Nursery cultural techniques to facilitate restoration of *Acacia koa* competing with exotic kikuyu grass in a dry tropical forest

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Collaborators: This project is being undertaken through cooperation between Purdue University, University of Idaho, USDA Forest Service, State of Hawaii, and US Fish and Wildlife Service.

Background: Koa (*Acacia koa* A. Gray) is one of the most valuable native hardwoods found on Hawaii 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 to success. We grew seedlings at Waimea State Tree Nursery (Waimea, HI) under a series of different nutrition and container size treatments to see if we could improve outplanting success (Table 1). This is just one component of several projects we are completing as part of an ongoing commitment to Hawaiian native plant regeneration.

Procedures: We grew seedlings for about 3 months at Waimea (Table 1); this is typical for koa at this nursery. We outplanted seedlings in March 2006 using tree spades on a 2-m spacing atop the Pu'u Wa'awa'a cinder cone. Our experiment was a 4 (nutrition levels) × 3 (container types) × 3 (blocks) randomized complete factorial design. In each block we planted 10 seedlings of each nutrition × container combination (120 seedlings total). Blocks were used to minimize site variability effects, and the experiment was within the fenced area to prevent browse damage. Immediately following planting, initial seedling heights and root-collar diameters were measured.

Approximately 6 and 12 months after outplanting (August 2006 and April 2007) we re-measured seedlings for height and root-collar diameter growth, and collected foliar samples for nutritional analysis. We do not plan any destructive sampling, thus an even density should develop over time.

Table 1. Summary of treatments employed during seedling production at Waimea State Tree Nursery.

Nutrition	**Comments**
Control	No fertilizer applied
Low	Conventional fertilizer applied to koa at Waimea State Tree Nursery
Medium	50% increase over conventional fertilizer rate applied
High	100% increase over conventional fertilizer rate applied

Container type	**Size (cm^3)**	**Comments**
Dibble-cell	49	Conventional container used for koa at Waimea State Tree Nursery
Ray-Leach Super-Cell	164	Experimental container
Deepot D-40	656	Experimental container

Figure 1. Pu'u Wa'awa'a: Newly outplanted seedling, view of the cinder cone, Doug Jacobs next to a D-40 seedling that received medium fertilizer rate about 6 months after outplanting (August 2006).

Findings to date: 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 with the most stem diameter and percentage of mature foliage (phyllodes). 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, this earlier transition to phyllodes on larger seedlings is perceived to be an added benefit. Rapid seedling establishment and growth to crown closure will help control kikuyu grass and aid in koa restoration.

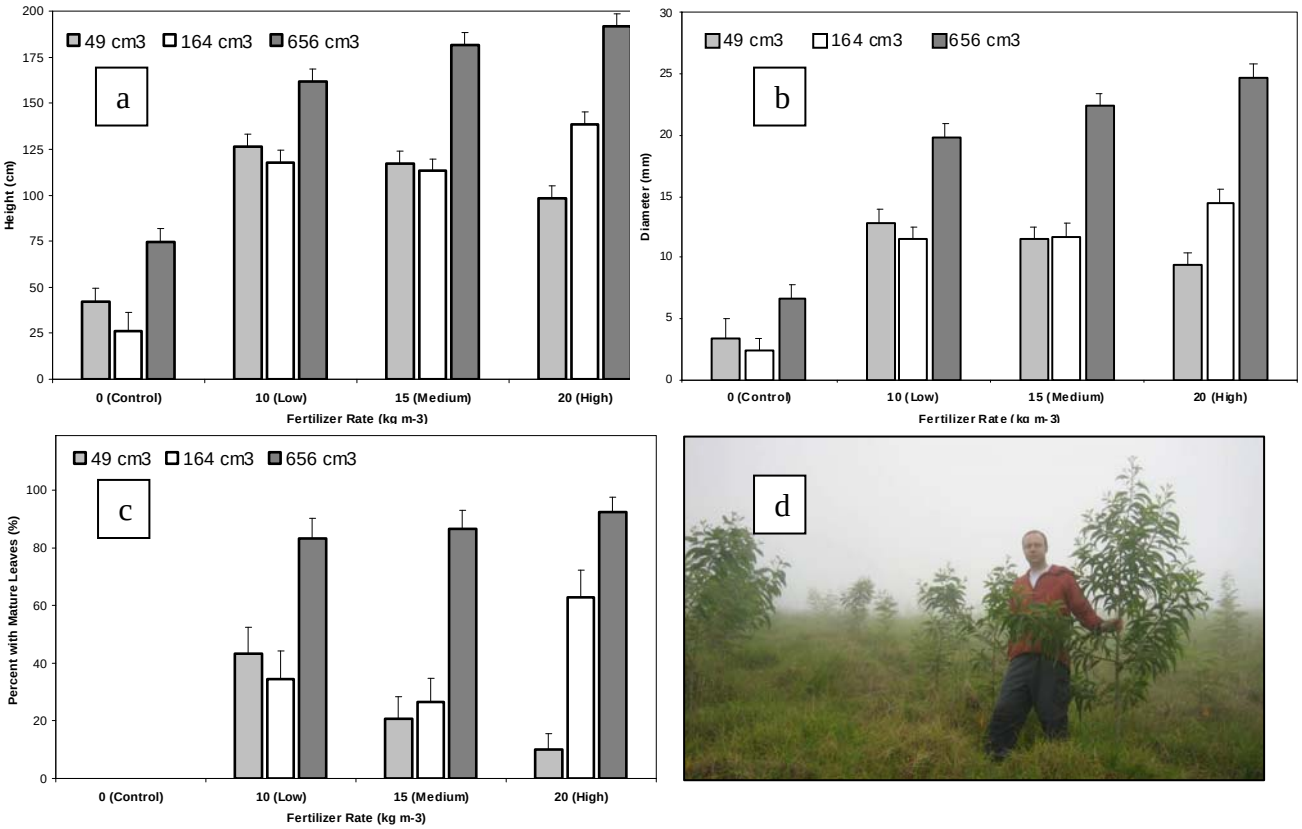

Figure 2. Total seedling height (a), root-collar diameter (b) and percentage of seedlings with phyllodes (c) as influenced by stocktype and rate of fertilization measured about 12 months after outplanting (April 2007). Doug Jacobs with a D-40, high fertilizer seedling 12 months after outplanting (d).