

# EARLY GROWTH OF LOBLOLLY AND SHORTLEAF PINE AT VARIOUS SPACINGS IN SOUTHERN ILLINOIS

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Past practices on land cleared for agriculture in southern Illinois have reduced the quality of many sites to the point where the valuable native hardwood species cannot be successfully grown. Hence it has been necessary to find less demanding species to reforest these degraded sites. Shortleaf pine (*Pinus echinata* Mill.) and loblolly pine (*Pinus taeda* L.) have been widely planted in this area, which is at the limit or north of their present natural ranges. The results of an experiment to study the effect of spacing on the growth and yield of shortleaf and loblolly pine planted on a site of medium quality are presented in this paper. The work was done at the Dixon Springs Experiment Station in Pope County.

## METHODS

Four replications of loblolly pine, and three of shortleaf pine, were planted at spacings of 4 x 4, 6 x 6, 8 x 8, and 10 x 10 feet in the spring of 1949. Plots were one-half acre in size, with a 33-foot isolation strip, and were laid out in a randomized block design. Seedlings were grown at the Union State Tree Nursery, Jonesboro, Illinois. Not much is known about seed source. Nursery records indicate that the loblolly pine was grown from seed obtained in north Alabama or Maryland, while the source of the shortleaf seed was unknown. However, at

that time the State Division of Forestry attempted to procure seed from as far north in the range of both species as possible.

Survival counts were made at the end of the first, second, third, eleventh, and thirteenth growing seasons. Diameter and height measurements were made during the fall of 1959 and 1961, when the plantations were 11 and 13 years old.

Local volume tables were constructed for each species and spacing, using the variable-square method described by Spurr (1952). Volumes are for peeled wood and include the entire bole of the tree.

## SITE DESCRIPTION

At planting time the site had been abandoned from cultivation for about ten years. There was a well-established ground cover of broomsedge (*Andropogon* spp.) where erosion was slight to moderate, while tickle grass (*Aristida dichotoma* Michx. and *Danthonia spicata* (L.) Beauv.) was dominant on severely eroded areas.

The soil belongs to the Grantsburg series. These are Gray-Brown Podzolic, intergrading with Red-Yellow Podzolic soils, that were developed under forest cover from loess (80 inches or less in depth) over a predominantly sandstone bedrock. When uneroded, soil texture varies from a silt loam in the A horizon to

a silty clay loam in the B horizon. A moderately well-developed silt pan (fragipan) occurs in the upper part of the C horizon. The pan is compact, coarse-blocky to structureless, and impedes both root penetration and the downward movement of moisture. These soils are reasonably well-supplied with available potassium but are low in phosphorous, nitrogen, and organic matter.

Moisture conditions were favorable during 1949, 1950, and 1951. Drought conditions of varying intensities prevailed in 1952, 1953, and 1954. The plantation was subjected to extreme cold in the winter of 1950-51 and heavy glaze storms in 1950 and 1952 (Bogges and McMillan, 1954).

### RESULTS

Early survival was better than 95 percent. After 13 growing seasons survival was 95 percent or better for all spacings except the 4 x 4-foot shortleaf pine, which was 82

percent. Current mortality is heaviest in the 4 x 4 foot spacings and is greater for shortleaf than for loblolly pine.

Spacing has had little effect on the total height of either species, but tree diameters were larger at the wider spacings (Table 1). Loblolly pine averaged about six feet more in height than shortleaf pine.

The differences in wood volume produced by shortleaf pine at the various spacings were statistically significant (one-percent level) when all trees were considered. On the basis of trees four inches and over in diameter, there was no significant difference between the 4 x 4- and 8 x 8-foot spacings, but all other comparisons were significant. In loblolly pine there were no significant differences between the 6 x 6- and 8 x 8-foot spacings, while the other spacings differed significantly. This was true for all trees as well as for those four inches in diameter and above.

TABLE 1.—Average Height and Diameter of Loblolly Pine and Shortleaf Pine.

Spacing, feet	Loblolly pine				Shortleaf pine			
	Height	Std. error	DBH	Std. error	Height	Std. error	DBH	Std. error
	Feet		Inches		Feet		Inches	
x 4.....	30.2	0.2	3.5	0.0	24.6	0.3	3.2	0.0
x 6.....	32.4	0.5	4.8	0.1	25.1	0.6	4.3	0.1
x 8.....	34.4	0.8	6.0	0.1	23.0	0.5	4.8	0.1
x 10.....	32.2	1.0	6.4	0.1	23.6	0.5	5.3	0.1

TABLE 2.—Number of Trees, Basal Area, and Cubic-Foot Volume Per Acre of Shortleaf Pine.

DBH	Spacing, feet						Volume, cubic feet			
	4x4	6x6	8x8	10x10	4x4	6x6		8x8	10x10	
0	4				0.01			0.35		
1	141	20			1.11	0.15	0.06	12.44	1.72	0.43
2	396	53	14	6	9.96	1.34	0.30	88.63	12.27	2.93
3	862	187	56	39	43.22	10.41	3.23	388.75	84.37	25.58
4	712	377	177	54	60.11	33.83	15.73	676.39	354.07	175.12
5	104	377	216	133	12.99	51.06	30.21	181.04	542.40	332.14
6	9	80	142	127	1.64	15.36	27.06	23.52	195.92	313.09
7	9	7	28	35	2.60	1.99	7.35	31.88	22.10	85.11
8		3	4	9		1.11	1.12		16.74	16.65
Total, all trees	2,237	1,104	637	403	131.64	115.25	85.06	1,403.00	1,229.59	951.05
Total, 4" or more DBH	834	844	567	358	77.34	103.35	81.47	912.83	1,131.23	922.11

TABLE 3.—Number of Trees, Basal Area, and Cubic-Foot Volume Per Acre of Loblolly Pine.

DBH	Spacing, feet											
	4x4	6x6	8x8	10x10	4x4	6x6	8x8	10x10	4x4	6x6	8x8	10x10
1.....	8	2	.....	4	0.28	0.03	.....	0.03	4.25	0.03	.....	0.86
2.....	318	25	3	4	8.60	0.46	0.06	0.13	89.98	5.05	0.82	1.60
3.....	926	95	8	2	48.33	5.20	0.40	0.11	586.80	47.60	5.05	1.38
4.....	935	275	26	16	82.33	25.79	2.49	1.44	997.62	199.38	28.95	15.34
5.....	214	462	165	54	27.33	64.98	23.31	7.76	347.83	811.69	320.94	91.53
6.....	19	230	290	126	3.40	43.84	59.14	25.89	50.40	683.79	806.80	304.66
7.....	.....	30	141	142	.....	7.48	36.54	38.26	.....	121.80	531.65	530.54
8.....	.....	.....	16	51	.....	.....	5.48	17.67	.....	.....	67.29	246.69
9.....	.....	.....	5	2	.....	.....	2.30	1.00	.....	.....	37.68	15.36
Total, all trees.....	2,420	1,119	654	401	170.27	147.78	129.72	92.29	2,076.88	1,869.34	1,799.18	1,207.96
Total, 4" or more DBH	1,168	997	643	391	113.06	142.09	129.26	92.02	6,395.85	1,816.66	1,793.31	1,204.12

Loblolly pine produced significantly more basal area and volume (one-percent level) at each spacing than did shortleaf pine (Tables 2 and 3). Shortleaf pine volume was 68 percent that of loblolly pine on the 4 x 4-, 66 percent on the 6 x 6-, and 53 percent on the 8 x 8- and 10 x 10-foot spacings. None of the observed differences could be attributed to site (block effect) on the basis of statistical analysis.

During the past two growing seasons, the percentage increase in volume has been greater at each spacing for shortleaf pine than for loblolly

pine (Fig. 1). In actual volume, however, shortleaf pine growth exceeded loblolly pine only on the 4 x 4-foot spacing.

#### DISCUSSION

As previously mentioned, differences in site quality were not a factor in determining the superior growth of loblolly pine over shortleaf pine. This is further emphasized by comparing the best shortleaf plot with the poorest loblolly plot on which shortleaf pine yields are only 64, 62, 58, and 54 percent as great

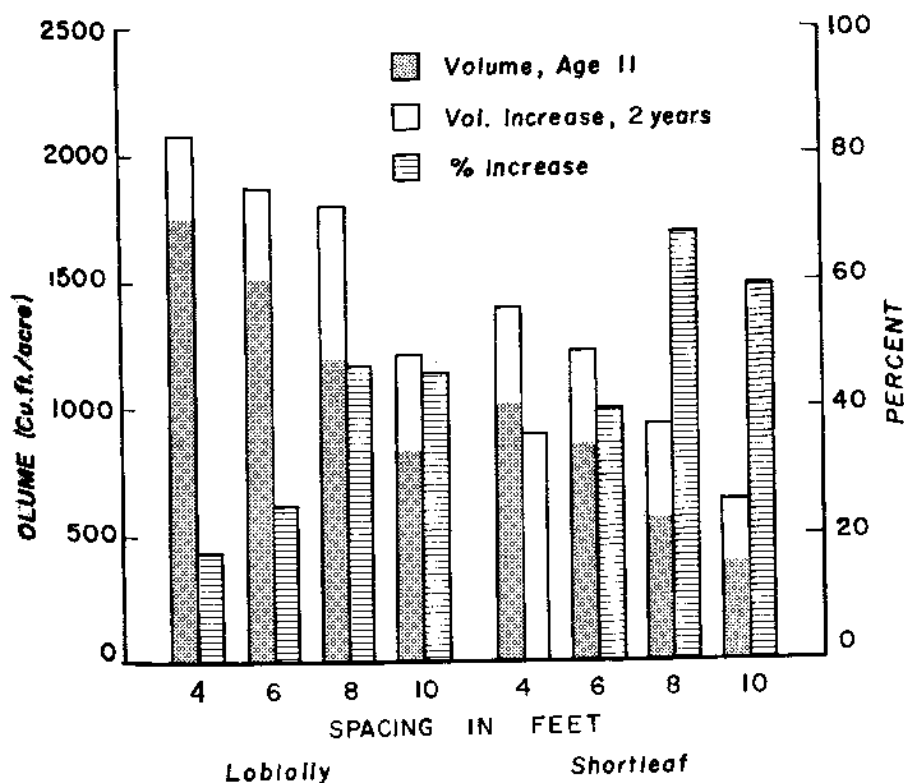


FIG. 1.—Total volume per acre and percentage increase during past two years.

as those of loblolly pine for the 4-, 6-, 8-, and 10-foot spacings, respectively.

We recognize that seed source could be an important factor in the growth differential between these two species and that in this case it is relatively unknown. However, other workers have reported superior growth of loblolly pine as compared to shortleaf when the two species are associated (Coile, 1948; Mann, 1953; Zahner, 1957; Williston, 1959). Our results confirm that this holds true in early plantation growth considerably north of the natural range of loblolly pine and at the northern limit of shortleaf pine in the Central States area.

The percentage volume increase during the past two years, when considered along with actual volume, gives some indications of the most desirable spacing for planting loblolly pine on medium quality sites in this area (Fig. 1). The percentage increase on the 4 x 4-foot spacing is about one-third, and the 6 x 6-foot spacing is about one-half, that of the two widest spacings. Then, too, the growth on the 4 x 4-foot spacing is being put on small trees, as only 67 percent of the volume is in trees four inches and above in diameter as compared with 97 percent and above on the 6 x 6-, 8 x 8-, and 10 x 10-foot spacings. While it is silviculturally desirable to thin the 4 x 4-foot spacing, a commercial thinning for pulpwood is not feasible because of the small tree size. The same is probably true for the 6 x 6-foot spacings. In contrast the two wider spacings are growing at a highly satisfactory rate, and a thinning now would be premature.

When all factors such as size, percent of live crown present, volume, and growth rate are considered, we believe that the most desirable spacing to plant loblolly pine lies between the 6 x 6- and the 8 x 8-foot spacing with the first thinning between ages 17 and 20. The shortleaf pine has not yet reached a point where such recommendations are indicated.

Comparisons of stocking, basal area, average diameter, and height of the Illinois plantations with that reported for spacing studies in 14-year-old loblolly pine at Auburn, Alabama (Ware and Stahelin, 1948); 14-year-old loblolly and shortleaf pine at Athens, Georgia (Jackson, 1958); and 11-year-old loblolly pine growing on a medium quality site in the Georgia Piedmont (Hamilton, 1956) are shown in Table 4. Loblolly pine in Illinois compares favorably, in all respects, with the 11-year-old, medium site, Georgia plantations. Considering the one-year age differences, the same holds true in comparing the Illinois loblolly pine and shortleaf pine with the older plantations in Alabama and Georgia.

The results of this study, although involving but 13 years of growth, emphasize the superior growth of loblolly pine as compared with shortleaf pine in southern Illinois. It also shows that the growth of both species, and loblolly pine in particular, compares favorably at this point with that reported for the same species in the southern states. There is some element of risk, due to the susceptibility of loblolly pine to glaze damage, in planting this species (Bogges and McMillan, 1954).

TABLE 4.—Comparison of Loblolly Pine and Shortleaf Pine Growth in Illinois, Alabama, and Georgia.

Location	Spacing, feet										Average height, ft.						
	4x4		6x6		8x8		10x10		4x4			6x6		8x8		10x10	
	Basal area, sq. ft./acre																
	Number of trees per acre																
	Loblolly pine																
Illinois <sup>1</sup>	2,497	1,131	654	410	155	127	106	71	3.4	4.5	5.5	5.6	30.2	32.4	34.4	32.2	
Illinois <sup>2</sup>	2,420	1,119	654	401	170	148	130	92	3.5	4.8	6.0	6.4	22.0	24.0	24.0	24.0	
Georgia <sup>1</sup>	2,360	1,190	720	.....	116	114	139	.....	2.8	4.1	5.5	.....	.....	.....	.....	.....	
Georgia <sup>2</sup>	2,143	1,070	634	.....	170	136	108	.....	3.3	4.8	5.6	.....	.....	.....	.....	.....	
Alabama <sup>3</sup>	1,904	982	566	418 <sup>4</sup>	142	134	116	91 <sup>4</sup>	3.7	5.0	6.1	6.3 <sup>4</sup>	.....	.....	.....	.....	
	Shortleaf pine																
Illinois <sup>2</sup>	2,237	1,104	637	403	132	115	85	63	3.2	4.3	4.8	5.3	24.6	25.1	23.9	23.6	
Georgia <sup>3</sup>	2,348	1,116	648	.....	131	94	79	.....	3.2	3.9	4.7	.....	.....	.....	.....	.....	

<sup>1</sup> Eleven years after planting.  
<sup>2</sup> Thirteen years after planting.  
<sup>3</sup> Fourteen years after planting.  
<sup>4</sup> Spacing was 9.6 x 9.6 feet.

Recent development of pulpwood markets within the area may help offset this disadvantage by providing an outlet for salvage materials.

#### SUMMARY

1. Loblolly pine (*Pinus taeda* L.) and shortleaf pine (*Pinus echinata* L.) were planted at spacings of 4 x 4-, 6 x 6-, 8 x 8-, and 10 x 10-feet on a site of medium quality in southern Illinois. Growth and yield data were collected at the end of the eleventh and thirteenth growing seasons.

2. Spacing had little effect on tree heights, but diameters were larger at the wider spacings.

3. Loblolly was taller, larger in diameter, and produced significantly more wood than shortleaf pine at each spacing. Spacings between 6 x 6- and 8 x 8-feet are suggested for planting loblolly pine, but present results do not yet warrant similar recommendations for shortleaf pine.

4. Growth and yield of both species compare favorably with that reported for similar studies in the Piedmont Region of Alabama and Georgia.

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