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Timing of Longleaf Pine Seedling Release from Overtopping Hardwoods: *A Look 30 Years Later*

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ABSTRACT. Significant differences in longleaf pine (Pinus palustris) growth among early and delayed seedling release treatments were recorded at age IO, but these differences had disappeared upon reexamination at age 31. A study begun in 1949 included six release treatments: complete seedling release from overtopping hardwoods at ages I, 2, 3, 4, and 8 years, plus an unreleased check. Treatments were randomly applied among six 0.1 -acre plots in each of six blocks, which included both poor and average sites. Seedling development was observed through age 10. When pines in five surviving blocks (two poor site, three average sue) were remeasured in. 1979 at age 31, there were no significant differences among release treatments in average tree heights and diameters or stand basal areas and volumes. The check treatment had significantly lower tree heights, stand densities, and stand volumes than any release treatment.

The effects of competition, both overstory and understory, on the survival and early growth of southern pines have been documented by studies on loblolly (*Pinus taeda*) (Cain and Mann 1980, Clason 1978, Nelson et al. 1981) and sand pine (*Pinus clausa*) (Hebb 198 1). Reduction of competition by pre-establishment site or seedbed preparation or by post-establishment release usually results in rapid growth and early domination of the site by pine.

The costs of either complete or partial control of competing vegetation can be high. Intensive mechanical site preparation can easily cost over $100 per acre. Will these costs be recovered through increased pine volume yields at harvest? While research has demonstrated a positive pine growth response to competition control for 5 to 10 years, long-term results are scarce and inconclusive. Some indicate that the initial growth advantage of pine planted on well-prepared sites may gradually diminish. Given adequate survival, the size and yield of pines established on sites with little preparation may, after 8 to 10 years, begin to catch up with those on well-prepared sites, according to observations of longleaf (Boyer 1983) and slash pines (Tiarks 1983). Should this occur, the costs of intensive site preparation might not be recovered. In other studies, the growth advantage resulting from early seedling release has persisted for at least 20 years for loblolly (Balmer et al. 1978) and longleaf pines (Michael 1980).

The value of competition-control treatments for improvement of pine growth remains uncertain, because of the lack of adequate long-term observations of pine growth in response to release. Relocation and remeasurement of an old release study, begun in 1949 and concluded in 1958, have provided some additional information about the effects of seedling release on long-term growth of longleaf pine.

THE STUDY

The objective of this study was to determine the effect of timing of release from overtopping hardwoods on the development of longleaf pine seedlings established naturally from the 1947 seed crop. The study was initiated in 1949 when six blocks, each with six O.l-acre plots, were established. Two were on poor sites and two on average sites on the Escambia Experimental Forest[1] in south Alabama. The two remaining blocks were on average sites on the nearby Conecuh National Forest, also in Alabama. Six treatments were randomly assigned among plots in each block, namely complete seedling release at age 1, 2, 3, 4 and 8 years, plus an unreleased check.

Hardwood cover on study sites was heavy. On the poor Escambia sites hardwood density averaged 354 stems and 35 ft^2 basal area/acre. Average sites on the Escambia had 324 stems and 29 ft^2 basal area/acre, while average sites on the Conecuh had 460 stems and 28 ft^2 basal area/acre.

All hardwood stems over 4.5 ft tall were controlled with sodium sulfamate (Ammate®) using the cup crystal method (Peevy and Campbell 1949) for large stems, while small stems were cut and the stump treated. Retreatment was done as needed to achieve complete hardwood control. Seedling stands were thinned in 1951, where needed, to no more than

[1] **Maintained by the Southern Forest Experiment Station, USDA Forest Service, in cooperation with the T. R. Miller Mill Company.**

three seedlings per 0.25-milacre subplot within each .025 acre net-plot.

Study plots were examined annually from establishment in March 1949 through January 1952 and biennially through the winter of 1958, when trees were 10 years old. Information on seedling survival, root-collar diameter, height, condition, and brown-spot infection were obtained. The positive effects of prompt release on the survival and growth of these seedlings through age 4 were reported (Walker 1954). At age 10, the dominant fraction of the seedling stand was considered to be the tallest 10 seedlings per net plot, or the tallest half, if there were fewer than 20 seedlings per plot. The study was closed after the 1958 examination.

In 1979 these six study blocks were relocated and reexamined to determine the effects of treatments on the subsequent development of longleaf pine stands. Plot monumentation was still intact. One block of plots on the Conecuh National Forest had been cut during the winter of 1979, but all other blocks had been preserved. Height and diameter measurements of all pines on net plots were completed in the spring of 1979, when they were 31 years old. Dominant-codominant trees in each plot were identified to determine average height of this fraction of the stand and also for estimations of site index (age 50). Site index was estimated from established site index curves (USDA 1976) using the equation developed by Farrar (1973). Cubic-foot volumes were obtained from published iongleaf pine volume equations (Farrar 1981). Statistical tests were conducted at the 0.05 significance level.

RESULTS

At seedling age 10, on the five surviving study blocks, release treatments significantly affected seedling density and heights (Table 1). Seedling numbers generally declined with delays in release, as did average heights for all trees and for the dominant-codominant fraction. Seedling mortality in this study was largely associated with three prescribed fires during the first 10 years (Boyer 1974). Of total seedling losses, 90% followed the fires. Fire-related mortality among unreleased seedlings was twice that among released seedlings, with a much greater impact on poor than on average sites. Initial seedling counts on the five blocks, made at age 2, averaged 10,100 per acre on poor and 13,800 on average sites, although differences among blocks were not significant. At age 10, survivors on poor sites averaged 693 trees per acre and on average sites 1,918 trees per acre. The average heights of all surviving seedlings at age 10 were not significantly different between sites (1.1 ft poor, 0.8 ft average).

At age 3 1, pine density ranged from 600 to 800 trees per acre among release treatments and 256 per acre on unreleased check plots (Table 1), although differences were not great enough to be statistically significant. There were no longer any statistically significant differences among release treatments in average tree heights for either all pines or just the dominant-codominant fraction. In both cases, released trees, regardless of timing of release, were significantly taller than unreleased trees.

The number of trees per acre was significantly greater on average sites (800) than on poor ones (380). Dominant-codominant tree heights were 54 ft on average sites and 42 ft on poor sites, a significant difference. Indicated site index (age 50) for each of the five study blocks, excluding unreleased check plots, averaged 60 and 61 ft for the poor sites, and 74, 74, and 75 ft for the average sites.

At stand age 31, pine volume (total ft^3 i.b.), either for all trees or just the merchantable trees, did not significantly differ among the five release treatments but did differ from the very low volumes on unreleased plots (Table 2). The same held for stand basal

Table 1. Effect of release treatments on pine 'stand density and height at ages 10 and 31.

Treatment (age at release)	Age 10			Age 31		
	Stand density	Tree height		Stand density	Tree height	
		All	Dom.		All	Dom.
Years	*Trees/acre*	.... *Feet*		Trees/acre	..... *Feet*	
1	1904a[2]	2.0a	4.8a	800a	36.7a	51.3a
2	1976a	0.8bcd	4.5a	728a	34.8a	53.2a
3	1552ab	I.Obc	2.5abc	640a	41.6a	52.1a
4	1384ab	1.1b	3.4ab	768a	35.5a	51 .Oa
8	1160ab	0.4cd	I.Ibc	600a	35.0a	52.1a
CK[1]	592b	0.3d	0.5c	256a	23.3b	35.2b
Avg.	1428	0.9	2.8	632	34.5	49.2

[1] Unreleased check.
[2] Means with same letter not significantly different at 0.05 level.

Table 2. Effect of release treatments on pine stem diameter, basal area, and volume at age 31.

Treatment (age at release)	Avg dbh	Basal area	Volume	
			Total[3]	Merchantable[4]
Years	*Inches*	*Ft²/area*	.... *Ft³/acre*	
1	3.9ab[2]	74a	1426a	1280a
2	3.6ab	7aa	1677a	1550a
3	4.7a	69a	1428a	1325a
4	3.9ab	76a	1599a	1464a
8	3.9ab	66a	1359a	1284a
CK'	2.6b	13b	202b	162b
Avg.	3.8	6 3	1282	1178

[1] Unreleased check.
[2] Means with same letter not significantly different at 0.05 level.
[3] Total tree volume i.b., trees 0.6-in dbh and larger, from 0.2 ft stump.
[4] Total tree volume, i.b., trees 3.6-in dbh and larger, from 0.2 ft stump.

areas, which ranged from 66 to 78 ft^2/acre for released stands and 13 ft^2/acre for unreleased stands. However, average dbh, which again did not differ significantly among release treatments, was not significantly greater than average dbh on unreleased plots in most cases.

Average sites, at stand age 31, had much greater volume, 1,654 ft^3/acre, and basal area, 79 ft^2/acre, than poor sites which had 724 ft^3/acre and 39 ft^2/acre, respectively. Average dbh over all treatments was the same on both average and poor sites, namely 3.8 in. On poor sites, the average volume of stands released at ages 1 and 2 was 1,3 16 ft^3/acre with an average basal area of 69 ft^2/acre, while stands released at 3, 4, and 8 years had an average volume of only 505 ft^3/acre and an average basal area of 27 ft^2/acre. The difference is due to the reduced number of surviving trees per acre on poor sites associated with release delayed beyond age 2 and the resulting fire mortality among these unreleased seedlings. The first fire occurred after the second-year release treatment, and this accounted for most of the reduced seedling survival on poor sites. There was no such impact of timing of release on survival of seedlings on average sites, even though all study blocks were burned at the same time.

Due to small plot size (O.l-acre gross, 0.025 net), with only 0.25-chain isolation border, tree growth on individual plots could be affected by competition from adjacent plots by age 3 1. However, after age 8, all plots in each block, with the exception of the unreleased plot, were free of pre-existing hardwood competition. Subsequent competition was mainly among surviving pines. Competition among plots should then have favored those with a head start resulting from early release. This result was not observed.

CONCLUSIONS

The timing of longleaf pine seedling release from overtopping hardwoods, whether occurring at seedling age 1 or delayed as long as seedling age 8, did not affect tree size or stand basal area and cubic foot volume at age 3 1. The significant effect of release timing on tree size at age 10 had disappeared by age 3 1. Pines on unreleased plots were shorter and much lower in stand basal area and volume than those found with any release treatment. The average dbh of surviving unreleased pines at age 3 1, however, was not significantly lower than that of pines on four out of five release treatments.

Average basal areas and volumes of pine stands on poor sites at age 31 was only about half of those prevailing on average sites, although average dbh was identical. On poor sites, only stands released at age 1 or 2 had acceptable yields at age 31, and this reflected differences in seedling survival. Most seedling mortality can be ascribed to periodic prescribed fires at seedling ages 2, 5, and 7. The risk of fire-related mortality was greatest among unreleased seedlings on poor sites, where even normal attrition can be high. Therefore, early seedling release from overtopping hardwoods is most important on poor sites, especially if these sites are to be burned. With prompt release, seedlings on poor sites grew somewhat better, through age 10, than similar seedlings on average sitess. The effects of site quality on tree growth was not expressed until sometime after age 10, and then primarily in terms of height growth. Delays in release can be tolerated on better sites, with little danger of adversely affecting long-term yields, provided initial stocking is good.

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