



1980

## Answers through Research for the Nursery Industry

University of Tennessee Agricultural Experiment Station

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# University of Tennessee Agricultural Experiment Station

Fall 1980

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## Research Report

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**Answers Through Research**

**for the  
Nursery Industry**



department of ornamental  
horticulture & landscape design

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## INTRODUCTION

This is our third annual report on research activities on woody ornamentals at the University of Tennessee. Our overall goal continues to be a balanced program between research, extension, and teaching in the area of nursery production and management. As the accompanying report will show, we are attempting to combine applied research on "how to do things" with basic research which tries to answer "why things occur or don't occur." Both types of research add to our overall base of knowledge, directly or indirectly help growers, and provide our students the opportunity to apply their classroom experiences to actual research-growing operations. The end result, our goal, is to provide our industry with up-to-date recommendations, answers to problems, and well-qualified students to work in our profession.

You will notice that our third report is longer than the last two years. We are growing fast! Many new projects have been initiated and several comprehensive Master's theses have been completed during the last two years. We are happy to summarize these student research projects in this publication. Some of our newer studies are included under the "Planned Research" section even though definitive results are not in yet.

We are continuing to develop our greenhouse and outdoor production areas for container- and field-grown plants. This includes overall organization of facilities, building up of our stock of plant materials and supplies, and obtaining research support. We still hope to someday have a "Teaching-Research Nursery" which carries out all the normal activities of a small commercial nursery and incorporates the most modern production practices. This type of research unit can generate a great deal of practical information and at the same time allow our students a hands-on experience of growing plants. Your help, support, and encouragement in building this facility and program is needed and sincerely appreciated.

Research reported here deals with several different aspects of ornamental plant production including propagation, nutrition, growth regulators, media, container and field growing. We hope to expand our field and container operations as support becomes available. We want to develop a comprehensive research program including evaluation, propagation production, and landscape performance of many different ornamentals.

Any suggestions you have on our program are most welcome. We hope you will suggest possible problems for study, endorse our program, and hire our graduates. We still have a lot of building to do but we are progressing - your support will help us achieve this goal!

If you have any suggestions or comments please address them to:

Dr. G.S. Smith  
Research-Teaching  
Nursery Production

Dr. W. T. Witte  
Extension  
Nursery Production

Dr. J.W. Day  
Teaching-Research  
Nursery Management

Mr. Hendrik van de Werken  
Research-Ornamentals  
Teaching-Landscape Design

Dr. Donald B. Williams  
Professor and Head  
Department of Ornamental Horticulture and Landscape  
Design

Mr. David T. Kendall  
Teaching  
Landscape Design

Sincerely,

G. Shannon Smith  
Associate Professor  
Ornamental Horticulture  
and Landscape Design

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Access to their soil mixing facilities, media, fertilizers, etc.  
and great moral support!

And finally, the undergraduate and graduate students of the University of Tennessee for their interest and labor in conducting research and help in producing their report.

Your assistance is sincerely appreciated!

RESEARCH COMPLETED OR IN PROGRESS



EFFECT OF H<sub>2</sub>SO<sub>4</sub> AND NaOH PRETREATMENTS ON  
ROOTING OF SELECTED ORNAMENTALS

Scott J. McCrary and G. Shannon Smith

**OBJECTIVES:** (1) To determine effects of acid and base with and without IBA, on rooting of 10 woody ornamentals; (2) to determine chemical effects on rooting at different times of the year; and (3) to compare rooting evaluation methods.

Much research in plant propagation has been concerned with the use of auxins like indolebutyric acid (IBA) and naphthalene acetic acid (NAA) to enhance rooting of cuttings. In recent years less attention has been given to effects of other chemicals such as acids and bases on promotion of rooting even though early studies showed that rooting percentages could be increased in certain media due probably to pH effect. Recently, California studies have further demonstrated the dramatic effects of simple acid and base treatments on rooting of ornamentals. Pretreatment of cuttings with sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) or sodium hydroxide (NaOH) significantly increased rooting of certain species, the response apparently being correlated with whether the species was tolerant of acid or basic soil conditions in its natural habitat. In addition, it has been demonstrated that acid treatments can increase root elongation.

**METHODS:** Species chosen for this study included 5 acid tolerant plants - Cornus florida (flowering dogwood), Rhododendron obtusum 'Coral Bells' (azalea), Ilex cornuta 'Burfordii' (Burford holly), Tsuga canadensis (hemlock), Juniperus horizontalis 'Bar Harbor' (Bar Harbor juniper); and 5 base tolerant plants; Juniperus virginiana (red cedar), Cercis canadensis (redbud), Juniperus conferta (Shore juniper), Philadelphus coronarius (mock orange), and Euonymus japonicus (Japanese euonymus). Three replications of 10 cuttings per treatment were randomly distributed over 3 mist beds measuring 1.2 x 3 m (4 ft. x 10 ft.) and filled with 25 cm (10 in.) of perlite at pH 7.0 - 7.5. Chemical treatments were:

- (1) Control - no treatment
- (2) Acid - 15 sec. dip in 2N H<sub>2</sub>SO<sub>4</sub>
- (3) Base - 10 min. dip in NaOH pH 10.5
- (4) Low IBA - 1000 ppm talc
- (5) High IBA - 3000 ppm for all treatments except dogwood and hemlock which were treated with 8000 ppm IBA
- (6) Acid + low IBA
- (7) Acid + high IBA
- (8) Base + low IBA
- (9) Base + high IBA

The entire experiment was repeated 3 times per year at different seasons. The first run started August 25, 1978, the second December 20, 1978, and the third June 7, 1979. After 25 - 97 days under mist (variable with species), cuttings were harvested and rooting %, root quality grade, root ball diameter, and root dry weights (48 hours at 100°C) were determined.

RESULTS: Seasonal variation in rooting was observed for most species. Shore juniper, mockorange and dogwood rooted best in spring; 'Burford' holly and 'Bar Harbor' juniper in winter; and 'Coral Bells' azalea in fall. Euonymus was easily rooted at any season. Red cedar rooted poorly and redbud and hemlock not at all. In general, rooting was better in spring followed by fall, than winter.

Treatment comparisons indicated that high or low IBA and acid or base plus high IBA were generally best for improved rooting. Treatment with IBA rooting hormone appeared to be much more effective than other chemicals. Contrary to results in California, this study gave little or no indication that acid-tolerant species rooted best when treated with base nor did base-tolerant plants root best under acid treatment. Five species did respond well to base plus high IBA.

A summary of rooting for individual species follows.

Euonymus was easily rooted at any season when treated with low or high IBA. Consistently good rooting of shore juniper occurred during spring if IBA was used. 'Bar Harbor' juniper, on the other hand, rooted best in winter with treatments having little effect; even control plants rooted adequately. Another juniper, Red Cedar, rooted poorly overall with only a few cuttings striking roots during the winter and where high IBA was used. 'Burford' holly rooted best in winter but only 60% average rooting occurred. Best treatments included IBA, base, and base plus IBA. High IBA treatment of spring collected mockorange cuttings gave best results. 'Coral Bells' azalea responded little to chemical treatments. Dogwood showed significant response to season and chemicals. Spring rooting was excellent averaging 87%. High IBA alone or with base gave best results. Both hemlock and redbud failed to root at any season regardless of chemical treatment.

#### REFERENCE

1. McCrary, S.J. 1980. Seasonal Rooting, as Measured by Four Parameters, of Ten Woody Ornamentals Treated with Acid ( $H_2SO_4$ ), Base (NaOH) and IBA. M.S. Thesis, University of Tennessee. 89pp.

Branching and Rooting of Six Ornamentals Following Treatment  
with Dikegulac-sodium (Atrinal) and IBA

David Wu and G.S. Smith

OBJECTIVES: (1) To determine effects of Atrinal on rooting and branching of six ornamentals. (2) To compare soak treatment with spraying of stock plants prior to taking cuttings. (3) To determine interaction effects of Atrinal and IBA.

Dikegulac-sodium (Atrinal) is a chemical pinching agent that temporarily halts apical dominance thereby allowing side branches to develop. It has systemic activity on woody ornamentals but has been used primarily to increase flowering on floricultural crops.

Previous studies have shown that dikegulac does not adversely affect cutting survival or rooting of some azalea cultivars thus can be used during propagation to produce well branched rooted cuttings. It may be favorable to propagators to find effective chemical methods to branch cuttings during rooting to produce more compact liners and avoid laborious hand pinching.

METHODS: Atrinal at five concentrations was applied as a spray and a soak to six ornamentals which require pinching to normally produce compact plants. Species chosen included:

<u>Forsythia x intermedia</u>	- Forsythia
<u>Juniperus conferta</u>	- Shore juniper
<u>Lagerstroemia indica</u>	- Crape myrtle
<u>Hedera helix</u>	- English ivy
<u>Photinia x fraseri</u>	- Photinia
<u>Ilex x attenuata 'Fosteri'</u>	- Foster's holly

Cuttings (or stock plants) were treated with Atrinal at 0,1,5,10,20 and 40 ml/l of commercial product. Cuttings were soaked in each concentration for 10 seconds and then placed in a cooler for 24 hours. Stock plants of each species were sprayed to runoff with each concentration, allowed to dry for 24 hours then cuttings were removed. All treated cuttings were placed under intermittent mist in sterilized sand medium. Half of the cuttings were treated with IBA talc at 3000 ppm. Cuttings were left in the mist bed for varying times depending on rooting times needed. The data collected included: (1) general observations on cutting survival, color and phytotoxicity; (2) % rooting; (3) rooting quality grade; (4) root dry weight; (5) number of shoots per cutting.

## RESULTS:

### Forsythia x intermedia - Forsythia

Forsythia cuttings rooted readily and rooted well. The number of breaks gradually increased as Atrinal concentration increased but peaked at 20 ml/l. Atrinal at 40 ml/l was phytotoxic to foliage but overall it did not appear detrimental to rooting of this species.

Cuttings taken from sprayed stock plants had higher root quality grade than cuttings soaked in Atrinal but root quality peaked at the 5 ml/l rate. Any rate in excess of 5 ml/l resulted in lower root weight than untreated control cuttings. IBA produced better quality roots than cuttings not receiving this rooting hormone.

Atrinal appears to be feasible to use as a branching agent on forsythia during rooting at rates of 5, 10, and 20 ml/l without decreasing rooting significantly.

### Hedera helix - English ivy

Low rates of Atrinal induced branching of English ivy. However, high rates were phytotoxic to foliage and interfered with rooting. Maximum number of breaks occurred where stock plants were sprayed at 1 ml/l.

Rooting percentage was unaffected by Atrinal at rates of 1, 5, or 10 ml/l, whether sprayed or applied as a soak. At rates exceeding 10 ml/l, rooting was reduced. Rooting was significantly better where IBA was used.

Low rates of Atrinal, either as a spray or soak, did increase branching of English ivy without decreasing rooting percentage and as long as rates below 10 ml/l were used, root quality and yield were not reduced. Higher rates, however, were deleterious to root development. IBA was necessary to produce maximum rooting, quality and dry weight and partially reversed the harmful effects of high rates of Atrinal.

### Juniperus conferta - Shore juniper

Response of shore juniper to Atrinal was poor. Maximum number of breaks was obtained at the low rate of 1 ml/l with rates of 10 ml/l or higher decreasing new shoot development and high rates producing visual phytotoxicity.

Atrinal in excess of 5 ml/l definitely interfered with rooting percentage and severely reduced quality grade. Even the lowest rate of 1 ml/l was deleterious to root yield (dry weight).

Spray treatments were better than soaks and IBA produced higher root quality grade. Otherwise, shore juniper did not respond favorably to Atrinal under the conditions of this experiment.

Lagerstroemia indica - Crape myrtle

Maximum breaks on crape myrtle occurred where Atrinal was applied at 10 ml/l as a spray. However, phytotoxicity was seen at this rate and became more severe as rates increased to 20 ml/l or 40 ml/l. IBA treatment seemed to favor branching at all levels of Atrinal.

At all rates of Atrinal, root quality grade was higher than control cuttings as long as IBA was used. Root quality peaked at 20 ml/l of Atrinal. IBA appeared essential for good quality rooting of crape myrtle.

Low rates of Atrinal plus IBA appeared beneficial in producing branched rooted cuttings of crape myrtle. No detrimental effects were recorded for rooting at lower rates as long as IBA was also utilized. Crape myrtle was the only species tested which seemed to react better to the soaking method of applying Atrinal.

Ilex x attenuata 'Fosteri' - Foster's holly

Foster's holly was relatively unresponsive to sprays or soaks of Atrinal. No concentration increased branching. Phytotoxicity was severe at high rates (40 ml/l) and in some cases lethal.

In general, spray treatments of Atrinal were not very detrimental to rooting percentage except at 40 ml/l. Soaks of 20 ml/l and 40 ml/l, however, drastically reduced rooting. Even the 10 ml/l rate suppressed rooting. IBA treatment favored rooting. Where cuttings survived, root quality grade and dry weight were unaffected by Atrinal or IBA. This was generally in the concentration range below 20 ml/l. Soaks produced lower quality grade and dry weight than spray treatments.

Atrinal was not effective in branching Foster's holly. At lower rates it did not reduce the numbers of cuttings which rooted but it appears to be of no advantage in propagation of this species. IBA was very beneficial to rooting of Foster's holly.

Photinia x fraseri - Redtip photinia

Photinia rooted very poorly under the conditions of this study with an overall average of only 14% being obtained. Data for this species were not analyzed and are not discussed due to such poor response regardless of treatment combinations. Further investigation of treatment effects on Photinia over longer rooting times may be warranted.

Production Practices to Increase Growth and Quality  
of Euonymus alatus 'Compactus'  
(Study #1)

G.S. Smith and Perry S. Sutherland

OBJECTIVES: (1) To determine effects of nutrition on growth rate (production time) and quality of Euonymus alatus 'Compactus' produced in containers.

Euonymus alatus 'Compactus', commonly known as the burning bush, has become very popular in landscape use due to its excellent form and pronounced fall color. This popularity in turn makes the production of burning bush very attractive to nurserymen. Euonymus alatus, however, only produces one flush of growth per year, making production costly. Often 3 to 5 years are needed to produce a saleable plant. Growing practices such as improved nutrition to increase the number of flushes or at least maximize vegetative growth during the single flush could possibly reduce production time.

METHODS: Uniform rooted liners of Euonymus were potted on March 4, 1979 into 1 gallon polybags containing medium of sand:pine bark:peat moss (1:1:½ v/v) amended with 8 lbs. dolomite and 4 lbs. Perk (minor elements) per cubic yard. Plants were fertilized with 4 rates of triple superphosphate and 6 rates of nitrogen from 18-5-11 Osmocote (slow release) The first application of triple superphosphate and Osmocote was made on March 4, with supplementary Osmocote treatments to the N<sub>4</sub>, N<sub>5</sub>, and N<sub>6</sub> plants added on July 9. Equivalent rates were as follows:

I. Triple Superphosphate

P<sub>0</sub> - 0 lbs per cu. yd.  
P<sub>1</sub> - ½ lb. per cu. yd  
P<sub>2</sub> - 1 lb. per cu. yd.  
P<sub>3</sub> - 3 lbs. per cu. yd.

II. Nitrogen (from 18-5-11 Osmocote)

N<sub>1</sub> - 500 lbs. per A per yr.  
N<sub>2</sub> - 1000 lbs. per A per yr.  
N<sub>3</sub> - 1500 lbs. per A per yr.  
N<sub>4</sub> - 2000 split in 2 appl.: 1500 + 500  
N<sub>5</sub> - 2500 split in 2 appl.: 1500 + 1000  
N<sub>6</sub> - 3000 split in 2 appl.: 1500 + 1500

Treatments were replicated 4 times in a completely randomized block. Data collected included: (1) initial number of branches and height of liner, (2) increase in breaks and height at 4 and 14 mos., (3) quality grade at 4 and 14 mos.

RESULTS: (4 Months) When P response was averaged over all N rates, Euonymus increased in height with increasing phosphorus from P<sub>0</sub> to P<sub>2</sub>, then decreased

from P<sub>2</sub> to P<sub>3</sub>. When N response was averaged over P rates, height increased with increasing nitrogen, peaking at N<sub>3</sub>; N<sub>4</sub> to N<sub>6</sub> receiving split applications of N were similar to N<sub>3</sub> at this date which was prior to additional N applications. The maximum height reported for any one treatment combination was P<sub>2</sub>N<sub>3</sub>, where the *Euonymus* increased in height by 36 cm. P<sub>2</sub>N<sub>2</sub> and P<sub>2</sub>N<sub>4</sub> followed closely with 28.5 and 24.5 cm. increases, respectively.

On the average, the number of breaks increased linearly as the phosphorus level rose to P<sub>3</sub>. Breaks, averaged over all P levels, also increased with increasing nitrogen, except for N<sub>4</sub> where a slight decrease was recorded. The maximum increase in breaks seen for any one treatment occurred at P<sub>3</sub>N<sub>6</sub>, the highest level of both P and N. P<sub>3</sub>N<sub>5</sub>, P<sub>3</sub>N<sub>3</sub>, P<sub>3</sub>N<sub>2</sub>, and P<sub>2</sub>N<sub>6</sub> produced nearly as many breaks as the best treatment.

The averaged quality rating increased from P<sub>0</sub> to P<sub>1</sub>, but decreased slightly from P<sub>1</sub> to P<sub>3</sub>. Average quality also increased with increasing nitrogen from N<sub>1</sub> to N<sub>3</sub>, then decreased slightly from N<sub>3</sub> to N<sub>6</sub>. The highest quality rating was generally observed for intermediate levels of P (P<sub>1</sub> and P<sub>2</sub>) combined with N levels above N<sub>1</sub>, (mainly N<sub>3</sub> to N<sub>6</sub>).

Severe mite infestations were observed on the high nitrogen/high phosphorus treatments. (P<sub>2</sub>N<sub>3</sub> , P<sub>2</sub>N<sub>4</sub> , P<sub>2</sub>N<sub>6</sub> , P<sub>3</sub>N<sub>5</sub> , P<sub>3</sub>N<sub>6</sub>).

During a severe drought period resulting from improper cultural methods, a significant percentage of plants within the high nitrogen treatments were killed. This loss from moisture stress was probably the result of high salt content in the soil combined with succulence from high N. Most severe damage occurred on P<sub>2</sub>N<sub>6</sub>, P<sub>2</sub>N<sub>5</sub>, and P<sub>1</sub>N<sub>6</sub>, and P<sub>0</sub>N<sub>5</sub> where 100%, 75%, 50%, and 50% loss was observed, respectively.

RESULTS: (14 Months) Analysis of results at 14 months indicates that when P response was averaged over all N rates, *Euonymus* increased in height with increasing P from P<sub>0</sub> to P<sub>2</sub> with a slight decrease to P<sub>3</sub>. When N response was averaged over all P rates, height increased to N<sub>3</sub> but N<sub>4</sub> - N<sub>6</sub> were about equally as good. Conclusive data is not available for N<sub>5</sub> and N<sub>6</sub> because a significant percentage of plants was lost in the first growing season due to cultural problems. The maximum height response was observed at N<sub>3</sub>P<sub>2</sub>.

On the average the number of breaks increased significantly from P<sub>0</sub> to P<sub>1</sub>, but decreased slightly at P<sub>2</sub> and P<sub>3</sub>. Breaks, averaged over all P levels, increased with increasing N to a maximum at the N<sub>5</sub> level. The maximum increase in breaks was observed at N<sub>3</sub>P<sub>2</sub>.

Quality ratings increased from P<sub>0</sub> to P<sub>1</sub>, but decreased at the P<sub>2</sub> and P<sub>3</sub> levels. Quality ratings for N levels increased to N<sub>3</sub> then leveled off. The highest quality ratings occurred at N<sub>3</sub>P<sub>2</sub> and N<sub>5</sub>P<sub>1</sub>.

Autumn ratings in the first growing season showed that plants treated with N/P fertilizer tended to stay greener and hold their leaves longer into the fall season when compared with untreated plants under the same environmental conditions.

Even though Euonymus alatus 'Compactus' is a popular and commonly grown woody ornamental, little, if any, nutritional work has been done on this cultivar. This study will be repeated this coming growing season to more accurately quantify optimum N and P rates for maximum production. Even though this preliminary study is not conclusive, it does show that large responses in height, increase in breaks and quality can be produced by nitrogen and phosphorus fertilization.



Increases in Height, Numbers of Breaks, and Quality Rating of  
Euonymus alatus 'Compacta' 4 Months After Fertilization with N and P

Table 1.

N TMT	Height Increase, cm.					Increase in # of Breaks					Quality Rating $\left(\frac{\text{ht.} + \text{wdt.}}{2}\right)$				
	P0	P1	P2	P3	AV.	P0	P1	P2	P3	AV.	P0	P1	P2	P3	AV.
N <sub>1</sub>	4.0	10.2	8.0	9.5	8.0	0.0	0.0	1.0	0.8	0.1	2.5	2.0	2.81	1.81	2.31
N <sub>2</sub>	6.2	4.2	28.5	8.7	12.0	0.0	1.5	1.5	1.8	1.2	2.8	3.8	4.5	2.5	3.4
N <sub>3</sub>	10.5	20.5	36.0	7.0	21.2	1.5	0.8	1.2	1.8	1.3	3.8	4.5	4.5	4.0	4.2
N <sub>4</sub>	9.9	15.2	24.5	19.0	17.2	0.3	1.5	0.8	0.8	0.8	3.5	4.5	3.5	3.8	3.8
N <sub>5</sub>	6.0	19.2	13.7	21.0	15.0	1.0	1.0	1.0	2.5	1.4	3.3	4.3	3.8	4.0	3.8
N <sub>6</sub>	14.5	14.2	20.6	23.0	18.2	1.0	0.5	1.8	3.0	1.6	3.8	4.5	4.0	3.8	4.0
AV.	8.5	13.9	21.9	14.7		0.5	0.8	1.2	1.7		3.3	3.9	3.8	3.3	—

Increases in Height, Number of Breaks, and Quality Rating of  
Euonymus alatus 'Compactus' 14 Months After Fertilization with N and P

Table 2.

	Height Increase, cm.					Increase # of Breaks					Quality Rating (ht. + wd) ÷ 2				
	P0	P1	P2	P3	AV.	P0	P1	P2	P3	AV.	P0	P1	P2	P3	AV.
N <sub>1</sub>	18.5	28.5	24.5	23.0	23.6	22.8	29.0	18.3	17.5	21.9	30	38	31	28	32
N <sub>2</sub>	23.3	26.5	42.8	34.8	31.9	14.8	36.5	44.5	33.0	35.9	30	38	46	40	39
N <sub>3</sub>	26.0	38.8	50.8	40.5	39.0	28.5	34.8	55.8	38.3	39.4	35	43	52	45	44
N <sub>4</sub>	31.0	34.0	35.3	43.0	35.8	27.5	48.5	47.0	36.7	39.9	39	49	43	44	44
N <sub>5</sub>	N/A	34.8	N/A	39.3	37.1	N/A	55.7	N/A	43.3	49.5	33	52	46	44	44
N <sub>6</sub>	33.0	N/A	N/A	42.7	37.9	32.3	N/A	N/A	52.3	42.3	40	48	N/A	47	45
AVG:	26.4	32.5	44.8	37.2		25.2	46.7	41.4	36.9		34	45	43	41	

Production Practices to Increase Growth  
and Quality of Euonymus alatus 'Compactus'  
(Study #2)

G.S. Smith

OBJECTIVES: (1) To determine effects of nutrition on growth rate (production time) and quality of Euonymus alatus 'Compactus' produced in containers. (2) To verify and expand on results of "Study #1" conducted in 1979.

METHODS: Uniform rooted liners of Euonymus were potted into 1 gallon poly bags containing medium of bark:sand:peat moss (2:1:½ v/v) amended with 8 lbs. dolomite and 4 lbs. Perk minor element mix with 4 rates of triple superphosphate and 7 rates of nitrogen using 18-5-11 Osmocote. The first application of triple superphosphate and Osmocote was made on April 9, 1980 with supplementary Osmocote treatments to the N<sub>5</sub>, N<sub>6</sub>, and N<sub>7</sub> plants added on July 14, 1980. Equivalent application rates were as follows:

TRIPLE SUPERPHOSPHATE

P<sub>1</sub> - 0 lbs. per cu. yd.  
P<sub>2</sub> - ½ lb. per cu. yd.  
P<sub>3</sub> - 1 lb. per cu. yd.  
P<sub>4</sub> - 3 lbs. per cu. yd.

NITROGEN (FROM 18-5-11 OSMOCOTE)

N<sub>1</sub> - 0 lbs per A per yr.  
N<sub>2</sub> - 500 lbs. per A per yr.  
N<sub>3</sub> - 1000 lbs. per A per yr.  
N<sub>4</sub> - 1500 lbs. per A per yr.  
N<sub>5</sub> - 2000 split in 2 appl: 1500 + 500  
N<sub>6</sub> - 2500 split in 2 appl: 1500 + 1000  
N<sub>7</sub> - 3000 split in 2 appl: 1500 + 1500

Equivalent rates were applied to containers and all treatments were replicated four times. Data collected included (1) initial number of breaks and height of liner (2) color comparisons 1 month after treatments. Height, width, color and number of breaks will be recorded over time.

RESULTS: Initial data on height and breaks were recorded May 6, 1980. Four weeks after the initial treatment color variations were obvious. Color ranged from very chlorotic at lowest N rates to the best green color at N<sub>4</sub> or N<sub>5</sub>. Higher rates of N did not improve color further. There did not appear to be significant differences in P rates; however the lower two rates gave slightly better color. The best color rating was N<sub>4</sub> P<sub>2</sub>.

Color Variations in Euonymus alatus 'Compactus'  
4 Weeks After Initial Treatment

TABLE 1.

N	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>
N <sub>1</sub>	1.9	1.8	1.3	1.8
N <sub>2</sub>	3.0	3.0	2.9	2.5
N <sub>3</sub>	3.3	3.5	3.1	3.1
N <sub>4</sub>	3.5	3.8	3.3	3.5
N <sub>5</sub>	3.4	3.5	3.5	3.3
N <sub>6</sub>	3.3	3.4	3.5	3.4
N <sub>7</sub>	3.3	3.3	3.4	3.3

1 = uniform chlorosis; 2 = yellow, mottled green; 3 = medium green; 4 = dark green

Evaluation of SCU, IBDU and Osmocote Proprietary Fertilizers  
for Production of Woody Ornamentals

G.S. Smith and T. Jacobs

OBJECTIVES: (1) Compare effectiveness of several commercially available fertilizers for topdressing container-grown ornamentals; (2) determine effective and economic application rates for these products.

Numerous fertilizer materials are commercially available and recommended for production of container-grown ornamentals. It is of interest to growers to know how species react to different materials including rates and sources of nitrogen and/or other macro nutrients. This study is a demonstration of species response to varying rates of nitrogen supplied from sulfur-coated urea, (SCU), isobutylidene-diurea (IBDU) and resin-coated-N (Osmocote).

METHODS: Species used were: Euonymus alatus 'Compactus', Photinia x fraseri, Ligustrum japonicum, Cercis canadensis, and Acer palmatum. Plants were already established in 1-gallon polybags or Zarn 200 plastic pots and were growing in a medium of pine bark:sand:peat in a 3:1:1 ratio by volume amended with 10 lbs. dolomite, 2 lbs. triple-superphosphate and 4 lbs. Perk minor element mix per cubic yard. Commercial fertilizers used were Osmocote 18-6-12, Sulfurkote 24-4-10 and IBDU pellets 31-0-0. Five or six rates of nitrogen (lbs. N/A/year) were used depending on numbers of each species available. Rates were 0, 250, 500, 1000, 1500 and 2000 lbs. N/A/year. All treatments were replicated four to five times and plants grown under routine production practices. Growth parameters such as height, width, quality, color will be measured over time.

RESULTS: Only initial visual response to materials and rates are mentioned here. More definitive data should be available by next year.

EUONYMUS - Euonymus, which was chlorotic prior to fertilization, responded very quickly to all materials. Color differences were observed for N rates. Plants treated with SCU at the two highest rates turned nearly white and partially defoliated; however some new growth was apparent after four weeks.

LIGUSTRUM - Ligustrum responded with a rapid greening and flush of new growth within three weeks. All treatments appear acceptable.

PHOTINIA - Redtip Photinia also flushed in two to three weeks however the high N rates from SCU caused considerable leaf drop during this same period.

CERCIS: - Redbud responded equally well to IBDU and SCU. Increasing N rate appeared to produce increasing amounts of new foliage growth.

ACER - Japanese maple responded poorly regardless of treatment.

Besides the individual species responses a few general observations were made regarding N sources. Plants treated with SCU responded first; then those receiving Osmocote; and lastly IBDU. After four to six weeks the major observable differences were among N rates rather than N sources except for the defoliation already mentioned for SCU. The IBDU tablets tend to float out of the containers with overhead watering. Even when covered with pine bark mulch the IBDU would move upward after watering. This observation may indicate a need to incorporate IBDU into the medium rather than use it as a topdressing.

## Evaluation of Selected Ornamentals for Landscape Use

G.S. Smith

OBJECTIVES: (1) To evaluate selected species of native and introduced plants for landscape use in the southeastern U.S. (2) Study propagation and commercial production systems for a species if it shows promise.

Even with all the species, varieties, and cultivars or ornamental plants now commercially available in the U.S., we have only observed a small fraction of the ornamentals available worldwide. Thousands of outstanding plants still await evaluation and detail study for indoor or outdoor landscape use in the southeastern states.

METHODS: Selected ornamental plants, including imported and native selections, are being propagated from seed and/or cuttings and evaluated at our green-houses and under field conditions.

Data on propagation (rate and % germination; % rooting; quality ratings; growth rates, etc.) is recorded. General observations on cultural requirements, seedling growth, and pest problems are made. Once plants are well established they will be planted in various landscapes and observed further.

RESULTS: Species tested and general comments on their performance are summarized below:

### A. Seed imports:

1. *Sophora tetraptera* - scarified seed germinated rapidly but seedlings *S. microphylla* very sensitive to damping-off and spider mites; about 10 plants left alive; older plants growing well in containers.
2. *Banksia integrifolia* - seedlings slow but older plants flush rapidly in containers; about 5 1-gal. plants doing well.
3. *Corynocarpus laevigatus* - slow to germinate and slow seedling growth; 3 plants.
4. *Clanthus puniceus* - germinated rapidly but cannot keep alive; damping off and very severe spider mites.
5. *Eucalyptus leucoxylon* 'Rosea' - seedlings rapid but developed severe leaf scorch and/or nutritional problems; lost.
6. *Hebe speciosa* selections - most germinated quickly and seedlings grow well; damping-off and heat stress(?) severe; losing many plants.
7. *Phormium tenax* - intermediate germination rate; variation among selections; slow growth and very susceptible to mites; 20-30 plants

8. *Pachystegia insignis* - poor germination; damping-off; only 3 seedlings survived but now growing well.
9. *Hibiscus trionum* - rapid germination and flowers as seedling; poor growing, sparse foliage; discarded.
10. *Entelea arborescens* - few seedlings sprouted; seedlings fast; susceptible to chemical burn and heat stress (?).
11. *Arthropodium cirrhatum* - few seedlings sprouted; growth slow but 15 plants well.
12. *Metrosideros excelsa* - easily germinated and most seedlings doing well; reasonably fast growth and few problems other than white flies and aphids.
13. *Leptospermum scoparium* - easily germinated and seedlings doing well; seem to shock badly if transplanted.

B. Native species:

1. *Zamia integrifolia* - seedlings germinate rapidly following pulp removal and scarification; growth very slow however.
2. *Leucothoe fontanesiana* - seed easily germinated when surface seeded on peat moss; seedlings very slow.
3. *Oxydendrum arboreum* - seed easily germinated when surface seeded on peat moss; seedlings slow unless transplanted quickly.
4. *Prunus caroliniana* - seed easily germinated but seedlings checked upon transplant.
5. *Forsythia* selections - easily rooted but most discarded after repeated pest problems and poor performance.
6. *Cladrastis lutea* - very easily germinated but seedlings ruined by damping-off.
7. *Cercis canadensis* alba - both selections easily germinated if scarified; many seedlings lost to disease and mites; purple form does not produce a significant number of similar seedlings.  
*C. canadensis*  
 (purple-leaf form)
9. *Gordonia lasianthus* - easily rooted from softwood and semi-hardwood cuttings; quick growth following transplant to containers; container plants flowered all summer; several plants sent to Experiment Station for cold tolerance testing.



Evaluation of Selected Micro Element Regimes  
on Container Production of Nursery Stock

G.S. Smith and T. Jacobs

OBJECTIVES: (1) To compare effectiveness and cost of commercially available micro element mixes and several experimental mixes. (2) Record visual deficiency or toxicity symptoms of micro elements on several woody ornamentals. (3) Formulate an effective and economical micro element regime for container-grown plants in Tennessee.

A number of proprietary micro element mixes are presently available and recommended for container production of floral crops, foliage plants, and woody ornamentals. Most products have not been evaluated under research conditions in Tennessee for effectiveness or economic production of quality ornamentals. This study will evaluate several commercial products and rates with several experimental mixes.

METHODS: The following products and rates were mixed into one standard nursery mix 3:1:1 pine bark:peat:sand amended with 10 lbs. dolomite, 4 lbs. superphosphate and 8 lbs. 18-5-11 Osmocote per cu. yd.

<u>Product</u>	<u>Rate-lbs./cu.yd.</u>
Perk-old	5, 7½
Perk-new	2, 4, 6
Micromax	1½, 2¼
Esmigran	5, 7½
Frit 555	1/8, 1/4
Experimental	½, 1, 3
Control	---

The following plants were potted into Zarn 300 plastic containers filled with the respective mixes: Quercus palustris (Pin Oak), Pyracantha coccinea (Pyracantha), Ilex x attenuata 'Fosteri' (Foster's holly), Cornus florida (Dogwood), and Koelreutaria paniculata (Goldenrain tree). All treatments were replicated four times and plants will be grown under standard production conditions. This study started in May, 1980.

RESULTS: Plants will be evaluated over several seasons and the following data taken:

1. visual deficiency or toxicity symptoms on each species.
2. visual grade
3. quality grade (ht. + width ÷ 2)
4. ht. increases
5. foliage and root weights on selected species

More definitive results should be available by next year.

Evaluation of Rates and Placement of SCU and Osmocote for  
Production of Selected Woody Ornamentals

G.S. Smith

OBJECTIVES: (1) Compare effectiveness of two proprietary fertilizers at three rates; (2) compare topdressing and medium incorporation of products.

Numerous fertilizer materials are available for production of container-grown ornamentals. It is of interest to growers to know how species react to commercially available materials, especially rates of application. Also, materials can either be topdressed or incorporated into the medium prior to planting. This study is a demonstration of species response to varying rates of nitrogen supplied from sulfur-coated urea (SCU) and resin-coated-N (Osmocote).

METHODS: Rooted liners of Juniperus conferta (Shore juniper), Ilex crenata 'Hetzii' (Hetz holly), Ligustrum japonicum (Japanese privet) and Photinia x fraseri (Redtip photinia) were potted into 1-gal. plastic containers filled with a medium of pine bark:sand:peat (3:1:1 v/v) amended with 8 lbs. dolomite, 1 lb. Micromax (minor element mix), and 2½ lbs. ordinary superphosphate per cubic yard. Plants were treated May 20, 1980 with equivalent rates of N of 1000 (1x) and 2000 (2x) lbs. N/A/Yr. from SCU and Osmocote 18-6-12.

1. SCU - 1x topdressed
2. SCU - 2x topdressed
3. SCU - 1x topdressed; ½ in Spring & ½ in Fall
4. SCU - 2x topdressed; 1 in Spring & 1 in Fall
5. OSM - 1x topdressed
6. OSM - 2x topdressed
7. OSM - 1x topdressed; ½ in Spring & ½ in Fall
8. OSM - 2x topdressed; 1 in Spring & 1 in Fall
9. SCU - 1x incorporated
10. SCU - 2x incorporated
11. OSM - 1x incorporated
12. OSM - 2x incorporated

Plants are grown under standard nursery practices and observed daily. The following data will be taken over time:

1. height and/or width increase
2. color
3. quality grade
4. visual foliage problems if any occur

RESULTS: Only initial visual response to materials are mentioned here. More definitive data should be available by next year.

#### JUNIPERUS

Few observable differences to date. Some chlorosis where the high rate of SCU was incorporated. Plants generally of good quality and color.

LIGUSTRUM

Plants of good quality and color for all treatments. Higher N rates slightly better than split applications. No observable toxicity from any treatment.

ILEX

Holly appears to be much more sensitive to damage than other species. Low rate (1x) of Osmocote and incorporation appears best; damage at 2x topdressed rate. Best SCU treatment appears to be split application at  $\frac{1}{2}$ x topdressed. Other SCU treatments producing stunted and damaged plants.

PHOTINIA

Plants of good quality and color for all treatments but just beginning to flush. No observable problems from any rates or placement.

Response of Juniperus and Zamia to Varying Ca/Mg Ratios

G.S. Smith

OBJECTIVES: (1) Determine if Mg and/or Ca deficiency symptoms can be produced in several ornamental plants; (2) record growth suppression and/or visual deficiency symptoms of Mg or Ca; and (3) measure growth under varying Ca:Mg nutritional regimes.

Calcium (Ca) and magnesium (Mg) are essential elements used in comparatively large amounts by woody plants but identifiable symptoms of their deficiency have not been reported on many species. This is probably because many soil mixes used for container production include dolomite which supplies both Ca and Mg. If limestone (calcium carbonate), as opposed to dolomite, alone is used to adjust media pH and supply Ca, Mg deficiency is possible. Calcic limestone supplies only Ca and not Mg. Furthermore, the high Ca levels may compete with plant uptake of Mg from other media components. A good mix must not only supply a sufficient level of Ca and Mg but the ratio of the two must be such that antagonism does not occur to such an extent that one nutrient induces a deficiency of the other.

This study is an attempt to induce Mg and/or Ca deficiency in plants suspected of being sensitive to these nutrients. Reduced growth and/or visual deficiency symptoms are expected and may be useful in diagnosis of problems in production areas using only limestone in their mixes.

METHODS: Rooted liners of Juniperus horizontalis 'Blue Rug', J. horizontalis 'Plumosa' (Andorra juniper), J. conferta (Shore juniper) and seedlings of Zamia intergrifolia (Florida Coontie) were potted into Zarn 200 plastic pots on May 1, 1980. The soil medium was a 2:½:1 mix by volume of pine bark:peat:sand amended with 1 lb. of triple superphosphate and ¾ lb. Micromax (minor element mix) per cubic yard. Varying levels of Mg and Ca were supplied by using Epsom salt (MgSO<sub>4</sub>), Gypsum (CaSO<sub>4</sub>) and dolomite (Ca-Mg carbonates) in different proportions. A relatively constant total quantity of Ca + Mg equal to approximately 13 lbs. of dolomite per yard was added to the medium via the components listed above. The ratio of Ca:Mg varied as follows, excluding the Ca from superphosphate: 1:12, 1:2, 1.1:1, 2.2:1, 13:1, 28:1, 43:1, 85:1, 4.3:0 and a check receiving no additional Ca or Mg. All soil treatments were replicated three times for the Juniperus and five times for Zamia. Plants are maintained under normal nursery production conditions with fertilization from Osmocote 18-6-12 at a rate of 500 lbs. N/A/Yr.

RESULTS: Plants are now well established and growing, however, no treatment differences are yet observable. More definitive data may be available by next year.

Production of Tree Seedlings Under  
Constant Light in Bottomless Containers

P. Anthony Cope and G. Shannon Smith

**OBJECTIVES:** (1) To determine the effects of constant light on tree seedlings growing in bottomless containers and (2) to determine subsequent tree growth after outplanting to field and/or to container.

Several advantages have been reported for propagation and production of tree seedlings in square, bottomless containers (modified milk cartons) and also from exposure to extended photoperiod. This system of growing tree seedlings is based on previous research that has shown: (1) growing trees in square, bottomless containers increases top growth and promotes a more fibrous root system than in conventional containers and (2) propagation in the greenhouse under continuous photoperiod greatly enhances growth of many tree species.

In this study the bottomless container and continuous photoperiod are combined into a production system with the following potential advantages: (1) a seedling large enough for outplanting is produced much faster than by conventional methods; (2) propagation of seedlings in the greenhouse system is not restricted to the normal growing season; (3) weather related crop failure is avoided; (4) seedlings can be transplanted during the summer months with a high liveability percentage; (5) nurserymen can react quicker to market demands for a particular tree with this accelerated growth system; and (6) accelerated growth realized in the greenhouse may continue after outplanting to the field or container.

**METHODS:** Tree seedlings were grown in the greenhouse under constant light supplied by fluorescent light units equipped with cool white lamps. The containers, constructed from quart milk cartons, were placed on benches covered with a heavy gauge wire mesh stretched over frames made from 2" x 4"'s. Seeds were sown and germinated in the individual containers and thinned to the single, most vigorous seedling. In this system roots grow down and out of the container bottom to the free air space below the wire mesh frames where they are terminated by desiccation, or "air pruned."

All trees were grown to a size sufficient to outplant under the following treatments: (1) continuous photoperiod/bottomless container; (2) continuous light/container with bottom; (3) natural photoperiod/bottomless container; and (4) natural photoperiod/container with bottom.

Species used were Acer rubrum, Betula pendula, Cornus florida, Liquidambar styraciflua, Magnolia grandiflora, Magnolia x soulangeana, Koelreuteria paniculata, Prunus caroliniana, and Quercus palustris.

Trees were transplanted to the field and/or 3-gallon containers where accelerated growth is expected to continue. Height data was collected prior to outplanting and height and caliper measurements will be taken over the growing season.

RESULTS: Height and caliper data for trees in the greenhouse and after out-planting will be presented next year. Treatment differences were seen. Initial observations of species response to this growing system are summarized below.

Acer rubrum: Seed germination very poor and erratic. Species discarded from further study due to lack of numbers.

Betula pendula: All treatments showing satisfactory growth. Seedlings averaged 24" - 30" at time of transplanting and were 15 weeks old. Transplant losses were approximately 25%.

Cornus florida: Seed germination very poor and erratic. Species discarded from further study due to lack of numbers.

Liquidambar styraciflua: Satisfactory growth response in all treatments. Vigorous, strong seedlings, 18" - 24" tall outplanted after 16 weeks from seed. Near 100% survival.

Magnolia grandiflora: No seed germinated.

Magnolia x soulangeana: Treatment differences seen. The continuous light/bottomless container treatment appears superior; seedlings vigorous and 18" - 24" tall after 13 weeks.

Koelreuteria paniculata: Satisfactory growth response in all treatments. Seedlings somewhat leggy but caliper is improving after outplanting. Approximately 90% survival.

Prunus caroliniana: Treatment differences seen. The continuous light/bottomless container treatment appears superior.

Quercus palustris: Results variable. Good seedlings produced but chlorosis a problem in all treatments. Good caliper and height seen in some seedlings. Near 100% survival.

Antitranspirants as an Aid in the Vegetative Propagation of  
Ilex crenata 'Compacta' and Rhododendron obtusum 'Coral Bells'

Mustafa-Kamal Bin Mohd. Shariff and John W. Day

OBJECTIVES: (1) To compare the performance of cuttings rooted using antitranspirants to prevent water loss (wilting) with those cuttings rooted using intermittent mist. (2) To evaluate nutrient content in the cuttings rooted using the two methods.

It has been reported by many researchers that cuttings rooted under intermittent mist lose nutrients from the leaves and stems by leaching. This decrease in nutrition may result in poor quality cuttings. In order to eliminate this problem, some growers have resorted to adding costly nutrients to the cuttings via the mist system. The use of antitranspirants (as a substitute for mist) to prevent cuttings from wilting while in the rooting beds has been suggested. This study concerns the possible advantages of using antitranspirants over the intermittent mist system.

METHODS: Azalea 'Coral Bells' and the dwarf Japanese Holly 'Compacta' were used in this experiment. The experiment was divided into two parts. The first part consisted of selection of suitable antitranspirants to be used. Four different antitranspirants were tested. They were Phenylmercuric Acetate (200 ppm), B-Nine (5000 ppm), Vapor Guard (2.5% v/v) and Wilt-Pruf (10% v/v). The concentrations chosen were either recommended by the manufacturers or had previously been used by others on other plant species.

Cuttings were selected and trimmed for uniformity on June 6, 1979. They were inserted into test tubes filled with a measured amount of water. The cuttings were held in place by one hole rubber stoppers and glue.

A total of 50 cuttings was used. They were divided into five groups. The antitranspirants were then sprayed onto the cuttings with one antitranspirant per group. The fifth group served as a control (untreated). Daily weights of water lost to the atmosphere were recorded. This part of the experiment was terminated after 15 days.

The second part of this experiment was started on September 22, 1979. A total of 70 cuttings of each kind of plant was used. The cuttings were selected and trimmed for uniformity. They were then rooted in a fine sand medium which had previously been washed to remove all the nutrients that may affect the experiment. Vapor Gard, Wilt Pruf, and intermittent mist were used to prevent wilting of the cuttings. The cuttings were removed for evaluation at the end of 50 days.

Experiment I - Untreated cuttings of 'Compacta' holly and 'Coral Bells' azalea lost more water than cuttings treated with Wilt-Pruf or Vapor Gard and leaf damage to cuttings was low. Both antitranspirants, at rates tested, were effective in reducing water loss without damaging foliage thus appeared feasible as a substitute for intermittent mist in propagation.

Experiment II- There was no significant difference in the mean number of roots per cutting or length of roots for either holly or azalea rooted under mist as compared to rooting after treatment with Wilt-Pruf or Vapor Gard. In other words, cuttings rooted equally as well under mist as they did when sprayed with antitranspirants. Cuttings treated with Wilt-Pruf had more leaf damage than those treated with Vapor Gard or those rooted under mist. Greater leaf damage occurred on 'Coral Bells' azalea than on 'Compacta' holly. The quantitative analysis of nutrient elements in tissue of treated cuttings was inconclusive as far as comparing individual treatments. In general, nitrogen, phosphorous, potassium and magnesium were lower in misted cuttings than untreated cuttings of holly. Calcium content increased under mist. For azalea, calcium and magnesium were higher while nitrogen, phosphorous and potassium were lower in misted as compared to untreated cuttings. Azalea nutrient levels were consistently lower than those found in holly cuttings.

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Effect of Field Containers on Root Environment  
and Performance of Nursery Stock

Hendrik van de Werken

OBJECTIVES: (1) To test and compare the root environment and performance of nursery stock in conventional and bottomless round or square containers. (2) To obtain better winter protection while simultaneously preventing "rooting out".

Winter kill and winter damage of container grown nursery stock during severe winters has meant losses of millions of dollars to Tennessee Nurserymen. This research is aimed at development of a container stock production system minimizing such losses.

METHODS: A field experiment was set up using conventional round, black, polyethylene 5.68 l. (6 qt.) containers. The bottom was cut from half the containers, the others left intact. Containers were then placed on black plastic or on soil and/or gravel drenched with a pentachlorophenol (P.C.P.) solution (1 part P.C.P. to 9 parts No. 2 fuel oil), and on soil drenched with "Coppo" (copper naphthenate solution). In addition, square 5.68 l. roofing felt bands (square, bottomless containers) were placed on plastic and on P.C.P. drenched soil. Chemical drenches were used to prevent "rooting out" of the container plants. Containers were placed against each other and planted with Juniperus horizontalis 'Bar Harbor' and Ilex crenata 'Hetzii'. Temperature fluctuations were continuously recorded during the winter of 1978-1979. Spring data on winter damage was collected.

RESULTS: All 'Bar Harbor' junipers (243 plants) survived the 1978-1979 winter without noticeable damage, regardless of the type of container or surface on which they were placed.

Hetzii holly, however, was damaged to varying degrees depending on container type but not to soil surface contact (containers with or without a bottom). Using a damage scale of 1 to 10 with 1 meaning no damage and 10 complete winter kill, Ilex rated 9.85 when grown in bottomless round containers; on gravel the rating was 9.95. Considering all surfaces and soil contact factors, winter damage for plants in round containers rated in no instance less than 9.5 (showing severe winter kill). Ilex plants in square containers (with sides in contact) had an average winter damage of only 1.2 (die back on a few young twigs) regardless of placement on bare soil or plastic.

These results suggest that soil surface contact of containers alone did not prevent winter damage while the side wall protection (insulation) as obtained by close placement of square containers prevented excessive heat loss and therefore provided excellent winter protection for Ilex crenata 'Hetzii'

Variations of this study are continuing and temperature data is being analyzed. Further results will be presented next year.

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Growth Rate of Shade Tree Cultivars as Affected by  
Kind of Fertilizer and Method of Application

Hendrik van de Werken

OBJECTIVES: (1) To measure the growth response of shade trees to nitrogen formulations, (2) compare surface and subsurface application methods. As the use of shade tree cultivars increase, information is needed on species response to nutrient formulations and methods of application.

METHODS: Six cultivars were used in this test: Acer platanoides 'Emerald Queen', Ulmus carpinifolia 'Christine Buisman', Quercus palustris 'Sovereign', Ginkgo biloba 'Princeton Sentry', Gleditsia triacanthos inermis 'Shade Master' and Tilia cordata 'Green Spire'. Trees were planted on the Cumberland Plateau at the Cumberland Plateau Experiment Station, Crossville, Tennessee, on phosphorus deficient land. Nutrient applications were based on 150 lbs N/acre (168 kg N/ha) equivalents as ammonium nitrate, 20-20-20 (soluble), 14-14-14 (slow release) and urea formaldehyde (26%N). One series received surface applications (broadcast), the other subsurface application (holes 15" (37 cm) deep, 2' (5 cm) apart).

RESULTS: Five years after planting, measurements were taken of trunk diameter (DBH), crown spread (average diameter) and greatest height. The product of these three measurements was used as a growth index. For maple, elm, oak, locust and linden the highest growth index was attained by trees which received 14-14-14 (Osmocote @ 1070 lbs/acre (1200 kg/ha) applied to the surface of the soil. For Ginkgo, the greatest growth index was found on trees which received 14-14-14 in holes. The next greatest index was found in the 14-14-14 broadcast plots. In general, the lowest growth index was found in plots which received urea formaldehyde in holes. Survival of 'Green Spire' linden was only 40%, 'Sovereign' pin oak 85%, 'Princeton Sentry' ginkgo 60% while the other cultivars survival was 99%-100%.

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## Heat Transfer in Conventional Round and Straight Sided Square Containers at Low Ambient Temperatures

Hendrik van de Werken

OBJECTIVES: (1) To measure temperature differences in square and round nursery containers filled with two soil mixes and placed on two surfaces. Hardy field grown nursery stock will generally survive severe winter conditions with temperatures around  $0^{\circ}\text{F}$  but severe damage or death may occur if the same plants are grown in containers. In Tennessee, where severe winters occur at an average of once every five to ten years, losses may run into millions of dollars. Placing the nursery containers close together or erecting a polyethylene covered shelter over them does not suffice during prolonged sub-zero weather. Fuel supply and prices now are such that heating of shelters is often considered prohibitive. To tap the heat reserve of the earth for use as winter protection of the roots of container grown nursery stock, the container bottoms must be in close contact with the soil. To obtain optimum benefit from the heat transfer from soil to container, heat loss from the sides of the containers must be largely eliminated.

METHODS: To test this concept two types of containers were placed together, exposed to  $9^{\circ}\text{F}$  ( $-12.8^{\circ}\text{C}$ ) ambient air and monitored with a recording tele-thermometer.

Both square and round nursery containers (6 quart size) were placed either on sand or gravel and filled with either bark and sand mix or peat, sand and loam mix. The temperature 3 inches below the containers was kept  $45^{\circ}\text{F}$  ( $7.2^{\circ}\text{C}$ ).

RESULTS: Exposure of all containers to  $9^{\circ}\text{F}$  ( $-12.8^{\circ}\text{C}$ ) for 48 hours resulted in an average temperature, 4" (10 cm) deep and 2" (5 cm) from the side, of  $29^{\circ}\text{F}$  ( $-1.7^{\circ}\text{C}$ ) in square containers and  $11.5^{\circ}\text{F}$  ( $-11.4^{\circ}\text{C}$ ) in round containers. The average for all containers placed on gravel was  $3.6^{\circ}\text{F}$  ( $2^{\circ}\text{C}$ ) higher than for those placed on sand. There was no difference in temperatures due to media. The temperature under the square containers was  $32^{\circ}\text{F}$  ( $0^{\circ}\text{C}$ ) and under the round containers  $31^{\circ}\text{F}$  ( $-0.6^{\circ}\text{C}$ ). The highest temperature was found in square containers placed on gravel i.e.  $31.5^{\circ}\text{F}$  ( $-0.3^{\circ}\text{C}$ ) while the lowest temperature was found in round containers placed on sand i.e.  $10^{\circ}\text{F}$  ( $-12.2^{\circ}\text{C}$ ). When containers were individually covered with a single layer of Micro-foam, media temperatures were not significantly higher. Also moisture content of the media did not significantly affect temperatures after 48 hours exposure. While all containers had the same volume of medium the main cause of temperature difference can be ascribed to heat loss from the sides of the round containers. Square containers were placed tightly against each other to simulate field conditions with only heat loss from the top.

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Cold Damage to Container Nursery Plants  
as Affected by Solar Exposure, Container Type and Hardening Time

Mark Rohsler

OBJECTIVES: (1) To determine the effects of container design on media temperature changes (as influenced by low ambient air temperature). (2) To determine the effects of: (a) two different solar exposures during the growing season on root tolerance during winter freezing temperatures (b) three different hardening off periods after cessation of growth on cold tolerance of roots. (3) To propose a container production scheme based upon our findings which will facilitate maximum winter protection at low cost.

Winter protection experimentation has been carried out at various institutions to find possible, practical means of safe guarding container root systems from injurious freezing temperatures. Because of skyrocketing energy costs, methods of winter protection which use little or no fuel (energy) are the target of present research.

Preliminary studies conducted at the University of Tennessee have shown that side wall protection (insulation) obtained by square containers in close contact prevents cold ambient air from circulating between the side walls of the containers. Because of this insulation effect, natural soil heat flow from the earth can be utilized as a means of winter root protection. Research has shown that certain plant species which can not be overwintered successfully in conventional round containers without additional protection, can be overwintered successfully if grown in square containers in close contact.

Producing woody nursery plants in square containers may have other advantages besides root protection during freezing temperatures. Some of these expected advantages are:

- 1) Container media will remain cooler during high summer temperatures.
- 2) Reduced water loss from evaporation thereby lowering irrigation needs.
- 3) Improved pattern of root growth in square containers as opposed to round containers.

METHODS:

The species to be used in this experiment are: Ilex crenata 'Hetzii', Buxus sempervirens, Euonymus alatus and Juniperus horizontalis 'Bar Harbor'. These species were selected because they exemplify an average range of root hardiness found in common nursery stock grown by Tennessee nurserymen. Two year bed grown liners will be used for each species in the study. Half of each population will be planted in

conventional round one gallon plastic containers while the other half will be planted in square containers of equal volume. The square containers will be constructed of 30 lb. roofing felt material and will have straight sidewalls. Every container will be placed side by side against one another in a block design and each block of square containers will be surrounded by a border of microfoam insulation.

All plants will be grown for one full growing season (one half under full photo-exposure and the rest under a 50% shade cloth) and then allowed to achieve natural dormancy during the fall. In late November plants will be transferred to a cooler where they will be given additional hardening off periods at 30-35<sup>o</sup>F for both tops and roots. After additional cold treatments are given, all plants will be transferred to a freezer unit where they will be subjected to freezing temperatures. Bottom heat will be supplied to the containers in the freezer by a heating cable to simulate outdoor soil heat flow.

After the freezing period, plants will be transferred to a greenhouse and held at 65-85<sup>o</sup>F to stimulate new growth. Quality and quantity of new top growth after freezing will be used to indicate the degree of inhibition of root system performance for each treatment.

Data will include fresh and dry weights of tops, visual appraisal of top growth as an indicator of root performance and a mortality count. Special emphasis will be placed on comparison of winter damage as affected by container design.

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In-Vitro Propagation of Sinningia speciosa  
'Cherry Bell'

Chuck Hill

OBJECTIVES: (1) To determine the nitrogen level that will maximize shoot production of selected cultivars of Gloxinia, Sinningia speciosa propagated in-vitro (under glass). (2) To determine whether or not leaf size will affect the number of shoots produced in-vitro.

Tissue culture is being used extensively in several labs across the country to produce many types of herbaceous plants as well as several woody ornamentals. Gloxinia is one of several Gesneriads that have been successfully tissue cultured, however, the procedure has not been refined to the point of making production economically feasible for the grower. If a nutritional program including an optimum nitrogen level can be reached that maximizes the number of new plants formed, desirable cultivars can be maintained and increased at a profit to the grower.

METHODS: Leaf sections of Sinningia speciosa 'Cherry Bell' were placed in Knop's medium containing various levels of nitrogen. Knop's medium is a low-salts medium containing macro and micro fertilizer elements in quantities tolerable to plant growth. The nitrogen concentration was varied in the media from absence to a toxic level.

Leaf sections placed on the medium gave rise to shoots within 4 - 6 weeks and roots formed soon afterward. Within 3 months shoots were separated and either planted out in flats or placed in new tubes to allow shoot multiplication to continue.

Final results of this research should be forthcoming in the next year.

The Effects of Dikegulac on Bud-break in Canes  
of Dracaena fragrans Ker. cv. Massangeana

Ann Johnson and John Day

OBJECTIVES: To determine the effect of dikegulac on bud-break in cane cuttings of 'Massangeana' dracaena during propagation.

Dracaena fragrans Ker. cv. Massangeana (also called Striped Corn Plant) is a beautiful tropical foliage plant used extensively in interior landscaping. It is normally propagated by sticking cane sections into the propagation medium and maintaining under mist. Buds usually sprout within 2 months and rooting occurs within about 3 months. However, buds near the top of cane sections are usually the only ones to develop. Because of this growth habit, growers usually plant 3 cuttings of different lengths per pot in order to produce a fuller plant. If buds could be forced to grow along the length of a cane, a more attractive plant could be produced using fewer canes and production costs would be reduced.

Dikegulac-sodium (Atrinal<sup>TM</sup>) is a growth regulator that reduces apical dominance thus inducing growth of lateral buds. It is effective on a number of woody plants and several tropical plants. Atrinal is normally sprayed on plant foliage but little is known about its effect on leafless stems such as dracaena canes. Increased branching of dracaena canes, especially during propagation, could greatly improve quality and reduce nursery production costs.

In order to determine the effects of Atrinal on leafy rooted cuttings of dracaena, a second experiment will be conducted and described at a later date.

METHODS: The experiment was initiated August 21, 1980. Cane cuttings from Costa Rica were cut into 20 cm sections and soaked in Atrinal (either 0, 2.5, 5, 10, 20, or 40 ml/l) for 1, 6 or 12 hours. After soaking, cuttings were air dried. Then, both cut ends were dusted with Captan 50% W.P. and the apical ends were waxed. The cuttings were placed in a propagation bed filled with moist sterilized river sand and kept under 57% shade. Each treatment contained 5 cuttings and was replicated 4 times.

DATA: After approximately 8 weeks the following data will be recorded, analyzed and reported:

1. number of buds per cutting.
2. length of buds or shoots.
3. extent of root system as determined by visual rating system.

Propagation of Flowering Dogwood (*Cornus florida*)

Anne L. Coker and E.T. Graham

OBJECTIVES: (1) To determine the type of medium most suitable for maintenance of dogwood shoots in vitro. (2) To determine the most suitable time of the year to collect material. (3) To determine the type and concentration of cytokinin most beneficial to shoot growth and proliferation. (4) To determine the type and concentration of auxin most conducive to root formation and growth.

METHODS: Apical buds were removed periodically from Cornus florida trees from March until July. These buds were disinfected and placed aseptically on sterile basal medium containing various concentrations of 6-benzylaminopurine (BA) or Kinetin. After eight weeks in culture, explants were transferred to medium containing various types and concentrations of auxin.

RESULTS: Young apical buds available from late April until mid June proved to be the most suitable culture material as tissue contamination was minimum. Buds collected in mid May yielded best results. Dormant buds collected in March and early April were found to be unsatisfactory for tissue culture due to high contamination.

Murashige and Skoog (M&S) medium, White's medium, and a modified Knop's medium were compared for effectiveness in culturing dogwood. Both M&S medium and White's medium proved to be harmful to the explants causing rapid deterioration and subsequent death. Knop's, a low salt medium, proved to be the most successful and caused no apparent ill effects in the explants.

Of the two cytokinins, BA and Kinetin, BA was superior in promoting shoot elongation and proliferation. Low concentrations of BA (0.1-0.5 mg/l) produced shoot elongation while higher concentrations (1.0-2.0mg/l) caused shoot proliferation.

Attempts to root eight week old explants in vitro has proved unsuccessful so far with the addition of NAA, IAA, and IBA to the rooting medium. The addition of phloroglucinol plus auxin also did not result in root initiation. Explants, which have been treated with varying levels of IBA, are presently in the mist bed, however, no root initiation has occurred at present.

Although preliminary research has yielded much valuable information on shoot initiation and proliferation of dogwoods in vitro, no real progress has been made towards rooting the explants in culture. Until further progress is made toward rooting explants in vitro, commercial production of dogwood through tissue culture methods is not feasible.

RESEARCH BEING INITIATED OR PLANNED

The Effects of Site and Three Plant Size-Spacing Combinations on  
the Rate of Vegetative Coverage of Shore Juniper  
(*Juniperus conferta*) in Ground Cover Plantings

John W. Day

**OBJECTIVES:** To determine the rate of vegetative coverage of Shore Juniper when used as a ground cover as affected by site and three specific plant size-spacing combinations. Data obtained from this study may provide information useful to designers and landscapers in writing improved specifications resulting in reduced costs for Shore Juniper ground cover plantings.

Shore Juniper is commonly used as an ornamental ground cover by landscapers because of its creeping growth habit and tolerance to exposed, dry planting sites. One or two gallon size plants are usually spaced 15" to 36" in the planting bed. However, there is no strict rule for spacing. Factors such as plant quality, plant sizes available, speed of coverage desired and budget must be considered. Rapid coverage of the planting bed is desirable to satisfy the functional and aesthetic objectives of the planting. The rate of coverage is determined by species growth potential, plant size and spacing combination, cultural management and environmental-edaphic factors including slope of planting site. The cost of planting junipers as ground covers is high, especially in large planting areas and when large plant sizes and close spacings are specified. Smaller plant sizes and wider spacings reduce costs, but more time is required for complete coverage.

**METHODS:** March 1981. Plants of Shore Juniper will be planted in 6 treatments (Fig. 1). The wholesale nursery cost of plant material in each treatment is equal and thus determines the total number of plants per treatment. Each treatment is replicated 3 times. After planting, the surface area covered by individual plants will be recorded. All plots will be maintained equally throughout the study period.

Figure 1. Six Treatments Used on Shore Juniper

Treatment No.	Plant Size	Plant Spacing	Site
1	16 cm liner	.29m	level
2	16 cm liner	.29m	slope
3	3.8 l can (1 gal)	.64m	level
4	3.8 l can (1 gal)	.64m	slope
5	7.6 l can (2 gal)	.91m	level
6	7.6 l can (2 gal)	.91m	slope

DATA: A) March 1982. The surface area covered by individual plants will be recorded and reported. Observations such as pest damage, cold injury and survivability will be reported.

B) March 1983. The surface area covered by individual plants, total surface area covered, rate of coverage and final observations will be analyzed and presented in a final report.