RESEARCH REPORT SERIES NO. 5 AUGUST 1987

RESEARCH REPORT 1987

ORNAMENTALS

ALABAMA AGRICULTURAL EXPERIMENT STATION AUBURN UNIVERSITY
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FOREWORD

We at the Alabama Agricultural Experiment Station are pleased to present this update of current Auburn University research being done to support Alabama's important ornamentals industry. This is the third publication in the Research Report series to deal with the many aspects of ornamental crops production being studied at the Experiment Station. Comments from members of the ornamentals industry indicated that the first two reports, published in 1983 and 1985, were useful to the industry. It is our hope that information contained in this report will also be valuable to nurserymen.

The 28 individual reports making up the publication were authored by faculty, staff, and students from four departments in the College of Agriculture, two substations of the Alabama Agricultural Experiment Station System (AAES), and the Cooperative Extension Service (ACES), making the report truly a team effort. Authors are listed below in alphabetical order:

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FIRST PRINTING 5M, AUGUST 1987

Information contained in this report is available to all persons without regard to race, color, sex, or national origin.

Propagation of Four Woody Ornamentals from Vegetative and Reproductive Stem Cuttings

Gary J. Keever, Gary S. Cobb, and Dean R. Mills

PRODUCTION CONSIDERATIONS frequently result in growers collecting shoot cuttings at times of the year when flower buds, flowers, or fruit are present. Some species develop reproductive parts during vegetative propagation. High auxin levels favor adventitious root formation and tend to inhibit flowering. Due to the depressing effect of reproductive parts on root initiation, cuttings of difficult-to-root species that have flower buds, flowers, or fruits initiate roots less readily than those having vegetative or leaf buds. With easily rooted species, the presence of flower buds does not appear to be a serious deterrent to rooting (effects of flowers or fruit on rooting are less well-documented). However, the time required for root initiation and development, and hence the period of time in the propagation area, may be longer. The objective of this study was to evaluate rooting of vegetative and reproductive cuttings of four easily rooted woody ornamentals. Species include *Rhododendron* x Stewartstonian (Stewartstonian azalea), *Abelia* x Edward Goucher (Edward Goucher abelia), *Ligustrum japonicum* Variegatum (variegated Japanese privet), and *Ilex* x *attenuata* Fosteri (Foster holly).

All species except azalea were vegetatively propagated from softwood cuttings in 72-cell pacs containing unamended peat:perlite (1:1, volume basis). Uniform 5-inch vegetative and flowering apical cuttings of abelia were taken July 3, 1985, from the same stock plants and given a 3-second quick dip of 2,000 p.p.m. IBA in 50 percent isopropyl alcohol. Vegetative and fruiting 4-inch cuttings of privet and holly, taken September 9, 1985, and October 14, 1985, were treated with 4,000 p.p.m. IBA. Budded 4-inch azalea cuttings taken October 7, 1985, were treated with 2,500 IBA and stuck in 3-inch-square containers of pine bark:peat (6:1, volume basis); half of the cuttings were disbudded when stuck. Cuttings were placed in a polyethylene greenhouse under intermittent mist (12 seconds every 10 minutes). Plants were evaluated when the majority of cuttings from one treatment had rooted. Data collected included percent rooting, root number per plant (except for azalea), and root dry weight. Due to the density of roots on azalea cuttings, rooting density was evaluated using a relative root rating.

TABLE 1. THE EFFECTS OF REPRODUCTIVE STAGES OF DEVELOPMENT ON THE VEGETATIVE PROPAGATION OF FOUR WOODY ORNAMENTALS

Cutting condition	Rooting success	Roots/ cutting	Root dry wt.
	Pct.	*No.*	*mg*
Abelia x Edward Goucher[1]			
Vegetative	100.0a[2]	28.1a	38.0a
Flowering	6.5b	.2b	.0b
Ligustrum japonicum Variegatum[3]			
Vegetative	74.1a	6.5a	205.0a
Fruiting	1.7b	.1b	1.0b
Ilex x *attenuata* Fosteri[4]			
Vegetative	83.3a	8.1a	14.0a
Fruiting	39.6b	2.9b	8.0b
Rhododendron x Stewartstonian[5]		Relative root rating[6]	
Disbudded	100.0a	3.5a	81.13a
Budded	100.0a	1.0b	.13b

[1]Cuttings stuck July 3, 1985, and evaluated July 23.
[2]Mean separation within columns and species by Duncan's multiple range test, 5 percent level.
[3]Cuttings stuck September 9, 1985, and evaluated December 6.
[4]Cuttings stuck October 14, 1985, and evaluated December 19.
[5]Cuttings stuck October 7, 1985, and evaluated November 25.
[6]Relative root rating: 0 = no roots; 1 = few roots; 5 = dense root development.

Vegetative cuttings of all species except Stewartstonian azalea had higher rooting percentages than reproductive cuttings, table 1. Percentages ranged from a high of 100 percent for vegetative cuttings of Edward Goucher abelia to a low of 6.5 percent for flowering cuttings of abelia and 1.7 percent for variegated privet with fruit. Some vegetative cuttings of abelia initiated flowers sporadically during propagation, but this did not affect root initiation.

Reproductive cuttings of abelia, privet, and holly that did initiate roots were sparsely rooted and were not ready to be removed from mist when evaluated. This was reflected in a lower root number per cutting and lower root dry weight compared to vegetative cuttings. Flowering cuttings of abelia that were returned to the mist after evaluation failed to root.

All budded and disbudded cuttings of Stewartstonian azalea initiated roots; however, there were differences in root development. Roots of disbudded cuttings were denser and longer than those of budded cuttings. This is evident from the relative root rating and root dry weight data. Disbudded rooted cuttings of Stewartstonian azalea maintained in the greenhouse until they had initiated a flush of top growth began growth about 2 weeks earlier than those with flower buds.

Enhanced rooting of vegetative cuttings compared to reproductive cuttings was noted in the rooting percentages of abelia, holly, and privet and in the root development of Stewartstonian azalea. To maximize rooting and subsequent root development and to minimize time in the propagation area, only vegetative wood should be selected. Removal of flower buds is a practice that should result in more rapid root development, earlier vegetative growth, and more efficient liner production.

See color plates numbers 1 and 2.

Effects of Container Volume and Fertility Rate on Growth of Two Woody Ornamentals

Gary J. Keever and Gary S. Cobb

GROWTH OF PLANTS in containers is influenced by physical and chemical characteristics of the container environment, including container volume, shape, and media fertility. Numerous studies have demonstrated a positive growth response to increased volume of growth medium. However, in many of these studies fertilizer was added on a volume basis; thus, different sized containers received different amounts of N, P, K, and other amendments. Changing container depth as volume is adjusted also influences the physical properties of the media. Research has shown that a decrease in container depth reduced the amount of growth medium with favorable air and water space for root growth. This study was initiated to investigate the influence of container diameter, volume, and fertility rate on root and shoot growth of two woody ornamental shrubs having different growth rates: *Euonymus japonica* Microphylla (heavy feeder exhibiting rapid, vigorous growth) and *Rhododendron* x Pink Supreme (light feeder with a slow to moderate growth rate).

Seventy-two uniform liners of each species were potted January 29, 1985, in an amended peat:perlite (1:1, volume basis) growth medium. Containers were made from white polyvinylchloride (PVC) pipe of three diameters (4, 6, and 8 inches). Azaleas and euonymus were potted into sections of pipe 4 inches and 6 inches deep, respectively, leaving 1 inch between the growth medium and top of the pot. Container volumes ranged from 38 cubic inches to 151 cubic inches in the 4-inch-deep pots, and from 63 cubic inches to 251 cubic inches in the 6-inch-deep pots. Bottoms of containers were covered with plastic netting before being spaced 18 inches apart on raised, wire benches in an unshaded glass greenhouse. Osmocote 17-7-12 was surface-applied February 4, 1985, at 6, 12, and 18 pounds per cubic yard. Growth medium soluble salts, relative root density, foliar color ratings, and top dry weights were determined after 5 months.

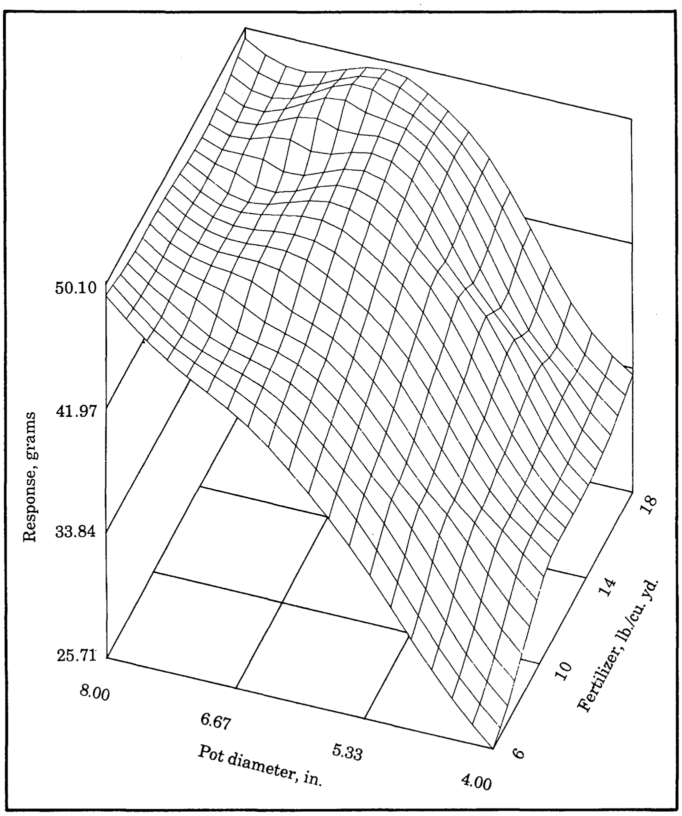

FIG. 1. Top dry weight of euonymus grown in pots of three diameters and fertilized at three rates.

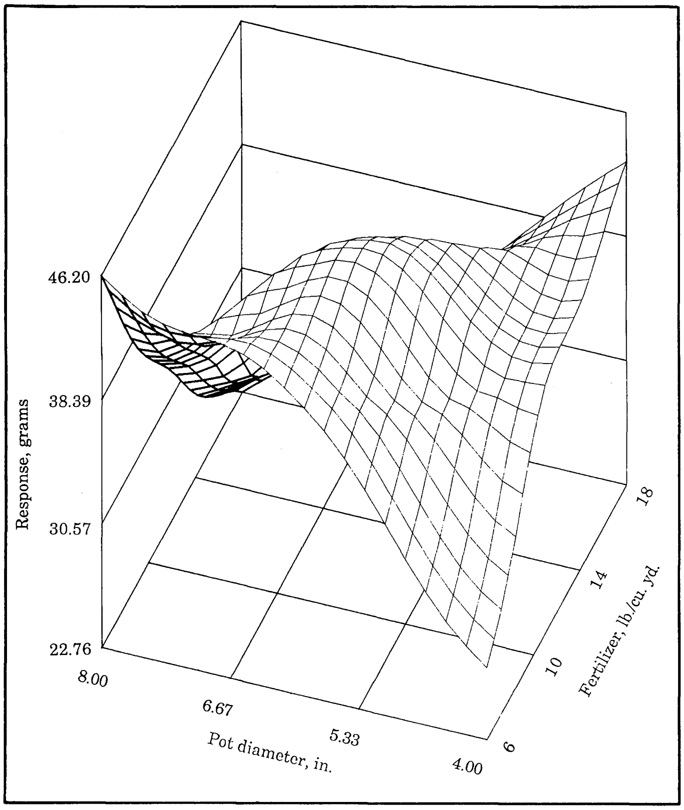

FIG. 2. Top dry weight of azaleas grown in pots of three diameters and fertilized at three rates.

Top dry weight of euonymus, figure 1, increased in response to increasing pot diameter and to increasing fertility rates and was closely correlated with foliar N, P, and K. There were interactions between pot diameter and fertility rates. For instance, with smaller pots or at lower fertility rates, top dry weight response was more pronounced, whereas in larger pots or at higher fertility, growth was not affected or was moderated.

Soluble salts in the growth medium increased linearly as fertility rate increased, while pot diameter had no effect. Positive correlation of growth through a wide range of fertility rates and pot diameters emphasizes the tolerance of rapid growing species, such as euonymus.

Unlike euonymus, the interaction response of pot diameter and fertility rates with regards to top dry weight of azalea was most notable, figure 2. Top growth of azalea increased in response to increasing fertility rates in the smallest pots, and also to increasing pot size at the lowest fertilizer rates. Response was opposite in the largest pot and at the highest fertility rate, respectively. This latter response was possibly due to the presence of relatively higher levels of soluble salts in contact with azalea plants that were unable to utilize these levels of fertilizers. In fact, the reduction in foliar color at the highest fertility levels and also symptoms of stress (reduced internode length and leaf size) observed in those plants seem to confirm this observation. Unlike euonymus, there appeared to be no discernible relationship of foliar N and P with top dry weight of azalea. However, there appeared to be an inverse relationship between foliar and top dry weight.

Euonymus and azalea responded differently to changes in container volume and fertility. Top growth of euonymus increased in response to both increased medium volume and fertility and was closely related to foliar levels of N, P, and K. Canopy growth of azalea increased in response to fertilizer in the smaller volumes and to pot diameter at the lower fertilizer rate. With an increase in both fertilizer and medium volume, growth of azalea was reduced, possibly due to high soluble salts in the medium. Foliar N and P of azalea were not closely related to top growth, whereas foliar K was inversely related to top dry weight. These results suggest that plant response to container volume and fertility is species-dependent. Faster growing species benefit most from larger media volumes and higher rates of fertilizer. Any adjustments in container sizes and fertility rates, however, should consider the overall production scheme, including scheduling, production costs, and market requirements, for greatest efficiency.

Effects of Irrigation Rate and Media Type on Growth of *Acer rubrum L.*

Chris A. Martin, Harry G. Ponder, and Charles H. Gilliam

IRRIGATION SYSTEM, irrigation schedule, and growth medium are major parameters affecting plant culture, and choices are available for each. An efficient alternative to the standard practice of overhead irrigation is the spray stake located in individual pots. Net evaportation from a Class A pan can provide data for use in irrigation scheduling of field grown nursery stock; however, the correlation between net evaporation and irrigation rate applied to container grown plants is not defined. Increased sand content in a pine bark and sand medium has been shown to decrease water percolation rate and cation exchange capacity and increase pH and bulk density. The objectives of this study were to determine the effects of irrigation rate, based on net evaporation from a Class A pan, and media type on growth of red maple in No. 10 containers, using a spray stake irrigation system.

One-year-old bare root seedlings of *Acer rubrum* were potted in No. 10 containers in April 1985. Forty seedlings were planted into each of three growth media: (1) 100 percent pine bark, (2) 80 percent pine bark:20 percent sand, and (3) 60 percent pine bark:40 percent sand (volume basis). Containers were spaced 29 inches apart and staked according to accepted nursery practices.

A spray stake irrigation system was installed with one Chapin Type N Spray Tube per pot. Four irrigation rates corresponding to 50, 100, 200, and 400 percent replacement of net evaporation from a Class A pan were evaluated with each growth medium. Trees were irrigated from May to October, 1985, and March to September, 1986, with each successive accumulation of 0.50 inch daily net evaporation.

Height of red maple was similar regardless of irrigation rate, table 2. Media did not influence height during the first growing season, but in 1986 increasing sand content increased height.

TABLE 2. EFFECT OF IRRIGATION RATE AND MEDIA TYPE ON HEIGHT OF RED MAPLE

Treatment	Mean cumulative increase in height	
	1985	1986
	Inches	*Inches*
Irrigation rate		
50% net evaportation.............	30.1	9.0
100% net evaportation............	33.6	9.9
200% net evaporation.............	33.1	12.8
400% net evaporation.............	36.6ns[1]	10.7ns
Media type		
100% pine bark..................	32.9	7.3
80% pine bark:20% sand..........	35.5	10.5
60% pine bark:40% sand..........	31.6ns	14.0

[1]ns—Treatments not significantly different.

During both growing seasons, caliper growth of red maple increased as irrigation rate increased, table 3. Results of other research with field grown red maples tend to support this trend. Media affected tree caliper only in 1986 when increased sand resulted in increased caliper growth. However, the higher sand content might increase shipping weight to the point that it would be impractical.

Both height and caliper growth were reduced the second year with all treatments. This was probably because the root systems were becoming too large for the containers.

Based on this research, it can be concluded that the spray stake irrigation method can be used to grow red maples in No. 10 containers.

TABLE 3. EFFECT OF IRRIGATION RATE AND MEDIA TYPE ON CALIPER OF RED MAPLE

Treatment	Mean cumulative increase in caliper	
	1985	1986
	Inches	*Inches*
Irrigation rate		
50% net evaportation.............	3.2	2.8
100% net evaportation............	4.1	2.7
200% net evaporation.............	4.3	3.3
400% net evaporation.............	4.6	3.4
Media type		
100% pine bark..................	4.1	2.2
80% pine bark:30% sand..........	4.1	3.0
60% pine bark:40% sand..........	3.9	3.9

[1]ns—Treatments not significantly different.

Comparison of Propagation and Transplanting Sequences for Container Production of Woody Ornamentals

Gary J. Keever and Gary S. Cobb

CONTAINER-GROWN woody ornamentals are typically produced by rooting stem cuttings in beds, flats, or containers and transplanting once or twice before plants are marketed. Transplanting increases labor and material costs, and results in delayed growth. Direct propagation in containers of marketable size eliminates transplanting, but requires more growing space during the early part of the production cycle. Due to space requirements, direct propagation may require that plants be grown outdoors in larger containers where it is more difficult to control environmental factors compared to greenhouse production in flats or smaller containers. Multiple cuttings per container can also reduce production time, but this practice increases material and labor costs.

Optimum propagation containers and number of cuttings per container have yet to be determined and may vary with species. This study was therefore performed to investigate the influence of container size for rooting and transplanting sequences on growth and production efficiency of several woody ornamentals. Propagation containers and transplanting sequences included: (1) cuttings rooted in 72-cell pacs transplanted into 3-inch containers and subsequently into 1-gallon containers; (2) 1 cell pac into each 1-gallon container; (3) 2 cell pacs into each 1-gallon container; (4) 3-inch containers (1 cutting each) into 1-gallon containers; (5) 3-inch container (2 cuttings each) into 1-gallon containers; (6) direct propagation in 1-gallon containers (1 cutting per container); and (7) 2 cuttings per 1-gallon container.

The responses of three species of woody ornamentals, *Lagerstroemia indica* x *fauriei* Basham's Party Pink (Basham's Party Pink crapemyrtle), *Rhododendron* x George Tabor (George Tabor azalea), and *Rhododendron* x Hino-crimson (Hino-crimson azalea), were evaluated. Stem cuttings of each species were rooted in cell pacs, 3-inch containers, and 1-gallon containers. Cell pacs were filled with unamended peat:perlite:vermiculite (1:1:1, volume basis). Three-inch and 1-gallon containers were filled with amended milled pine bark. Cuttings were taken in the spring of 1984 and treated with IBA (a rooting hormone). Cell pacs and 3-inch containers were placed in a shaded greenhouse, while 1-gallon containers were placed outdoors under shade cloth (47 percent light exclusion). In both cases, irrigation frequency was adjusted to maintain a film of water on the foliage to facilitate rooting. A weekly liquid fertilization program of 100 p.p.m. N from 20-20-20 was begun following signs of root emergence, regardless of propagation container. Liners in cell pacs and 3-inch containers were transplanted into an amended, 100 percent milled pine bark medium when roots had developed sufficiently to maintain the growth medium intact upon removal of the container. After being transplanted into 1-gallon containers and placed outdoors under 47 percent shade, plants were topdressed monthly with 1 teaspoon of 12-4-6 per container. Rooting was evaluated when cuttings were removed from intermittent irrigation (June-July 1984). Top growth and root growth were measured in May 1985.

There were no differences in percent rooting among container treatments for any of the three species; however, the time required for rooting varied among propagation container types, table 4. Cuttings of all species were 2-3½ weeks slower to root in 1-gallon containers than in cell pacs or 3-inch containers. This was probably the result of environmental differences between the greenhouse and shade house.

Growth per container (top dry weight) varied somewhat among species, but was generally greatest when two cuttings were propagated in 1-gallon containers (treatment 7). Least growth resulted when cuttings were propagated in cell pacs and subsequently transplanted to 3-inch and then 1-gallon containers (treatment 1, table 5.)

Top growth of crapemyrtle was only slightly greater when cuttings were rooted in cell pacs and transplanted directly into 1-gallon containers (treatment 2), compared to transplanting twice (treatment 1). Transplanting two cell pacs into a 1-gallon container (treatment 3) resulted in similar total top growth as when one or two cuttings were rooted directly in 3-inch containers and later transplanted into 1-gallon containers (treatments 4 and 5). Growth did not differ when one or two cuttings were propagated in either 3-inch or 1-gallon containers, suggesting that propagation of multiple cuttings per container may not be beneficial with rapidly growing species, such as crapemyrtle. This could change if shorter production cycles or larger containers were used.

Response of George Tabor and Hino-crimson azaleas to transplanting sequence was similar to that of crapemyrtle. However, both cultivars did produce more top growth per container when two cell pacs were transplanted into a 1-gallon container (treatment 3) or two cuttings were rooted in each 3-inch and 1-gallon container (treatments 5 and 7). This suggests that the production cycle for slower growing species may be shortened by placing multiple cuttings or liners in marketable containers.

Relative root density of the three species correlated closely with the top dry weight data. Root density was always least when plants were transplanted twice and greatest when two cuttings were directly propagated in 1-gallon containers, except with George Tabor azalea, table 6.

TABLE 4. EFFECTS OF PROPAGATION MEDIA AND CONTAINER TYPE ON THE ROOTING OF THREE WOODY ORNAMENTALS

Cultivar	Rooting		
	Cell pac[1]	3-in. container[2]	1-gal. container[3]
	Pct.	*Pct.*	*Pct.*
Basham's Party Pink crapemyrtle	88.9[2]	86.1 (0)[3]	91.7 (2)
George Tabor azalea	99.3	97.2 (0)	100 (3.5)
Hino-Crimson azalea	95.2	96.6 (0)	97.2 (3.5)

[1]Peat:perlite:vermiculite (1:1:1 by volume) rooting medium in cell pacs; 100 percent milled pine bark in 3-inch and 1-gallon containers.

[2]No significant differences in percent rooting occurred among container treatments for any species.

[3]Numbers in parenthesis indicate the weeks of delay in rooting compared to cuttings in cell pacs.

TABLE 5. EFFECTS OF TRANSPLANTING SEQUENCE ON TOP DRY WEIGHTS PER CONTAINER OF THREE WOODY ORNAMENTALS

Cultivar	Top weight/container, by transplanting sequence						
	Cell pac → 3-in. pot → 1 gal.	Cell pac → 1-gal.	2 cell pacs → 1-gal.	3-in pot (1 cutting) → 1-gal.	3-in pot (2 cuttings) → 1-gal.	Direct propagation in 1-gal. pot: 1 cutting/pot	Direct propagation in 1-gal. pot: 2 cuttings/pot
	Grams	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Basham's Party Pink crapemyrtle	11.0d[1]	13.8c	20.5b	18.3b	19.4b	27.8a	29.8a
George Tabor azalea	7.2f	10.7e	17.5cd	16.1d	18.6c	21.8b	29.7a
Hino-Crimson azalea	1.6e	3.0d	5.1b	4.2c	5.2b	3.7c	6.4a

[1]Mean separation within rows by Duncan's multiple range test, 5 percent level.

TABLE 6. EFFECTS OF TRANSPLANTING SEQUENCE ON RELATIVE ROOT DENSITY OF THREE WOODY ORNAMENTALS

Cultivar	Root density,[1] by transplanting sequence						
	Cell pac → 3-in. pot → 1 gal.	Cell pac → 1-gal.	2 cell pacs → 1-gal.	3-in pot (1 cutting) → 1-gal.	3-in pot (2 cuttings) → 1-gal.	Direct propagation in 1-gal. pot: 1 cutting/pot	Direct propagation in 1-gal. pot: 2 cuttings/pot
Basham's Party Pink crapemyrtle	3.5f[2]	4.1e	4.3d	4.3d	4.5c	4.8b	5.0a
George Tabor azalea	2.3e	3.6d	4.3b	4.5a	4.5a	3.8c	4.2b
Hino-Crimson azalea	1.0e	3.1d	3.7c	3.1d	4.1b	4.1b	4.7a

[1]Relative root density: 1 = few surface roots on rootball; 3 = moderate root density over entire rootball; 5 = dense matting over entire rootball.
[2]Mean separation within rows by Duncan's multiple range test, 5 percent level.

Although cuttings of the three species rooted quicker in smaller containers in the greenhouse, rooting percentages did not differ between the greenhouse and outdoors. Furthermore, top and root growth were greater after 12 months when plants were propagated directly in marketable containers. The stress experienced by transplanted liners, particularly those in cell pacs transplanted once or twice, appeared to reduce growth through the remainder of the production cycle.

Results of this study suggest that woody ornamentals grown in containers can be produced in the shortest time when transplantings are minimized. Transplanting is stressful and delays growth through the remainder of the production cycle. Propagating multiple cuttings per container or transplanting multiple rooted cuttings to each container appears to have merit with slow to moderate growing species; however, material costs and production scheduling must be carefully evaluated for optimal efficiency.

See color plate number 3.

Evaluation of Ornamental Pears as Shade Trees

Donna C. Fare, Charles H. Gilliam,
Harry G. Ponder, and Wallace A. Griffey

A STUDY OF SHADE and ornamental trees is being conducted at the Piedmont Substation, Camp Hill, Alabama. During the past 6 years, 250 different selections of trees have been evaluated for growth rate and adaptability to the Southeast. Flowering, fruiting, and fall leaf color have also been observed.

Pyrus calleryana cultivars have attracted a lot of interest. Bradford, the most widely known cultivar, is found in many landscapes in the United States. Among its many landscape qualities, the Bradford pear is one of the earliest spring flowering trees. In late March or early April, trees are covered with spur-borne white flower clusters. These flowers are slightly malodorous, but this is not significant. Leaves unfurl toward the end of the flowering period. Fall color is outstanding, with summer leaves changing to various colors of reds, yellows, and burgundies during fall. Leaf color intensity and quality is dependent on climatic conditions. It has been reported that Bradford pear does not have the outstanding fall color in Northern States as it does in the South. Mature tree shape is a broad oval canopy with upright branching. There have been problems with severe splitting of the tight upright branch crotches of older Bradford trees. However, there are newer cultivars that have stronger branching habits.

One selection, Aristocrat, is a looser growing tree with a broad pyramidal canopy outline. Crotch angles are less acute, allowing this tree to have a more open and potentially stronger habit of growth. It appears that this selection will make a much larger tree than Bradford. Leaves are more tapered at the apex, but still have the same glossy green appearance as Bradford. Fall leaf color has not been as showy as other pear selections in the test, but farther north it is reported to have excellent fall color. This trend may be more climate-induced than inherited. Fruiting of Aristocrat pear is heavier than on other cultivars, but not extremely showy.

In late autumn, the small pears attract birds and the fruit are eaten before they fall. Flowering is similar to Bradford and other selections as far as color and size are concerned. One major difference is time of flowering. Aristocrat peaks in flowering 10-14 days after Bradford.

Autumn Blaze, a newer pear selection, is similar to Bradford in flowering characteristics and time of flowering. Leaves are not as ovate as Bradford and not as tapered as Aristocrat, but it still has the glossy green foliage like most ornamental pears. Fall color is brilliant red and consistently 3 to 4 weeks earlier than Bradford pear. Subsequently, leaf drop on Autumn Blaze is sooner in the fall, allowing earlier dormant handling. This selection is developing a dense pyramidal canopy with less acute branching habits than Bradford. One complaint voiced about this selection is the occasional appearance of thorns found on branches. This results from the parent species, which has an abundance of thorns. The few thorns found on Autumn Blaze should not deter the use of this selection.

Autumn Blaze and Bradford were not as vigorous as Aristocrat pear in the test. Trees of the two cultivars are averaging 25-27 inches a year in height growth, whereas Aristocrat is averaging over 3 feet a year.

See color plates numbers 4 and 5.

Reducing Moisture Stress in Flowering Dogwood

David Williams, Harry G. Ponder, and Charles H. Gilliam

FLOWERING DOGWOOD, *Cornus florida,* is one of the most popular small flowering trees used in Southern landscapes. Unfortunately, dogwood is drought sensitive and prolonged drought stress is detrimental to its growth and survival. Since periods of drought stress occur almost annually in the Southeast, a means of reducing moisture stress in dogwood warrants investigation.

Reduction of the transpiring surface is one of the drought-resistance mechanisms in many plants. Sometimes plants reduce the transpiring surface by naturally shredding leaves. It has been shown that hand defoliation reduces wilt and stress after transplanting leafed-out dogwood. Research has also proved that some nursery stock can be chemically defoliated to reduce transpiration. The purpose of this study was to evaluate use of chemical defoliants as a means of alleviating moisture stress in dogwood.

On October 4, 1984, 48 dogwood liners in 3-gallon containers were placed in an outdoor nursery to evaluate chemical defoliants. The plants were maintained under normal nursery conditions. Experimental treatments were 100, 200, and 400 p.p.m. of the defoliants Harvade® and Ethrel®. Dupont WK®, a surfactant, was applied with each rate and in a separate treatment at a 2 percent rate. Percent

TABLE 7. DEFOLIATION OF DOGWOOD TREATED WITH HARVADE, ETHREL, AND SURFACTANT

Treatment	Defoliation, by days after application			
	12	18	26	32
	Pct.	*Pct.*	*Pct.*	*Pct.*
Harvade, 100 p.p.m.	9.2b[1]	88.5ab	89.7a	90.5a
Harvade, 200 p.p.m.	11.7b	71.5b	77.5b	82.5a
Harvade, 400 p.p.m.	7.5b	80.8ab	87.8a	90.5a
Ethrel, 100 p.p.m.	46.7a	92.3a	93.8a	94.6a
Ethrel, 200 p.p.m.	33.3a	84.0a	90.3a	92.8a
Ethrel, 400 p.p.m.	45.0a	85.8a	90.8a	94.2a
Dupont WK, 2%	5.8b	26.7c	34.2b	35.2b
Control	0b	0d	0c	0c

[1]Mean separation within columns by Duncan's multiple range test, 5 percent level.

defoliation was rated 12, 18, 26, and 32 days after applying treatments.

Initially, dogwoods receiving Ethrel treatments lost a higher percentage of leaves than those receiving Harvade treatments, table 7. However, by day 18 all defoliant treatments had effectively defoliated plants, with defoliation ranging from 71.5 to 92.3 percent.

Ethrel gave the most rapid defoliation without injury. The 100 p.p.m. Ethrel rate may be preferred since rapid defoliation reduces water loss via transpiration. Only the 400 p.p.m. rate of Harvade resulted in any plant phytotoxicity. In a report of research[1] in which 17-year-old pin oaks were 85 percent defoliated, by 10 weeks after defoliation the tree had 90 percent of the number of leaves as trees not defoliated. This suggests that the use of defoliation as a means of alleviating drought stress should be limited to a time period during the first half of the growing season to allow time for natural refoliation to occur.

In situations where regular watering of drought-stressed dogwoods is not possible, defoliation may provide an alternative to losing trees due to prolonged drought stress. Additionally, survival of summer-dug dogwood could possibly be enhanced by defoliation prior to digging or soon after digging. Also, these data suggest that fall defoliation of dogwood prior to harvesting bare root or ball and burlapped is a feasible practice.

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[1]Sterett, J.P. and R.A. Creager. 1978. Chemical Defoliation of Pin Oak in the Expanding Leaf Stage. HortScience 13:32-33.

Optimizing Production of Container-Grown Pecans

Gary J. Keever and Gary S. Cobb

DEMAND FOR container-grown pecan trees has increased rapidly in recent years, primarily because trees can be transplanted year round and with greater success than field-grown, bare root trees. However, there are two potential drawbacks: (1) kinking and circling of major roots are common with tap-rooted trees in containers, and (2) since container-grown pecans are typically produced by budding

TABLE 8. EFFECT OF ROOT PRUNING AT TRANSPLANTING ON THE NUMBER OF MAIN ROOTS PER TREE AND THE FIBROUS ROOT DRY WEIGHT OF ELLIOTT PECAN SEEDINGS

Treatment	Main roots/ tree	Fibrous root dry weight
	No.	*Grams*
Pruned	2.8a[1]	9.1a
Unpruned	1.0b	6.4b

[1]Mean separation within columns by Duncan's multiple range test, 5 percent level.

or grafting the desired cultivar onto 1- to 2-year-old seedlings, at least one additional growing season is required before marketing.

The effects of nut size, container size and shape, and root pruning on growth of pecan seedlings prior to budding were evaluated with the objective of minimizing the time required to reach the budding stage. Nuts from seedling and Jackson pecan trees located at the Gulf Coast Substation, Fairhope, were collected in the fall of 1983, and graded by size. Average weight per nut was 0.13 ounce for small nuts (119 nuts per pound), 0.23 ounce for medium nuts (70 nuts per pound) from seedling trees, and 0.45 ounce for large nuts (36 nuts per pound). Nuts were stratified for 6 weeks at 44 °F and sown February 1984 in 1-gallon pots of amended pine bark. Pots were placed in a heated greenhouse and, after germination, fertilized weekly with 100 p.p.m. N from 20-20-20 soluble fertilizer. On May 15, 1984, seedlings were root pruned (tap root pruned 3½ inches below the nut) and transplanted into 5-gallon pots of amended milled pine bark-sandy loam growth medium. Pots were placed outdoors in full sun, drip irrigated, and fertilized 2 weeks later with 18-7-10 (4 ounces per pot). In September 1984, tree height and caliper, top and root dry weights, and number of main roots per tree were determined.

Nut size significantly affected all measured parameters. With increasing nut size there was an increase in tree height, caliper, number of main roots per tree, top dry weight, and root dry weight. These results agree with previous findings and are possibly explained by the dependency of early growth on stored reserves within the nut.

Root pruning did not affect tree height, caliper, top dry weight, or tap root dry weight. However, there was a significant increase in both the number of main roots per tree and the fibrous root dry weight, table 8. Root growth in the non-pruned treatment generally resulted in a single tap root that was twisted and knotted at a depth corresponding to the bottom of the propagation container. The tap root circled the bottom of the container, with secondary and feeder roots developing in greatest numbers toward the distal end. When the tap root was pruned at transplanting, three to four main roots developed, all of which produced secondary and feeder roots. No twisting of the main roots occurred, and there was less root circling in the bottom of the container than with non-pruned treatments.

In a second experiment, Elliott pecans were sown February 1983 in 1-gallon pots of amended pine bark. Pots were placed in a heated greenhouse, fertilized weekly, and transplanted in April into the different sized containers listed in table 9. In August, Cheyenne pecan scion wood was patch-budded onto Elliott stock.

TABLE 9. EFFECT OF CONTAINER SIZE AND SHAPE ON CALIPER (8 INCHES ABOVE THE MEDIUM) AND HEIGHT OF ELLIOTT SEEDLING PECANS 7 MONTHS AFTER SOWING

Container size			
Volume	Dimension, width X height	Trunk caliper	Tree height
	In.	*In.*	*In.*
10 gal.	17 X 15	0.38a[1]	27.0a
5 gal.	13 X 11¾	.35a	24.3a
5 gal.	9 X 20	.30b	19.4b
3 gal.	10½ X 9	.29b	19.8b
3 gal.	9 X 15	.28b	19.4b

[1]Mean separation within columns by Duncan's multiple range test, 5 percent level.

Greatest tree caliper and height occurred in 10-gallon and shallow 5-gallon pots; however, all trees were of sufficient size for budding (pencil diameter or larger) in July 1983. Ninety-six percent of attempted buds were still green 4 weeks after budding, with no treatment effect noted.

Container-grown seedling pecans can be sown and budded in one growing season. Since early budding is limited by seedling size, this study indicates that shallow containers at least 5 gallons in volume and larger nuts should be used to maximize growth. Budded trees in 1 year would allow earlier field transplanting of younger trees, which should enhance survival. Root pruning at transplanting can increase branching of the tap root and produce a more desirable root system for subsequent field transplanting without reducing top growth.

See color plate number 6.

Pruning Effects on Ornamentals

Donna C. Fare, Charles H. Gilliam, and Gary S. Cobb

PRODUCTION OF LINERS traditionally starts during early to mid-summer, with rooted cuttings potted in small containers and grown until stepping-up to a larger container. Often these plants become leggy and severe pruning is done to develop a more compact plant. Most commercial nurseries prune liners when stepping-up the plants to larger containers. While pruning obviously stimulates new shoot growth, little is known about how pruning affects the root system.

Pruning effects on root and shoot development were evaluated with transplanted liners of *Buxus microphylla* koreana, *Ilex crenata* Compacta, *Photinia* x *Fraseri,* and *Rhododendron* x Fashion in 1-gallon containers. Also, root and shoot growth were evaluated on *Photinia* x *Fraseri* and *R.* x Fashion when shifted from 1-gallon to 3-gallon containers.

Potting medium was 100 percent milled pine bark amended per cubic yard with 6 pounds dolomitic limestone, 2 pounds gypsum, 1½ pounds Micromax, and 12 pounds of 17-7-12 Osmocote. Plants were potted April 25, 1985, and

TABLE 10. PRUNING EFFECTS OF PLANT GROWTH OF *I. CRENATA* COMPACTA AND *PHOTINIA* X *FRASERI* IN ONE-GALLON CONTAINERS

Treatment	Root rating[1], by months after pruning			Root dry weight, by months after pruning			Shoot dry weight, by months after pruning		
	2	4	6	2	4	6	2	4	6
				Grams	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
I. crenata Compacta									
check........................	2.8a[2]	4.3a	4.6a	2.0a	4.6a	31.4a	0.7a	10.0a	29.4a
Pruned at potting............	2.1c	3.9a	4.3a	.8b	2.5b	29.3a	.8a	6.2b	19.2a
Pruned 6 weeks after potting..	2.4b	2.6b	4.4a	1.6a	2.9b	25.4a	.2b	4.0b	19.1a
Photinia x Fraseri									
check........................	3.4a[2]	4.6a	4.5a	1.2a	2.5a	27.6a	1.7a	11.0a	21.1a
Pruned at potting............	2.2b	4.2a	4.4ab	.4b	1.1b	18.3b	.3b	3.0b	16.5a
Pruned 6 weeks after potting..	2.3b	2.7b	3.8b	.7b	.8b	12.0c	.5b	2.3b	14.0a

[1]Rating scale: 1 = no roots showing; 2 = very sparse root development; 3 = moderate root development; 4 = roots generally covering entire rootball; and 5 = matting of entire rootball.
[2]Mean separation within columns by Duncan's multiple range test, 5 percent level.

grown in full sun, except Fashion azaleas were grown under 47 percent shade cloth.

Three treatments were evaluated: nonpruned, pruned at potting, and pruned 6 weeks after potting. At each pruning, approximately 50 percent of the plant was removed. Two, 4, and 6 months after potting, a visual root rating, along with root and shoot dry weights, was taken. With Fashion azaleas, only visual root ratings and end of the season growth indices were taken.

Shoot pruning at potting initially suppressed root growth of all plants tested. Two months after potting, nonpruned plants had higher visual root ratings. Root dry weights reflect this, with nonpruned plants having greater root weight than either pruned treatment, table 10. Shoot dry weight reflected more growth with the nonpruned plants than with either pruned treatment. Initially, this was expected since plants pruned 6 weeks after potting were pruned 2 weeks prior to this rating. The same trend was observed regardless of container size.

At the end of the growing season (6 months after potting), it was observed that pruning effects on root growth were species dependent. Fraser photinia (1-gallon) and Korean boxwood had less root development with either pruned treatment compared to the nonpruned plants. However, there was little difference in the visual rating and root dry weights between the two pruned treatments. When shoot dry weight was taken, there was no difference among treatments. Generally, 3-gallon photinias were showing the same growth trend as the 1-gallon photinias. By the end of the season, however, there were no differences in root growth of Fashion azalea and Compacta holly when comparing pruned and nonpruned treatments. These plants had outgrown the initial growth differences between pruned and nonpruned plants. Furthermore, there was no difference among treatments with shoot dry weight of compacta holly. With Fashion azalea, growth indices were similar among treatments in both 1- and 3-gallon containers.

It was observed that more root and shoot growth took place during the 4- to 6-month period than the 2- to 4-month period regardless of plant species. Furthermore, it appeared that neither treatment (nonpruned or pruned at potting) affected the timing on this flush of growth, but the amount of root and shoot growth was species dependent.

These data show that pruning initially suppresses root growth of all plants tested, but end-of-the-season responses vary with species. However, the greatest amount of root and shoot growth took place at the same time disregarding treatment effect. Root and shoot growth patterns were similar between plants shifted from a linear to a 1-gallon container and a 1-gallon plant stepped-up to a 3-gallon container.

These data suggest that delaying shoot pruning of some ornamental plants would allow roots to become more established prior to a flush of shoot growth.

GREENHOUSE CROPS

Lime, Molybdenum, and Cultivar Effects on Molybdenum Deficiency of Poinsettia

Douglas A. Cox and Ginger C. Bartley

DEFICIENCY OF THE MICRONUTRIENT molybdenum (Mo) causes interveinal chlorosis and marginal necrosis on poinsettia leaves. Growers often report the development of these symptoms in the late fall. Because of the unsightliness of the injury, the economic value of the plants is greatly reduced. This study was conducted to study the effects of lime, Mo fertilization, and cultivar on the occurrence of Mo deficiency.

Rooted cuttings of poinsettia cultivars Annette Hegg Brilliant Diamond, Gutbier V-14 Glory, and Eckespoint C-1 Red were planted in 6-inch pots of amended sphagnum peat moss and perlite (1:1, volume basis) medium. To study the effects of liming, no limestone or dolomitic limestone at the rate of 5 pounds per cubic yard was incorporated in the medium, resulting in pH values of 4.7 and 5.8, respectively. No micronutrient fertilizer was incorporated in the medium, but micronutrient solutions were applied two or three times per week with the routine application of water-soluble nitrogen and potassium fertilizer. One micronutrient solution supplied all micronutrients but Mo, while Mo, from ammonium molybdate, was added to the other at 0.1 p.p.m. To evaluate treatment effects on Mo status of plants, upper leaves were analyzed for Mo content. These analytical results were compared to the tissue analysis standard of 0.5 p.p.m. established for poinsettia.

The combination of low pH and no supplemental Mo caused severe Mo deficiency symptoms in Gutbier V-14 Glory and Annette Hegg Brilliant Diamond. Symptoms were absent from Eckespoint C-1 Red. Increasing growing medium pH and/or application of Mo-containing solution prevented the occurrence of Mo-deficiency symptoms. Plant height and dry weight were not affected by liming or Mo. Leaf analysis revealed that tissue Mo was at or below the standard value (0.5 p.p.m.) with the combination of low pH and no supplemental Mo. In most cases, raising the pH and/or applying Mo raised the tissue Mo content to levels exceeding the standard. Even though tissue Mo in Eckespoint C-1 Red was below standard in two treatments, no symptoms occurred. This suggests that Eckespoint C-1 Red has a lower requirement for Mo than the other cultivars or that a broader tissue analysis standard range is needed for Mo.

Results of this study show that the most reliable way of preventing Mo deficiency is the incorporation of enough limestone in the medium to achieve a pH of about 5.8 and frequent application of a dilute Mo solution. In all cultivars tested, the combination of liming to pH 5.8 and supplemental Mo resulted in tissue Mo levels at least three times greater than the established critical level.

TABLE 11. EFFECT OF GROWING MEDIUM PH AND MOLYBDENUM ON MOLYBDENUM CONTENT OF POINSETTIA LEAVES

Treatment	Mo tissue analysis		
	Eckespoint C-1 Red	Gutbier V-14 Glory	Annette Hegg Brilliant Diamond
	p.p.m.	*p.p.m.*	*p.p.m.*
-Lime, -Mo[1]	0.3	0.5	0.3
-Lime, +Mo	.7	.8	.7
+Lime, -Mo	.4	.7	.6
+Lime, +Mo	1.7	1.8	1.4

[1]Lime and Mo effects were significant at 1 percent level in all cultivars.

Production of *Centaurea montana* for Early Spring Sales

Douglas A. Cox

MOUNTAIN BLUET, or perennial bachelor's button *(Centaurea montana),* is a vigorous perennial adaptable to sun or partial shade that is normally planted for mass effect. It is particularly valued for its blue flowers produced from late spring to midsummer, which make excellent cut flowers. It is readily propagated from seed and reaches 4- to 5-inch pot size in the greenhouse 1½-2 months after transplanting. However, young plants produced for early spring markets (beginning in late March) assume a compact, rosette-like form and do not flower until late spring or early summer. The objective of this study was to determine if *C. montana* can be forced by night-lighting, thereby producing a flowering plant for early spring marketing.

Seeds were sown in vermiculite on December 18, 1984, and placed under mist to germinate. On January 4, seedlings were transplanted to 5-inch standard plastic pots of an amended sphagnum peat moss and perlite medium, (1:1, volume basis). Plants were grown in the greenhouse at 70°/65°F day/night temperature and were fertilized at every watering with Peter's 20-20-20 at 200 p.p.m. N.

At transplanting, three treatments were established: natural daylength, natural daylength + 4 hours night-lighting (10 p.m. to 2 a.m.), and natural daylength + 6 hours night-lighting (10 p.m. to 4 a.m.) Night-lighting was supplied by 60-watt incandescent lamps spaced 3 feet apart and 3 feet above the pot rim; lighting was continued until the experiment ended (April 14).

Half of the plants in night-lighting treatments were pinched; plants in the natural daylength treatments were not pinched since they did not elongate. Pinching was accomplished by removing 5-6 inches of the terminal portions of basal shoots.

Four or 6 hours of night-lighting successfully stimulated stem elongation and flowering of *C. montana.* All plants

TABLE 12. GROWTH AND FLOWERING OF *CENTAUREA MONTANA* AS INFLUENCED BY PHOTOPERIOD AND PINCH TREATMENT

Photoperiod treatment	Pinch	Number flowered[1]	Days to visible bud[2]	Days to anthesis[3]	Plant height at anthesis	Shoots per plant
		Pct.	*No.*	*No.*	*In.*	*No.*
Natural day................	No	0	--	--	--	--
Natural day + 4 hours night-lighting............	No	100	63	71	18.0	3.8
Natural day + 4 hours night-lighting............	Yes	100	65	75	15.3	4.7
Natural day + 6 hours night-lighting............	No	100	54	63	14.0	3.0
Natural day + 6 hours night-lighting............	Yes	100	64	74	15.6	5.2
Pinch, 4 hours vs. 6 hours			ns[3]	ns	ns	ns
No pinch, 4 hours vs. 6 hours			**	**	**	ns
4 hours, pinch vs. no pinch			ns	ns	ns	ns
6 hours, pinch vs. no pinch			**	**	ns	**

[1]During 100-day period following transplanting and start of photoperiod treatments.
[2]Days from transplanting and start of photoperiod treatments.
[3]Treatments effects were nonsignificant (ns) or significant at the 5 percent (*) or 1 percent (**) level.

flowered in the lighted treatments, table 12. Under natural daylength with no night-lighting, stem elongation did not occur, plants remained in a compact rosette, and flower buds did not form. Plants in this treatment were 7.8 ± 1.3 inches tall at the end of the experiment.

Night-lighting for 4 or 6 hours had no effect on growth and flowering of pinched plants, but nonpinched plants lighted for 6 hours formed buds earlier, flowered earlier, and were shorter than those receiving 4 hours of night-lighting. With 6 hours of night-lighting, pinching delayed bud formation and flowering, but increased shoot number. Pinching had no effect on final plant height in either photoperiod treatment. However, shoots resulting from the pinch were weaker than those arising at the soil-line of nonpinched plants and required support. Because plant height was not reduced and shoot number not greatly increased, pinching of *C. montana* during production does not appear beneficial.

This study shows that flowering or budded plants of *Centaurea montana* can be produced from seed for early spring sales by night-lighting. Both 4 and 6 hours of night-lighting were effective in promoting flowering. Production was most rapid when plants were not pinched and were exposed to 6 hours of night-lighting. Larger pots than those used in this study are needed for production.

Salinity Effects on Bedding Plants

Zong T. Huang and Douglas A. Cox

WATER QUALITY is an important and often overlooked factor in greenhouse plant production. Salinity, as determined by electrical conductivity (EC) of water, is one aspect of water quality which may affect plant growth and quality. High EC may result from excess fertilizer, use of water contaminated by salts, or proximity of water source to seawater. Damage to plants results from water stress caused by high soluble salts in the growing medium, phytotoxic effects of salt ions, or both. The objective of this study was to determine the effects of salinity on the growth of three common bedding plants.

Seeds of marigold (*Tagetes erecta* First Lady), geranium (*Pelargonium* x *hortorum* Jackpot), and annual vinca (*Catharanthus roseus* Pink Carpet) were sown in vermiculite. Seedlings were transplanted to amended peat-perlite (1:1, volume basis) in 5-inch standard plastic pots. Plants were fertilized at every watering with 200 p.p.m. of N and K from ammonium nitrate and potassium nitrate. Salinity treatments were 3.0, 4.5, 7.9, and 13.9 mmho/cm EC obtained by adding a mixture of sodium chloride and calcium chloride to the fertilizer solutions. Fertilizer solution without salt had an EC of 1.3 mmho/cm EC (control). Plant height and dry weight measurements were made when the plants began to flower.

Increasing salinity level reduced plant height and dry weight of all three species, table 13. Foliar symptoms of salt injury, leaf yellowing and marginal necrosis, occurred on marigold and geranium at the two highest salinity levels. No injury occurred on annual vinca at any salt level even though growth decreased as salinity increased. Height and dry weight reductions of all species were generally less than 10 percent of the control at 3.0 and 4.5 mmho/cm, indicating some tolerance to moderate salinity levels. At the highest salt level (13.9 mmho/cm), growth was reduced at least 25 percent for all species; reductions were greatest for geranium and marigold and least for annual vinca.

TABLE 13. EFFECT OF SALINITY ON GROWTH OF BEDDING PLANTS

Salinity level, mmho/cm[2]	Marigold		Geranium		Annual vinca	
	Height[1]	Dry wt.[1]	Height	Dry wt.	Height	Dry wt.
	In.	*Grams*	*In.*	*Grams*	*In.*	*Grams*
1.3 (control)[3]...........	19.5	27.3	18.0	9.2	9.0	3.9
3.0....................	18.2	26.3	19.0	10.0	8.5	3.4
4.5....................	17.8	29.5	17.0	9.3	8.5	3.1
7.9....................	15.0	23.0	15.5	7.9	6.5	2.2
13.9...................	13.5	14.7	11.3	4.7	6.6	2.5

[1]Relationship between salt level and height and dry weight of all species was significant at the 1 percent level and changes followed a straight line.
[2]mmho/cm x 100 = K x 10^{-5}.
[3]Electrical conductivity (EC) of fertilizer solution with no added salt.

Results of this study show that growth and quality of several bedding plants are reduced by irrigation water salinity in the range of 3.0 to 13.9 mmho/cm. Growers can check their water for potential salinity problems using a simple conductivity meter. However, salinity levels similar to those in this study may cause different effects; sodium and chloride salts were used to create salinity in this experiment and plants may respond differently to other salts.

Container Production of Comptie, *Zamia furfuracea* Ait.

Gary J. Keever and Gary S. Cobb

COMPTIE (*Zamia furfuracea* Ait. [*Z. pumila* L.]) is one of about 40 species of palm-like, dioecious cycads in the Zamiaceae family native to tropical and subtropical America. Comptie has a trunk up to 6 inches high or wholly underground. Leaves are pinnately compound, 2 to 4 feet long with 2 to 13 pairs of thick, leathery leaflets that are 2 to 8 inches long and oblong-obovate in shape. As a group, cycads are tolerant of drought and grow in full sun or partial shade and they make attractive landscape plants. Because of difficulty in germinating seed and a long cropping period (3 to 5 years for saleable plants), however, few nurserymen grow cycads and they are infrequently used in the landscape. Cycads are reported to fix nitrogen and have a supposedly unchangeable growth rate, but little research has been reported on the manipulation of early growth of comptie. Two studies were conducted to investigate the influence of several cultural practices, including light intensity, nitrogen fertilization, liming rate, and container volume, on the growth of comptie.

In the first study, bare-root seedlings of comptie were potted November 2, 1981, in 4-inch containers of milled pine bark-sandy loam soil (7:1, volume basis) amended with 2 pounds superphosphate, 2 pounds gypsum, and 4 pounds Esmigran per cubic yard, and 2 rates of dolomitic limestone, 2 pounds and 8 pounds per cubic yard. Plants were placed under 47 percent shade and misted until established. On December 28, 1981, plants were selected for uniformity and half of those receiving each liming rate were placed under each of two light regimes, 47 and 72 percent shade. Beginning January 19, 1982, plants received weekly applications of 100, 200, or 300 p.p.m. N with 50 p.p.m. N from KNO_3 and the remainder from NH_4NO_3. Growth medium soluble salts and pH were determined in April and September, 1982; leaf number was counted in July and October, 1982.

In a second study, the influence of container size on growth and leaf development of comptie was determined. On March 26, 1985, uniform 2-year-old seedlings were potted in four sizes of containers using an unamended milled pine bark-sandy loam soil (7:1, volume basis) and placed in a 47 percent shaded greenhouse. Container volumes were 46, 76, 153, and 320 cubic inches. To lessen the influence of fertilization on growth medium volume, surface application of 0.13 ounce dolomitic limestone, 0.072 ounce gypsum, 0.05 ounce Micromax, and 0.11 ounce Osmocote 13-13-13 per container plus weekly application of 150 p.p.m. N from NH_4NO_3 was made. Leaf number was determined at potting and again on November 15, 1985; growth index was measured January 9, 1986.

By October 1982, more leaves were produced by plants grown under 47 percent shade compared to 72 percent shade, table 14. Comptie responded to N fertilization up to 200 p.p.m. N per week with an increase in leaf number. No additional benefit was obtained from weekly applications of 300 p.p.m. N. Plants continued to form new leaves throughout the study, and by October 1982 plants were considered marketable in the 4-inch containers or of sufficient size to transplant into 1-gallon containers.

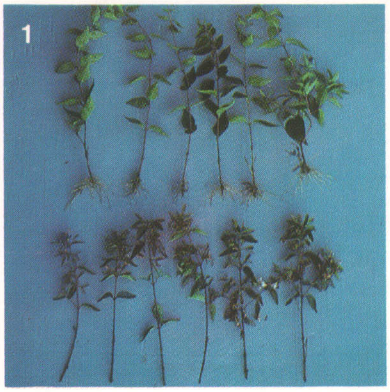
Dolomitic limestone applied at the 8-pound-per-cubic-yard rate resulted in fewer leaves than the 2-pound-per-cubic-yard rate at both sampling dates. In November 1982, plants were placed under 47 percent shade and fertilized weekly with 200 p.p.m. N. By September 1983, plants given the lower rate of dolomitic limestone had developed interveinal chlorosis of the mature leaves. These symptoms are characteristic of magnesium deficiency, and this suggests that although comptie benefited from a highly acidic growth medium (pH 4.2), magnesium should be added when the medium is amended with low rates of dolomitic limestone.

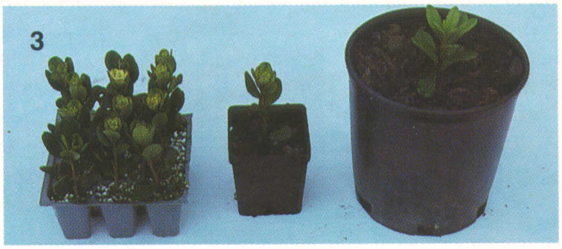
Increasing rates of NH_4NO_3 decreased growth medium pH and increased soluble salts at both sampling dates. Higher liming rates increased growth medium pH, but did not affect soluble salts levels in the medium at either sampling date.

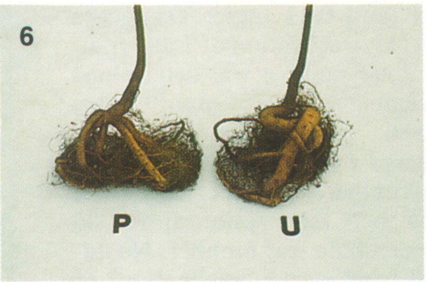
TABLE 14. EFFECTS OF CULTURAL PRACTICES ON MEDIUM PH, SOLUBLE SALTS, AND LEAF NUMBER OF COMPTIE

Treatment	pH		Soluble salts (mmhos cm[1])		Leaf number	
	April 30	Sept. 20	April 30	Sept. 20	July 13	Oct. 13
Light exclusion						
47%	5.1	4.6	0.71	0.76	5.3	7.6a[1]
72%	5.1ns	4.5ns	.51ns	.54ns	4.7ns	6.4b
Nitrogen fertilization (p.p.m./week)						
100	5.4a	5.4a	.25c	.16c	4.7b	6.3b
200	5.0b	4.3b	.64b	.74b	5.3a	7.3a
300	4.8c	4.0c	.95a	1.05a	5.1a	7.5a
Liming rate (lb./cu.yd.)						
2	4.5b	4.2b	.58	.56	5.3a	7.3a
8	5.6a	4.9a	.65ns	.74ns	4.7b	6.8b

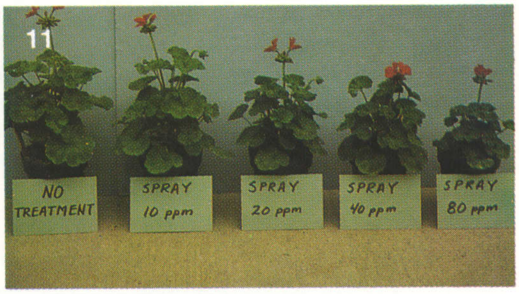
[1]Mean separation within columns of main effects by Duncan's multiple range test, 5 percent level. Interactions between main effects were not significant.



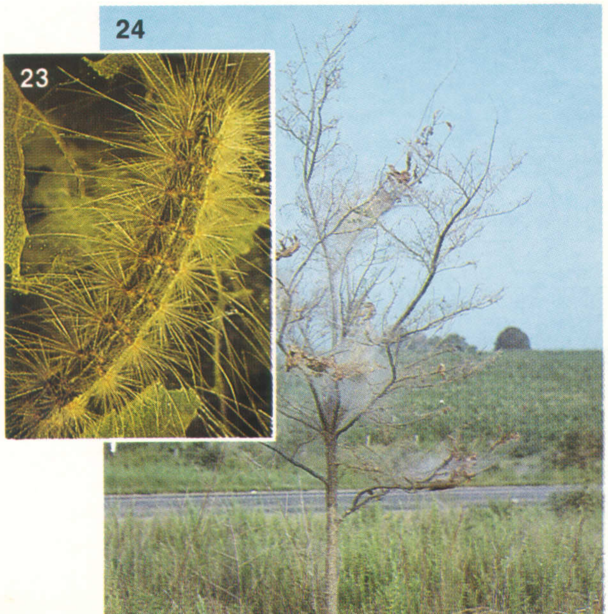




(1) Rooting of vegetative (top) and flowering (bottom) cuttings of abelia. (2) Rooting of vegetative (left) and fruiting (right) cuttings of Foster holly. (3) Cuttings propagated in cell pacs (left), 3-inch pots (center), and 1-gallon pots (right). (4) Fall color of Autumn Blaze pear. (5) Flowering of Aristocrat pear. (6) Effect of root pruning at transplanting on root growth patterns of seedling pecan: P = pruned, U = not pruned. (7) Varieties (left to right) C-1 Red, V-14 Glory, and Hegg Diamond show effects of low pH and no Mo treatment (front row) and with lime and Mo (back row). (8) *Centeaurea montana* plants 65 days after transplanting, with (left to right) natural daylength, natural day + 4 hours light, and natural day + 6 hours light. (9) Comptie *(Zamie furfuraceae* Ait.), dioecious cycad of the Zamiaceae family. (10-14) Effect of paclobutrazol on geranium and zinnia (left to right): 10—untreated, 0.03 mg drench, 0.06 mg drench, 0.12 mg drench, and 0.24 mg drench on geranium; 11—untreated, 10 p.p.m. spray, 20 p.p.m. spray, 40 p.p.m. spray, and 80 p.p.m. spray on geranium; 12—untreated, 0.5 mg drench, 1.0 mg drench, 2.0 mg drench, and 4.0 mg drench on zinnia; 13—untreated, 250 p.p.m. spray, 500 p.p.m. spray, 1,000 p.p.m. spray, and 2,000 p.p.m. spray on zinnia.



(14) Poinsettia growth regulation from, left to right, Sumagic foliar spray, Cycocel spray, Cycocel + B-Nine spray, and untreated. (15) Roses sprayed at 2-week interval with Systhane, 10 ounces per 100 gallons of water. (16) Roses sprayed at 1-week interval with Triforine at 1 fluid ounce per 100 gallons of water. (17) Bacterial leaf spot on schip laurel. (18) Fungus was introduced into trunk of seedling dogwood via a superficial slit. (19) Dogwood from which water was withheld 4-6 days before inoculation. (20) Azalea caterpillar feeding on Indica azalea. (21) Whitefly pupae on underside of gardenia leaf. (22) False spider mite injury to liriope. (23) Fall armyworm feeding on persimmon. (24) Tree completely defoliated by fall webworm. (25) Holly looper feeding on Japanese holly. (26) Late-stage tip moth damage to Virginia pine.



Container volume had no effect on either leaf number or growth index of comptie. These results differ from those reported in other studies in which an increase in container volume produced more growth; however, in several of these studies, fertilizer was applied on a volume basis. Consequently, response to a greater growth medium volume may have actually been a response to increased fertilizer.

Comptie responded to both reduced levels of shading and nitrogen applications up to 200 p.p.m. N per week by forming more leaves, thus showing that production time can be shortened by manipulating cultural practices. Low levels of dolomitic limestone were beneficial, whereas container size was not critical provided 200 p.p.m. N per week was supplied. The positive response found to certain cultural practices might encourage nurserymen to grow the versatile, attractive cycad.

See color plate number 9.

Paclobutrazol as a Growth Retardant for Geranium and Zinnia

Douglas A. Cox and Gary J. Keever

GROWTH-RETARDING CHEMICALS are often used by bedding plant growers to reduce the height of many species. Compact bedding plants are more attractive and are easier to handle and ship. B-Nine is the principle growth retardant currently used on bedding plants. Recently a new chemical, paclobutrazol, has shown powerful growth-retarding effects on several ornamental plants when applied as a spray or drench. A paclobutrazol-containing retardant (trade name Bonzi^{A}) is currently labeled for poinsettia, but not for use on bedding plants. The purpose of this study was to evaluate the potential of paclobutrazol for height control of two bedding plants, geranium and zinnia.

Seeds of geranium (*Pelargonium* x *hortorum* Smash Hit) and zinnia (*Zinnia elegans* Scarlet Ruffles) were direct-sown in 5-inch pots of an amended sphagnum peat moss and perlite medium (1:1, volume basis) on April 21, 1986. Seedlings were thinned to one per pot. A spray or drench treatment was made to zinnia 22 days after sowing (May 13) when the plants were about 2.5 inches tall and to geranium 35 days after sowing (May 26) when the plants were about 1.75 inches tall. Spray rates of 10, 20, 40, or 80 p.p.m. and 250, 500, 1,000, or 2,000 p.p.m. were applied to geranium and zinnia, respectively. Drench rates of 0.03, 0.06, 0.12, or 0.24 milligrams of active ingredient per pot (mg a.i. per pot) and 0.5, 1.0, 2.0, or 4.0 mg a.i. per pot were applied to geranium and zinnia, respectively. Drenches were applied at 1.7 fluid ounces per pot. Plants of both species receiving no treatment were included for comparison. Spray and drench rates were chosen based on results of an earlier study. Growth measurements were made 35 days (June 17) and 40 days (June 22) after treatment on zinnia and geranium, respectively.

Geranium Results. Paclobutrazol sprays and drenches at all rates significantly reduced plant height and dry weight of geranium compared to plants receiving no treatment, table 15. As the rate of drench or spray increased, height decreased. Dry weight decreased with increasing spray rate, but not with increasing drench rate. Drench application of paclobutrazol caused excessive height reduction at all rates tested; internodes were extremely compressed and leaf size greatly reduced. Further testing of drench rates below 0.03

TABLE 15. EFFECT OF PACLOBUTRAZOL ON GERANIUM GROWTH

Treatment	Adjusted height[1]	Dry weight
	In.	*Grams*
Method		
Drench	3.0c[2]	3.4b
Spray	6.5b	7.0a
Control	8.5a	7.7a
Drench rate (mg a.i./pot)		
0.03	4.4	4.3
0.06	3.2	3.8
0.12	2.6	3.0
0.24	1.8	2.4
Significance[3]	L**Q**	ns
Spray rate (p.p.m.)		
10	7.6	7.8
20	7.0	6.9
40	6.0	7.3
80	6.0	6.0
Significance[3]	L**Q**	L*

[1]Height to top of flower 40 days after treatment minus plant height at time of treatment.
[2]Means followed by the same letter are not statistically different at the 1 percent level.
[3]Linear (L) or quadratic (Q) regression significant at 5 percent (*), or 1 percent (**) level, or not significant (ns).

TABLE 16. EFFECT OF PACLOBUTRAZOL ON ZINNIA GROWTH

Treatment	Adjusted height[1]	Dry weight
	In.	*Grams*
Method		
Drench	6.6b[2]	5.0c
Spray	7.0b	5.7b
Control	17.5a	8.9a
Drench rate (mg a.i./pot)		
0.5	10.6	6.0
1.0	8.2	5.5
2.0	4.6	4.3
4.0	3.9	4.1
Significance[3]	L**	L**
Spray rate (p.p.m.)		
250	9.1	6.6
500	7.6	5.9
1,000	6.1	5.4
2,000	5.5	4.7
Significance[3]	L**Q**	L**

[1]Height to top of flower 35 days after treatment minus plant height at time of treatment.
[2]Means followed by the same letter are not statistically different at the 1 percent level.
[3]Linear (L) or quadratic (Q) regression significant at 1 percent (**).

mg a.i. per pot is needed to find rates producing acceptable height reduction. Spray applications of 20 and 40 p.p.m. produced acceptable height reductions without any undesirable effects.

Zinnia Results. As with geranium, paclobutrazol sprays and drenches were effective in reducing plant height and dry weight, but much higher rates were required for zinnia compared to geranium, table 16. As the rate of drench or spray increased, both height and dry weight decreased. Acceptable height reductions resulted from drench applications of 0.5 and 1.0 mg a.i. per pot, and spray applications of 250, 500 and 1,000 p.p.m. Height reductions caused by drenches of 2.0 and 4.0 mg a.i. per pot and spray of 2,000 p.p.m. were excessive and were accompanied by reduced leaf size and suppressed branch growth.

Results of this study showed that paclobutrazol is an effective growth retardant for geranium and zinnia. Best results were obtained for geranium with sprays of 20 and 40 p.p.m. and for zinnia with drenches of 0.5 and 1.0 mg a.i. per pot and sprays of 250, 500, and 1,000 p.p.m.

See color plates numbers 10, 11, 12, and 13.

Sumagic Shows Promise as Growth Regulator for Poinsettia Production

James C. Stephenson and Ronald L. Shumack

PRODUCTION OF QUALITY poinsettias depends, in part, on controlling the height. While newer cultivars are more compact, a grower must generally still make two to four applications of a growth regulator to produce a marketable plant. Poinsettia plant growth regulators are applied as either a soil drench or foliar spray. Soil drenches are more effective per application in reducing plant height but require preparation of a greater volume of chemical and more labor to apply. On the other hand, foliar sprays require multiple applications which increase total labor required and may produce some undesirable side effects. These include chlorotic and necrotic lesions on leaves, reduced bract size, and bract crinkling.

Sumagic® was evaluated as a single-application plant growth regulator for season-long height control without side effects. Chevron is marketing this product in the United States and is expected to have a full ornamental label by late 1987.

Poinsettia, *Euphorbia pulcherrima* Gutbier V-14, rooted cuttings were potted August 22, 1986, in Lerio RT 600 pots (6-inch). The medium consisted of milled pine bark-peat moss (3:1, volume basis) amended with 6 pounds dolomitic lime, 2 pounds gypsum, and 1.5 pounds Micromax per cubic yard. Plants were topdressed with 1 teaspoon Osmocote 19-6-12 at potting and received 500 p.p.m. N weekly from Peters 20-10-20 Peat-Lite Special liquid fertilizer. In addition, twice during the growing season all plants were drenched with epson salts ($MgSO_4$) at 600 and molybdenum at 0.2 p.p.m. Approximate maximum day temperature was 85 °F and minimum night temperature 65 °F. Sumagic was applied once as a 50-milliliter-per-pot drench or foliar spray to run-off on September 25, 1986; Cycocel spray and Cycocel and B-Nine spray treatments were made on this date also and three additional weekly applications were made in accordance with the label, table 17.

Following a 15-week growing season, poinsettia bract measurements, quality rating, and plant heights were taken, table 17. Bract size was not effected by Sumagic or any other treatments except the combination of B-Nine and Cycocel. With the B-Nine and Cycocel treatment, bract size was consistently smaller throughout the study. Quality rating was highest on the three Sumagic foliar sprays, Sumagic drench at the highest rate, and Cycocel. Treatments having optimum plant height, 15-18 inches, were the 10 and 25 p.p.m. Sumagic foliar spray and 2,000 p.p.m. Cycocel foliar spray.

To summarize, Sumagic applied as a single 10-25 p.p.m. foliar spray 2 weeks after pinch gave an excellent compact and shapely plant with good bract and leaf color and no bract size reduction. Sumagic shows promise for the floriculture market.

See color plate number 14.

TABLE 17. EFFECT OF SUMAGIC ON POINSETTIA GUTBIER V-14

Treatment	Rate	Application method	Bract measurement[1]	Quality rating[2]	Height[3]
	p.p.m.		*In.*		*In.*
Sumagic	5	Foliar	5.8	4.8	19.0
Sumagic	10	Foliar	6.0	4.8	17.3
Sumagic	25	Foliar	5.7	4.8	15.0
Sumagic	2	Drench	6.0	3.9	11.3
Sumagic	3	Drench	5.6	4.5	12.0
Sumagic	5	Drench	5.5	4.7	9.8
Cycocel	2,000	Foliar	5.3	4.9	14.5
Cycocel + B-Nine	2,000 + 2,500	Foliar	3.3	3.8	13.0
Control			5.4	4.2	20.6

[1]Measurement taken along midvein from petiole end to bract apex.
[2]1 = dead plant; 2 = leaves yellow, poor form, bract undeveloped; 3 = not marketable, small bracts, too tall; 4 = marketable; 5 = optimum quality, deep green leaves, vivid bracts, compact, well shaped plant.
[3]Measurement from soil surface to tallest flower.

Evaluation of Systhane and Folicur for the Control of Rose Blackspot

Austin K. Hagan, Charles H. Gilliam, and Donna C. Fare

BLACKSPOT IS THE MOST damaging disease of cultivated roses in Alabama. Contact fungicides, such as Daconil® 2787 and Folpet®, provide good blackspot control when used repeatedly according to label directions. However, a rapidly expanding group of systemic fungicides called sterol biosynthesis inhibitors (SBI) may prove superior to available contact fungicides. Research on recently introduced SBI fungicides for blackspot control on roses is limited. The objective of this work was the evaluation of Systhane® and Folicur® in separate tests for the control of blackspot and a comparison of their effectiveness with Daconil 2787 and Triforine® .

In February 1986, Mister Lincoln roses were planted in sandy loam soil amended with pine bark. At 3-month intervals, 8 ounces of 8-8-8 fertilizer was spread around the base of each plant. Water was applied as needed through overhead sprinklers. Each plant was regularly pruned to remove spent blooms and suckers. Fungicides were applied with a pump-up compressed air sprayer to run-off on all leaf surfaces. Activate® adjuvant was included in wettable powder tank-mixes at a rate of ½ pint per 100 gallons of water. Disease severity was assessed on a scale of 1 = no disease to 5 = severe defoliation.

In the spring 1986 trial, Systhane 40W at 2.5, 5.0, and 10.0 ounces, Daconil 2787 4.17F at 2 pints, and Triforine 1.6E at 12 fluid ounces per 100 gallons of water were evaluated for blackspot control. Applications were made at 1-, 2-, and 4-week intervals from April 18 through October 6. Disease assessments were made on June 6, August 19, and October 6.

In the fall of 1986, Folicur 25W at 1, 2, and 4 ounces per 100 gallons of water and Daconil 2787 4.17F at 2 pints per 100 gallons of water were evaluated for the control of blackspot on Double Delight roses grown in an amended pine bark medium in 1-gallon containers. Plants were heavily defoliated by blackspot before the first fungicide application. All rates of Folicur 25W were applied from September 22 to November 20 at 1-, 2-, and 4-week intervals, while Daconil 2787 applications were made weekly.

In the first screening test, all fungicide treatments significantly reduced blackspot severity through the growing season compared to the nonsprayed control. However, differences in disease control were noted among the fungicide treatments.

Initially, the two higher rates of Systhane 40W applied weekly maintained good disease control through the spring, table 18. The 2.5-ounce rate proved less effective against this disease than the two higher rates. Efficacy of Systhane at the two higher rates for blackspot control was similar to Daconil 2787 and Triforine through June 6.

As the summer progressed, the effectiveness of several fungicide treatments declined, table 18. By August 21, the two lower rates of Systhane no longer maintained effective disease control. Disease severity of both the 2.5- and 5.0-ounce treatments remained higher than the 10.0-ounce rate of Systhane. The high rate controlled blackspot as well as Daconil 2787. Both the 10-ounce rate of Systhane and Daconil provided better disease control than Triforine.

All fungicide treatments applied weekly consistently provided better blackspot protection than the same product applied at 2- or 4-week intervals (data not shown). With a 2-week spray interval, only the high rate of Systhane and Daconil 2787 maintained adequate disease control. Although the remaining treatments applied every 2 weeks reduced disease severity compared to the control, spotting of the leaves and defoliation were unacceptable. With a 4-week spray interval, none of the fungicides evaluated prevented disease spread.

In the fall 1986 test, which had severe disease pressure, the roses were already defoliated by blackspot before the first fungicide application. As a result, all Folicur treatments and Daconil 2787 treatments failed to provide adequate disease control, table 19.

Folicur at 2 and 4 ounces significantly reduced disease severity below that on the nonsprayed controls, table 19. Damage on plants sprayed with either of these Folicur rates was limited to leaf spotting and light defoliation. The level of disease control provided by both Folicur rates was similar to that from Daconil 2787. Weekly applications of the low rate of Folicur also significantly reduced disease severity, but the disease control provided was less than from the two higher rates of Folicur or Daconil 2787.

As in the previous study, fungicide efficacy declined sharply as spray intervals increased from 1 to 4 weeks. Disease severity ratings for all rates of Folicur applied every 2 weeks were consistency higher than those recorded at 1-week intervals. Blackspot levels on the roses sprayed monthly with Folicur were similar to those on the nonsprayed control plants.

TABLE 18. COMPARISON OF SYSTHANE WITH DACONIL 2787 AND TRIFORINE APPLIED WEEKLY FOR BLACKSPOT CONTROL ON MISTER LINCOLN ROSE

Treatment	Rate/ 100 gal.	Disease severity[1] June 6	August 1	October 6
Systhane 40W	2.5 oz.	1.8b[2]	2.0b	2.5b
Systhane 40W	5.0 oz.	1.0c	2.3b	2.0b
Systhane 40W	10.0 oz.	1.0c	1.0c	1.0c
Daconil 2787 4.17F	2 pt.	1.0c	1.0c	1.0c
Triforine 1.6E	12 fl. oz.	1.5bc	2.3b	2.5c
Unsprayed control	--	2.6a	3.5a	4.5a

[1]Disease severity was evaluated on a scale of 1 = no disease to 5 = severe defoliation.
[2]Means followed by the same letter are not significantly different according to Duncan's multiple range test (P = 0.05).

TABLE 19. EVALUATION OF FOLICUR FOR BLACKSPOT CONTROL ON DOUBLE DELIGHT ROSES, FALL 1986

Fungicide rate/100 gal.	Disease severity[1]
Folicur 25W, 1 oz./100 gal.	
Sprayed weekly	3.0cd[2]
Sprayed every 2 weeks	3.6bc
Sprayed every 4 weeks	4.4a
Folicur 25W, 2 oz./100 gal.	
Sprayed weekly	2.4de
Sprayed every 2 weeks	4.6a
Sprayed every 4 weeks	4.4a
Folicur 25W, 4 oz./100 gal.	
Sprayed weekly	1.8e
Sprayed every 2 weeks	3.2c
Sprayed every 4 weeks	4.2ab
Daconil 2787, 4.17F, 2 pt./100 gal.	
Sprayed weekly	2.0e
Unsprayed control	4.6a

[1]Disease severity was evaluated on a scale of 1 = no disease to 5 = severe defoliation on November 10.
[2]Means within a column followed by the same letter are not significantly different according to Duncan's mutliple range test (P = 0.05).

Several sterol biosynthesis inhibitory (SBI) fungicides reportedly have plant growth regulator side effects on some ornamentals. Previous studies have shown that another SBI fungicide, XE 779, reduced shoot elongation of rose. However, neither Systhane nor Folicur had any adverse effect on plant growth or flower production. Bronzing of Mister Lincoln foliage seen on the Daconil 2787-treated roses was especially noticeable during the summer on plants sprayed with this fungicide at 1- or 2-week intervals. Daconil 2787 did not damage rose foliage in the fall 1986 test.

Efficacy of Systhane and Folicur was similar to that of Daconil 2787 for the control of blackspot on rose. Systhane provided better disease control than Triforine, which was surprisingly ineffective in this study. As with Daconil 2787, weekly applications of the full rate of Systhane prevented disease development through the entire growing season. Lower rates of Systhane applied weekly would likely provide effective disease control under less disease pressure. Higher rates of Folicur performed well considering the plants were severely diseased at the beginning of the test. Results of both tests clearly show that Systhane and Folicur were no more effective than Daconil 2787 in controlling blackspot at spray intervals longer than 1 week. Repeated applications of Systhane and Folicur did not exhibit any plant growth regulator activity on roses or cause bronzing of the leaves.

Daconil 2787 and Triforine (Funginex Rose Disease Control) are considered the fungicides of choice for blackspot control on rose. Systhane and Folicur are currently being evaluated for activity against a wide variety of diseases on field and fruit crops, as well as on ornamentals, and are not labeled for use in this country.

See color plates numbers 15 and 16.

Chemical Control of Bacterial Leaf Spot of Cherry Laurel

Austin K. Hagan, Charles H. Gilliam, and Donna C. Fare

BACTERIAL LEAF SPOT caused by *Xanthomonas pruni* is a common and persistent disease of container-grown schip laurel *(Prunus laurocerasus* Schipkaensis) and cherry laurel (*P. laurocerasus* Otto Lukens). This disease is usually seen during periods of frequent showers in the summer on closely spaced laurels produced under sprinkler irrigation. Severely damaged plants are often unmarketable due to heavy, premature leaf drop.

Control of bacterial leaf spot on container-grown laurel has not been previously studied. When *X. pruni* leaf spot becomes a problem on peach or plum, orchard growers control the disease by maintaining tree vigor. However, cultural practices alone will not control this disease in nursery situations.

This study was designed to evaluate the efficacy of several available bactericides for the control of bacterial leaf spot on laurel.

Agri-strep® 21.1W, Kocide® 101 77W, Tri-basic Copper Sulfate® 53 W, and Bordeaux® mixture were evaluated for control of bacterial leaf spot in 1985. Schip laurel liners were potted in an amended pine bark medium in 3-quart containers on April 15. One block of schip laurel was irrigated with overhead sprinklers and a second block was watered with a drip emitter in each container. To ensure disease development, diseased laurels were placed throughout the treatment area. Foliar sprays were applied to run-off with a compressed air pump-up sprayer every 2 weeks from May 22 to August 1. A spray adjuvant, CS-7, was included in all tank mixes at ½ pint per 100 gallons of spray volume. Disease severity was evaluated using a 1 to 5 scale on August 15.

Disease severity remained low on all treatments until frequent showers in July, table 20. Both immature and mature leaves were heavily spotted. Disease severity on schip laurel was reduced by Kocide 101, Tri-basic Copper Sulfate, and Bordeaux mixture. Plants sprayed with these products generally showed a light spotting of the leaves as compared to heavy leaf drop on the unsprayed controls. Kocide, Tribasic Copper Sulfate, and Bordeaux treatments provided fairly similar levels of disease protection.

TABLE 20. CHEMICAL CONTROL OF BACTERIAL LEAF SPOT ON SCHIP LAUREL

Fungicide	Rate/ 100 gal.	Disease severity[1]	
		Drip	Sprinkler
	Lb.		
Agri-strep 21.1W	1.0	2.7ab[2]	4.2a
Kocide 101 77W	1.5	1.8c	2.6bc
Tri-basic Cooper Sulfate 53W	4.0	1.8c	2.3c
Bordeaux mixture	4.0	2.1bc	2.8b
Control	--	3.2a	3.7a

[1]Rated on scale of 1 to 5, with 1 = no disease to 5 = severe damage.
[2]Means within same column followed by same letter do not differ significantly according to Duncan's multiple range test (P = 0.05).

Agri-strep proved ineffective against bacterial leaf spot. Both the drip and sprinkler irrigated schip laurel treated with this bactericide had leaf spot damage levels equal to the unsprayed control plants. Lower disease levels were found on the other treatments compared with those on the Agri-strep sprayed schip laurel.

Although this work was not designed to evaluate the effect of irrigation on bacterial leaf spot, disease levels were clearly lower on the drip irrigated schip laurel. Such results were not unexpected because splash dispersal of *X. pruni* would be reduced on the drip irrigated plants. Drip irrigation alone was not sufficient to maintain plant quality, but it was helpful in reducing disease severity when combined with foliar sprays of Tri-basic Copper Sulfate, Kocide 101, or Bordeaux mixture.

None of the products evaluated in this study is clearly labeled for bacterial leaf spot control on laurel. However, Bordeaux mixture is cleared for the control of leaf spot diseases, which should include bacterial leaf spot on laurel, at 4 tablespoons per gallon. Kocide 101 and Tri-basic Copper Sulfate are registered for fungal leaf spot control on several *Prunus* spp. EPA regulations permit their use on laurel for bacterial leaf spot control with the understanding that the user assumes all liability for product failure or damage on the crop.

See color plate number 17.

Dogwoods in an Alabama Nursery Decline and Die from a Previously Unreported Canker Disease

Jacqueline M. Mullen, Charles H. Gilliam, Austin K. Hagan, and Gareth Morgan-Jones

IN THE SPRING of 1985, several field-grown 3-year-old-pink dogwoods (4-5 feet tall) in a nursery setting began to decline. Wilting, which often began on one side of a tree and gradually spread to involve the whole tree, was followed by terminal death of the branch. Gradually whole branches died. Most of the dead and dying foliage remained on the trees during dieback progression in late spring and summer. By September and October, many entire trees had died, and dead foliage had dropped. All declining trees showed evidence of large, inconspicuous trunk cankers slightly darker than the normal bark color. Tissue below the canker surface was brown and discolored. The fungus *Botryodiplodia theobromae* was consistently isolated from canker margins.

Pathogenicity tests were conducted to determine if *B. theobromae* caused the canker disease. Tests were conducted on healthy white seedling dogwoods, 4-5 feet tall, by introducing the fungus into the trunk via a superficial slit-type wound. After 2 months, observations showed no canker development in these trees. However, fruiting bodies of *B. theobromae* could be seen scattered across the wound site. *B. theobromae* was consistently isolated from the wound margins.

Since this fungus is often considered a disease agent of weakened plants, pathogenicity tests were also run on drought-stressed white seedling dogwoods. Water was withheld from these trees for a period of 4-6 days until foliage reached a condition of incipient wilt. At this time, plants showing wilt in the afternoon remained limp and wilted throughout the night. On the morning of incipient wilt, plants were inoculated with the fungus and then normal watering practices were resumed. After 2 months, canker development was obvious. Cracking and discoloration were evident above and below the wound site. Fungal fruiting bodies were scattered across the surface of the canker, and tissue cultures of the canker margins repeatedly produced *B. theobromae.*

Results showed that drought stress was a significant factor in dogwood susceptibility to *B. theobromae.* The fungus grew superficially on nonstressed trees, but did not cause disease. Canker disease developed on those trees which had been drought-stressed before fungus introduction. If irrigation can be applied to young dogwoods during droughty periods, this potentially severe disease may be prevented.

See color plates numbers 18 and 19.

Bionomics of the Azalea Caterpillar

Gary L. Miller and Michael L. Williams

AZALEAS ARE ONE of the more colorful and important nursery crops in Alabama. Because of the azalea's popularity as a landscape plant and its value as a nursery commodity, pests of these plants deserve more research attention. Unfortunately, much of the life history of azalea pests is not well known. The azalea caterpillar, *Datana major* Grote and Robinson, is one such pest. This insect can be a serious defoliating pest of azaleas and has also been recorded feeding on apples, blueberries, and red oak. Plant damage results from larval feeding, whereas adults do not feed on foliage.

Studies on the biology of this pest reveal that females deposit up to 100 or more eggs in clutches on the underside of leaves. Eggs are white, spherical, and approximately 1.0 millimeters in diameter. Newly hatched caterpillars are gregarious feeders. Caterpillars exhibit a unique defensive posture when disturbed, with the first and second stages swaying back and forth in unison.

Total development time from egg to pupa takes approximately 58 days with five larval stages, table 21. Although

TABLE 21. DURATION OF EGG AND LARVAL STAGES OF THE AZALEA CATERPILLAR AT 85°F

Stage	Duration, days
Egg	12
1st stage larva	7
2nd stage larva	7
3rd stage larva	7
4th stage larva	8
5th stage larva	17

first-stage larvae skeletonize the leaf surface, subsequent stages will defoliate the plant. Individual second-stage larvae were found to consume an average of nearly 0.156 square inch of indica azalea foliage per day. This leaf consumption increases to over 6 square inches of leaf area per day per individual larva by the time a caterpillar has reached the last stage. In similar comparison, the average mass of leaves consumed per day was 0.02 gram for first-stage larvae and increased to nearly 0.70 gram for fifth-stage larvae. Theoretically, as few as 12 fifth-stage larvae could denude an azalea 2 feet high and approximately 2 feet wide in 1 week. In addition to the problem of the caterpillar's ravenous appetite, caterpillars were found to migrate up to 9 feet to feed on another plant.

When last-stage larvae are fully fed, they migrate from the host plant to pupate in the soil. The pupa may overwinter or last a month before adults emerge for a possible second generation. This explains why azaleas in the same locality tend to be reinfested year after year.

Registered insecticides such as Diazionon®, Larvin®, Orthene®, and Sevin® provide excellent control. Caterpillars may also be hand picked, or infested leaves and branches may be pruned, removed, and destroyed along with the caterpillars. As with many pests, it is important to control the caterpillar before it has reached the larger, more damaging state.

See color plate number 20.

Control of Citrus Whitefly on Common Gardenia

Harlan J. Hendricks, Gary L. Miller, Michael L. Williams, and James C. Stephenson

CITRUS WHITEFLY, *Dialeurodes citri* (Ashmead), is an economically important pest of citrus and several species of ornamental plants throughout the Southeast. In Alabama, it is primarily a pest of gardenias and several species of privet (*Ligustrum* spp.). Both adults and nymphs feed; however, the damage caused by their direct feeding is not great. Primary host damage results from the growth of sooty mold on honeydew excreted by the nymphs. Sooty mold reduces the plant's vitality by interfering with its photosynthetic activity and also reduces its aesthetic value, making it unfit for sale.

In 1986, seven insecticides were evaluated for control of citrus whitefly infesting common gardenia, *Gardenia jasminoides* Ellis. Thirty-six 1-foot common gardenia plants heavily infested with whitefly were selected for treatment. Test plants were growing in 3-quart plastic pots at the Ornamental Horticulture Substation in Mobile. Treatments were replicated four times, one plant constituting a replication. A single foliar application of test materials was made November 14, 1986, with the adjuvant Chevron Spray Sticker® added to all treatments at the rate of 0.5 pint per gallon. Plants were sprayed to runoff using hand-held, compressed-air sprayers. Pesticide efficacy was determined 7 and 21 days after treatment by examining 100 pupae per plant and recording them as dead or alive. Mortality counts were made November 21 and December 5 by observing each pupa with the aid of a stereo-microscope, and counting it as living, if normally colored and full bodied, or dead, if discolored and shrivelled or dried.

TABLE 22. CITRUS WHITEFLY CONTROL ON COMMON GARDENIA

Insecticide[1]	Rate, a.i./ 100 gal.	Mean mortality[2,3]	
		7 DAT	21 DAT
	Lb.	*Pct.*	*Pct.*
Danitol 2.4EC	0.30	73a	100a
Orthene 75S	.75	36b	90a
DiBeta 1.5EC	.14	6c	15b
CME 13406 15%SC	.31	4c	9b
MR100	1.00	5c	7b
CME 13406 15%SC	1.25	6c	6b
ABG 6211 1.5EC	.14	6c	6b
ABG 6206 10WP	.14	3c	4b
Untreated check	--	6c	8b

[1]Treatment applied November 14, 1986.
[2]Mortality determined November 21, 1986, and December 5, 1986.
[3]Means within columns followed by the same letter are not significantly different according to Duncan's multiple range test, P = 0.05.

Efficacy varied among treatments, table 22. At the rates tested, Danitol® and Orthene® provided excellent control, whereas other materials were not significantly different from the untreated check. In previous tests by the authors, Cygon®, Supracide®, Metasystox-R®, Vydate®, and Mavrik® have also provided excellent control of this pest attacking common gardenia. These currently registered materials, as well as new materials such as Danitol®, are quite effective against citrus whitefly. Biological control studies have shown that citrus whitefly attacking gardenia in southern Alabama can be successfully controlled by the parasitic wasp, *Encarsia lahorensis* (Howard).

See color plate number 21.

A False Spider Mite on Liriope

James C. Stephenson, Michael L. Williams and Gary L. Miller

LIRIOPE IS A WIDELY grown and popular plant in the South. There are several cultivars, including green and variegated forms. Utilized primarily in the landscape as borders and ground covers, it is low in maintenance and has few pest problems. One pest recently found on *Liriope muscari* Variegata and Big Blue at the Ornamental Horticulture Substation, Mobile, was a mite, *Brevipalpus* sp. This mite is an undescribed species in a group of mites known as false spider mites. Symptoms of plant damage were common foliar stippling caused by sharp, piercing mouth parts imparting a grayish or silvery hue to the variegated cultivar and a pale hue to green cultivars. Three

TABLE 23. CONTROL OF A FALSE SPIDER MITE ON *LIRIOPE MUSCARI* VARIEGATA

Insecticide[1]	Rate/ 100 gal.	Mean number on mites per sample	
		7 DAT[2]	21 DAT
Pentac 4F	0.50 pt.	13.5bc[3]	10.3c
Morestan 25WP	1.00 lb.	4.8bc	1.5c
DPX Y-5893 50WP	0.60 lb.	26.5b	22.5bc
DPX Y-5893 50WP	1.20 lb.	56.0a	37.0c
ABG 6162	2.00 qt.	21.5bc	7.5c
ABG 6162	4.00 qt.	8.5bc	10.0c
ABG 6162	8.00 qt.	9.3bc	2.0c
Danitol 2.4EC	0.15 pt.	4.0c	.0c
Danitol 2.4EC	0.33 pt.	5.8bc	.3c
Control	--	53.5a	81.0a

[1]Application October 3, 1985, dry bulb 70°F, wet bulb 66°F.
[2]Evaluation October 10, 1985, and October 24, 1985.
[3]Mean separation within columns by Duncan's multiple range test, 5 percent level.

TABLE 24. CONTROL OF FALL WEBWORM ON PERSIMMON

Insecticide[1]	Rate a.i./ 100 gal.	Mean number live larvae [2,3]	
		1985, 3 DAT	1986, 7 DAT
	Lb.	*No.*	*No.*
Tempo 2C	0.03	0a	0.0a
Orthene 75S	.67	0a	.7a
Diazinon AG500	1.00	3a	*
DiBeta 1.5EC	.07	9a	*
DiBeta 1.5EC	.14	*	3.3a
DiBeta 1.5EC	.28	33a	*
MR-100 WP	1.00	*	7.7a
ABG-6206 10WP	.14	*	26.0ab
Untreated check		200b	63.7b

[1]Treatments applied August 19, 1985, and August 5, 1986.
[2]Evaluated August 22, 1985, and August 12, 1986.
[3]Values followed by the same letter within columns are not significantly different (P=0.05; DMRT).
*Pesticide or rate not tested.

standard and two experimental miticides were evaluated for control of this pest.

Infested 1-gallon *Liriope muscari* Variegata growing in 100 percent milled pine bark amended with 6 pounds dolomitic lime, 2 pounds gypsum, 1.5 pounds Micromax, and 12 pounds Osmocote 17-7-12 per cubic yard were selected for treatments outlined in table 23. All treatments were single-application foliar sprays applied to run-off. Chevron Spray Sticker® was added to all treatments at 0.5 pint per 100 gallons of water. Efficacy was evaluated 7 and 21 days after treatment (DAT).

Mite counts, table 23, show Danitol® 2.4EC, Pentac® 4F, Morestan® 25 WP, and ABG 6162 provided good control 7 days after treatment application. Two weeks later (21 days after application), all treatments indicated some degree of control. Excellent control was provided by Danitol 2.4EC, Morestan 25WP, and the high rate of ABG 6162 and good control with Pentac 4F and two lower rates of ABG 6162. DPX Y-5893 did not provide adequate control at 7 or 21 DAT.

In summary, this mite does not appear hard to control with presently available ornamental miticides. However, plant damage can be minimized if the problem is recognized early so miticide application can be made early or by including a miticide in a regular spray program.

See color plate number 22.

Control of Fall Webworm

Michael L. Williams, Barbara J. Sheffer, Gary L. Miller, and Harlan J. Hendricks

THE FALL WEBWORM, *Hyphantria cunea* (Drury), is a native of North America and Mexico. It feeds on almost all shade, fruit, and ornamental trees except conifers. Common hosts in the South include apple, ash, hickory, pecan, persimmon, walnut, willow, and white oak; roses and other shrubs are sometimes attacked. Fall webworms are mainly detrimental to the beauty of the host and are thus more a nuisance than a threat to the health of the tree.

In Alabama, two generations of fall webworms occur; one in spring and one in late summer. The late summer generation is the more destructive. Larvae of the fall webworm pass through as many as 11 stages of development. In each larval stage, feeding occurs within a distinct web made of silk produced by the larvae. The larvae spin layers of silk over the surface of a leaf as soon as they start feeding, eventually webbing together ends of several branches. Fall webworm nests are unsightly, and one or more branches may be defoliated (seldom the entire tree). Nests always occur terminally on the branches of the host.

Several pesticides were tested for efficacy against fall webworm caterpillars in August 1985 and 1986. Persimmon trees, *Diospyros virginiana,* growing along roadsides and in home landscapes and infested with fall webworm, were selected for treatment. Test materials were applied August 19, 1985, and August 5, 1986, to active webworm colonies by spraying individual webs and surrounding foliage to runoff with hand-pumped, compressed-air sprayers. Efficacy of test materials was determined 3 days after treatment in 1985 and 7 days after treatment in 1986 by pruning webs from the trees, dismantling the web, and counting the number of live caterpillars. Results are presented in table 24.

See color plates numbers 23 and 24.

Preemergence-Applied Herbicides Evaluated for *Oxalis* Control in Container-Grown Ornamentals

Diana L. Berchielli, Charles H. Gilliam, and Donna C. Fare

MANY HERBICIDES have been evaluated for efficacy in container-grown ornamentals, but few have become wide-

TABLE 25. EFFECT OF PREEMERGENCE HERBICIDE ON *OXALIS* CONTROL IN EXPERIMENTS 1 AND 2

Herbicide	Rate/acre	Experiment 1			Experiment 2		
		Weeds/pot		Dry weight	Weeds/pot		Dry weight
		4 weeks	8 weeks		12 weeks	18 weeks	
	Lb.	*No.*	*No.*	*Grams*	*No.*	*No.*	*Grams*
Rout	1.5	0.1	0.1	0.0	5.5	4.3	1.6
Rout	3.0	.3	.3	.0	4.7	3.6	1.4
Rout	6.0	.1	.0	.0	.1	.1	.1
OH-2	2.0	1.4	1.6	.2	3.8	3.3	1.5
OH-2	4.0	1.4	1.4	.2	3.3	3.1	1.5
OH-2	8.0	.3	.0	.0	1.6	1.4	.6
Ronstar	2.0	7.3	6.6	.9	3.6	2.9	1.1
Ronstar	4.0	.9	1.0	.2	5.7	4.9	1.8
Ronstar	8.0	.6	1.6	.0	4.5	3.9	1.5
Surflan	2.0	.8	.4	.0	2.4	1.4	.5
Surflan	4.0	.3	.0	.0	.8	.1	.0
Surflan	8.0	.1	.0	.2	.0	.0	.0
Goal	1.0	.5	.6	.0	4.4	3.3	1.0
Goal	2.0	1.0	.0	.0	1.3	1.3	.9
Goal	4.0	.0	.0	.0	.9	.6	.2
Control	--	25.0	25.0	1.9	9.3	9.4	2.6

ly utilized. Ronstar® has the most extensive registration for use in ornamentals, with over 50 species listed on its label. One problem reported by growers is limited *Oxalis* control with Ronstar herbicide. *Oxalis* is a winter annual that is a problem in container-grown ornamentals. Two separate experiments were conducted to evaluate several preemergence-applied herbicides for control (both immediate and residual) of *Oxalis* in container-grown ornamentals.

Experiment 1. Rout®, OH-2®, Ronstar®, Surflan®, and Goal® were applied on October 28, 1985, to 3½-inch-square plastic nursery containers with a pine bark-sand medium (6:1, volume basis). Herbicides were applied at ½, 1, and 2 times the rate as recommended by the manufacturer. Nontreated control pots were included. About 25 weed seeds per pot were sown 1 week after herbicide application. Pots were watered as needed.

The number of *Oxalis* per container was counted 4 and 8 weeks after herbicide application. To determine the degree of growth suppression, weeds were harvested and dry weight determined at 8 weeks.

Experiment 2. Experiment 2 was conducted similarly to Experiment 1, with the following exceptions: (1) herbicides were applied February 27, 1986; (2) *Oxalis* was sown 7 weeks after application of herbicides to determine residual activity; (3) *Oxalis* numbers per container were counted at 12 and 18 weeks; and (4) *Oxalis* were harvested and dry weights determined at 18 weeks.

Evaluation at 4 and 8 weeks after treatment revealed that with Surflan, Goal, Rout, and OH-2, control was not affected by rate, table 25. For example, with Rout, *Oxalis* number per pot was 0.1, 0.3, and 0.1 for the 1.5, 3.0, and 6.0 pound-per-acre rates, respectively, at both 4- and 8-week ratings. Increasing the rates of Ronstar resulted in increased control. For example, the number of *Oxalis* per pot was 6.6, 1.0, and 1.6 for the 2.0-, 4.0-, and 8.0-pound-per-acre rates at the 8-week rating.

Evaluation of residual activity revealed that few of the herbicides provided control beyond 12 weeks. When applied at recommended rates, only Surflan (4 pounds per acre) resulted in less than 1 *Oxalis* plant per pot 18 weeks after treatment. Goal was the only other herbicide applied at the recommended rate that provided limited residual activity. Among these herbicides, only Rout at the 6.0-pound-per-acre (2x) rate provided excellent *Oxalis* control.

Ronstar for many years has been the primary herbicide for container weed control; however, growers have periodically reported poor control. These data show that Ronstar control of *Oxalis* is rate sensitive and residual activity is minimal past 8 weeks. Applications of the flowable formulations of Surflan and Goal generally resulted in excellent initial control, with some residual activity, especially with Surflan.

These results show that Surflan and Goal or combination products with these herbicides were superior with respect to *Oxalis* control. Furthermore, if using Ronstar herbicide for *Oxalis* control, more frequent applications (6-8 weeks) will be needed.

Ability of Polypropylene Fabric to Inhibit the Growth of Six Weed Species

Chris A. Martin, Harry G. Ponder, and Charles H. Gilliam

LAYING PLASTIC underneath an organic mulch is a common installation practice in landscape plantings. However, research has shown that polyethylene black plastic beneath pine bark mulch makes little difference in weed control and results in 60 percent greater winter kill of plants than with pine bark mulch alone. Landscape mat fabrics composed of polypropylene polymer woven and nonwoven fibers offer an alternative to polyethylene plastic sheeting that is water and gas permeable; however, the effectiveness of weed suppression among mat fabrics needs to be evaluated. This study was designed to compare the effectiveness of nine polypropylene landscape mats in inhibiting growth of six weed species.

Two experiments were conducted in a polycovered greenhouse. Rectangular plastic flats (11 x 21 inches) were

TABLE 26. SHOOT DRY WEIGHT PER PLANT OF WEED SPECIES PENETRATING LANDSCAPE MATS 30 DAYS AFTER SOWING, EXPERIMENT 1

Mat	Shoot dry weight					
	Yellow nutsedge	Bermuda-grass	Johnson-grass	Pigweed	Sicklepod	Smallflower morningglory
	Grams	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
DeWitt	1.5a[1]	0.4a	0.6a	0.0a	0.0a	0.0a
Innovative Geotextile	.0a	3.7a	11.4ab	.0a	.0a	.0a
Amoco Rita-a-weed	.2a	7.3a	40.2c	7.5b	.0a	.0a
Phillips Fibers Duon	.3a	5.2a	42.6c	9.6b	.0a	.0a
Easy Gardener	9.8b	22.3b	31.7bc	24.7c	.0a	.0a
Check	44.4c	25.9b	70.3d	27.1c	18.7b	13.2b

[1]Mean separation within columns by Duncan's multiple range test, 5 percent level.

filled with pine bark: sand: sandy loam soil (1:1:1, volume basis) amended with 4.0 pounds per cubic yard Osmocote (18N-2.6P-9.9K). Seed of two weed species were sown separately in opposite halves of each flat and covered with polypropylene fabric (26 x 36 inches). Decorative landscape bark nuggets (2 pounds of 1- to 5-inch diameter) were placed on top of all flats to simulate normal use and to ensure contact between the fabric and growth medium. Flats were irrigated as needed. At the end of 30 days, shoot dry weights were taken of those weeds which had penetrated the polypropylene fabric.

Experiment 1. In Experiment 1, the following weed species were used: pigweed (*Aranthus* sp.), sicklepod (*Cassia obtusifolia*), bermudagrass (*Cynodon dactylon*), yellow nutsedge (*Cyperus esculentus*), smallflower morningglory (*Jaquemontia tamnifolia*), and johnsongrass (*Sorghum halepense*). The following polypropylene landscape mat fabrics were used: Dewitt Weed Barrier woven (manufactured by Dewitt Co. of Sikeston, Missouri 63801), Amoco Rit-a-Weed heavy nonwoven (manufactured by Atlantic Construction Fabrics Inc. of Richmond, Virginia 23237), Phillips Fibers Duon 70.85g nonwoven (distribution by Blunks Wholesale Supply Inc. of Bridgeview, Illinois 60455), Geoscape Landscape Fabric nonwoven (manufactured by Innovative Geotextile Inc. of Charlotte, North Carolina 28234), and Weedblock Fabric nonwoven (manufactured by Easy Gardener Inc. of Waco, Texas 76702). One check treatment consisted of flats without mat coverings.

Growth of sicklepod and smallflower morningglory was completely inhibited by all landscape mat fabrics, table 26. Growth of pigweed was completely inhibited by landscape mat fabrics from Dewitt and Innovative Geotextile. Growth of bermudagrass and pigweed using the landscape mat fabric by Easy Gardener was similar to the check treatment. Partial inhibition in the growth of yellow nutsedge, bermudagrass, johnsongrass, and pigweed resulted from the use of all other landscape mat fabrics versus the check treatment.

Experiment 2. In experiment 2, the same weed species were sown except that sicklepod and smallflower morningglory were omitted. The following polypropylene fabrics were used: Dewitt Pro 5 Weed Barrier nonwoven (manufactured by DeWitt Co. of Sikeston, Missouri 63801), Amoco Rit-a-Weed heavy nonwoven, Phillips Fibers Duon 70.85g nonwoven, Geoscape Landscape Fabric nonwoven, Weedblock Fabric woven, Weed Barrier Mat (manufactured by American Woven Fabrics of Glenview, Illinois 60025), and DuPont Typar 307 nonwoven and Typar 312 nonwoven

TABLE 27. SHOOT DRY WEIGHT OF WEEDS PENETRATING LANDSCAPE MATS 30 DAYS AFTER SOWING, EXPERIMENT 2

Mat	Shoot dry weight			
	Yellow nutsedge	Bermuda-grass	Johnson-grass	Pigweed
	Grams	*Grams*	*Grams*	*Grams*
DuPont 307	0.0a[1]	2.9ab	0.0a	0.0a
DuPont 312	.0a	.9a	.0a	1.1a
American Woven Fabrics	1.4ab	.0a	.3a	.0a
DeWitt Pro 5	3.6ab	3.0ab	5.8ab	1.9a
Innovative Geotextile	4.6b	4.4b	4.3ab	.0a
Amoco Rit-a-Weed	4.0b	5.2b	9.7bc	5.0b
Phillips Fiber Duon	3.6ab	5.6b	13.4cd	6.6b
Easy Gardener	3.7ab	10.3c	10.4bc	12.1c
Check	23.1c	12.8c	19.7d	13.2c

[1]Mean separation within columns by Duncan's multiple range test, 5 percent level.

(manufactured by DuPont Corp. of Wilmington, Delaware 19898). All weed seeds were sown at the rate of ¼ teaspoon in each half flat, except for yellow nutsedge which had 15 tubers each.

Growth of yellow nutsedge and johnsongrass was completely inhibited by the landscape mat fabrics from DuPont, table 27. Growth of pigweed was completly inhibited by DuPont Typar 307 and Innovative Geotextile Geoscape landscape fabric. The Weed Barrier Mat completely inhibited the growth of bermudagrass and pigweed. Growth of bermudagrass and pigweed using the landscape mat fabric by Easy Gardener was similar to the check treatment. Partial inhibition in the growth of yellow nutsedge, bermudagrass, johnsongrass, and pigweed resulted from the use of all other landscape mat fabrics. The landscape mat fabrics by American Woven Fabrics, Dewitt Co., DuPont Corp., and Innovative Geotextile resulted in the best overall weed suppression.

Control of Yellow Nutsedge in Woody Ornamentals

Diana L. Berchielli, Charles H. Gilliam, Glenn R. Wehtje, Donna C. Fare, and Thomas V. Hicks

CONTROL OF ANNUAL WEED growth in nursery crop production continues to be a major economic problem for nurserymen. Yellow nutsedge ranks as one of the major weed problems in the United States. A single plant is capable of forming up to 3,000 tubers in a single growing season under good growing conditions.

Currently there are no labelled herbicides that adequately control yellow nutsedge without causing injury to ornamental species. Consequently, when nutsedge appears in a field or around a container area it rapidly becomes a major problem.

Selected herbicides applied preplant incorporated (PPI), preemergence (PRE), and postemergence (POST) were evaluated for control of yellow nutsedge and for phytotoxicity to four container-grown ornamental species. Herbicides were applied PPI and PRE on March 21 to Dothan sandy loam soil in 1-quart plastic containers. Yellow nutsedge tubers were planted to a depth of 1 inch below the surface of the treated soil. Herbicides were applied at ½, 1, 1½, and 2X rates as recommended by the manufacturer. On April 11, 4-inch-tall yellow nutsedge plants were treated with four herbicides (POST) at three rates each. For phytotoxicity evaluation, liners of Big Blue liriope, Copperman azalea, common boxwood, and Natchez crapemyrtle received over-the-top applications of all herbicide treatments.

Classic® at 0.75 and 1.0 ounce active ingredient (a.i.) per acre and Scepter® at 1.0 pound a.i. PPI resulted in excellent control of yellow nutsedge at 8 weeks as reported in table 28. Classic at 0.5 ounce a.i. per acre and Scepter at 0.75 pound a.i., applied PPI, showed initial control, but by week 8, healthy nutsedge began emerging. Reflex® applied PPI, PRE, and POST at 0.75 and 1.0 pound a.i. per acre showed limited nutsedge activity (8 weeks). In tests the previous year, Reflex had shown good yellow nutsedge control. While all preemergence-applied herbicide treatments initially delayed emergence of yellow nutsedge, only Classic and Scepter at the high rates continued to inhibit emergence beyond 8 weeks with PRE treatments.

TABLE 28. EFFECTS OF SELECTED HERBICIDES ON YELLOW NUTSEDGE CONTROL 8 WEEKS AFTER APPLICATION

Herbicide and rate of active ingredient/acre	Control rating by type of application		
	PPI[1]	Pre[1]	Post[2]
Reflex			
0.25 lb...........	1.3	1.4	1.0
0.50 lb...........	1.7	1.4	1.0
0.75 lb...........	2.1	1.8	1.0
1.00 lb...........	1.4	2.1	1.0
Classic			
0.50 oz...........	3.5	3.3	2.8
0.75 oz...........	4.4	4.0	3.3
1.00 oz...........	5.2	4.9	3.5
Scepter			
0.25 lb...........	1.0	1.0	1.0
0.50 lb...........	1.8	1.8	1.0
0.75 lb...........	1.8	1.8	1.0
1.00 lb...........	5.0	5.2	1.0
Control	1.0	1.0	1.0

[1]Scale used to evaluate amount of yellow nutsedge control was as follows: 1 = healthy vigorous growth, 2 = light chlorosis or necrosis, 3 = moderate chlorosis or necrosis, 4 = severe chlorosis or necrosis, 5 = dead nutsedge, 6 = no emergence.

[2]Scale used to evaluate amount of control was as follows: 1 = healthy vigorous growth, 2 = light chlorosis or necrosis, 3 = moderate chlorosis or necrosis, 4 = severe chlorosis or necrosis, 5 = dead nutsedge.

Classic applied postemergence at 0.75 and 1.0 ounce a.i. per acre resulted in good control of yellow nutsedge at 8 weeks, table 28. Although Classic, Scepter, Reflex, and Roundup applied POST at all other rates initially caused chlorosis to the nutsedge, by 8 weeks the nutsedge outgrew any previous injuries and healthy growth emerged.

With respect to phytotoxicity, neither Big Blue liriope nor common boxwood exhibited any injury symptoms from any of the herbicides at 8 weeks. Scepter at all rates suppressed growth of Natchez crapemyrtle and Copperman azalea. Phytotoxicity symptoms were characterized by stunted plants with lanceolated leaves arising in a fashion similar to a witches broom. Reflex at all rates initially showed some chlorotic spotting on all ornamental species; however, at 4 weeks all species grew past the injury. Classic at the 2X rate initially caused stunting of growth in Natchez crapemyrtle and Copperman azalea, but by 8 weeks these plants were similar to the control plants.

Classic at 0.25, 0.5, and 0.75 ounce a.i. per acre was safe on all four ornamental species tested, with the 0.75- and 1.0-ounce rates, both PPI and PRE, providing excellent yellow nutsedge control. None of these herbicides is currently registered for use on woody nursery stock, but Classic appears promising for yellow nutsedge control in woody ornamentals.

Response of Azalea Cultivars to Fusilade 2000

Charles H. Gilliam, Gary S. Cobb, and Donna C. Fare

FUSILADE® 4E WAS LABELLED for postemergence grass control in ornamentals in 1983, and since that time has been shown to cause injury (tip burn) to several azalea cultivars. Although Fusilade 4E and Fusilade 2000 cause injury to a few azalea cultivars, most azalea cultivars are not injured. Tests conducted in the Northeastern United States evaluated 28 azalea cultivars and found only two (Hino-Crimson and Hinodegiri) to be definitely injured by Fusilade. Hershey Red was listed as possibly sensitive to Fusilade in these tests. Other azaleas cultivars sensitive to Fusilade are Rosebud, Mother's Day, and Hexe. From these tests it appears that only red flowering azaleas are sensitive to Fusilade.

The objectives of these studies were to screen red flowering azalea cultivars for sensitivity to Fusilade 2000. A second objective was to determine how late in the year Fusilade 2000 could be applied over the top of sensitive and nonsensitive cultivars before flowering the following spring was suppressed.

Experiment 1. Uniform liners of Mrs. G. G. Gerbing and Hino-Crimson azaleas were potted into No. 1 containers in March 1984, in a 100 percent pine bark medium amended on a cubic yard basis with 6 pounds dolomitic limestone, 2 pounds gypsum, 1.5 pounds Micromax®, and 10 pounds Osmocote (18-6-12). Plants were grown under 47 percent shade, outdoors. Treatments consisted of single applications

TABLE 29. SENSITIVITY OF RED FLOWERING AZALEA CULTIVARS TO FUSILADE 2000, EXPERIMENT 2

Cultivar	Damage[1] 15 DAT, by rate/acre			Damage[1] 30 DAT, by rate/acre		
	0.125 lb.	0.25 lb.	Control	0.125 lb.	0.25 lb.	Control
Girard's Hot Shot....	10.0a[2]	10.0a	10.0a	10.0a	10.0a	10.0a
Girard's Scarlet.......	9.7a	7.3c	10.0a	9.0a	4.7b	9.8a
Girard's Rose........	8.5b	6.0b	10.0a	8.9a	5.0b	9.6a
Sherwood Red........	6.0b	6.0b	10.0a	6.0b	3.8c	10.0a
Hino-Crimson........	9.3b	7.3c	10.0a	8.7b	6.8c	10.0a
Hinodegiri...........	6.9b	6.3b	10.0a	7.9b	6.8c	10.0a
Red Ruffle...........	10.0a	10.0a	10.0a	10.0a	9.6a	10.0a
Red Formosa.........	10.0a	10.0a	10.0a	10.0a	9.0b	10.0a
Vayk's Scarlet........	10.0a	10.0a	10.0a	10.0a	9.8a	10.0a
Mother's Day........	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a
Trouper.............	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a
Little John...........	10.0a	10.0a	10.0a	9.8a	7.8b	10.0a
Hershey Red.........	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a

[1]Plants were rated on a 1-10 scale where 1 = dead plant, 5 = dead terminals + leaf chlorosis + leaf necrosis, and 10 = normal plant growth.
[2]Mean separation within columns followed by the same letter or letters are not significantly different at the 5 percent level as determined by Duncan's multiple range test.

of Fusilade 2000 at 0.125 pound per acre a.i. plus Ortho X-77® spreader (½ percent by volume), Ortho X-77 alone, and Off-Shoot-O® (a commercial pruning agent). Each was applied on four different dates (July 2, August 1, September 3, and October 1). Off-Shoot-O was applied (9 percent volume) because the authors had observed injury from this compound was similar to Fusilade. Fusilade 2000 was applied in 15 gallons of water per acre. Plants were rated for phytotoxicity at monthly intervals beginning August 1. Flower buds were counted the following spring and growth indices measured.

Experiment 2. Fifteen liners each of 14 azalea cultivars were potted on April 12, 1985, in No. 1 containers in an amended medium similar to that used in Experiment 1. Plants were grown under 47 percent shade. Treatments were applied on July 23 and consisted of Fusilade 2000 at 0, 0.125, and 0.25 pound per acre applied in 15 gallons of water. Each treatment contained Ortho X-77 spreader. Plants were rated for phytotoxicity 15 and 30 days after treatment. Both experiments were conducted at the Ornamental Horticulture Substation, Mobile.

In Experiment 1, Mrs. G. G. Gerbing azaleas were not injured by any treatment (data not shown). When applied on July 2 to Hino-Crimson, Fusilade 2000 at 0.125 pound per acre a.i. resulted in initial injury; however, plants outgrew the injury and were comparable to untreated plants within 60 days. Later applications resulted in similar injury, but recovery appeared slower. Application of Fusilade 2000 to Hino-Crimson azaleas resulted in greater branching and flowering the following spring compared to application of Off-Shoot-O. Mrs. G. G. Gerbing was not affected by Fusilade 2000 application.

Application of Fusilade 2000 and Off-Shoot-O in July and August resulted in greater flower bud numbers than the nontreated control plants, while September application decreased flower bud numbers of Hino-Crimson azaleas compared to nontreated plants. These data show that Fusilade 2000 can be safely applied as an over-the-top application on azaleas previously reported sensitive to Fusilade 2000. The limiting factor for safe application of Fusilade 2000 to azaleas is not the cultivar but the time of the year applied. From these data it appears that Fusilade 2000 can be safely applied on sensitive azaleas as late in the year as a grower would normally use a chemical pinching agent such as Off-Shoot-O.

In Experiment 2, 9 of the 14 red flowering azalea cultivars were not injured by the recommended rate (0.125 pound per acre) of Fusilade 2000, table 29. Injury ranged from tip burn to stem dieback and leaf necrosis. Of the cultivars injured, there were two Kurume type azaleas, Hino-Crimson and Hinodegiri, two Girard azaleas, Scarlet and Rose, and Sherwood Red (Kurume hybrid). Previous work had demonstrated Hino-Crimson and Hinodegiri sensitivity to Fusilade 4E. Other researchers have reported Girard's Rose to be unaffected by Fusilade 4E; however, in this test it was sensitive to Fusilade 2000. Conversely, Hershey Red, earlier reported sensitive to Fusilade 4E, was not affected by Fusilade 2000 in this test.

Increasing the rate of Fusilade 2000 to 0.25 pound per acre (2x) resulted in injury to 9 of the 14 cultivars 30 days after treatment. These data indicate that application beyond the recommended rate for annual grass control may result in injury ranging from tip burn to stem dieback and leaf necrosis.

Fusilade 2000 stimulated flowering on sensitive azalea cultivars the following spring when applied prior to September in the Mobile area with Hino-Crimson injury being similar to that from an application of Off-Shoot-O. From this work and other research, sensitive cultivars appear to be red flowering azaleas only; other colored azaleas are not affected (injured/pruned) by Fusilade 2000. With these nonred azaleas, Fusilade 2000 may be applied safely at any time of the year. Among the red flowering azaleas tested, sensitive azaleas that should not be treated with Fusilade 2000 after September include Hino-Crimson, Hinodegiri, Sherwood Red, Girard's Red, and Girard's Rose.

Herbicide Combinations for Grass Control in Ornamentals

John W. Wilcut, Charles H. Gilliam,
Glenn Wehtje, and Donna C. Fare

WEEDS COMPETE with ornamentals for nutrients, water, space, and light, resulting in slower growth and poorer quality plants. Losses may range from 47 to 75 percent depending on weed species and densities. Mechanical weed control in containers is impractical and manual weeding is expensive and laborious. Thus, herbicidal control is desired.

The ideal herbicide would selectively kill existing weeds rapidly while providing long-term residual control. Unfortunately, no such herbicide is currently available. This necessitates the use of herbicide combinations to achieve rapid control from postemergence herbicides and also provide the long-term residual control obtained by using preemergence herbicides.

Fusilade® 2000 and Poast® are two herbicides currently labeled for postemergence grass control in ornamentals. Fusilade 2000 also has limited preemergence activity on annual grasses. These herbicides are not recommended for simultaneous applications (tank-mixing) with other herbicides because of potential antagonism. Assure®, Whip®, Verdict®, and Trophy® are four new herbicides being developed for postemergence grass control.

The preemergence herbicides Surflan® and Dual® are widely used in the nursery industry. They are active primarily against annual grasses and small-seeded broadleaf species.

Experiments were conducted to evaluate combinations of preemergence and postemergence herbicides for possible antagonisms when used for the control of large crabgrass [*Digitaria sanguinalis* (L.) Scopolis] and goosegrass (*Eleusine indicia* (L.) Gaertner].

Pots were overseeded initially with equal amounts of goosegrass and large crabgrass to produce a uniform grass infestation and seeded again 2 weeks after herbicide application. Herbicides were applied 1 month after initial seeding when grass seedlings were 4-6 inches in height and tillering. All herbicides were applied with a tractor-mounted compressed air sprayer in a volume of water equivalent to 20 gallons per acre.

Herbicides were evaluated for annual grass control at the following per acre rates: Surflan at 2 pounds; Dual at 2 pounds; Assure at 1.5 ounces; Verdict at 0.075 pound; Trophy at 0.0098 pound; Fusilade 2000 at 0.125 pound; and Poast at 0.25 pound.

Residual preemergence control from Surflan combinations was greater (91 percent control, averaged for all postemergence herbicides) than for Dual combinations (63 percent), table 30. Residual preemergence control was optimized when Surflan was applied with either Assure (94 percent), Verdict (90 percent), Trophy (94 percent), or Fusilade 2000 (88 percent). Optimum preemergence control was also obtained from Dual applied with either Verdict (90 percent) or Trophy (90 percent). Antagonism of preemergence weed control activity occurred when Poast was applied with Surflan (84 percent control) compared to 94 percent control from Surflan alone. Preemergence control from Dual was also antagonized when applied with Poast (34 percent control) compared to 50 percent control from Dual applied alone.

At 30 days after treatment, greater postemergence control was obtained with Surflan combinations (78 percent, average across postemergence herbicides) than with Dual combinations (71 percent control), table 31. Optimum postemergence control was obtained from Verdict (92 percent), Trophy (90 percent), or Fusilade 2000 (94 percent) applied singularly. Excellent control was also obtained with Surflan applied with Verdict (92 percent), Trophy (98 percent), Fusilade 2000 (98 percent), or Poast (92 percent). Several Dual combinations provided optimum control, including Dual applied with Verdict (92 percent), Trophy (90 percent), or Fusilade 2000 (94 percent). Synergistic effects were observed when Surflan was applied with Assure or Poast. Antagonism of postemergence control occurred when Fusilade 2000 was applied with Dual.

This research indicates that care should be observed when applying postemergence and preemergence herbicides simultaneously. Antagonism of both preemergence and postemergence control is possible. However, excellent control or increased control may also occur from simultaneous applications. Examining all treatments, maximum residual preemergence and postemergence control was obtained with Surflan or Dual applied with Trophy.

TABLE 30. EFFECTS OF PREEMERGENCE AND POSTEMERGENCE HERBICIDES ON PREEMERGENCE CONTROL OF ANNUAL GRASSES, 90 DAYS AFTER TREATMENT

Postemergence herbicides	Rate/acre	Weed control when combined with postemergence herbicides[1]			
		Surflan, 2 lb./acre	Dual, 2 lb./acre	None	Mean
		Pct.	*Pct.*	*Pct.*	*Pct.*
Assure	1.5 oz.	94a	40c	0f	45
Verdict	0.075 lb.	90ab	90ab	0f	60
Trophy	0.0098 lb.	94a	90ab	0f	61
Fusilade 2000	0.125 lb.	88a	74c	0f	54
Poast	0.25 lb.	84b	34c	0f	39
None		94a	50d	0f	48

[1]Treatments followed by the same letter are not different (P =0.05).

TABLE 31. EFFECTS OF PREEMERGENCE AND POSTEMERGENCE HERBICIDES ON POSTEMERGENCE CONTROL OF ANNUAL GRASSES, 30 DAYS AFTER TREATMENT

Postemergence herbicides	Rate/acre	Weed control when combined with preemergence herbicides[1]			
		Surflan, 2 lb./acre	Dual, 2 lb./acre	None	Mean
		Pct.	*Pct.*	*Pct.*	*Pct.*
Assure	1.5 oz.	62d	50e	50e	54
Verdict	0.075 lb.	92ab	92ab	92ab	92
Trophy	0.0098 lb.	98a	94a	90abc	94
Fusilade 2000	0.125 lb.	98a	82c	94a	86
Poast	0.25 lb.	92ab	84bc	82c	86
None		24f	24f	0g	16

[1]Treatments followed by the same letter are not different (P =0.05).

The Holly Looper, A New Pest of Holly in the Southern Landscape

Michael L. Williams, Gary L. Miller, and Harlan J. Hendricks

THE HOLLY LOOPER, *Thysanopyga intractata* (Walker) (Lepidoptera: Geometridae), is a relatively new pest of holly in the South, first reported in 1972. Damage is caused by feeding of the larval stages on the foliage of *Ilex aquifolium, I. crenata, I. cornuta, I. opaca,* and *I. vomitoria.* Some plants may be 100 percent defoliated, while others are not touched. In general appearance, the mature larva is similar to spring and fall cankerworms. The caterpillar is light green, has two pairs of prolegs, and moves about with the typical inchworm movement. Little is known about the biology of this pest, but under normal winter conditions this species overwinters in the Gulf States and migrates northward. Its range extends from Alabama north to Virginia and southern Maryland.

In the spring of 1986, an experiment was conducted to determine the effectiveness of three insecticides (Orthene® 75S, Tempo® 2EC, and DiBeta® 1.5EC) against holly looper larvae feeding on a Japanese holly hedge in Auburn. Four 10-foot sections of hedge were selected for the study. Sections to be treated were sampled for larvae and then sprayed to runoff using compressed air sprayers. One section was left as an untreated check. Chevron® spreader-sticker was added to the spray mixtures at the rate of 0.5 pint per 100 gallons. Efficacy was determined 2 and 7 days after treatment by beating three areas of each section of hedge and counting the number of live larvae falling on a 2-foot by 2-foot section of white poster board. Results are presented in table 32.

TABLE 32. CONTROL OF HOLLY LOOPER ON JAPANESE HOLLY

Insecticide[1]	Rate a.i./ 100 gal.	Mean number live larvae [2,3] 2 DAT	7 DAT
	Lb.	*No.*	*No.*
Orthene 75S	0.5	0.3a	0.0a
Tempo 2EC	.03	.7a	.0a
DiBeta 1.5EC	.14	3.7a	6.7a
Untreated check	--	21.7b	19.0b

[1]Treatments applied April 11, 1986.
[2]Evaluated April 13 and 18, 1986.
[3]Values followed by the same letter are not significantly different by Duncan's multiple range test, P = 0.05.

All treatments significantly reduced the number of holly looper larvae when compared to the untreated check. Seven days after treatment, no live larvae could be found in the sections of hedge sprayed with Orthene or Tempo. DiBeta, which is a biological pesticide formulation containing the beta-exotoxin metabolite of *Bacillus thuringiensis,* was slower acting and did not completely eradicate the holly looper larvae during the test period.

See color plate number 25.

Nantucket Pine Tip Moth Control in Christmas Trees with Tempo 2C, Lynx 25W, and Oftanol 2

Patricia P. Cobb and Ralph R. Beauchamp

NANTUCKET PINE TIP MOTH, *Rhyacionia frustrana,* is the major insect pest on Virginia pine (*Pinus virginiana*) Christmas trees. Tip moth larvae damage new shoots by feeding within and destroying new growth. This distorts tree shape and stunts tree growth, thereby extending the time required to produce a marketable tree. Growers apply insecticides three to six times per season for control, depending on number of tip moth generations in various areas of the State.

Several insecticides are currently registered for control of tip moth in Virginia pine Christmas trees. Cygon®, when used continuously for more than 2 or 3 years, becomes ineffective, perhaps due to insect resistance, Dimilin®, an insect growth regulator, is highly effective, but labeling limits use to once a season in some states, and early timing of applications is critical. The pyrethroids, Mavrik Aquaflow® and Pydrin® 2.4EC, are registered, but application must be made only once or twice from mid- to late season. If used earlier, they disrupt parasite-predator complexes, which usually results in sudden increases in pine tortoise scale. Dursban® 50W, also highly effective for tip moth control, is incompatible with daconil sprays used for needlecast disease control. Phytotoxicity occurs when Dursban is sprayed within a week, before or after, a daconil (Bravo®) treatment. Furadan®, a soil-applied systemic insecticide, is effective only if soil moisture is adequate, and it is also expensive and time consuming to apply. Orthene® is ineffective during mid- to late season.

Control programs for tip moth usually involve the use of two or more insecticides per season. Seasonal studies are done each year to find effective insecticidal controls since choices are limited. During 1986, a study was done in Elmore County with Virginia pine Christmas trees in their second field growing season to determine the efficacy of these insecticides for tip moth control: (1) Lynx® 25W, an insect growth regulator (unregistered); (2) Tempo® 2C, a new pyrethroid insecticide (unregistered), and (3) Oftanol® 2, a residual organopohosphorus insecticide currently

TABLE 33. NANTUCKET PINE TIP MOTH CONTROL IN VIRGINIA PINE CHRISTMAS TREES, ELMORE COUNTY, 1986

Insecticide	Rate/acre	Infested terminals, average[1] 6/24	9/17
	Lb.	*No.*	*No.*
Lynx 25W	0.125	0.25b	0.25b
Tempo 2C	.025	.00b	.25b
Tempo 2C	.05	.00b	.00b
Oftanol 2	.25	.00b	.00b
Untreated		2.50a	6.25a

[1]Means followed by same letter are not significantly different according to Duncan's multiple range test, P = 0.05.

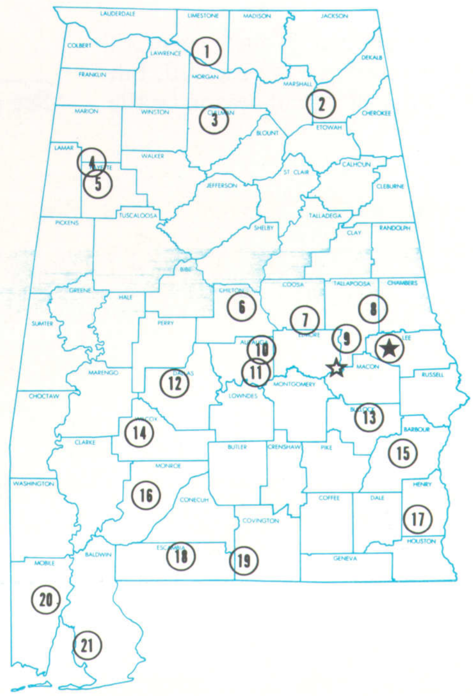
registered on turf but not on ornamentals. The grower treated the first tip moth field generation with Cygon, and sheared instead of spraying for control of the third generation. Insecticidal treatments were timed with pheromone trap data for the second and fourth tip moth generations, May 16 and August 28, respectively. Sprays were applied with pump-up sprayers, 2.75 gallons per acre, over the top only. Counts of infested terminals were made June 24 and September 17, table 33.

All treatments controlled the second and fourth tip moth generations in this test. No phytoxocity was observed, but fungicide treatments were not applied at mid-season by the grower as a part of the total management program. Therefore, interactions between insecticides and fungicides were not noted. No secondary pest populations (scale, aphids, mites) were observed, but further studies are necessary to draw conclusions about effects on parasite-predator complexes. Since Oftanol 2 is already registered for turf, registration for Christmas trees may occur as a label expansion if 1987 tests are promising.

See color plate number 26.

Alabama's Agricultural Experiment Station System
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

⍟ **Main Agricultural Experiment Station, Auburn.**
☆ **E. V. Smith Research Center, Shorter.**

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Chilton Area Horticulture Substation, Clanton.
7. Forestry Unit, Coosa County.
8. Piedmont Substation, Camp Hill.
9. Plant Breeding Unit, Tallassee.
10. Forestry Unit, Autauga County.
11. Prattville Experiment Field, Prattville.
12. Black Belt Substation, Marion Junction.
13. The Turnipseed-Ikenberry Place, Union Springs.
14. Lower Coastal Plain Substation, Camden.
15. Forestry Unit, Barbour County.
16. Monroeville Experiment Field, Monroeville.
17. Wiregrass Substation, Headland.
18. Brewton Experiment Field, Brewton.
19. Solon Dixon Forestry Education Center, Covington and Escambia counties.
20. Ornamental Horticulture Substation, Spring Hill.
21. Gulf Coast Substation, Fairhope.