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ORNAMENTALS

ALABAMA AGRICULTURAL EXPERIMENT STATION AUBURN UNIVERSITY
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FOREWORD

This publication is the first of a new series—"Research Report Series"—being established by the Alabama Agricultural Experiment Station to fill a specific need. Whereas other Experiment Station publications usually report on individual projects, the Research Report Series will bring together results of several phases of work dealing with a specific crop or commodity. Thus, a single publication will provide an update of available research information on a specific crop or commodity.

The new publication is a natural outgrowth of the systems approach to agricultural research, in which researchers from several departments work together to provide solutions to problems faced in the production of a single crop. It will serve as a vehicle by which findings by all members of a research team are combined into a comprehensive report. Such a publication could provide a valuable service to farmers and agribusinesses involved with that crop or commodity, and this is the sole reason the new publication series was instituted.

Information provided in this publication, Research Report Series 1, resulted from research done to provide support for Alabama's important ornamental horticulture industry. We hope this information will be useful and contribute to the success of individual nursery operations and the overall ornamentals industry in the State.

The team that prepared this publication included faculty and staff of three departments and one outlying unit of the Alabama Agricultural Experiment Station (AAES), state and district staff of the Alabama Cooperative Extension Service (ACES), a student in the School of Agriculture, Forestry, and Biological Sciences (SAFBS), and a faculty member from the University of Georgia, who assisted in the research. The contributors are:

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Future publications in this series will report on ongoing research dealing with other important Alabama agricultural crops or commodities.

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COVER PHOTO. Newest members of the ornamental horticulture research faculty of the Alabama Agricultural Experiment Station, Douglas A. Cox (left) and Gary J. Keever, check growth of experimental poinsettias.

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

Growth of Hershey's Red Azaleas in Three Pot/Mulch Combinations

Gary J. Keever and Gary S. Cobb

High soil temperatures have been shown to reduce root and shoot growth of plants. Research indicates that optimum root growth for many plants occurs between 77° and 86°F. Growth is reduced at soil temperatures above 86°F and will cease in many species when temperature exceeds 104°F. Soil temperatures above 120° have been observed in both green and black pots exposed to direct solar radiation. This work was initiated to evaluate temperature fluctuations and growth of *Rhododendron* Hershey's Red in three pot/mulch combinations during the summer months.

In March 1982, uniform Hershey's Red liners were potted in 1-gallon black or white polyethylene pots in amended pine bark. Three treatments were selected to determine pot/mulch effects on growing medium temperatures and plant growth: (1) black pots on a white shell mulch; (2) white pots on a black polyethylene mulch; and (3) black pots recessed into a white plywood frame so that the pot sides were not exposed to direct solar radiation.

Air and medium temperatures were monitored continuously during the summer months. In September, percent root coverage of the surface of the bark medium, relative root development, growth indices, and top dry weight were determined.

Growing medium in the black pots on white mulch consistently reached the highest maximum temperatures. Medium in white pots on a black mulch averaged 6°F cooler. Temperatures in the plywood frame, which simulated jammed plants where pots are shaded, were lower than the other two pot/mulch combinations and lower than ambient air temperature. Maximum temperatures at the different locations within a single black pot on white mulch decreased in the following order: south wall, west, south, east, center, and north side. Maximum ambient air temperature was lower than any of the maximum pot temperatures.

Percent root coverage of the bark surface was greatest for plants grown in the plywood frame, followed in order by plants in white pots on black mulch and those in black pots and white mulch, table 1. Root coverage was greater on the north side of white pots on black mulch than on the south side. Although not significantly different, values indicated less coverage of the south side of black pots on white mulch compared to the north side. Relative root development and growth indices were greater in the plywood frame and in white pots on black mulch than in black pots on white mulch. Growth (measured by top dry weight) was greater in the white pots on black mulch than in black pots on white mulch.

Lower temperatures and greater root and top growth in white pots on black mulch suggest the need to reconsider black pot/white shell mulch combinations commonly used in south Alabama. White pots on a black mulch appear to provide a viable alternative for growers. Lower temperatures and better root development of plants in the plywood frames suggest that it is beneficial to jam plants or to space plants so that foliage minimizes direct solar radiation to the sides of pots during the summer months.

TABLE 1. ROOT COVERAGE (PCT.) OF THE NORTH AND SOUTH BARK SURFACES, RELATIVE ROOT DEVELOPMENT, GROWTH INDEX, AND TOP DRY WEIGHT OF HERSHEY'S RED AZALEA IN THREE POT/MULCH COMBINATIONS

Pot/mulch combination	Root coverage North	Root coverage South	Relative root development[1]	Growth index $\frac{(H+W)}{2}$	Top dry weight
	Pct.	*Pct.*			*Grams*
Black pot/white mulch	7.2 d[2]	0.7 d	2.6 b	23.6 b	27.5 b
White pot/black mulch	31.1 b	20.4 c	3.3 a	26.0 a	36.7 a
Black pot/plywood frame	47.4 a	42.6 a	3.6 a	25.8 a	34.1 ab

[1]Rating: 1 = least developed and 5 = most developed root systems.
[2]Mean separation within columns by Duncan's Multiple Range Test, 5 percent level; root coverage values separated among all means.

See color plate number 1, page 12.

The Effects of Supplemental N on Plant Growth in Fresh and Aged Pine Bark

Gary S. Cobb and Gary J. Keever

Pine bark is commonly used as a growing medium or a medium component in the production of container-grown woody ornamentals in the Southeast. Growers have reported that the use of fresh pine bark instead of aged pine bark resulted in reduced plant growth. Since fresh bark has a higher carbon to nitrogen (C/N) ratio than aged bark, there is an increased demand for N by microorganisms actively decomposing the medium. This increased demand for N in fresh pine bark may require additional N applications if a similar growth response is to be achieved in both bark types. This study was initiated to evaluate the effects of supplemental N on the growth of selected woody ornamentals growing in fresh and aged bark.

Uniform liners of *Euonymus japonica* Microphylla, *Illex crenata* Compacta, and *Rhododendron* Hino-Crimson were potted in amended pine bark medium. Treatments included fresh and aged pine bark with Osmocote 17-7-12, 10 pounds per cubic yard, incorporated plus weekly applications of 0, 100, 200, or 300 p.p.m. N from ammonium nitrate. After 3 months, foliar color was rated on a scale of 1 to 5, with severe chlorosis = 1 and dark green foliage = 5. Growth indices, foliar analysis, and shoot dry weight data were also collected.

Foliar ratings at 0 and 100 p.p.m. supplemental N and growth indices at all N levels were generally higher for plants grown in fresh compared to aged bark, figures 1 and 2. Foliar rating and growth indices increased with increasing rates of N regardless of bark age. Plant dry weight increased with increasing N, figure 3, and growth was not generally different between bark types. With both fresh and aged bark, foliar N increased, while foliar K, P, Ca, Mg, Fe, Mn, and Zn decreased with increasing levels of N fertilization.

Plant growth and appearance were as good in fresh as in aged bark, even without supplemental N. This indicates that

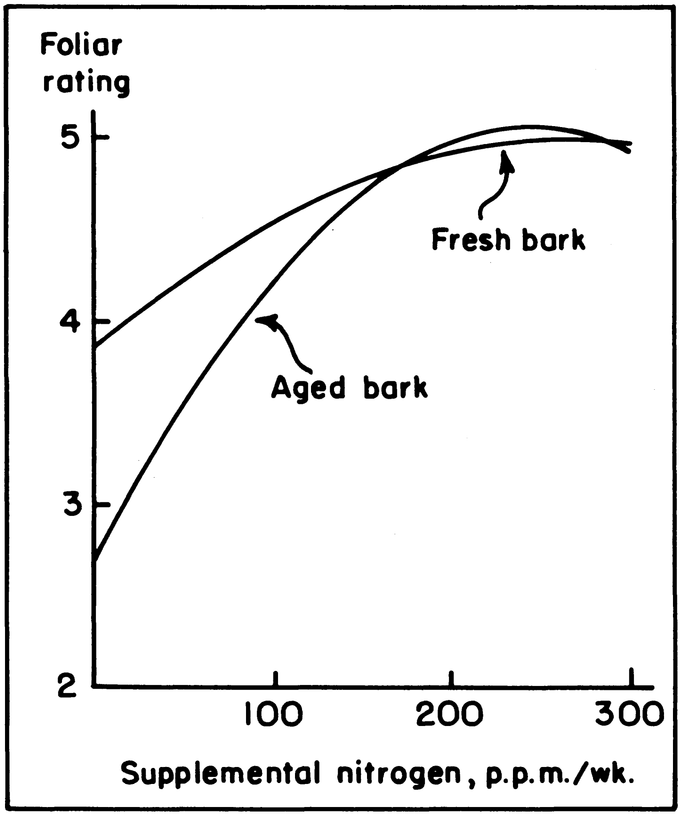


FIG. 1. Foliar rating of *Euonymus japonica* Microphylla grown in fresh and aged pine bark and supplied with different rates of supplemental N: 1 = chlorotic foliage, 5 = dark green foliage.

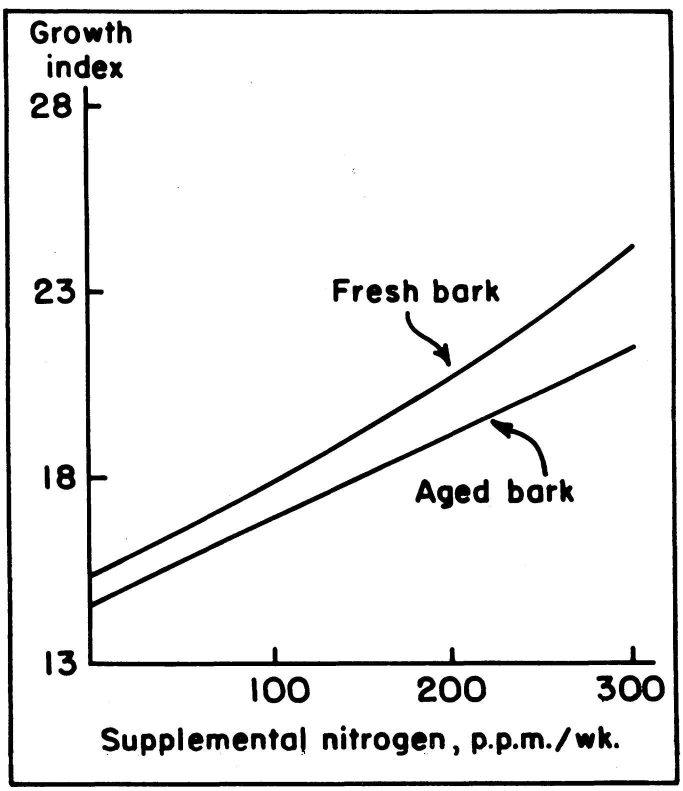


FIG. 2. Growth index (height + width ÷ 2) for *Ilex crenata* Compacta grown in fresh and aged pine bark and supplied with different rates of supplemental N.

additional N demands in fresh bark were low and were met by the incorporated Osmocote. Plant quality increased with supplemental N up to 200 p.p.m. and growth increased as N increased. This indicates the benefits of supplemental N fertilization when Osmocote 17-7-12, 10 pounds per cubic yard, is incorporated in a pine bark growing medium.

See color plates numbers 2 and 3.

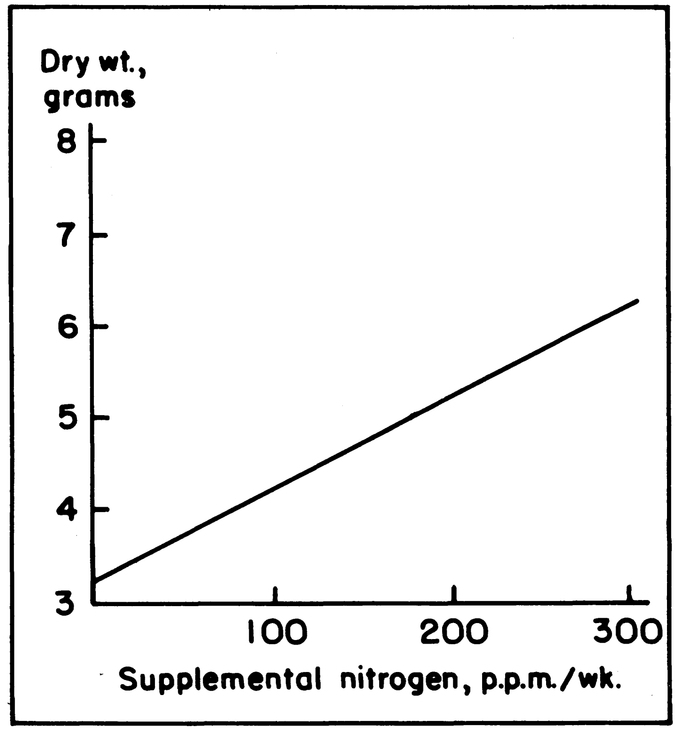


FIG. 3. Growth of *Rhododendron* Hino-Crimson in fresh and aged pine bark when supplied with different rates of supplemental N.

Medium pH and Growth of Two Woody Ornamentals as Influenced by Liming Rate

Gary S. Cobb

Liming of growing media is common practice among commercial nurserymen. Rates vary, but growers often incorporate 8 to 12 pounds of dolomitic limestone per cubic yard of medium. This reduces the acidity of the medium (raises pH) and supplies calcium (Ca) and magnesium (Mg), two required plant nutrients. It has been shown that plants grow well at a lower pH in soilless organic media than in soil. This study was initiated to investigate the growth response of two woody ornamentals as affected by liming rates.

Uniform liners of *Pittosporum tobira* Variegata and *Juniperus virginiana* Sky Rocket were potted March 1981 in 1-gallon plastic containers using a milled pine bark-sandy clay growing medium, 5:1, (v,v), amended with 2 pounds gypsum, 2 pounds regular superphosphate, 1.5 pounds Micromax, and 10 pounds Osmocote 17-7-12 per cubic yard. Liming rates varied from 0 to 15 pounds per cubic yard, table 2. Magnesium sulfate (Epsom salt), ¼ pound per cubic yard,

TABLE 2. EFFECT OF LIMING RATES ON GROWING MEDIUM pH AND FOLIAR LEVELS OF CALCIUM, MAGNESIUM, AND POTASSIUM IN *JUNIPERUS VIRGINIANA* SKY ROCKET 16 MONTHS AFTER INCORPORATION

Dolomitic limestone, lb./cubic yard	pH	Foliar levels, pct. dry wt.		
		Calcium	Magnesium	Potassium
0.0	3.5	1.12	0.24	1.50
2.5	3.5	1.07	.26	1.23
5.0	3.9	1.01	.30	.96
7.5	4.3	1.15	.38	1.10
10.0	4.9	1.09	.44	1.04
15.0	5.7	1.01	.47	1.09

was incorporated at the 0 rate of dolomitic limestone to provide a source of magnesium. Plant growth, foliar nutrient levels, and medium pH were monitored.

The growing medium had an initial pH of 3.6. Samples taken 8 and 16 months after potting demonstrated that pH increased linearly as the rate of dolomitic limestone increased, figure 4. However, pH declined for all treatments between the 8- and 16-month sampling times.

With Sky Rocket, tissue levels of calcium were unaffected by liming rates, table 2. Potassium levels were reduced when dolomitic limestone was incorporated and magnesium increased as the rate of limestone increased. Growth (top dry weight) was not influenced by treatment or medium pH.

Results of this study suggest that liming rates may be significantly reduced without adversely affecting growth or nutrient uptake of these two woody ornamentals.

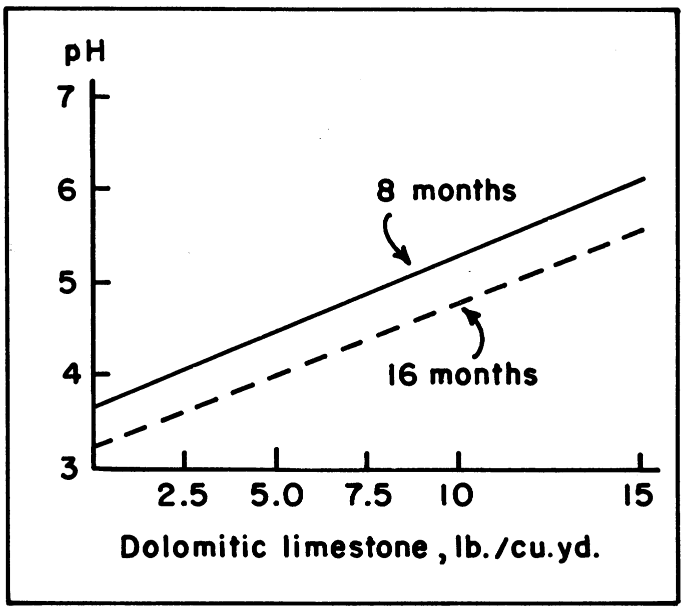


FIG. 4. Effect of liming rates on growing medium pH (acidity) 8 and 16 months after incorporation.

Effect of Foliar Application of Atrinal on Carolina Jasmine

Gary S. Cobb

Gelsemium sempervirens, Carolina jasmine, is an evergreen, twining shrub that produces fragrant, yellow flowers in the early spring. It is grown commercially for landscape use on trellises, porches, banks, and fence rows. The vining nature of the shrub dictates a relatively high labor requirement during production. Failure to keep the plants staked or pruned results in an entagled mass whose separation is difficult, time consuming, and often injurious to the vines. Preliminary tests indicated potential for producing a compact, well-branched plant by foliar application of Atrinal® (dikegulac sodium).

Uniform liners were potted February 20, 1981, in 1-gallon plastic containers using an amended pine bark-peat moss (2:1, v/v) growing medium. Plants were pruned to a maximum shoot length of 8 inches and placed in a plastic-covered, unheated greenhouse in full sun. Treatments listed in table 3 were applied using a hand-pumped, compressed air sprayer on February 24, 1981, completely wetting the upper surface of the foliage. Evaluation was based on phytotoxicity, shoot numbers, and growth.

TABLE 3. EFFECT OF FOLIAR APPLICATION OF ATRINAL ON SHOOT NUMBERS AND GROWTH (SHOOT DRY WEIGHTS) OF *GELSEMIUM SEMPERVIRENS*, CAROLINA JASMINE

Treatment	Shoots/plant	Shoot dry wt.
	No.[1]	*Grams*[1]
Control	24 d[1]	30.9 a[1]
Atrinal, 1 oz./gal.	49 c	23.6 b
Atrinal, 2 oz./gal.	72 b	24.6 b
Atrinal, 3 oz./gal.	113 a	20.9 b

[1]Mean separation within columns by Duncan's Multiple Range Test, 5 percent level; values followed by the same letter are not statistically different.

Two to 3 weeks after spraying, treated plants began to exhibit chlorosis and abnormal leaf shape (small and narrow blades) on young, expanding foliage. Symptoms increased in severity as concentration of Atrinal increased.

Shoot numbers increased as the concentration of Atrinal increased, table 3. Shoot dry weights of plants treated with Atrinal were suppressed compared to the control. After 8 weeks, control plants required staking and at 16 weeks plant height exceeded 4 feet. Plants treated with Atrinal were fuller and more compact than control plants. Those sprayed with Atrinal, 1 ounce per gallon of water, needed staking or pruning 12 weeks after treatment; however, those treated with the higher concentrations required no additional care for 16 weeks.

At the conclusion of the study (16 weeks), the control plants and those treated with Atrinal at rates of 1-2 ounces per gallon were judged marketable by nurserymen despite differences in height and branching. Difference in growth between treated and untreated plants, as reflected by shoot dry weights, was statistically significant, but the difference was not considered to be a marketing factor. Plants treated with Atrinal at 3 ounces per gallon still exhibited chlorosis and foliar distortion after 16 weeks.

In summary, a well-shaped, compact shrub was produced with minimal labor by a single foliar application of Atrinal, 2 ounces per gallon of water. No permanent alteration in growth habit resulted from Atrinal treatment.

See color plate number 4.

GREENHOUSE CROPS

Fertilization of Roosevelt Boston Fern

Charles H. Gilliam, Ronald L. Shumack, and Clyde E. Evans

In the production of Boston ferns, fertilizer is usually applied at frequent intervals on a regular basis. Some growers use a constant fertilization system whereby fertilizer is added at each watering, while others fertilize weekly or biweekly. Nitrogen rates commonly range from 100 to 200 p.p.m. (continuous feed) to 300 to 500 p.p.m. (weekly applications). Previous research has primarily considered the effects of nitrogen rates applied on fern growth rather than effects on fern quality.

Generally, consumers prefer a dark green fern in comparison to lighter-colored ferns. When fertilizer recommendations are based only on total growth, other important aspects, such as greenness of color, may be overlooked. Nitrogen fertilization influences greenness of color, but the relationship between color and growth have not been considered. The objective of this research was to determine the effects of rate and frequency of fertilizer application on growth, nutrient content, and color of Roosevelt Boston fern.

Uniform 2-inch tissue culture fern liners of Roosevelt fern were potted on August 14 into 6-inch plastic containers in Metro-Mix 300. Two weeks later, nine treatments were initiated. Treatments consisted of three fertilization rates: 50, 150, and 300 p.p.m. N from Peters 20-20-20 applied one, two, or three times weekly. Ferns were watered on treatment days if no fertilizer was applied. Plants were grown in a greenhouse under natural photoperiod with temperatures ranging from 65° to 80°F.

Six weeks after treatment initiation, fronds longer than 4 inches were counted. Six weeks later, frond number, color evaluation, and dry weight were taken from two plants per replicate. Samples from frond mid-sections were collected for tissue analysis.

Fern dry weight increased with increasing rates of fertilizer when applied once weekly, table 4. Ferns grown with 150 p.p.m. N applied twice weekly resulted in fern dry weights equal to or greater than all other treatments. These data concur with previous research with Roosevelt fern. Ferns receiving 150 or 300 p.p.m. N three times weekly had growth similar to ferns receiving 150 p.p.m. N twice weekly. Fertilization with 150 p.p.m. N twice weekly would require one-third the amount of fertilizer. These data indicate that optimum growth of Roosevelt fern is obtained at much lower levels of fertility than is commonly applied. Results also indicate that ferns can tolerate a wide range of fertility without adverse effects. This contrasts with other research which showed a 42 percent suppression of fern growth when 300 p.p.m. N applied twice weekly was compared to 200 p.p.m. N applied twice weekly. The data also showed a slight suppression of fern growth when 300 p.p.m. N was applied twice weekly, but then no suppression of growth when 300 p.p.m. N was applied three times weekly. One possible explanation for the dramatic effect of high N rates reported in previous research may be the size and age of liners used in the experiment. Results from the current study and earlier work were similar in nature and duration with regard to the 300 p.p.m. N rate applied twice weekly, yet ferns in the current study had about 2.5 times more dry weight. Most likely this could be attributed to liner age and would suggest that young liners may be more susceptible to soluble salt damage than the 2-inch liners used in this study. The number of fronds at 6 weeks indicated that ferns were not limited initially by high fertility levels. In fact, the greatest number of fronds occurred at the highest fertility levels.

TABLE 4. EFFECT OF RATE AND FREQUENCY OF FERTILIZATION ON ROOSEVELT FERN GROWTH AFTER 12 WEEKS

Treatment: N conc. p.p.m.	Treatment: Frequency per week	Fronds over 12 in.	Dry weight	Green color[1] -a/b	Tissue or foliar N
		No.	*Grams*		*Pct.*
50	1	3 d[2]	10 d	-0.62 d	0.8 f
150	1	15 c	23 c	- .65 c	1.8 d
300	1	20 c	30 b	- .69 b	2.4 c
50	2	12 c	13 d	- .64 cd	1.1 e
150	2	33 ab	37 a	- .69 b	2.1 c
300	2	22 bc	31 b	- .73 a	3.4 a
50	3	11 c	20 c	- .66 c	1.6 d
150	3	37 a	37 a	- .69 b	2.8 b
300	3	31 ab	38 a	- .73 a	3.6 a

[1]Color values were obtained by use of a Hunter Color Difference Meter; the more negative the number, the greener the color.
[2]Mean separation within columns by Duncan's Multiple Range Test, 5 percent level.

Frond numbers at both sampling dates responded similarly to fern dry weight. At the 12-week sample date, frond numbers included only fronds greater than 12 inches in length. Ferns treated with 150 p.p.m. N twice weekly had frond numbers equal to or greater than those with 150 p.p.m. N three times weekly or with 300 p.p.m. N two or three times weekly.

Tissue N increased with increasing rates and frequency of applied fertilizer, table 4. At the end of 12 weeks, increasing the frequency of fertilization at a given rate increased the concentration of tissue N, with the exception of 300 p.p.m. applied three times. Greatest dry weight accumulation occurred when tissue N was greater than 2.0 percent. Increasing the tissue N concentration above 2.0 percent did not increase growth; however, frond color was enhanced when tissue N concentrations were 3.4-3.6 percent. Greatest tissue N concentrations resulted from fertilization with 300 p.p.m. N two or three times weekly. Ferns with a -.69 or lower value had an acceptable green color; however, ferns treated with 300 p.p.m. N two or three times weekly had a darker green color than ferns treated with 150 p.p.m. N two or three times weekly, table 4.

These results show that ferns can be produced with one-third the fertilizer that many commercial producers now apply. With 150 p.p.m. N applied twice weekly, fern growth was equal to or greater than fern growth at higher rates and frequencies. Higher N rates did improve frond color; however, improved frond color may be attainable by using the higher rates and frequencies during the last 1-2 weeks of production.

These data show that when fertilizer is applied once weekly, growth will be limited if the N level is 300 p.p.m. or lower. Furthermore, addition of weekly fertilizer at a level greater than 300 p.p.m. N would result in excessive fertilizer use.

See color plate number 5.

Effect of N and Lime Fertility on Whitmanii Boston Fern

James S. Crockett, Charles H. Gilliam, Clyde E. Evans, and Ronald L. Shumack

Research has shown that Roosevelt Boston fern has maximum growth when fertilized with 150-200 p.p.m. N twice per week. Other research has shown that liming influences growth of Compacta Boston fern. The objective of this study was to determine the influence of liming on the N requirement and growth of Whitmanii Boston fern, a much slower growing fern than the Roosevelt fern.

Whitmanii Boston ferns were grown in a medium of peat and perlite (1:1, v:v) under natural light conditions in a greenhouse from November to March. Half of the experimental medium was limed with dolomitic lime at the rate of 10 pounds per cubic yard and half received no lime. Two weeks after planting, six treatments consisting of three N rates (150, 300, and 450 p.p.m.) were applied at two application frequencies (two and three times weekly). Peters 20-20-20 commercial fertilizer was used twice weekly, but the third weekly application consisted of ammonium nitrate to avoid additional application of P and K. Peters Soluble Trace Element Mix was applied according to label recommendations.

Ferns grown with 150 p.p.m. N applied two or three times weekly and 300 p.p.m. N twice weekly generally had the greatest growth, the highest visual ratings, and the lowest soluble salt readings, table 5. There was no additional growth when ferns were fertilized at N rates greater than 150 p.p.m. N twice weekly.

Liming did not affect dry weights or visual ratings at the lowest N rate regardless of application frequency, table 5. Dry weights did vary at higher N rates, indicating that excessive fertility levels were suppressive, especially for non-limed plants. Visual ratings for limed material were better with ferns receiving 300 and 450 p.p.m. N. The limed medium had less pH variability than the non-limed medium. Non-limed ferns showed soluble salt damage before limed ferns. Limited damage was visible on limed plants with soluble salt readings of 1.1 to 1.4 millimhos (mmhos) compared to 50 to 70 percent damage to non-limed plants at levels of 0.6 to 0.7 mmhos. At no time did the best plants exceed a soluble salt level of 0.4 mmhos regardless of lime treatment to the media.

Generally, 150 p.p.m. N applied two or three times weekly resulted in fern growth equal to or greater than any other treatment. Visual ratings for limed ferns treated with 300 p.p.m. and 450 p.p.m. N were better than from those same treatments in a non-limed medium. While the growth benefits of applying lime were limited when compared to plants grown without liming, it appears that liming is important in a soilless mix because it provides the medium with a buffer against excess fertility and possible soluble salt damage.

See color plates numbers 6 and 7.

TABLE 5. EFFECTS OF N RATE AND FREQUENCY ON FROND NUMBERS, DRY WEIGHTS, QUALITY, PH, AND SOLUBLE SALTS ON THE WHITMANNI FERN IN BOTH LIMED AND NON-LIMED MEDIA

Treatment		Dry weight at 18 weeks	Visual rating[1] at 18 weeks	pH		Soluble salts at 18 weeks	N at 18 weeks
N conc., p.p.m.	Frequency per week			12 weeks	18 weeks		
	No.	*Grams*					*Pct.*
Limed							
150	2	46.5 a[2]	1.3 cd	5.5 a	5.8 a	0.4 c	3.66 d
300	2	41.8 ab	1.6 c	5.4 a	4.9 c	.9 b	4.22 c
450	2	37.9 b	2.6 b	5.3 a	4.9 c	1.4 a	4.76 c
150	3	45.9 a	1.1 d	5.4 a	5.2 b	.3 c	4.07 c
300	3	41.7 ab	1.7 c	5.3 a	4.7 d	.8 b	4.69 b
450	3	35.7 b	3.1 a	5.2 a	5.1 bc	1.1 a	5.21 a
Non-limed							
150	2	40.0 ab	1.4 d	4.4 c	4.5 c	.2 d	4.25 d
300	2	43.7 a	2.1 d	5.3 b	6.5 ab	.4 c	4.97 c
450	2	27.5 c	5.8 b	6.0 a	6.8 ab	.7 a	5.16 bc
150	3	41.2 ab	1.7 d	4.4 c	4.9 c	.2 d	4.71 c
300	3	38.1 b	3.3 c	5.3 b	6.1 b	.5 b	5.45 ab
450	3	28.2 c	7.1 a	6.2 a	7.3 a	.6 a	5.67 a
Lime[3]		**	**	NS	**	**	**
N rate		**	**	**	**	**	**
Lime vs. N rate		*	**	**	**	*	NS
Frequency		NS	**	NS	NS	NS	**
Lime vs. frequency		NS	*	NS	NS	NS	NS
N rate vs. frequency		NS	*	NS	NS	NS	NS
Lime vs. N rate vs. frequency		NS	NS	NS	NS	NS	NS

[1]Based on values from 1 to 10, 1 being a healthy plant, 5 being 50 percent dead, 10 being 100 percent dead.
[2]Mean separation within columns by Duncan's Multiple Range Test, 5 percent level.
[3]Factorial analysis demonstrating no significance (NS), 5 percent level (*), and 1 percent level (**).

Effects of Slow-Release Fertilizers on Growth and Post-Production Performance of Boston Fern

Charles H. Gilliam, Douglas A. Cox,
Ronald L. Shumack, and Clyde E. Evans

High quality foliage plants can be commercially produced by following either liquid or slow-release fertilizer programs. One area receiving increased attention is that of post-production handling. Research has established that acclimatizing foliage plants prior to entering the interior environment is beneficial, and shown that plants acclimatized to lower light levels require less fertilizer.

Many foliage plants are sold to garden centers and other retail outlets where the plants may remain for as long as 2 months. It is often assumed that plants receiving liquid fertilization rapidly become depleted of nutrients when taken off regular fertilization, leading to a reduction in plant quality. In view of previous research on foliage plants and the interaction of light and fertilizer levels, it was thought that perhaps holding ferns in low light conditions prior to sale would enhance plant quality, benefiting both the retailer and consumer.

The objective of this experiment was to determine the effects of two slow-release fertilizers and liquid fertilization on the growth, foliar N content, and quality of Compacta Boston fern in two post-production environments.

Fern liners were potted September 23, 1981, in 6-inch plastic pots of peat-perlite (1:1, v/v) amended with gypsum at 2 pounds per cubic yard. Prior to planting, experimental sulfur-coated Slow Release Encapsulated Fertilizer (SREF), 20-4-10, for foliage plants or Osmocote 19-6-12 was incorporated at either 1.5, 3.0, or 6.0 pounds N per cubic yard. For comparison, other plants received liquid fertilization with Millers 20-2-20 at 150 p.p.m. N twice weekly. Ferns were grown in a double layer polyethylene house with maximum illuminance of 500 foot-candles and a temperature range of 65° to 80°F.

Following a production period of 16 weeks ending January 16, 1982, half of the ferns were moved to an interior environment, while the others were left in the greenhouse. Interior lighting was provided by cool white fluorescent lamps plus natural light through windows. Maximum illuminance was about 230 foot-candles and minimum illuminance about 100 foot-candles. No fertilizer was applied to the plants in either post-production environment after January 16. Six weeks later, dry weight and color difference measurements were made on plants in the two post-production environments. Foliar N analyses were made at the end of the production period and after 6 weeks in the post-production environments.

Commercial production. The greatest fern growth during normal production (16 weeks) occurred with liquid fertilization or the incorporation of 3 pounds N per cubic yard of Osmocote, table 6. Ferns grown with Osmocote at the 1.5 or 3 pounds N per cubic yard rate were larger than in the corresponding SREF treatments. There were no differences in dry weight between the two highest Osmocote and SREF rates. Foliar N was greatest with liquid fertilization and 6.0 pounds N per cubic yard of each slow-release fertilizer and lowest with 1.5 pounds N per cubic yard.

Post-production period. Little additional growth occurred in the interior environment; generally, dry weight after 6 weeks was within 5 percent of the weight 6 weeks earlier. In contrast, ferns in the greenhouse environment continued to grow and most treatments had dry weight increases of 20 percent or more. Even ferns receiving liquid fertilization during production and no subsequent fertilization during the post-production period increased 28 percent in dry weight.

Foliage color was similar among all fertilizer treatments at the end of the production period except for plants receiving 1.5 pounds N per cubic yard of SREF, which were lighter green. At the end of the post-production period, ferns in the greenhouse tended to be lighter in color than at the beginning, but plants in the interior environment were darker than at the beginning.

These results have several practical implications. Many retail garden centers have greenhouses to hold and maintain foliage plants prior to sale. The data indicate that ferns may actually improve in color under low light conditions, even when no liquid fertilizer is added, disputing the notion that slow-release fertilizers are superior to liquid fertilizers in maintaining green color following the production period. Ferns which received liquid fertilization and were then held for 6 weeks with no fertilization were as green as those with slow-release fertilizers, regardless of the post-production environment.

Foliar N data further support the fact that ferns grown with liquid fertilization did not become N deficient, table 6. When sampled at the end of the production period, foliar N

TABLE 6. EFFECTS OF TWO SLOW-RELEASE FERTILIZERS ON COMPACTA BOSTON FERN DRY WEIGHT, FOLIAR N, AND COLOR

Treatment lb. N/ cu. yd.	Dry wt., grams			Foliar N, pct.			Green color (a/b)[2]		
	End of production	Post-production[1] Greenhouse	Post-production[1] Interior	End of production	Post-production Greenhouse	Post-production Interior	End of production	Post-production Greenhouse	Post-production Interior
SREF 20-4-10									
1.5	55.1 c[3]	70.3 d	57.2 b	1.5 d	1.6 d	1.8 c	-0.62 a	-0.56 a	-0.66 a
3.0	61.6 bc	70.0 d	60.5 b	2.5 bc	2.6 a	3.0 a	- .66 b	- .62 a	- .66 a
6.0	62.8 b	89.2 b	61.3 b	2.7 ab	2.5 ab	3.1 a	- .68 b	- .53 a	- .70 ab
Osmocote 19-6-12									
1.5	65.9 b	79.3 c	62.9 b	2.2 c	1.9 cd	2.5 b	- .67 b	- .62 a	- .74 b
3.0	75.9 a	103.1 a	75.5 a	2.5 bc	2.1 bc	3.0 a	- .67 b	- .57 a	- .71 ab
6.0	63.6 b	95.5 b	72.4 a	2.6 ab	2.2 abc	3.1 a	- .68 b	- .62 a	- .71 ab
20-2-20, 150 p.p.m. N	78.7 a	109.5 a	80.2 a	2.9 a	2.4 ab	3.3 a	- .68 b	- .61 a	- .71 ab

[1]Production period was September 23 to January 16. Post-production was January 16 to February 25.
[2]Green color: more negative the number, greener the color.
[3]Mean separation within columns by Duncan's Multiple Range Test, 5 percent level.

of ferns grown with liquid fertilization was equal to or greater than with the slow-release fertilizer treatments. Six weeks later these ferns still had foliar N content similar to or higher than all other treatments, regardless of the post-production environment. Apparently enough N was retained in the medium after liquid fertilization was stopped to sustain the plants under conditions in the test.

These results indicate that it may not be necessary to fertilize ferns for at least 6 weeks following the end of commercial production if the plants are held under low light conditions at the retail outlet. This is true regardless of method of fertilization used during production.

Preliminary Evaluation of Cut Rose Production in South Alabama

Gary S. Cobb

Commercial U.S. production of long stem florist roses has been located primarily in the West and Northeast. Nearness to population centers and transportation availability favored these locations, but population shifts and modern transportation capabilities have eroded their advantages. Nevertheless, areas such as the Southeast have not developed production to furnish locally available markets. In fact, roses retailed in the Southeast at present are produced in California or imported from Colombia.

Rose production in the Southeast traditionally has been limited by two cultural problems: high temperatures and disease (powdery mildew). However, modern cooling and heating systems can provide effective temperature control for greenhouse crops and rose powdery mildew can be effectively controlled by environmental and chemical methods. High light intensity, reduced energy costs, the availability of high quality water, and an increasing population favor the establishment of commercial rose production facilities in the Southeast.

An existing 25 x 30 foot glass greenhouse was modified with perimeter heating and an improved temperature control system. Two cultivars, Forever Yours (red) and Town Crier (yellow), grade XX and budded on *Rosa Manettii* root stocks, were planted one per square foot in raised benches in January 1980. Support was provided by wire and bamboo caging placed at 1-foot intervals. Two growing media, 100 percent milled pine bark and milled pine bark-peat-sandy clay (2:2:1, v/v/v), were evaluated. Plants were fertilized with each irrigation using 250 p.p.m. nitrogen and 200 p.p.m. potassium. Micronutrients and supplemental iron were injected periodically. Plants received two soft pinches before they were allowed to flower. Summer day temperatures were kept at 85° to 90°F. Minimum winter temperatures were maintained at 60°F during the night and 70°F during the day. Standard commercial greenhouse pest control methods were used. Roses were cut twice daily. Production data included yield, stem length, and flower weight for continuous flower production from May 1980 through April 1981.

Forever Yours yielded a greater number of blooms per plant than did Town Crier, table 7. While no attempt was made to schedule the crop, annual yields for both cultivars equalled or exceeded published reports on productivity from other areas. Stem length was not significantly different between cultivars; however, flowering stem weights for Town Crier were greater than for Forever Yours. Local florists judged the flowers to be of commercial quality.

TABLE 7. EFFECT OF CULTIVAR ON FIRST YEAR'S MARKETABLE FLOWER YIELD, STEM LENGTH, AND FRESH STEM WEIGHT OF CUT ROSES

Cultivar	Yield, flowers/plant	Shoot	
		Length	Weight
	No.	*cm*	*Grams*
Forever Yours	42.3 a[1]	57.4 a[1]	24.6 b[1]
Town Crier	29.3 b	61.0 a	27.5 a

[1]Mean separation within columns by Duncan's Multiple Range Test, 5 percent level; values followed by the same letter are not statistically different.

TABLE 8. EFFECT OF GROWING MEDIA ON THE FIRST YEAR'S MARKETABLE FLOWER YIELD, STEM LENGTH, AND FRESH STEM WEIGHT OF CUT ROSES

Medium	Yield, flowers/plant	Shoot	
		Length	Weight
	No.	*cm*	*Grams*
Milled pine bark	33.3 b[1]	58.3 a[1]	25.5 a[1]
Milled pine bark-peat-sandy clay (2:2:1, v/v/v)	38.3 a	59.4 a	26.0 a

[1]Mean separation within columns by Duncan's Multiple Range Test, 5 percent level; values followed by the same letter are not statistically different.

Yield in milled pine bark-peat-sandy clay was higher than in 100 percent milled pine bark, table 8. Stem length and weight were not affected by media for either cultivar. Frequency of irrigation was greater in 100 percent milled pine bark, reflecting the lower water holding capacity of the medium.

Infrequent outbreaks of powdery mildew occurred in the spring and fall. Eradicative control was obtained with a single application of Milban® (1 quart per 100 gallons of water) plus Nu-Film® 17 (0.5 pint per 100 gallons of water). Infrequent infestations of spider mites, flower thrips, and armyworms were kept in check with insecticide sprays.

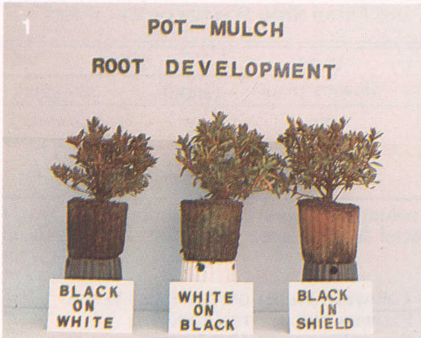
A recent report in a national publication noted that for U.S. growers to be competitive in the cut rose market, they must be near their market and minimize production costs such as winter heating bills. If production could be economically feasible, south Alabama could be a favorable location for commercial rose production.

See color plates, numbers 8 and 9.

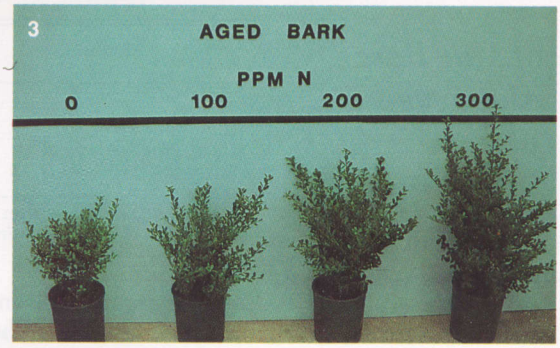
Cotton Waste as a Tomato Media Amendment

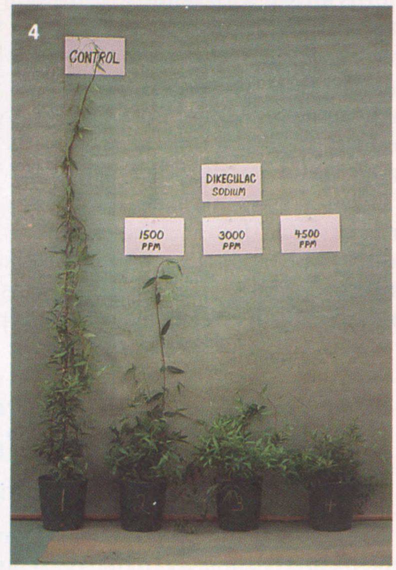
Ronald L. Shumack, Charles H. Gilliam, and Frank Pokorny

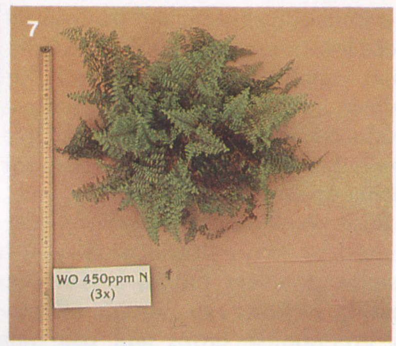
Bedding plant production requires a medium that is high enough in fertility for plants to grow quickly but low enough in salts not to burn new roots. The medium must also be as inexpensive as practical. Pine bark based media are usually lower in cost than peat based media, but they have often

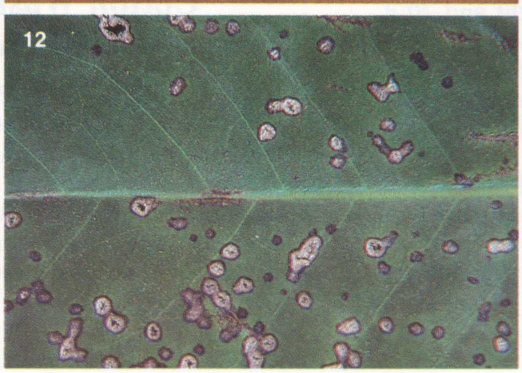


(1) Root development of Hershey's Red azaleas in three pot/mulch combinations. (2, 3) Effects of supplemental N on Compacta holly growth in fresh and aged pine bark. (4) Effects of foliar application of Atrinal on Carolina jasmine. (5) Fertilization of Roosevelt Boston fern with 150 p.p.m. N 1, 2, or 3 times weekly. (6, 7) Salt injury on Whitmanni Boston ferns. (8, 9) Production of Forever Yours roses at the Ornamental Horticulture Field Station. (10) Tomato seedlings grown in three media at 150 p.p.m. N with no MagAmp, and (11) with 10 pounds per cubic yard of MagAmp. (12) Symptoms of fungal leaf spot, and (13) bacterial leaf spot on southern magnolia.

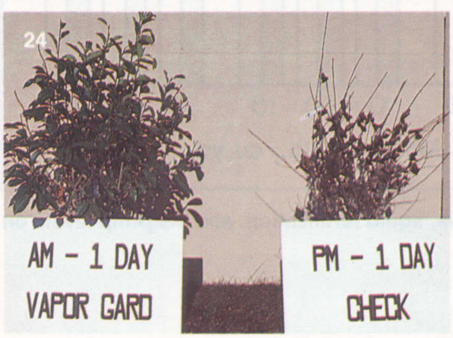


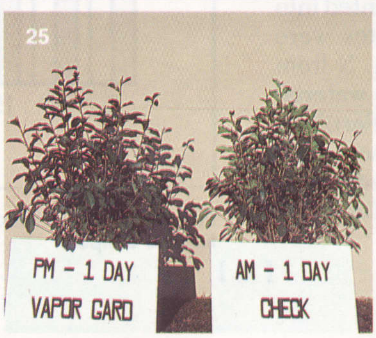






(14) Virginia pine Christmas tree plantation, and (15) symptoms of Nantucket pine tip moth injury. (16, 17) Pine tortoise scale adult females on Virginia pine. (18) *Paria* leaf beetle damage on azalea. (19) Close up of *Alternaria Tenuissima,* and (20) symptoms of alternaria leaf spot on *Pittosporum tobira.* (21) Close up of photinia leaf spot. (22) Symptoms of petal blight, and (23) chemical injury on geranium. (24) Vapor Gard/a.m., and (25) Vapor Gard/p.m. on summer dug photinia. (26) Effects of postemergence applied herbicides on bermudagrass control.





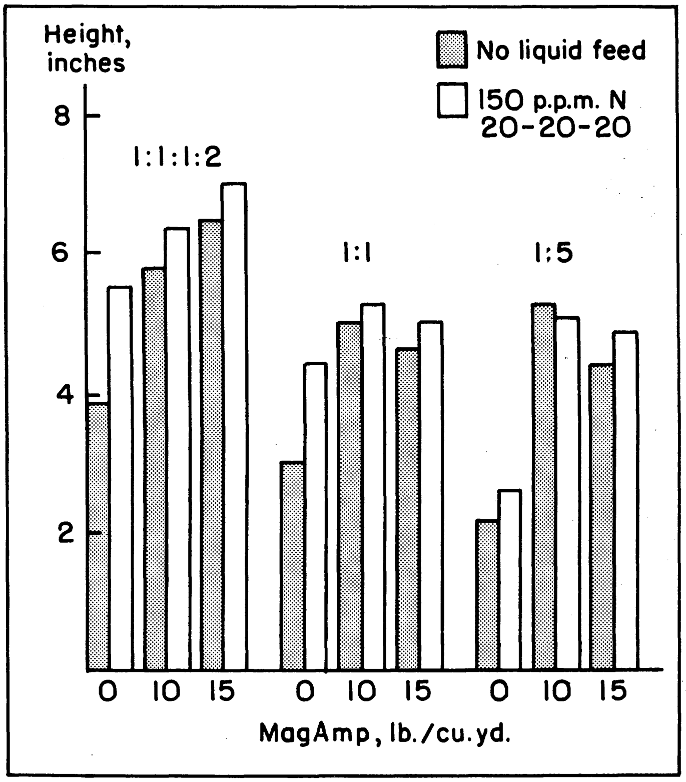


FIG. 5. Effects of media, liquid fertilization, and MagAmp levels on tomato height.

Four weeks later, 624 plants per treatment were cut at the soil line for dry weight determination. Leaves from the remaining plants were taken for analysis for N, P, K, Ca, Mg, and Mn. A screen analysis was done on each medium before the start of the study.

These data show that the 1:1:1:2 medium (peat moss: vermiculite: cotton waste: pine bark) produced taller tomato plants with larger stem caliper, figures 5 and 6. When MagAmp was added to the 1:1:1:2 medium, plants were larger (height and caliper) compared to plants grown in media with no MagAmp. Liquid fertilization was beneficial only when no MagAmp was present in the medium. Plants grown in the peat:perlite medium and the cotton waste: pinebark medium (1:5) responded similarly when MagAmp was added at the 10 or 15 pounds per cubic yard rate. When no MagAmp was added, the peat: perlite medium produced taller plants with greater stem caliper compared to the 1:5 medium.

Tomato dry weight was greater for the 1:1:1:2 mix than for the 1:1 and 1:5 media, figure 7. As with height and caliper, the addition of MagAmp resulted in greater dry weight accumulation compared to the 0 rate. Only with 1:1:1:2 was there a linear response to increasing rates of MagAmp. Tomato plants in the 1:1 and 1:5 media had less dry weight at the 15-pound MagAmp level or similar dry weight as compared to the 10-pound rate, both with and without liquid feed.

been less than completely successful in the production of bedding plants. Preliminary studies with cotton waste from the ginning operation have shown it to be a suitable product for greenhouse media, if it is not contaminated with arsenic. Use of pine bark and cotton waste as a medium has not been reported. This study was designed to determine the effect of a combination of pine bark and cotton waste on the growth and nutrient content of Better Boy tomatoes.

Three media combinations were mixed (by volume) on April 1: (1) 1:1:1:2—1 part sphagnum peat moss, 1 part vermiculite, 1 part cotton waste, and 2 parts pine bark; (2) 1:5—1 part cotton waste and 5 parts pine bark; and (3) 1:1—1 part sphagnum peat moss and 1 part perlite. To each cubic yard of media was added the following lime and nutrients: 5 pounds dolomitic limestone, 2 pounds gypsum, 2 pounds superphosphate, 1 pound iron sulphate, 1 pound calcium nitrate, and 3 ounces Fritted Trace Element #555, plus 0, 10, and 15 pounds of MagAmp. Final medium pH for the three media were: 1:1:1:2, pH 6.4; 1:1, pH 5.5; and 1:5, pH 6.1. Uniform Better Boy tomato seedlings were transplanted into bedding plant flats. Three liquid fertilization rates were applied after transplanting: 0, 150, and 300 p.p.m. N from Peters 20-20-20 commercial fertilizer. Plants were watered on treatment days if no fertilizer was added. Fertilizer solutions were applied until medium saturation occurred. Plants were grown in a double polyethylene covered greenhouse under natural photoperiod with no shade. Temperatures ranged from 68° to 90°F.

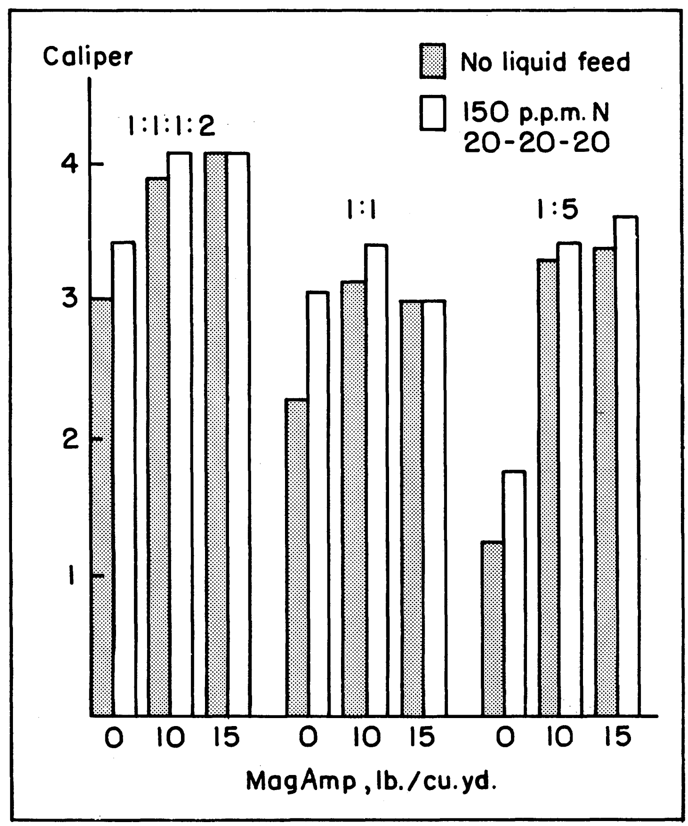


FIG. 6. Effects of media, liquid fertilization, and MagAmp levels on tomato caliper.

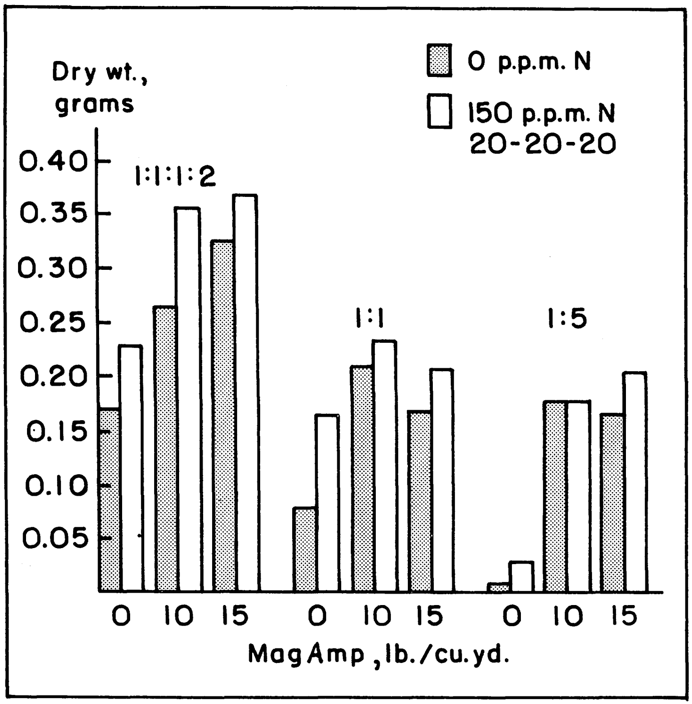


FIG. 7. Effects of media, liquid fertilization, and MagAmp levels on tomato dry weight.

TABLE 9. SCREEN ANALYSIS OF THREE MEDIA

Screen		Analysis of media		
NBS No.	Opening, mm	Peat: perlite	1:1:1:2	1:5
4	4.76	5.5	7.2	7.4
8	2.38	21.7	13.6	19.2
10	2.00	9.8	5.5	6.2
18	1.00	24.3	26.8	22.2
20	.84	3.8	7.9	5.9
30	.60	7.6	13.2	11.0
40	.42	8.4	9.8	9.4
Pan	<.42	19.0	16.0	18.8

The screen analysis showed the three media to be close in particle size distribution, table 9.

All tomato plants grown in this experiment were salable except those grown at the 0 MagAmp rate in the 1:1 and 1:5 media. These results show that quality tomato transplants can be grown in a mix where cotton waste is used in conjunction with peat, vermiculite, and pine bark. Other possible problems with cotton waste, such as arsenic contamination and weed seed, may need further study.

See color plates numbers 10 and 11.

DISEASE AND INSECT CONTROL

Management Program Developed For an Alabama Magnolia Orchard

Jacqueline M. Mullen, Patricia P. Cobb, and Ronald L. Shumack

For the past 10 years, disease and insect problems have sporadically plagued a large southern Alabama magnolia (*Magnolia grandiflora*) orchard which produces foliage for the national fresh-flower arrangement market. Every year, unidentified leaf spots and insect problems cause a portion of the foliage to be unmarketable. Depending on weather conditions, the incidence and severity of the damage fluctuated from year to year. Due to the nature of this crop, disease incidence at any level is unacceptable.

In 1980 efforts were begun to diagnose these disease and insect problems and develop a management program to maximize the production of blemish-free foliage.

During the past 3 years, the magnolias were sampled regularly for incidence of leaf spot disease, insect damage, and pesticide phytotoxicity. Fungal, algal, and bacterial leaf spots were identified. Fungal pathogens included *Phyllosticta* sp., *Alternaria* sp., *Gloeosporium* sp., and *Colletotrichum* sp. Cephaleuros algal leaf spot was diagnosed in 1980 and 1982. The causal agent of a bacterial leaf spot was tentatively identified in 1981 as a *Pseudomonas* sp. This diagnosis was confirmed in 1982 when pathogenicity tests were conducted. While this bacterial leaf spot had not previously been reported on *Magnolia grandiflora* in the literature, it had been found in the Mobile area. Insect and arachnid problems included scales, spider mites, and stink bugs. The scales were identified as *Hemiberlesia lataniae* (Signoret) and *Velataspis dentata* (Hoke). Soil tests were performed in 1980 to develop an appropriate fertilization schedule.

The biweekly fungicide spray program implemented during the spring of 1980 involved a mixture of mancozeb (Manzate® 200 80 WP), benomyl (Benlate® 50 WP), and spreader-sticker. This mixture, 1.4 pounds Manzate 200, 0.25 pound Benlate, and 0.5 pint spreader-sticker per 100 gallons of water, gave adequate leaf spot control during the relatively dry growing seasons of 1980 and 1981. When leaf spot tissue culture studies in 1981 indicated that a bacterial pathogen might be present in the plantings, copper hydroxide (Kocide® 101 86 WP) treatments were substituted for the Manzate 200-Benlate mixture. During the wet month of May 1982 when new foliage was rapidly unfolding, Kocide 101 sprays (1 pound Kocide 101 plus 0.5 pint spreader-sticker per 100 gallons of water) were applied at weekly intervals. After new foliage had developed a protective cuticle layer (early to mid-June), treatment intervals were increased to 2 weeks.

The spray treatments for insect and spider mite control in 1981 and 1982 included petroleum oil (Oil-I-Cide®), acephate (Orthene® 75 S), and hexakis (Vendex® 50 WP). Oil-I-Cide (2.0 gallons per 100 gallons of water) was applied in mid-March for the control of scale and spider mites. Orthene was applied as a spray (0.5 pound active ingredient per 100 gallons of water) at 2-week intervals from April through mid-August with a final treatment in September for insect control. Vendex was added to the spray mixture at label recommended rates (12 ounces per 100 gallons of water) at monthly intervals for spider mite control.

Based on soil test results and available research information, the following fertilization schedule was developed:

Time of fertilization	*Amount per acre*
Spring 1982	1 ton dolomitic limestone
	500 pounds 5-15-30
	500 pounds ammonium nitrate
July 1982	200 pounds ammonium nitrate
December 1982	500 pounds 13-13-13

The December fertilization provided tree roots with the minerals required for a large flush of spring growth. Since the orchard ground cover of bahiagrass normally competes with the deep-rooted magnolia trees for mineral supplies, it was felt that fertilizing in winter when bahiagrass is dormant would allow maximum nutrient availability to the tree roots.

Despite the wet conditions of 1982, which were conducive for disease and some insect development, there appeared to be a large increase in new foliage production and a low incidence of disease and insect damage. This increased production of healthy foliage is attributed to an appropriately timed schedule of effective pesticides in conjunction with a fertilization program designed to maintain a vigorous stand of magnolias. Spray mixtures of fungicides, insecticides, and miticides used on these magnolias during the past 2 years were compatible and did not result in any significant phytotoxicity effects.

See color plates numbers 12 and 13.

Control of Nantucket Pine Tip Moth on Virginia Pine Christmas Trees with Dimethoate, Carbofuran, and Diflubenzuron

Patricia P. Cobb

Nantucket pine tip moth, *Rhyacionia frustrana* (Comstock), is a major pest on Virginia pine, *Pinus virginiana*, Christmas trees. Tip moth larvae feed within new shoots, destroying terminal and lateral tips. The growth of many new shoots around a dead tip ruins the "Christmas tree shape" of the plant. Additional time and effort are required in shaping a tip moth-damaged tree into a marketable product.

Although several chemicals are available for tip moth control, only a few have been found to be effective in Virginia pine plantations. Dimethoate (Cygon® 2E) and carbofuran (Furadan® 10G) are commonly used in Alabama. Growers may make four to seven foliar sprays of Cygon, two soil applications of granular Furadan, or a single spring application of Furadan, followed 90 days later by a series of dimethoate sprays (at 3- to 4-week intervals through September). All three programs effectively control tip moths; however, both chemicals are phytotoxic to Virginia pines under certain conditions. In plantations that have been sprayed for tip moth for 3 or 4 years, populations of other insect pests (scale, aphids) may build up.

Diflubenzuron (Dimilin®) is an insect growth regulator that effectively controls gypsy moth larvae in forestry and nursery situations. Dimilin prevents the proper formation of the insect's exoskeleton during molting. It does not affect adult insects, is harmless to many parasite/predator populations, and is nontoxic to warm blooded animals. Dimilin has demonstrated activity in controlling tip moths on Virginia pine Christmas trees. The purpose of this study was to evaluate Dimilin for control of Nantucket pine tip moth in a Virginia pine Christmas tree plantation.

Trials were conducted in Bullock County on second-year trees (about 2 feet) planted in a well drained, sandy loam field on 4-foot by 7-foot spacing. Rainfall during February and March kept soil moisture high. One hundred trees were randomly selected for a pre-treatment count of infested terminals on March 2, 1982. Infested terminals were counted four times, post treatment. On March 2, 1982, all except the untreated checks received 1 teaspoon of Furadan 10G granules incorporated into the soil at a single site halfway between the tree trunk and the drip line.

Treatments were arranged in randomized complete blocks with four replications per treatment and 10 trees per replication. Previous tests indicated that carbofuran controls tip moths for up to 90 days. Additional granular and foliar

TABLE 10. CONTROL OF NANTUCKET PINE TIP MOTH ON 2-YEAR VIRGINIA PINE CHRISTMAS TREES

Formulation, rates, and treatment dates[1,2]	Counts of infested terminals, 40 trees per treatment				Average no. of infested terminals[4]	Percent control[5]
	6/2	7/1	7/30[3]	11/29	11/9	
Cygon 2E, 4 tsp./gal., 6/2/82	0	4	15	31	7.75 ab	22.5
Cygon 2E, 4 tsp./gal., 6/2/82; 7/1/82	1	2	20	31	7.75 ab	22.5
Cygon 2E, 4 tsp./gal., 6/2/82; 7/1/82; 8/5/82	0	1	14	20	4.75 cd	50.0
Furadan 10G, 1 tsp./tree, 6/2/82	1	3	2	19	4.75 cd	52.5
Dimilin 25W, 2 tbsp./gal.[4], 6/2/82	0	5	17	27	6.75 bc	32.5
Dimilin 25W, 2 tbsp./gal., 6/2/82; 7/1/82	2	3	6	22	5.50 bc	45.0
Dimilin 25W, 2 tbsp./gal., 6/2/82; 7/1/82; 8/5/82	0	1	4	12	3.00 d	70.0
Dimilin 25W, 4 tbsp./gal.[5], 6/2/82	0	0	5	29	7.29 b	27.5
Dimilin 25W, 4 tbsp./gal., 6/2/82; 7/1/82	1	0	3	17	5.50 bc	57.5
Dimilin 25W, 4 tbsp./gal., 6/2/82; 7/1/82; 8/5/82	0	0	2	11	2.75 d	72.5
Check (untreated)	12	20	39	39	9.75 a	2.5

[1]All treatments (except check) were preceded by Furadan 10G applied March 2, 1982, at 1 teaspoon per tree.
[2]All sprays included NuFilm 17 at 1 teaspoon per gallon (16 ounces per 100 gallons).
[3]Trees were sheared August 1, 1982.
[4]Mean per 10-tree replication; means followed by the same letter are not significantly different according to Duncan's New Multiple Range Test, $P = 0.05$.
[5]Percent uninfested terminals per treatment as determined in November.

treatments were initiated June 2, 1982, to compare insecticide rates and scheduling. Trees were sprayed uniformly with a mist, but not to the point of drip. Counts of infested terminals were made prior to each spraying and again in late November after trees became dormant.

June, July, and November counts of infested terminals and percent control are presented in table 10.

The poorest control was observed with one or two sprays of Cygon or one spray of Dimilin at either rate. Best control (70 percent or more uninfested terminals) was with three applications of Dimilin, regardless of rate.

Acceptable control is 85-90 percent uninfested terminals. Some damage to terminals found in November might have been prevented if a September spray had been applied; however, differences in control among various treatments were present in late July. This was after the emergence and re-infestation of trees by the second generation of tip moths. Monthly spray applications June through September should result in better control of tip moth than one, two, or three applications, or a second application of Furadan in June.

See color plates numbers 14 and 15.

Pine Tortoise Scale Control in Christmas Tree Plantations

Michael L. Williams and Patricia P. Cobb

Pine tortoise scale, *Toumeyella parvicornis* (Cockerell), is an important scale insect pest of Christmas tree plantations in the South. It is frequently a pest of landscape plantings of pine, but becomes a more serious pest where pines are grown in monoculture. Pine tortoise scale can rapidly spread through a stand of pines, causing a 40 percent reduction of tree growth and, in the case of Christmas tree plantings, render the trees unfit for sale.

During 1982, several Christmas tree farms in Alabama experienced heavy infestations of pine tortoise scale and had difficulty controlling them. This research investigated six insecticides for efficacy against immature pine tortoise scales infesting Virginia pine, *Pinus virginiana* Mill.

Twenty-one 5- to 6-foot-tall Virginia pine heavily infested with pine tortoise scale were selected for treatment. Test plants were growing in a managed Christmas tree plantation in Lee County, Alabama. Treatments were replicated three times, a single tree constituting a replication. A single foliar application of test materials was made May 14, 1982, with NuFilm 17® added to all treatments as an adjuvant. Trees were sprayed to runoff using compressed air sprayers. Efficacy of the treatments was determined after 7 days by examining 100 individual insects per tree. Mortality counts were made May 21, 1982, by observing each scale insect and counting it as living, if normally colored and full bodied, or dead, if discolored and shriveled or dried. Results are presented in table 11. Excellent control of immature pine tortoise scale was achieved with Cygon®, Enstar®, Ficam®, Mavrik®, and Orthene®. Pounce® did not provide effective control at the rate tested. Some needle burn was observed in the Cygon-treated trees. No phytotoxicity was noted with the other materials tested.

TABLE 11. PINE TORTOISE SCALE CONTROL ON VIRGINIA PINE CHRISTMAS TREES

Treatment[1,2], lb. ai/100 gal.	Mean pct. mortality[3] of immature pine tortoise scale
Orthene 75S, 0.5	99.7 a
Ficam 76WP, 0.5	98.7 a
Mavrik 2E, 0.1	95.0 a
Enstar 2F, 0.1	94.0 a
Cygon 2E, 1.0	92.3 a
Pounce 3.2EC, 0.1	21.7 b
Check (water)	5.3 c

Means followed by the same letter are not significantly different according to Duncans New Multiple Range Test, P = 0.05.
[1]Treatment applied May 14, 1982.
[2]All treatments included Nu-Film 17 at 16 ounces per 100 gallons.
[3]Mortality determined May 21, 1982.

It appears that several materials currently registered for scale insect control on trees and shrubs are effective against immature pine tortoise scale. As with most scale insects, the immature stages are most easily controlled. Pine tortoise scale may have three to four generations per year depending on weather conditions. Sprays should be applied when the immature or "crawler" stages are settling on new growth twigs and needles.

See color plates numbers 16 and 17.

Paria Leaf Beetle Control on Azaleas

James C. Stephenson, Jr., Gary S. Cobb, and Michael L. Williams

In October 1982, a Chrysomelid leaf beetle, *Paria* sp., caused severe foliar damage on approximately 30,000 container-grown azaleas at a nursery in Mobile County, Alabama. Damage included irregular necrotic areas 1-3 millimeters in diameter with tan centers and dark brown margins. Kurume, Gumpo, and other hybrid groups were damaged while Southern Indica cultivars were not affected. The beetle, dark brown and 4-5 millimeters in length, appeared to feed nocturnally on the upper leaf surface, leaving the lower epidermis intact. During the day it could be found hidden in apical shoot tips.

TABLE 12. COMPARISON OF NINE INSECTICIDES FOR LEAF BEETLE CONTROL ON AMY AZALEAS

Treatment[1]		Percent
Insecticide	Rate/100 gal. water	mortality[2]
Chlorpyrifos 2E (Lorsban®)	2.00 pt.	98 a
Bendiocarb 76WP (Ficam®)	.66 lb.	96 ab
Carbaryl 2.4F (Sevin®)	1.66 pt.	89 abc
Acephate 75SP (Orthene®)	.66 lb.	88 abc
Fenpropathrin 2.4EC (Danitol®)	.25 pt.	84 abc
Fenpropathrin 2.4EC (Danitol®)	.33 pt.	77 bc
Methomyl 1.8L (Lannate®)	2.20 pt.	76 bc
Oxamyl 2L (Vydate®)	2.00 pt.	72 cd
Fluvalinate 2E (Mavrik®)	.40 pt.	70 cd
Diazinon 2E (Spectracide®)	2.00 pt.	69 cd
Fluvalinate 2E (Mavrik®)	.20 pt.	53 d
Chevron Spray Sticker®	.50 pt.	12 e
Control		3 e

[1]Treatments applied November 5, 1982. Temperature 80°F.
[2]Mean separation within columns by Duncan's Multiple Range Test, 5 percent level; values followed by the same letter are not statistically different.

Nine insecticides were evaluated for control of the beetle at rates outlined in table 12. Foliar treatments were applied to run-off to heavily infested Amy azaleas *(Rhododendron* X Amy) on November 5, 1982. Chevron Spray Sticker® (½ pint per 100 gallons of water) was included with all insecticide sprays. Each plant was isolated and beetle mortality determined 72 hours after treatment.

Insecticide efficacy varied among treatments, table 12. Mortality greater than 85 percent was observed with chlorpyrifos, bendiocarb, carbaryl, and acephate. Excellent beetle control can be expected with currently available insecticides; however, early diagnosis or a preventative spray program is essential to minimize plant damage.

See color plate number 18.

Control of Alternaria Leaf Spot on Pittosporum tobira Wheeler's Dwarf

Gary S. Cobb

A persistent leaf spot problem has been reported on rooted cuttings and liners of *Pittosporum tobira* Wheeler's Dwarf in some south Alabama nurseries. Symptoms include depressed, irregular lesions, 1-5 millimeters in diameter. On the upper leaf surfaces, spots have tan centers, dark brown margins, and surrounding yellow halo; on the lower leaf surfaces the halo is less distinct.

In February 1982, *Alternaria tenuissima,* a reported pathogen on *P. tobira,* was isolated from leaf spots on *P. tobira* Wheeler's Dwarf obtained from a local nursery. Five fungicides were evaluated for control of the disease. Infected liners were lightly pruned to induce a uniform flush of growth, potted in 1-quart plastic containers using an amended milled pine bark-peat moss growing medium, and placed in a plastic-covered greenhouse. Beginning March 30, 1982, the treatments outlined in table 13 were applied at 14-day intervals. Nu-Film® 17 (0.5 pint per 100 gallons of water) was included with all fungicide treatments. Foliar sprays were applied to run-off with hand-pumped, compressed air sprayers. There were eight single-plant replicates per treatment arranged in a completely randomized design.

When natural infection failed to develop on the new foliage, four plants per treatment were inoculated with a spore suspension containing 36,000 *A. tenuissima* spores per milliliter (Experiment 1). A second spore suspension containing 15,000 spores per milliliter was used to inoculate the four remaining plants per treatment. Fourteen days after inoculation, the number of lesions per plant was determined. Fungicidal phytotoxicity and the effect of tissue age on susceptibility to infection were also examined.

Leaf spot control was achieved in both inoculation experiments. The low rate of each of the five fungicides evaluated provided effective disease control, table 13. Daconil® 2787 was phytotoxic at both rates, causing vertical leaf orientation, reduced leaf size, and reduced growth as reflected by dry weights. Inoculated check plants developed lesions on old and new growth. However, the number of spots was significantly higher on the immature foliage, suggesting that young foliage is more susceptible to the leaf spot pathogen. Visible residue on the foliage was least on plants treated with Chipco® 26019 and greatest on plants treated with Manzate® 200, Dithane® Z-78, and the high rate of Zyban®.

TABLE 13. NUMBER OF LEAF SPOTS PER PLANT ON NEW GROWTH OF *PITTOSPORUM TOBIRA* WHEELER'S DWARF 14 DAYS AFTER INOCULATION WITH *ALTERNARIA TENUISSIMA* AND MEAN DRY WEIGHT PER PLANT 20 WEEKS AFTER POTTING

Treatment, fungicide and rate/100 gal.	Leaf spots/plant		Dry wt.
	Expt. 1	Expt. 2	
	No.	*No.*	*Grams*
Chipco 26019 50WP (iprodione)			
1.0 lb.	2 a[1]	0 a[1]	19.6 bc[1]
2.0 lb.	1 a	1 a	21.7 ab
Manzate 200 80WP (mancozeb)			
1.5 lb.	0 a	1 a	19.9 b
3.0 lb.	0 a	0 a	23.6 a
Zyban 75WP (mancozeb + thiophanate methyl)			
1.5 lb.	1 a	1 a	22.2 ab
3.0 lb.	0 a	1 a	20.7 ab
Dithane Z-78 (zineb)			
1.5 lb.	3 a	2 a	22.0 ab
3.0 lb.	0 a	0 a	19.0 bc
Daconil 2787 75WP (chlorothalonil)			
1.0 lb.	0 a	0 a	16.5 c
2.0 lb.	0 a	0 a	13.2 d
Nu-Film 17			
0.5 pt.	242 b	93 b	21.7 ab
Check, inoculated	583 c	75 b	20.2 ab
Check, noninoculated	1 a	2 a	22.2 ab
Check, inoculated old foliage	163 b	--	--

[1]Mean separation within columns by Duncan's Multiple Range Test, 5 percent level; values followed by the same letter are not statistically different.

See color plates numbers 19 and 20.

Fungicides for the Control of Entomosporium Leaf Spot on Photinia

Austin K. Hagan, Charles H. Gilliam, J.M. Mullen, James S. Crockett, and Ronald L. Shumack

Entomosporium leaf spot is difficult to control in nursery situations. However, some fungicides reportedly provide good control of this disease. Benlate® (benomyl) has been used for several years with good results and currently is recommended for leaf spot control on photinias in several Southern States. However, nurseryman recently have reported that Benlate no longer provides satisfactory disease control. The objective of this research was to evaluate several fungicides for the control of Entomosporium leaf spot on photinia.

Fungicide tests were conducted during the spring of 1981 at a commercial nursery in north-central Alabama. Three-year-old photinia *(P. fraseri)* were grown in 3-gallon containers in pine bark, shale, and sand (1:1:1), following commerical nursery practices. Plants were watered as needed with overhead irrigation. No other pesticides were applied to the plants during these studies.

Experiment 1. Bordeaux mixture (50 percent hydrated lime + 50 percent $CuSO_4$), Daconil® 2787 4.17F (chlorothalonil), Manzate® 200 80W (mancozeb), and Benlate® 50W (benomyl) were applied to runoff to naturally infected photinias with a CO_2-powered sprayer. Three applications of each fungicide were made biweekly beginning prior to bud break on February 26. With two treatments, the initial application of Benlate was delayed 2 and 4 weeks, respectively, until March 12 and March 24.

Disease incidence was determined April 7 as the percentage of newly expanded leaves in each replicate exhibiting typical symptoms of Entomosporium leaf spot. Disease severity was assessed using a scale of 0 to 5 with 0 = no disease and 5 = 81-100 percent of the newly expanded foliage diseased.

Experiment 2. Bordeaux mixture, Daconil 2787 75W (chlorothalonil), mancozeb, benomyl, Bayleton® 50W (triadimefon), and Zyban® (thiophanate methyl + mancozeb) were applied to naturally infected photinias as in Experiment 1. Just prior to the first fungicide application, the main shoots on all plants were pruned to stimulate new shoot development. Fungicides were applied at 2-week intervals from April 7 through June 4. A spreader-extender, Nu-Film® 17 (Miller Chemical, Hanover, Pennsylvania), was added to all treatments at a rate of 0.75 pint per 100 gallons of water.

Leaf spot development was assessed on June 18, 2 weeks after the last fungicide application, as (1) the percentage of a 20-leaf sample collected at random from each replicate with Entomosporium leaf spot symptoms, (2) an estimate of the leaf area damaged by the fungus, and (3) the percent defoliation.

Daconil 2787 consistently provided good control of Entomosporium leaf spot, tables 14 and 15. Disease incidence and severity ratings were always lower on the Daconil 2787 treated plants than on plants from all other treatments in Experiment 1. In the second experiment, Daconil 2787 proved to be more effective than all other treatments in preventing infection of the foliage of photinia by the fungus, *Entomosporium maculatum.* The percentage of leaf area diseased and level of defoliation were also quite low on Daconil 2787-treated plants. Although no direct comparison was made, there appeared to be little difference in the performance between the flowable and wettable powder formulations of Daconil 2787.

Manzate 200 and Bordeaux mixture were slightly less effective than Daconil 2787 in controlling Entomosporium leaf spot, tables 14 and 15. No significant differences in disease severity were noted on the plants treated with Manzate 200, Bordeaux mixture, or Daconil 2787 in Experiment 2. In Experiment 1, however, neither of these fungicides proved to be as effective in controlling leaf spot as Daconil 2787. The improved performance of Manzate 200 and Bordeaux mixture in Experiment 2 probably was due to the addition of a spreader-extender.

TABLE 14. EFFECT OF FUNGICIDES ON THE DEVELOPMENT OF ENTOMOSPORIUM LEAF SPOT ON NEWLY EXPANDED FOLIAGE OF CONTAINER-GROWN *PHOTINIA FRASERI*[1]

Treatment: Fungicide	Rate/ 100 gal.	Diseased leaves	Disease severity rating[2]
		Pct.	
Bordeaux mixture (50% $CuSO_4$ + 50% lime)	11 lb.	55 c[3]	1.8 b
Daconil 2787 4.17F	2 pt.	11 d	.6 c
Manzate 200 80W	2 lb.	48 c	1.6 b
Benlate (3/24)	1 lb.	71 b	1.8 b
Benlate (3/12 & 3/24)	1 lb.	63 bc	1.6 b
Benlate	1 lb.	51 c	1.7 b
Control		91 a	3.5 a

[1]Fungicides were applied at 2-week intervals from February 26 to March 24. In one Benlate treatment, the first application was delayed 2 weeks and in a second treatment it was delayed 4 weeks.

[2]Disease severity was rated on a scale of 0-5, where 0 = no disease and 5 = 81 to 100 percent of the newly expanded foliage diseased.

[3]Mean separation within columns according to Duncan's Multiple Range Test, P = 0.05.

TABLE 15. EFFECT OF FUNGICIDES ON THE DEVELOPMENT OF ENTOMOSPORIUM LEAF SPOT ON CONTAINER-GROWN *PHOTINIA FRASERI*[1]

Treatment: Fungicide	Rate/ 100 gal.	Diseased leaves	Disease severity: Leaf area diseased	Disease severity: Defoliation
		Pct.	Pct.	Pct.
Bordeaux mixture (50% $CuSO_4$ + 50% lime)	11 lb.	70 b[2]	7 d	0 e
Zyban 75W	1.1 lb.	91 a	28 c	40 d
Bayleton 50W	0.3 lb.	91 a	48 b	67 bc
Benlate 50W	1.0 lb.	93 a	58 b	61 c
Daconil 2787 75W	1.0 lb.	46 c	5 d	0 e
Manzate 200 80W	2.0 lb.	70 b	13 cd	6 e
Control		99 a	50 b	95 a
Control + Nu-Film 17		100 a	91 a	81 ab

[1]Fungicides were applied at 2-week intervals from April 7 to June 4.

[2]Mean separation within columns according to Duncan's Multiple Range Test, P = 0.05.

Benlate, Bayleton, and Zyban did not adequately control Entomosporium leaf spot. Benlate provided some leaf spot control in Experiment 1, table 14, but was not effective under heavy disease pressure in Experiment 2, table 15. Little difference was observed between disease incidence and severity ratings on the Benlate-treated plants and the untreated controls. Results of these tests concur with observations made by others that Benlate may provide erratic disease control when used to control existing leaf spot infections. Bayleton was the least effective fungicide evaluated in Experiment 2. Data showed that it had little effect on disease development, table 15. Zyban was applied at a low rate; higher application rates may prove more effective.

A gradual increase in leaf spot incidence was noted on the treatments where the initial Benlate application was delayed 2 or 4 weeks in late February and early March, table 14. During the same season, rapid growth on photinia usually begins. These results indicate the importance of initiating a fungicide spray program as early as possible to prevent infection of rapidly growing shoots.

In summary, the data show that Daconil 2787, Manzate 200, and Bordeaux mixture provided good control of existing infections of Entomosporium leaf spot on photinia. Delaying the initial application of Benlate past bud break did lead to a significant increase in disease development. Benlate, the current industry standard, did not provide acceptable control of Entomosporium leaf spot under heavy disease pressure.

Entomosporium leaf spot also can become a serious problem on photinia cuttings in propagation houses. Therefore, cuttings should be collected from stock plants free of Entomosporium leaf spot.

Daconil 2787 4.17F and Daconil 2787 75W are the only fungicides currently registered for use on photinia for Entomosporium leaf spot control. Label recommendations per 100 gallons are 2 pints and 1.5 pounds of formulated product of Daconil 2787 4.17F and Daconil 75W, respectively. The use schedule calls for applications to begin in the spring at bud break and continue at 10- to 14-day intervals until all new growth has matured, with applications resumed prior to the fall growth flush and continued until all foliage fully matures in late November or December.

See color plate number 21.

Chipco 26019, a New Fungicide for Petal Blight Control on Floral Crops

A.K. Hagan, Charles H. Gilliam,
and Ronald L. Shumack

Petal blight caused by *Botrytis cinerea* has been recognized as a common destructive disease on floral crops in the greenhouse and field. Generally, a combination of environmental manipulation and fungicide applications is required to maintain disease control. A wide range of fungicides including Benlate®, Daconil® 2787, Termil®, Dithane® M-45, Zineb®, Captan®, and Botran® are currently recommended for use on floral crops for the control of Botrytis. The objective of this study was to evaluate the efficacy of unregistered fungicides, Chipco® 26019, RP 26019®, and Bayleton®, for the control of Botrytis petal blight on azaleas and geraniums.

Experiment 1. Hexe azalea liners were potted in a 1:1 peat and bagasse soil mixture. The plants were kept cool for several weeks to prevent bud break. Approximately 2 weeks before fungicide application, the plants were placed in the greenhouse and allowed to flower. Chipco 26019 50W, RP 26019 25E, Benlate 50W, Manzate 200 80W, Daconil 2787 75W, and Bayleton 50W were applied to run-off with a 3-gallon compressed air sprayer. After treatment, the foliage was allowed to dry, then inoculated with a *B. cinerea* conidium suspension applied with an ASL air flow compressed air sprayer. A polyethylene tent was erected over the plants to maintain a humid environment. The azaleas were held in a greenhouse for 10 days at 65° to 80°F. Disease incidence was based on the percentage of blighted blossoms on each plant. The phytotoxicity of each chemical was rated.

Experiment 2. Geraniums Springer Scarlett were grown in a Vergro soil mix consisting of peat moss, vermiculite, perlite, and calcined clay. All floral clusters were removed several weeks before the first fungicide application to ensure nearly simultaneous flowering on all plants. Chipco 26019 50W, RP 26019 25E, and Benlate 50W were applied to run-off with a 3-gallon compressed air sprayer. The first application was made as the flowers in most floral clusters began to open. A second fungicide application was made after 7 days. Botrytis petal blight on stock plants provided sufficient disease pressure. Disease incidence and fungicide phytotoxicity were evaluated 7 days after the second application.

All fungicide treatments significantly reduced the incidence of Botrytis petal blight on azaleas, table 16. The most effective disease control was provided by RP 26019 at 2 quarts per 100 gallons. Petal blight control was also quite good on plants sprayed with the other fungicide treatments. No significant differences in disease development were noted among plants treated with Chipco 26019, Benlate, Manzate 200, Daconil 2787, or Bayleton.

Benlate, Chipco 26019, and RP 26019 provided adequate control of petal blight on geraniums, table 16; however, Chipco 26019 and RP 26019 were more effective in reducing disease development than Benlate. No difference in disease control was observed between the low and high rates of Chipco 26019 or RP 26019.

Most fungicides recommended for the control of Botrytis petal blight have the potential to injure delicate flowers or foliage. A significant percentage of the azalea blossoms treated with RP 26019 and Bayleton were damaged, table 17. Chipco 26019, Benlate, Manzate 200, and Daconil 2787 generally were not as phytotoxic as RP 26019 or Bayleton. Symptoms of chemical burn included necrotic flecks from Manzate 200 to ringspots and marginal burn from Chipco 26019, Benlate, and Daconil 2787.

Geranium blossoms also proved to be sensitive to RP 26019. Damage appeared primarily as a marginal bleaching and slight distortion of the petals. Chipco 26019 and Benlate were much less phytotoxic but symptoms were similar to those observed with RP 26019.

While Chipco 26019 and RP 26019 share the same active ingredient, application rates and formulation had a significant impact on the phytotoxicity of the two fungicides. On both azaleas and geraniums, the high rate of RP 26019 was much more phytotoxic than the low rate, table 17. Application rate had little impact on the phytotoxicity of Chipco 26019 on either plant. Chipco 26019, a wettable powder, was much less phytotoxic than RP 26019, an emulsifiable concentrate. The solvents, emulsifiers, and adjuvants

TABLE 16. EFFECT OF FUNGICIDES ON THE INCIDENCE OF PETAL BLIGHT CAUSED BY *BOTRYTIS CINEREA* ON AZALEAS AND GERANIUMS

Treatment and rate/100 gal.	Blighted flowers	
	Azalea	Geranium
	Pct.	*Pct.*
Chipco 26019 50W, 1.0 lb.	11 b[1]	11 a[1]
Chipco 26019 50W, 2.0 lb.	4 ab	12 a
RP 26019 25E, 1.0 qt.	4 ab	11 a
RP 26019 25E, 2.0 qt.	1 a	8 a
Benlate 50W, 2.0 lb.	12 b	17 b
Manzate 200 80W, 1.3 lb.	10 b	--
Daconil 2787 75W, 2.0 lb.	10 b	--
Bayleton 50W, 2.0 lb.	7 ab	--
Control	31 c	40 c

[1]Values in the same column followed by the same letter are not statistically different according to Duncan's Multiple Range Test, P = 0.05.

TABLE 17. PHYTOTOXICITY OF FUNGICIDES ON AZALEAS AND GERANIUMS

Treatment and rate/100 gal.	Damaged flowers	
	Azalea	Geranium
	Pct.	*Pct.*
Chipco 26019 50W, 1.0 lb.	5 abc[1]	1 a[1]
Chipco 26019 50W, 2.0 lb.	7 abc	3 ab
RP 26019 25E, 1.0 qt.	14 c	11 c
RP 26019 25E, 2.0 qt.	29 d	22 d
Benlate 50W, 2.0 lb.	9 abc	6 b
Manzate 200 80W, 1.3 lb.	2 ab	--
Daconil 2787 75W, 2.0 lb.	11 bc	--
Bayleton 50W, 2.0 lb.	28 d	--
Control	0 a	0 a

[1]Values in the same column followed by the same letter are not statistically different according to Duncan's Multiple Range Test, P = 0.05.

in RP 26019 are undoubtedly responsible for the phytotoxic reaction on azaleas and geraniums.

In summary, the level of disease control provided by Chipco 26019, RP 26019, and Bayleton met or exceeded that of currently recommended fungicides. However, the relatively high phytotoxicity of RP 26019 and Bayleton make these two fungicides unacceptable for use on azaleas and geraniums in bloom. Chipco 26019 provided the best combination of Botrytis petal blight control and low phytotoxicity. Recently, Chipco 26019 was cleared for use on 33 ornamentals for the control of Botrytis petal blight.

Control of Botrytis blight in greenhouses and landscape plantings requires a combination of environmental, cultural, and chemical controls. Good air circulation and a relative humidity below 85 percent will limit the development and spread of Botrytis blight on greenhouse floral crops. Plant debris which serves as an important inoculum source should be removed from greenhouse areas and badly diseased plants should be destroyed. Termil, Daconil 2787, Benlate, Chipco 26019, Dithane M-45, Zineb, Captan, and Botran are currently labeled on many floral crops for Botrytis blight control. Consult the label for recommended application rates and spray intervals.

See color plates numbers 22 and 23.

FIELD PRODUCTION

Successfully Transplanting Photinia in the Summer

Harry G. Ponder, Charles H. Gilliam,
and Heather J. Dawes

Nurserymen have for years had a problem transplanting Fraser photinia *(Photinia fraseri)* from the field during the summer months when the plants are in full growth. This situation is further complicated when larger landscape size plants are specified. Yet landscape contractors consistently order these plants during the summer.

With holly, it has been shown that the cutting of roots, which is part of the digging process, increases plant moisture stress[1]. It has also been shown with holly[2] and chrysanthemum[3] that antitranspirants (materials that when mixed with water and sprayed on the foliage of plants form a plastic film over the foliage) reduce plant water loss. In this study, digging time, prewatering, and antitranspirants were evaluated as to their influence on the survival of summer dug photinia.

This research was performed at Crossville Nursery, Crossville, Alabama, in a uniform block of 3- to 4-foot photinia. The photinia had 6-8 inches of current season's growth and 1-2 inches of succulent new growth. Leaf analysis and leaf color at the time of digging showed that plants were in good nutritional condition.

Rainfall during the 3-week period prior to digging totaled 0.18 inch and daily temperatures ranged from 64° to 100°F with the high temperature each day exceeding 93°F.

Forty plants were used in the study. Fifteen plants were watered prior to digging, 15 plants were left unwatered, and 10 plants were sprayed with the antitranspirant Vapor Gard® (VG). Plant moisture stress was measured throughout the experiment using a Scholander pressure bomb[4].

On the afternoon of July 23, 15 plants were thoroughly watered. On July 24, at 8:15 a.m., five plants were sprayed to runoff with VG at the rate of 23 milliliters per liter of water. Five watered, five non-watered, and five VG-treated plants were dug between 8:30 and 9:00 a.m. by the Crossville Nursery digging crew. The plants were transported to the nursery's enclosed storage building. The foliage was misted and the rootballs watered as per typical nursery holding practices except that only the rootballs of VG-treated plants were watered to keep from washing the spray off. At 1:00 p.m., another 15 plants treated the same as the morning dug plants were dug.

On July 25, the photinia were cross stacked onto a 1-ton truck with side-bodies and a tarpaulin and hauled to Auburn. At Auburn, the plants were unloaded into a shadehouse (47 percent shade) and plant tops were untied. Plants were misted at least three times daily. Even the VG plants were misted because the VG had dried on the foliage.

Two weeks after digging, plants were planted out into a field on the Auburn University campus and watered in thoroughly. Four weeks later, plants were rated (live vs. dead). Plants rated as alive had new growth and no dead wood.

The data in table 18 show that morning dug photinia had 80 percent survival or greater regardless of treatment. Eighty percent survival was achieved with the no prewatering-no VG treatment. One hundred percent survival was obtained with the prewatering and VG treatment.

Afternoon digging considerably reduced survivability except with the VG-treated plants, table 18. VG-treated plants had 100 percent survivability, while prewatered and non-watered plants had 20 and 40 percent survival.

Plant moisture stress measurements showed there was no difference in the degree of stress regardless of treatment with any morning dug plants, table 18. With the afternoon dug plants, only the VG treatment had as low moisture stress levels as the morning dug plants.

All morning dug plants and afternoon dug VG-treated plants had almost no leaf droppage during the experiment and all showed new growth by the conclusion of the experiment. The few living prewatered and unwatered plants from the afternoon digging had lost considerable foliage during the experiment and had almost no new growth. These plants would have been unacceptable for sale.

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[1]RANDOLPH, W.S. AND S.C. WIEST. 1981. Relative Importance of Tractable Factors Affecting the Establishment of Transplanted Holly. J. Amer. Soc. Hort. Sci. 103:327-331.

[2]PAIR, J.C. AND S.M. STILL. 1982. Antitranspirant Effects of Leaf Water Potential and Winter Injury of Holly. J. Amer. Soc. Hort. Sci. 107:9-13.

[3]MARTIN, J.D. AND C.B. LINK. 1978. The Potential Use of Antitranspirants in the Greenhouse Production of Chrysanthemum. J. Amer. Soc. Hort. Sci. 103:327-331.

[4]SCHOLANDER, P.F., H.T. HAMMEL, E.D. BRADSTREET, AND E.A. HEMMINGSEN. 1965. Sap Pressure in Vascular Plants. Science 148:339-346.

TABLE 18. SHOOT WATER POTENTIAL OF PHOTINIA AFTER SHIPPING, BEFORE PLANTING, AND AFTER PLANTING[1]

Time of digging	Treatment: Irrigated before digging	Treatment: Anti-transpirant (Vapor Gard)	Shoot water potential (bars): After shipping-before planting: July 30, 7 a.m.	July 30, 2 p.m.	July 31, 7 am.	August 7, 7 a.m.	After planting: August 17, 8 a.m.	August 17, 3 p.m.	August 18, 8 a.m.	Survival September 9, pct.
Morning	−	−	6.4 c[2]	24.4 b	9.0 b	14.0 b	21.0 ab	26.4 a	13.2 bc	80
	+	−	6.0 c	25.6 b	7.3 b	10.2 b	18.7 b	26.5 a	10.2 c	100
Afternoon	−	−	12.5 b	29.3 a	15.7 a	24.2 a	30.3 a	32.8 a	21.6 ab	40
	+	−	18.3 a	32.6 a	20.2 a	29.4 a	35.0 a	37.4 a	33.5 a	20
Morning	−	+	3.6 c	25.0 b	9.2 b	14.9 b	21.0 ab	29.2 a	13.9 bc	100
Afternoon	−	+	3.2 c	25.9 b	7.2 b	9.4 b	16.1 b	23.9 a	9.7 c	100

[1]Plants were shipped July 25 and planted August 10.
[2]Mean separation within columns by Duncan's Multiple Range Test, 5 percent level.

In summary, all plants dug before 9:30 a.m., regardless of treatment, had highly satisfactory survivability (80 percent +). With afternoon digging, only the plants sprayed with VG had satisfactory survivability. Since all these plants were dug during the hottest, driest period of a hot dry summer, it appears that photinia can be dug successfully in the summer provided proper precautions are taken.

See color plates numbers 24 and 25.

Postemergence Applied Grass Weed Herbicides

Charles H. Gilliam, James S. Crockett, and Cecil Pounders

Control of broadleaf weeds and grass is a major problem in the production of field-grown ornamentals, even when pre-emergence herbicides are used. Preemergence herbicides often fail to control weeds adequately because of improper timing and rate of application, weather conditions, and volatilization. Nurserymen generally utilize hand labor to remove weeds that preemergence herbicides fail to control. While the effect of weed competition on growth of field-grown ornamentals has not been documented, research with container-grown woody ornamentals has shown that weed competition can reduce growth of woody plants by 50 percent or more. One chemical widely used as a postemergence applied herbicide is glyphosate (Roundup®). Glyphosate is absorbed by the leaves and translocated throughout the plant. It is effective for the control of many perennial weeds; however, many ornamental plants are injured when sprayed with glyphosate.

Within the last few years, a new group of chemicals has been developed as postemergence applied grass weed herbicides. These materials reportedly have no activity against broadleaf plants and have potential for use in nursery plantings. The objective of this experiment was to determine the efficacy of two postemergence applied herbicides on common bermudagrass and the resulting phytotoxicity to ornamentals.

1981. Preliminary tests conducted in 1980 with Poast® showed this material to be safe on a number of ornamentals when applied over the top of the plant. In 1981, two experiments were conducted with two postemergence applied herbicides: Poast and Fusilade®. In Experiment 1, each material was applied over the top of established ornamentals at three rates: 0.25, 0.50, or 1.0 pound per acre active ingredient (ai) on June 15 and 10 days later. Crop oil concentrate surfactant was added to Poast and a non-ionic surfactant was added to Fusilade (1.0 percent). A CO_2 sprayer was used to apply chemicals in 20 gallons of water per acre. Plants sprayed included *Juniperus chinensis* Nick's Compact, *Ilex crenata* Rotundifolia, and *Taxus cuspidata* grown in nurseries at Crossville, Alabama. Junipers had been in the field 3 years and were heavily infested with Coastal bermudagrass. Rotundifolia liners were spring planted into common bermudagrass. *Taxus* had been grown 2 years in the field and were infested with yellow nutsedge. Experiment 2 in 1981 evaluated the effectiveness of one application of these two materials at the same rates as in Experiment 1 on *J. horizontalis* Plumosa and *J. chinensis* Nick's Compact. Treatments were applied on July 1 and evaluated 14 and 60 days later for grass weed control and phytotoxicity.

Both herbicides resulted in excellent control of bermudagrass (Coastal or common) regardless of the application rate. With the exception of Poast at the 0.25 pound per acre ai rate, all treatments provided greater than 90 percent control through the middle of October. No further evaluations were made after that time. None of the materials controlled yellow nutsedge.

There was little or no phytotoxicity on plants tested. Chlorosis occurred only on the junipers growing in the Coastal bermudagrass. This may have been the result of sunscald, since the interior portions of the plant where the chlorosis was most evident had been heavily shaded before the grass died. At the 60-day evaluation, most plants no longer exhibited chlorotic symptoms.

In Experiment 2, both treatments resulted in 90 percent control of common bermudagrass after 14 days, table 19. At 60 days, only Fusilade provided 90 percent grass control at

TABLE 19. EFFECTS OF ONE APPLICATION OF POSTEMERGENCE HERBICIDES ON PERCENT CONTROL OF BERMUDAGRASS IN FIELD GROWN JUNIPER[1]

Rate, lb./acre ai	Control from Poast, Days after application: 14	Control from Poast: 60	Control from Fusilade, Days after application: 14	Control from Fusilade: 60
	Pct.	*Pct.*	*Pct.*	*Pct.*
0.25	90 a[2]	53 d	91 a	79 bc
0.50	94 a	74 c	94 a	87 b
1.00	94 a	85 b	98 a	97 a

[1]There was no phytotoxicity on any of the plants. Crop oil concentrate was added to Poast (1.0 percent), while a non-ionic surfactant was added to Fusilade.
[2]Mean separation by Duncan's Multiple Range Test within days after application, 5 percent level.

TABLE 20. EFFECTS OF TWO POSTEMERGENCE APPLIED HERBICIDES ON PERCENT CONTROL OF COMMON BERMUDAGRASS IN 1982

Days after first application	Grass control, pct.															
	Fusilade, lb./acre ai							Poast, lb./acre ai								
	¼	½	1	2	¼+¼	½+½	1+1	¼	½	1	2	¼+¼	½+½	1+1	coc[1]	check
14..........	38 fg[2]	42 efg	88 ab	90 a	33 g	52 defg	62 cdef	28 g	52 defg	68 abcd	77 abc	35 g	52 defg	65 bcde	3 h	0 h
30..........	90 a	90 a	100 a	98 a	100 a	100 a	100 a	38 c	63 b	90 a	92 a	97 a	93 a	98 a	8 d	0 d
45..........	78 b	93 ab	98 a	100 a	100 a	100 a	100 a	13 d	58 c	90 ab	95 a	85 ab	95 a	100 a	0 d	0 d
70..........	63 ab	97 a	100 a	100 a	100 a	100 a	100 a	3 c	58 b	95 a	95 ab	72 ab	98 a	98 a	0 c	0 c

[1]Crop oil concentrate was applied at the rate of 1.0 percent by volume.
[2]Mean separation within rows by Duncan's Multiple Range Test, 5 percent level.

the 1.0 pound per acre ai rate when one application was made. There was no phytotoxicity with either treatment.

1982. Split applications of Poast and Fusilade were compared with a single application on *T. cuspidata* infested with common bermudagrass. Treatments were applied on July 29 and August 11, and evaluated at 14, 30, and 90 days for grass control and phytotoxcity. All treatments were applied when bermudagrass runners were 6-12 inches in length and included a crop oil concentrate at 1.0 percent by volume.

Minimum rates of Fusilade and Poast for 90 percent control for 60 days were ½ and 1 pound per acre ai, respectively, table 20. Either single applications of ½ pound per acre ai or split applications of ¼ pound per acre ai of Fusilade resulted in greater than 95 percent control of common bermudagrass. Lower rates resulted in initial dieback of the bermudagrass, but regrowth occurred from the base of the bermudagrass. There appeared to be no advantage to applying higher rates than that required for 90 percent control.

See color plate number 26.

PROPAGATION

Propagation of Upright Juniper

Cecil Pounders and Charles H. Gilliam

Upright juniper cultivars have generally been propagated by grafting because of poor success experienced by growers in rooting cuttings. Grafting is expensive and requires skilled labor, however, so many area nurseries have limited production to cutting propagated varieties. In recent years, several California nurseries have developed techniques for rooting a number of upright juniper cultivars under West Coast conditions.

To determine if upright junipers could also be successfully propagated in Alabama, a study was conducted at Limestone Nursery near Decatur, Alabama. The five cultivars used in the study included *Juniperus virginiana* Hillspire, Skyrocket, and Silver Spreader, *J. chinensis* Blue Point, and *J. scopulorum* Cologreen. These cultivars are representative of the three main species of juniper having upright selections commonly available. Four of the cultivars have upright growth habits while Silver Spreader, as the name indicates, has a spreading habit.

On March 11, 1982, cuttings of the five cultivars were taken from field grown stock plants and stuck in a fiberglass greenhouse in a pine bark, peat, and shale medium with bottom heat maintained at 60°F. Cuttings were approximately 6 inches long with a base of fully matured wood. Cuttings received the grower's normal juniper misting program, which is determined by environmental conditions.

Five treatments, listed in table 21, were applied to each cultivar before sticking to determine if solvents used in combination with the IBA and NAA affected rooting and to see if a 10-second liquid dip was superior to the Hormidine #3 talc dip used by many growers. Dimethyl sulfoxide (DMSO) has been used as a solvent in Dip 'n' Grow, while dimethyl formamide is used for the same purpose in Wood's Rooting Compound. All liquid dip treatments were formulated in 250 milliliters of solution that contained 40 milliliters of ethanol and 11 KOH pellets. Test solvents were substituted for an equal volume of water. Each treatment was replicated four times per cultivar with five cuttings.

On July 1, 1982, the cuttings were scored using a scale of 1 (no callus) to 5 (well rooted > 15 roots). Results indicated that all cultivars in the study could be successfully rooted. All cultivars showed equivalent response trends to treatments. Cologreen, Skyrocket, and Hillspire rooted as well as Silver Spreader. The root scores of Blue Point were consistently lower for all treatments.

Liquid dips proved superior for rooting upright junipers as compared to a talc dip or the untreated cuttings, table 21. Blue Point was the only cultivar that showed a response to a solvent, with dimethyl formamide showing best results.

TABLE 21. PROPAGATION OF FIVE JUNIPER CULTIVARS AS AFFECTED BY HORMONE TREATMENT

Treatment	Average of 5 cultivars[1]	Blue Point
Liquid dip		
5,000 p.p.m. IBA, 2,500 p.p.m. NAA, and 20% dimethyl formamide........................	3.7 a[2]	3.4 a
5,000 p.p.m. IBA and 2,500 p.p.m. NAA......	3.4 a	2.0 b
5,000 p.p.m. IBA, 2,500 p.p.m. NAA, and 20% DMSO..................................	3.3 a	1.8 bc
Talc dip		
Hormodin #3 and 8,000 p.p.m. IBA..........	2.3 b	1.3 bc
Check (untreated)..........................	1.9 b	1.2 c

[1]Based on rating scale of 1 = no callus, 2 = callused, 3 = 1-5 roots, 4 = 5-15 roots, 5 = well rooted > 15 roots.
[2]Means followed by the same letter are not significantly different, according to Duncan's Multiple Range Test, 5 percent level.

Propagation of Ilex glabra and Rhododendron nudiflorum from Softwood Cuttings

Fred B. Perry, Jr.

The production of *Ilex glabra* plants from seed or collected plants has been considered in the past to be the most economical method to produce plants in quantity. Seedlings of this species usually vary in one or more ways: sex, size, and shape of plant; luster and shape of the leaf; color of fruit; age at which fruiting begins; and hardiness. Stem cuttings of *I. glabra* have been found to root either slowly or poorly by some nurserymen. However, *I. glabra* can be grown from root cuttings the size of a pencil and 5 to 6 inches long. The use of root cuttings does not lend itself to large scale economical plant production. The successful propagation by cuttings should permit large-scale production of choice clones.

Evergreen azaleas of the Indian and Kurume groups are usually produced from cuttings, while *Rhododendron nudiflorum* and other deciduous American species and varieties are grown by mound layering as well as from seeds. Cuttings of all deciduous azaleas are difficult to root, but there are reports of successful rooting of cuttings from growth that is quite soft in the spring.

Indolebutryic acid (IBA) and chloromone are root promoting hormones which have been reported to enhance rooting of stem cuttings from many plant species. The most effective concentration of these hormones varies from species to species and even among cultivars.

Tip cuttings of recently mature growth, approximately 5 inches long, were taken and the lower one-third of the leaves were stripped. Cuttings were treated with rooting hormones, table 22, and stuck in a rooting medium of sterilized sharp sand.

The propagation area was shaded (54 percent) and mist was applied each 2½ minutes for 2½ seconds from 5:30 a.m. to 7:30 p.m.

Experimental design for *Rhododendron* and *Ilex* was a complete randomized block consisting of four and eight replications of 10 cuttings, respectively.

After 8 weeks, percentage rooting was determined and the cuttings were rated as excellent, good, fair, poor, or no roots, depending on the root system produced, table 22.

Softwood cuttings of *Rhododendron nudiflorum* treated with 0.3 percent IBA, 0.8 percent IBA, and 25 percent chloromone responded by rooting better than non-treated cuttings under intermittent mist, but not in sufficient quantities to be commercially feasible. The possibility exists that higher concentrations of rooting hormones may further aid in increasing the rooting percentage of this plant by softwood cuttings. Since none of the non-treated cuttings rooted, addition of a root-promoting substance is needed for the rooting of softwood cuttings from this plant.

Softwood cuttings of *Ilex glabra* rooted up to 95-96 percent when treated with IBA-talc and placed under intermittent mist. Although there was no significant difference between 0.3 percent and 0.8 percent IBA in total number rooted, the cuttings treated with the latter concentration produced better root systems. Cuttings treated with 25 percent chloromone responded with acceptable percentages rooted, but less than cuttings treated with 0.3-0.8 percent IBA in talc. Selected clones of *Ilex glabra* should be produced under intermittent mist in sufficient amounts to be commercialy profitable using 0.8 percent IBA in talc as rooting agent.

TABLE 22. EFFECTS OF HORMONE TREATMENTS ON ROOTING PERCENT OF *ILEX GLABRA*

Treatment	Total rooted[1]	Percent rooted, by grade			
		Excellent	Good	Fair	Poor
Check	41.25 c	0.00	5.00	11.25	25.00
0.3% IBA	96.25 a	42.50	18.75	20.00	15.00
0.8% IBA	94.75 a	56.25	21.25	12.25	5.00
25% chloromone	86.25 b	38.75	28.75	11.25	7.50

[1]Means identified with the same letter are not different at the 95 percent level of confidence.