Accelerating the restoration trajectory of *Acacia koa*

Jeremiah R. Pinto
Rocky Mountain Research Station
USDA Forest Service, Moscow, ID

Anthony S. Davis
College of Forestry
Oregon State University, Corvallis, OR

James J. K. Leary
Department of Natural Resources & Environmental Management
University of Hawaii at Manoa, Maui, HI

Matthew M. Aghai
School of Environmental and Forest Sciences
University of Washington, Seattle, WA

Rocky Mountain Research Station
Oregon State University College of Forestry
Cooperative Extension
University of Hawai'i at Mānoa
College of Tropical Agriculture and Human Resources
University of Washington
College of the Environment

History

Koa (*Acacia koa* A. Gray) is a dominant canopy species in mesic-montane forests, which have been degraded over the last two centuries by deforestation and pasture conversion (Wagner et al. 1990).

Problem

Cattle preference for young koa seedlings is exhausting the seed bank detrimental to the natural restorative capacity of the original forest community.

Problem

Ungulate exclusion is a necessary initial step to site restoration, but inherently leads to dominant occupation of the exotic forages. Kikuyu grass (*Pennisetum clandestinum*) is the most prevalent C4 species.

Opportunity
A "young" 15 year-old koa plantation was comparable to an "old growth" koa forest as a foraging habitat for endemic avifauna, supporting high density populations at no reproductive cost (Pejchar et al. 2005, Pejchar et al. 2007).

Koa is also one of the most economically valuable timber species in the world (Elevitch et al. 2006), thereby creating unique potentials to incentivize koa habitat restoration via multi-purpose systems (Pejchar and Press 2006).

Akiapola'au (*Hemignathus munroi*)

Opportunity

Glyphosate and imazapyr are highly effective short and long-term suppressors of kikuyu grass, respectively.

Glyphosate (left) and imazapyr (right) treatments at 3 MAT. Note how grass is recovering in the clipped area in GLY plot, while IMZ continues to show residual expression.

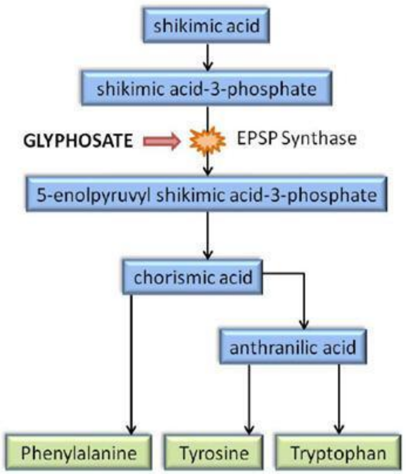
Opportunity

Anecdotal evidence of koa exhibiting imazapyr tolerance.

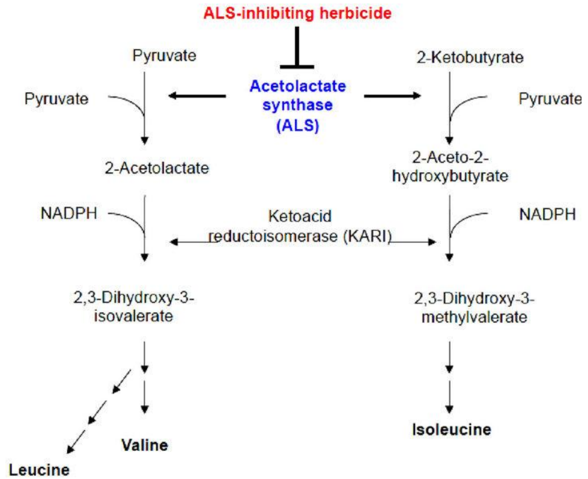
Modes of Action

Glyphosate:

- Inhibits the shikimate pathway enzyme EPSPSase interrupting biosynthesis of aromatic amino acids: phenylalanine, tyrosine and tryptophane.
- Rapidly moves to apical areas of the plant (source-sink photosynthate movement) and inhibits protein synthesis. Death ultimately results from dehydration and desiccation.



http://www.glyphosate.eu



Endo et al. 2013

Imazapyr:

- Inhibits the enzyme acetohydroxy acid synthase (AHAS), also known as acetolactate synthase (ALS) Inhibiting production of branched-chain aliphatic amino acids, valine, leucine, and isoleucine.
- It is translocated to the meristematic tissues. The rate of plant death usually is slow (several weeks) and is likely related to the amount of stored amino acids available to the plant.

Objective

To determine how grass suppression can accelerate the growth trajectory of outplanted koa.

Approach

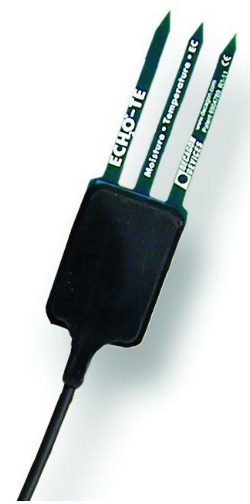
Install and monitor a replicated field experiment (w/ and w/o herbicide suppression) at Ulupalakua Ranch, Maui

-1 MAT: on May 2011, herbicide combination of glyphosate and imazapyr applied at 1.7 kg ae ha^{-1}, respectively, with a total volume rate of 250 L ha^{-1}. Applied with compressed air @ 25 psi using XP Boomjet® spray tip calibrated to deliver a 4 m coarse droplet swath at 3 L min^{-1}.

0 MAT: on June 2011, seedlings (~105 days old) were outplanted in close 1 × 1 m spacing with 20 experimental trees and a total of 40 trees.

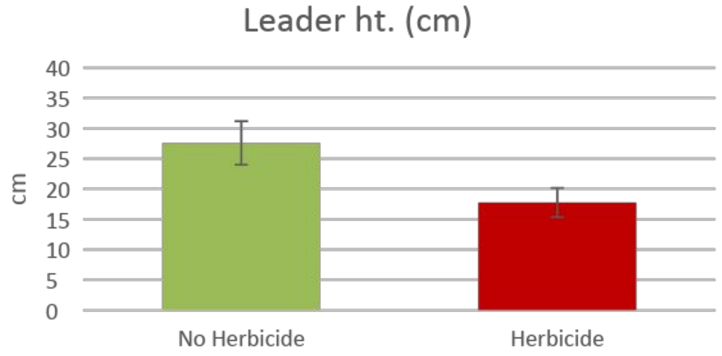
Approach

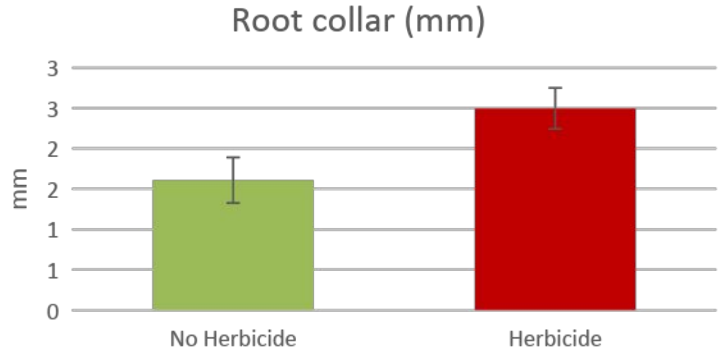
Environmental monitoring with Decagon® 5TM soil sensor recording to EM50G data loggers measuring (hourly) T (°C) and VWC (v/v)



Results

4 MAT: Strong Grass suppression, but also with collateral injury and koa growth suppression exhibited by residual of IMZ application (30 DAT).





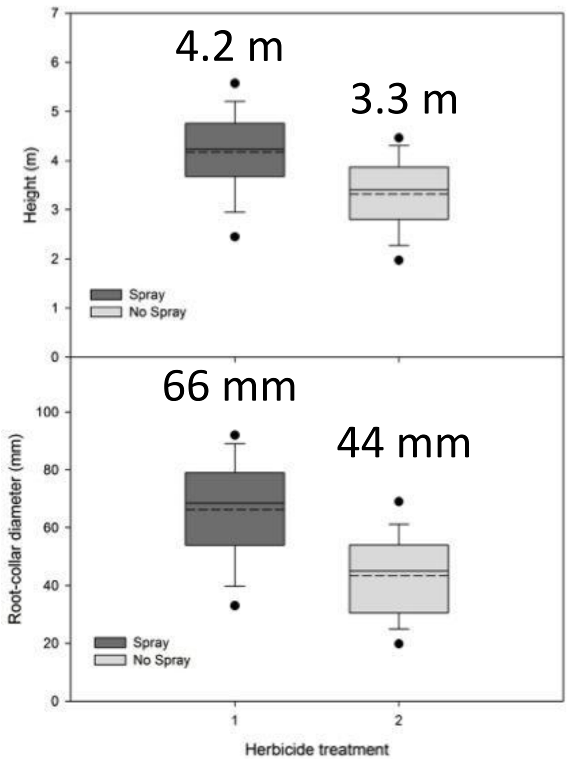
Results

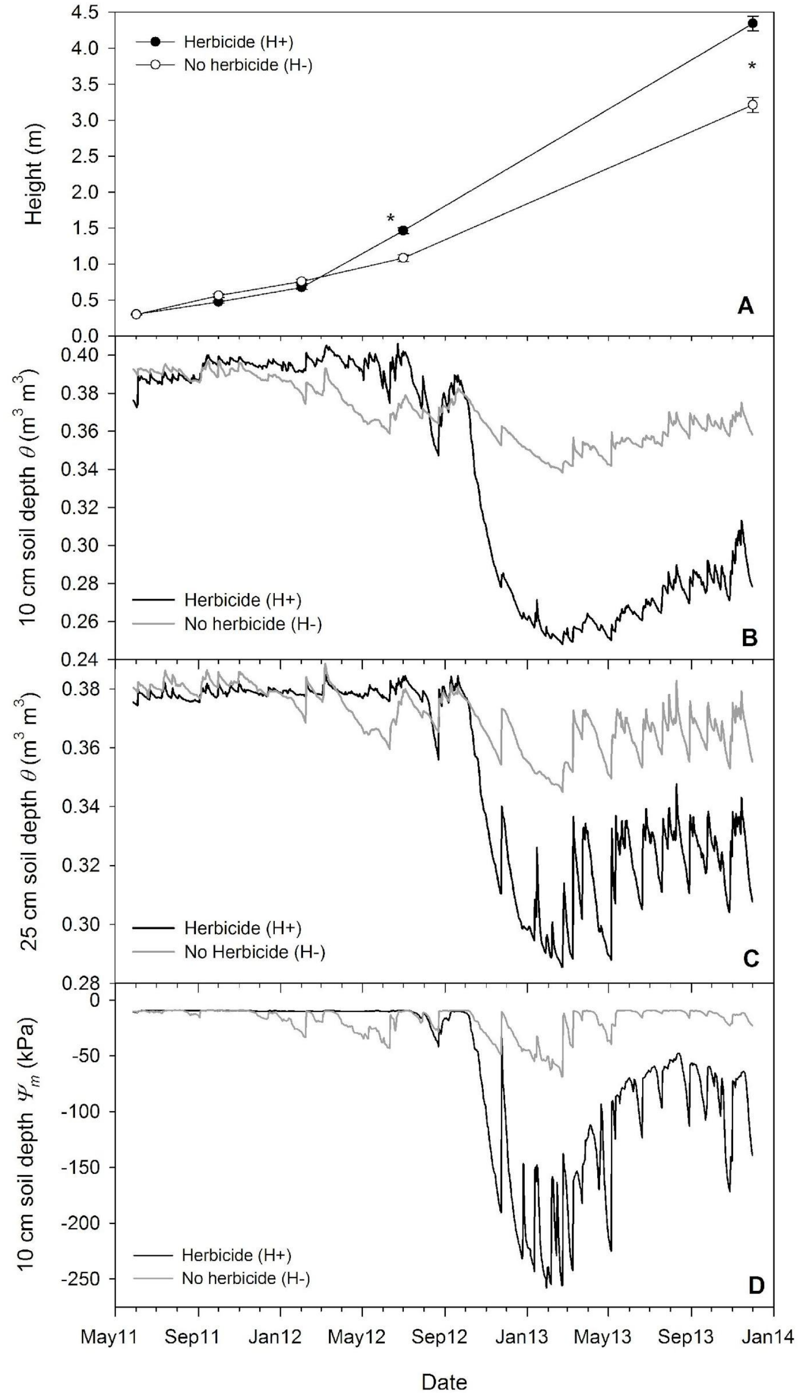
12 MAT: Reversal of fortune with significantly greater koa growth in grass suppression treatment.

>95% survival for the entire experiment!

Results

36 MAT: Drop in VWC corresponding to log-phase growth enhanced by grass suppression.





Conclusions

The combination of GLY and IMZ is an excellent combination for grass suppression.

Koa exhibits unique tolerance (not resistance) to pre-plant applications of IMZ at the max labeled use rate.

The high rate of IMZ (1.7 kg a.i. ha^{-1}) provides grass suppression > 1 yr.

Recommend planting 2-4 MAT to minimize collateral suppression to outplanted stock and also increase planting efficiency.

Tolerance to post-plant applications TBD, but could be quite useful.

Data loggers may provide novel remote sensing of koa production and health status.

While survival was less of an issue, grass suppression is critical to maximizing growth rates and production, which could lead to ecosystem provisions (i.e., functional habitat) in shorter rotations (< 10 yrs).

Thank you

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