

PACIFIC SOUTHWEST Forest and Range Experiment Station

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
P.O. BOX 245, BERKELEY, CALIFORNIA 94701

EARLY EFFECTS OF SPACING ON LOBLOLLY PINE IN HAWAII

Craig D. Whitesell

*USDA Forest Service
Research Note PSW-223
1970*

Widely grown in the southern United States, loblolly pine (*Pinus taeda* L.) thrives in Hawaii's subtropical climate. A trial is underway on the island of Maui to gather information on growth response of the species to four spacing intervals: 6, 8, 10, and 12 feet. Trial plots were set up in 1961 near Olinda by the Hawaii Division of Forestry in cooperation with the U.S. Forest Service. Measurements 7 years later indicate that the growth and survival rates of the experimental seedlings compare favorably with that of loblolly pine grown in the Southeast.

THE STUDY SITE

The elevation of the experimental planting is 3,740 feet, at latitude 20°49'N and longitude 156°17'W. Aspect varies from west to south, with a general slope of 10 to 15 percent, increasing to between 50 and 100 percent in a small gulch. Annual rainfall for a 20-year period averaged 54 inches; minimum recorded was 22 inches, and maximum 94 inches. Rainfall for the period February through April averages 14.4 inches, with recorded extremes of 1.3 and 62 inches. Mean annual temperature is about 57°F.; average January temperature is 54°F.; and average July temperature is 60°F.

The soil is Olinda loam, a member of the medial isomesic family of Entic Dystrandepts (formerly the Latosolic Brown Forest great soil group). Typically the surface layer is a dark reddish-brown granular loam about 6 inches thick. The subsoil is a dark reddish-brown and yellowish-red subangular blocky silty-clay loam about 36 inches thick. The parent material is volcanic ash over andesite or basalt. This soil is well-drained, runoff is medium, and permeability is moderately rapid. The soil is slightly acid (pH 6.2 to 6.4) in both the surface layer and subsoil.¹

The spacing trial was established in an old pasture. More than 40 years earlier the area had become covered with gorse (*Ulex europaeus* L.). In 1927, the

ABSTRACT: The optimum interval at which to plant loblolly pine (*Pinus taeda* L.) is being studied on the island of Maui, Hawaii. Four spacings are being tried: 6, 8, 10, and 12 feet. Measurements of trial plots in 1968—7 years after plots were set up—show that (a) survival rate exceeded 95 percent; (b) height growth averaged about 30 feet in all spacings; (c) average d.b.h. increases ranged from 5.3 inches at the 6-foot spacing to 7.8 inches in the 12-foot spacing; and (d) basal area ranged from 95 sq. ft. per acre in the 12-foot spacing to 193 sq. ft. per acre in the 6-foot spacing.

OXFORD: 174.7 *Pinus taeda* (969):232.43:181.65.

RETRIEVAL TERMS: *Pinus taeda*; Hawaii; planting density; growth response.

first attempt was made to clear the pasture of this noxious weed, by digging and burning. Later it was burned and cleared several times in futile attempts to eradicate the gorse. By 1961, the ground cover was a 3-inch sod layer of kikuyu grass (*Pennisetum clandestinum* Hochst.) and rattail grass (*Sporobolus capensis* [Willd.] Kunth), and some gorse.

METHODS

The 1-1 loblolly pine seedlings were grown from seed purchased commercially. The seedlings were graded, and only thrifty trees with 8- to 12-inch tops and well developed root systems were planted. The grass was grazed heavily just before planting. The sod was removed at each planting spot, and holes 1 foot deep were dug.

The experimental design is a Latin square of four replications. The treatments consist of four spacings, on 4.3 acres: 6, 8, 10, and 12 feet. The 16 major plots are of equal size (0.27 acre), with the central 25 trees forming the measurement plots.

In both 1962 and 1965, the heights of all trees in the 25-tree plots were measured, and nine randomly selected trees in each plot were measured in 1968. Diameters of all trees were measured at breast height in 1965 and 1968.

RESULTS AND DISCUSSION

Survival—Twenty-one seedlings (5 percent) died during the first year and were replaced with seedlings of the same planting stock. In the next 6 years, only six seedlings died—they were not replaced. Survival also remained very high in the buffer zones around the measured plots.

Diameter growth—At age 4 there was no difference attributable to spacing in the average diameter of the trees (table 1). They averaged 3 inches d.b.h. in each

of the four spacings. Diameters ranged from a minimum of 0.9 inch for a tree in the 6-foot spacing plot to 5.3 inches for a tree in the 12-foot spacing plot. Differences in diameter growth among the four spacings had become statistically significant (at the 1 percent level) by the end of the seventh year as competition increased. By then the average d.b.h. of the trees at the 12-foot spacing was 43 percent greater than those at the 6-foot spacing. Average diameter at all four initial spacings at age 7 equaled that of loblolly pines twice their age on the United States mainland.² The largest d.b.h. measured was that of a 10.7-inch tree in a 12-foot spacing plot.

Basal area growth—Total basal area ranged from 21 square feet per acre in the 12-foot spacing to 60 square feet per acre in the 6-foot spacing, at age 4. Three years later the basal area was 98 square feet and 193 square feet, respectively, at these two spacings.

Expressed as a percent of basal area at age 4, growth during the next 3 years, by spacing intervals, was: 222 (6 ft.), 272 (8 ft.), 338 (10 ft.), and 367 (12 ft.).

Height growth—Spacing did not influence height growth. At age 4, the saplings averaged nearly 15 feet at all spacings, and during the next 3 years they grew to nearly 30 feet. Tree heights ranged from 17 feet to 41 feet at age 7. The mean annual height growth at 7 years was 4.2 feet.

It will be interesting to compare average height of the dominant and codominants in this spacing trial at age 10 with the 47 feet reached in a 10-year-old "wonder" plot described by Langdon, Hatchell, and LeGrande.³ The plot is on the Santee Experimental Forest in South Carolina. The Hawaii trees should beat them easily.

Crown development—The crowns closed rapidly by the fourth year in the 6-foot spacing, and by the

Table 1—Rate of growth and survival in 7-year old loblolly pine plantings, by four spacing intervals, Olinda Forest Reserve, Maui, Hawaii

Spacing (ft.)	Trees per acre			Survival		Average diameter		Basal area		Average height		Live crown
	1961	1965	1968	1965	1968	1965	1968	1965	1968	1965	1968	1968
	No.			Pct.		Inches		Sq. ft. per acre		Feet		Pct.
6	1,210	1,210	1,198	100	99	3.0	5.3	60	193	15	30	64
8	681	654	654	96	96	3.2	6.2	37	138	14	28	72
10	435	431	431	99	99	3.2	6.8	26	114	14	30	78
12	302	302	302	100	100	3.5	7.6	21	98	15	30	81

seventh year in the 8-foot and 10-foot spacings. Trees planted at a 12-foot spacing had 27 percent more live crown than did those planted at the 6-foot spacing. No natural pruning had occurred. On the Mainland, a loblolly pine takes about 8 years to self-prune after branches die.⁴ From this requirement, the expectation is that natural pruning will begin at around age 10 at a 6-foot spacing.

The forest floor in the closer spacings, 6 and 8 feet, are now covered with a dense layer of pine needles which have suppressed the grass and gorse. In the wider spacings, grass and gorse is still growing—but at greatly reduced vigor.

NOTES

¹*Descriptive Legend*. Soil Conserv. Serv., U.S. Department of Agriculture, Honolulu, Hawaii. p. 515-519, 1970.

²Bender, E. V. *Initial spacing in loblolly pine*. In, A guide to loblolly and slash pine plantation management in southeastern U.S.A. Georgia Forest Res. Council Rep. 14, p. 40-47. 1965.

³Langdon, O. G., G. E. Hatchell, and W. P. LeGrande. *Can you top this loblolly pine growth?* Southern Lumberman. 217(2704): 197. 1968.

⁴Mattoon, W. R. *Pruning southern pines*. USDA Farmer's Bull. 1892, 34 p. 1942.

The Author

CRAIG D. WHITESELL is assigned to the Station's Institute of Pacific Islands Forestry, headquartered in Honolulu, Hawaii. He is doing research on the silviculture of native and planted forests. He received his bachelor's (1951) from West Virginia University, and his master's degree (1954) from Duke University—both in forestry. He has been with the Station's Hawaii staff since 1962.

U.S. Forest Service research in Hawaii
is conducted in cooperation with
Division of Forestry
Hawaii Department of Land and Natural Resources



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