2000

North Carolina State University
North Carolina Association of Nurserymen

Nursery

Short Course

February 17-18, 2000
Jane S. McKimmon Center
Raleigh, North Carolina

Sponsored by
North Carolina State University
North Carolina Agricultural Research Service
North Carolina Cooperative Extension
North Carolina Association of Nurserymen

NCSU NURSERY SHORT COURSE
February 17 & 18, 2000
McKimmon Center
Raleigh, N.C.

Registration	NCAN	8-9 a.m.

9-12 a.m.

DIVERSIFYING YOUR PLANT PALETTE

9:00 - 9:05 Welcome and Opening Remarks- Joe Stoffregen-President NCAN

9:05-9:45.....Bryce Lane -'Adding Shrubs to your Production List? Consider Fantastic Shrubs With Fabulous Fruit and Fall Color

9:45-10:30....Jean-Jacques Dubois -'Camellia Savvy for the Nurseryman: A Revitalized Look at a Classical Plant and its Companions.'

10:30-10:45.....BREAK

10:45-11:30.....Bob Lyons - 'An Indispensable Checklist of Late Flowering

11:30-Noon.....Bob Lyons - The JC Raulston Arboretum Update

Lunch	12- 1 p.m.

EXPERIMENTS THAT YOU DIDN'T TRY AT HOME! 1-5p.m.

1:00 Dr. Stuart Warren- Incorporation or Topdress Fertilizers- Which is Best?

1:30 Dr. Ted Bilderback- Have You Any Microclimates In Your Nursery?

2:00 Lee Ivy- Should Growers Adjust The Fertilizer Rate Depending Upon The Break 2:30

3:00 Dr. Mike Benson- Are Diseases Getting You Down?

3:30 Dr. Stuart Warren- Does Time of Day You Irrigate Make Any Difference?

4:00 - 4:40 Dr. Ted Bilderback- Have You Tried This? Yaw'nt To?

4:00 Discussion

Reception 5-6 p.m.
McKimmon

FEB 18

Registration NCAN 8-9

GETTING STARTED WITH PROPAGATION 9-12 a.m.

9:00 - 9:45 Dr. Dennis Werner - So You Want To Be A Plant Breeder?:
The Basics of Plant -Hybridization and Improvement
9:50 - 10:10 Dr. Frank Blazich- Culture and Propagation of Anemone X hybrida

10:15 - 10:45 BREAK

10:45 - 11:15 Jason Griffin- Propagating 'Green Giant' and Other Difficult

11:20 - noon Dr. Tom Ranney- Engineering Superior Trees Through Grafting
and Rootstock Selection

Lunch 12-1 p.m.

LOOKING FOR TROUBLE? 1-5 p.m.

1:00 Dick Bir - Invasive Plants and the Nursery Industry

1:45 Ms. Gina Penny -Nursery IPM Scouting

2:15 Dr. James Baker- Insect and Mite Control in Nurseries

2:45 Break

3:00	Dr. James Baker, Insect and Mite Control, cont.
3:30	Dr. Joe Neal - New weeds in NC Nurseries -Identification, Spread & Management
4:00	Discussion
	Depart

ADDING SHRUBS TO YOUR PRODUCTION LIST? CONSIDER FANTASTIC SHRUBS WITH FABULOUS FRUIT AND FALL COLOR

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New and historic deciduous shrubs are being used in the landscape more frequently. The mixed shrub border of herbaceous perennials and shrubs is now a popular form of gardening. Landscapers, retailers, and home gardeners are looking for plants with seasonal interest. If you are looking to increase your production list, you might want to consider some of the following shrubs that have ornamental characteristics in the fall and early winter. The following list of shrubs are "easy to propagate" by cuttings unless noted otherwise. Those shrubs difficult to propagate by cuttings are identified by an asterisk.

1.	*Aronia arbutifolia* 'Brilliantissma'	red chokeberry
2.	*Berberis wilsoniae* var. *Stapfiana*	wilson barberry
3.	*Callicarpa americana*	american beautyberry
4.	*Callicarpa bodinieri*	bodinier beautyberry
5.	*Callicarpa dichotoma*	purple beautyberry
6.	*Caryopteris x clandonensis* 'Worcestor Gold'	golden bluebeard
7.	*Chimonanthus praecox*	fragrant wintersweet
8.	*Cornus kousa* var *angustata**	evergreen kousa dogwood
9.	*Cornus sanguinea* 'Midwinter Fire'	bloodtwig dogwood
10.	*Cyrilla racemiflora**	swamp cyrilla
11.	*Dapnie odora* 'Aureomarginata'	variegated winter daphne
12.	*Daphnephyllum macropodum*	daphniphyllum
13.	*Enkianthus perulatus**	white enkianthus
14.	*Fothergilla major* 'Mt. Airy'	mount airy fothergilla
15.	*Heptacodium miconioides**	seven -son flower
16.	*Hydrangea paniculata* 'Tardivia'	panicle hydrangea
17.	*Hydrangea quercifolia*	oakleaf hydrangea
18.	*Hypericum androsaemum* 'Albury Purple'	albury purple hypericum
19.	*Itea virginica* 'Henrys Garnet'	henry's garnet sweetspire
20.	*Kerria japonica* cultivars	japanese kerria
21.	*Lindera umbellata**	spice bush
22.	*Mahonia* 'Arthur Menzies'*	arthur menzies mahonia
23.	*Osmanthus fragrans* var. *aurantiacus**	fragrant tea olive
24.	*Pieris japonica* 'Mt. Fire'	mountt. fire pieris
25.	*Serissa foetida* 'Pink Variegated'	pink yellow rim

CAMELLIA SAVVY FOR THE NURSERYMAN: A REVITALIZED LOOK AT A CLASSICAL PLANT AND ITS COMPANIONS.

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Camellias are among the ornamental shrubs with the longest history of cultivation in our state. In fact, they are such a familiar sight in coastal areas, the sand hills, and much of the piedmont, that we may be tempted to omit them in our marketing efforts, hoping in effect that they will sell themselves. No other plant, after all, can deliver what camellias do: an evergreen shrub with a vivid floral display in late fall, and with the right cultivars, all through winter. In addition, they are reasonably easy to grow and minimally fussy in the landscape, and they come in a tremendous variety of forms and colors. There are, however, a few issues that if properly addressed, would greatly enhance their commercial potential. For instance, much of the public is only aware of the existence of two species: *Camellia sasanqua* and *Camellia japonica*. Among those two species, only a relatively small number of cultivars are generally available. Are there other species of *Camellia* that could be successfully marketed? Are the most commonly available cultivars really the best? Another issue is that of cold hardiness. Species of *Camellia*, and cultivars within species, vary in their sensitivity to frost: what constitutes cold hardiness in camellias, and which cultivars will be the most cold-hardy? Finally, if camellias peak in fall and winter, what can we do to maintain interest the rest of the year? What other plants will thrive in the same conditions, and provide suitable companions?

Species of Camellia for North Carolina. There are approximately 250 species of *Camellia*, all of them native from Asia. Seven of them are directly relevant to North Carolina growers, although some nurseries are actively trialing more species, and working towards introducing them to the trade. Those seven species are *C.* x *vernalis*, *C. oleifera*, *C. japonica*, *C. reticulata*, *C. sasanqua*, *C. sinensis*, and *C.* x *williamsii*. *C. oleifera* and *C. sinensis* have only few ornamental merits of their own, but are used extensively in attempting to bring increased cold hardiness into their more showy relatives. Conversely, *C. reticulata* is generally not hardy outside of USDA zone 9, but is being used in breeding better floral display into more cold hardy relatives. *C. sasanqua* is the familiar smaller-leaved, fall-flowering camellia whose flowers range between 2 and 3 inches in diameter. A number of plants long thought to belong to this species have been shown to be the result of hybridization and back-crossing between *C. japonica* and *C. sasanqua* over time, and were given the name *C.* x *vernalis*.. *Camellia japonica* is the more formal-looking, larger leaved plant whose spectacular flowers, 3 to 5 inches in diameter, appear between October and April, depending on cultivar. *C.* x *williamsii* is barely hardy in the Piedmont, but distinguishes itself by its profuse flowering. All told, there are over 32000 known cultivars of ornamental camellia.

Camellia Cold Hardiness. Camellias provide an excellent case study in the factors that influence plant cold hardiness. First, the most cold sensitive parts are open flowers. Open camellia blossoms, with the exception of a few cultivars, will brown out at temperatures below

32 F. Then come flowers buds, with the floral buds of *C. japonica* tolerating temperatures lower then *C. sasanqua*. Leaves come next, followed by stems, and roots. Most important however are the rate at which temperature changes occur, both over the course of seasons, and over the course of each day. The more gradual cooling is in the fall, the greater the ability of plants to tolerate extremes of cold in winter. Likewise, over the course of hours, rapid thawing of a moderately frozen plant by morning sun is potentially far more injurious than a gradual thawing, even starting from lower temperatures. This is why site selection (micro climate) is one of the most important aspects of customer education when marketing camellias. The cover of tall evergreen, such as mature loblolly pines, or a northwestern exposure near buildings are the two most desirable situations.

Beyond site selection, nutrition also plays a role: elevated nitrogen nutrition late in the growing season results in a decreased ability to acclimate to cold temperatures.
Two breeding programs, started in the 1960's, have pursued increased cold hardiness. In part because planting conditions have such a strong influence on the survival of individual plants, it has been difficult to prove that the results of those breeding efforts exhibit greater cold hardiness then the hardiest among traditional cultivars of *C. japonica*.

Camellia Companions. Camellias thrive in light shade, with some protection from direct sun in summer, and from radiational cooling on winter nights. They do best in somewhat acidic, well aerated soils that are rich in organic matter. These conditions are well suited to a fairly broad range of both woody and herbaceous plants, with either floral or textural interest to complement camellias outside of fall and winter.
Among woody shrubs, pieris, kalmia, and rhododendrons are obvious choices, but any of the many species of viburnum that tolerate or prefer filtered light, would make fine companions. Plants such as *Hydrangea quercifolia* and mahonias should be considered for the strong textural conterpoint they provide to the rather bland effect of camellia foliage and branching.

As for herbaceous perennials, a number of species can be combined with camellias to create a woodland atmosphere: *Epimidium*., *Hexastylis*, *Chrysogonum virginianum*, *Endymion hispanicus*, trilliums even. Others would emphasize the camellias' formal character. These would include ground covers such as *Pachysandra procumbens*, *Lamium* or orderly arragements of hostas. Others still would use camellias as backdrop for a shade garden: *Anemone* x *hybrida*, *Polygonatum odoratum* 'Variegatum', *Heuchera* spp. *Astilbe*, *Pulmonaria* , *Trycirtis* all thrive in conditions similar to camellias.

Regardless of particular customers' preferences, however, being able to recommend a whole group of plants for year-round interest, might be the key to boosting sales of all of them, including camellias.

AN INDISPENSIBLE CHECKLIST
OF LATE FLOWERING PERENNIALS FOR NURSERY MANAGERS

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Slides follow this order.....

North American Natives and Derivatives
Eupatorium coelestinum (hardy ageratum)
Vernonia noveboracensis (new york ironweed)
Helianthus maximillianii (maximillian daisy)
Eupatorium purpureum 'Gateway' (dwarf joe pye weed)
Lobelia cardinalis (cardinal flower)
Lobelia siphilitica (great blue lobelia)
Liatris pycnostachya.....after flowering (blazing star)
Hibiscus moscheutos (swamp hibiscus)
Solidago (goldenrod)
Helenium autumnale (sneezeweed)
Boltonia asteroides (boltonia)
Aster novae-angliae (new england aster)

Other Possibilities
Ajania pacificum [syn. *Chrysanthemum pacificum*].....(pacific daisy)
A. pacificum 'Pink Ice' (pink pacific daisy)
Hylotelephium x spectablile 'Autumn Joy' (autumn joy sedum)
Caryopteris x clandonensis (bluebeard)
C. x clandonensis 'Worcester Gold' (gold bluebeard)
Ligularia (ligularia)
Nipponanthemum niponicum [syn. *Chrysanthemum nipponicum*].....(nippon daisy)
Anemone japonica (fall anenome)

More Than Just Flowers
Clematis tangutica (yellow bell clematis)
Iris foetidissima (iris)
Belamcanda chinensis (blackberry lily)

"Bulbs"....Appropriate and Underused
Colchicum (autumn crocus)
Sternbergia lutea (winter daffodil)
Crocus sativus (saffron crocus)

INCORPORATING OR TOPDRESSING FERTILIZERS - WHICH IS BEST?

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Concerns with water quality places pressure on growers to develop "best management practices" to reduce or eliminate nutrient contamination in irrigation effluent. Thus, any production technique that improves efficiency and reduces nutrient losses could be advantageous. Recently, it was recommended that the initial application of controlled-release fertilizer (CRF) should be incorporated into the growth medium at potting, in lieu of applying the CRF to the surface of the medium (topdress). This recommendation infers that adjustments in method of fertilizer application may provide a management tool for increasing nutrient efficiency, yielding environmental as well as monetary paybacks for growers.

Several studies have been conducted to determine whether topdressing or incorporating CRF produces larger plants. Plant growth varies depending on the method of application, nutrient release characteristics of the CRF, rate of fertilization, container medium and plant species. However, little is known concerning the effect of method of fertilizer application on nutrient losses and efficiency. Therefore, the objective of this study was to evaluate the method of fertilizer application (topdressing or incorporation) of two commercial CRFs on plant growth and nutrient losses.

In this study, each plant was fertilized at potting with 5.0 g N from Nutricote18-6-8 or Meister 18-6-12. Total dry weight (shoots + roots) of cotoneaster grown with topdressed Meister was 20% greater compared to incorporated Meister. In contrast, total dry weight (shoots + roots) of cotoneaster grown with incorporated Nutricote was 35% greater than plants grown with topdressed Nutricote. Previous studies have reported similar contrasting results. *Rhododendron* 'Coral Bells' had 31% greater shoot dry weight when Osmocote 18N-2.6P-10K was topdressed compared to incorporated. However, shoot dry of *Ligustrum japonicum* and *Rhododendron* 'Mrs G.G. Gerbing' fertilized with Osmocote 18N-2.6P-10K were unaffected by method of fertilizer application. Nutricote 16N-4.4P-8.3K produced greater dry weight of *Juniperous conferta* 'Blue Pacific' compared to topdressed.

Even though the nutrient release characteristics and N source varied by CRF product, both CRFs lost greater quantities of NO_3 and P when incorporated compared to topdressed. Nitrate losses increased 105% or 258% when Nutricote or Meister was incorporated compared to topdressed, respectively. Phosphorus losses increased 33% or 88% when Nutricote or Meister was incorporated compared to tpdressed, respectively. Similarly, Meister when incorporated lost greater quantities of NH_4-N compared to surface application. Nutricote had similar NH_4-N losses regardless of method of application. This difference in NH_4 losses may have resulted from differing sources of N.

This data suggests that nutrients released from incorporated CRF may be more easily leached since the fertilizer is dispersed uniformly throughout the medium in contrast to surface application. Also, incorporated fertilizer may have a faster release rate compared to surface-applied fertilizer due to differences in medium temperature and water content. A faster nutrient release rate, if not subsequently absorbed by the plant, could result in higher nutrient losses in the effluent.

Incorporating CRFs increased NO_3 and P losses in runoff an average of 61% and 36% respectively, compared to topdressed. A single study does not necessarily mandate changes in the choice of fertilizer application. However, growers should be aware that method of fertilizer application can affect nutrient losses in the irrigation effluent depending on fertilizer, medium, and irrigation management. Therefore, if growers incorporate CRFs, irrigation practices such as cycled irrigation or monitoring irrigation volume to decrease leaching could be critical.

DO YOU HAVE ANY MICROCLIMATES IN YOUR NURSERY?

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A new concept for production of container grown ornamentals is to look for alternative production practices which offset stressful environmental conditions. Growers should look for unique environmental exposures around the nursery and imagine how they might take advantage of these characteristics for growing crops. Wooded areas on south or west perimeters of nurseries may be ideal for providing afternoon shade for crops, including some variegated varieties that grow best in full sunlight, but are easily stressed by intense afternoon sunlight and heat. Also, strips of wooded areas, possibly those that serve as riparian buffers along ditches or creeks that run through the nursery, may provide the same afternoon shade opportunities casting shade over areas several times their height as the sun moves lower in the sky. Growers may even want to experiment with where they place various crops within this afternoon shaded zone. Some of the same opportunities may exist for variations in topography over the nursery. Many times we get caught up in just finding space to set new crops down. However, doing an environmental audit by looking at the nursery for unique spaces, may reduce irrigation requirements and plant protection chemical applications for some crops. Pine tree shade areas are becoming less common at nurseries. Many have been destroyed and caused crop damage as hurricanes passed through. These pine stands may have developed weakened root systems due to frequent overhead irrigation for crops grown on the ground below. Consider using such areas for growing crops such as camellias or 'Auto Luyken' cherrylaurel spray stakes in each pot. These crops generally have special watering requirements and do not do well in irrigation zones with other crops.

Pot in Pot

The best example of environmental modification of growing conditions for outdoor nursery container production is Pot in Pot (P n P). Pot in Pot production of nursery crops has emerged over that last decade as a new standard method of producing large container grown nursery crops. This production technique has caught on not only in the Southeastern U.S., but also in the Northern-midwest. Wide adoption of this practice throughout the nursery industry demonstrates that plants grow faster in this system due to moderated container temperatures. Also, the P in P production system also provides winter protection with no further over-wintering practices necessary. Nurseries in northern states report that approximately the top 1 inch of the container substrate surface freezes but the remaining depth of the container remains above freezing temperatures. Another major benefit of P in P production is that trees and screening plants with big canopies do not blow over which is a frequent problem with large plants in above ground containers. However, Pot in Pot appears to be limited for economic reasons, to large containers from 7 to 25 gallon sizes s. An exception may be to grow bareroot tree liners in smaller three to five gallon containers at dense spacing in trenches or P n P liner production areas to decrease production time in large PnP containers. Traditionally grown crops in 1, 3 and 5 gallon containers generally are still exposed to high summer root zone temperatures.

Double Pot Container Production

An adaptation of PnP is using double pots above ground. In a research study conducted at N.C. State University, *Ilex crenata* 'Compacta ' holly liners were potted in two gallon containers (8.5 inches high). One-half of the hollies container plants were placed in 3 gallon squat containers (7.5 inches high) with the air space between containers left open. All the containerized plants were on a gravel based nursery research area and irrigated with spray spot spitters placed in each container. Daily maximum and minimum temperatures were recorded in selected containers by thermocouple wire installed one inch from the outside southwest-facing side of containers and 1 inch below the substrate surface. Recorded temperatures averaged 122 ^{o}F for single pots and 105 ^{o}F for double container root zones. For 17 of the brightest days, temperatures in single pots reached and average 148 ^{o}F and 108 ^{o}F for double pot containers. Shading roots in containers with a second pot resulted in visually compelling and statistically significant improvement in plant size. Protection of roots from direct sunlight resulted in an average of 51% greater root dry mass and 47% greater shoot dry weight. Also, lower root zone temperatures in double pots resulted in decreased leachate NH_4-N and pH. Nurseries frequently have an ample supply of many sizes of containers. If smaller containers are placed inside larger containers, direct sun contact is made on the outside container, but the air space between containers does not conduct the heat to the inside container root zone. Growers have had success using the double pot system. One grower painted the outside container white to reflect sunlight radiation and measured temperatures that were 10 to 25^{0} F lower than single containers placed in the same growing area. This nurseryman nailed larger 3 gallon containers to the ground fabric in growing areas and placed one or two gallon containers inside the secured larger containers. An additional benefit noted was that azaleas bloomed 10 to 14 days later in double pot containers than the same cultivars he had in other traditional growing blocks. Thus, he was able to extend sales to garden centers with plants in peak bloom for that two-week period.

Low Profile Containers

The common assumption would be that since standard height containers are taller, drain better and have greater volume. They would hold more water and nutrient resources, therefore plants would grow faster in larger containers. However, this assumption does not take into account the smaller area contacted by direct sun. Growers who use mum pots for horizontal growing crops such as 'Blue Rug' or 'Bar Harbor' juniper get an additional bonus due to the effect of crops growing over the side of the pot early in the growing season, providing protection to their own root system. Results indicated spreading plants seem to grow much faster and become fuller in shorter profile pots sooner, than in standard height containers.

Summary

Success stories lead to new experiments with cultural practices at many nurseries. Let your imagination wander through your nursery. Think about how you could do a better job growing one of the crops that you have trouble with. Take advantage of resources that you already have, but just haven't thought about.

Are Diseases Getting You Down?

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Phytophthora root rot and Phytophthora dieback (and to a lesser extent) are two diseases that continue to cause problems for growers of many nursery crops. The primarly pathogen is *Phytophthora cinnamomi*, but *P. parasitica*, *P. cactorum* and other species can cause loss in ornamentals. We grow many crops in North Carolina that are susceptible to *Phytophthora* including, andromeda (*Pieris*), arborvitae, aucuba, azalea, *Camellia*, *Chamaecyparis*, *Cunninghamia*, *Daphne*, deodar cedar, dogwood, forsythia, Fraser fir, hemlock, Japanese holly, juniper, *Pittosporum*, *Podocarpus*, *Rhododendron*, *Stewartia*, *Taxus*, pine, and others.

Phytophthora root rot. Symptoms of Phytophthora root rot include poor growth, smaller than normal leaves, smaller diameter stems, chlorosis, wilting, discolored roots, and plant death. Spores of Phytophthora capable of causing infection of roots are present in many soils, but also may be present in re-cycled irrigation water. Normally, roots become infected by spores of *Phytophthora* during heavy thunderstorms or irrigation events when the soilless potting mix is near saturation in the pot. As more and more of the root system becomes infected by *Phytophthora*, foliar symptoms progress from mild to severe.

Soilless mix and suppression of Phytophthora root rot. During the last two summers we have been investigating the use of swine solids as an component of pine bark potting mixes and biocontrol agents to suppress Phytophthora root rot. Experiments were conducted at the Horticultural Field Lab in Raleigh with Hinode-giri azalea grown in pine bark mix amended with dried swine solids at rates of 5 (95/5), 10 (90/10), and 20 (80/20) % (v/v). In the second year, the biocontrol agent, SoilGard™ (Thermo-Triology, Inc, Columbia, MD) was included with the swine solids in an attempt to improve suppression of the mix to Phytophthora root rot. In early June, one half the plants in pots were inoculated with *P. cinnamomi*. Plants in the pine bark sand (90/10) treatments (controls) received 3.2 g N per pot of 16-5-10 Wilbro NPK fertilizer. No fertilizer was added to pots with swine solids. Pots under a shade cloth were irrigated by overhead sprinkler daily. Foliar symptoms of disease were rated regularly over the summer. The VTEM 'pour through' method was used to determine soluble salts levels in the pots during the season. In September, plant top weight was determined and the roots of each plant rated for extent of Phytophthora root rot, where 1= healthy roots, 5 = roots completely rotten and plant dead.

***Phytophthora*, swine solids, SoilGard™ and growth of azaleas**. In the absence of *Phytophthora*, the greatest plant growth was observed on azaleas in the pine bark mix amended with 5% swine solids plus SoilGard™ (Fig. 1). Plant growth was poor in all azaleas grown in pine bark mix infested with *P. cinnamomi* regardless of rate of swine solid or use of SoilGard™ **.**

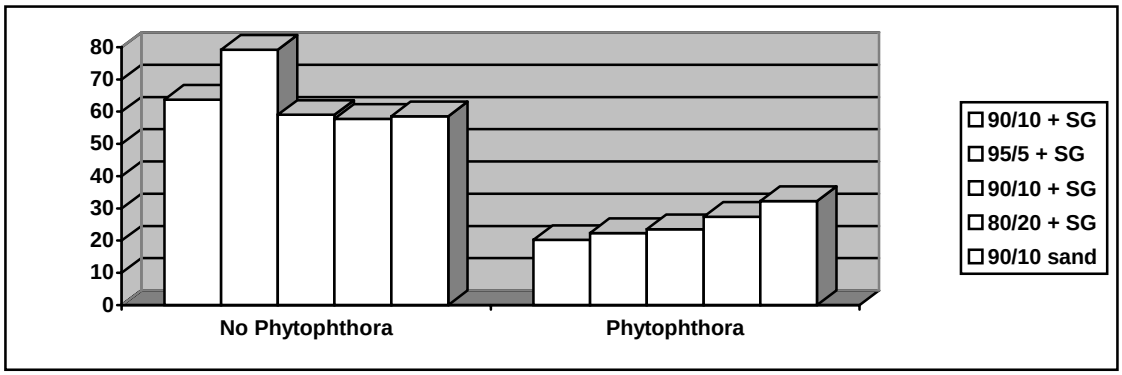

Figure 1. Effect of swine solids at 5, 10 or 20% (v/v) in a pine bark mix and SoilGard™ (SG) on azalea top weight (g) in the absence and presence of *Phytophthora cinnamomi*.

***Phytophthora*, swine solids, SoilGard™ and root rot of azaleas**. In the absence of *P. cinnamomi*, roots of azaleas appeared healthy (ratings near 1.0) except for plants grown in pine bark amended with 20% (80/20) swine solids and SoilGard™ (Fig. 2). Although azalea grown with 10% swine solids were not smaller than those in 20% swine solids, root discoloration at 20% was evident. Azaleas grown in pine bark mix infested with *P. cinnamomi* and amended with swine solids and SoilGard™ had root rot ratings near 3, indicating severe Phytophthora root rot (Fig 2). Thus, swine solids and SoilGard™ amended in a pine bark mix did not suppress Phytophthora root rot as anticipated.

Effect of swine solids on soluble salts in azalea. Soluble salts readings were highest in pine bark mix amended with 20% swine solids. Initial conductivity near 0.75 mmhos/cm in mix with 20% swine solids dropped to near 0.3 mmhos /cm by season's end. Initial conductivity in pine bark sand and the 5 and 10% swine solids was between 0.3 and 0.45 mmhos/cm, dropping to 0.25 to 0.3 mmhos/cm by season's end.

Acknowledgements. The authors gratefully acknowledge the support of BION Inc., Smithfield, NC, and the technical assistance of Kala Parker, Billy Daughtry, and Mary Lorscheider.

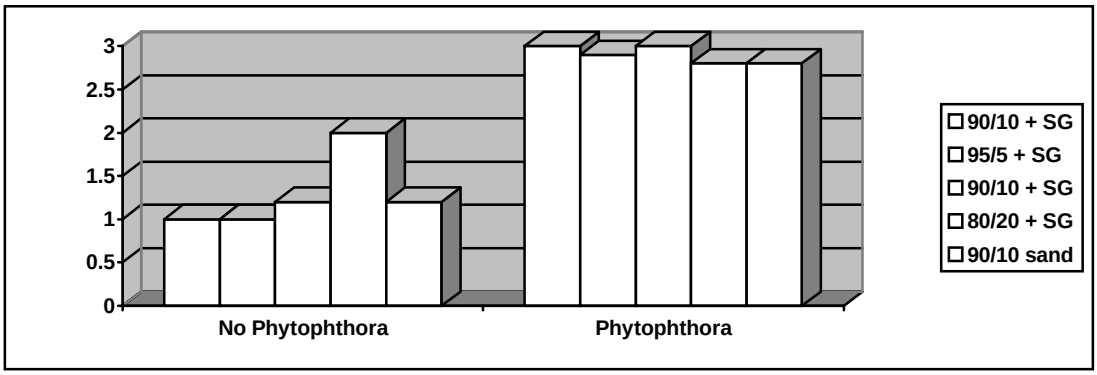

Figure 2. Phytophthora root rot of azalea for plants grown in a pine bark mix amended with swine solids at 5, 10, or 20% (v/v) and SoilGard™ and infested with *P. cinnamomi* or left noninfested (No Phytophthora). Scale 1 = healthy, no root rot, 3= severe root rot.

DOES TIMING OF IRRIGATION MAKE A DIFFERENCE?

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Much research has focused on increasing irrigation efficiency by improving method of application (cyclic application) and reducing irrigation volume. Previous research has demonstrated that cyclic irrigation can reduce water loss by 25% to 35%. In addition, leaching fractions of 0.15 to 0.25 have maximized plant growth. However, even with these improvementS, substantial volumes of water are still lost from the container during irrigation. Growers need additional techniques for irrigation efficiency to continue to improve. Ideally, these new techniques could be implemented with minimum changes to their current production systems. One technique may be irrigation scheduling.

Irrigation scheduling is defined as the process of determining when to irrigate and how much to apply. The goal of irrigation scheduling is to control the water status of the crop to achieve a targeted level of plant performance. The performance level can vary from optimizing irrigation input, to maximizing water use efficiency, to maximizing plant growth. Since the commercial value of woody landscape plants is generally based on size and aesthetics, most growers are focused on maximizing plant growth. Irrigation scheduling has received considerable attention in field crop production. However, no one has examined the impact of irrigation scheduling, i.e. time of irrigation application in regards to container-grown nursery crops.

Many growers traditionally irrigate pre-dawn to reduce water lost to evaporation and to minimize interfering with workers. Irrigating during other times of the day may have advantages in addition to increasing water efficiency, such as reducing heat load and minimizing water stress in later times of the day. Would it be possible to increase irrigation efficiency and improve plant growth by changing the typical irrigation schedule? The objective of this study is to evaluate the effects of irrigation scheduling on plant growth.

Irrigation was applied in equal parts at the following times each day:

A. 3:00 A.M., 5:00 A.M., and 7:00 A.M.
B. 5:00 A.M., 12:00 P.M., and 7 P.M.
C. 9:00 A.M., 12:00 P.M., and 3 P.M.
D. 12:00 P.M., 3:00 P.M., and 6:00 P.M.

Total plant growth (top and roots) was increased 34% to 57% when irrigation was applied throughout the day compared to early morning irrigation.

HAVE YOU TRIED THIS ? YAW'NT TO?

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This presentation is intended to provide some new ideas for a few changes around the nursery. This presentation welcomes discussion and comments from the audience.

A small study was conducted at Taylors' Nursery, Raleigh, N.C. during the summer of 1999. We selected sixteen plants of red maple, southern magnolia, willow oak and flowering dogwood in 5 gallon containers for a study. Four plants of each species were placed in four areas with different growing conditions. One group of plants were placed in full sun and irrigated once a day. A second group were placed in 55% shade and irrigated once a day. A third group was placed in full sun, but irrigated once a day and misted for 30 seconds every 30 minutes during daylight hours. The fourth group was placed in shade, irrigated once a day and then misted as with the third group throughout the day. What were the results? All four test plants in full sun and misted plants appeared to be larger. What else happened? Dogwoods irrigated once a day developed powdery mildew. Dogwoods misted during the day were larger and had shinny leaves without any mildew. The dogwood results should really not be a surprise. Powdery mildew, unlike many foliar diseases, is most successful when environmental conditions are warm (59-86o F) with high humidity, but without free water. Intermittent mist dogwood production might be reasonable to try when it gets hot and dry after the cool spring season and infection of spot anthracnose is over.

Growing liners in beds is far from beinga new idea. However, creating drainage and aeration similar to containers by adding liberal amounts of pine bark and frequent irrigation to beds are an innovation worth considering. Irrigation can be provided by drip tubes for narrow beds as wide as tilling equipment, or overhead sprinklers could be used for wider beds. Liner beds could also be prepared like plastic culture used for strawberry production. The advantage of bed production for liners is the incredible root development. Root growth may exceed growth in containers due to reduced root zone temperatures and ideal air and water characteristics.

Another idea passed on by Pat McCraken at Taylors' Nursery, Raleigh, is mixing seed with potting mix and propagation trays with the mixture. With wax myrtle, Pat mixes about two to three cups of seed per 15 gallon batch of propagation mix. This is done in fall and seeds exposed to winter temperatures germinate in the spring. The fastest growing seedlings germinate from the top few inches of propagation mix and shade other weaker growing seedlings out. This method saves the tedious task of placing a few seeds in each cell of propagation trays.

THE BASICS OF PLANT HYBRIDIZATION AND IMPROVEMENT

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New ornamental plant cultivars can arise in any number of ways, including discovery and domestication of desirable plants found in the wild, identification and commercialization of superior seedlings obtained from seed collected off of garden-worthy plants, and asexual propagation of rare branch or bud sports arising on pre-existing cultivars. Additionally, many new cultivars of plants have arisen as a consequence of controlled hybridization between selected parents. Successful development of new, improved plant cultivars by controlled hybridization is most successful if the hybridizer possesses a solid foundation in plant genetics. However, amateur plant breeders can and have had significant success in the development of new ornamental cultivars. In this presentation, some basic principles and techniques involved in plant hybridization and improvement will be discussed. This background will equip the amateur with the tools needed to initiate a simple plant breeding effort. The presentation will focus on the following steps in the hybridization program.

1. Selection of the appropriate parents.
2. Bringing chosen parents into flower simultaneously.
3. Pollen collection. Short and long term storage of pollen. Predicting the storage longevity of pollen of various species.
4. Importance of the direction of the cross. Criteria which will help determine which parent will serve as the male and which will serve as the female.
5. Emasculation (removal of male flower parts from female parent) procedures. Determining when emasculation is not necessary.
6. Pollination of the female parent. Protection of pollinated flowers. Recording the cross.
7. Observation of fruit set and development.
8. Collection of fruit and extraction of seeds.
9. Seed germination.
10. Seedling culture and transplanting to field or garden site.
11. Field selection among hybrids.
12. Remember Mendel! Recessive characters and the need to proceed to the next generation.
13. Propagation of selected seedlings. Seed vs. asexual propagation.

Also, the challenges of interspecific hybridization will be discussed, and the use of colchicine for the development of plants with increased chromosome number will be covered.

CULTURE AND PROPAGATION OF *ANEMONE* X *HYBRIDA*

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Propagation

Stock plants of *Anemone* x *hybrida* Paxton 'Honorine Jobert' and 'Richard Ahrens' were grown in 3.8 liter (#1) containers for 30 weeks beginning in April, and fertilized daily with a complete nutrient solution providing 10, 40, 80 or 150 mg/liter (ppm) nitrogen (N), in a constant ratio of 1 ammonium : 2 nitrate. At the end of 30 weeks (November), root cuttings 4 cm (1.6 in.) in length were harvested from the stock plants and treated with the potassium salt (K-salt) of indolebutyric acid (K-IBA) at 0, 100, 500 or 1000 mg/liter (ppm), then placed in cell packs containing a pine bark-based substrate, one cutting per cell. The containers were arranged under intermittent mist in a heated greenhouse. Overall, 91% of the cuttings regenerated a complete plant. There were cultivar differences in regeneration, and the highest K-IBA concentration was inhibitory to 'Honorine Jobert'. Nitrogen nutrition of the stock plants, K-IBA treatment of the root cuttings, and fresh weight of the root cuttings had no significant effect on percent regeneration. Time to shoot emergence was reduced by higher rates of N applied to the stock plants, and increased at the highest concentration of K-IBA in 'Honorine Jobert', but not in 'Richard Ahrens'. Dry weights of the regenerated plants increased with increasing weight of the cuttings from which they originated. They were related linearly to rate of N applied to the stock plants in 'Honorine Jobert', and quadratically in 'Richard Ahrens', with maximum plantlet weight predicted at 114 mg/liter (ppm) N. At the observed optimal rate of N applied to the stock plants, dry weights of the regenerated plants increased with increasing K-IBA concentration in a quadratic manner. Maximum plantlet weight is predicted at 459 mg/liter (ppm) K-IBA in 'Honorine Jobert', and at 425 mg/liter (ppm) in 'Richard Ahrens'.

Nitrogen Nutrition

Uniform, single crown plantlets of 'Margarete' anemone were grown in 3.8 liter (#1) containers filled with a substrate of 8 composted pine bark : 1 sand (by vol.). Plants were fertilized three times weekly for 15 weeks with a complete nutrient solution at N application rates (NARs) of 10, 40, 80, 150 or 300 mg/liter (ppm) N, in a constant ratio of 1 ammonium: 2 nitrate. All other nutrients were held constant. Leaf area, top dry weight, and root dry weight increased with increasing NAR until reaching a plateau at a NAR of 144 " 21 mg/liter (ppm), 158 " 28 mg/liter (ppm), and 119 " 30 mg/liter (ppm) respectively. The proportion of fine roots to thick roots was unaffected, and production of propagation material (root cuttings) reached a plateau at a NAR of 108 " 28 mg/liter (ppm). Leaf concentrations of N, P, and K at maximum leaf area were 4.7%, 0.5%, and 3.5%, respectively.

PROPAGATING 'GREEN GIANT' AND OTHER DIFFICULT WOODIES

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Propagating -The Good. 'Green Giant' arborvitae (*Thuja* L. x 'Green Giant') has recently found its way into production at selected nurseries. This plant is becoming increasingly popular with good reason. For starters, an exceptional growth rate (> 3 ft per year) combined with dense, deep green foliage has attracted much attention. In addition, observations in N.C. indicate white tailed deer are uninterested in 'Green Giant' as a food source. This arborvitae may be ideally suited for screening situations, as it reaches a height of approximately 60 ft with a pyramidal growth habit. Why then, has is taken 'Green Giant' (first observed in 1935) more than 60 years to become part of nursery production? Perhaps uncertainties regarding propagation and growth of a new plant have lead to some hesitation. However, there are *no* difficulties propagating 'Green Giant' by stem cuttings.

In greenhouse studies it was determined that stem cuttings of 'Green Giant' are easily rooted throughout the year with any concentration of rooting hormone. Cuttings collected in February, August, and October and treated with 0.0, 0.3, 0.6, or 0.9% IBA (indolebutyric acid) all rooted > 85% in as little as 6 weeks. The rooting medium was 2 perlite : 1 peat moss, and cuttings were placed under intermittent mist. IBA at 0.6% consistently gave the best results with 100% rooting in February. Not only do cuttings root easily, but the root system produced is large and healthy. Rooted cuttings easily produced > 10 roots per cutting that were evenly distributed around the stem. So propagators, rest at ease. 'Green Giant' will root easily, and rooted cuttings will grow rapidly, offering yet one more plant to add to the palette.

Propagating -The Bad. 'Santa Rosa' sweetbay (*Magnolia virginiana* L. 'Santa Rosa') is a Woodlanders Nursery (Aiken, S.C.) selection with outstanding landscape potential. This selection has a phenomenal growth rate (> 3 ft per year), deep green, glossy leaves, and fragrant flowers slightly larger than typical sweetbay. Unfortunately, this plant is not very common in the nursery trade due to difficulties in propagation. Propagating sweetbay is usually done in July – August, when the wood is firm and a terminal bud is present. However, shoots of 'Santa Rosa' are still actively growing at that time. These actively growing shoots of 'Santa Rosa' do not produce cuttings that root.

To determine the correct time to propagate 'Santa Rosa', cuttings were collected in February, August, and November. Cuttings from February rooted poorly, and those in August (shoots were still growing) responded even worse. November was chosen as the time when terminal growth had stopped and the wood was sufficiently firm. Cuttings were treated with all combinations of 0.0, 0.13, 0.25 or 0.5% IBA and 0.0, 0.11, 0.23 or 0.46% NAA (naphthaleneacetic acid) and placed under intermittent mist in a rooting medium identical to that mentioned above. It was determined that NAA was not beneficial to rooting. Increasing concentrations of IBA resulted in increased rooting. Maximum rooting (83%) was reached with

0.5% IBA and 0.0% NAA. The accepted practice of propagating sweetbay in July – August has proven effective for many selections, although these results indicated that 'Santa Rosa' is not just another selection. It forces us to review our procedures when a plant proves difficult to propagate.

Propagating -The Ugly. When discussing propagation of *Manglietia yunnanensis* Hu, JC Raulston wrote in his notes that not a single cutting had been rooted. Todd Lasseigne, and I have now proven this statement accurate two years running. We have failed to root even a single cutting of this evergreen member of the Magnoliaceae Juss. However, the ornamental attributes of the plant warrant further attempts. The dense oval growth habit of this plant combined with lustrous green leaves and large white magnolia-like flowers with red stamens justify additional efforts to uncover the secrets to propagating this plant.

When attempting to produce roots on a difficult-to-root plant, one key factor is reducing propagule stress. One way to minimize stress is to initiate roots before the cutting is removed. Its an old technique, but mound layering (stooling) is still very useful if the species is valuable enough or if you simply need more stock plants. Mound layering consists of cutting back the stock to the ground to encourage new shoots to arise from the base. When these shoots reach 6 – 8 in. in length they can be wounded and treated with a root-promoting compound before a rooting medium is used to cover half of the new shoot. As the new shoot continues to grow more rooting medium is added. By summer's end, the rooting medium can be pulled away. Each shoot should have abundant roots surrounding its base. Thus, roots have been produced before the cuttings are excised.

Other, more labor-intensive techniques that are reserved for only the most difficult plants are those of etiolation and banding. Excluding light from that portion of a shoot that is to become the cutting base has been shown to greatly stimulate rooting in a range of species. Stem tissue grown in the dark has a higher concentration of auxin, and reduced concentration of rooting inhibitors. Preformed root initials as well as reduced physical barriers have been observed also. Just as buds begin to expand, plants are placed in the dark. Shoots are allowed to elongate to 3 in. A 1 in. band of black velcro or aluminum foil is placed at the base of the shoot to retain that portion in the dark. The upper portion is slowly acclimated to light conditions. Once the acclimation process is complete, the shoot is treated just as any other stem cutting. This technique has been used to successfully root various species of oak (*Quercus* L.) and hornbeam (*Carpinus* L.) in high percentages.

Combined techniques of etiolation and mound layering have proven particularly useful in propagating species of oak (*Quercus* L.). Stock plants are cut back to the ground and covered to exclude light just as new shoots begin to emerge. When those new shoots reach 3 -5 in. of length, they can be treated with a root-promoting compound and covered with a rooting medium. Shoots are then allowed to grow out of the rooting medium and are treated like normal mound layers from there on. Nearly all of the oak species that were etiolated and mounded produced rooted shoots. None of the light grown shoots produced roots. These examples show that much work is needed in the field of propagation. Non-traditional methods are sometimes called-for when species prove difficult-to-root.

ENGINEERING SUPERIOR TREES THROUGH GRAFTING AND ROOTSTOCK SELECTION

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The ability to construct composite plants consisting of selected parts from different clones, species, and sometimes even different genera is both amazing and horticulturally valuable. Grafting is a specialized skill and generally more expensive than other propagation methods. Therefore, it is often considered a method of last resort when other methods prove to be inadequate. However, in addition to simply propagating plants, grafting provides opportunities for deliberately designing plants for greater adaptability, pest resistance, growth, and ornamental features.

Humans have been grafting plants for the last 3,500 years, but there is still much that is not known. The vast majority of information and experience that exists on grafting applies to the propagation and production of fruit trees. In many cases, there is specific information on rootstock characteristics (disease and insect resistance, soil adaptability, anchorage, etc.) and interactions between scions and rootstocks, often on a clone-by-clone basis, for a variety of fruit trees. Although there is generally less information available about rootstock characteristics and graft compatibility of nursery crops, we are slowly making progress. There are ample opportunities for improving many nursery crops through grafting.

Grafting can be an effective way to overcome certain limitations that a particular species or cultivar may have. Rootstocks can vary dramatically in their tolerance to soil conditions, diseases, and insects. Combining desirable ornamental traits of a superior scion with greater environmental and pest resistance of a superior rootstock can result in the creation of a vastly improved composite plant. Also, rootstocks and interstems can be utilized to introduce desirable trunk attributes (e.g. exfoliating bark) and novel forms (e.g. weeping and top-worked standards).

There are limits to which scions are compatible with which rootstocks. In general, the more closely the two plants are related, the better the chance that they will be graft compatible. However, the genetic limits of graft compatibility varies considerably among different groups of plants. Some oaks (e.g. *Quercus palustris*) may be incompatible with other clones of the same species, whereas in other cases, species from one genus can be successfully grafted onto other species from completely different genera (e.g. grafting *Pyrus* onto *Cydonia*; *Syringa* onto *Ligustrum*; *Chamaecyparis* onto *Platycladus*).

This presentation will provide a brief overview of selected grafting techniques, scion : rootstock interactions, graft compatibility, rootstock selection, and opportunities for engineering superior trees.

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NURSERY IPM SCOUTING

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Integrated pest management is a program that attempts to use all of the tools and techniques available to manage pest populations in the most effective, economical and environmentally safe manner. An IPM program is composed of many different elements, including correct pest identification, monitoring pest and beneficial populations, understanding population thresholds and management options, and evaluation. The cornerstone of any IPM program is pest scouting. Scouting is the regular examination of plants and pests in order to measure pest levels and anticipate when pest control is needed. When scouting, growers can also assess whether or not their management strategies are working.

Begin by mapping areas where scouting will occur. Most nurseries have maps available; if not, create a map. Each production block needs to be labeled. Again, most nurseries have a labeling or numbering system (often based upon the irrigation system layout). Wherever possible, use the existing nursery maps and labeling system. This ensures that reports will be clearly understood by the nursery manager or other nursery employees. Note the specific nursery crop species present in each block on the maps. The goals and objectives of Arthropod and disease scouting differ significantly from those of weed scouting. Therefore, they are discussed separately.

Arthropod and Disease Scouting

There are 5 objectives to keep in mind when scouting for arthropods and diseases

1. Determine what pests are present and their growth stages.
2. Note the presence of any predators.
3. Determine if pest numbers have reached economic thresholds and need to be treated.
4. Determine the proper time to control a particular pest.
5. Assess the effectiveness of control measures.

We recommend starting at one end of the block. A scouting block should contain no less than 100 plants. Te largest may cover an acre or more. Survey the area. Ask yourself the following questions: Do the plants appear to be healthy? Do they show good color? Are there any plants that exhibit obvious areas of infestation or disease? Also, keep in mind what a healthy plant of the species that you are scouting looks like. This way you can compare the sampled plants to this image.

Enter the block and begin walking. Stop approximately every ten to twelve paces. Examine all plants within arms reach. Randomly sample approximately 5-10 leaves from each plant (from the top, middle and bottom of each plant) for signs of pests or pest damage. Continue in this manner until you have inspected the entire length of the block. Record all of your findings on the scouting sheet. If you encounter any "hot spots" (high problem areas), record these areas on the scouting form and scout them more intensely. These areas can be early warning signs of problems to come. It is a good idea to mark hot spots with flagging tape or flags to make them easier to find.

While scouting container nurseries during the 1999 season, some of the more common insect and disease pests encountered included: powdery mildew, Japanese beetle, azalea lace bugs, aphids, leafminers and flea beetles.

Weed Scouting

The goals and methods of weed scouting differ from those used for arthropods and diseases. The main objective is to build an inventory of weed species present, and note their relative importance in the production system. Determining exact population levels is not required. These data will enable the nursery pest management operator to continually monitor the effectiveness of the weed management program and to make appropriate adjustments and changes, as well as identifying key weed species,, that are escaping control.

Walk the entire area to determine weed distribution, the first time a nursery block is scputed. In subsequent scouting events, this can be done from the perimeter of the bed, even from a vehicle with periodic stops to spot check the interior of the blocks for weeds that are not visible from the edges. We recommend a uniform pattern of scouting. Walk each edge of the block and through the center. The number of passes through each block will depend upon the uniformity of plant materials, size of the plants and how much they block your view of adjacent pots, and the size of the blocks.

In each scouting event, build an inventory of weeds present. Highlight the "most important" weeds, which are:

* most prevalent
* perennial
* noxious
* new weeds
* weeds that are escaping control methods

Also, look for patterns. Are weeds spread evenly throughout the block, or are they found only in specific areas (clumps)? These patterns could be indicative of non-uniform herbicide application or weed seed spread.

Liners should be scouted before they are potted. Established and carry over plants should be scouted before cleanup, prior to preemergence herbicide application. Production areas should be scouted for weeds at least three times a year: spring, early to mid summer and early to mid fall.

Spring: scout any established plants to determine which weeds are escaping fall herbicide programs, as well as winter annuals that may have germinated during the cool season (after the herbicide has run out).

Summer: any summer annuals escaping herbicide control can be identified and controlled using selective post-emergent herbicide or cultivation. Also, it is possible to determine which winter annuals persisted throughout the season.

Fall: early fall, is preferred, before frost has killed the summer annuals ,then it is easy to identify summer annual and perennial weeds or which escaped control procedures. It is

also possible to identify many winter annual seedlings. The result of autumn scouting is useful for evaluating the effectiveness of your overall weed management program.

Weed scouting results should provide insights into the effectiveness of the overall weed management program and enable the nursery manager to answer these crucial questions: Are current herbicides working? Are the weeds susceptible to the herbicides being used? If so, why have the weeds not been controlled? If not, are there alternatives which would be more effective? What new weeds were encountered ? Will they be controlled by my weed management program? How were these new weeds introduced? Are there opportunities to reduce weed introduction? If each of these questions is asked and answered, then the scouting program has been a success and weed management programs will be improved. However, with every change in a weed management program (or in the production system) – different weeds will emerge as "important". Therefore, weed scouting, like other pest scouting, is an on-going effort, that needs to be institutionalized into the nursery pest management program.

The information provided here is intended only as an overview. To get more information consult the references listed below.

Sources for More Information

Weeds of Southern Turfgrass		Weeds of the Northeast
Publication Distributions Center		Cornell University Press
IFAS Building 664, P.O. Box 110011		P.O Box 6525
University of Florida		Ithaca, NY 14851-6525 ($29.95)
Gainesville, Florida 32611 ($8.00)		

Handbook of IPM for Turf and Ornamentals		Diseases and Pests of Ornamental Plants, 5th ed.
Edited by Anne R. Leslie. 1994		By Pascal P. Pirone, 1978
American Nurseryman ($79.95)		American nurseryman ($79.95)

Scouting and Controlling Woody Ornamental Diseases in Landscapes and Nurseries
Prepared by Gary W. Moorman
Publications Distribution Center, The Pennsylvania State University
112 Ag. Administration Bldg.
University park, PA 16802-2602
Phone: 814-865-6713 ($7.00)

INSECT PEST MANAGEMENT IN THE NURSERY

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Nurserymen are concerned with producing plants free of noxious insects, diseases, and weeds to satisfy inspection standards set by the Department of Agriculture and customer standards. Several methods of insect and mite suppression should be considered in woody plan production: cultural control, biological control, and chemical control. Sometimes these concepts are integrated into a pest suppression scheme called Integrated Pest Management or IPM. The goal of IPM is to reduce pests to tolerable levels using those pest control practices that are environmentally safe and not too time consuming or too expensive. IPM differs from traditional pest control in two ways: 1) rather than applying chemicals preventatively or by a calendar date, plants are scouted or examined at regular intervals to detect pests and to determine if and when pest numbers become abundant enough to warrant some sort of control measures, and 2) aesthetics may be more important than plant health in deciding when to treat and what method to use. The pests considered in IPM of woody ornamentals are similar to row crop IPM: insects, mites, nematodes, vertebrates, diseases, and weeds. This program addresses insect and mite control on woody ornamentals.

An IPM program includes scouting, record keeping, and suppression techniques. To scout effectively depends upon correct identification of the pest involved. Knowing the biology of pests helps in choosing a suppression technique. Several publications help identify insects and mites. Record keeping of pesticide applications is required by law,. But ,these records also reveal whether or not a certain pesticide works and will provide a data base to predict when a pest may appear in a landscape or nursery. Suppression techniques include cultural control, biological control, and chemical control.

Identification and Biology. Publications helpful for identifying pests include the *Golden Guide to Insects*, *Golden Guide to Insect Pests*, and *Golden Guide to Butterflies and Moths.* These relatively inexpensive publications are filled with wonderful color illustrations. The North Carolina Cooperative Extension Service has published Insect and Related Pests of Shrubs. Johnson and Lyon's Insects that Feed on Trees and Shrubs is an excellent reference with full-page color photographs on almost every other page.

The azalea lace bug, azalea stem borer, climbing cutworms, rhododendron borer, and southern red mite are important pests of azaleas in the Southeast. Bagworms, spruce spider mite, juniper scale insect, and juniper tip dwarf mite are important pests of junipers. Ambrosia beetles, including the Asian ambrosia beetle and black twig borer, seem to be the primary pest of tree saplings in nurseries. Aphids (including the white pine aphid), adelgids, pine spittlebugs, pine webworm , Pityogenes ambrosia beetle and redheaded pine sawflies are important pests of pines in the Southeast.

Suppression techniques. Cultural control includes choosing proper plants, host plant resistance, pruning, raking, excluding, trapping, and using irrigation as well as maintenance of healthy plants. Biological control includes the Bacillus thuringiensis (*Bt*) pesticides and the use of predators such as parasitic nematodes. Chemical controls are important in most landscape and nursery IPM programs. Insects, mites and slugs can be treated after the pest is already in the landscape. Nematode and root and stem disease pests must be treated before plants are introduced into the landscape or nursery. In other words, some pests can be corrected and others must be prevented to avoid extensive plant damage. Choices range from environmentally soft pesticides (soaps, oils, neem seed extracts) to traditional petrochemical pesticides (chlorinated hydrocarbons, organophosphates, carbamates and pyrethroids). If used properly, these latter pesticides are not particularly damaging to the environment. However, traditional petrochemicals may cause unacceptable environmental consequences, if used to excess or carelessly,.

Remember, coverage and timing often are more important than the pesticide chosen for an insect or mite control program. In all cases, read the label on the pesticide container and follow all instructions to make sure you comply with the law. Rational pesticide use does not constitute a threat to the quality of our environment. Informed nurserymen can use many horticultural practices and pesticidal treatments to enhance the vitality and quality of nursery crops.

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NEW WEEDS IN NORTH CAROLINA NURSERIES: IDENTIFICATION, SPREAD AND MANAGEMENT

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When in comes to weeds, we are sometimes our own worst enemies. Many of our most troublesome weeds have been introduced with nursery stock purchased from other regions (and other countries). Familiar examples include the introduction of common groundsel (*Senecio vulgaris)* and liverwort (*Marchantia*) into east coast container nurseries in contaminated nursery stock from the west coast. Once established in a nursery, these species are there to stay! Current practices in the nursery industry involve the transport of liner stock and finished plants across the country,a system that facilitates the rapid spread of weeds. In the southeastern US, we are particularly concerned with the introduction of tropical and sub-tropical species in liners produced in the gulf coast states. Recent introductions from those areas include mulberry weed, nodding spurge, garden spurge, mulberry weed and two species of phyllanthus. Additionally, North Carolina nurseries have seen occasional introductions of a noxious weed, *Rorippa sylvestris*, in contaminated herbaceous perennials from Northern Europe. Each of these species is described separately.

Doveweed (*Murdannia nudiflora;* formerly *Aneilema nudiflora)*:

A prostrate, somewhat grass-like, summer annual in the dayflower family, often forming a dense mat. Leaves are, alternate and clasping the stem with a sheath, 2 to 4 (up to 5) inches long, about 1/2 to 1/4 inch wide, pointed, with parallel veins;. Stems are succulent, trailing, and rooting at nodes. Purplish 3-petalled flowers (like *Tradescantia*, only smaller) occur in loose groups from mid-summer to fall.

Doveweed is propagated exclusively by seed but once established it can spread by trailing stems. Seeds germinate in early summer, generally in drainage ditches or heavily irrigated beds. Doveweed gets into pots when nearby plants grow erect along the edge of pots and drop seeds into the pots, or when infestations are allowed near potting substrate storage areas. Otherwise, this plant should not find its way into containers. We have not found a truly effective herbicide.

Preemergently, products containing oxyfluorfen (OH2, Rout, & Regal O-O) have provided adequate control for ~6 weeks. No postemergence herbicide labeled for use in nurseries has provided adequate control. Spot spray with Gramoxone, Diquat or Finale when seedlings are visible. Roundup-Pro has not provided satisfactory control. Sanitation is the key to managing this weed. Prevent plants from going to seed. Eradicate small infestations before they can spread.

Yellow fieldcress *(Rorippa sylvestris)* ** North Carolina Class B Noxious Weed ****.**

Also known as yellow cress and creeping yellow-cress, yellow fieldcress is a spreading perennial. The young plant forms a basal rosette of deeply divided leaves. The plant elongates to a branched, erect plant 8 inches to 2 feet tall in late spring, and flowers from spring through summer. On mature plants, alternate and smooth compound leaves are up to 6 inches long at the base but shorter on the upper portions of the plant. Leaves are finely cut (pinnatifid), usually with 8 to 11 large-toothed, spear-shaped leaflets (lobes) and a terminal lobe. Flowers are typical of the mustard family, with 4 small yellow petals, 4 green sepals, and 6 stamens. Yellow fieldcress is very similar to marsh yellowcress (*R. islandica*), a winter annual in NC with a slender taproot, but no rhizome-like spreading roots. Yellow fieldcress is the only *Rorripa* species that has petals longer than the sepals. Yellow fieldcress spreads by seed and creeping fleshy roots that produce new plants. Infestations in nurseries usually begin with introduced plant materials that are contaminated with either seed or pieces of the creeping root. In NC nurseries, I have found yellow fieldcress commonly in potted herbaceous perennials that were imported from northern Europe.

Although little research has been published on its control, yellow fieldcress can be controlled preemergently by most herbicides which are effective on mustards, including triazines, Gallery (isoxaben), and dinitroanilines. Established plants can be controlled in some nursery stock with Casoron (dichlobenil). Roundup-Pro and Finale should provide control of emerged plants. Sightings in North Carolina should be reported to the NCDA, Plant Protection Section (1-800-206-9333)

Mulberry weed ; hairy crabweed. (*Fatoua villosa*)

Mulberry weed is an erect, branched summer annual in NC (but may be a perennial in the deep south) resembling a young mulberry seedling, but with a hairy stem. Leaves are alternate, roughly triangular in outline with prominently toothed margins. Flowers are in feathery clusters, up to 3/4 inch in diameter, in the leaf axils. Flower clusters are purple when young, fading to dark brown with age. Mulberry weed was introduced this century from eastern Asia. Earliest herbarium specimens are from 1964. It is now established in several locations in Ohio, the Southeastern US from North Carolina to Florida and west to Texas and Oklahoma, California and Oregon. It is almost exclusively a weed of container nursery crops and landscape plantings in N.C. Plants reproduce by seed. Plants are prolific seed producers and may initiate flowering when quite young, by the three-leaf stage of growth. Seeds mostly are dropped near the mother plant, but some fruit are explosively dehiscent, throwing seeds up to 4 feet away. Plants can have at least two generations per season, probably many more.

Mulberry weed appears to be controlled by several of the broad-spectrum preemergent herbicides commonly used in nursery stock (see Table 1), but apparently “breaks through” early. Prevent introduction as much as possible. Inspect liner stock for this weed. If found in liners, remove the top 1/2 inch of media before potting. Destroy contaminated debris. Control the weed around propagation and liner areas with pre- and postemergence herbicides. Postemergently, Gramoxone (paraquat) has provided better control than other herbicides tested.

Chamberbitter (*Phyllanthus urinaria*) and longstalked phyllanthus (*Phyllanthus tenellus*):

Both chamberbitter and longstalked phyllanthus are members of the Euphorbiaceae, Spurges are in the same family. However, these plants more closely resemble some lespedezas than spurges. They are erect summer annuals (in NC) that germinate from early summer through early fall. Seedlings of these species are very similar. Leaves are smooth, wider at the tip and taper to the petiole. Leaves are alternate and arranged in two rows on slender branches, creating the illusion of compound leaves. Flowers are very small and formed in the axils of the leaves. Plants are differentiated by mature growth habit and seed capsules. Longstalked phyllanthus has a slender, erect growth habit. Seed capsules are borne on stalks that are about _ as long as the leaves. In contrast, chamberbitter is more branched, with a more stout stem, and seed capsules are borne in the axils of the leaves (no stalks). They are commonly introduced in liner stock produced along the gulf coast.

Both species of phyllanthus are controlled by nursery herbicides that contain oxyfluorfen (OH2, Rout, Regal OO). There have been conflicting reports on control (or lack there of) with Ronstar and dinitroaniline herbicides. Our research suggests that Snapshot TG, Factor, Pendulum do not control either species. Surflan has controlled both species.

Nodding and Garden Spurge (*Euphorbia nutans* and *Euphorbia hirta*, respectively):

The presence of spurges in container nurseries is a common thing. However, we have seen in the past two years an increase in the incidence of two relative newcomers nodding spurge and garden spurge. Nodding spurge has been in the state for quite some time, but we did not see it in container nurseries until recently. Garden spurge has recently been introduced and may have the potential to spread faster that other spurges. Like all spurges, both nodding and garden spurge have a milky sap. Also, both have erect stems with opposite leaves. Nodding spurge looks like the familiar spotted spurge, but, larger and more erect. Garden spurge has lighter green leaves with pointed tips and shallowly toothed margins. Both are summer annual weeds, germinating in early summer though early fall. While both have multiple generations per year, garden spurge appears to have an effective mechanism for seed dispersal, germinates faster than other spurges, and produces seed at a younger age. While this weed is common in the coastal south, it has now spread as far north as New York via contaminated nursery stock to nurseries.

Fortunately, our research has shown that both nodding spurge and garden spurge are controlled by the same herbicides that are effective on prostrate and spotted spurge. See Table 1. The dinitroanaline herbicides appear to be particularly effective.

Management of introduced species.

The two most important components of an effective management program for introduced species are (1) early detection and identification, and (2) sanitation. While no nursery manager can know every plant that could possibly infest his or her nursery, each nursery has a spectrum of weeds that are common. Learn to recognize these weeds that are already on-site, AND be able to recognize when a new species in introduced. If at all possible, eradicate infestations of new weeds by intensively managing small infestations (yes, that may sometimes mean hand weeding and disposal). If this is not possible, conduct a little research to determine if this species has the potential to spread and become more troublesome in your nursery. Preemergence herbicides are available to control most of these species; although, they are so new

to the industry that they do not appear in many herbicide labels or extension publications. Table 1 provides rankings on the effectiveness of some common nursery herbicides on these weeds. These rankings are based on results of research conducted at NCSU and elsewhere over the past three years. Using this (and similar) information, plan a weed control program that will control these invaders. Your local cooperative extension office can provide assistance in developing this management plan.

Table 1. Relative effectiveness of common nursery herbicides on some new weeds

Herbicide	Doveweed	Mulberry weed	Spurge, garden	Spurge, nodding	Phyllanthus
Scotts OH2	Fair	Good	Good	Good	Fair to Good
Rout	Fair	Fair	Good	Good	Fair to Good
Snapshot	Poor	Poor	Poor	Poor to fair	Poor to Fair
Regal O-O	Fair	Fair	Fair	Fair	Fair
Ronstar	Poor	Fair	Fair	Fair	Fair