‘Iliahi Restoration and Management Workshop

Tuesday, February 24, 2026
Kealakekua Mountain Reserve, Captain Cook, Hawai‘i

Presenters: Travis Idol, JB Friday, Douglass Jacobs

Itinerary

Tuesday, February 24, 2026, 9:00 am – 3:00 pm

Time	Activities
08:30 am	• Meet up at Choice Mart/Ace Hardware in Captain Cook • Carpool to KMR field office and nursery
09:00 am	• Meet at KMR Nursery and Introductions • Review workshop itinerary and questions from participants • Load up and head to host suitability site (9:15)
09:45 am	**Host suitability experiment** • Rationale and design • Establishment of ‘iliahi:host pairs, 0-3 yrs • Development of community interactions, 3-6 yrs • Q&A
10:45 am	**Kīpuka koa underplanting experiment** • Rationale and design • Establishment of ‘iliahi seedlings, 0-3 yrs • Development of community interactions, 3-5 yrs • Thinning responses, 5-6 yrs • Q&A • Load up and head back to KMR field office (11:45)
12:30 pm	**Lunch and Nursery tour**
01:30 pm	**Discussion** • ‘Iliahi forest industry momentum and survey • Other ongoing or planned ‘iliahi research • Priority topics for future research • Forming a research hui to pursue big funding • Load up and head back to Captain Cook (3:00)

Natural and Land Use History of Kealakekua Mountain Reserve

Notes:

Host Suitability Experiment

Motivation and Purpose:

Notes:

Planting Design:

- 40 rows planted with 9 ‘iliahi seedlings, each 6 m (19-20 ft) apart
- Rows spaced 3 m (10 ft) apart
- ‘Iliahi seedlings planted with one “host” seedling of koa (*Acacia koa*) or ‘a‘ali‘i (*Dodonaea viscosa*) or planted alone
- Host seedlings spaced at different distances:
    - Adjacent: ~20 cm (8 in)
    - 0.5 m (19-20 in)
    - 1.0 m (3.3 ft)
    - 2.0 m (6.5-7.0 ft)
- Each combination planted randomly, but equal number of replicates (40)
- Seedling age and size at planting varied by species (Table 1)

Table 1. Seedlings Outplanted in the Host Suitability Experiment

Name	Container (mL)	Age (mo)	Height (cm)	Diameter (mm)
‘Iliahi	D40 (656)	12	45	4.7
Koa	SC10 (140)	03	38	3.1
‘A‘ali‘i	SC10 (140)	08	28	2.6

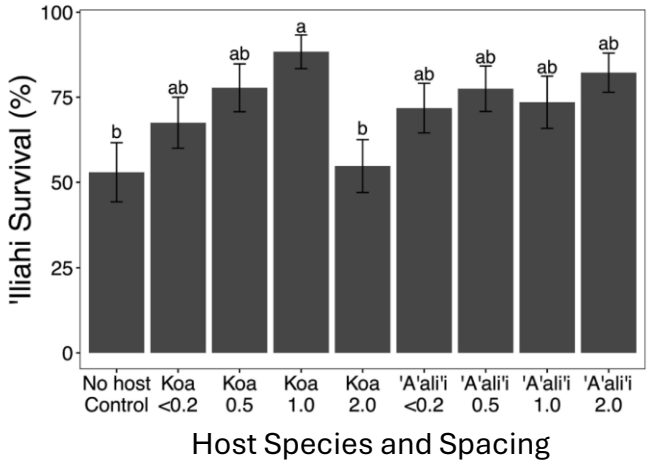
Results, First 3 Years

(Thyroff et al., 2023)

Seedling Survival

- ‘Iliahi survival varied by host species and planting distance, from ~50-85%
- ‘Iliahi survival greater with host; no difference by species (Fig. 1)
- Koa and ‘a‘ali‘i survival was 85-90% with no effect of planting distance

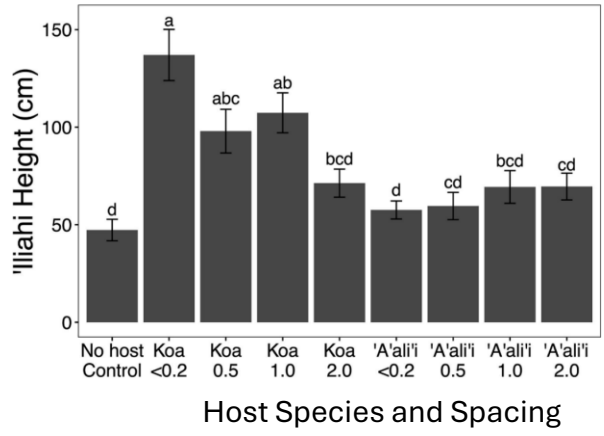
Fig. 1. ‘Iliahi Survival 3 Years After Planting

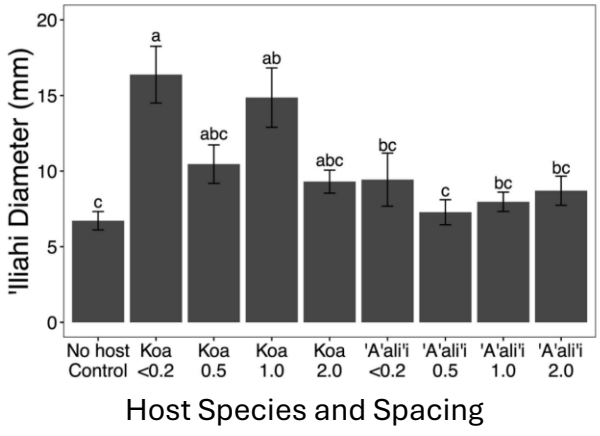


Seedling Growth

- ‘Iliahi height and diameter growth better with koa and at closer spacing
- Koa and ‘a‘ali‘i growth not affected by planting distance

Figure 2. ‘Iliahi Seedling Growth 3 Years After Planting





Community-Level Study, 4-6 Years

(Wirabuana, 2025)

Redesigning Experimental Plots:

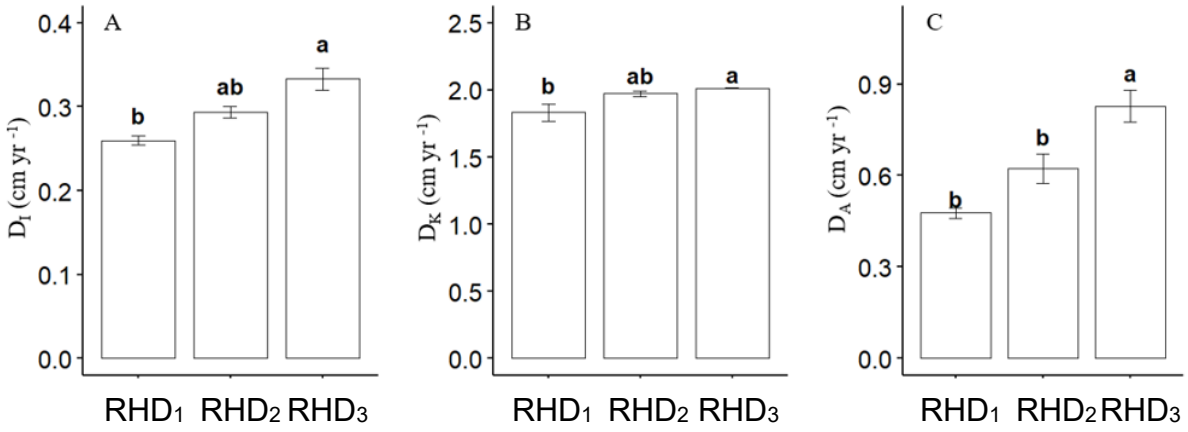
- Plants large enough to assume roots interacting across adjacent plantings
- Rows and plantings grouped into 20 x 20 m plots; 28 plantings per plot
- Mortality + natural regeneration of koa resulted in variable # of plants per plot
- Plots categorized by relative host density (RHD): Host < ‘Iliahi (RHD_1), Host ≅ ‘Iliahi (RHD_2), Host > ‘Iliahi (RHD_3)
- Growth of plants measured over two years
- Level of plant interactions estimated from relative plant growth
  - Competition (CL): basal area of the plot
  - Facilitation (FL): increased growth of ‘iliahi as RHD increases
  - Parasitism (PL): decreased growth of host as RHD decreases

Results

Plant Growth

- Growth of all species increased as RHD increased (Fig. 3)
- ‘A‘ali‘i had greatest relative increase (50-60%)
- Suggests parasitism is important at the community level

Fig. 3. Effect of Relative Host Density (RHD) on Plant Diameter Growth



A, ‘Iliahi; B, Koa; C, ‘A‘ali‘i

Plant Interactions and Optimal Host Proportion

- Competition (basal area) increased with RHD (Fig. 4)
- Much of this due to growth of koa (Fig. 3)
- Facilitation increased and parasitism decreased with RHD
- Plotting FL vs PL revealed an optimal host proportion of ~68% (Fig. 5), or a host:iliahi ratio of 2:1
- Similar to recommendations from plantation management of *Santalum album*

Fig. 4. Effect of Relative Host Density on Plant Interaction Levels

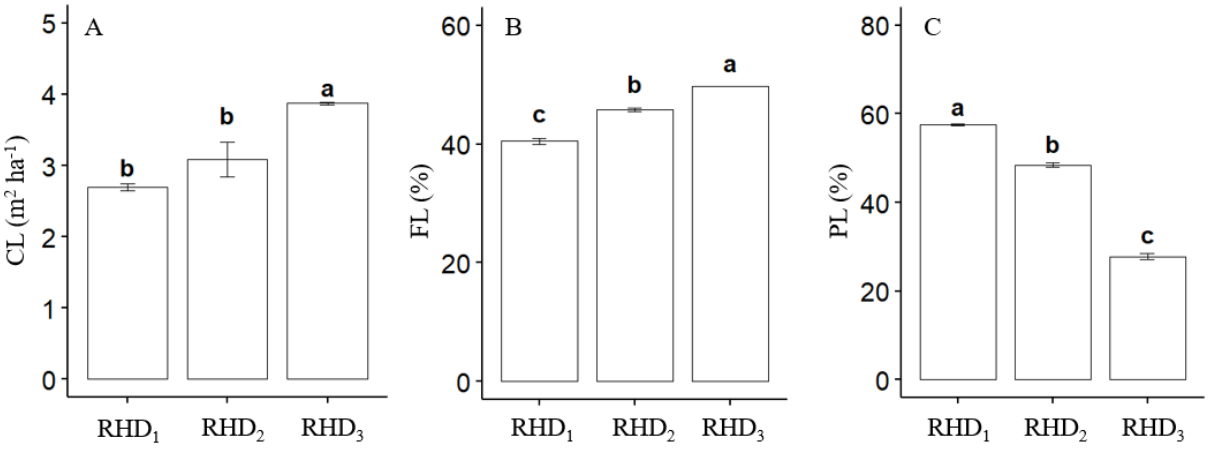
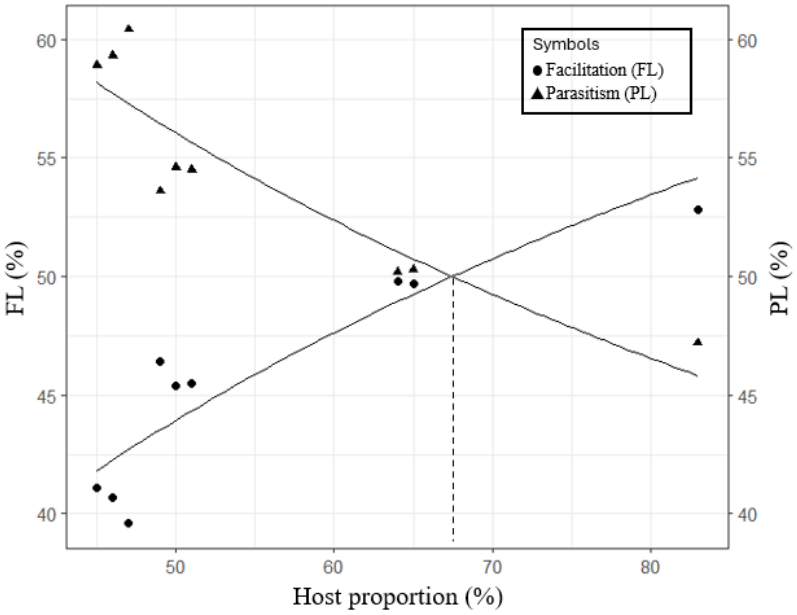


Fig. 5. Optimizing Host Proportion Based on Plant Interaction Levels



Underplanting Experiment

Motivation and Purpose:

Notes:

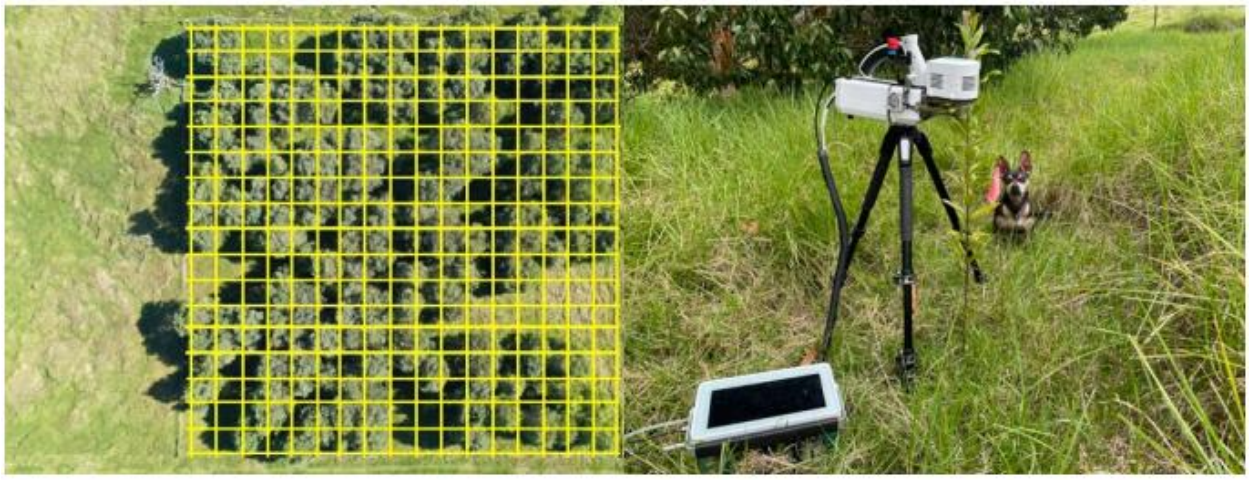
Planting Design:

- 2-acre pasture site planted in koa (271 seedlings) in 2010 (Fig. 6)
- Koa mortality early on due to dry years resulted in variable canopy cover
- ‘Iliahi underplanted (324 seedlings) on 4.5-m grid spacing in 2020 (Fig. 7)

Fig. 6. Planting Koa in Open Pasture, 2010

At the time of planting koa in 2010.
Photo credit: JB Friday

Fig. 7. Overhead View of Koa Underplanting Site, 2020



Results, First 3 Years

(Thyroff et al., 2024)

- Canopy openness over the ‘iliahi seedlings ranged from 09-90% (Fig. 8)
- Correlated with distance to nearest koa tree, < 1-12 m (Fig. 9)

Fig. 8. Canopy Openness

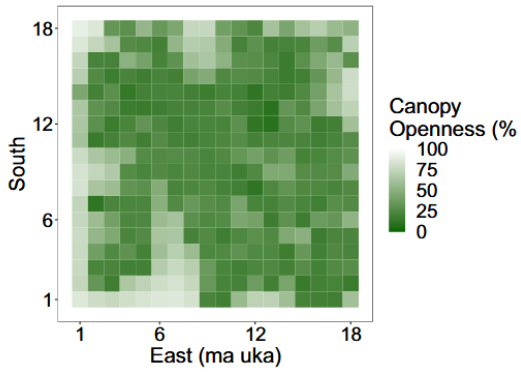
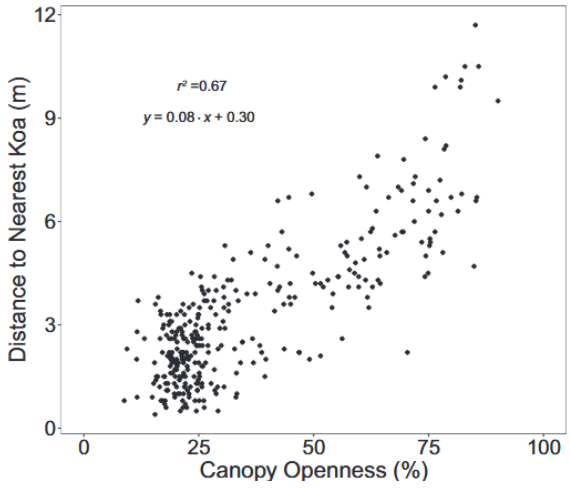


Fig. 9. Relationship of Openness to Distance to Nearest Koa Tree

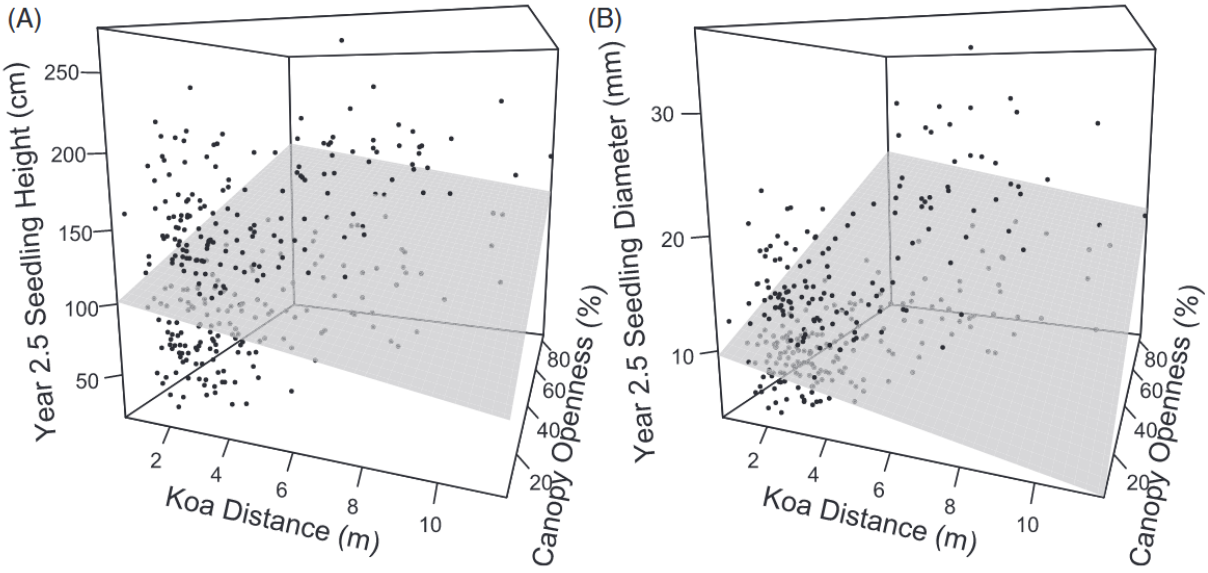


Results, First 3 Years

(Thyroff et al., 2024)

- ‘Iliahi survival > 95% overall
- Height and diameter doubled with increased canopy openness (Fig. 10)
- Also benefited from closer distance to nearest koa tree
- Shade tolerance much greater than expected (Merlin et al., 2006)

Fig. 10. Effect of Canopy Openness and Distance to Nearest Koa Tree on ‘Iliahi Seedling Growth



Community-Level Study, 4-6 Years

Redesigning Experimental Plots:

- 20 x 20-m plots created to study growth and ‘iliahi-koa interactions at the community (forest stand) level
- 9 plots established with 10-15 koa trees and 10-15 ‘iliahi saplings in each
- Canopy openness estimated at the plot level
- Five-year periodic annual increment (PAI) of ‘iliahi and koa diameter estimated
- Competition (CL), facilitation (FL), and parasitism (PL) calculated as in the host suitability experiment

Results

(Wirabuana, 2025)

- Canopy openness at the plot level was high and relatively constant, ~75-80%
- ‘Iliahi PAI increased with CL (basal area) up to ~25 m^2 ha^{-1} (~110 ft^2 ac^{-1}) **(Fig. 11)**
- Koa PAI decreased with increased CL **(Fig. 12)**

Fig. 11. Effect of Basal Area (CL) on ‘Iliahi Diameter Increment

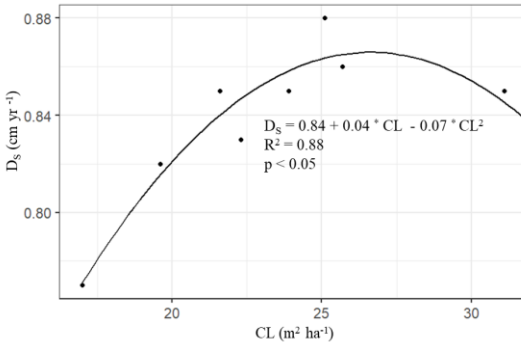
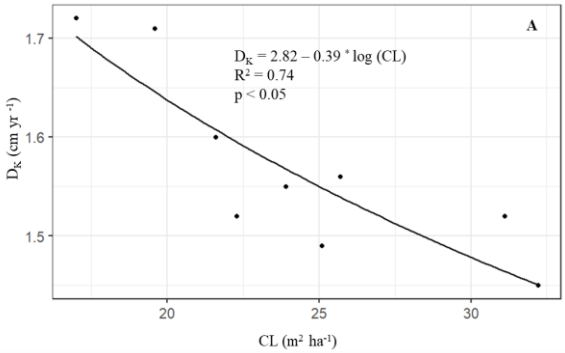
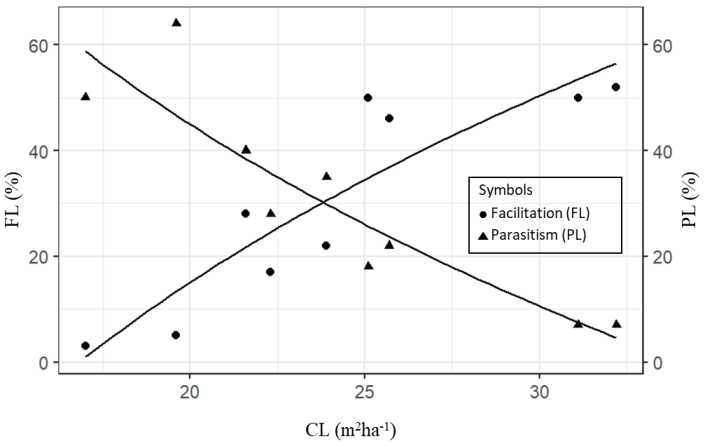


Fig. 12. Effect of Basal Area (CL) on Koa Diameter Increment



- Facilitation increased and parasitism decreased with increasing basal area
- Optimal basal area was ~24 m^2 ha^{-1} (105 ft^2 ac^{-1}) (Fig. 13)

Fig. 13. Effect of Basal Area (CL) on Facilitation (FL) and Parasitism (PL)



Koa Understory Planting: Thinning Experiment

- Given the effect of canopy openness on ‘iliahi growth and the effect of basal area on koa growth, would both species benefit from thinning of the koa?
- In 2024, selected 5 of 9 plots to thin from below to 50% of existing basal area

Results

- Diameter growth increased for koa and ‘iliahi in the year after thinning
  - Thinning improved ‘iliahi growth but decreased koa growth (Fig. 14)
- ‘Iliahi growth increased exponentially with canopy openness (Fig. 15)
  - Increase in parasitism on koa may explain negative effect of thinning

Fig. 14. One-Year Diameter Increment Growth After Thinning

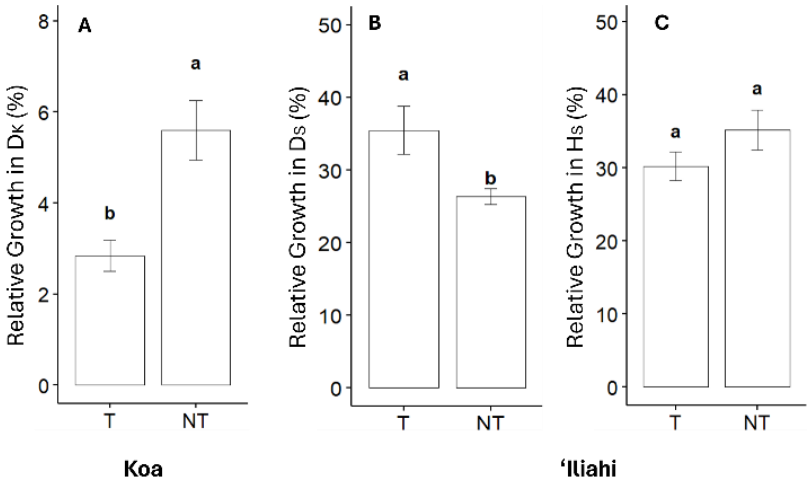
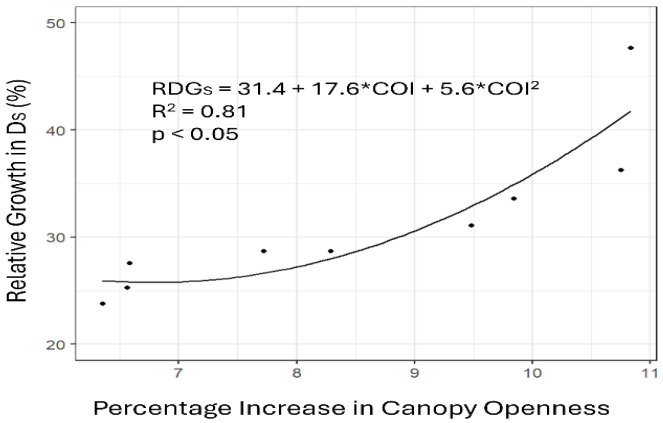


Fig. 15. Effect of Change in Canopy Openness on ‘Iliahi Diameter Growth



Take-Home Messages

- ‘Iliahi seedling survival is improved with a host and greatly benefits from having an established host (root network)
- Mixed-species host plantings may be suitable rather than focusing on a “best” host, such as koa or other nitrogen-fixing species
- Host:‘iliahi ratio of 2:1 is recommended to optimize abundance of ‘iliahi with long-term surivival and growth of all species
- Underplanting ‘iliahi in established forests is feasible, but there are tradeoffs
  - Individual plant growth is better with greater canopy openness
  - At the plot level, growth increases with host basal area up to an optimal level
- Established ‘Iliahi responds well to overstory/host thinning, but remaining hosts may suffer from increased parasitism
- Planting ‘iliahi after thinning established hosts allows may minimize tradeoff of canopy openness with host:‘iliahi ratio

References

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Acknowledgments

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