Containerized Seedling Longleaf Production

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Abstract-This paper will discuss the production activities and the history of containerized longleaf seedling production in the southeastern United States. Containerized longleaf seedling production began in the mid 1970's. Since the early 1980's production capacity increased approximately 500,000 to 1,000,000 seedlings each year. Through 1996 the estimated total production is nearly 30,000,000 seedlings. Most of the containerized longleaf seedling production is in Georgia, where 15 different nurseries are producing seedlings in a variety of containers. But production also occurs in North Carolina, South Carolina, Florida, Alabama, Mississippi, and Louisiana. Production activities from site selection through packaging for shipment are discussed.

Keywords: Longleaf pine, *Pinus palustris* Mill., containerized seedlings.

INTRODUCTION

Containerized longleaf seedling production dates probably to the mid 1970's in Pineville, Louisiana. Dr. James Barnett, USDA Forest Service Chief Silviculturist began growing longleaf in containers as an alternative to planting bareroot seedlings in silvicultural research outplantings. Successful bareroot seedling establishment of longleaf is difficult. It is a widely know fact among foresters that a substantial risk is taken to transport, handle, and plant bareroot longleaf seedlings. It is very common to obtain less than 50 percent survival from planting bareroot longleaf seedlings. To evade the failure, more bareroot seedlings were planted. Resulting stands remained difficult to manage. They were either greatly overstocked or poorly distributed. Frequent success was limited to plantations established close to the nursery. Survival decreased for those seedlings required to be stored and then transported for long distances away from the nursery. Because of these problems with bareroot seedlings, Dr. Barnett was researching new methods to establish longleaf pine seedlings.

The Florida Division of Forestry is Probably the first organization that began a significant production of containerized longleaf seedlings. They began in 1982 growing containerized seedlings in Styroblocks in Punta Gorda, Florida. Also, during that time period, Speedling Nurseries Inc. in Tampa, Florida began growing containerized seedlings (Figure 1). Several pulp & paper company personnel in South Georgia recognized the need as well to find a way to plant longleaf pine seedlings and obtain acceptable survival.

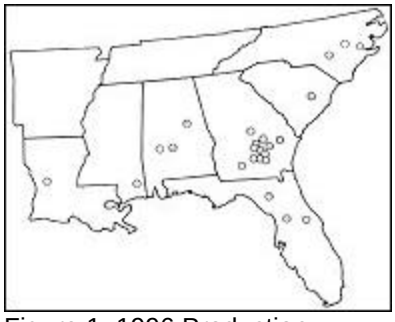

Figure 1. 1996 Production locations of containerized longleaf seedlings.

Frank Vande Linde with Brunswick Pulp and Land Company, began some research in cooperation of Howard Waters in Jesup, Georgia. Their objectives were to solve the seed germination problems associated with longleaf and establish the minimum standards to grow

containerized longleaf seedlings.

International Forest Seed Company began growing containerized longleaf in 1983 and has increased it's production every year, reaching the current annual production capacity of 9,000,000 seedlings. Other nurseries starting large operations of containerized longleaf during the 1980's include: Southern Seed Company Dublin, Georgia, South Carolina Forestry Commission Wedgefield, South Carolina, U.S. Forest Service Brooklyn, Mississippi and Weyerhaeuser Company Aiken, South Carolina. Howard Waters owner of Waters Plant House Jesup, Georgia, produced several million seedlings and has encouraged other growers in south Georgia to grow seedlings as well (Table 1).

Table 1. Container Longleaf Production Estimates for the 1996 Growing Season (Millions of Seedlings)

	Government	Private	Total
NC	1.7	2.15	3.85
SC	1.3	0.0	1.2
GA	0.0	13.78	13.78
FL	2.8	0.2	3.0
AL	0.0	5.1	5.1
MS	2.6	0.0	2.6
LA	0.5	0.0	0.5
	8.9	21.23	30.03

The many successes of plantations established with containerized seedlings have become widely known over the last few years. The results of containerized longleaf technology has instilled new confidence in artificial longleaf regeneration as evidenced in a steady production expansion (Figure 2).

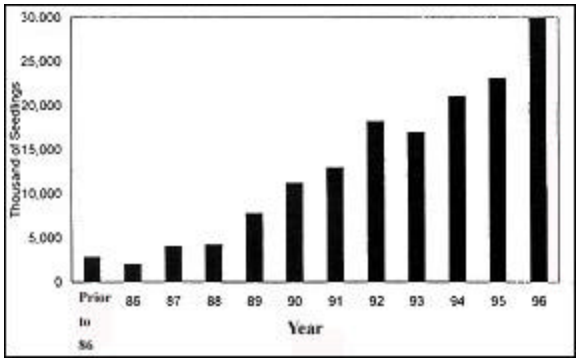

Figure 2. Container longleaf seedling production during the last 10 years.

PRODUCTION CONSIDERATIONS: NURSERY LOCATION

Selecting a site to grow containerized longleaf seedlings requires thoughtful consideration. The first consideration must be the water quality. It is of course the quality of the irrigation water that will eventually lead to your success or failure over time when growing tree

seedlings, whether containerized or bareroot. The source of water Is very critical and usually determines whether or not you would choose 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 warm spring (temperatures below 85 F) facilities excellent germination. Longleaf thrive in full sunlight. The summer months throughout the longleaf range will be hot regardless of where you establish your nursery. Establish the nursery within the natural range of longleaf, but choose an area where the plants can be exposed to seasonal changes.

Containerized seedling production is a laboring process. The third most important factor when considering your location is the infrastructure to support the nursery production. Obtaining labor to grow the crops is an important consideration. In this modern age of having a "just in time" suppliers 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.

PRODUCTION CONSIDERATIONS: PRODUCT & 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 multipots are available. Experience has shown that a 5.7 cubic inch cavity with a 3.5 inch depth works well. Multipots 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 seedling quality (the product) and customer service is directly effected by the container used.

PRODUCTION CONSIDERATIONS: SEED

Longleaf seed germination still appears to be an enigma to just about all nursery managers. It is the most important variable in regards to germination and vigor when considering all the Southern pines. It's large size and soft seed coat make it extremely difficult to condition in the seed plant. Methods are in place, however costly, to consistently produce clean seed with germinations of 85% and better. Once again, experience demonstrates that any improvement in seed quality that can be made, should be made, when considering the subsequent compounding effects poor seed quality has on seedling production.

Choose seed with good vigor. That is, seed which germinates fully and quickly. Purities should be higher than 98% since debris slows sowing operations. Stratify the seed 7 to 10 days at 33 F 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 from sowing through shipment. Total estimated germination usually drives the decision as to the number of seeds to sow in each cavity. 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%. Less than 90%, usually involves sowing more seed per cavity. Germinations less than 60% are rarely cost effective.

PRODUCTION CONSIDERATIONS: MEDIA

Don't use dirt! Use a soiless 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 meg/100cc.

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

Mycorrhizae, usually *Pisolithus tinctorius* (PT), is added to the media to improve seedling health. When PT is incorporated in the media, more fibrous roots develop aiding in water and nutrient absorption. It stands to reason that a healthier tree will have a better change at survival in the nursery as well as on the planting site. At the same time, granular fungicides are amended to the media to control soil borne pathogens. Choose chemicals however that do not inhibit mycorrhizae development.

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. Mulch the seed lightly with grit, vermiculite, perlite, or peatmoss. Mulching helps maintain seedcoat moisture through the germination phase of seedling growth.

Once the filled containers are placed in the production area, immediate action is necessary to

protect your investment from environmental damage. Cover the crop with shade clothe. This will protect the seed and germinating seedlings from predators, heavy rains, hail storms and wind damage. The clothe should stay in place during the first 4 to 5 weeks after sowing or until about 90% of the seeds have germinated.

Irrigation should be frequent enough during the entire germination phase to maintain seed coat moisture levels that promote germination, but minimizes pathogen development. Over watering as well as under watering can cause severe variation in filled cavity percentages. It is this point in time of the operation that has the greatest influence on the success or failure of the crop. Be sure to have monthly plant development goals in place before your operation begins, against which you can measure your progress. It is easy to plot on a line graph characteristics such has height, shoot weight, root weight, and root collar caliper.

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

PRODUCTION ACTIVITIES: 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 drain media also aides in fertility and pest management.

PRODUCTION ACTIVITIES: FERTILITY MANAGEMENT

The goal for which a nursery manager should aim, is to first produce a seedling with a developed rootball and then a well developed shoot. It takes relatively little effort to produce a nice looking shoot, 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 breakdown the growing 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 high nitrogen in the approximate ratio of 20-10-20 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.

PRODUCTION ACTIVITIES: PEST MANAGEMENT

The key to successful control of all pests, is daily observation, 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, insect 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.

PRODUCTION ACTIVITIES: 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 necessitates that any herbicides used must be very target specific. 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.

PRODUCTION ACTIVITIES: INSECT CONTROL

Until recently, insect control has not been an activity in which container 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 Seed Company have 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 soil-less, 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.

PRODUCTION ACTIVITIES: 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 of 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 due 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 containerized 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 list 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.

PRODUCTION ACTIVITIES: 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. Cults 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.

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 it the same cubic foot area than can trees shipped in the sets.

Although shipping tree in the containers has many disadvantages for the nursery manager, many 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 container.

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% moisture would ship well in non-refrigerated vans.

We feel that one of the greatest advantages to container seedlings is that it 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 customers successfully 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

Seed Company are very strong proponents of fall or late summer planting of container trees.

SUMMARY
Containerized longleaf seedling production has grown to over 30 million trees during the ten year period through the 1996 growing season. Over 20 growers are producing seedlings in a variety of multipot containers . The keys to successful crops are container choice and the use of quality seed, water and pest management practices. Well trained experienced employees to plan and implement the growing strategy are crucial to the success of any nursery crop, especially containerized longleaf.

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