Southern Forest Experiment Station

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Research Note

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Plantation Spacing Affects Early Growth of Planted Virginia Pine

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SUMMARY

Spacings ranging from 4 x 4 to 8 x 8 ft did not affect 15-year height growth of Virginia pines planted on a cutover Cumberland Plateau site. Wider spacings produced trees of larger diameters than did closer spacings; closer spacings had more basal area and volume. Although height to the base of the live crown increased as spacing narrowed, self-pruning was poor at all spacings.

Additional keywords: *Pinus virginiana* Mill., artificial regeneration of pines.

STUDY OBJECTIVES

The role of spacing in the early growth of planted pines has been researched in numerous studies throughout the South, but few spacing studies have included Virginia pine. Specific information on the response of this species to planting density is lacking for the Cumberland Plateau, where Virginia pine is an important commercial species.

In 1961, this study was started near Sewanee, Tennessee, to test the effects of spacings of 4 x 4, 6 x 6, and 8 x 8 ft on performance of unthinned Virginia pine over a 30-year rotation. Expecting that the 4 x 4 ft spacing would produce mainly trees of small diameter but anticipating that future markets might accept small trees, I included this unusually close spacing to get information on the yields obtainable at high planting densities. Also, self-pruning is notoriously poor in Virginia pine, so another goal was to see if self-pruning could be improved by planting at a high density. This note presents results halfway through the planned rotation.

STUDY AREA

The study was carried out on the Cumberland Plateau at an elevation of 1,940 ft. Plots are near the crest of a broad ridge, on gentle slopes with a west to southwest aspect. Soils are well-drained fine sandy loams of the Ramsey, Hartsells, and Lonewood series. Depth to bedrock varies from less than 20 inches to almost 4 ft. This area is typical of the thousands of acres of drier-than-average Plateau sites where Virginia pine is more productive than native hardwoods.

Before conversion to pine, the stand had about 50 ft^2 of basal area per acre mainly in either culls or low-grade chestnut oaks, scarlet oaks, and white oaks of sawtimber size. Besides reproduction of these species, the sparse understory contained blackgum, hickories, sourwood, hairy locust, and sumac. The area also had a fairly heavy but spotty ground cover of huckleberries.

STUDY METHODS

Virginia pine was bar planted in February. Seedlings were 1-0 stock grown by the Hiwassee Land Company at its Rose Island nursery. Seed had been collected in McMinn County, Tennessee, about 100 miles northeast of Sewanee, and from trees of above average form and growth rate. Within 1 month after planting, existing hardwoods were deadened by applying an oil-herbicide solution as a basal spray to stems under 4 inches d.b.h. or in frills to trees larger than 4 inches d.b.h. All sprouts or invading hardwood seedlings were cut each spring for 5 years after planting. A few scattered, large hardwoods that

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recovered from the initial treatment were eliminated by tree injection.

Spacings of 4 x 4, 6 x 6, and 8 x 8 ft were tested on 0.25-acre plots and replicated four times in randomized blocks. Measurements were taken on a central plot that was about 0.1-acre but varied slightly in size depending on spacing. Survival, diameter, and basal area data include all trees on the measurement plots. Total heights and stem characteristics are based on a sample. I selected this sample so that the numbers of trees measured in every 1-inch diameter class were proportional to the numbers of stems in the diameter class on an individual plot. Results were interpreted by analysis of variance; differences stated as significant were tested at the 0.05 level.

RESULTS

Survival

Survival 5 years after planting was 94 percent or better for all spacings. At 10 years survival averaged 84 percent for the 4 x 4 and 6 x 6 ft spacings and 93 percent for the 8 x 8 ft spacing, a significant difference. Mortality continued to be a factor in these stands. After 15 years, survival was 54 percent for 4 x 4, 74 percent for 6 x 6, and 86 percent for 8 x 8 ft spacings (table 1).

Table 1.—*Effects of spacing on survival, diameter, basal areas, and volumes after 15 years*

spacing (feet)	Survival	d.b.h.	Basal area	Volumes[1]
	Percent	*Inches*	*Ft2 per acre*	*Ft3 per acre*
4 x 4	54 a[2]	4.0 a	129 a	1830 a
6 x 6	74 b	4.7 b	108 b	1520 b
8 x 8	86 c	5.4 c	95 b	1300 b

[1]Cubic feet volumes per acre for entire stem, less bark.
[2]Means in each line followed by different letters are significantly different at the 0.05 level of probability.

Growth

Total heights averaged 32.7 ft and varied less than 1 ft among spacings. Despite considerable differences in soils among the 12 plots, mean heights from the poorest plot to the best plot varied by only 4.2 ft. Effects of site on height growth of Virginia pine may not be fully expressed by 15 years.

Planting at high densities failed to improve self-pruning. Dead branches persisted to within 1 ft of the ground for all spacings. Height to the base of the live crown, however, averaged only 15.2 ft for pines in the 8 x 8 ft spacing — significantly less than the 18.2 ft for pines planted at 4 x 4 ft.

Average d.b.h. increased uniformly from the closest to the widest spacing, but basal area was significantly higher only on plots planted at 4 x 4 ft (table 1). Total volumes corresponded closely with basal areas, increasing as plantation density increased. Volume per square foot of basal area averaged about 14 ft^3 at all spacings.

Diameter distributions

The distribution of diameters in this 15-year-old plantation further emphasizes the effect of planting density on the development of young Virginia pines (table 2). The 6 x 6 ft spacing yielded more trees per acre in the 5-inch and larger d.b.h. classes than either closer or wider spacings. However, there were over three times as many 7- and 8-inch stems at 8 x 8 than at 6 x 6 ft.

Table 2.—*Distribution of diameters as related to initial plantation spacing*

Spacing (feet)	d.b.h. class (inches)								
	1	2	3	4	5	6	7	8	All
	Trees per acre								
4 x 4	3	185	465	438	278	92	18	2	1481
6 x 6	-	40	160	220	290	155	25	2	892
8 x 8	-	9	31	127	175	156	76	14	588

On plots planted at 4 x 4 ft only 26 percent of surviving pines are 5 inches d.b.h. or larger and thus merchantable for pulpwood under current local standards. In stands planted at 6 x 6 and 8 x 8 ft merchantable stems averaged 53 percent and 72 percent of the stands, respectively. The proportion of planted trees that both survived and reached merchantable size in 15 years ranged from 14 percent for the 4 x 4 to 62 percent for the 8 x 8 ft spacing.

CONCLUSIONS

The 6 x 6 and 8 x 8 ft spacings produced about the same number of merchantable trees, but the wider spacing had more 7- and 8-inch trees and thus would be preferred under present marketing conditions. High basal area and a corresponding high biomass can be produced by young stands planted at 4 x 4 ft. But planting this many trees per acre is expensive and excessive early mortality of Virginia pine in such dense stands is likely. Extremely close spacings will be attractive only where stems smaller than 5 inches d.b.h. can be utilized and then only if rotations of not much longer than 10 years are planned.

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