months at 2 frequencies, a single (1) and a split (2) application.

		Caddo		Bigtooth		Red	
		Frequency					
		1	2	1	2	1	2
N	City	1.65	1.51	1.23	1.29	1.14	1.22
(%)	Rain	1.44	1.39	1.66	1.22	1.57	1.26
P	City	.13	.12	.13	.10	.10	.11
(%)	Rain	.12	.11	.11	.10	.11	.10
K	City	.58	.57	.59	.51	.76	.58
(%)	Rain	.76	.80	.70	.68	.78	.65
Ca	City	1.39	1.33	1.06	1.16	1.13	1.49
(%)	Rain	1.27	1.31	1.15	1.51	1.10	1.20
Mg	City	.39	.29	.36	.33	.50	.71
(%)	Rain	.26	.31	.35	.31	.44	.45
Fe	City	306	294	203	187	193	234
(ppm)	Rain	188	206	199	208	206	192
Mn	City	80	93	77	81	70	54
(ppm)	Rain	63	56	47	54	63	53
Na	City	1130	2047	692	2522	424	282
(ppm)	Rain	275	643	167	224	244	205
Cu	City	19	20	25	30	18	35
(ppm)	Rain	25	19	22	19	22	24
Cl	City	2215	1591	2383	2438	6691	6864
(ppm)	Rain	1502	1320	1873	1723	3817	3371

Significance[z]	N	P	K	Ca	Mg	Fe	Mn	Cu	Na	Cl
Species (S)					**					**
Water (W)	**				**		**		**	*
Frequency (F)				*						
SxW				*						
S x F										
SxWxF					*					

[z] *, ** represent significance at the 5% and 1% levels by F-test, respectively.

Table 4. Foliar analyses of native stands of 3 maple species.

Species	No. Trees Sampled	N	P	K	Ca	Mg	Fe	Mn	Cu	Na	Cl
		%							ppm		
Caddo	5	1.16	0.33	0.54	1.03	0.30	188	69	22	122	460
Bigtooth	6	0.96	0.06	0.90	1.37	0.18	139	86	22	151	733
Red	4	0.93	0.04	0.65	0.74	0.19	191	583	19	184	667