CONTAINER-GROWN LONGLEAF PINE SEEDLING QUALITY

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Abstract—The Longleaf Alliance, in cooperation with the USDA Forest Service, the Georgia Forestry Commission, and the Clemson Extension Service, has installed numerous longleaf pine (*Pinus palustris* Mill.) seedling quality studies across the Southeastern United States. This paper reviews survival and growth for different classes of container-grown longleaf pine including: target seedlings, floppies, doubles, and sondereggers (hybrids) two to three growing seasons post-outplanting.

INTRODUCTION

Longleaf seedlings are usually sold on a per thousand basis *(*The Longleaf Nursery List 2004), and an average lot of 1000 seedlings will contain several classes or categories of seedlings. These studies were initiated to determine the feasibility of increasing longleaf pine planting success by visually sorting through given lots of container-grown longleaf pine seedlings and removing non-target seedlings. Container-grown longleaf seedling quality may vary dramatically from nursery to nursery. If seedlings are judged by the Interim Guidelines for Growing Longleaf Seedlings in Containers (Barnett and others, n.d.; Barnett and others 2002), some nurseries ship batches of seedlings from which the vast majority are good quality/target seedlings, while other nurseries ship lots from which the majority should be culled. Some nurseries pack boxes with a given number of good/target seedlings and include cull/floppy seedlings as extras to be planted or discarded at the purchaser's discretion.

When first conceived, the goal of these seedling quality studies was to determine if seedlings could be visually sorted into various classifications, which would then be tracked to determine the relative survivability and vigor of the classifications. By collecting this data, it could be determined how much a landowner, forester, or tree planter could gain from the removal of culls, hybrids, or doubles.

Initially, survival and growth were tracked based solely upon visual classifications. Upon further review, we determined that it would be beneficial to track how visually grading seedlings affected average measurements, such as root collar diameter (RCD). With the benefit of simple RCD measurements, a forester or tree planter could compare their longleaf seedling classification or categories to those utilized in this study. More recently, Dr. David South (Auburn University, School of Forestry and Wildlife Sciences) suggested additional studies to track RCD and other measurements by individual seedlings and their location within a study site.

METHODS

Study Design

Seedlings were selected from one nursery and one seed source for each site. Seedlings were out-planted by hand in randomized complete blocks. Seedlings were planted so that the plug was level with or protruding above the soil surface, depending on the site preparation for a given study site. There were 3 or 4 replications per site, 3 to 7 treatments (seedlings classes or categories), and 14 to 20 seedlings per treatment. Data reported are from studies installed in 2001, 2002, and 2003 in Georgia, Alabama, and South Carolina.

Seedling Categories/Classes

Target/good—Longleaf seedlings are grown in small ribbed containers with individual container cavities having a volume of about 6 cubic inches, a minimum depth of 4.5 inches, and a seedling density of < 50 per square foot (Barnett and McGilvray 1997). Typical seedlings are sown in the spring and form a well-rooted "plug" by late fall or early winter. Target seedlings met seedling quality standards as defined by the Interim Standards for Longleaf Pine Container Seedlings Stock (Barnett and others n.d.; Barnett and others 2002).

Doubles—Some nurseries double-seed containers to insure an optimum percentage of cells are filled with viable seed, often resulting in two live seedlings per plug. Some nurseries remove one of the seedlings by clipping the smaller seedling at the top of the plug, approximately where one would measure RCD. In these studies, only those plugs with two intact seedlings were included as doubles.

Floppies—Suppressed seedlings usually do not develop sufficient root collars or fine root systems to form a good plug and are typically referred to as "culls" or in this study as "floppies". Seedlings that did not meet the Interim standards because of inadequate plugs were selected as floppies. In subsequent studies, floppies were further subdivided into those greater or lesser than 4.75 mm in RCD.

Sondereggers—Hybrids between longleaf and loblolly are historically referred to as "sondereggers" (Walker and Wiant 1966). Sonderegger seedlings typically exhibit height growth while still in the container. Initial attempts to include sondereggers in seedling quality studies were largely inconclusive due to difficulty in identification of hybrid seedlings. At first, any seedling exhibiting stem growth was assumed to be a hybrid. In later studies, only seedlings with exaggerated stem growth of ≥ 4 inches were included as hybrid seedlings.

Extra large—Visually, extra large seedlings would automatically go into the "target/good" seedling pile. However, there is some concern that extra-large seedlings may become rootbound. Seedlings > 9.0 mm were selected as extra-large on two sites. In the most recent seedling quality study seedlings > 10.0 mm (1 cm) in RCD were selected.

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Buds on stem—Some longleaf seedlings exhibit multiple bud formation approximately where the tap-root meets the first needle growth, at or around where one would measure RCD. It is currently unknown if adventitious bud formation is an early indication of potential problems with the seedling or if these buds are of no importance to seedling quality. Seedlings exhibiting bud growth separate from the terminal bud were first selected for study inclusion and out-planted on February 8, 2005.

Weeds in plug—It is common to find other plant species occupying the same plug as a longleaf pine seedling. The Interim Standards call for plugs with weeds to be rejected as cull seedlings. In January, 2005, longleaf plugs with willows in the same plug were acquired from a nursery in Georgia. These plugs were selected for study inclusion and out-planted in Virginia on January 21, 2005, and in Alabama on two sites on February 8, 2005, and February 11, 2005.

Study Sites

Alabama, Samson Site—This site was an old field utilized for cotton and peanut production until 3 years prior to study installation. A scalping site preparation was utilized. Seedlings were grown by Meek's Farms of Kite, GA, and hand planted on December 14, 2001. Seedlings were released with 2 ounces of Oust® per broadcast acre in April, 2002.

Alabama, Monroe Site—This site is part of an Auburn University Agriculture Experiment Station and was in cotton production the year prior to study installation. The site was scalped prior to planting. Seedlings grown by Simmons Tree Farm of Denton, GA, were hand-planted on February 21, 2002, with dibble bars and plug tools. Seedlings were released with 2 ounces of Oust® per broadcast acre in April 2002.

Alabama, Davis Ridge Site—This is a cutover, mixed-pine hardwood stand with a chemical site preparation following harvest. Seedlings provided by Meeks Tree Farm of Kite, GA, were planted with OST "dibble" bars on December 19, 2002. Seedlings were released the spring following planting.

Georgia, Milledgeville Site—This is an old agricultural field that has been fallow for several years. The site was scalped and then hand-planted to container-grown seedlings from Meeks Tree Farm of Kite, GA, on January 15, 2003. Seedlings were released the spring following planting.

Georgia, Denton Site—This site was a cotton field the year prior to study installation. No site preparation was applied. Seedlings provided by Simmons Tree Farm of Denton, GA, were hand-planted using a plug tool on February 6, 2003.

South Carolina, Pelion Site—This site was a cutover sand ridge. Hardwoods were sprayed with 16 ounces of Arsenal® per broadcast acre in 2001. Remaining live hardwoods and longleaf were cut down at the time of planting on February 4, 2003.

RESULTS AND DISCUSSION

Floppies and sonderegger seedlings yielded the lowest survival rates of the various seedling categories/classes (table 1). Seedlings classified as "floppies" but with RCDs > 4.75 mm exhibited comparable survival rates but grew slower in comparison with target seedlings. Small floppies (RCDs < 4.75 mm) exhibited lower survival and growth rates than target seedlings (table 1).

Table 1—Percent difference for survival and height of selected seedling categories compared to good/target seedlings. Values for good/target seedlings are in parentheses

Percent difference	2 year survival	2 year height	Number of seedlings planted & number of sites
	- - - - - - *feet* - - - - - -		
Good/target (all RCDs)	90.5% (0.0%)	0.56' (0.0%)	546
XL only	94.8% (-0.6%)	0.62' (+12.8%)	172
Floppy (all RCDs)	71.8% (-18.7%)	0.26' (-53.3%)	532
Floppy –large (>4.5 mm RCD)	89.2% (-3.8%)	0.26' (-55.8%)	158
Floppy – small (<4.5 mm RCD)	76.6% (-16.5%)	0.19' (-67.3%)	158
Doubles	95.3% (+1.4%)	0.36' (-21.1%)	256
Seedlings w/ stem growth (in plug)	68.1% (-18.3%)	1.12' (+28.7%)	216

Doubles exhibited slightly higher survival rates than target/good quality seedlings (table 1, fig. 1), but many doubles persisted with resultant decreases in height growth (fig. 2).

True sonderegger seedlings may suffer high mortality rates when compared to target seedlings. On the Monroe Site and the Samson Site, nearly 100 percent of the sonderegger seedlings died in the first growing season. Almost all seedlings with < 4 inches of stem growth that were initially selected as hybrids now appear to be true longleaf seedlings. If visual parameters are utilized to select hybrids, most seedlings exhibiting stem elongation > 4 inches in the container are hybrids, while seedlings with < 4 inches are often true longleaf seedlings.

Extra-large seedlings did not exhibit significant differences in survival but did add more height in the first two growing seasons when compared to smaller, good-quality seedlings.

Additional Studies

(1) Seedlings in recently planted studies will be tracked by individual RCD. (2) Seedlings with willows have been out-planted on two dry sites and one wet site. (3) Seedlings with other weed species will be examined as feasible. (4) Seedlings with buds on the taproot have been out-planted and will be examined based upon the number of visible buds and RCD. (5) Further examination of root morphology is required to determine if certain containers lend themselves to spiraled roots or other problems with longleaf seedlings.

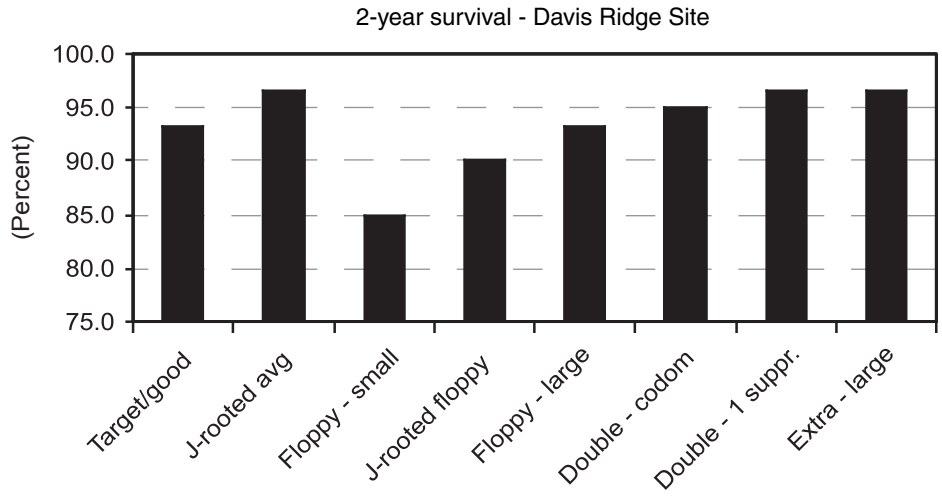

Figure 1—Two year seedling survival at the Davis Ridge Site.

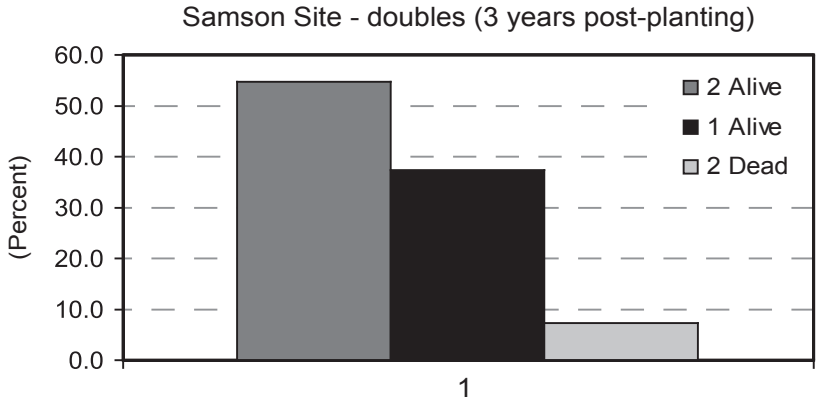

Figure 2—Height growth of doubles 3 years post-planting at the Samson Site.

SUMMARY

Visually sorting container-grown longleaf pine seedlings may result in the removal of numerous floppy, hybrid, and double seedlings. Removing small RCD floppies and true sondereggers will likely result in an increased overall survival rate, especially when adverse environmental factors stress newly planted seedlings. Clipping doubles and discarding the smallest (< 4.75 mm RCD) floppies should yield increases in the average height of surviving seedlings at 2 years post-planting.

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