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Performance of Container and Bareroot Loblolly Pine Seedlings on Bottomlands in South Carolina

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ABSTRACT. *The performance of container and bareroot loblolly pine (Pinus taeda* L. *) seedlings from the same improved seedlot was compared on highly productive bottomland sites in South Carolina. At the time of planting, size and quality of the open-grown container stock were equal to or better than bareroot material. When outplanting conditions were ideal, field plantings in March, April, and May of 2 successive years indicated equal performance of the 2 stock types. When conditions were more stressful, container stock survived and grew better than bareroot seedlings. Needle-tip burn caused by postplanting applications of herbicides had no long-term effects on seedling growth. South. J. Appl. For. 17(2): 80–83.*

Container southern pine seedlings survive or grow better than conventional bareroot stock, particularly on droughty or marginal sites (Amidon et al. 1982, Barnett 1984, Boyer 1989, Goodwin 1976). The advantages of container seedlings seem to vary by species, site, method of site preparation, and planting date (South and Barnett 1986). Owston and Stein (1974) suggested that to ensure an unbiased comparison of container and bareroot stock, the seed source should be the same, and both stock types should be planted at the same time and by the same person or crew. Few studies have followed all of these recommendations (Brissette and Barnett 1989, South and Barnett 1986).

Most of the reported comparisons were conducted on adverse sites where field performance of container stock was better than bareroot seedlings because the intact root system of the container seedlings limited the transplanting shock that is common with bareroot seedlings (Barnett 1984). The question of relative performance on high quality sites has not been adequately addressed, although some results indicate that performance is about equal on such sites (South and Barnett 1986). In addition, the early studies did not consider the morphological or physiological characteristics of planting stock.

NOTE. The Santee River and Congaree River Limited Partnerships provided study sites, partial funding, and other resources to conduct the study, and Milliken Forestry Company and Sid McKnight, Consulting Forester, Inc., provided support during study installation and implementation.

In this study, loblolly pine (*Pinus taeda* L.) seedling performance was compared between container and bareroot stock outplanted on different dates on a highly productive bottomland site along the Santee River in South Carolina.

Methods

Loblolly pine seedlings were grown from an improved single-family seedlot (8-76) obtained from the Weyerhaeuser Company. The container stock was grown at the Alexandria Forestry Center in Pineville, LA, according to the cultural techniques outlined by Barnett and Brissette (1986), except that the seedlings were produced in full sunlight outside a greenhouse. Recent studies have shown that this type of production markedly improves the performance of southern pine seedlings (Barnett 1989). The container stock was grown in Ray Leach Stubby Cone-tainers™ for approximately 7 mo in full sun at a density of 50 per ft^2. Peat and vermiculite (1:1) were used as the growing mix, and all seedlings received supplemental fertilizer (Peters™ 20-19-18 NPK) through the irrigation system after the seedlings had reached 3 wk old.

The bareroot stock was produced by the Weyerhaeuser Company in its operational nursery at Aiken, SC. Seedlings (1+0 stock) were grown under operational conditions with conventional nursery culture (about 27 per ft^2). Root pruning was done late in the growing season, and top pruning was not used. Seedlings were lifted from the nursery in February, 1987 and 1988, and were subsequently kept in cold storage (34 to 38°F) until used.

All seedlings were characterized at the time of outplanting by determining height, root collar diameter, and root and shoot dry weights of 10 seedlings per treatment replication. Although about 3,000 seedlings were outplanted for each treatment combination, only five 100-seedling plots (replications) were used to evaluate field performance. Container seedling and bareroot stock were planted on three different dates: March, April, and May in two successive years, 1987 and 1988. The large outplantings were used so that longer term growth plots could be followed.

The study site is in southern Clarendon County, SC. The soils are a silty clay belonging to the Tawcaw Series and are members of the fine, kaolinitic thermic family of Fluvaquentic Dystrochrepts. They are characterized by slow permeability and slow runoff, with high available water capacity and 5 to 7% organic matter. This Coastal Plain river bottom is typical of many very high site index lands (> 120 ft at 50 yr) in the South. The planting site is below the Lake Marion Dam and may be flooded with 1 to 5 ft of water several times a year when dam gates are opened to relieve high water levels. Flooding normally occurs between the middle of December and the end of March each year, with each inundation lasting from one to several weeks. Planting dates in March, April, and May were selected because of these traditional flooding dates.

The sites were clearcut in the year before planting and were disked and bedded in the fall before planting. All planting was by hand using dibbles. Herbaceous competition rapidly colonized the planting sites, and aerial applications of sulfometuron methyl (Oust™) and metsulfuron methyl (Arsenal™) were used to reduce the levels of competition. Michael (1985) discussed the effectiveness of these treatments on a nearby site.

The study design was a randomized block with five replications of the treatment (seedling type times planting date combination) and was blocked by year of planting. Statistical significance was tested at the 0.05 level. Treatment effects and their interactions were statistically significant. Significant differences are indicated for the field performance data.

Results And Discussion

1987 Plantings

Initial Morphology. —Initial seedling size of both container and bareroot seedlings was determined at the time of planting (March 19, April 15, and May 12, 1987). Measurements included height (before flush) and length of new growth (flush) of container stock, diameter at root collar, and dry weight of shoots and roots (Table 1). Bareroot seedlings were held in cold storage from the time of lifting (February), but some morphological characteristics did differ among the planting dates. Container stock was larger than bareroot material in every characteristic measured. Because the container seedlings were held in a greenhouse instead of cold storage, flushes of new height growth occurred between lifting dates. The lengths of new shoot growth at planting time averaged 33, 105, and 140 mm, respectively, for the March, April, and May plantings comprising 33, 37, and 71% increases, respectively, in dry weight of container stock shoots compared with that of bareroot stock. The greatest difference between container and bareroot stock was in root dry weights. Container roots were 108 to 122% heavier than the roots of comparable operationally lifted bareroot stock (Table 1).

Seedling Performance. —Both stock type and planting date influenced seedling survival. In all cases, container stock survived equally as well or better than bareroot stock (Figure 1). However, the differences between the two stock types increased as planting was delayed from March to May—from 6% for March to 16 and 45% for April and May, respectively.

Seedling heights varied by stock type and planting date. Here again, the container stock was larger, and the differences in height increased as planting was delayed from March to May (Figure 1). This difference reflects the growth of container stock between March and May. Seedling diameters were greater for container than for bareroot stock.

Herbicide Damage. —The herbicide Arsenal™ (0. 25 lb ai/ac) was applied in early June to control the rapidly developing

Table 1. Initial morphological characteristics of loblolly pine seedlings at the time of planting.

	Container stock						Bareroot stock			
	Total height	Height		Diam.	O.D. top weight	O.D. root weight	Height	Diam.	O.D. top weight	O.D root weight
		Flush	Before flush							
	(mm)				(mg)		(mm)		(mg)	
					1987					
Planting date										
March	326	33	293	3.9	2,570	911	241	3.5	1,927	414
April	395	105	290	4.0	3,009	957	259	3.5	2,198	460
May	452	140	312	3.9	3,265	930	247	3.4	1,912	418
					1988					
March	328	4	324	4.1	3,096	1,251	270	3.6	2,342	557
April	356	29	327	4.4	3,219	1,205	271	3.9	2,799	624
May	350	28	322	4.4	3,149	1,210	260	3.8	2,270	478

Note: O.D. = oven-dried.

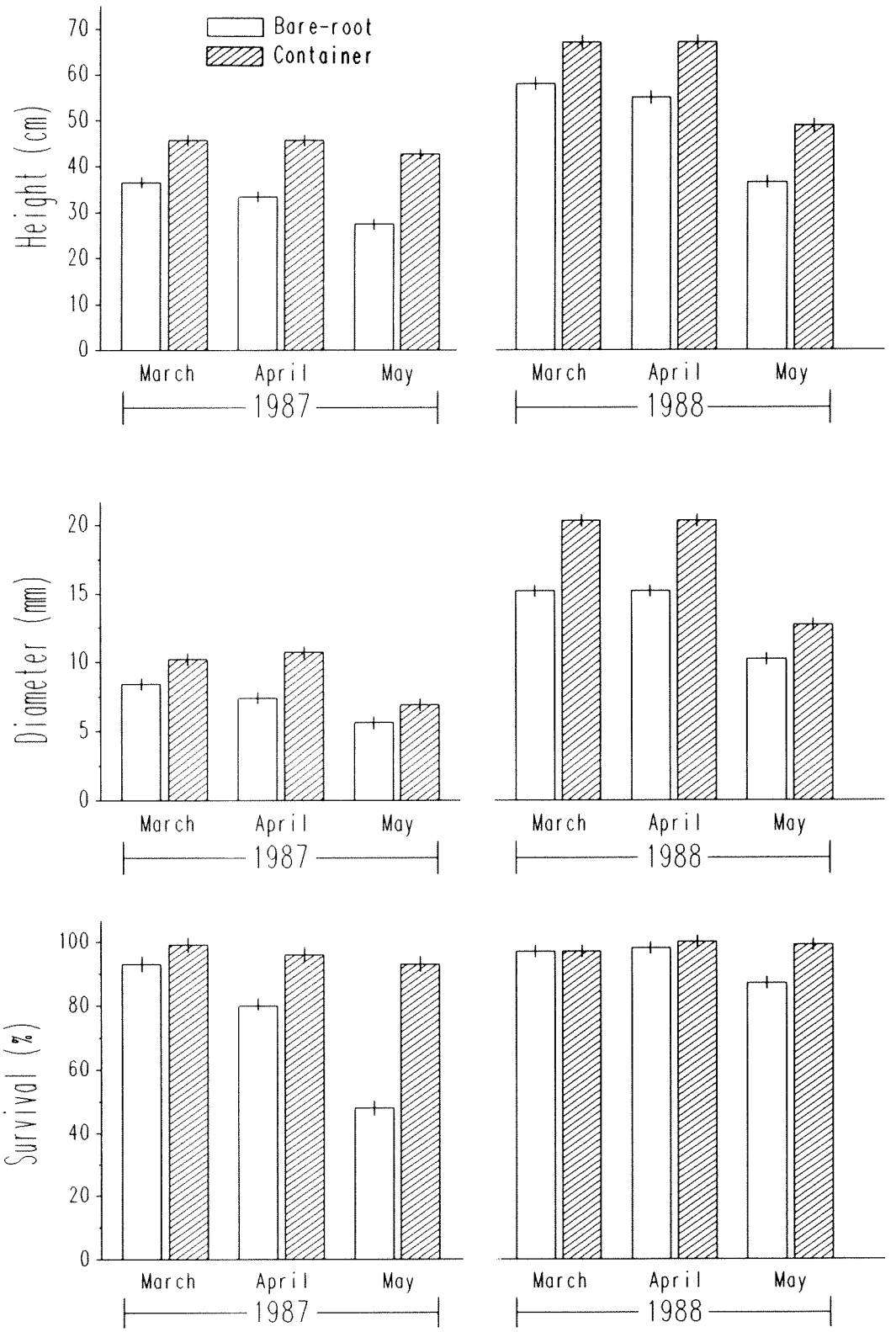

Figure 1. Average seedling performance of loblolly pines planted in the spring of 1987 and 1988 and measured in the following fall. Vertical lines on bars that overlap within years and measurement parameters are not significantly different at the 0. 05 level.

competing vegetation. Soon after application, visual injury to seedling shoots was noted, and considerable dieback occurred. At this time (July 1987), the seedlings were evaluated for the extent of herbicide damage (Table 2). The percentage of damaged seedlings varied by stock type and planting date, but the injury levels were the same in the late plantings as for the March planting. Bareroot seedling injury decreased with planting date—the later dates resulted in lower injury. In contrast, container seedling injury increased with later planting. Seedling susceptibility is apparently related to the recency of new growth flushes. The bareroot stock was dormant when planted, regardless of date, and the seedlings planted in April and May had little new growth when the herbicide was applied. Container stock produced new growth in the greenhouse before planting, and the later planting dates had more new growth when the herbicide was sprayed.

When seedling heights and diameters were measured in November 1987, herbicide damage was evaluated by category. At this time, there were no consistent differences in height or diameter resulting from herbicide injury (Table 2). Therefore, although tip dieback occurred, it had no long-term effect on seedling growth.

1988 Plantings

Initial Morphology. —Initial seedling size was measured at planting time (March 9, April 6, and May 4, 1988). Measurements included the same parameters as in 1987, and again, the container stock was consistently larger than bareroot stock (Table 1). In fact, most of the trends established in the 1987 test were repeated in 1988.

Seedling Performance.—Although seedling quality was comparable in the two outplantings, field performance differed considerably. Heights and stem diameters at the end of the first year in the field were greater in 1988 than in 1987 (Figure 1). Heights were as much as 21 cm taller, and diameters were twice those of the 1987 stock. The May outplanting resulted in less growth in both stock types. Differences in seedling survival were less in 1988; only the bareroot stock planted in May had lower survival rates than container stock. Year 1988 was a more favorable for seedling establishment than 1987.

These results confirm that one of the primary advantages of container stock is its better performance when planted on difficult or adverse sites. The more favorable the site or planting condition, the smaller are the differences between the performance of container and bareroot stock types. The better performance of container stock must be weighed against generally higher costs of production and planting.

Conclusions

Several conclusions can be drawn: (1) Seedling establishment and performance were excellent on this high-quality bottomland site, regardless of stock type, if seedlings were planted early in the spring when soil and temperature conditions were ideal, (2) container stock outperformed bareroot stock when planting was delayed until later in the spring when environmental conditions were more stressful, (3) the performance of bareroot stock declined when it was held in storage for several months, and (4) herbicide injury that resulted in needle-tip burn had no lasting adverse effect on seedling growth.

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Table 2. Average seedling survival, size, and damage from herbicide of loblolly pines planted in spring 1987 and measured in July 1987.

Planting date	Treatment	Height (m)			Diameter (cm)			Survival (%)	Damaged (%)
		All trees	Damaged	Undamaged	All trees	Damaged	Undamaged		
March	Container	0.47(99)[1]	0.48(27)	0.47(72)	1.02	1.14	1.04	100	27
	Bareroot	0.36(93)	0.37(22)	0.36(71)	0.84	0.89	0.81	94	24
April	Container	0.46(96)	0.44(30)	0.47(66)	1.07	1.02	1.09	98	32
	Bareroot	0.34(80)	0.34(14)	0.74(66)	0.74	0.74	0.74	81	17
May	Container	0.41(93)	0.40(43)	0.43(50)	0.71	0.71	0.71	98	53
	Bareroot	0.29(48)	0.27(3)	0.29(45)	0.56	0.66[2]	0.58[2]	51	6

[1] Average number of trees is shown in parenthesis.
[2] Based on four blocks only.