COMMERCIAL CONTAINERIZED HARDWOOD SEEDLING PRODUCTION IN THE SOUTHERN USA'

John McRae[2]

ABSTRACT-This paper will discuss the production activity and the history of containerized hardwood seedling production in the southeastern United States. Containerized hardwood seedling production began in the mid 1980's. Since the early 1980's production capacity expanded from approximately 50,000 to about 500,000 seedlings per year. Through 1998 the estimated total annual production is nearly 600,000 seedlings. Most of the containerized hardwood seedling production is in Mississippi, where the USDA Forest Ashe Nursery is producing seedlings in containers. But, production also occurs in Florida, Alabama, and Georgia. Production activities from site selection through packaging for shipment are discussed.

INTRODUCTION

Commercial containerized hardwood seedling production dates probably to the mid 1980's in Odenville, Alabama. International Forest Company began growing *Quercus* spp. in containers in response to requests by the U.S. Corps of Engineers. Successful bareroot seedling establishment of Quercus spp. was difficult in areas of the Mississippi Delta. Frequent flooding and extremely elastic soils hindered bottomland restoration efforts. It is a widely known fact among foresters that a substantial risk is taken to transport, handle, and plant usually large bareroot *Quercus* seedlings.

Such seedlings normally contain large root systems requiring extra effort to plant properly, and the planting window was limited to the cold months of fall and winter. Many sites are naturally flooded or will flood during this period making planting and subsequent survival risky. Container hardwood seedlings offered a larger planting window since they do not necessarily have to be shipped during the dormant season. They were also easier to handle, being extremely uniform, with root plugs the same shape and size and shoot heights within manageable limits across all species. As with container longleaf pine, survival was all but guaranteed.

The success of plantations established by the Corps, using container hardwood seedlings, resulted in continued use and preference to this alternative to bareroot seedlings, especially in areas flooded for long duration.

PRODUCTION CONSIDERATIONS

Nursery Location

Selecting a site to grow containerized seedlings requires thoughtful consideration. The first consideration must be water quality. It is of course the water that will eventually lead to success or failure over time when growing tree seedlings, whether container or bareroot. The source of water is very critical and usually determines whether or not you would like to grow on a particular site. The pH of the water is probably the most important factor. A range of 5.5 to 6.5 is ideal. Also, consider the amount of other minerals and elements in the water. The recommendations of Dr. Charles B. Davey of Zobel Forestry Associates Inc. is an excellent source to use in establishing water quality thresholds.

When choosing a site, consider the climate in which you plan to grow. Seasonal changes are preferred to help produce quality seedlings. The cool weather in the fall is needed to help push seedlings into dormancy and the cold weather in the winter is needed to maintain dormancy. Of course, a cool spring (temperatures below 85" F) facilities excellent germination. Most hardwoods native to the southeastern USA do not require full sunlight to live. However, growing in full sunlight usually promotes rapid growth. Establish the nursery within the natural range of the species you plan to grow, but choose an area where the plants can be exposed to seasonal changes,

Containerized seedling production is a labor intensive process. The third most important factor when considering your location is to make sure that you have the infrastructure to support the nursery production. Obtaining labor to grow the crops is an important consideration. In this modern of times having "just in time" suppliers, a responsive distribution system is usually not a problem anywhere throughout the South. However, remember it is the biological deadlines of growing a crop that must steer your budgeting and planning.

Product and Service Objectives

The container in which you grow is without a doubt the most important decision to be made. The demands of customer requirements and the biological needs to establish a successful plantation drive this decision. A variety of cavity sizes and multi-pots are available. Experience has shown that the larger the cavity the larger the hardwood will grow. Only water and poor nutrition will limit them it seems. Successful plants, 14 to 24 inches tall with RCD of 5 to 7mm can be grown in 5.7 cubic inch cavity with a 3.5 inch depth. Multi-pots tend to cost less per cavity and are easier and less costly to manage when growing large quantities of seedlings. Removable cells provide extra flexibility if sorting is necessary but, in general add to production, packaging, and shipping costs. The grower usually finds, however, that

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[2]Vice President, International Forest Company, P.O. Box 490, Odenville, AL 35120; TEL: 800/633-4506.

when producing hardwoods, the option of sorting by height growth yields more shippable seedlings, and sorting is much easier completed when using removable cells. The seedling quality (the product) and customer service is directly effected by the container used.

Seed

Quercus spp. seed germination still appears to be an enigma to just about all nurserymen. Germination vigor varies considerably within and among species. It is best to use uniform acorns, sized in groups varying only 50 to 100 seed per pound. Usually, large seeds germinate and grow best. Methods are in place, however costly, to consistently produce clean seed with germination of 85 percent and better. Once again, experience has shown that any improvements to seed quality that can be made, should be made, considering the additional costs involved in seedling production.

Choose seed with good vigor. That is, seed which germinates fully and quickly. Purities should be higher than 98 percent since debris slows sowing operations. Float off the empty seed and stratify the "sinkers" 0 to 30 days at 33" F depending on the species to enhance total germination and vigor. It is also advisable to sterilize the seed coat before sowing to remove or kill any pathogens that can inhibit germination.

The sowing strategy involves seed use management and how you plan to manage the crop. Total estimated germination usually drives the decision as to the number of seeds to sow in each cavity. But when considering *Quercus* spp., usually only one seed will fit to a cavity. Multiple seeds can be sown to a single cavity when species such as *Fraxinus* are grown. Considering labor costs to sow seed and to thin unneeded germinates from the cavity, the minimum germination for single sowing (one seed per cavity) is 90 percent. Less than 90 percent usually involves sowing more seed per cavity. Germination less than 60 percent are rarely cost effective. So choose your seed wisely.

Media

Don't use dirt! Use a **soilless** media. Commonly equal proportions of peatmoss, coarse vermiculite and perlite are used as a growing media. They must be well blended, but care needs to be taken to avoid destroying the material structure. Equal pore space of air:water:media is desirable for proper drainage. The target cation exchange rate should be 25-35 MEQ/L. Often, a few to several amendments are incorporated into the media during blending. Controlled release fertilizers and micronutrients are usually incorporated by most growers. The intent is to optimize growth throughout the seedling life cycle, even into the first few months after outplanting. Considerable investigation is recommended before deciding upon products and rates.

Wetting agents added to the media greatly improve the water distribution in the cavity. This affects drainage, which in turn greatly influences root and shoot growth. In general, any management activity that can optimize the drainage properties of the growing media will result in more plantable seedlings.

PRODUCTION ACTIVITIES

Media Filling and Germination Management

Filling the containers properly after the media is thoroughly blended is a critical operation that should not be taken lightly. First, the containers must be cleaned well enough to prevent weed seeds and/or diseases from significantly affecting seedling growth and development. During filling, careful tamping of the media is extremely important, as subsequent drainage and root growth are greatly influenced by this operation. Tamp each cavity precisely and uniformly. Do not destroy the media structure with "over tamping." Leave a depression on the top in which to place the seed. Mulching the seed is usually not necessary.

Once the filled containers are placed in the production area, immediate action is necessary to protect your investment from any environmental damage. Cover the crop with shade cloth. This will protect the seed and germinating seedlings from predators, heavy rains, hail storms and wind damage. The cloth should stay in place during the first 4 to 5 weeks after sowing or until about 90 percent of the seeds have germinated.

Irrigation should be frequent enough during the entire germination phase to maintain seed moisture levels that promote germination, but minimize pathogen development. Over watering, as well as under watering, can cause severe variation in filled cavity percentages. It is at this point in time of the operation that has the greatest influence on the success or failure of the crop. Be sure to have plant development goals in place before your operation begins, against which you can measure your progress.

To prevent disease development during the germination phase, regular fungicide applications are recommended. The "preventive" applications are used to manage against aggressive and undetected pathogens that can very quickly destroy a crop.

Water Management

Water management is the single most important activity the nursery manager must command. Earlier mention of pH and media drainage alluded to the fact that these factors are the two critical elements of water management. The pH of the irrigation water and the **leachate** should be between 5.5 and 6.5. The various fertilizers and chemicals applied throughout the growing season function best in this range. The drainage characteristics of the media also greatly influence water management decisions. Plant/water relations are continually monitored by the nursery manager. By maintaining a consistently drained media, accurate water schedules are easier to establish. A well-drained media also aides in fertility and pest management.

Fertility Management

The goal that a nursery manager should aim for is to produce a seedling with a good **rootball** first and good shoot growth second. It takes relatively little effort to produce a nice looking top, however, more effort is required to get a good **rootball** with abundant secondary and tertiary roots.

Resist the temptation for apply high levels of nitrogen early in the season. Instead, emphasize the phosphorus and potassium.

If you could roughly break down the season in thirds, apply low levels of nitrogen, and high levels of phosphorus and potassium during the first third of the season. During the second third of the season, apply more nitrogen in the approximate ratio of 20-1 O-20 or even a balanced fertilizer.

As shipping season approaches during the last third of the growing season, back off the nitrogen once again by applying a low nitrogen fertilizer with medium levels of phosphorus and potassium.

Pest Management

The keys to successful control of all pests are daily observations, monitoring and action. Every nursery manager should live by the saying "Don't expect what you don't inspect". All pests, whether they be disease, insects or weeds have the potential to explosively develop in the nursery environment. It is only through frequent inspection that problems can be diverted.

Just as daily inspection of the nursery crop is imperative, knowledge for all nursery workers of what a healthy tree looks like is just as important. A person can never identify the abnormal until they are familiar with what is normal, Bank tellers are trained to identify counterfeit money not by learning what the abnormal looks like but rather by having a thorough knowledge of the genuine.

Weed Control

Weeds are the perpetual nemesis of all nursery managers. The question we must answer each year is not "if we have a weed problem" but rather "when the weeds start developing."

Although our "bareroot" nursery counterparts may not agree, weeds are more difficult to control in a container nursery than in a bareroot nursery.

The small cavities used to grow container trees necessitate that any herbicides used must be very target specific and few exist for most the hardwoods grown. A container nursery manager can not afford to use a herbicide that may potentially cause any root inhibition to the container seedling. Such a chemical may control the weed, but may reduce the growth of the seedling due to root damage.

The nursery manager must consider the use of pre-emergent herbicides as the first choice in controlling the weed problem. To rely exclusively on post emergent control can be potentially damaging to the tree crop. First, a nursery manager may not find a post-emergent herbicide that will control the weed pest without doing damage to the trees. Of course, while the nursery manager is looking and experimenting with other post-emergent herbicides, the weeds are lushly growing at the direct benefit of tree that shares the cavity.

Unfortunately, many container nursery managers have relied too heavily upon hand weeding. Every manager knows that this labor intensive activity is a "budget killer." It is costly due to the amount of time required to "climb" in and around the container sets to hand weed. It is also costly due to the time it takes to separate a weed from the tree growing in an individual container cavity.

We as nursery managers owe it to our customers to be continually looking for not only new chemicals but experimenting with different rates of current herbicides to achieve an economic level of control. We can reduce the cost of container seedlings once we find a method of better controlling weeds in the nursery.

Insect Control

Until recently, insect control has not been an activity in which nursery managers have spent a great deal of their time. Their main focus has been on diseases, weeds or an occasional raccoon or opossum that decides to run across the top of the container sets. For years, International Forest Company has applied relatively few insecticides during the growth of the tree crop.

Nursery managers need to pay closer attention to the control of insects that directly attack trees and those that have a role in the spread of plant pathogens as insect vectors. Again, the key to successful insect management is monitoring and inspection.

Most container grown trees are grown in a soilless, high organic media. Under wet conditions this high organic media can support and propagate incredibly large populations of fungus gnats. Their exact role, as to whether they can directly attack and kill young trees or only act as a vector of other plant pathogens, is still being defined. All nursery managers should view this particular insect a potentially serious problem. Control of the moisture in and around the container sets is essential to controlling fungal gnats.

Other more "traditional" insect problems can be controlled fairly easily only if they are detected early. Again, daily inspection and monitoring is the key to successful pest management.

Disease Control

Water management is the primary factor in control of plant diseases in container nurseries. All nursery managers have noted that in dry years much less fungicides are used than in wetter years. Tied to water management is control of the water pH.

Container design also plays an important role in controlling plant diseases. Some containers used today can potentially harbor plant pathogens by allowing them to "overwinter' either inside the walls of the container or on the wall surface in organic matter left over after the trees were extracted. Each nursery manager must address the problem of set sanitation before the container sets are reused.

All containers used in the industry today have water drainage holes in the bottom of the container. The size and location of these holes or hole can play a part in control of plant pathogens that cause root problems. In general a well designed container set will allow free water to rapidly drain out of the cavity.

Allowing the tree foliage to dry down as rapidly as possible each morning after an evening rain or dew is extremely important in controlling foliar pathogens. Most foliar plant pathogens require free moisture to develop. Limiting the amount of time the foliage stays wet following irrigation, rainfall or dew can significantly reduce losses due to plant pathogens.

A review of approved chemicals for container trees indicates a broad choice of available options. However, an informal survey of the most frequently used chemicals indicates a much smaller list. The most popular chemicals of choice are Banrot (or it's components used individually), Captan, Cleary 3336. Most nursery managers sincerely regret that we have lost the use of Benlate.

The chemicals listed above are not a "recommended list." Each manager must make their own choice dependent upon the results in their own nursery and the species of trees grown.

Use of chemicals should be rotated in order to prevent any resistance buildup in the pathogen population. Be sure that the chemical rotation includes chemicals which are not in the same group or similar chemical structure.

Regardless of the chemicals chosen, control of the water pH is imperative. All chemicals have an optimum pH range at which the chemical remains active in the water. This information is not readily available for chemical labels. However if you are using water with a pH much outside the recommended range around 6.0, you should check with the manufacturer to determine if the chemical remains active for as long as you require at your pH.

Shipping

Shipping season is not necessarily the end of the headaches, for many managers, it is only the beginning. Decisions as to how to ship the seedlings, how to store them and weather concerns permeate the shipping season.

Perhaps the most common way to ship seedlings is to extract them from the container and ship in a box to the customer. Extraction of all the seedlings allows for better quality control than shipping the seedlings to the customer in the container sets. Culls are easily removed before they are shipped to the customer.

Weather conditions are an important consideration during the extraction of seedlings. A wet rootball is more difficult to extract than a rootball that is dry. A seedling that is difficult to extract or has a marginally good rootball may end up as a cull if it must be extracted when very wet. However, the root plugs of hardwoods are usually very well formed leaving only the obvious culls as problem seedlings.

Container trees are also shipped in the container sets. This is not a preferred method for the nursery manager for several reasons. First, good seedlings and culls that could have been detected by extraction are shipped together. The tree planters seldom remove any culls unless well trained. Second, container sets sent to the customer are frequently not returned or returned damaged. A deposit can be required, however, it significantly increases the amount of administrative bookkeeping to track them. Thirdly, shipping the trees in the sets is more costly than extracted. More extracted trees can be shipped in the same cubic foot area than can trees shipped in the sets.

Although shipping trees in the containers has many disadvantages for the nursery manager, some customers prefer this method. Difficulty in lining up planting crews is not as much of a problem since the customer can easily water and maintain their trees in the containers.

Container trees do not need to be shipped in refrigerated vans unless they are traveling to a much hotter location. A tree with a rootball of about 80 percent moisture would have no problem being shipped in non-refrigerated vans.

We feel that one of the greatest advantages to container seedlings is that they can be planted anytime of the year as long as adequate soil moisture exists. Nursery managers need to encourage customers to accept shipment as early as possible in the fall. We have had customer plant container trees in late July when good summer rains occur.

The other advantage to early planting is the ability to avoid freezing temperatures that are common after mid December in the Southeastern United States. We at International Forest Company are very strong proponents of fall or late summer planting'of container trees.