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GROWTH OF YOUNG SALIGNA EUCALYPTUS IN HAWAII:
6 years after thinning

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The effect of thinning on growth rate and quality of a 6-year-old *Eucalyptus saligna* Sm. stand on Maui, Hawaii, was studied by testing three levels of thinning from below: 100, 85, and 70 sq ft per acre (23, 19.5, and 16 sq m/ha). The stand had an average basal area of 102 sq ft per acre (23 sq m/ha). Initial spacing was about 10 by 10 feet. During the next 6 years, no significant differences in growth response were found among the three treatments. Basal area increased to an average of 144 sq ft per acre (33 sq m/ha) at age 12, and the average height of dominant and codominant trees increased from 71 to 100 ft (22 to 30 m). More time must elapse before effects of thinning on the quality of the residual trees can be determined.

Oxford: 175.1 *Eucalyptus saligna* (969):562.22
Retrieval Terms: thinning; stand density; Hawaii; *Eucalyptus saligna.*

One of the most favored introduced tree species for reforestation in Hawaii is saligna eucalyptus (*Eucalyptus saligna* Sm.). Plantation yields can be high.[1] The wood is used locally for general construction lumber, flooring, and pallets and is potentially useful for poles and piling, furniture, and particle board.

Specific guides are needed for management of fast-growing eucalyptus stands. Some trees are spindly, with crook, sweep, or excessive branching. Others are robust and tall—sometimes exceeding 100 feet (30 m) in height at age 5 years. When sawtimber is the major management objective, thinning at an early age is often recommended to (1) release trees from competition, thus allowing them to grow more quickly to the size desired for harvesting, and (2) concentrate wood increment, thus maintaining value, on the larger, highest quality trees.

To find out how thinning affects the growth rate and quality of young saligna stands, the U. S. Forest Service and the Hawaii Division of Forestry started a joint study in 1966. A 6-year-old saligna plantation on the island of Maui was thinned to three levels of stocking: light, medium, and heavy. Six years later no significant differences in growth response among treatments were found. Basal area values increased at about the same rate—56 to 67 square feet per acre (13 to 15 sq m/ha) during the 6 years. Mean annual volumetric increments averaged about 300 cubic feet per acre (21 cu m/ha), both before and after thinning.

STUDY AREA

The study area is in a 40-acre (16-ha) saligna plantation at Lupi, Koolau Forest Reserve, at 800 feet (240 m) elevation. Rainfall averages 130 inches (3300 mm) annually, but varies greatly from year to year. Aspect varies from east to northeast, with slopes from 1 to 20 percent.

The soil is mapped as Pauwela silty clay, and is a member of the clayey, ferritic, isothermic family Humoxic Tropohumults (formerly classified as a Humic

Ferruginous Latosol). This well-drained upland soil has developed from material weathered from basic igneous rocks.[2]

The vegetation cleared from the site consisted mainly of paperbark (*Melaleuca quinquenervia* [Cav.] S. T. Blake) and guava (*Psidium guajava* L.) trees, and several grass species. After clearing, 6-months-old balled-root saligna seedlings were planted at an initial spacing of about 10 by 10 feet (3 by 3 m).

When this thinning study was established in the 6-year-old plantation, the understory vegetation consisted mainly of paperbark and scattered koa (*Acacia koa* Gray) reproduction, dense patches of swordfern (*Nephrolepis hersutula* [Forst.] Presl.), and grasses. The woody vegetation was cut close to ground level when the experimental plots were laid out. Basal area of the saligna stand at age 6 averaged 102 square feet per acre (23 sq m/ha).

METHODS

Three degrees of thinning from below were tested: heavy, with a residual basal area of 70 square feet per acre (16 sq m/ha); medium, with 85 square feet (19.5 sq m) basal area; and light, with 100 square feet (23 sq m) basal area. Each treatment was replicated three times.

Treated plots were one-fifth acre (0.09 ha), but only the central 0.05 acre (0.021 ha) was measured. The three lightly thinned plots can be considered comparable to an unthinned control because they were reduced in basal area by an average of 8 square feet per acre (2 sq m/ha) or only 7 percent.

Tree diameters at breast height, total heights, merchantable heights to a 4-inch (10-cm) top diameter outside bark, and form diameters were measured at the time of thinning and 6 years later, at age 12. Cubic foot volumes were computed by using a regression formula developed for the Forest Survey of Hawaii:[3]

$$\text{Vol. (cu ft)} = 1.03313 - 0.0019797\,H^2 - 0.0011062\,\frac{(D^2H)^2}{10{,}000} \div 0.0051696\,D^2HF$$

in which: H = merchantable length in feet to a 4-inch (10-cm) top d.o.b.
D = d.b.h.
F = form class

Only one tree, in a heavily thinned plot, died during the 6-year period after thinning. Its volume was excluded in computation of the data for trees at age 12.

RESULTS

The high growth rates on all plots continued, with no important differences in response to thinning among the three levels of stocking (*table 1*). Gross volume production for the 12 years ranged from over 3000 to nearly 3800 cubic feet per acre (210 to 265 cu m/ha) and was achieved without the benefit of other intensive cultural practices.

Table 1—*Stand conditions before and after thinning 6-year-old saligna eucalyptus on Maui, Hawaii*

Stand condition	Thinning treatment		
	Light (up to 100 sq ft/acre)	Medium (up to 85 sq ft/acre)	Heavy (up to 70 sq ft/acre)
Stocking:		– Trees/acre –	
Before thinning (age 6)	547	440	467
After thinning (age 6)	413	247	280
After thinning (age 12)	407	247	280
Basal area:		– Sq ft/acre –	
Before thinning (age 6)	108	103	95
After thinning (age 6)	100	85	69
After thinning (age 12)	156	152	125
Volume:		– Cu ft/acre –	
After thinning (age 6)	1985	1916	1362
After thinning (age 12)	3785	3813	3068
Diameter:[1]		– Inches –	
Before thinning (age 6)	6.1	6.6	6.1
After thinning (age 6)	6.7	7.9	6.7
After thinning (age 12)	8.4	10.6	9.0
Total height:[2]		– Feet –	
After thinning (age 6)	64	76	74
After thinning (age 12)	96	107	97

[1] Diameter of tree of mean basal area.
[2] Average height of trees classified as dominant and co-dominant.

Mean annual growth for the 6 years after thinning was as follows:

1. Annual basal area growth averaged 10.0 square feet per acre (2.3 sq m/ha) on the lightest thinned plots, 11.7 square feet (2.7 sq m) on the medium thinned plots, and 9.9 square feet (2.3 sq m) on the heaviest thinned plots. An analysis indicated no statistically significant differences (at the 5 percent level) among these three levels.

2. Cubic volume increment was not significantly related to residual basal area. Periodic annual cubic volume increment for all three thinning levels averaged 318 cubic feet per acre (22 cu m/ha).

3. Average diameter growth ranged from a low of 0.30 inch (0.8 cm) annually on plots thinned to 100

square feet of basal area to a high of 0.48 inch (1.2 cm) on the plots thinned to 85 square feet per acre. On the plots thinned to 70 square feet per acre, diameter growth averaged 0.41 inch (1.0 cm) yearly.

4. Height growth of the dominant and codominant trees was little affected by thinning treatments. Any differences between treatments were not statistically significant at the 5 percent level. Annual height increment was 4.1 feet (1.2 m) for the light thinning, 5.6 feet (1.7 m) for the medium thinning, and 5.7 feet (1.7 m) for the heavy thinning.

Conservative thinnings of 6-year-old saligna eucalyptus, leaving 70, 85, or 100 square feet per acre (16, 19.5, or 23 sq m/ha), resulted in no statistically significant differences in growth among treatments at age 12. More time must elapse before effects of thinning at age 6 on the quality of the residual trees can be determined.

CONCLUSIONS

Information obtained from this experiment leads me to conclude that saligna eucalyptus stands planted at a 10- by 10-foot (3- by 3-m) spacing do not require thinning until basal area is at least 200 square feet per acre (46 sq m/ha)—and perhaps not even then. This study indicates that a basal area of 200 square feet per acre should be reached at about age 15 on sites similar to the study area. Judging by the lack of response shown to the thinning levels prescribed for this study, a heavy thinning that reduced basal area by 40 percent or more at about age 15 would probably be required to obtain a substantial increase in diameter growth. The larger of the trees removed in such a thinning would provide sawlogs;[4] the smaller trees could be chipped to supply the developing export market for wood chips. Many of the trees removed would be more than 125 feet tall and would be difficult to fell without damaging residual trees. Because of such uncertainties, however, further research is required before firm management guides can be prescribed.

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NOTES

[1] Pickford, G. D., and R. K. LeBarron. 1960. *A study of forest plantations for timber production on the island of Hawaii.* USDA Forest Serv. Tech. Paper 52, 17 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

[2] U.S. Department of Agriculture. 1972. *Soil survey of the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii.* 232 p. Soil Conserv. Serv., Washington, D.C.

[3] Nelson, Robert E., Tom K. Tagawa, Nobuo Honda, and E. M. Hornibrook. 1958. *Manual of instructions for initial survey of the timber resource in the State of Hawaii.* (Unpublished report on file, Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.)

[4] Skolmen, Roger G. 1974. *Lumber potential of 12-year-old saligna eucalyptus trees in Hawaii.* USDA Forest Serv. Res. Note PSW-288, 7 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

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