

SILVICULTURE

NURSERY HARDENING TO PROMOTE KOA FIELD ESTABLISHMENT

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Abstract

After centuries of habitat loss, the distribution of *Acacia koa* (koa) has largely been relegated to high-elevation, fragmented populations. In addition to being one of the most valuable trees in the world, koa provides critical habitat for endangered plant and animal species and is revered in Hawaiian culture. Invasive plant competition, animal browsing, drought, and climate change challenge establishment of koa seedlings. Climate change induced decreases in available soil moisture in conjunction with increases in solar radiation and temperature will greatly stress outplanted seedlings. Ensuring the survival of nursery-grown seedlings on sites that contain limited soil-moisture necessitates the employment of horticultural techniques in the nursery that modify morphological and physiological attributes of field-bound seedlings. Nutrition and container-type influence the survival and growth of outplanted seedlings. The root-to-shoot ratio (R:S) is a standard measure of seedling morphology, which is commonly used to predict drought avoidance potential and establishment success. High-quality seedlings have shoots that are not so



Figure 1: Comparing koa seedlings grown in RootMaker® (left) and Deepot™ (right) and containers of the same volume both 410 cm³.

large as to have a transpiration requirement that cannot be met by the roots at the time of planting. Nitrogen hardening is a horticultural technique in which the amount of applied nitrogen is reduced in the weeks prior to outplanting to decrease height and shoot growth, while increasing root growth and R:S. Deeper containers train roots to soil depths that can contain increased soil moisture, while air-pruning containers create a fibrous root system with an increased quantity of root tips. To test the efficacy of Nitrogen hardening koa for outplanting, seedlings were grown for 13 weeks in Deepot™ (25.4 cm deep) and RootMaker® (10.2 cm deep) containers (both 410 cm³), with and without Nitrogen hardening. Seedlings were outplanted into a field site in the Northwestern Ko'olau Mountains in January, 2016. At the end of nursery culture, Nitrogen hardened and Deepot™ seedlings exhibited a significantly increased R:S. Nitrogen hardening did not confer survival or growth benefits to seedlings in the field in this instance. All seedlings exhibited a high survival rate 8 months after planting (>95%). Container-type was the most influential factor, with Deepot™ containers demonstrating a significantly increased height (+9.4%) and root-collar diameter (+12.5%) after 8 months of field growth compared to RootMaker® containers.



Figure 2: Root structure in a 12-week-old koa seedling grown in RootMaker® container.