FIFTEEN-YEAR RESULTS ON A SWEETGUM SPACING STUDY

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Spacing of 7 by 7 feet is recommended as the most desirable for short rotations where total-tree chip harvesting is used, while wider spacings such as 9 by 9 feet are recommended if conventional merchantability standards are used in harvesting.

Knowledge concerning the plantation management of southern hardwoods was very meager a decade ago. Even as research results and trial-and-error experience became available, the bulk of the knowledge was centered around establishment and management of natural stands. Only a few inquisitive pine foresters who saw the possible need for ultimately growing hardwoods in the future were willing to plant hardwoods and see what those "weeds" would do if given a chance. If hardwoods were to be established artificially, one obvious question was, "At what spacing should they be planted?" This paper reports the results of one pioneer planting established to evaluate the effects of various spacings of sweetgum *(Liquidambar styraciflua* L.) on growth and survival.

Methods

American Can Company established the study in 1961 on an overflow bottom of the Tombigbee River near Myrtlewood, Ala. The site, an abandoned pasture, has a pine site index of 100 (base 50 years). The soil is characterized as a heavy clay (Oktibbeha Series) and is inundated during extreme flooding of the river. The site was prepared by double-disking with a bush and bog disk.

Table 1.—*Summary of all measurements taken on the Myrtlewood sweetgum spacing study*

Spacing	Measurement Year	Total Height	DBH	Total Volume[1]	Merchantable Volume[2]
(feet)		*(feet)*	*(inches)*	*(cords/acre)*[3]	*(cords/acre)*
5 x 5	1	1.7	—	—	—
	2	2.7	—	—	—
	3	3.9	—	—	—
	4	5.7	—	—	—
	5	8.7	0.72	0.19	—
	10	20.3	2.33	5.99	—
	15	31.1	3.10	13.80	—
7 x 7	1	1.8	—	—	—
	2	2.9	—	—	—
	3	4.0	—	—	—
	4	5.9	—	—	—
	5	9.0	0.87	0.15	—
	10	21.8	2.99	4.81	—
	15	36.5	4.20	14.97	7.27
9 x 9	1	1.6	—	—	—
	2	2.7	—	—	—
	3	3.9	—	—	—
	4	5.8	—	—	—
	5	8.7	0.77	0.07	—
	10	20.5	3.00	2.90	—
	15	36.4	4.70	11.70	9.05

[1] Total volume in cubic feet = $0.00186DBH^2$ x (total height - 0.5); total volume includes all volume inside bark, excluding limbs.
[2] Merchantable volume is total volume to a 4 inch outside bark top.
[3] 1 cord = 70 ft^3 of wood.

Table 2.—*Height, diameter, and volume of sweetgum at age 15 on different spacings in the Myrtlewood spacing study*

Spacing	Height	DBH	Total Volume[1]	Merchantable Volume
(feet)	*(feet)*	*(inches)*	*(cords/acre)*	*(cords/acre)*
5 x 5	31.1 a[2]	3.1 a	13.8 a	—
7 x 7	36.5 b	4.2 b	15.0 a	7.3 a
9 x 9	36.4 b	4.7 c	11.7 a	9.0 a

[1] Total volume includes all cubic-foot volume inside bark, excluding limbs, with cubic feet converted to cords by a factor of 70 cubic feet per cord.
[2] Averages followed by the same letter are not significantly different at the .05 level, using Duncan's Multiple Range Test.

The study evaluated three spacings: 5 by 5 feet, 7 by 7 feet, and 9 by 9 feet. The study design was a randomized complete block with four replications. Spacing plots consisted of 11 rows of 11 trees, with the middle 7 rows of 7 trees being designated as the measurement sub-plot.

Results

Height measurements were taken at years 1, 2, 3, 4, 5, 10, and 15; in addition, diameter measurements were taken at years 5, 10, and 15. A summary of these measurements is presented in table 1.

The means for the 15-year measurement in table 2 show that the 7- by 7-foot spacing has the largest per-acre total volume, but this volume is not statistically different from the total volume of the other two spacings. The individual tree volumes increase with a decrease in stand density; these differences are statistically significant. Survival has been good for all spacings, averaging 96 percent, 98 percent and 99 percent for the 5 by 5 feet, 7 by 7 feet, and 9 by 9 feet, respectively.

The mean height, diameter, and volume growth of the various spacings over time are illustrated in figure 1. The curves also show that individual tree growth is best for the wider spacings, but as stems per acre are considered, per-acre volume is highest for the 7- by 7-foot spacing. While there were no statistically significant per-acre volume differences, the volume curves indicate that the trees spaced at 5 by 5 feet are slowing in growth at age 15 while the trees at the 7- by 7-foot and 9- by 9-foot spacings are producing volume at an accelerating rate.

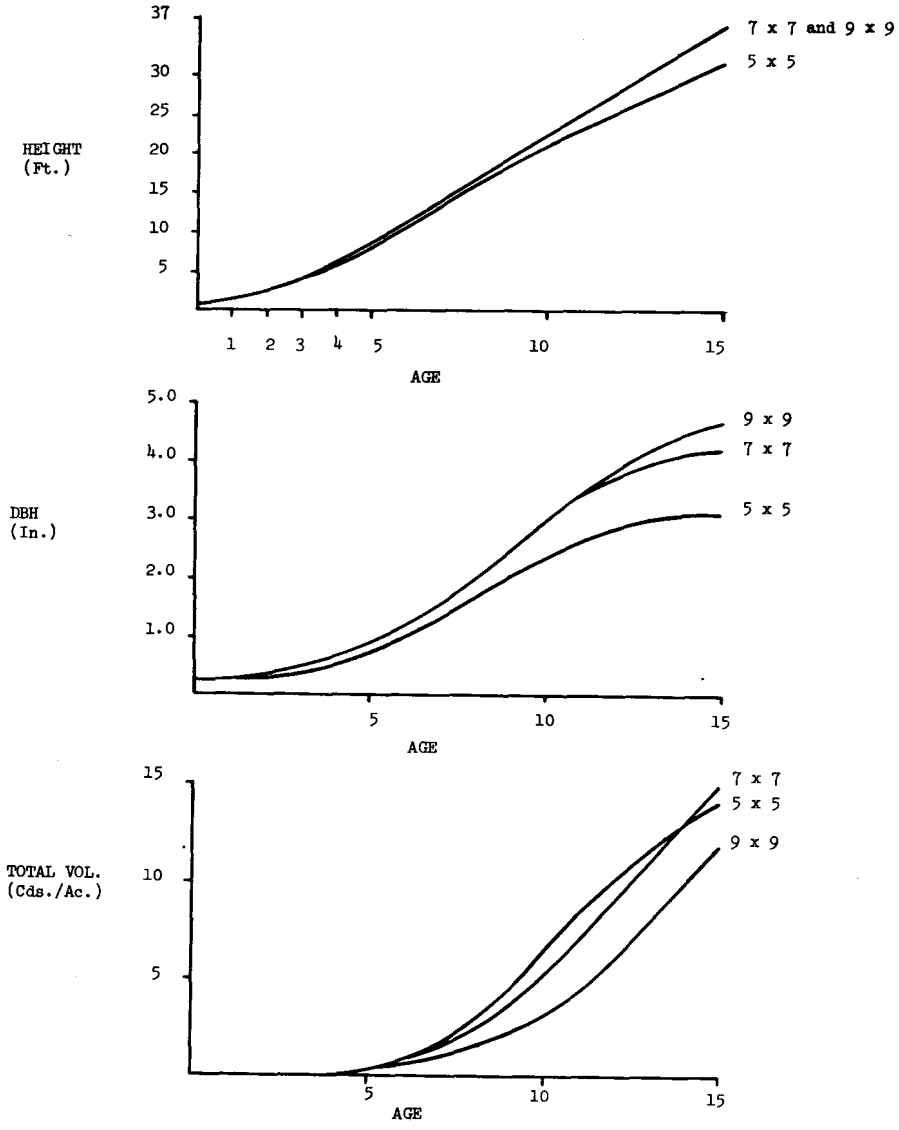

Figure 1.—*Mean height, diameter, and total volume-growth over time.*

Discussion

Any decision as to the optimum spacing for any species must be made only after consideration of the desired product, rotation length, and method of harvesting. If fiber for pulp is the desired product, then the tighter spacings maximize total biomass. Management for total biomass usually employs short rotations and whole tree harvesting operations. If lumber is the desired product, or if conventional harvesting methods are used where merchantability standards are imposed, then wider spacings that favor growth of the individual tree are desired. These constraints usually dictate longer rotations which in themselves require wider spacings if thinning and natural mortality are to be minimized.

In this study, the 7- by 7-foot spacing yielded the highest total volume at year 15; however, the 9- by 9-foot spacing yielded the largest volume of wood when conventional harvesting techniques were used.

In a review of sweetgum silviculture, McElwee (*2*) recommended either an 8- by 8-foot or 8- by 10-foot spacing for pulpwood rotations. Stubbs (*3*) found no height differences among planted sweetgum at spacings of 4 by 4 feet, 6 by 6 feet, or 8 by 8 feet; however, his data were based on 5-year results and reflect the relatively slow early growth rate of sweetgum. Results from a cottonwood spacing study in the Mississippi Delta indicated that spacings of either 8 by 9 feet or 12 by 12 feet produced the largest pulpwood volumes at age 10 as compared to spacings of 4 by 9 feet or 16 by 18 feet (1). The closer spacings had slower individual tree growth rates due to overcrowding, while the wider spacings failed to fully utilize the sites at early ages. Since sweetgum has a slower growth rate than cottonwood, one might conjecture that the optimum spacing for sweetgum would be less than the 12- by 12-foot spacing.

A point related to rotation length and subsequent optimum spacing is the level of site preparation, aftercare, and fertilization involved operationally. Present knowledge on hardwood plantation management indicates that intensive site preparation and cultural aftercare such as disking for 1 to 3 years is required for maximum growth and to allow hardwood seedlings to escape competing vegetation. Large seedlings with good root systems are also necessary for optimum growth. The Myrtlewood study did not have plantation aftercare. Therefore, it is fair to conclude that with aftercare, growth rates would have increased; thus the effects of competition would have arrived at an earlier date. The wider spacings would have been favored then.

In conclusion, for rotations of 12 to 20 years on good sites, a spacing of 7 by 7 feet for sweetgum appears to be the tightest spacing advisable; this spacing seems especially well suited to total tree harvesting operations. Somewhat wider spacings such as 9 by 9 feet or wider are advisable if conventional harvesting and initial plantation aftercare are planned or if lumber is the desired product.

Literature Cited

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