Influence of stocktype and fertilizer rate on field performance of *Acacia koa* competing with exotic kikuyu grass in a dry tropical forest

A.S. Davis[1], D.F. Jacobs[2], R.K. Dumroese[3], J. Leary[4], and A. Cho[4]

[1]University of Idaho, Moscow, ID
[2]Purdue University, W. Lafayette, IN
[3]USDA Forest Service, Moscow, ID
[4]University of Hawai'i, Manoa, HI

Background and procedures

Koa (*Acacia koa* A. Gray) is one of the most ecologically and economically valuable native hardwoods found on Hawai'i and is planted extensively for forest restoration purposes. Concern exists over the present nursery cultural practices employed and their effect on seedling performance after outplanting. The time required to reach a free-to-grow state can limit seedling establishment success, with stress from weather and competition being two major impediments. Growing seedlings in different container sizes and under various fertilization regimes can be used to manipulate seedling growth after outplanting. Kikuyu grass (*Pennisetum clandestinum* Hochst. Ex Chiov.), an exotic, invasive species introduced to Hawai'i from Kenya in the 1920s is the prevalent competing ground vegetation at the outplanting site.

We grew seedlings for approximately 3 months at Waimea State Tree Nursery (Waimea, HI, Figure 1) under a series of different nutrition and container size treatments (Table 1). Nutrition levels consisted of controlled-release fertilizer rates 0, 10, 15, 20 kg m^{-3} of Osmocote Plus (15-9-12+ other macro and micronutrients) mixed into the growing media. Containers were the dibble tube used throughout Hawai'i (49 cm^3/3 in^3), Ray Leach Super Cells (164 cm^3/10 in^3), or Deepot D-40s (656 cm^3/40 in^3). We outplanted seedlings in March 2006 using tree spades on a 2-m spacing atop the Pu'u Wa'awa'a cinder cone (elevation approximately 1200 m, annual rainfall 1100 mm). Our experiment was a 4 (nutrition levels) × 3 (container types) randomized complete block design with three replications. In each block we planted 10 seedlings of each nutrition × container combination. Blocks were used to minimize site variability effects and the experiment was within the fenced area to prevent browse damage. Following planting, initial seedling heights and root-collar diameters were measured. About 12 months after outplanting we re-measured seedling height and root-collar diameter and assessed seedling survival and the status of phyllode development. Analysis of variance was used to identify treatment differences in seedling height and root-collar diameter growth as well as to assess phyllode development and survival. SAS (Cary, NC) software was used for all data analyses.

Table 1. Summary of nutrition and container treatments.

Nutrition	Rate (kg m^{-3})	Comments
Control	0	No fertilizer applied
Low	10	Conventional fertilizer applied to koa at Waimea State Tree Nursery
Medium	15	50% increase over conventional fertilizer rate applied
High	20	100% increase over conventional fertilizer rate applied
Container type	**Size (cm^3/in^3)**	**Comments**
Dibble-tube	49/3	Container used for koa at Waimea State Tree Nursery
Ray-Leach Super-Cell	164/10	Experimental container
Deepot D-40	656/40	Experimental container

Figure 1. Seedlings growing (left) and root washed (from 656 and 49 cm^3 containers, respectively) at Waimea State Tree Nursery.

Results

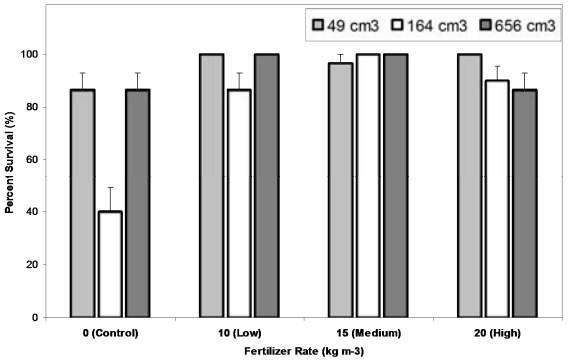

Figure 2. Effect of container size and fertilization rate on seedling survival one year following outplanting.

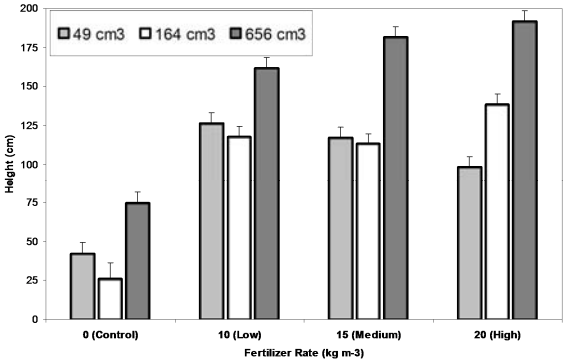

Figure 3. Total height of seedlings one year following outplanting as influenced by container size and fertilization rate.

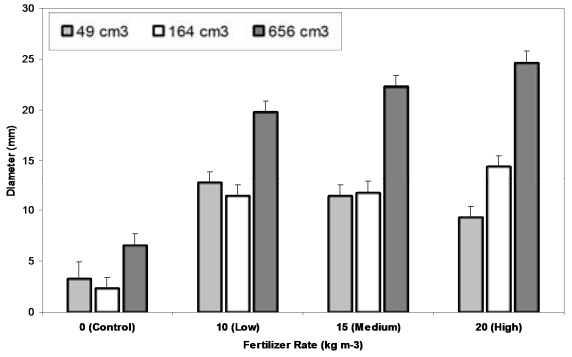

Figure 4. Total root-collar diameter of seedlings one year following outplanting as influenced by container size and fertilization rate.

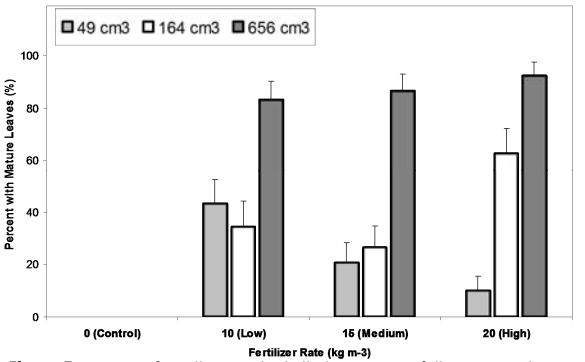

Figure 5. Percent of seedlings with phyllodes one year following outplanting.

Summary

Fertilization rate and container size have a large impact on seedling quality and resulting field performance. One year after outplanting, the largest containers (D-40, 656 cm^3) given the most fertilizer (20 kg m^{-3}) produced the tallest seedlings (Figure 3) with the largest stem diameter (Figure 4) and percentage of mature foliage (Figure 5). Because koa is a phyllodial species that undergoes a change from true leaves to sickle-shaped phyllodes that are better adapted to resist moisture stress, the greater presence of phyllodes on larger seedlings may be an added benefit given periodicity of rainfall and heavy competition for water at this site (Figure 6). Rapid seedling establishment and growth to crown closure will help control kikuyu grass and aid in koa restoration. Continuing to identify nursery cultural practices that optimize field performance should help us to more effectively establish target vegetation in a timely and cost effective manner.

Acknowledgements

This project was funded by the USDA Forest Service Regeneration, Nurseries, and Genetic Resources team, the Hardwood Tree Improvement and Regeneration Center at Purdue University, and the University of Idaho Center for Forest Nursery and Seedling Research. Assistance in establishing the study was provided by Dr. Alex Moore (Cornell University) and her students. We are grateful to Ian Shigematsu and Mike Donoho of the Hawai'i Division of Forestry and Wildlife for their strong support of this research. We also thank Owen Burney, Jeremy Pinto, Rhonda Pinto, and Amy Ross-Davis for their contributions to the study.

Figure 6. Cinder cone at Pu'u Wa'awa'a.