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Fast Tracking Color Crops: Does Fertilizer Count?

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Introduction: A significant portion of the container nursery industry has become devoted to "color." "Color" has come to mean any plant that can be grown from start to finish and sold in one season. Therefore, color can mean annual flowers and foliage, herbaceous perennials, ornamental grasses and rapidly growing woody plants. Color plants are all destined for use via garden center and landscape sales with hopes for stimulating impulse buying by the retail customer or a sense of instant gratification, i.e., color, in the landscape.

Color crops are most often purchased as "plugs" or small liners/transplants early in the growing season, potted into the container in which they will be sold and fertilized either with a controlled release granular fertilizer (CRF) or a completely soluble fertilizer. In most nurseries that would normally be growing shrubs and trees, the color crops fertilizer of choice has been a controlled release fertilizer (CRF) or weekly feeding with a completely soluble fertilizer until plants are ready for sale.

Controlled Release vs. Liquid Feed: Research conducted at MHCRS, Fletcher in 1999 and 2000 compared CRFs from 4 different companies applied once at the beginning of the experiment with completely soluble fertilizers applied weekly. Fertilizers were applied at three rates such that all plants were fertilized by a rate that was calculated to provide the same amount of nitrogen per pot per month from different sources for each tests species, i.e., we tried to provide a level playing field so each fertilizer was evaluated at the same nitrogen application rate.

CRFs consistently produced the best growth, regardless of the company providing the fertilizer. In 2000, we compared Multicote 17-17-17 and Wilbro 19-5-12 applied at the rate of 1.5#N/100 sq. ft./month with the same rate of Plantex 20-20-20 applied weekly. Twice as much above ground growth of *Buddleia* 'Pink Delight,' 2.5 times as much *Echinacea* 'Bright Star' and 1.5 times as much growth in *Pennisetum orientale* was measured as fresh weight at the end of the experiment from CRF fertilization.

Wulpak: In 2000 tests, when the processed wool fiber product Wulpak was applied at rates calculated to provide the same amount of nitrogen as the standard fertilizer products, the CRF fertilized plants produced from 200 to 400% more growth during the experiment as those receiving only Wulpak. Data indicated that available nitrogen from Wulpak was released during the first two weeks of the experiment. Observations were that, for some species, a superior root system seemed to develop where Wulpak was top-dressed, presumably because of temperature and water stress modification by Wulpak as a mulch.

In 2001, research conducted with Wulpak alone and in combination with CRFs revealed that Wulpak provides some fertilizer value along with mulch value. Mulch may help to retain moisture, maintain a cooler rootball and suppress weeds. None of the mulching values were measured, only the fertilizer implications, but it is impossible to separate moisture and temperature from fertilizer performance so we report what happened and do not speculate as to

why it happened. When Wulpak is used alone, equivalent growth to about that achieved when 0.25 times the standard controlled release fertilizer treatment was achieved.

If a grower is using Wulpak for mulching value anyway, no more than the 0.5 rate of controlled release fertilizer needs to be used for *Buddleia* 'Nanho Purple' and no more than 0.5 rate should be used for *Eupatorium fistulosum* 'Carin.' However, when growing the ornamental grass *Panicum virgatum* 'Prairie Skies,' the full rate of CRF application with Wulpak resulted in increased growth over the full CRF rate alone. Therefore, a higher application rate of the CRF may be worth exploring.

Conclusions from 1999, 2000, and 2001 Research: A one time application of controlled release fertilizer top dressed at the medium suggested application rate provided superior growth on color crops over weekly applications of a complete, soluble fertilizer. Similar results were obtained when the controlled release fertilizers tested were Osmocote, Multicote or Wilbro and the completely soluble fertilizers were Excel or Plantex.

These results suggest that if a liquid fertilizer program is adopted at nurseries growing color crops under conditions similar to those at MHCRS, Fletcher, either more fertilizer in weekly applications or fertilizing more frequently with the soluble fertilizer will be required to achieve growth equal to that seen when CRFs were used. However, neither higher application rates nor more frequent fertilization was tested so this is just speculation.

Wulpak alone does not provide adequate nutrients for growing these crops. However, if Wulpak is used the rate of CRF application can be reduced.

Plants evaluated over the 3 years of the test include: *Buddleia* 'Dartmoor', 'Pink Delight' and 'Nanho Purple'; *Coleus* 'India Frills'; *Echinacea purpurea* 'Bright Star'; *Eupatorium fistulosum* 'Carin'; *Helianthus angustifolius* 'Gold Lace'; *Panicum virgatum* 'Cloud Nine' and 'Prairie Skies' plus *Pennisetum orientale*.

Foliar Nematodes: Are These a Problem Worming? Their Way into Your Nursery?

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A 400% increase in the number of ornamental plant samples diagnosed with foliar nematodes (Aphelenchoides spp.) was recorded between 1990 and 2000 at the North Carolina State University Plant Disease and Insect Clinic. Foliar nematodes are expected to become an even larger problem due to extremely limited management options available for control. Nematicides based on nervous system blockers were removed from the US market several years ago due to toxicity issues, as well as the threat of groundwater contamination. As a result, there are currently no registered pesticides labeled for the control of foliar nematodes on established ornamentals in North Carolina. This is of particular concern because greenhouse and nursery crops are especially susceptible to foliar nematodes, and the introduction of nematode-infested material (on cuttings, seedlings, and other vegetatively propagated material) often results in rapid spread of the nematode.

Unfortunately the detection of foliar nematodes can be problematic because infested plants may not show symptoms until late summer or early fall when nematode populations reach their highest levels, or, the symptoms present may not be recognized as foliar nematode damage. Therefore, infested material may be unknowingly propagated or shipped to other locations.

Abelia, Viburnum, elderberry, Buddleia, and Heuchera are among the 270+ known plant species that are susceptible to attack by foliar nematodes. This presentation will familiarize you with plant symptoms associated with foliar nematodes, discuss the biology of these pathogens, and look at possible control measures.

Mugwort (*Artemisia vulgaris*) Control in Field-Grown Nursery Crops

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Mugwort, *Artemisia vulgaris L.*, is a rhizomatous perennial weed common in field grown nursery crops, landscape plantings, and turfgrass. The primary means of introduction into landscapes is in the root balls of contaminated nursery crops. From these introductions, rhizomes spread to adjacent plantings and turf. Once introduced, mugwort is very difficult to control; it is spread by cultivation, tolerates mowing and is not controlled by standard preemergence herbicide programs. Additionally, postemergence herbicides have not provided adequate control. Despite the frequent use of Roundup in nursery crops, mugwort persists.

Persistent rhizomes make mugwort difficult to control in perennial crops. Standard recommendations for control include late summer or early fall applications of glyphosate (Roundup-Pro, Glyfos, Touchdown Pro, others) or winter applications of dichlobenil (Casoron or Barrier). Casoron has controlled mugwort in field nursery crops and landscape plantings. Casoron is a soil-applied herbicide that must be used in the winter months. If used in the spring or summer this volatile herbicide will vaporize rapidly and not provide acceptable weed control. The soil residual will prevent mugwort from coming up through early summer after which time some plants will re-sprout. Casoron is relatively expensive and can severly injure newly planted nursery crops and some established species. In particular hemlocks are quite sensitive.

Spring and summer applications of Roundup-Pro have not provided adequate control of mugwort. Most control guidelines emphasize the importance of late summer or early fall applications. At that time of year the herbicide translocates to the roots and rhizomes more effectively. However, if you wait until August to spray – the weeds may be five to six feet tall making selective applications in nursery crops difficult or impossible. Early season treatments can keep the mugwort from growing so tall, but Roundup can be more injurious to evergreens when applied early in the growing season.

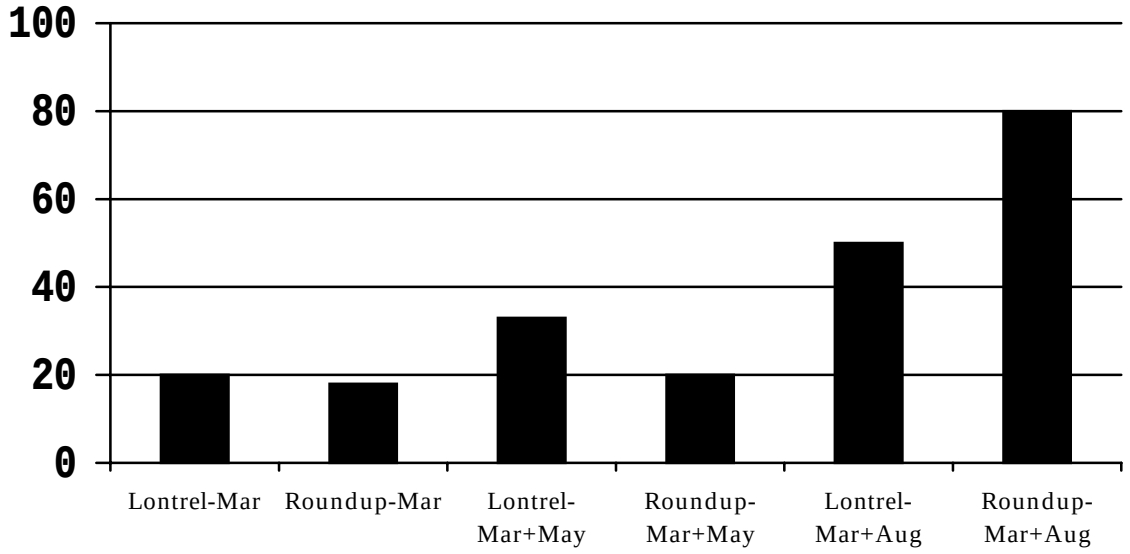
Other researchers have shown that clopyralid (Lontrel) may be effective on mugwort. Lontrel is a selective herbicide that controls plants in the legume and aster families (mugwort is in the aster family), with little or no injury to most evergreens. We conducted a series of experiments to compare Lontrel and Roundup-Pro for mugwort control in field nursery crops.

Two experiments were conducted, one in 1998-1999, the second in 2000. Each year the herbicides and application rates were: Lontrel (clopyralid) at 0.25 lb ai/A and Roundup-Pro (glyphosate) at 2 lb ai/A. Herbicides were applied with a CO2 pressurized backpack sprayer calibrated to deliver 30 gallons per acre. In 1998, herbicides were applied singly in May or August, and sequentially in May plus August as directed applications in a two-year old planting of Callery pear (*Pyrus calleryana*). In May mugwort was 6 to 24 inches tall; in August mugwort plants were up to five feet tall and flowering. Since single applications in August to five-foot tall weeds are impractical, this treatment was dropped from the 2000 test. In the 2000 test, herbicides were applied singly in May to three-inch tall weeds (early-post (EPO), EPO and again four weeks later, or EPO and again in August. In 2000 herbicides were applied as

directed applications to two-year old 'Green Giant' arborvitae (*Thuja plicata* 'Green Giant'), contacting the lower 12 inches of the foliage. Weed control was visually evaluated on a percent scale where 0 = no control (equal to the untreated plots) and 100 = complete control. Plots were evaluated periodically through the first season and again the following spring.

Results Evaluated in the spring of 1999, the August 1998 application of Lontrel provided no mugwort control whereas the spring treatment provided 32% control. Two applications (May plus August) of Lontrel, provided about 50% control, which was equivalent to one application of Roundup-Pro in either May or August. Two applications of Roundup-Pro provided over 90% mugwort control. Similar results were observed in 2000, where two applications of Lontrel, regardless of the application interval, provided about 60% control. As in the first test, mugwort control with two applications of Roundup-Pro was greater than 90%, regardless of the application interval (See Figure 1). 'Green Giant' arborvitae sustained slight injury to from directed applications of Roundup-Pro in May and June. However, the injury was limited to contacted foliage. No injury was observed from Lontrel applications. No injury to two-year old Callery pear was observed from directed applications of either herbicide.

Figure 1. Percent mugwort control (evaluated in June 2001) following treatments in March, May and August 2000.



Mugwort continues to be a difficult-to-control weed of field nursery crops and landscape plantings. This research suggests that two applications, spring and summer, of Roundup-Pro can provide greater than 80 to 90% control; however, care must be taken to avoid contact with the foliage of desirable plants. Where Roundup-Pro cannot be used, multiple applications of Lontrel will provide some suppression of mugwort with less potential for damage on conifers. Winter applications of Casoron are another effective alternative that can be used in established, tolerant crops.

I Can See Clearly Now The Weeds Are Gone!

Joseph C. Neal
North Carolina State University

Managing weeds in field nursery crops is essential to economic production of a quality crop. Yet, maintaining 100% bare ground is not desirable for many reasons. Therefore, the goal of a nursery weed management program is to reduce or eliminate in-row competition with the crop and to maintain a non-competitive between row vegetation that provides the benefits of field access and erosion control. This is accomplished by managing the crop row quite differently than the area between the rows. In-row weed control is maintained with pre and/or postemergent herbicides, often supplemented with cultivation. Between-row areas are maintained by mowing, cultivation or chemical suppression (chemical mowing or growth regulators).

In-row vegetation management.

There are two basic strategies of in-row vegetation management relying either on preemergence or postemergence herbicides. The *preemergence strategy* involves properly timed applications of residual herbicides for summer annual and perennial weed control, supplemented with spot applications of postemergence herbicides. This strategy has been the standard of the nursery industry for many years. Herbicides often used in such a system include Gallery (isoxaben) or Princep (simazine) for residual broadleaf weed control, combined with a "grass" control herbicide such as Surflan (oryzalin), Pendulum (pendimethalin), Barricade (prodiamine), or Pennant (metolachlor). Gallery is often used on newly planted nursery crops, on the few field-grown species which are injured by Princep, or when Princep resistant weed populations are present. Princep is less expensive and more widely used for preemergence weed control in field nursery crops. Pennant is used when yellow nutsedge is present in the field. Otherwise one or the other three grass herbicides is typically chosen because they tend to provide longer residual control.

The total *postemergence strategy* is gaining popularity among producers of field grown trees. In this strategy a non-selective, postemergence herbicide, such as Roundup (glyphosate), Finale (glufosinate), or Gramoxone (paraquat), is applied as a directed spray (avoiding contact with foliage or green stems of the crop) on an as-needed basis. A typical schedule will involve between three and five applications per year. The simplicity and low cost of this option is attractive to many growers. However, applications must be carefully applied to avoid crop injury. Research and grower experience has shown than any of these herbicides can be chosen but we have found that Gramoxone and Finale tend to be more injurious on conifers than Roundup. However, spray drift or mis-applications of Roundup that contact the foliage of the crop have a greater potential to translocate and cause severe crop damage.

Either system can work. The grower needs to make the decisions about which system best fits the nursery crops being grown, soil and environmental conditions at the nursery, available trained labor pool for herbicide applications, and the grower's own tolerance of weed cover. Certain particularly difficult to control weeds may necessitate adjustments to either program.

Between Row Vegetation Management.

Between the crop rows it is desirable to maintain some vegetation. Exactly what this vegetation is – your crop does not care, as long as you keep it between the crop rows and don't

let it encroach. Grasses are generally easier to maintain than broadleaves. Fescue, bermudagrass, and orchardgrass are often maintained between crop rows by mowing. An alternative to mowing is sometimes termed “chemical mowing” or “sod suppression”. If sod suppression is chosen: first treatments are applied in the spring when new growth is about 4 to 6 inches tall. Reapply as regrowth reaches 4 to 6 inches. If vegetation gets taller, it may be mowed and regrowth treated. Products used for chemical growth suppression include a combination of 8 to 16 oz Goal + 8 to 16 oz Vantage per acre (the higher rate for heavier more competitive vegetation, lower rate for less competitive, younger vegetation). Another alternative is carefully directed applications of Roundup-Pro, 8 to 12 oz per acre has been used successfully in mountain conifers but has not been widely tested in Eastern NC.

What's Quality for a Plant Grown in a BIG CONTAINER?

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Do you know quality when you see it? What are the characteristics that bestow perceptions of quality to landscape trees and shrubs grown in containers. Are the perceptions of quality the same for everyone, for example, landscape and nursery professionals compared to home owners?

Research has shown that professionals and consumers tend to think alike. Both groups prefer symmetrical round or conical shapes versus asymmetrical lopsided shapes for most container plants used for traditional functions in the landscape. Shrubbery with full compact canopies without obvious structural defects, openings, damaged branches, off color foliage or sparse growth are preferred. Most perceptions related to quality also suggest that plants not be root bound, however this quality is seldom investigated until they are planted in the landscape.

Large container grown trees are frequently the most expensive plant material used in new landscapes and the most expensive for growers to guarantee and replace. Therefore, the first measure of quality is how well the roots grow and become established after it is removed from the container. The growers responsibility in landscape establishment is to sell a well developed root system, distributed throughout the container. To accomplish a quality root system, the grower must make the right choices of potting substrate, fertilizer strategies and irrigation.

The potting substrate for 15 gallon and larger containers is most often a pine bark : sand potting mix. Ratio's of 6:1 or 8:1 pine bark : sand are popular. Sand as a potting mix component adds weight, and provides anchorage to reduce blow over from wind gusts. Beyond anchorage, the major role of container substrates is to provide a reservoir of water and nutrients for root absorption, plant survival and growth. A red maple with a large canopy in mid summer can easily utilize all of the available water in a 15 gallon container. Analysis of physical characteristics of a 6 pine bark: 1 sand (v/v) potting mix consistently indicates that approximately 30% to 35% of the volume of the substrate is available water content. Therefore, at least 5 gallons of water may be required per container to avoid water stress on a hot day in July for a crop of red maples. Deciduous crops tend to have the highest water requirements during the growing season, followed by broad leaved evergreens and then conifers, however there are many exceptions and each crop may require it's own irrigation strategy based on the moisture retention characteristics of the potting substrate. One criticism of pine bark and sand substrates is that they have high aeration characteristics and hold too little available water content. However, many experiments have illustrated that substrates with high air space characteristics and less water holding capacity produce larger plants than substrates with high water holding characteristics and limited air space, if irrigation is not limiting. Therefore, if irrigation is applied frequently such as would be practiced with cycled irrigation, rapid plant growth is expected.

Some growers are experimenting with addition of 5% to 10% soil (by volume) to pine bark for growing large container plants. Soil may not increase weight as much as sand however,

increased available water content and nutrient retention may result. The key to adding soil will be increasing moisture retention without limiting aeration in the substrate and using irrigation practices that coincide the substrate. Traditionally, if soil is used in potting substrates, it should be sterilized to reduce disease, nematode and weed infestation problems. A possible alternative may be to mine soil well below topsoil layer. Soils from the B-horizon, harvested 6 feet to 10 feet below top soil might be less likely to be infested. There is great variability in the chemical and physical characteristics of B-horizon soils and their contributions to potting substrates will vary from location to location. Experiments are underway at N.C. State on use of commercial soil products with known particle size and chemical characteristics as soil additions to pine bark substrates. Results of these studies can be compared to other experimental studies with various B-Horizon soil : pine bark combinations. The intent of each study is to determine the potential for use of soil as an ingredient in larger container potting substrates. Ultimately, striking the right ratio of aeration and moisture retention matched to the irrigation will be necessary for success.

Overhead sprinkler nozzle irrigation is a very inefficient method to apply water to plants in large containers. Much of the water from sprinklers is deflected by the canopy of container plants and does not enter the container. This practice leads to dry spots in the potting media and eventually hydrophobic conditions in the substrate that shed water rather than absorbing water. Ultimately, poorly distributed root systems develop in the containers. Irrigation of large containers is most efficient using low volume / low pressure spray stakes. Spray stakes with application rates of 5 to 15 gallons per hour are preferable to drip or trickle nozzles with flow rates of 1 to 5 gallons per hour. Drip or trickle nozzles simply cannot supply water fast enough to replenish up to 35% of the container volume each day. Irrigating containers using multiple applications throughout the day (cycled irrigation) is a good irrigation strategy. Multiple irrigation cycles maintain near maximum available water content and assist crops to continue growing rather than closing stomates and undergoing water stress. Container plants in 15 gallon size and up generally benefit from more than one spray stake per container for two reasons. First, water distribution is frequently blocked by the stem of the plant creating a dry spot opposite the stem. Secondly, water movement laterally across pine bark media in the container is very limited so only the column in the spray stake pattern is sufficiently moistened. Distribution of irrigation water for thorough irrigation has a great influence on the quality of root system developed in the container.

Growers need to ensure that 13 essential nutrient elements are available for plant growth. However, some nutrients may be provided in sufficient quantity by irrigation or from the substrate. For example, irrigation supplies frequently contain significant amounts of calcium and reduce or replace calcium supplied by the addition of dolomitic limestone. Secondly, if soil is used as a potting component, supplementing the substrate with a minor element product may not be necessary. A complete laboratory nutritional analysis of irrigation water and the substrate is necessary to determine what nutrients need to be supplemented for optimal plant growth. Most growers producing plants in large containers use controlled release fertilizers (CRFS) for at least part of their fertilizer program. CRF's can be applied in one or combinations of four application techniques. Incorporation of CRF's at potting is an efficient means of getting distribution of the fertilizer throughout the potting substrate, however this practice may be limited to nurseries with mixing equipment. A second method might be to fill part of the container with potting mix, add a layer of CRF, place the plant into the container and continue filling the container to finish planting. Surface application or topdressing CRF can be used as the only application technique or it can be used in combination with the layer method or as a

means of re-applying fertilizer to containers incorporated with fertilizer. A fourth application technique might be described as drill and fill or punch bar technique where a column or columns of CRF is applied adjacent to the root ball after drilling or punching a hole in the backfill of the container mix. In addition to CRF application, soluble liquid fertilizer application can be applied through the irrigation nozzles as a supplement or as the sole nutrient application practice.

The pool of nutrients available for adsorption and subsequent growth of container crops must be soluble and contained in the liquid solution held by the container substrate. For a grower to understand the nutrient status, this liquid solution must be extracted and analyzed. Obtaining liquid solution or leachate from large containers is a greater challenge than using the Pour Thru Extraction Technique, since it is difficult to lift the container and collect leachate from drainage holes. However, equipment is available for extraction of solution from large containers. Soil water samplers, called suction cup lysimeters, are available for extracting nutrients from large containers (5 gallon and above). The samplers are installed to the bottom of the container and left in place for periodic sampling of the water in the container. The sampler consists of a porous ceramic cup attached to the bottom of a sampling tube. One to two hours following irrigation a vacuum pump is used to create a vacuum in the sampler, which draws water from the container through the ceramic cup and into the sampler. Adequate water collects in the sampler in 5 to 10 minutes which can be withdrawn with a syringe for subsequent EC, pH or a complete nutrient analysis. Three or four water samplers should be installed within a block of plants of similar size and nutrition. Additional information, cost and information to order suction cup lysimeters can be found at the following webpage: http://www.soilmoisture.com/horticulture.htm

Irrigation practices, nutrient application strategies and characteristics of container substrates are inseparable regarding their influence on development of the hidden indicator of quality; the root system of plants grown in large containers. The ability to manage all three in concert determines how successful a grower will be in bringing crops to sale and satisfying customers on their performance after sale.

The top of the plant, the canopy is the obvious visual indication of quality. Knowledge of pruning, staking and training are necessary to produce highly aesthetic nursery crops. Broadleaved evergreen and coniferous evergreen crops are usually sheared frequently up to 3 to 7 times during the growing season to produce a dense branching structure. All growing tips are removed with each shearing. For conical shaped plants. a single terminal leader is encouraged to grow upward several inchesthen the tip is removed to stimulate branching. A new single terminal shoot is then again selected to grow upward and other shoots are pruned back several nodes to a node with a bud on the bottom side of the branch or to a small branch with an orientation to grow outward and down rather than upright. Stakes taller than the leader attached to the main stem are frequently required during the first few months of production while anchorage of the root system occurs and to encourage upright growth of the plant. Stakes should be removed before the leader out grows the height of the stake, otherwise the leader will grow away from the stake and become mis-shaped. Be certain to remove stakes within the first growing season or damage may result to the leader and at points where the stake is attached to the main stem.

Pruning single leader trees such as red maples or oaks to preserve the leader and maintain a single dominant leader is an entirely different approach than described for shrubbery. The pruning philosophy for pruning single leader trees is very selective. Initially, the height of the

canopy or where the first permanent branches will be set, is determined by the size of tree to be grown and the potential market for which the tree is being developed. Trees grown to 2.5 inch caliper in a 25 gallon container may have a head height set at 60 or 72 inches, while a 1.5 inch caliper tree in a 15 gallon container may have a head height of 48 or 60 inches. Small twigs can be left on the lower stem of single leader trees during the current growing season to stimulate growth in caliper in Fall, however twigs should be removed before they reach a diameter of over 1/4 inch, otherwise a larger wound than desired. Branches within in the permanent canopy are selected for wide angles of growth and branches with tight angles of growth are removed. Branches on the same side of the canopy that are growing in the same direction are selected to have at least 6 inches minimal distance spacing on the trunk, with branches giving the appearance of spiraling as one looks from the ground into the canopy. Occasionally, the main terminal leader is lost or removed. To develop a new leader, a bud or twig can be selected. Potentially competing buds or branches are removed or significantly pruned back. In the case of choosing a bud to become the terminal, a strip of masking tape can be attached to the stem opposite the bud and a tunnel or tube formed around the bud to direct it straight upward as it elongates and becomes the new terminal. If a lateral twig is selected as the terminal, a short support stake can be tied to the terminal to form a splint to pull the twig upright or if a terminal still is present, all buds and shoots can be removed and the remaining stick used to act as a splint for attaching masking tape in two or three places to pull the lateral twig upright. In any case, the masking tape will deteriorate after it has served it's intended purpose. The most important quality characteristic for single leader trees is that a single dominant leader be maintained throughout the height of the tree. The Florida Standards for Quality grade trees based upon their height with a single dominant leader. Branch spacing and angles of lateral branches are also important quality characteristics in the Florida Standards.

Other specimen ornamental and flowering trees are grown as standards, with a single stem without branches to a specified height, such as 5 feet and then several main scaffold branches are selected as a canopy over the next two to three feet of height to yield an inverted umbrella like appearance. Branch selection and spacing follow steps as described for single leader trees.

Quality of plants grown in large containers are first assessed by their appearance, as seen through their symmetry, structure and line, dense canopy and color of their ornamental characteristics including bark, flowers, fruit and foliage. For plant professionals, quality characteristics extend beyond appearance to the distribution and fullness of the root system and the ability of the roots to grow rapidly and become established in the landscape.

2002 Economic Outlook – General Trends National and North Carolina

M. L. Walden
William Neal Reynolds Distinguished Professor and Extension Economist

THE NATIONAL ECONOMY: A RECESSION BEGINS

According to the National Bureau of Economc Research, the national economy entered a recession in March, 2001. This marked the start of the first recession in ten years. As 2001 came to a close, the major questions were: how bad would the recession be, and how long would it last?

The movement to a recession can clearly be seen in the aggregate statistics. Real gross domestic product, the broadest measure of economic activity, increased 4.1% in 2000. But in the first quarter of 2001, it increased 1.3%; in the second quarter, 0.3%; and in the third quarter real gross domestic product *declined* by 1.4%. It is widely expected the decline will continue in the fourth quarter of 2001 and possibly the first quarter of 2002.

To date, the 2001 recession has been different than other recent recessions. The 2001 recession has primarily affected the business sector. Although unemployment has increased, consumers have fared better than businesses.

Industrial production fell 2% in 2001, and business investment disappeared. Corporate profits were negative, and one million manufacturing jobs were cut during the year. The troubles in the business sector were reflected in a declining stock market in the first half of 2001.

In contrast, consumers weathered the economic storm rather well. Although the jobless rate did jump from 4.2% to 5.7% during 2001, the unemployment rate was still significantly lower than in previous recessions. Wages rose at an annual rate of 3.5%, and both inflation-adjusted disposable income and consumer spending rose. In previous recessions, consumer income and spending didn't increase or fell.

IMPACT OF SEPTEMBER 11

Indeed, the strength of the consumer and non-manufacturing sectors of the economy in the spring and summer of 2001 has led many economists to believe the economy would have escaped an official recession had it not been for the terrorist attacks of September 11. The economic aftershocks of the attacks were strong enough to cause the economy to decline in the third quarter and likely again in the fourth quarter.

Admittedly, it is difficult to estimate the economic impact of 9/11. However, one estimate puts the annual reduction in national income as a result of the attacks at $250 billion, or 2.5% of gross domestic product.

MR. GREENSPAN'S MEDICINE

Well before the official recession was called, the Federal Reserve (the "Fed") was using its power over monetary policy to stimulate the economy. During 2001, the Fed reduced its key short-term interest rate (the federal funds rate) eleven times, from 6.5% to 1.75%. The Fed's goal was to reduce the cost of borrowing and encourage increased borrowing and spending by both businesses and consumers.

There was little evidence the Fed's medicine worked for the business sector in 2001. However, lower interest rates certainly motivated consumers to purchase homes, refinance mortgages, and buy vehicles during the year. Yet the full impact of the Fed's cheap money policy are likely yet to be felt. Typically it takes one year to eighteen months for Fed interest rate reductions to have their full impact on the economy.

WHEN WILL THE RECESSION END?

The consensus view among economists is the recession will end in the second quarter of 2002. If correct, the 2001-2002 recession will be average in length for the post-World War II recessions.

It is important to understand what an end to the recession means and doesn't mean. An end to the recession *doesn't* mean the economy will suddenly be back to where it was two years ago, with a 4% unemployment rate and all the lost jobs recovered. Instead, an end to the recession means the economy will begin to *improve*. The "economic bleeding" will stop and the "patient" will start to recover. Firms will begin re-hiring and increasing production, and aggregate economic activity will increase. But the economy will *not* be back to running full-speed. This will take time.

There are three major reasons for optimism that the recession will be relatively short-lived. First, the Fed's interest rate cuts began early and have been very aggressive, pushing short-term interest rates to below the inflation rate. This is providing a strong inducement for future borrowing and spending.

Second, energy prices have been falling. Oil prices have dropped by one-third, and natural gas prices have fallen by one-half since the beginning of 2001. These price reductions are saving billions of dollars in energy costs for both busineses and consumers.

Third, the economy is naturally self-correcting. During a recession, businesses reduce the production of new goods as they sell from inventories. In the first nine months of 2001, businesses reduced inventories by over $125 billion. Eventually, inventories will be depleted to such a level as to require businesses to increase production and hiring.

In total, it appears the 2001-2002 recession will be of average duration but less severe than the recessions in the post-World War II period. But this also means the recovery will likely be less robust than previous recoveries. Consumer spending accounts for almost two-thirds of all spending in the economy. Since consumer spending has remained relatively strong during the recession, there won't be the usual surge in consumer spending once the economic recovery begins.

NORTH CAROLINA: A DEEPER RECESSION

Due to North Carolina's greater reliance on manufacturing, the recession has impacted North Carolina more than the nation. Manufacturing accounts for 23% of North Carolina's income compared to 16% for the nation. Recessions always hurt manufacturing more because consumers and businesses can postpone purchasing manufactured products until the economy improves.

The impact of the recession on North Carolina's economy can been seen in the labor market. In October 2000, North Carolina's unemployment rate was less than the national unemployment rate (3.9% compared to 4.1%). One year later, in October 2001, North Carolina's unemployment rate had moved above the national unemployment rate (5.5% compard to 5.4%). In the first ten months of 2001, the number of unemployed increased 33% in North Carolina compared to an increase of 30% for the nation.

The big job losses in North Carolina have been in manufacturing, as would be expected. During the year spanning September 2000 to September 2001, traditional manufacturing industries in North Carolina (tobacco, textiles, apparel, and furniture) cut over 25,000 jobs, and other manufacturing firms cut 27,000 jobs. In contrast, the service sector and government (including teachers) added 58,000 jobs.

This is the bad news. The good news is, despite the terrorist attacks of September 11, the North Carolina economy is forecasted to recover in 2002. The state's unemployment rate is expected to peak at 6.6% in the first quarter of 2002 and decline thereafter. However, at the end of 2002, the statewide unemployment rate is still projected to be above 5.5%.

The events of 9/11 will delay, but not prevent, the economic recovery in North Carolina. However, although no terrorist attacks occurred in North Carolina, the state will still suffer costs from the aftermath of the attacks. For example, it is expected that retail sales in North Carolina will be $1 billion *less* in 2002 as a result of the attacks.

Although the North Carolina economy is expected to improve beginning in the second quarter of 2002, structural change will continue in the state. Most of the 25,000 jobs lost during the last year in traditional manufacturing will not come back. In particular, job losses will continue in textiles and apparel as these industries move to more mechanized production with fewer workers.

Most of the jobs lost in "other" or "non-traditional" manufacturing in North Carolina will eventually return. For example, in the first year after the 1990-1991 recession, all of the jobs lost in non-traditional manufacturing in North Carolina were recovered. However, because the economic recovery is expected to be slower after the 2001-2002 recession, it will likely take much longer than a year for non-traditional manufacturing employment in North Carolina to return to its pre-recession levels.

LOOKING BACK AND AHEAD

The current recessionary cycle was prompted by a desire by the Federal Reserve to temper the strong economic growth rates of the late 1990s. Consequently, the Fed *increased* interest rates in 1999 and 2000. These rate hikes set the stage for the slowdown in the economy in 2001.

Clearly, the Fed didn't want to cause an outright recession in 2001. The Fed's goal was to *slow* economic growth; not to cause economic growth to go into reverse. It looked as if the Fed had achieved its goal of slower growth, without a recession, until the terrorist attacks of September 11.

Of course, this issue is now academic. The economy is now in a recession, and the Fed has been actively fighting it. But as expectations increase of an economic recovery in 2002, eyes are turning to the nature of the economy in 2002 and beyond and potential threats to the economy.

Certainly one threat is future terrorist attacks. Terrorist attacks not only cost lives and wealth today, but they also increase risk. Greater risk increases the cost of economic activity and reduces investment and commerce. It is hoped the current military and security efforts to confront terrorism will reduce this threat in the future.

Another threat that always arises when an economic recovery occurs is the threat of faster increases in prices - that is - higher future inflation rates. Current data indicate inflation is low now. In fact, in some markets, deflation (falling prices) is occurring. But some economists are worried that the tremendous monetary stimulus provided by the Fed, combined with a likely *fiscal* stimulus (increased spending and reduced taxes) from the federal government, will provide such a boost to the economy in 2002 that production won't be able to keep pace with desired purchases. In such an environment, prices rise at faster rates.

Balanced against these threats is the assessment that the country's economic fundamentals are good. The annual inflation rate is, and will likely remain, in the low single digits. Government debt relative to the size of the economy has been falling. Productivity (output per input) has been rising even during the recession. Household net wealth is higher than a decade ago. The economic future still looks bright!

Hydrangea macrophylla: Travels, Trials and Some New Ideas

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According to most references, old and new, *Hydrangea macrophylla* flowers on "old growth" only. That is, flower buds are formed in the late summer or early fall of the previous season, over-winter as dormant buds, and finally flower the following summer. The problem lies with the species' susceptibility to injury from low temperatures and untimely frosts. Temperatures below –10ºF in the winter typically result in dead tissues including flower buds. Shoots will often rejuvenate from the base the following spring even if plants are killed to the ground. However, these shoots remain mostly vegetative for the entire season leaving the hopeful grower or gardener without the prized inflorescences. Consequently, hydrangea's reliability as a flowering shrub is limited to USDA Hardiness Zone 6 and south. Unusually warm temperatures in the late winter followed by temperatures 25ºF or below often damage or kill flower buds that have deacclimated. However, one needs look no further than their neighbor's garden to discover that within the species exists a great deal of variation in foliage, habit, stems, flower colors and sizes.

A remontant flowering, or reblooming, *Hydrangea macrophylla* could change how and where the plants are produced and used. What seemed like a dream is now, and probably always was, a reality. In September 1998 a *Hydrangea macrophylla* clone was spotted growing, and flowering, in the trial plots of Bailey Nurseries Inc., St. Paul Minnesota (USDA Hardiness Zone 3) by Dr. Mike Dirr. Cuttings were acquired and flowering quickly resumed on the newly rooted cuttings. The flowering was so prolific that vegetative cutting material was difficult to obtain. Numbers were eventually increased and other *Hydrangea macrophylla* cultivars with putative remontant flowering capabilities were accessioned and propagated.

Studies investigating floral control of *Hydrangea macrophylla* have supported the premise that flowering occurs only from preformed flower buds. However, these studies were performed using cultivars specifically selected for strict control of flowering for greenhouse production. Michael Haworth-Booth, in *The Hydrangea*'s, reported 12 remontant flowering cultivars. In March 2000, a study was conducted to evaluate putative remontant flowering cultivars at The University of Georgia, Athens. Plants with only vegetative buds present were placed in either inductive or non-inductive conditions. The inductive conditions essentially mimic fall-like conditions while non-inductive conditions would represent summer conditions. The idea was to identify which and to what degree cultivars would develop flower primordia under non-inductive conditions and compare the rate of development to inductive conditions. Cultivars forming flower primordia in non-inductive conditions may, therefore, do likewise in the landscape. All cultivars formed some floral primordia. However, 'Penny Mac', 'Endless Summer', 'Lilacina', 'Mme. Emile Mouillère', and 'Nikko Blue' formed highly developed floral primordia indicating a superior remontant flowering potential.

In addition to the remontant flowering types, other cultivars have shown a remarkable propensity to produce multiple lateral flower buds. The benefit is that if freezing temperatures damage terminal flower buds the laterals develop and produce flowers. A late January 1999 visit to southern England provided a unique opportunity to evaluate a large number of cultivars for flowering potential following a late spring frost. The hydrangea collections at The Sir Harold Hillier Gardens and Arboretum suffered severe damage from April frosts in 1998. It was easy to distinguish which cultivars flowered better than others from the retained spent inflorescences. A particularly impressive clone (accession 84-2157) was loaded with inflorescences and clearly

performed head and shoulders above the rest. Unfortunately, the cultivar name was missing and the name remains a mystery. Whether the survivors faired better because of remontant flowering potential or because they possessed multiple lateral flower buds is undetermined.

The remontant flowering and lateral flower bud characteristics are not black and white issues. Some cultivars, like the 'Endless Summer' and 'Penny Mac', express the remontant flowering trait strongly while others, like 'Mme. Emile Moulliere' or 'Veitchii', are intermediate and still others, like 'Mariesii Variegata', seem to possess zero remontant flowering potential. In fact, 'Endless Summer' flowered throughout the summer and into late November at Dudley Nursery, Thompson, Georgia before going dormant. Of those that tend to produce significant lateral flower buds 'Dooley' may be king. Although 'Dooley' seems to have little remontant flowering potential, flowering reliability is remarkable despite late winter or spring freezes. It is probable that among the hundreds of extant *Hydrangea macrophylla* cultivars more superior types exist. It would be worthwhile identifying these and offering them in place of poor performers.

The number of extant *Hydrangea macrophylla* cultivars is overwhelming, and uncountable. Corinne and Robert Mallet manage what is likely the largest European hydrangea collection in southern France and have over 600 *H. macrophylla* and *H. serrata* cultivars and more than 1000 *Hydrangea* sp. The variation among these cultivars represents an untapped resource for breeding truly novel and hardy cultivars. Most currently available cultivars are derived from open pollinated plants or sports. For instance, a unique sport of 'Veitchii' with white and green flowers was recently observed in the garden of Mrs. Elizabeth Bullivant, Stourton House, Wiltshire, England. This represents one of many clones tagged each year for introduction. However, after thousands of years in cultivation it's unlikely that significant advances in cultivar improvement will be made without integrating new genetic diversity into a controlled breeding program. For now, the trick is to select superior cultivars from the hundreds available. An overview of cultivar diversity and cultural requirements will be presented.

Breeding Efforts with Stokesia and Buddleia at North Carolina State University

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Breeding and genetic studies of (*Stokesia laevis* (J. Hill) Greene) and *Buddleia* sp. are currently in progress under the direction of Dr. Dennis Werner at North Carolina State University. In addition to development of new ornamental cultivars, this research program focuses on other related objectives including studies of genetic diversity, propagation, and inheritance of important traits in these genera. To date, we have recovered various interesting progeny with potential commercial value. These will be discussed.

Stokesia

Stokes aster, a flowering herbaceous perennial native to the southeastern United States, is used primarily as a landscape ornamental or a specialty cut flower. Despite the fact that stokes aster is indigenous to the Southeast, it is classified as hardy in USDA hardiness zones 5-8. Stokes aster is a versatile plant that thrives in a variety of climates including full sun to part shade in well drained to moderately damp soils. The flowers of stokes aster, a member of the Asteraceae family, are perfect and composite. Historically, stokes aster has enjoyed moderate popularity, but is still overlooked by the landscape and nursery industry. Recently, renewed interest in this plant has been fueled by the new introductions of 'Honeysong Purple' and 'Colorwheel'. Both cultivars have exciting new flower colors that make great additions to any landscape.

Research Goals

- ***Expanding Color Range***

Stokes aster flowers are typically found in a range of blues and lavenders with a few white flowering types and one pale yellow flowering type sold under the cultivar name 'Mary Gregory'. In general most cultivars of stokes aster are thought to be selections from the wild or garden populations, but no formal documentation exists as to how most cultivars arose. One of our primary research objectives focuses on understanding the inheritance of flower color and expanding the range of available flower colors. By incorporating new cultivars like 'Honeysong Purple' and 'Colorwheel' into our breeding program we have been able to develop advanced selections with deeper purples and red undertones that dramatically enhance the traditional flower colors. Some of these advanced selections will be presented.

- ***Creating an Upright Series***

Another introduction that has led to renewed interest in stokes aster development was the discovery of an unusual population of stokes aster growing in Colquitt County, GA, near the town of Omega by Ron Determann of the Atlanta Botanical Garden. From this population, 'Omega Skyrocket' was selected for its unique upright flower scapes that differ dramatically

from the shorter, non-upright scapes typical of the species. Currently, 'Omega Skyrocket' is available only with the bluish-violet flower color and is primarily propagated vegetatively or by seed. To take advantage of this unique upright architecture we have focused on incorporating this novel architecture into a broader range of flower colors. Accordingly we have hybridized 'Omega Skyrocket' with cultivars demonstrating white, yellow, violet, and deep violet flower color and hope to recover progeny with upright architecture in a variety of flower colors. Our work has proven quite successful in producing advanced selections with deep purple flowers and upright architecture. Additionally, we hope to recover white and yellow flowered selections this summer that also possess this unique upright architecture.

- ***Cut Flower Potential***

As more upright types of stokes aster are released, the interest in using stokes aster as a specialty cut flower has also increased. To date, several of our newer selections possess many essential traits of a cut flower including long flower scapes, excellent scape thickness, and large flower size and color range. Our research group has recognized these traits and plan to evaluate them this summer to ascertain their potential as field grown specialty cut flowers.

Buddleia

The high amount of genetic variability present in *Buddleia* affords considerable opportunity to develop new and novel taxa through controlled breeding. Initial efforts in our *Buddleia* breeding have focused on compactness, silver-gray leaf color, flower color, and branched-panicle (inflorescence) architecture. Considerable effort has been made hybridizing the yellow-flowered *Buddleia* 'Honeycomb' with various cultivars with the objective of developing yellow-flowered taxa demonstrating more compact growth, greater flower production, silver-gray foliage color, and improved panicle architecture. The branched-panicle character presently found only in *B. davidii* cultivar 'Dartmoor' behaves as a recessive trait in controlled hybridizations with cultivars demonstrating normal (non-branched) panicle architecture. Efforts have also been initiated in hybridization of the unique compact cultivar 'White Ball' with other color forms in order to develop a series of compact forms demonstrating different colors.

The potential for interspecific hybridization in *Buddleia* appears great. At this time, progeny from hybridization of *B. lindleyana* with *B. davidii* 'Nanho Purple' appear promising. Progeny from the hybridization of these species demonstrate improved leaf color, compact growth, and large flower size. Some of these new selections will be discussed.

Its True, when you irrigate affects plant growth! Final results.

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Introduction

Much research has focused on increasing irrigation efficiency by improving method of application and reducing irrigation volume. Previous research has shown 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 carried out with minimum changes to their current production systems. One technique may be irrigation scheduling.

Irrigation scheduling is 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. Since the commercial value of woody landscape plants is generally based on size and aesthetics, most growers are currently focused on maximizing plant growth. Irrigation scheduling has received considerable attention in field crop production. However, until 1999 no one had examined the impact of irrigation scheduling, i.e., time of irrigation application with container-grown nursery crops.

In 1999, irrigation was applied in equal parts at the following times:

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. 5:00 A.M., 12:00 P.M., and 3 P.M.
D. 12:00 P.M., 3:00 P. M., and 7:00 P.M.

Plant growth increased 57% when irrigation was applied in the P.M. (treatment D) compared to early morning irrigation (Treatment A). The smallest plants were produced when irrigation was applied in the early A.M. (Treatment A). This was surprising since many growers traditionally irrigate predawn to reduce water lost to evaporation and to minimize interfering with workers. However, a single study is not enough evidence to recommend changing irrigation scheduling, so the study was repeated in 2000.

In 2000, irrigation was applied at:

A. 2:00 A.M., 4:00 A.M., and 6:00 A.M.
B. 6:00 A.M. 9:00 A.M., and 12:00 P.M.
C. 12:00 P.M., 3:00 P.M., and 6:00 P.M.
D. 6:00 A.M., 12:00 P.M. and 6 P.M.

Results

Plant growth was increased 69% when irrigation was applied in the PM (Treatment C) compared to predawn irrigation (Treatment A). Watering throughout the day (Treatment D) increased growth 51% compared to predawn whereas, watering in the morning increased growth 34% compared to predawn. Why? We speculated that it could be due to reduced container temperature and/or increased late day photosynthesis. Compared to plants irrigated at predawn, plants watered in the PM had much higher levels of photosynthesis throughout the day resulting in larger plants.

Disease Suppressive Potting Mixes

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Farmers have used animal manures for centuries as an organic source of nutrients for crop production. When manures are added to soil high numbers of microscopic bacteria and fungi develop to break down the manures and utilize the carbohydrates and nitrogen associated with the residue. The dramatic increase in microbial population may have an additional benefit in that these bacteria and fungi may help to suppress root diseases caused by *Rhizoctonia solani*, *Pythium* spp. and *Phytophthora cinnamomi* that attack many important nursery crops in container production. Although pine bark-based container mixes are suppressive to these pathogens due to drainage characteristics, disease can still develop when potting mix is over watered. We have been evaluating animal manures in the last few years as amendments to container mixes to suppress root diseases. Development of value-added products based on manures generated by the expanding swine production in the state could be beneficial both to the animal and nursery industry. Our goal is to understand the microbial factors associated with suppressiveness of container mixes and to learn how to manipulate these microorganisms for disease control.

Animal manures. We conducted two different experiments to determine how suppressive container mixes amended with animal wastes were to *Pythium ultimum* and *P. cinnamomi* in 2001. Two types of animal manures were used: an uncomposted swine waste collected from a lagoon and pelletized (BION Soil, BION, Inc. Smithfield, NC) and a composted swine waste (NCSU, Animal Waste Management Center),

Cucumber bioassay. General suppression of the manures was tested in a cucumber bioassay with *Pythium*. The manures were amended to Fafard 4P peat-based potting mix at rates of 4, 8, or 12% (v/v). The amended mix in 4" pots was planted with eight cucumber seeds, irrigated heavily to remove salts, and then placed in a growth chamber with 16 hr of light/day at a constant temperature of 68 F. After 10 days, each pot was examined and the cucumbers rated for disease.

Results of bioassay. Both uncomposted swine waste and composted swine waste incorporated into Fafard 4P were suppressive to Pythium root rot at 8 or 12% rates of incorporation (Table 1). However, disease was not suppressed completely as ratings of 2 meant that cucumber seedlings emerged but were stunted compared to seedlings in the controls.

Table 1. Cucumber bioassay to detect suppression of Pythium root rot in either an uncomposted swine waste or a composted swine waste incorporated into Fafard 4P potting mix

Treatment	Rate	Disease*
Uncomposted swine waste	4 %	3.4
Uncomposted swine waste	8 %	2.5
Uncomposted swine waste	12 %	2.4
Composted swine waste	4 %	2.9
Composted swine waste	8 %	2.3
Composted swine waste	12 %	1.9
Fafard mix alone	100%	3.3

*Disease severity is 1=healthy, vigorous seedling, 2= seedling emerged but stunted, 3=emergence but seedling diseased and 4=dead, no emergence.

Phytophthora root rot of azalea. The second experiment was conducted at the Horticultural Field Lab at NCSU with Hinodegiri azalea to test the suppression of manures for control of Phytophthora root rot. Azaleas were grown in pine bark mix amended with the manures at rates of 4, 8, or 16% (v/v). In early June, one half the plants in pots were inoculated with *P. cinnamomi*. Plants in control treatments without manures received 3.2 g N per pot of 16-5-10 Wilbro NPK fertilizer. No fertilizer was added to pots with manures. Pots placed under a shade cloth were irrigated by overhead sprinkler daily. Foliar symptoms of disease were rated regularly over the summer. The VTM 'pour through' method was used to determine soluble salts and pH 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.

Results of nursery test. Azaleas in swine waste amended mixes infested with *P. cinnamomi* developed symptoms of Phytophthora root rot on the foliage of azaleas beginning in July and progressing over the summer. Phytophthora root rot was not suppressed in any pine bark mix incorporated with the animal manures at rates of 4 to 16% compared to pine bark mix only (Table 2).

Table 2. Effect of amending uncomposted and composted swine waste at 4, 8, or 16% (v/v) in a pine bark mix on development of Phytophthora root rot and top weight (g) of azalea in treatments with *Phytophthora cinnamomi* at the HFL, 2001

Treatment	Rate	Disease*	Weight
Uncomposted swine waste	4 %	3.6	15 g
Uncomposted swine waste	8 %	3.7	15 g
Uncomposted swine waste	16 %	3.8	16 g
Composted swine waste	4 %	3.1	17 g
Composted swine waste	8 %	3.4	15 g
Composted swine waste	16 %	3.3	12 g
Pine bark + sand alone	6:1	3.4	15 g
Pine bark + sand + Subdue Maxx fungicide	6:1	1.9	77 g
Pine bark + sand with no *Phytophthora*	6:1	1.0	51 g

*Disease severity scale: 1 = healthy, no root rot, 3= severe root rot, with many coarse roots diseased, 4 = very severe root rot, no new root growth from original root ball.

Microbial respiration (CO2) was greatest in uncomposed swine waste (BION) followed by composted swine waste treatments. Respiration was very low in pine bark sand only. Microbial biomass carbon also was 2 to 5 times higher in the mixes amended with manures compared to pine bark sand only but the nature of microorganisms contributing to these increases is unknown at present (Table 3). Based on top weights and foliar chlorosis ratings (data not shown), neither swine waste provided enough nutrients for growth of azalea throughout the growing season (Table 3). Chlorosis was first evident about 6 weeks after potting.

Table 3. Top weight (g) of azaleas grown in a pine bark mix amended with swine waste at 4, 8, or 16% (v/v) in treatments without *Phytophthora cinnamomi* and carbon dioxide evolution (CO2), and microbial biomass carbon in the potting mix at the HFL, 2001

Treatment	Rate	Weight*	CO2**	MBC***
Uncomposted swine waste	4 %	30 g	62	1,485
Uncomposted swine waste	8 %	38 g	62	1,846
Uncomposted swine waste	16 %	36 g	47	2,198
Composted swine waste	4 %	29 g	31	1,862
Composted swine waste	8 %	27 g	41	1,033
Composted swine waste	16 %	24 g	38	1,248
Pine bark + sand alone	6:1	51 g	10	480

*Treatments with swine waste did not receive additional fertilizer.
**Cumulative CO2 evolution in milligrams per gram of potting mix at day 21 after incubation.
***Microbial biomass carbon in milligrams per kilogram potting mix on day 103.

Impact to nursery industry. Animal manure amendments were suppressive to Pythium but not Phytophthora root rot of azalea. In the absence of disease, swine waste did not provide sufficient nutrients for season long plant growth.

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Use of Poulty Litter in Field Nursery Production

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The poultry industry seeks disposal methods for litter produced during poultry production. For every one to five flocks raised, the bedding and manure is removed from confinement houses and replaced with fresh bedding. Litter may be used as an organic fertilizer on cropland. However, in some areas the nutrients in the manure exceed the capacity of local agricultural soils. Producers need alternate sites for litter application. Since acreage of field-grown nursery stock is increasing, it seems reasonable to evaluate the potential of poultry litter for use as a nutrient source in field-grown nursery stock.

This project was initiated at Knats Creek Nursery, Moore County North Carolina to compare poultry litter with a controlled release fertilizer (CRF) and the water-soluble fertilizer (WS) used by the nursery. The nursery is located on an exposed ridge; the soil is a Candor sand with excessive drainage extending more than ten feet deep. Initial pH ranged from 5.8 to 6.1. The nursery is not irrigated.

The randomized complete block design with three replications consisted of five treatments:

1. poultry litter, pre-plant incorporated at 50 pounds nitrogen (N) / acre, plus a surface applied litter application in the fall at 0.5 oz N / tree, plus yearly spring applications of 0.5 oz N / tree

2. poultry litter, pre-plant incorporated at 50 pounds N / acre, plus yearly spring applications of 0.5 oz N / tree

3. poultry litter, pre-plant incorporated at 100 pounds N / acre, plus yearly spring applications of 1.0 oz N / tree

4. controlled-release fertilizer (Polyon / Wilbro 16-5-10, N source = ammonium nitrate) post-plant surface applied at 0.5 oz N / tree, plus yearly spring applications of 0.5 oz N / tree

5. water-soluble fertilizer (Maxi-Grow 10-10-10, N source = ammonium nitrate) post-plant surface applied at 0.5 oz N / tree, plus yearly spring applications of 0.5 oz N / tree (This was the nursery's standard fertility practice).

The same litter was used for all applications. After the initial litter application to treatments 1, 2, and 3, the entire site was tilled and graded. Thirty-two 1 gallon Leyland cypress (*X Cupressocyparis leylandii*) were planted in each plot with 5 ft between rows and in row spacing of 5 ft. In November 1998, poultry litter at 0.5 oz N / tree was surface applied in treatment 1. In March 1999, litter was surface applied at a rate of 0.5 oz N / tree in treatments 1 and 2 and 1.0 oz N / tree in treatment 3. All litter was lightly incorporated by hand raking. CRF and WS were surface applied to treatments 4 and 5 respectively, at a rate of 0.5 oz N / tree for both post-plant and March 1999 application.

Eight plants in the interior of each plot were selected for growth measurements. Measurements for each tree included height, maximum width, and minimum width. A growth

index (GI) was calculated for each tree as follows: GI = {[(maximum width + minimum width) / 2] + height / 2}. Trees were measured after planting, December 1998, and March 2000.

In July and December 1998, soil was sampled to a depth of 40 in beneath each of four interior plants in each plot. Samples were divided into depths of 0 to 6 in, 6 to 12 in, 12 to 18 in, 18 to 30 in, and greater than 30 in. These samples were analyzed for ammonium and nitrate content to track leaching of these nutrients through the soil profile.

The initial GI was not significantly different between treatments, so trees were of a similar size at planting. Percent increase in GI over one and two years was unaffected by treatments suggesting that poultry litter was as effective as the CRF and WS fertilizers. The GI increased an average of 95% over the two growing seasons. However, treatments significantly affected survival. CRF and WS had similar rates of survival. All poultry litter treatments significantly decreased survival compared to WS, however the poultry litter treatments had similar rates of survival. Poultry litter was positively correlated with tree mortality.

We suspect weather conditions, lack of irrigation, and the release mechanism of the fertilizers played a role in tree mortality. The study received 5 in of rain from April 24 until May 30, 1998. In addition, the average maximum air and soil temperatures for May were 81.5 F and 78.1 F, respectively (3). In June and July, total rainfall was 1.3 in and 2.2 in, respectively.

Treatment 3 with the highest addition of poultry litter consistently had the highest soil nitrate levels, whereas the CRF had the lowest. However, these treatments were not always significantly different from the other treatments. Poultry litter treatments 1 and 2, and WS (Treatment 5) maintained similar levels of soil nitrate regardless of time and depth. Since the GI was similar among treatments the elevated nitrate level in treatment 3 might lead to increased nitrate losses. Soil data suggests that mineralization was nearly complete and nitrification advanced. Soil temperature was in ranges where this progression might have been predicted.

Poultry litter can be a usable source of nutrients for field nursery production. Without irrigation, it is less subject to control by the grower. We would hesitate to suggest use of this material without the availability of irrigation.

Oh, Those Shady Anise

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In today's urban environment, shade tolerant plants have become a vital ingredient to nearly all landscapes. Nearby structures can cast large shadows that greatly reduce the amount of sunlight reaching the ground, and a single shade tree can often shade an entire lawn for a significant portion of the day. Such conditions can limit the number of plants at the landscaper's disposal. While the flowering anise (*Illicium* spp.) have proven to be very comfortable in low light conditions, we often find them struggling in what can only be described as hostile conditions. Some commercial sites and many new home construction projects often lack the shade required for anise to flourish.

For the past two summers we have been evaluating many of the commercially available taxa of *Illicium* for their tolerance to full sun conditions. In the process we have been exposed to a group of plants with diverse growth habits, a wide range of flowering times, spectacular flower color, and phenomenal foliage quality. What follows is a brief description of ornamental characteristics and sun adaptability of the taxa we tested.

All taxa are broad leaved evergreens that eventually form multi-stemmed shrubs.

Illicium anisatum – can be a tall (to 10 feet) multi-stemmed shrub with medium sized white flowers hidden under the foliage. Thick, dark-green leaves with an undulating margin make this a great foliage plant.

Illicium floridanum – one of only two species native to the southeastern US and the only native species with red flowers. Attractive plant, however, selected cultivars offer superior ornamental quality.

Illicium floridanum 'Halleys Commet' – the attractive red flowers on this selection are borne over a longer period than the species. Additionally, flowers are more numerous making this selection a good alternative to the species.

Illicium floridanum 'Head's Compact' – a selection from Head-Lee Nursery (SC), this cultivar offers all the advantages of the previous selection, in a compact form. Numerous red flowers on a 3-4 foot 'meat ball'.

Illicium floridanum 'Semmes' – a selection of the naturally occurring white variety (var. alba). As opposed to every other taxa I have seen, this selection lacks red pigmentation completely. Stems, petioles, bud scales, and flowers are without the slightest trace of red pigment. This is a beautiful plant with pure white flowers that stand out against the deep green foliage.

Illicium henryi – this selection will eventually form a small tree (to 15 feet). Small 'pinkish' flowers are hidden under the foliage, but interesting when found. Although a personal favorite, it is more of a novelty item and probably will never have mass-market appeal.

Illicium lanceolatum – very similar to the above species in all aspects with the exception of slightly elongated leaves. In our evaluations, this species performed much better in container production than did *I. henryi*.

Illicium mexicanum 'Aztec Fire' – native to Mexico, this species is similar to *I. floridanum*. This particular selection from the JC Raulston Arboretum blooms much heavier and with larger flowers than it's US counterpart. A real show stopper when flowering.

Illicium parviflorum and *I. parviflorum* 'Forest Green' – this is the other species native to the US. In the nursery industry this is the workhorse of the genus. Easy to propagate, easy to grow, and tolerant of a wide array of landscape exposures explain the abundance of this species in production. Makes a very dense hedge (to 10 feet). Unfortunately, small yellow flowers are practically unnoticeable. The selection 'Forest Green' is more robust, with darker green foliage, and performed slightly better in our studies. If you want to continue growing *I. parviflorum* it is worth the effort to locate this cultivar.

Illicium x 'Woodland Ruby' – if you are not growing this selection…you are not growing the best *Illicium*. This selection from Woodlanders Nursery (Aiken, SC) is a chance hybrid of *I. mexicanum* and *I. floridanum* 'Semmes'. Numerous, large pink flowers on a fast growing plant is only the beginning. In our trials 'Woodland Ruby' started flowering in June, and kept re-blooming until the first hard frost. In addition, when grown under shade, this selection produced foliage that would rival any tropical species. Large, dark green leaves, highlighted by large pink flowers from summer to fall…….please, somebody grow this plant!

Below is a table listing three sun exposure situations and the taxa that should perform well there:

All Day Sun Exposure	Partial Sun	Shade
I. parviflorum	I. anisatum	All taxa
I. parviflorum 'Forest Green'	*I. floridanum* 'Halleys Commet'	
	I. floridanum *'Semmes'*	
	I. parviflorum	
	I. parviflorum 'Forest Green'	
	I. x 'Woodland Ruby'	

Propagating Evergreen Oaks and Related Species

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Looking for an evergreen tree or large shrub? Tired of Redtips and Burford hollies? Think about the wide selection of underused evergreen oaks and related species that are hardy in our area. There are many species in the genera *Quercus*, *Castanopsis*, and *Lithocarpus* that can be used to spice up the plant palate. Many of these plants are tolerant of poor soils, shade, and drought, and therefore excellent choices for the Piedmont and Coastal Plain.

Traditionally, oaks are propagated from seed. Since many species readily hybridize with others, there is no guarantee the tree you grow from seed will look exactly like the specimen the seed was collected from. Also, some oaks can take 15 years or more to produce seed! The solution to this dilemma is propagation by cuttings.

The following is a list of plants and methods of propagation, both seed and cuttings, which was compiled from research and growers' personal experience.

<table>
<tr><th rowspan="2">Species</th><th colspan="2">Propagation Method</th></tr>
<tr><th>Cuttings</th><th>Seed</th></tr>
<tr><td>Quercus acuta
Q. germana
Q. glauca
Q. myrtifolia
Q. phillyreoides 'Emerald Sentinel'
Q. polymorpha
Q. rysophylla
Q. sartorii
Q. virginiana</td><td>Softwood cuttings treated with 8000 to10000 ppm KIBA</td><td rowspan="7">Collect seed in Fall and sow immediately. Place containers in unheated greenhouse, or store seeds and provide 1 to 2 months moist stratification at 38 - 40 degrees F, then sow in Spring. (Quercus virginiana reported to require no cold treatment).</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Q. canbyi
Q. myrsinifolia</td><td>Softwood cuttings treated with 3000 pm KIBA</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Lithocarpus henryi
L. glaber
L. densiflorus
L. edulis 'Variegata'</td><td>Semi-hardwood cuttings (June) treated with 8000 to 10000 ppm IBA</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Castanopsis cuspidata
C. cuspidata var. sieboldii 'Angyo Yellow'
C. sclerophylla</td><td>Softwood cuttings treated with 8000 ppm KIBA</td></tr>
</table>

Herbicide Dissipation in Container Substrates.

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In southeastern U.S. container nursery systems, few selective postemergence herbicides are available for broad-spectrum weed control. Therefore, frequent applications (every 8 to 10 weeks) of preemergence herbicides are made when chemical weed control is employed. Most preemergence herbicide programs include dinitroaniline herbicides (ie. trifluralin, pendimethalin, oryzalin or prodiamine) for grass control. Often, they are pre-packaged or tank-mixed with a broadleaf herbicide to achieve broad-spectrum weed control (i.e. isoxaben or oxyfluorfen). Experiment were conducted to determine the dissipation of trifluralin in a pine bark plus sand (7:1 v/v) potting substrate over time and to compare grass inhibition over the same time period. Trifluralin was applied at 4.0 lb ai/A, the recommended use rate for container nurseries. Large crabgrass (*Digitaria sanguinalis)* and perennial ryegrass (*Lolium perenne)* were seeded at 0, 7, 14, 28, 42 and 56 days after treatment (DAT). Shoot and root measurements were taken 2 weeks after seeding. Additionally, samples were taken from the top 2 cm of the potting substrate at 0, 1, 3, 7, 14, 28, 42 and 56 DAT and trifluralin was quantified using gas chromatographic techniques. Trifluralin lost effectiveness about 6 weeks after treatment, after which time weeds emerged. Laboratory analyses suggest the trifluralin residues in the surface of the potting substrate decrease rapidly within 24 hours after application and slowly thereafter, reaching what may be considered critically low levels approximately 4 to 6 weeks after application. These results suggest that the common reapplication interval of 8 to 10 weeks may need to be shortened in the southeastern U.S. Or at the very least, scouting for weeds on container pads should begin taking place around 4 weeks after application, especially during warmer months when herbicide dissipation rates are at their highest.

Making the Cut

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Commercial field-grown cut flower production encompasses an incredible array of plant materials including fresh and dried/preserved materials, flowers, stems and berries. Enterprising growers are constantly looking for new species and cultivars, such as woody cuts, to provide their customers with different products and enhance sales. In addition, woody plant species with decorative stems and berries can be harvested in the fall, winter and early spring when other field cuts are not available and provide growers with sales during the off season. However, many growers are reluctant to include woodies on their farms because of the lack of information about producing, harvesting, and holding the cut stems.

Woody cuts are grown for four purposes: flowers, foliage, fruit, and decorative stems. In this research, woodies grown for their foliage include *Buxus sempervirens, Myrica cerifera*, and *Ilex crenata*, and the woody species grown for its fruit is *Ilex* cornuta 'Nellie R. Stevens. Desirable traits in a woody plant that make it suitable for cutting include fast growth, long stems that hold their foliage or fruit, and long vase life.

Vase life is determined by several factors. Air temperature is the most important factor affecting postharvest flower quality and vase life. The temperature range for holding most species of temperate annual and perennial cut flowers is 0 to 4°C; higher temperatures promote senescence. Other benefits of lower temperatures include less endogenous ethylene production, lowered sensitivity to atmospheric ethylene, lower respiration rate and water loss, and slower development of microorganisms in vase solution. High relative humidity (95%) is also conducive to longer vase life.

Water temperature is also important in extending vase life. Warm water (38-43°C, 100-110°F) is recommended for two reasons: preservatives dissolve more easily in it, and warm water contains less oxygen, which can plug the cut stem with air bubbles. Using water temperatures above 40°C for more than a few hours usually results in a short vase life.

Light is not as important as temperature to the keeping quality of cut flowers. However, low or no light during long storage periods can induce leaf yellowing in some species.

Although many cuts can be stored wet or dry, dry storage can decrease vase life. In wet storage, water quality is important to vase life. Water containing high levels of salinity, sodium, or fluoride cause damage to cuts. Low pH (between 3.0 and 4.0) is recommended for longer vase life, because acidic water travels faster in the xylem.

Postharvest techniques can be divided into two broad categories: pre-treatments and holding solutions. Pre-treatments and pulses are short-term treatments (lasting 1-48 hours) that are conducted just after harvest. The idea is to 'load' the stems and leaves with a high concentration of sucrose or other preservative to aid in development. A common pulse uses 20% sucrose and is applied overnight. Another effective floral preservative that is pulsed is silver thiosulphate (STS). STS works by blocking the sites of attachment to plant tissue and is effective against both endogenous and exogenous ethylene. 1-methylcyclopropene (1-MCP) works in the same way as STS and is also effective against endogenous and exogenous ethylene. In several studies, 1-MCP has proven as effective in extending vase life as STS for several cut flowers including carnation,

alstromeria, snapdragon, stock, gypsophila and delphinium. 1-MCP may be preferable to STS because it contains no silver, the disposal of which has caused some environmental concern.

Very little information exists on postharvest handling of woody cuts. General recommendations include treating woody stems for a few seconds with hot water (80-90°C, 176-194°F), before returning them to cold water. Another general recommendation is to split the stem end of woodies for 3-4 inches.

The objective of this research is to discover holding solutions and strategies that will increase vase life for woody cuts.

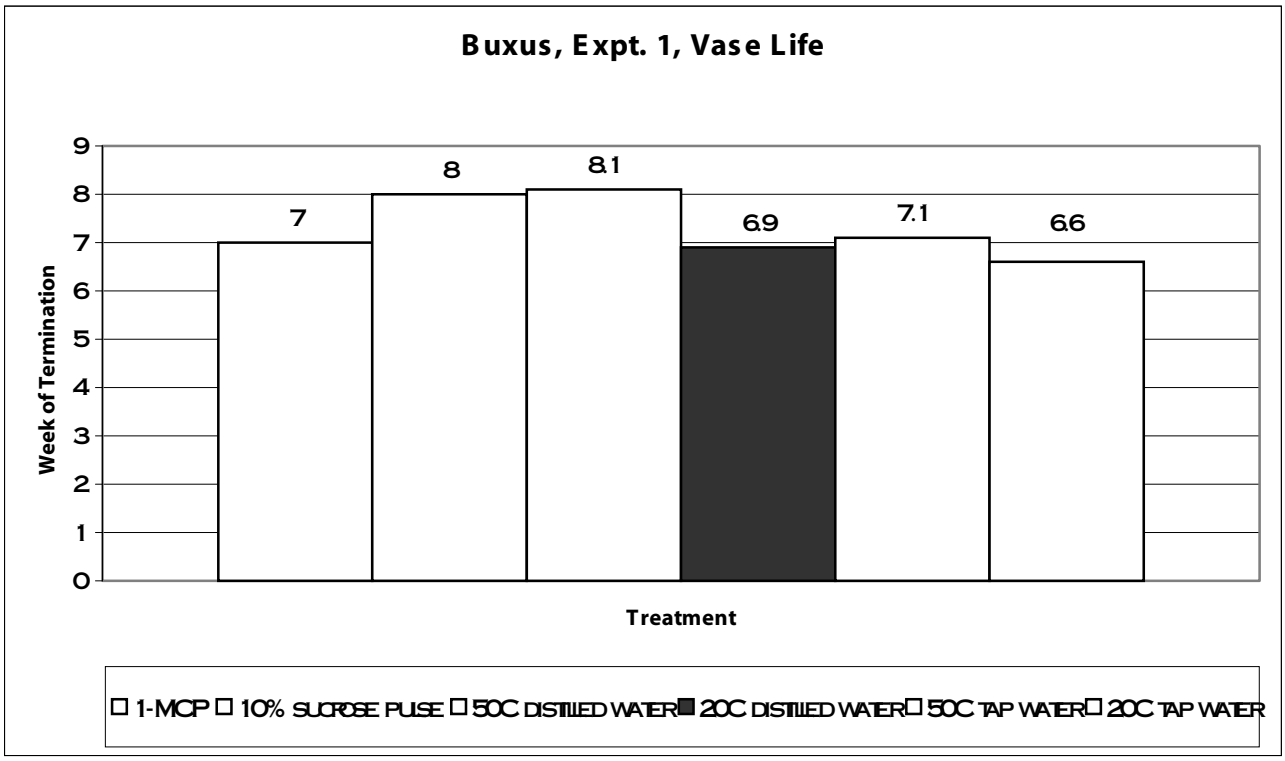
Experiment I

For each species, ten stems were placed in glass vases and treated with one of the following for 24 hours:

1. 1-MCP using distilled water
2. 10% sucrose pulse using distilled water
3. warm distilled water (50˚C, 122˚F)
4. ambient distilled water (20˚C, 68˚F)
5. warm tap water (50˚C, 122˚F)
6. ambient tap water (20˚C, 68˚F)

After treatment, the stems were transferred to a lighted area at 20°C (68°F) and evaluated every week as to visual quality, fresh weight, solution pH, and solution uptake.

Experiment II

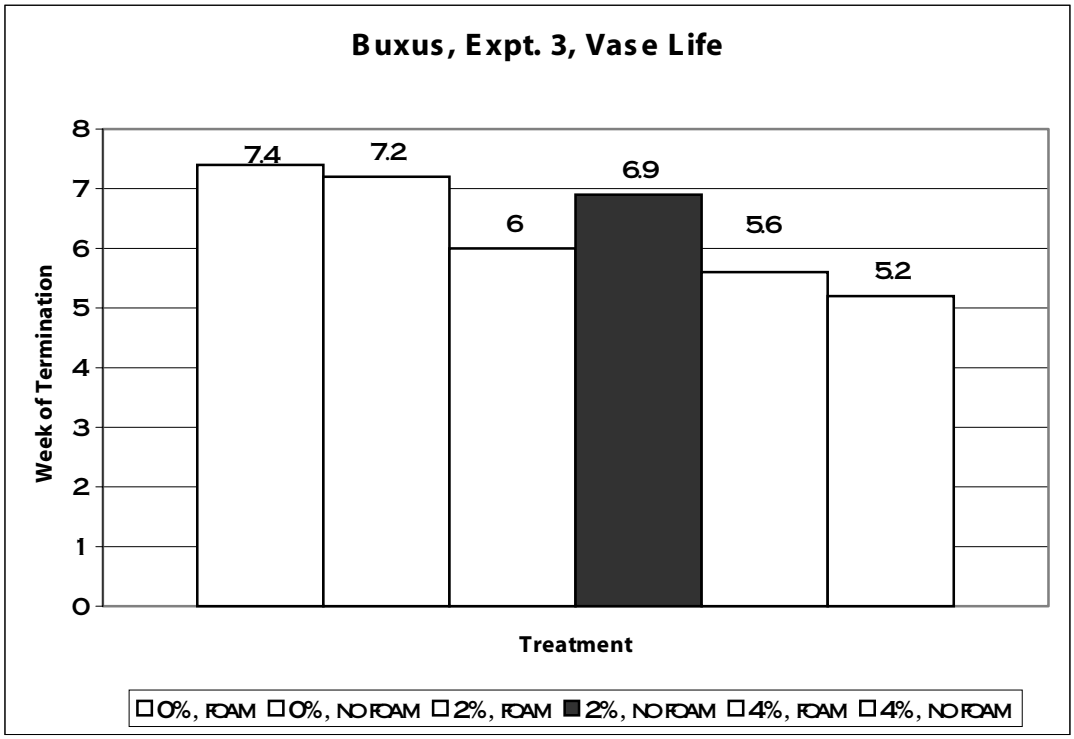


For each species, ten stems were placed in glass vases and held:

1. Dry or wet (in ambient distilled water)
2. With or without light
3. At 5˚C for 0, 1, 2, or 3 weeks, after which time they were transferred to a lighted area at 20˚C and evaluated every week as to visual quality, fresh weight, solution pH, and solution uptake.

Experiment III

For each species, ten stems were placed in glass vases and held:

1. With or without foam
2. In 0, 2, or 4% sucrose at 20°C in a lighted area.

Each species was evaluated weekly as to visual quality, fresh weight, solution pH, and solution uptake.