SILVICULTURE

STAND MANAGEMENT OF KOA: THINNING AND FERTILIZATION

Travis Idol, Ph.D. (University of Hawai'i at Mānoa Department of Natural Resources and Environmental Management), Paul Scowcroft (USDA Forest Service, Institute of Pacific Islands Forestry), J.B. Friday (University of Hawai'i at Mānoa Department of Natural Resources and Environmental Management)

In many areas of Hawai'i, *Acacia koa* (koa) has been naturally regenerated through soil scarification or other disturbances such as fire, resulting in single-age cohorts of dense but patchy stands. Managing these stands for timber production usually includes thinning to maintain growth potential and prevent suppression through intraspecific competion. Other treatments, such as fertilization or grass control, may have additional positive effects on the selected trees ("crop trees").

A growing body of research offers insights into responses to thinning and other treatments for dense, naturally-regenerated koa stands. Scowcroft and Stein (1986) studied a 10-year-old koa stand on Maui situated at 1100 m above sea level (asl) on nutrient-poor soil that received on average 2500 mm mean annual precipitation (MAP). Stand density at 10 years was 2100 stems ha^{1} and a majority of trees were considered dying or weak. Experimental treatments included thinning to 50% residual density and fertilization with N-P-K (10-30-10) at 460 kg ha^{-1} and $MgSO_4$ at 170 kg ha^{-1}. Thinning significantly increased stand relative growth rate for the first 2-3 years, until an outbreak of koa looper moth (*Scotorhythra paludicola*) defoliated the stand. Fertilization had no significant independent or additional effect to thinning.

Pearson and Vitousek (2001) studied a 9-year-old koa stand on Hawai'i Island situated at 1500 m asl on a 2000-3000 year-old lava flow soil (Mauna Loa) that received on average 2500 mm MAP. Stand density was 16,000 stems ha^{-1} with a basal area of 21 m^{2} ha^{-1}. Experimental treatments included thinning to 50% residual basal area and fertilization with 70 kg ha^{-1} of nitrogen (N) as ammonium nitrate. Thinning increased mean annual stem diameter (DBH) increment from 0.4 to 1.1 cm. Fertilization had no significant independent or additional effect to thinning.

In the same location, Scowcroft et al. (2007) studied a 23-year-old koa stand. Stand density was approximately 900 stems ha-1. Experimental treatments included thinning around selected crop trees (all trees with overlapping or touching crowns), herbicide grass control, and fertilization with 750 kg ha-1 of phosphorus (P) as triple super phosphate. The full combination of treatments resulted in a significant increase in annual DBH increment from 0.5 to 1.09 cm. This difference was due to a significant decline in DBH increment over time in the control plots vs no difference over time in the fully treated plots.

Baker et al. (2008) studied 30-year-old koa stands on Hawai'i Island situated at 1500 m asl on a 1500-300 year-old lava flow soil (Mauna Loa) that received on average 1200 mm MAP. Experimental treatments included thinning around selected crop trees to different set distances, representing residual stand densities from 900 to 200 stems ha^{-1}, and herbicide grass control. After 3 years, stem DBH increment was twice as great with thinning to 900 stems ha^{-1} and almost 4 times as great at 200 stems ha^{-1}. Grass control had no significant independent or additional effect.

Idol et al. (2017) studied a 9 year-old koa stand situated on Hawai'i Island at 1500 m asl on a deep ash soil (Mauna Kea) that received on average 2000 mm MAP. Experimental treatments included thinning around selected crop trees to a residual stand density of 500 stems ha^{-1} (4.5-m radius), fertilization with 600 kg ha^{-1} of P as triple super phosphate, and herbicide grass control. Thinning increased annual stem DBH increment from 1.0 to 2.0 cm. Fertilization and grass control had no significant independent or additional effect on DBH increment. For thinned trees, P fertilization significantly increased height growth from 0.5 to 1.0 m over 2 years. Gap closure after thinning progressed at a rate that was projected to result in full canopy closure after approximately 5 years.

Conclusions and recommendations from this study include the following :

1. The time of first thinning should take place at 6-8 years of age, depending upon initial density and average crop tree size.

2. Crop tree selection thinning is recommended to focus efforts on trees with the best timber potential. The thinning intensity (radius) should be as wide as practicable, up to the expected crown area requirement of trees at the first commercial thinning or harvest.

3. Thinning at a young age should approximately double stem DBH increment, maintaining growth potential of trees in otherwise overstocked stands.

4. Fertilization with P is recommended at a rate of at least 500 kg ha^{-1}. This appears to be more important for older stands, but there may be improvements in height growth even for younger stands.

5. Given the greater expense of thinning vs fertilization and the potential increase in height growth, repeated P fertilization may improve the canopy dominance of crop trees and reduce or eliminate the need for additional pre-commercial thinning as thinned gaps close in.

Figure 1: A 12-year-old potential crop tree on Mauna Kea responds with healthy crown development four years after release

Figure 2: All less vigorous or forked trees were felled within a 15-foot radius of each potential crop tree in this study in a 9-year-old stand on Mauna Kea.

Figure 3: The young koa stand on the left was regenerated by scarification by bulldozer and fencing to exclude cattle. A healthy seed bank had been built up in the soil by the remaining overstory koa trees in these pastures on Mauna Kea.

References

Baker, P.J., Robinson, A.P., Ewel, J.J., 2008. Sudden and sustained response of *Acacia koa* crop trees to crown release in stagnant stands. Canadian Journal of Forest Research 38, 656-666.

Idol, T.W., Martinez Morales, R., Friday, J.B., Scowcroft, P.G. 2017. Precommercial release thinning of potential *Acacia koa* crop trees increases stem and crown growth in dense, 8-year-old stands in Hawai'i. Forest Ecology and Management 392: 105-114.

Pearson, H.L., Vitousek, P.M., 2001. Stand dynamics, nitrogen accumulation, and symbiotic nitrogen fixation in regenerating stands of *Acacia koa*. Ecological Applications 11, 1381-1394.

Scowcroft, P.G., Friday, J.B., Idol, T.W., Dudley, N., Haraguchi, J., Meason, D., 2007. Growth response of *Acacia koa* trees to thinning, grass control, and phosphorus fertilization in a secondary forest in Hawai'i. Forest Ecol Manage 239, 69-80.

Scowcroft, P.G., Stein, J.D., 1986. Stimulating growth of stagnated *Acacia koa* by thinning and fertilizing. Research Note - Pacific Southwest Forest and Range Experiment Station, USDA Forest Service, 8 pp.