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Small Topographic Differences Affect Slash Pine Response to Site Preparation and Fertilization

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ABSTRACT. On a Wrightsville-Vidrine silt loam flatwoods in southwest Louisiana, six-year-old slash pines (Pinus elliottii *Engelm. var.* elliottii) *planted on the better drained Vidrine-pimple mounds and Vidrine-like ridges were nearly four times larger than pines planted in the poorly drained Wrightsville depressions. Site preparation treatments did not affect tree growth on the better drained sites. In the poorly drained depressions, pines planted on beds were 37 percent taller and averaged 49 percent more volume per tree than pines planted on harrowed plots. Fertilization did not increase yields on the poorly drained sites. On the better drained sites, pines fertilized with triple superphosphate were 24 percent taller and averaged 84 percent more volume per tree than unfertilized pines.*

Bedding concentrates soil organic matter into planting ridges, which increases nutrient availability in the rooting zone of planted pines and raises the seedling's root system above standing water during rainy periods (Pritchett and Gooding 1975). On medium- to fine-textured soils, bedding improves aeration and increases the rate of water movement through the soil (Shoulders and Terry 1978). McKee and Shoulders (1970, 1974) determined that the growth benefits resulting from bedding are correlated with the amount of added depth to free water provided by the beds where the average table depth is less than 18 inches after winter rains. Phosphorus fertilization increases pine growth on many poorly drained sites and may compensate for poor root development on some nonbedded, poorly drained soils (Pritchett and Gooding 1975, Shoulders 1976).

Derr and Mann (1977) concluded from six studies established on silt loam flatwoods in Louisiana that bedding caused modest and erratic increases in height and volume growth of slash pine and increased the incidence of fusiform rust (*Cronartium quercuum* (Berk.) Miyabe and Shirai f. sp. *fusiforme*). Bedding disrupted the natural drainage pattern of these very gently rolling sites and water collected in the depressions adversely affecting tree development.

Studies by Derr and Mann (1977) alluded to the influence of relatively minor soil and topographic changes on the response of slash pine to site preparation treatments. To evaluate such soil and topographic effects, data from a six-year-old study were analyzed to demonstrate the influence of site preparation and fertilization on slash pine growth on a flatwoods site in Louisiana.

The study area in Calcasieu Parish, Louisiana originally supported a natural longleaf pine (*P. palustris* Mill.) stand and a dense cover of native grasses with widely scattered clumps of southern bayberry (*Myrica cerifera* L.) and blackberry (*Rubus* spp.).

The soil is a Wrightsville (Typic Glossaqualf, fine, mixed, thermic) and Vidrine (Glossaquic Hapludalf, coarse-silty over clayey, mixed, thermic) silt loam complex with a general slope of 0 to 1 percent. Many "pimple" mounds of Vidrine silt loam occupy about 16 percent of the study area. The upper foot of these mounds is generally well drained with both soil moisture and yellowish brown mottling increasing with depth. A less permeable silty clay subsoil with distinct red mottling generally begins at 30 inches and slopes downward from under the mounds, reaching a low point under the Wrightsville silt loam depressions. A perched water table rests above the subsoil for two to four months in winter and spring. Vidrine-like silt loam constitutes 49 percent of the study area, surrounds the mounds and may form ridges connecting them. This soil is not as well drained as the solitary mounds. Wrightsville silt loam comprises 35 percent of the study area. It forms unconnected, meandering swales that contain standing water during winter between the Vidrine mounds and Vidrine-like ridges with no natural outlet for surface drainage.

METHODS

The longleaf stand was clearcut in 1971 and the area was burned in September 1972. Six treatments were laid out in a randomized complete block design with four replications of 0.4-acre plots on a 14-acre study area. Treatments were: (1) burned only-unfertilized, (2) burned only-fertilized, (3) harrowed-unfertilized, (4) harrowed-fertilized, (5) bedded-unfertilized and (6) bedded-fertilized. There were 272 planting sites on each plot, which were divided into 16 rows of 17 trees.

Treatments were applied in October 1972. Fertilization was done by broadcasting 500 lbs. per acre of triple superphosphate (0-46-0) before mechanical site preparation. Bedded plots were first harrowed; then continuous beds were formed using a Rome bedding harrow equipped with a shaping roller. These beds were perpendicular to the general slope of the tract (Figures 1 and 2). Bed centers were 10 inches high (furrow to crest) before settling and were spaced 8 feet apart.

Freshly lifted, bare root 1-0 slash pine seedlings were planted by hand on an 8- by 8-foot spacing in late February 1973. Two seedlings were planted at each location. If both survived, the less vigorous was removed after two growing seasons.

Each planting site was assigned to one of two topography classes at stand age 4: (1) drier microsites of Vidrine mounds and Vidrine-like ridges and (2) Wrightsville depressions.

An inventory of the whole plot was conducted and determinations made of survival, d.b.h., and total height. At stand age 6, cubic-foot volume for trees measuring 4.5 feet or more in height was calculated with Schmitt and Bower's (1970) formula. Individual tree volumes were averaged to get mean values for each topographic class.

The data were analyzed for slash pine differences resulting from the two main effects, fertilization and site preparation, and fertilization × site preparation interaction. The unfertilized *vs.* fertilized comparisons were made by analyses of variance ($\alpha = 0.05$). The degrees of freedom and sums of squares for site preparation within the analyses of variance were partitioned into orthogonal trend comparisons to determine site preparation effects. Burned-only was contrasted against mechanical site preparation, and harrowing was contrasted against bedding in the comparisons. Elevation classes were analyzed separately because interaction between topographic classes and whole plot factors made a split-plot design infeasible for determining the influences of site preparation and fertilization on tree growth.

Figure 1. Finished planting beds. Note the slight change in elevation common on silt loam flatwoods soils of the West Gulf Coastal Plain.

Figure 2. A bedding harrow, equipped with a shaping roller, in operation.

RESULTS AND DISCUSSION

Drier Microsites

For percent survival, d.b.h., height, and volume per tree analysis of variance showed that fertilization × site preparation interactions were not significant at stand age 6. The average fertilized pine had 32 percent larger d.b.h., 24 percent greater height, and 84 percent more volume per tree than unfertilized pines. Average height growth during the sixth year on fertilized drier microsites was 22 percent better than on unfertilized drier microsites.

Pines on drier microsites averaged 4 percent greater d.b.h. with harrowing or bedding than with burning alone (Table 1), with no difference

Table 1. Sixth year results for slash pine on the drier sites.

Treatment	Survival	D.b.h.	Total height	6-year height	Volume per tree
	Percent	*Inches*	*Feet*	*Feet*	*Ft³*
Burn only[1]					
Fertilized	88	2.9	15.8	3.8	.36
Unfertilized	92	2.0	12.1	3.1	.16
Average	90 a[2]	2.5 a	14.0 a	3.5 a	.26 a
Harrow[1]					
Fertilized	91	2.9	15.8	4.0	.34
Unfertilized	93	2.3	13.0	3.3	.20
Average	92 a	2.6 b	14.4 a	3.7 a	.27 a
Bed[1]					
Fertilized	89	2.9	15.9	3.8	.36
Unfertilized	93	2.3	13.0	3.2	.20
Average	91 a	2.6 b	14.5 a	3.5 a	.28 a
Burn only + harrow + bed					
Fertilized	89 a[3]	2.9 a	15.8 b	3.9 b	.35 b
Unfertilized	92 b	2.2 b	12.7 a	3.2 a	.19 a

[1] *Plot sizes varied on the drier microsites. The number of planting locations ranged from 136 to 228 and 177 per plot. Two trees planted per location. If both survived to age 2, the less vigorous was removed. Survival is among remaining pines.*
[2] *Within columns, averages for the three site preparation treatments, burn only, harrow, and bed, that are followed by the same letter are not significantly different (α = 0.05).*
[3] *Within columns, averages for the two fertilization treatments, fertilized and unfertilized, that are followed by the same letter are not significantly different (α = 0.05).*

between the harrowed and bedded treatments. The added diameter on mechanically treated plots might be attributed to controlling competition and improving fertility by mixing organic matter into the soil and by creating better soil aeration (Moehring 1977). Bedding which increased the depth to free water did not significantly improve tree growth. Cain (1978) had similar results with loblolly pine (*P. taeda* L.) on a Caddo and Beauregard silt loam complex in Rapides Parish, Louisiana.

Depressions

For percent survival, d.b.h., height, and volume per tree, analysis of variance showed that fertilization × site preparation interactions were not significant at stand age 6. Slash pine survival in depressions was greatly reduced by fertilization and mechanical site preparation (Table 2). After harrowing and bedding, the soils had settled only four months before planting. Related work indicates that this period is insufficient when working silt loam soils, and probably too many air pockets were present during the first growing season, which would result in poorer survival on harrowed and bedded plots.

Although phosphorus fertilization coupled with bedding has increased pine growth on other soils (Pritchett and Smith 1974), here the difference between fertilized and unfertilized beds was not significant. In depressions planting beds provide better drained microsites for root growth. At stand age 6, pines in bedded depressions averaged 25 percent larger d.b.h., 37 percent greater total height, and 49 percent more volume per tree than pines in harrowed depressions. And during the sixth year, pines in bedded depressions had 36 percent greater height growth than trees in harrowed depressions.

Pine survival after six years averaged 36 percentage points less in the wet depression than the average survival for the drier microsites. The average d.b.h. was 101 percent greater on drier microsites than in depressions, total height was 84 percent greater, and average volume per tree 286 percent greater (Figure 3). Pines in depressions averaged 2.5 feet in height growth during the sixth season, which is a large increase compared to the five-year average total height of 5.3 feet. This indicated that pines might be able to overcome the adverse conditions of the depressions; however,

Table 2. Sixth year results for slash pine in depressions.

Treatment	Survival	D.b.h.	Total height	6-year height	Volume per tree
	Percent	*Inches*	*Feet*	*Feet*	*Ft³*
Burn only[1]					
Fertilized	58	1.3	7.8	2.6	.069
Unfertilized	75	1.1	7.0	2.2	.049
Average	66 b[2]	1.2 a	7.4 a	2.4 a	.059 a
Harrow[1]					
Fertilized	46	1.2	6.8	2.2	.067
Unfertilized	58	1.1	6.6	2.1	.055
Average	52 a	1.2 a	6.7 a	2.2 a	.061 a
Bed[1]					
Fertilized	38	1.5	9.5	3.2	.101
Unfertilized	55	1.4	8.9	2.8	.081
Average	46 a	1.5 b	9.2 b	3.0 b	.091 b
Burn only + harrow + bed					
Fertilized	47 a[3]	1.3 a	8.0 a	2.7 a	.079 a
Unfertilized	62 b	1.2 a	7.5 a	2.4 a	.062 a

[1] *Plot size varied in the depressions. The number of planting locations ranged from 44 to 136 and averaged 94 per plot. Two trees were planted per location. If both survived to age 2, the less vigorous was removed. Survival is among remaining pines.*
[2] *Within columns, averages for the three site preparation treatments, burn only, harrow, and bed, that are followed by the same letter are not significantly different (α = 0.05).*
[3] *Within columns, averages for the two fertilization treatments, fertilized and unfertilized, that are followed by the same letter are not significantly different (α = 0.05).*

Figure 3. Fifth-year view showing an untreated depressional site in the foreground with a fertilized, disked Vidrine mound in the background.

pines on drier microsites still grew 1 foot taller than those in depressions during the sixth year.

APPLICATION

About 240,000 forested acres in Louisiana are included in the Wrightsville, Wrightsville-complex series. Other main Alfisol Aqualfs commonly associated with the Wrightsville series make up an additional 1,000,000 forested acres in Louisiana. Vidrine and Wrightsville soils are also found in Arkansas, Oklahoma, and Texas; thus, these results have broad application in the West Gulf Coastal Region.

Bedding did not increase tree growth on the drier microsites in this study. In areas where drier sites and wet depressions are large and distinguishable, beds could be created in depressions and the high flats left unbedded. Bedding increased tree growth in depressions, but, if water stands in the bedded depressions over winter, it may prove uneconomical. Installation of drainage systems on these sites after bedding can alleviate the problem of impounded water and boost the height and diameter growth of young pines. Proper alignment of beds with natural and artificial drainage is essential because they can impede runoff where the topography is very gently rolling. On the high flats, ground equipment could distribute the phosphorus in conjunction with a harrowing treatment. Harrowing should boost diameter growth of young pines.

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