Regeneration of ‘Iliahi: Hemiparasitic Relationships in Hawaiian Tropical Dry Forests

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Overview:

- ‘Iliahi (*Santalum paniculatum*), a hemiparasitic tree, can be successfully planted in a plantation of nitrogen-fixing koa (*Acacia koa*) trees as indicated by a 99% survival rate and impressive growth rates.
- After the first growing season, ‘iliahi seedling height and diameter growth (38.89 $\pm$ 1.38 cm and 4.26 $\pm$ 0.11 mm) was greater with greater canopy cover (canopy openness range from 6.2% to 84.7%) (fig. 1 and fig. 2).
- We hypothesize that these results are due to the benefits of a denser host root network outweighing the greater competition for light and soil resources during the establishment phase for these hemiparasitic ‘iliahi seedlings.

Summary:

Management problem: *Santalum* species, including the endemic Hawaiian ‘iliahi (*Santalum paniculatum*), are ecologically distinct as evergreen, hemiparasitic trees. Being hemiparasitic means ‘iliahi can photosynthesize yet require suitable hosts for resource acquisition and long-term survival. Degradation of native tropical dry forests and the unsustainable removal of native tree species has resulted in ‘iliahi and other trees, including potential hosts to ‘iliahi, having greatly reduced populations and distributions.

Management need: Reforestation and sustainable forestry of ‘iliahi in degraded tropical dry forest sites require supporting host plant communities. Planting ‘iliahi among established hosts may increase the probability of making early and abundant hemiparasitic connections, but this must be balanced with competition for limiting resources.

Research purpose: Our experiment aims to improve the survival and establishment of planted ‘iliahi seedlings by better understanding regeneration and establishment tradeoffs between ‘iliahi and koa (*Acacia koa*), a native tree species commonly planted at reforestation and restoration sites.

Silvicultural Concepts:

- In 2010, koa seedlings were planted in a 0.81-ha fenced plot. Patchy survival over 10 years resulted in varying gap sizes, creating a matrix of micro-environments into which 10-month-old seedlings of ʻiliahi were planted using a completely randomized experimental design.
- Underplanting could be a way to not only diversify initial reforestation efforts but also to introduce an endemic species that is hemiparasitic and requires host plants for long-term growth and survival.
- Morphological and physiological measures are being taken to identify parasitic connections and understand drivers of ʻiliahi establishment.
- After the first growing season, ʻiliahi seedlings had high survival and growth rates, with greater height and diameter growth under less open koa canopies. We are still processing and analyzing physiological measures such as gas exchange and stomatal impressions to estimate photosynthesis, resource acquistion, and the balance of competition vs. parasitic transfer of resources.
- There is potentially an optimal range of overstory gap sizes that balances competition for resources and abundant root networks for ʻiliahi to establish hemiparasitic root connections.

Management Applications:

- Our results show that it is possible to have high first-year survival of ʻiliahi seedlings underplanted in an established koa plantation.
- Small gaps or relatively high canopy cover may be suitable to establish ʻiliahi and perhaps preferred for better early growth.
- These results contribute to better understanding ʻiliahi establishment within gaps of established hosts and help improve silvicultural efforts to restore functionally compatible and diverse native dry forests in Hawaiʻi.

Figure 1— 6.2% canopy openness.

Figure 2—84.7 % canopy openness.