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DETERMINING THE CORRECT PLANTING DEPTH FOR CONTAINER-GROWN LONGLEAF PINE SEEDLINGS

Mark J. Hainds[1]

Abstract—The Longleaf Alliance installed four planting-depth studies from 1998 to 2002 to determine the optimal depth for container-grown longleaf pine (*Pinus palustris* Mill.) seedlings. Results indicate that deep planting significantly reduced seedling survival and growth. Results also indicate that longleaf is very tolerant of shallow planting whereby the plug is exposed at the time of planting, thus discrediting the "wick" theory. Planting-depth guidelines for most States may be incorrect. Emphasis should be shifted from depth of the plug to height of the terminal bud above the soil surface.

INTRODUCTION

Approximately 30 million container-grown longleaf pine (*Pinus palustris* Mill.) were planted annually in the Southeastern United States as early as 1996 (Hainds 2002). Approximately 45 million container-grown longleaf pine seedlings will be planted during the 2002-03 planting season (Hainds unpublished data). Despite these huge investments in artificial regeneration of longleaf pine, no research was done prior to 1998 that examined methods for planting container-grown longleaf pine seedlings.

In December 1998, The Longleaf Alliance installed the first planting-depth study to validate information related by tree planters and foresters who had considerable experience planting bareroot loblolly and slash pine. Common knowledge stressed that "deeper is better" regardless of the pine species being planted. Planting guidelines developed from these theories typically emphasized a narrow planting window with a major concern being the avoidance of shallow planting that exposed the plug. The prevailing theory was that an exposed plug would act as a "wick" (Larson 2002), drying out the plug and increasing seedling mortality. Furthermore, most guidelines allowed the terminal bud to be covered with soil at the time of planting, assuming that erosion will uncover the bud and allow unrestricted growth. Consequently, these planting guidelines encouraged deep planting.

Prior to this 1998 study, no research examining planting depth and container-grown longleaf pine seedling survival could be located in the existing literature. Initial findings from the 1998 study indicated that covering the terminal bud with soil was severely detrimental to seedling survival and growth (table 1), (Orchard Site). "Shallow" seedlings exhibited no ill effects from exposing the plug. Suspecting this finding was an anomaly, three subsequent planting-depth studies were installed over the following years.

METHODS

Study Designs

All four planting-depth studies utilized the randomized complete block design. Each study had 4 or 5 replications of each treatment (depth) and 14 seedlings per plot. Survival rates were assessed at 1 to 2 years postplanting.

Planting Methods, Soils, and Seedlings

All seedlings were planted by hand using either plug tools or OST planting bars (dibbles). Soils across all sites were sandy loams or loamy sands. The Monroe Study was unique in that soils were exceptionally wet with the seedlings often being under water following rainfall events. Seedlings were 4 ½-inch plugs on the Orchard Site and 6-inch plugs with the remaining three studies.

STUDY SITES

Orchard site (1998)—This study was installed in an old pecan orchard on the Solon Dixon Center in southern Alabama. Site preparation consisted of a scalping operation exposing a trench about 4 inches deep and 30 inches in width. Immediately after scalping, the site was ripped/subsoiled to an approximate depth of 16 inches. Seedlings were hand planted with a plug tool in December 1998. Four planting depths were examined:

Table 1—Percent mortality by planting depth from deep to shallow[a] (height to terminal bud)

Study site	-3 CM	-1 CM	Level	+1 CM	+2 CM	+3 CM	+6 CM
				percent			
Silvopasture	57	41	24		21		
Godwin	79	71	39		36		
Orchard		56	19	17	20		
Monroe			38			33	21

[a] Mortality assessed 1 or 2 years after planting.

[1] Research coordinator, The Longleaf Alliance, 12130 Dixon Center Road, Andalusia, AL 36420.

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1. Exposed plug, terminal bud 2 cm above soil surface (+2 CM)
2. Exposed plug, terminal bud 1 cm above soil surface (+1 CM)
3. Plug covered - 1 cm below soil surface, terminal bud not covered (level)
4. Plug 2 cm below soil surface, terminal bud 1 cm deep (-1 CM).

Silvopasture site (2000)—Six-inch plug seedlings were planted with an OST dibble on December 7, 2000, on a cutover site that had minimal mechanical site preparation. Survival was assessed on June 10, 2002. Terminal bud position was used for treatment depths rather than plug position. The 4 treatments were:

1. Bud 3 cm (1.2 inches) beneath soil surface (-3 CM)
2. Terminal bud 1cm (0.4 inch) beneath soil surface (-1 CM)
3. Bud exposed at soil surface (level)
4. Bud 2 cm (0.8 inch) above soil surface (+2 CM).

Godwin site (2000)—Site preparation consisted of a scalping operation exposing a trench about 4 inches deep and 30 inches in width. Six-inch plug seedlings were planted with an OST bar on December 1, 2000, and survival was assessed on December 3, 2002. Terminal bud position was used for treatment depths rather than plug position. The 4 treatments were the same as for the Silvopasture site.

Monroe site (2002)—Site preparation consisted of a scalping operation exposing a trench about 4 inches deep and 30 inches in width. Six-inch plug seedlings were planted with an OST bar on February 21, 2002, and survival was assessed on February 18, 2003. Terminal bud position was used for treatment depths rather than plug position. The 3 treatments were:

1. Plug exposed, bud 1 cm (0.4 inch) above soil surface (+1 CM)
2. Terminal bud 3 cm (1.4 inches) above soil surface (+3 CM)
3. Terminal bud 6 cm (2.4 inches) above soil surface (+6 CM).

RESULTS AND DISCUSSION

Seedling survival and growth were negatively affected by deep planting (table 1). Mortality increased if the bud was covered at the time of planting or buds were subsequently covered by soil moving onto buds in scalped rows. In scalped furrows, seedlings planted with the bud at, or slightly above, the soil surface ended with the bud covered by soil moving into the scalped furrow. Approximately 1 inch of soil moved into 3- to 4-inches deep scalped furrows within 6 months of planting. If seedlings were not planted with the plug protruding at least 1.5 inches above the soil surface in deeper furrows, soil movement into the furrow and over the terminal bud may result in increased mortality and decreased growth rates of surviving seedlings. No significant increases in mortality were detected in seedlings planted with the plug exposed, even where approximately 5 cm of the plug was above the soil surface on the Monroe Site.

CONCLUSIONS

1. Deep planting, where the terminal bud is covered with soil, resulted in increased seedling mortality and reduced growth.
2. The wick theory is invalid. Container-grown longleaf pine seedlings appeared tolerant of shallow planting with the plug exposed.

NEW RECOMMENDATIONS FROM THE LONGLEAF ALLIANCE

Rather than focusing on depth of the plug, focus on anticipated position or depth of the terminal bud 6 months to 1 year postplanting.

1. On flat-planted sites, instruct tree planters to leave plug slightly exposed so that the terminal bud is above the soil surface.
2. On scalped sites, try to position the terminal bud approximately 2 inches above soil surface, leaving 1 to 1.5 inches of the plug exposed.
3. On extremely wet sites, position terminal bud > 2 inches above the soil surface, leaving 2 to 3 inches of the plug exposed.

ADDITIONAL STUDY

A fifth planting-depth study was installed at the Solon Dixon Center on a cutover site in July 2002. A sixth study was installed in Milledgeville, GA, in January 2003. Sites number 7 and 8 were planted February 4, 2003, in Lexington, SC. Finally, a ninth site was selected and planted in Denton, GA, on February 6, 2003. Additional studies will be installed with plugs protruding further above the soil surface on cutover sites. Sites with heavier soils should be examined in future replications. Also, different plug lengths and seedling root-collar diameters should be examined for tolerance of shallow planting.

SUMMARY

Seedlings planted with the plug protruding above the soil surface survived and grew at the best rates regardless of the site, environmental conditions, or plug length. Position of the terminal bud is more important that position of the plug. Seedlings planted with the terminal bud beneath the soil surface suffered increased mortality compared to seedlings with the terminal bud above the soil surface. Benefits of shallow planting appear to be more pronounced in areas where soil will move onto the seedling (i.e., scalped fields) and very wet sites. Seedlings planted with the plug exposed did not suffer increased mortality as previously supposed with the wick theory.

LITERATURE CITED

Hainds, M.J. 2002. Longleaf seedlings trends. In: Barnett, J.P.; Dumroese, R.K.; Moorhead, D.J., eds. Proceedings of workshops on growing longleaf pine in containers – 1999 and 2001. Gen. Tech. Rep. SRS-56. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 3-4.

Larson, D.R. 2002. Field planting longleaf pine seedlings. In: Barnett, J.P.; Dumroese, R.K.; Moorhead, D.J., eds. 2002. Proceedings of workshops on growing longleaf pine in containers – 1999 and 2001. Gen. Tech. Rep. SRS-56. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 63 p.

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Description: Ninety-two papers and thirty-six poster summaries address a range of issues affecting southern forests. Papers are grouped in 15 sessions that include wildlife ecology; fire ecology; natural pine management; forest health; growth and yield; upland hardwoods - natural regeneration; hardwood intermediate treatments; longleaf pine; pine plantation silviculture; site amelioration and productivity; pine nutrition; pine planting, stocking, spacing; ecophysiology; bottomland hardwoods - natural regeneration; and bottomland hardwoods—artificial regeneration.