

# Container Seedling Handling and Storage in the Southeastern States

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In: Riley, L. E.; Dumroese, R. K.; Landis, T. D., tech coords. National proceedings: Forest and Conservation Nursery Associations—2003; 2003 June 9–12; Coeur d'Alene, ID; and 2003 July 14–17; Springfield, IL. Proc. RMRS-P-33. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

**Abstract:** Most container seedlings grown in the southeastern US are outplanted during winter, although 10 to 20% are outplanted during summer. Longleaf pine accounts for more than 80% of all container seedlings produced. Very little information is published on cold hardiness and storage effects on container-grown southern pines and hardwoods. In general, growers attempt to minimize storage time by coordinating extraction with outplanting, particularly during summer outplanting. Seedlings are hand extracted and placed into wax-coated boxes with slits or holes in the sides, either with or without a plastic liner, and placed into cooler storage. Seedlings for summer outplanting are generally stored at 40 to 70 °F (4 to 21 °C) but usually for a week or less. Seedlings extracted in winter (November through January) are kept at cooler temperatures (35 to 50 °F [2 to 10 °C]), sometimes for as long as 3 months. Research on cold hardiness development would be helpful in understanding proper storage conditions and lengths for southern pines.

**Keywords:** longleaf pine, slash, loblolly, *Pinus palustris*, *P. elliotii*, *P. taeda*, cold hardiness, hardwoods, research

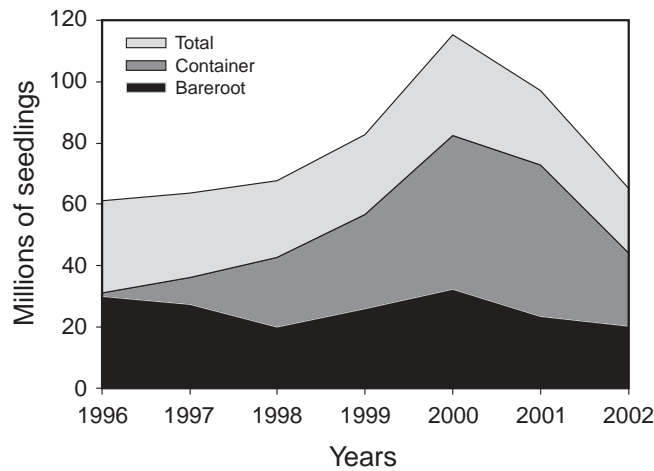
## Introduction

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The 3 major reforestation conifer species in the southeastern US are pines: loblolly (*Pinus taeda*), slash (*P. elliotii*), and longleaf (*P. palustris*). For decades these species were only grown as bareroot stock types. Today, all 3 species are grown in containers as well. Despite the fact that container loblolly have been shown to outperform bareroot loblolly on difficult sites (South and Barnett 1986; Barnett and McGilvray 1993), bareroot production still dwarfs container production due to the higher costs of container stock. For longleaf, however, the story is different.

In the 1990s, overall demand for longleaf soared because of federal incentives associated with the Conservation Research Program (Outcalt 2000), peaking at more than 115 million seedlings in 2000 (Figure 1). In the mid 1990s, container production was increasing at 12% or more per year (Hains 2002), but dramatically increased by more than 2.5 times between 1996 and the peak of production in 2000. In 2000, container production accounted for 70% of all longleaf seedlings grown (Hains 2003). Demand also surged because, for some landowners, longleaf was considered a more secure investment than the other southern pines because of its fire tolerance, resistance to bark beetles, better growth on sand ridges, and higher value as sawtimber (Hains 2002). Longleaf stands can be managed under a variety of harvesting techniques (for example, shelterwood, even-aged), and specialty products like pine straw for landscaping markets can increase income (Outcalt 2000).

Container longleaf production surged for several reasons. Container production made more efficient use of seeds in short supply (Barnett and McGilvray 2002). Once produced, container longleaf (Figure 2) are thought to be easier to outplant than bareroot longleaf because their root plugs are more compact and uniform (Hains 2002; Larson 2002). Container seedlings have a much wider outplanting window, in fact, a year-round outplanting window, but most container longleaf continue to be outplanted from mid-September through March if suitable soil moisture is present. Some operational foresters believe longleaf pine seedlings outplanted between September and November perform better than those outplanted from December through March (Larson 2002), presumably because of the root growth during fall. And most importantly, Boyer (1989) and Barber and Smith (1996) showed that container longleaf survive and grow better on outplanting sites than bareroot stock.



**Figure 1**—Annual production of bareroot and container longleaf pine seedlings in the southeastern United States from 1996 through 2002 (source Hains 2003).

Even though millions of container longleaf pine are produced annually, target seedling specifications are still incomplete. Barnett and others (2002) suggest general, interim, morphological specifications without physiological attributes because of the paucity of literature on the latter. Some literature discusses cold storage of bareroot longleaf pine and indicates that seedling morphology and physiology significantly affect field performance after storage (White 1981), but it is unclear how this would correlate with container production. One study with container longleaf reported that roots show very little seasonal variation in cold hardiness, reach maximum hardiness levels in December, and should never be allowed to experience temperatures below 26 °F (−3 °C) to prevent injury (Tinus and others 2002). The need for additional physiological information is borne out by unpublished data supplied by Pickens (2003); he found that seedlings lifted in mid-October and stored up to 8 weeks sometimes performed on outplanting sites as well as seedlings that remain in their containers in the nursery, but other years had 50% less survival.

Although research has yet to be reported, growers are storing container longleaf pine and other species with success. Here we report on some operational practices being conducted in the South, and suggest topics for future research projects that would help clarify the questions surrounding storage of southern pine seedlings.

## Current Handling and Storage Practices

Nearly 40 million seedlings are being grown at the 4 nurseries in the southeastern US we surveyed. About 82% of the container seedlings are longleaf pine, followed by 10% loblolly, 6% slash, with 2 nurseries growing about 600,000 “other” seedlings representing 27 species (Table 1; Aiking 2003; McRae 2003; Parkhurst 2003; Pittman 2003). In the South, seedlings are generally outplanted within 2 windows: “summer” which includes April through August (particularly the



**Figure 2**—Typical longleaf pine container seedling.

rainy season months of June through August) and “winter” which is generally November through February, although the trend seems to be for year-round outplanting as long as soil moisture levels permit (McRae 2003; Pittman 2002, 2003). About 80 to 90% of the seedlings are outplanted during winter. The handling and storage of seedlings, however, is much the same regardless of planting season. All of the nurseries attempt to minimize storage by extracting and shipping seedlings to customers in increments equal to what the customers can plant within a week.

Typically, seedlings are irrigated to field capacity prior to extracting from the containers. One nursery applies MilStop, a potassium bicarbonate-based, broad spectrum foliar fungicide with a minimal restricted entry interval (BioWorks Inc, Geneva, New York) to protect against disease during storage (Aiking 2003). Once foliage is dry, containers may or may not be sent through a plug-loosening machine, but all seedlings

**Table 1**—Annual container seedling production by species at four nurseries in the southeastern United States.

Nursery	Container seedlings produced (millions)			
	Longleaf pine	Loblolly pine	Slash pine	Other <sup>a</sup>
American Tree Seedling, Georgia	10	1	1	
Andrews Nursery, Division of Forestry, State of Florida	4			
Claridge State Forest Seedling Nursery, Division of Forest Resources, State of North Carolina	3	0.1	0.5 <sup>b</sup>	
International Forest Company, Georgia	15	3	1.5	0.1
<b>Total</b>	<b>32</b>	<b>4.1</b>	<b>2.5</b>	<b>0.6</b>

<sup>a</sup>Includes: *Aesculus flava* (yellow buckeye); *Carya illinoensis* (pecan); *Cercis canadensis* (redbud); *Chamaecyparis thyoides* (Atlantic whitecedar); *Cornus florida* (dogwood); *Diospyros virginiana* (persimmon); *Elaeagnus umbellata* (autumn olive); *Lespedeza bicolor* (lespedeza); *Liriodendron tulipifera* (yellow poplar); *Malus* sp. (crabapple); *Prunus angustifolia* (chickasaw plum); *Prunus* sp. (flatwoods plum); *Quercus acutissima* (sawtooth), *alba* (white), *georgiana* (Georgia), *lyrata* (overcup), *Michauxii* (swamp chestnut), *nigra* (water), *pagoda* (cherrybark), *phellos* (willow), *prinoides* (dwarf chinkapin), *rubra* (northern red), *shumardii* (Shumard), *texana* (Texas red [formerly Nuttall]), *velutina* (black), *virginiana* (live); *Taxodium distichum* (bald cypress). Nomenclature follows USDA NRCS (2002).

<sup>b</sup>*Chamaecyparis thyoides* (Atlantic whitecedar).

are extracted by hand (Figure 3). Some nurseries use a plastic liner to retard moisture loss. All of the nurseries use wax-coated cardboard boxes, generally developed for some type of produce, and having slits or holes in the side and top of the box to allow air circulation or light entry (Figure 4). Boxes hold between 125 and 400 seedlings depending on species, container volume, and stock size. During summer extraction, seedlings are stored in onsite coolers or rented refrigerated trucks at 40 to 70 °F (4 to 21 °C) for no more than a week. Storage at cool temperatures reduces transpiration and helps maintain moisture in the root plugs. One nursery ships small quantities (300 to 1,500 seedlings) via United Parcel Service because delivery occurs within 2 or 3 days in the South (McRae 2003).

During winter extraction seedlings are extracted and stored in a similar manner, although storage temperatures are generally lower, 35 to 50 °F (2 to 10 °C). Before extracting in winter, nursery managers would like to see the crop experience some hardening temperatures. One nursery attempts to store seedlings no longer than a month, while other nurseries will store seedlings up to 3 months (Figure 5). McRae (2003) uses this general guideline for storage duration: For conifers harvested in September and October, maximum storage length is generally a week or less. By November, seedlings can be held 1 to 2 weeks, and by January seedlings can be held for 2 or 3 months, although loblolly buds may begin to elongate and whiten with longer storage durations.

Hardwoods (“other” species listed in Table 1) are limited to winter outplanting and are generally handled and stored the same way. Although harvesting usually waits until they drop their leaves, it is not always necessary (McRae 2003). Short storage durations also limit disease progression.

## Research Needs

Barnett and others (2002), in proposing interim specifications for longleaf pine seedlings, indicate that those guidelines require updating based on evaluating seedling performance over a wide range of morphological and physiological characteristics. Indeed, it would be useful to growers to have information on the interactions between various cultural practices and resulting seedling quality, in terms of both morphological and physiological attributes. For example,

optimum foliar nitrogen, or even the range of suitable nitrogen concentrations, is still unknown. We see a need to document the influence of growing seedlings at lower irrigation frequencies to improve water use efficiency and hasten development of cold hardiness in late summer. Answering these



**Figure 3**—Seedlings are extracted by hand.





**Figure 4**—Seedlings are placed into wax-coated boxes for storage and shipment. Boxes are generally designed for produce and have slits or holes for ventilation and hold between 125 and 400 seedlings.



**Figure 5**—Once extracted, seedlings can be held for short periods in refrigerated storage until planting.

types of questions should lead to enhanced seedling quality. And, quantifying physiological and morphological characteristics and how they interact during various storage conditions and lengths would be helpful for determining when and for how long seedlings could be stored. Ideally, this type of research would follow seedlings all the way to the outplanting site.

## Acknowledgments

We thank Arne Aiking, American Tree Seedling; John McRae, International Forest Company; Jeff Parkhurst, State of North Carolina; and Tim Pittman, State of Florida for providing information about their seedling handling and storage practices.

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