Development of Silvicultural Practices to Promote Growth and Quality of *Acacia koa*

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Acacia koa is the premier timber species of the Hawaiian forest. The range of *Acacia koa* has been greatly reduced due to logging, land clearing for agricultural production, and cattle grazing. Presently, the demand for *Acacia koa* lumber exceeds the sustainable supply. This has resulted in shortages and a significant increase in price. Landowners are considering reforestation with *A. koa* as a viable land-use alternative.

As these *A. koa* plantings expand, what combination of genetic potential and forest management will enhance the value of these regenerated koa forests? The first steps towards answering this question are the development of a forest management system for *A. koa* and the development of genetically improved seedlings for future planting.

Forest management options can range from no silvicultural interventions to a series of treatments over the life of the stand to promote quality and growth. Little is known about the effects of silvicultural treatments on stands of *A. koa*. However, related research indicates that faster rates of growth, an increase in the quality of timber in the stand, and a significant increase in value over unmanaged stands may be expected (Daniel et al. 1979).

Silvicultural management is most effective when combined with tree improvement. This ensures that the tree with the best possible genetic make-up is utilized to produce the most valuable forest product as rapidly and as efficiently as possible. The objective of a tree improvement program is to produce trees that exhibit superior growth rates, high quality wood, and resistance to pests. Several rate-of-return analyses on tree improvement programs indicate wood volume improvement as low as 6.3 percent will yield 8 percent return on rotation ages up to 50 years (Zobel 1984).

With the above introduction, I would like to share my experience managing *A. koa* tree improvement trials at Maunawili, O'ahu. This site is on former sugarcane land at 350 ft elevation. The soil series is Kaneohe silty clay loam. The historical average rainfall is 83 inches per year. The historical average temperature is 77°F. At this site, a series of *Acacia koa* family trials were established in cooperation with the University of Hawai'i in 1994, 1995, and 1996. There are over 150 different *A. koa* families, representing a state-wide collection.

Site preparation

When establishing a koa stand on former agricultural or range land where a seed bank of *A. koa* does not exist, sampling the soil of the planting area is very important to understand the nutrient status of the site. The planting site can then be amended as indicated by soil test results. In site preparation, the degree of tillage and depth are important considerations. Disking and ripping (subsoiling) operations need only occur along the planting lines as the site is prepared. Koa seedlings are highly sensitive to the quality of soil preparation. Better growth and survival of koa seedlings can be expected on sites that have been well prepared.

Planting stock

Only well-grown *A. koa* seedlings should be planted. Visually inspect the seedlings for vigor and check the root plug for rhizobium nodules. Here is the formula for tree improvement and characteristics of ideal *A. koa* seedlings: Plant *A. koa* seedling with best genetic potential + management at right time and amount = tree improvement. The ideal type of koa has highly figured wood, good stem form (straight and erect), good branch angles (and self pruning), resistance to insects and disease, and a moderate to fast growth rate.

Vegetation management

Weed competition will limit growth and survival of young koa seedlings. Control can be easily and economically accomplished with the selective use of herbicides or mechanical methods. Reduced competition of weeds for nutrients and soil moisture will enhance tree growth. Mechanical vegetation management methods include mowing, mulching, and crushing. Pre-plant herbicides should control a broad spectrum of weeds, and selective herbicides are used to control specific types of weeds post-planting. The post-planting control can then be further divided

between preemergence applications and postemergent applications. To quickly establish the *A. koa* seedling, each of the chemical control methods were utilized.

Pests

Although the pests of koa are well known (Whitesell 1990), at the Maunawili site significant damage was caused by the black twig borer (*Xylosandrus compactus*). A qualitative index of insect damage was developed with a range of 0 to 4. A tree with no insect damage was given a rating of zero and the higher the amount of infestation the higher the score, with complete mortality scoring a 4. The scoring was based on 10 trees per plot. The following ranking was assigned: families scoring 20 or less were ranked as tolerant; families scoring between 20 and 30 were ranked as moderately susceptible; families with scores of 30 were ranked as being highly susceptible. There were 12 families of 35 (34.3%) that ranked as tolerant. An additional 20 families of 35 (57.2%), were ranked as moderately susceptible. Finally, 3 families of 35 (8.6%), were ranked as highly susceptible.

Maintaining growth and quality

At 30 months, the 1994 *A. koa* family trial was thinned by half per family. After identifying the dominant and codominant trees in the stand, a selective thinning treatment was applied. The thinning is expected to increase stand vigor by removing less vigorous trees and reducing competition for light and nutrients. This will also increase volume in the remaining trees.

The objective of pruning is to improve stem form and remove lateral branches at an early age to promote development of a single, dominant stem with defect-free, high-value wood. This is a two-step process. First, corrective pruning removes forks or multiple leaders from selected trees. Then, lateral branches are removed. Generally, this is done periodically until at least 9 ft of the tree is clear, because veneer logs are normally 8 ft long. This initial pruning treatment will be limited to 25 percent of the canopy leaf area of any one tree. Pruning wounds should be monitored for rates of closure and insect infestation.

Summary

This is an intensive approach that a land manager could use in managing *A. koa*. After three years of experience, we have gained some insight into how to establish a koa stand on former sugarcane land. The forest management techniques outlined above should be viewed as tools that can be adopted where appropriate. Finally, the issues of wood quality will take some time to answer. It is not known whether the offspring of a curly koa mother will retain the same character in the wood and if regenerated koa will retain similar wood properties to wild-grown koa.

References

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Whitesell, C.D. 1990. *Acacia koa* Gray. In: Silvics of North America, vol. 2. USDA Forest Service, Agricultural Handbook 654. p. 17-28.

Zobel, B., and J. Talbert. 1984. Applied forest tree improvement. John Wiley and Sons, New York. 505 p.

Questions

Q: Do you think pruning might increase susceptibility to the twig borer?

A: I don't know. My gut feeling is, no. I think the twig borer attacks a tree based on stress and maybe some physiological or chemical signals it gets. The more likely scenario might be a fungal or bacterial attack in the wound. I think the other thing that's important is the size of the pruned branch. It's important to get to the branches at a fairly small diameter so the wounds close fast.

Q: You showed crushing the sugarcane down and planting directly in it. Did the sugarcane become real competition? **A:** It's dead.

Q: Your sprayed it before you crushed it? **A:** Yes.

Q: My question has to do with wood quality versus the silviculture. You say you don't have the answer to get those high-quality woods.

A: My point is that you have to apply silviculture to get high-quality wood. On the other hand, I don't know. I haven't taken it to harvest. The path along the way may be full of obstacles.

Q: Do you have any suggestions on what path research could take to try and develop that relationship?

A: I suggest the questions generated by this study. You can break down each component. You can do more weed control studies. You can do more pruning studies. You can do more fertilizer studies. I feel that probably the two things to enhance stand quality would be looking at pruning and thinning in a critical way. A relatively condensed 24- or 36-month study might be appropriate.