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Seedbed Densities and Sowing and Lifting Dates Affect Nursery Development and Field Survival of Longleaf Pine Seedlings

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Longleaf pine seedling development was markedly affected by seedbed densities: Larger and better quality stock resulted from lower bed densities. Seedlings lifted in December were markedly smaller if they had been sown in the spring rather than in the fall of the previous year; the smaller size produced lower field survival. Fall sowing resulted in greater seedling size and survival when lifting was done in December as opposed to February. When lifting was delayed until February, the effects of sowing dates declined. Tree Planters' Notes 42(3):28-31; 1991.

Longleaf pine *(Pinus palustris* Mill.) is potentially one of the most important pine species for reforestation in the southern Coastal Plain of the United States. Vast unspoiled tracts of longleaf pine previously existed across the South from eastern Texas to South Carolina. This species is characterized by its lack of regeneration on sites that have extensive amounts of competing vegetation. Longleaf pine has no early epicotyl growth and its peculiar "grass stage" contributes to its sensitivity to competition. Regeneration has become more difficult with the advent of fire control, and longleaf pine has failed to maintain its competitive position because of the rapid early juvenile growth of other southern pine species. Acreage in longleaf pine is now only about 10% of that in the original forest. However, there has been an increasing interest in the use of longleaf pine because of its resistance to insect and disease problems and to the high quality of forest products made from its solid wood.

One of the methods of improving reforestation success is to increase the quality of longleaf pine planting stock. Several nursery studies have shown the importance of such factors as seedbed density, dates of sowing, and culture treatments on quality of the planting stock (Derr 1955, Huberman 1938, Scarbrough and Allen 1954, Shipman 1958, Shoulders 1963, Wakeley 1954). Other studies have shown that seedling size and quality affect field survival and early height growth (Lauer 1987, White 1981). Seedling storage is another factor critical to the performance of longleaf pine planting stock and storability seems related to seedling morphology and physiology (Barnett et al. 1990, White 1981). Also, use of fungicides in the packing medium greatly improves the field performance after storage (Barnett et al. 1988). It has been demonstrated that selected nursery culture and seedling handling practices can markedly increase longleaf pine reforestation success (Cordell et al. 1990).

This study was initiated to clarify the relationships among seedbed densities, sowing dates, and lifting dates and their effects on longleaf pine seedling development and field performance.

Methods

Four randomized complete blocks with 25-foot-long plots for each of two sowing dates, two lifting dates, and three densities-10, 20, and 30 seedlings per square foot-were established at the W. W. Ashe Nursery at Brooklyn, Mississippi. Both fall (October 31, 1978) and spring (April 3, 1978) sowings were tested. The thinning necessary to bring the seedbed seedling densities into conformance with the appropriate density targets was done in late May, somewhat later than normal because of a wet spring.

All of the seedlings were undercut to a 6-inch depth on September 15 and November 1, 1979 and in addition, the seedlings scheduled to be lifted in February were root-pruned on December 15, 1979 to stimulate lateral root growth and to retard the devel-

Table 1—*Effect of sowing times, seedbed densities, and lifting dates on percentages of small (4 to 5 mm) and large (11 to 12 mm) longleaf pine seedlings*

	Percent of possible total seedlings/cell			
Seedbed densities	December lift		February lift	
(seedlings/ft^2)	Small	Large	Small	Large
Fall sowing				
10	7	19	5	20
20	23	11	11	17
30	12	11	17	15
Spring sowing				
10	18	9	8	17
20	18	5	15	11
30	25	3	20	8

opment of a long taproot. On December 12-13, 1979, and February 5-6, 1980, 200 seedlings were lifted from each test plot and graded according to root-collar diameter to obtain an estimate of the relative yield per grade as influenced by treatment.

Seedlings from the December and February lift dates were outplanted, 200 for each of the treatment replication combinations, in the same month that the lifting occurred. They were packed according to the operational system used at the nursery-clay slurry treatment in Kraft-polyethylene bags. The stock was outplanted by hand on the Palustris Experimental Forest in central Louisiana at a 2- by 2-foot spacing in the same experimental design as they were grown in the nursery. Survival determinations were made annually for 2 years following planting. Only results after the first year in the field are presented because of low survival due to one of the most severe droughts on record during the summer and fall after planting.

Statistical analyses of treatment means followed analysis of variance procedures with $P < 0.05$ level was used to test significance. Since all treatment effects and their interactions were statistically significant, no detailed statistical data are presented and the results are presented graphically.

Results and Discussion

Seedling development. Two major trends in seedling development are obvious from the data. First, seedbed density affected seedling size at the time of lifting. The percentages of small seedlings were much lower when they were grown at a bed density of 10 per square foot for both December and February lift dates (figure 1). The percentage of larger seedlings was greater at this low density. The highest density (30 per square foot) produced the smallest seedlings regardless of lifting dates (table 1), except for the fall sow/December lift.

Second, there was a relation between sowing dates and lifting dates. Seedlings lifted in December were smaller if they had been spring-sown rather than fall-sown (table 1), which confirms Shipman's (1958) conclusions that larger planting stock resulted from fall-sown pine seeds. However, when lifting was delayed until later in the season (February), the percentage of larger plantable stock increased significantly for both sowing times. The longleaf pine seedlings continued to develop in the winter months in this south Mississippi nursery. The size of planting stock increased when lifting was delayed from December to February, but the size differences were greater for spring-sown than fall-sown seedlings.

Seedling survival. Seedling survival of the planting stock was determined one full growing season after planting (figure 2). Because of the severe drought in the year following planting, seedling survival averaged 69 and 50% for December and February lifted stock when measured in the following July. By the end of the growing season, it had dropped to levels that were completely unacceptable for operational plantings. However, even though they must be interpreted with caution, the percentages still provide valuable insights into the effects of the treatments applied. The December planting survival was much greater than for the February planting. This most likely reflects the greater opportunity for the December-lifted trees to become established after planting before the severe drought occurred. Those December-lifted seedlings grown at lower seedbed densities from the fall sowing performed best (figure 2). Spring-sown, December-lifted plants were consistently poorer performers than fall-sown, February-lifted plants.

Although survival of December-lifted trees was better from fall sowing than spring sowing, February-lifted stock survived better when spring-sown (figure 2). This relationship is not fully understood; it may reflect the development of large seedlings that were more difficult to properly lift and plant when fall sowings were held until February. No physiological evaluations of the stock were made. Recent research has shown that the optimum "lifting window" for longleaf pine may be in early January and that the February lift date may have resulted in lower physiological quality (Brissette et al. 1988).

These results strengthen the earlier reports (Derr 1955, Huberman 1938, Scarbrough and Allen 1954, Shipman 1958, Shoulders 1963) that low seedbed densities are necessary to produce the best quality longleaf pine planting stock and they point out the merits of fall sowing. They also raise questions about the best lifting times for longleaf pine. Clearly, more research is needed in this area to identify the most appropriate lifting windows for longleaf pine.

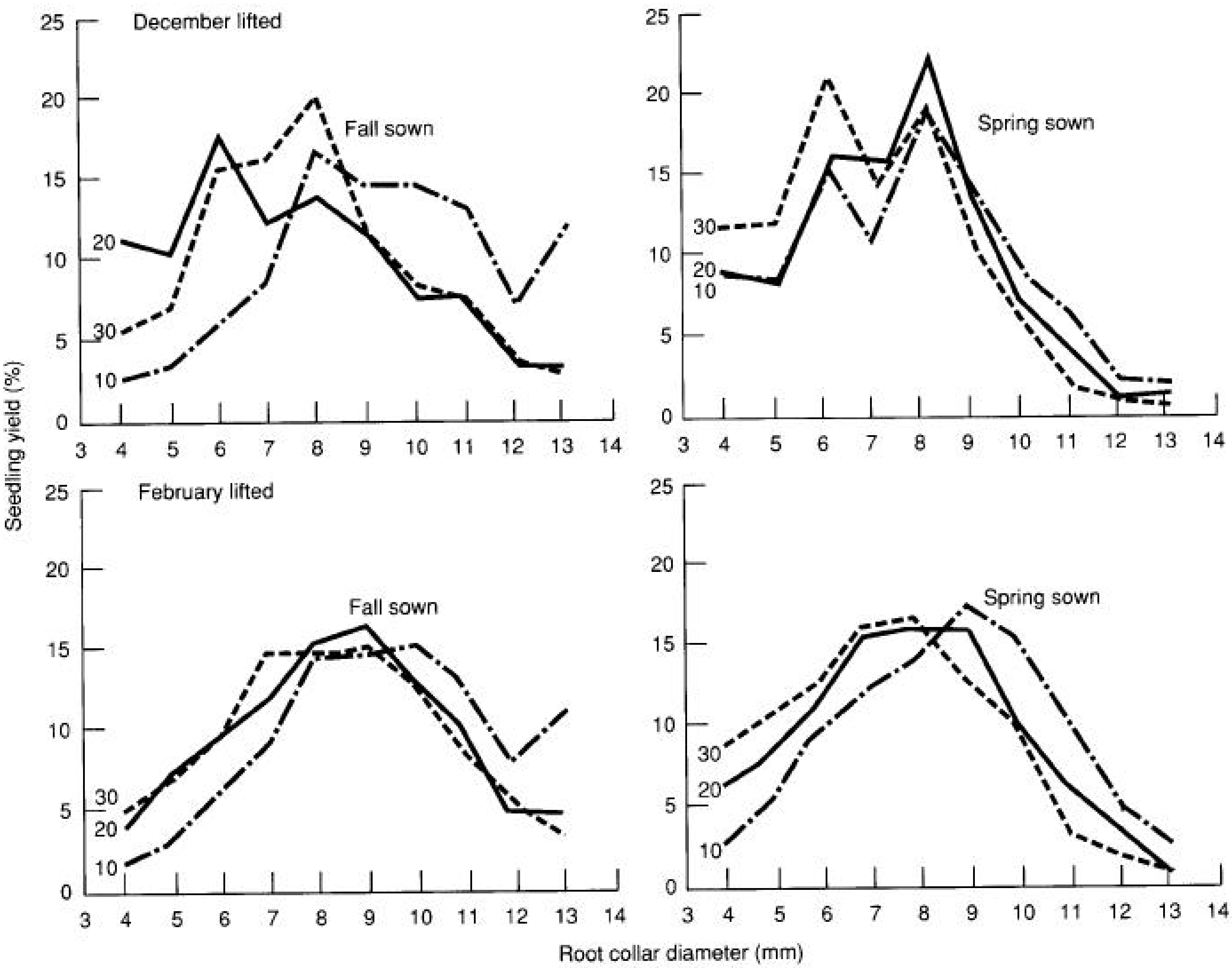

Figure 1—*Relative yield of longleaf pine seedlings by size of root-collar diameters as influenced by sowing date, lifting date, and seedbed density. The plotted percentages are for seedlings grown at 10, 20, and 30 per square foot, respectively.*

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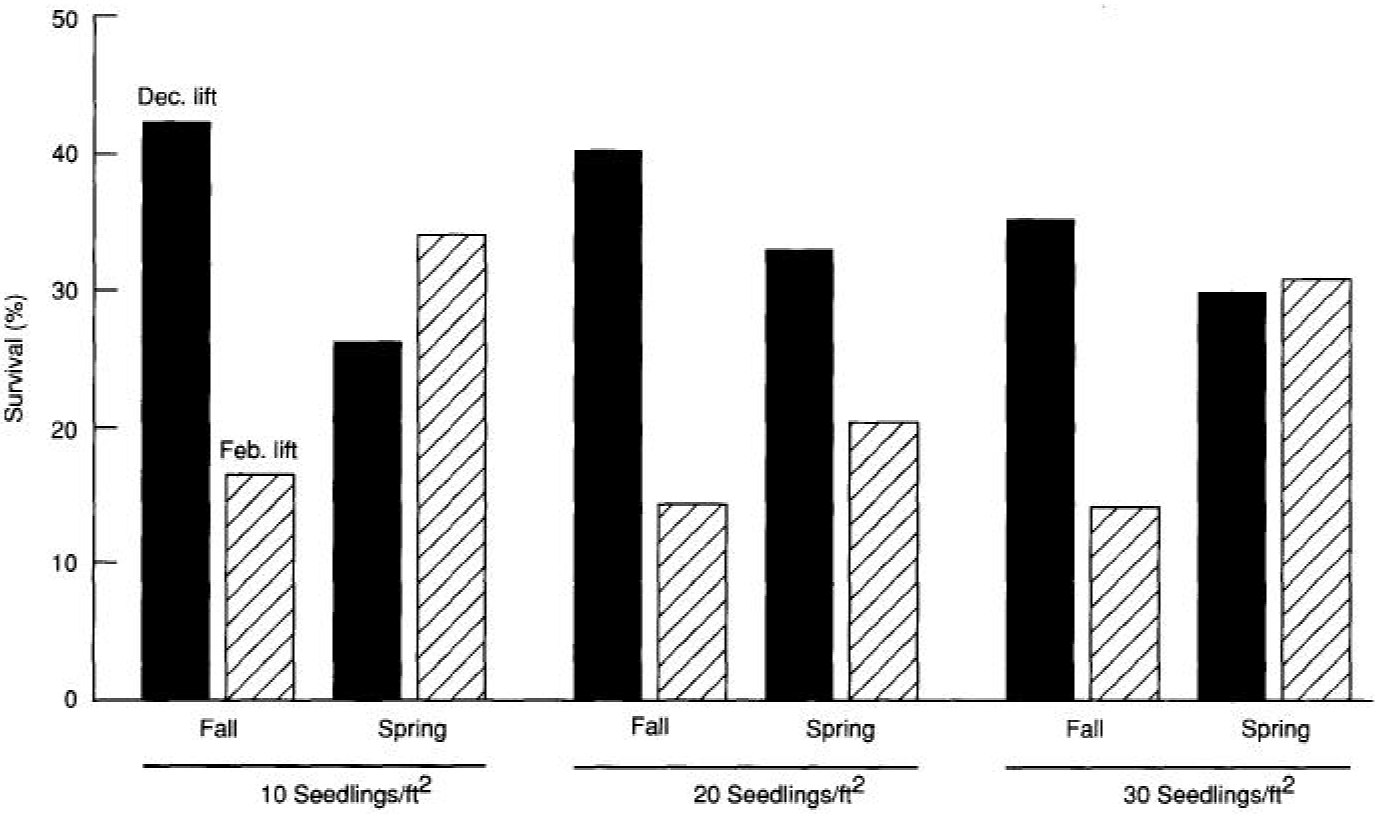

Figure 2—*Survival of longleaf pine seedlings as affected by nursery seedbed densities, dates of sowing, and dates of lifting.*

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