12X12 INITIAL SPACINGS BEST IN COTTONWOOD PLANTATIONS

R. M. KRINARD 1
Southern Forest Experiment Station
USDA Forest Service

Most of the 30,000 acres of eastern cottonwood *(Populus deltoides* Bartr.) plantations in the lower Mississippi River Valley had initial tree spacings of 9 by 9 or 10 by 10 feet. These spacings were thought adequate for both cordwood and sawtimber production without precommercial treatment, were convenient for first-year mechanical cultivation, and provided adequate stocking if only two-thirds of the trees survived.[2] This report summarizes 7 years of growth data from a plantation near Fitler, Miss., which indicate that a 12by 12-foot spacing may be near optimum.

Methods

In January 1963, 20-inch cuttings were planted at spacings of 4- by 9-, 8- by 9-, 12- by 12-, and 16- by 18-feet on plots 144 feet square. Each increase in spacing doubled the growing space per tree, or halved the number of trees per acre. There were eight plots per spacing. To secure high survival, two cuttings separated by 4 to 6 inches were planted at each planting spot. Where both cuttings sprouted, one tree was cut after the first year.

Since the study area had been in pasture for many years, it was plowed before planting to a depth of about 14 inches to break any pan. The soils were medium textured, predominantly Commerce and Convent silt loams.

After the fourth growing season, the eight measurement plots per spacing were arrayed according to basal area. Thinning treatments were assigned to the four plots with highest and lowest basal area within each spacing. These treatments were applied when specified basal areas were reached, but through seven growing seasons, four plots each at the 4- by 9-foot and 8- by 9-foot, six at the 12- by 12-foot, and eight at the 16- by 18foot spacings were not thinned. Only the performance of trees in these unthinned plots is reported here.

1 The author is mensurationist at the Southern Hardwoods Laboratory (Stoneville, Miss.) maintained in cooperation with the Miss. Agr. Exp. Sta. and the Southern Hardwood Forest Research Group.

[2]Maisenhelder, L. C. Cottonwood plantations for southern bottomlands. USDA Forest Serv., Occas. Pap. 179, 24 pp., Southern Forest Exp. Sta., New Orleans, La. 1960

Each year, all trees on the plots were counted to determine survival. Height measurements were taken of 50 sprouts per plot at the end of the first year, and five dominant trees per plot after the fourth and sixth years. From the fourth through the seventh years, diameters of all trees taller than 4.5 feet were measured with calipers.

Results

As number of trees per acre increased, average diameter decreased, and basal area increased. Height of dominant trees was not significantly affected by density of stocking.

Survival, defined as the average percentage of planting spots with a live cottonwood stem, ranged from 76 percent at 4- by 9-feet to 85 percent at 16- by 18-feet after 1 year, and 72 at 4by 9-feet to 83 at 16- by 18-feet after 4 years. Poorer tree survival at the closest spacing in the first year may be attributed to early cessation of mechanical cross cultivation rather than tree competition. Tree mortality in three 4- by 9-foot plots increased by 2 to 10 percent from the fourth through the seventh year, and 22 percent in the fourth plot. Mortality for the last 3 years for plots of the three wider spacings ranged from 0 to 5 percent.

Diameter growth increased as stocking decreased (table 1). Average diameters after 4 years were 3.5, 4.3, 5.3, and 5.8 inches for closest to widest spacings. After 7 years, the average diameter of trees at the widest spacing was 4.2 inches larger than that at the closest spacing. Average annual diameter growth dropped below 1 inch for the 4- by 9-foot plots after the fourth year and for the 8- by 9-foot plots after 6 years. The average for the two wider spacings remained above 1 inch for the 7 years. However, there was less than an inch increase during each of the last 3 years for the 12- by 12-foot plots and during the seventh year for the widest spacing.

Heights of dominant trees were not greatly influenced by planting spacing. In order of increasing spacing, average heights of sample trees at the end of the first season were 9.5, 8.4, 8.6, and 8.1 feet. At the end of the fourth year, the average dominant-tree height ranged from a high of 50 feet for 12- by 12-foot spacing to a low of 46 feet for 16- by 18-foot spacing. Heights ranged from 67 feet at 12- by 12-feet to 64 feet at 4- by 9- and 16- by 18-feet after 6 years.

As expected, *basal areas* were highest at the closest spacings. At age 4, basal areas per acre were 67, 56, 42, and 26 square feet per acre for closest to widest spacings. Basal area growth the last 3 years ranged from 35 square feet per acre for the 8- by 9-foot spacing to 30 square feet per acre for the 16- by 18-foot spacing.

A local volume table was made using Smalian's formula and data obtained from trees cut at the end of the sixth and seventh years. A smooth curve was fitted to 1-inch diameter classes. Volumes were computed to a minimum top diameter of 4.0 inches outside bark. For trees 5.0 inches d.b.h. or larger, *cubic volumes per acre* after 4 years were 380, 550, 725, and 480 cubic feet for closest to widest spacings. Volumes after 7 years in 5.0-inch and larger trees were 1,380, 1,630, 1,625, and 1,360 cubic feet per acre. Assuming a conversion factor of 90 cubic feet per cord, annual cordwood growth per acre was about 2.2 cords at 4- by 9-feet and 16- by 18-feet, and 2.6 cords at 8- by 9-feet and 12- by 12-feet. Mean annual volume increment is increasing for all spacings.

TABLE 1—*Average basal areas, diameters, volumes, and survival after 4 and 7 years, by spacing*

Spacing	No. of plots	Basal area per acre[1]	D.B.H.[1]	Percent survival[1]	Volume[2]
Feet		*Sq. ft.*	*In.*		*Cords*
		Fourth year			
4 by 9	4	67.5	3.5	72	4.2
8 by 9	4	55.6	4.3	81	6.1
12 by 12	6	41.8	5.3	80	8.0
16 by 18	8	25.6	5.8	83	5.3
		Seventh year			
4 by 9	4	98.9	4.6	62	15.3
8 by 9	4	90.7	5.6	78	18.1
12 by 12	6	72.7	7.1	79	18.0
16 by 18	8	55.8	8.8	82	15.1

[1]Based on all trees ≥0.1 inch d.b.h.
[2]Volume in trees ≥5.0 inches d.b.h., to 4-inch top outside bark, with 90 cubic feet per cord.

Discussion

With present utilization standards, the 12- by 12-foot spacing appears to be the best of the four tested. This spacing produced 70 square feet of basal area per acre in 7 years and average diameter growth exceeded 1 inch for that period. Pulpwood production in trees 5.0 inches d.b.h. to a 4-inch top diameter was about 18 cords per acre at both the 12- by 12-foot and the 8- by 9-foot spacings (table 2). Better crown development of dominant trees at the wider spacing was a plus factor for future growth.

Trees planted at 16- by 18-feet have not adequately utilized the site. Also, it appears that trees will not be of sufficient quality for sawtimber and veneer without pruning.

Although the 8- by 9-foot spacing had the same volume yield as the 12- by 12-foot spacing, no particular benefits can be seen for spacings of 8by 9-feet or closer. Even as a hedge against mortality, these spacings do not appear beneficial. In the study planting, dead trees were not uniformly spaced. Gaps occurred and trees in pockets of good survival were too closely spaced for adequate development.

TABLE 2.—*Effect of spacing on diameter distribution after 4 and 7 years*

Spacing	D.b.h. class (inches)						
	<4.0	4.0-4.9	5.0-5.9	6.0-6.9	7.0-8.9	≥9.0	Total
Feet	*Stems per acre*						
	Fourth year						
4 by 9	529	212	117	19	1		878
8 by 9	166	144	135	39	7		491
12 by 12	35	32	58	68	42		242
16 by 18	19	13	21	34	38		125
	Seventh year						
4 by 9	314	145	118	93	86	4	760
8 by 9	97	70	88	92	110	16	473
12 by 12	17	13	16	32	102	47	237
16 by 18	7	2	4	7	34	70	124

INVITATION TO READERS

Every reader is a potential author of an article of value to Tree Planters' Notes. Please write in if you have developed or found useful a new piece of equipment, a new nursery operation, a new technique or method of planting or seeding trees, handling or packing seedlings, improving seedling growth, or site preparation; or a new seed collecting, processing, or storage procedure, which might be helpful to someone else working in the same field.

Articles are welcome in any form-letter, rough draft, or final; however, they must be typed and double spaced. Send clear, closeup glossy print photographs or black ink drawings, if possible, to increase readers' interest and understanding of the article. When sending photos be sure to secure them to heavy cardboard with rubber bands; never use paper clips. Black and white negatives are acceptable, and will be returned as soon as glossy prints can be made. Send suggestions and articles to Chief, Forest Service, (Attn. Tree Planters' Notes), U.S. Department of Agriculture, Washington, D.C. 20250. Permission is granted to reproduce any articles. Authors will be furnished a reasonable number of copies of their articles if they do not have facilities for reproducing them.