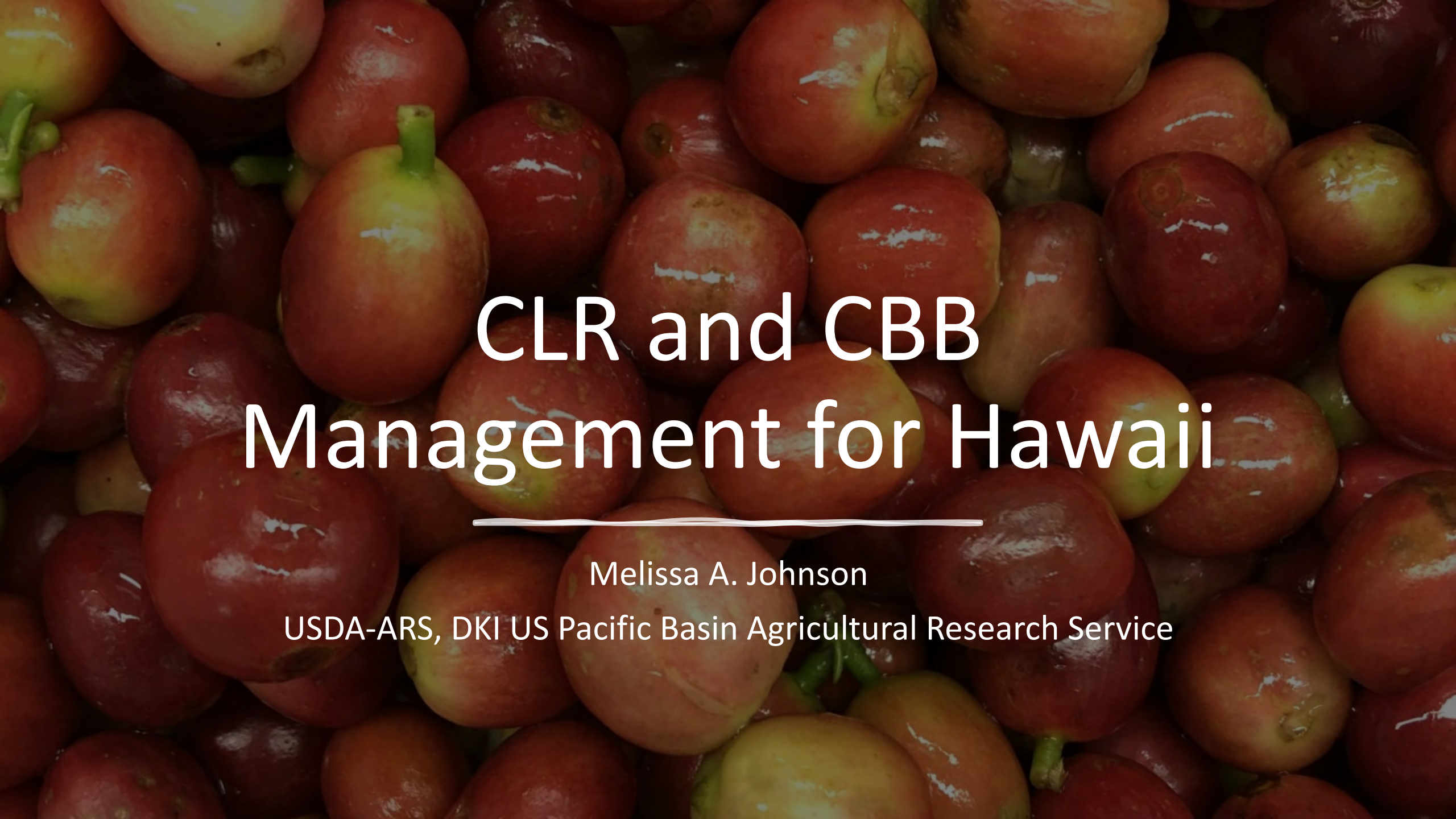


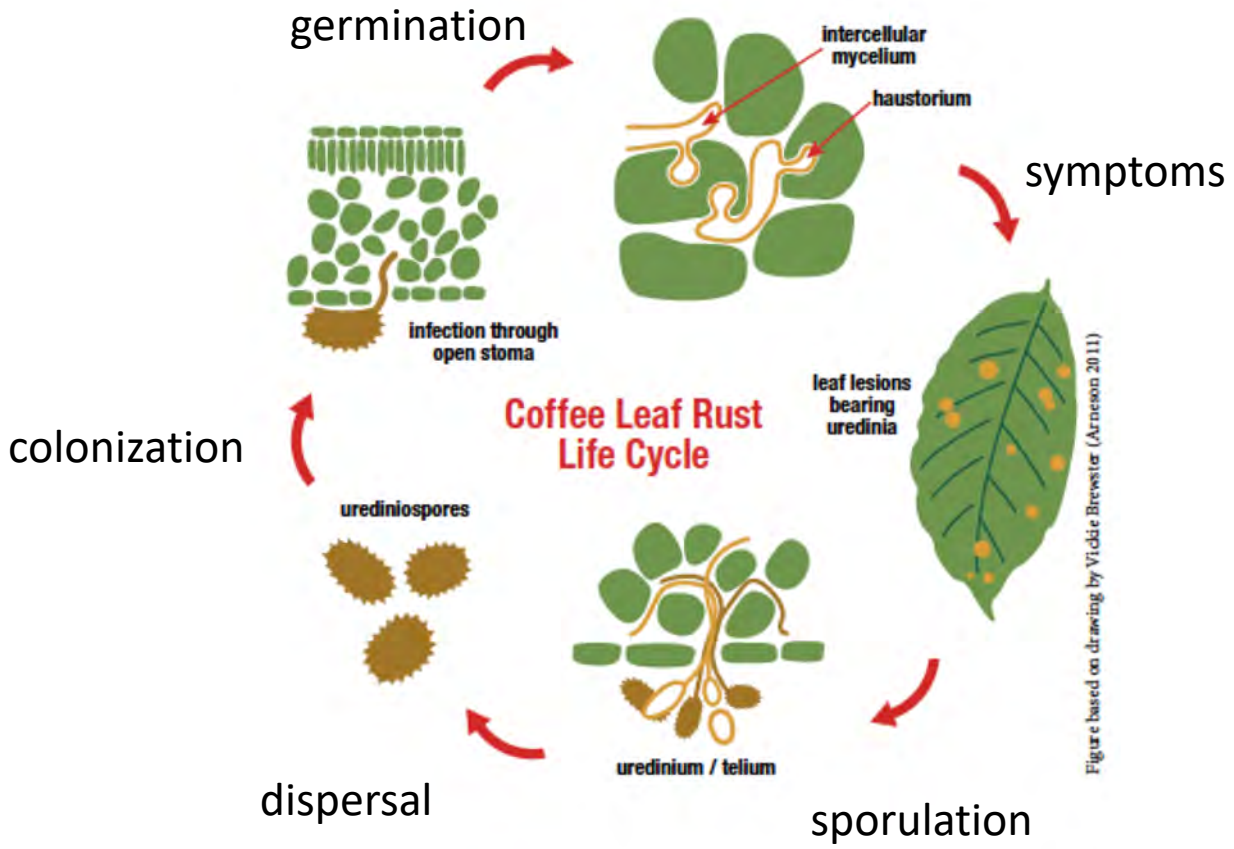
CLR and CBB Management for Hawaii

Melissa A. Johnson

USDA-ARS, DKI US Pacific Basin Agricultural Research Service

Coffee leaf rust (CLR, *Hemileia vastatrix*)

- Pathogenic fungus that attacks coffee leaves
- Widely recognized as most serious disease of coffee worldwide
- Found on Maui in late 2020, rapidly spread to other islands
- Spread by wind, people, animals, vehicles
- High severity results in leaf drop, reduced yields, branch death
- Favored by warm temperatures, high humidity, moisture on leaf surface



CLR in Hawaii

- Low infection in Spring (Mar-June)
- Infection begins to increase in July
- High infection during harvest and post-harvest (Aug-Feb)
- CLR is easiest to manage if kept below 5% incidence

CLR Management Strategy

- Prune
- Feed
- Scout
- Spray

Holualoa 2019

Holualoa 2021

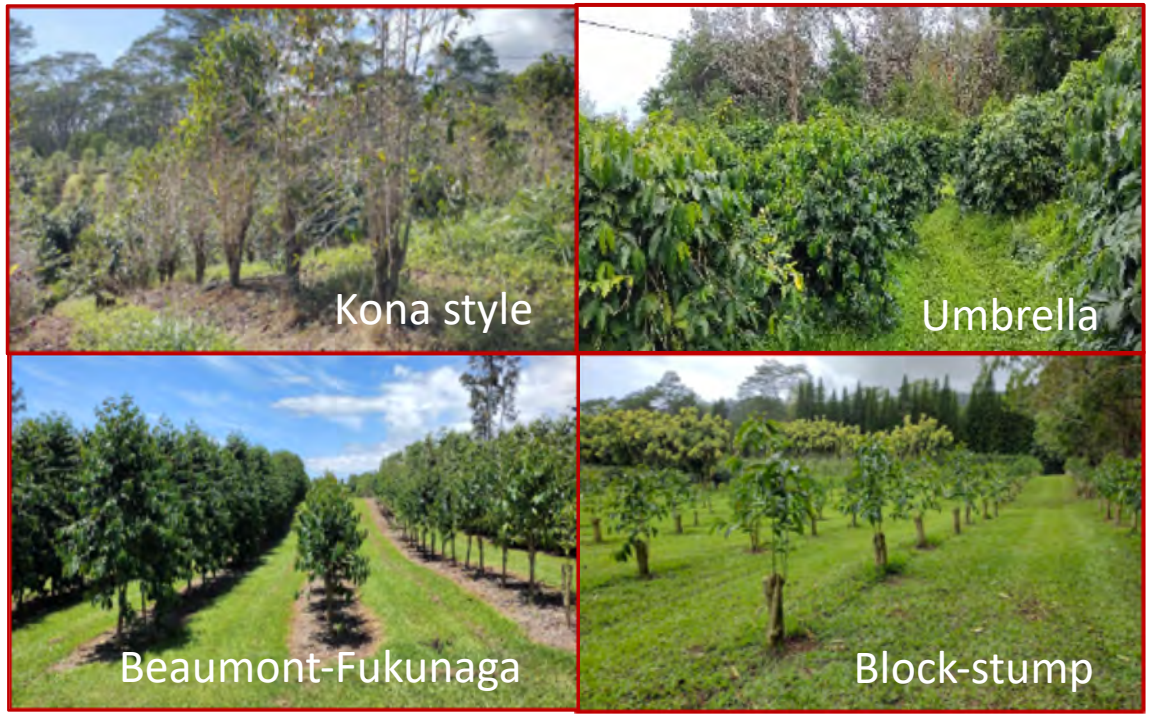
Pruning for CLR

- Kona style has highest CLR infection

- If using Kona style or BF, limit to 3-5 verticals to promote air-flow, minimize self-shading, and allow better spray coverage

- Remove suckers frequently – they tend to get infected quickly & serve as source of infection

- Annual prune can be combined with Oxidate (applied before or after pruning)



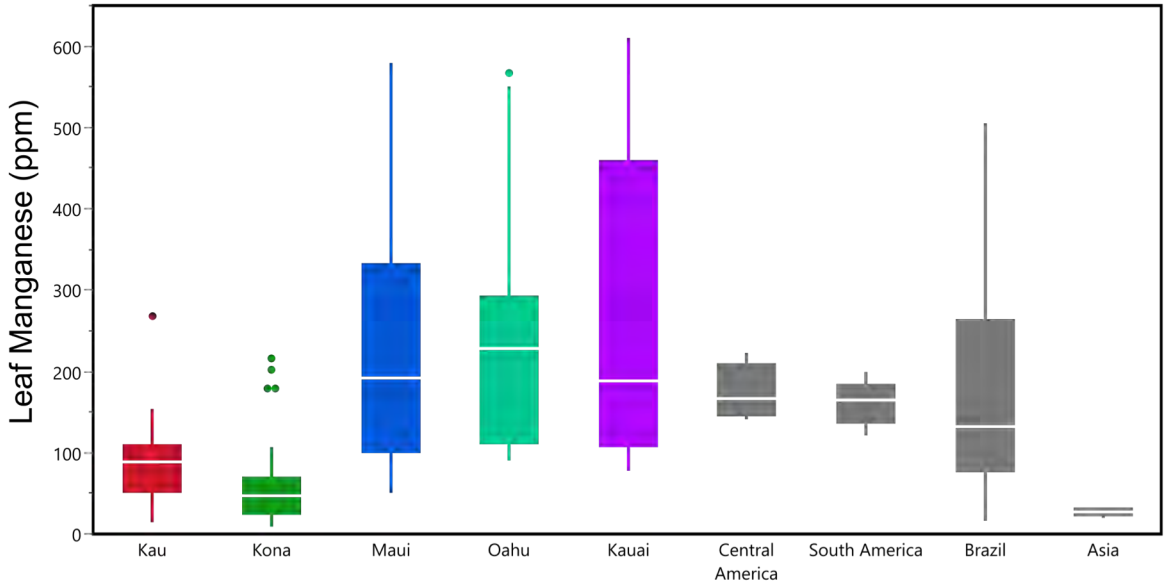
Aristizábal et al. In Prep.

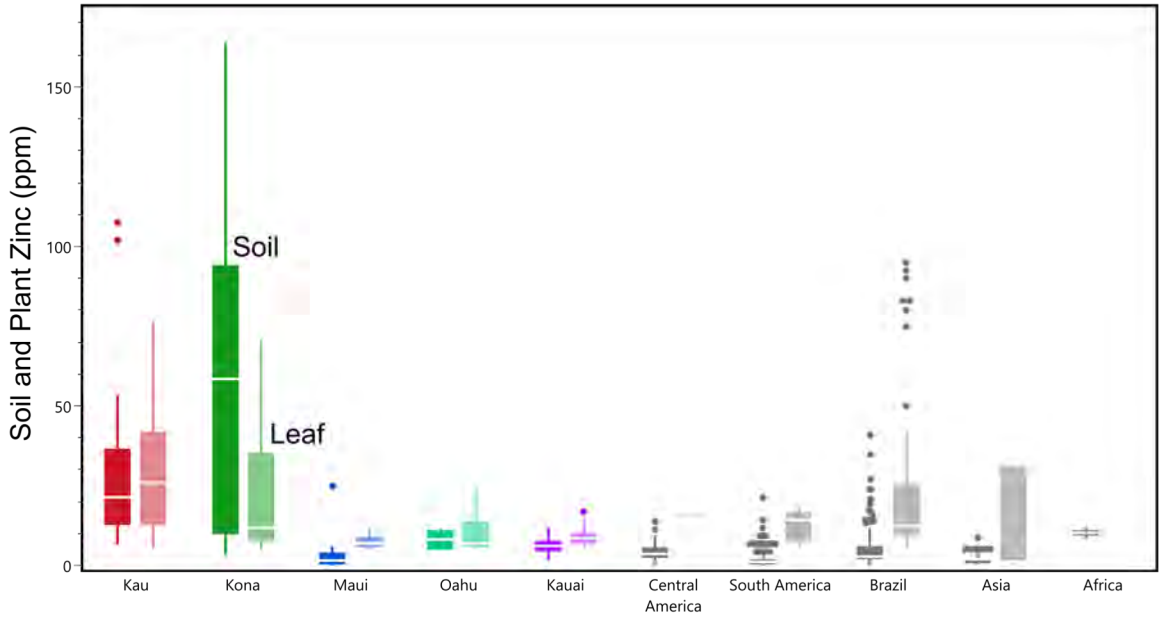
Feed

- Start season with soil and tissue sampling for nutrient analysis
- Soil and tissue results need to be used together to determine fertilizer plan
  - Each will provide different clues about soil/plant health
  - Compare with optimal values to determine how to correct any imbalances
- Granular fertilizer can be applied in smaller amounts more frequently
  - 4-6x per season
- Foliar fertilizer can increase micronutrients
  - Cafedak, Tropical Metasolate

Statewide Nutrient Survey

- 160 coffee farms
- Nutrient profile of Hawaii Island is distinct from other islands and other coffee growing regions
- High levels of some macronutrients in soil (P, Ca)
- Low levels of some micronutrients in leaves (Fe, Mn)
- Results will inform development of location-specific fertilizer recommendations





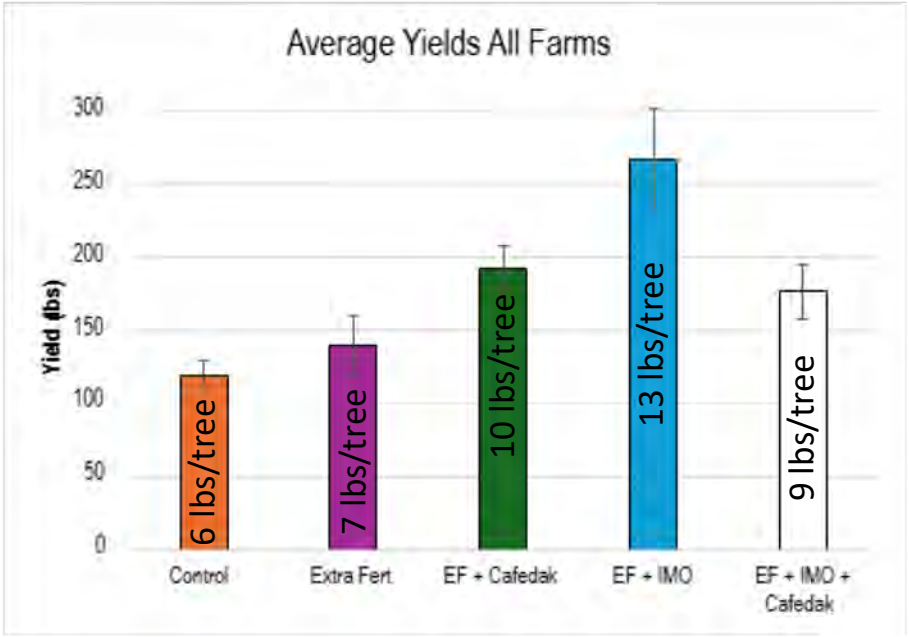
Can improved plant/soil health reduce impacts of CLR?

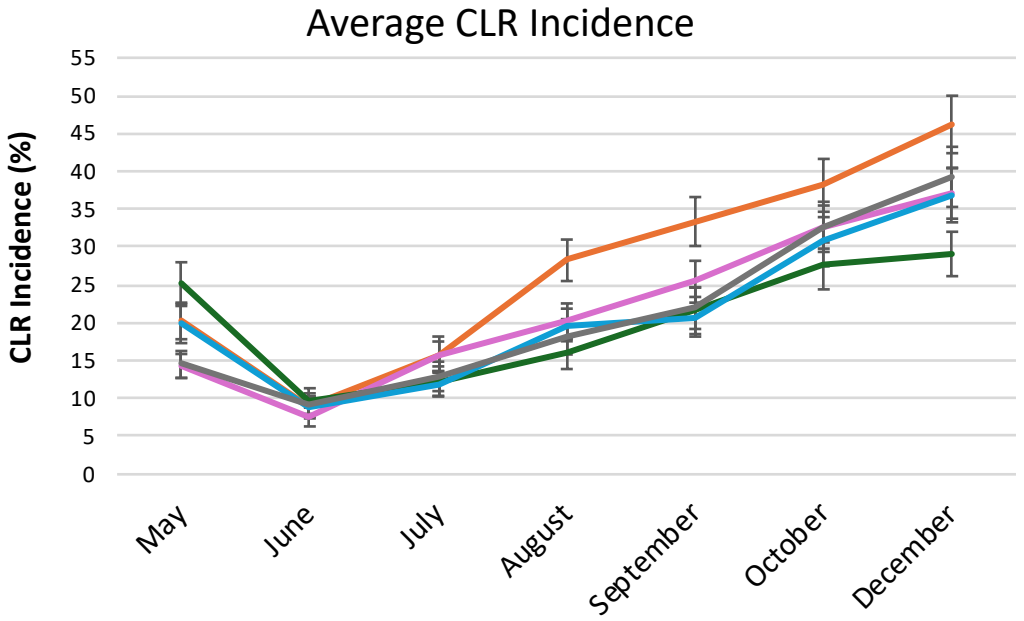
ORGANIC FARMING RESEARCH FOUNDATION

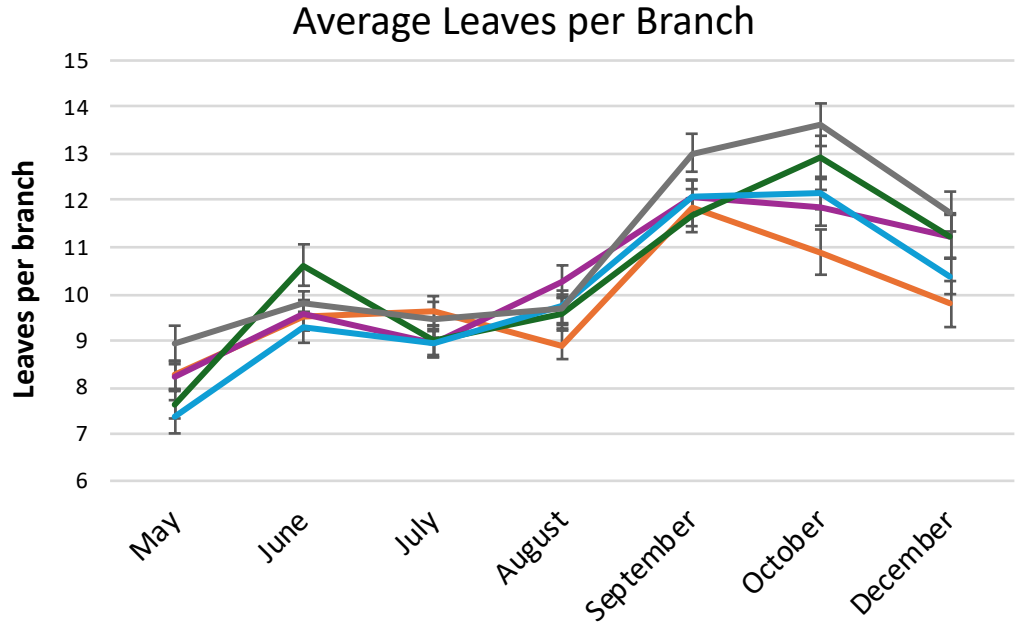
- 4 organic Kona coffee farms
- Emphasis on sustainable and locally available inputs
- Indigenous microorganisms cultivated through KNF
- 5 treatments
  - Control = granular fish fert 8-8-6 NPK (2x)
  - Extra Fert = granular fish fert (6x)
  - EF + Cafedak = fish fert (6x) + Cafedak foliar
  - EF + IMO = fish fert (6x) + IMO (soil & foliar)
  - EF + Cafedak + IMO = fish fert (6x) + IMO + Cafedak
- CLR incidence, leaf retention, yield

Preliminary Results

- Significantly higher CLR in control plots; lowest in EF + CafeDak plots
- Significantly lower leaf retention in control
- Yields increased with extra fertilizer and foliar inputs







Scout

- When: Year-round with emphasis from Mar-July
- How: 20-25 trees (1 branch per tree) per 2-2.5 acres; CLR leaves/total leaves x 100 = CLR incidence (%)
- With this method, CLR can be detected at very low levels (<1%)
- Scout to check efficacy of sprays
  - if effective, lesions should appear dried up ~1-2 weeks post-spray

Spray

- Timing: start early in the season to protect new leaf growth
- Rate: use medium rate when range is given
- Coverage: underside of leaves must be sprayed for contact fungicides
- Scout to check efficacy of sprays
  - lesions should appear dried up after 1-2 weeks

The key to successful control of CLR is in **preventatively** applying fungicides.

Infection levels above 30% will be difficult to control

Not sprayed | Copper spray | Priaxor spray

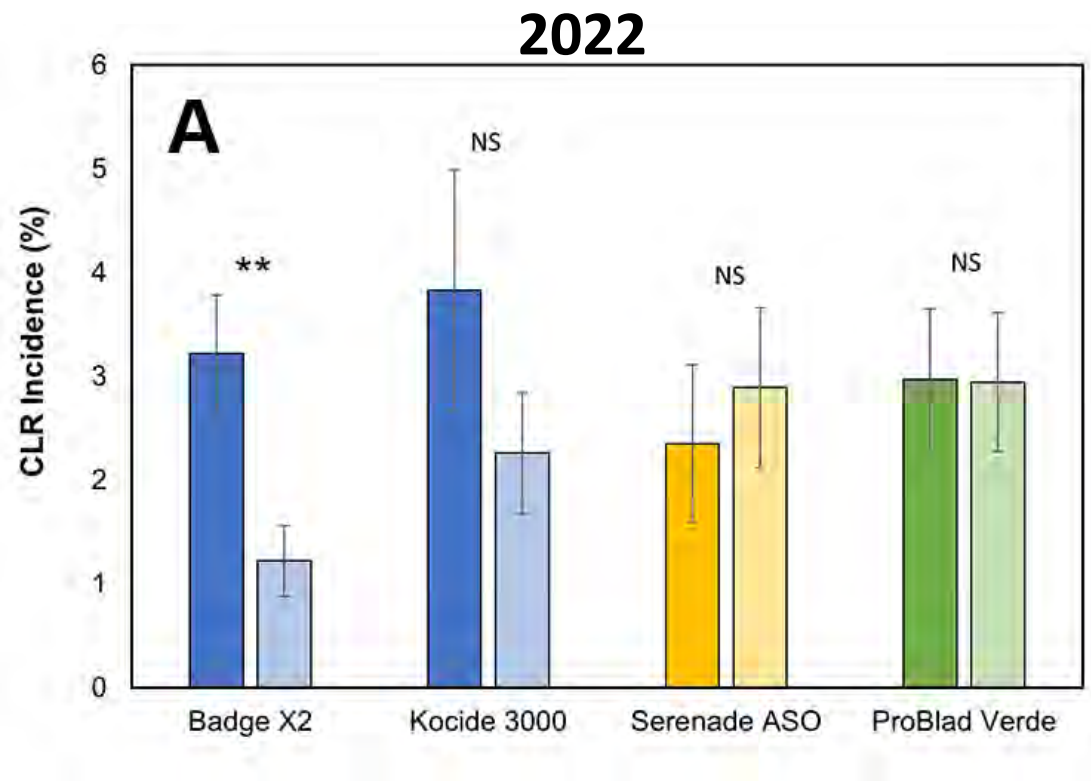
Fungicides field tested for CLR in Hawaii

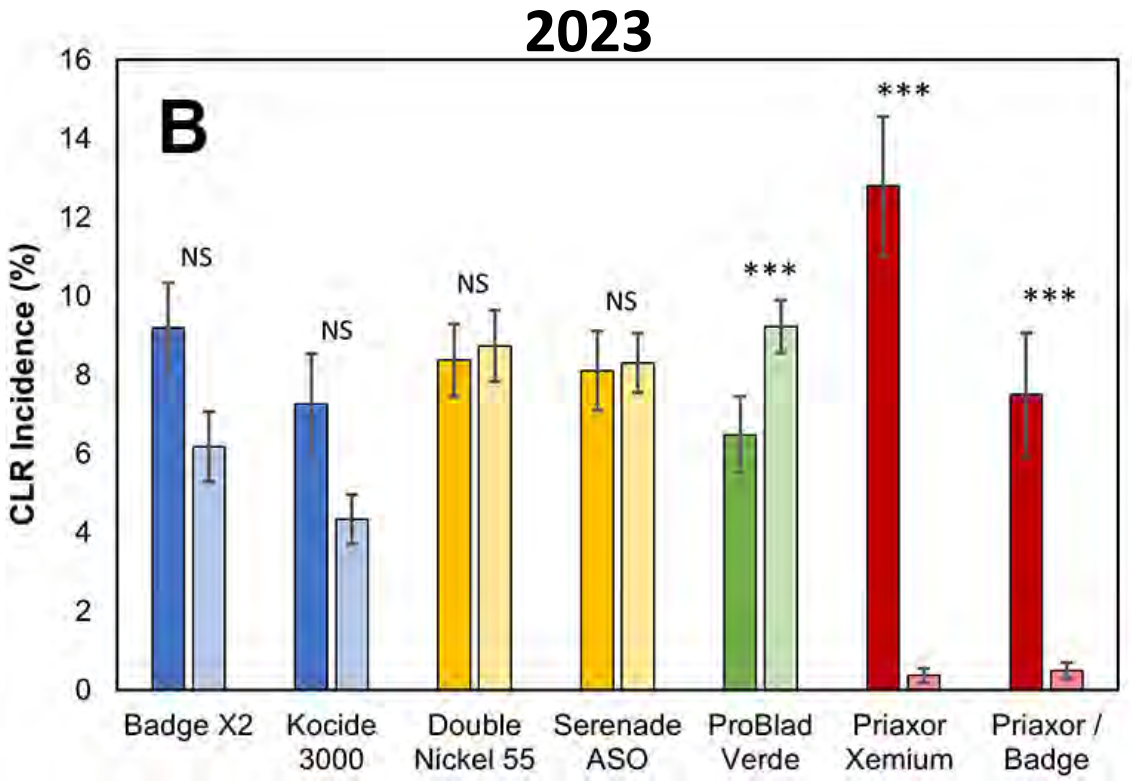
Product	**Active Ingredient**
Serenade ASO	*Bacillus subtilis*
Double Nickel	*Bacillus amyloliquefaciens*
Kocide 3000	Copper hydroxide
Badge X2	Copper hydroxide + copper oxychloride
ProBlad Verde	*Lupinus albus*
Priaxor Xemium	Fluxapyroxad + pyraclostrobin

Aristizábal, Maeda, Matsumoto, Johnson. In Review.

Fungicide Efficacy

Pre-application (Week 0, dark colors) vs. post-application (Week 6 or 8, light colors)

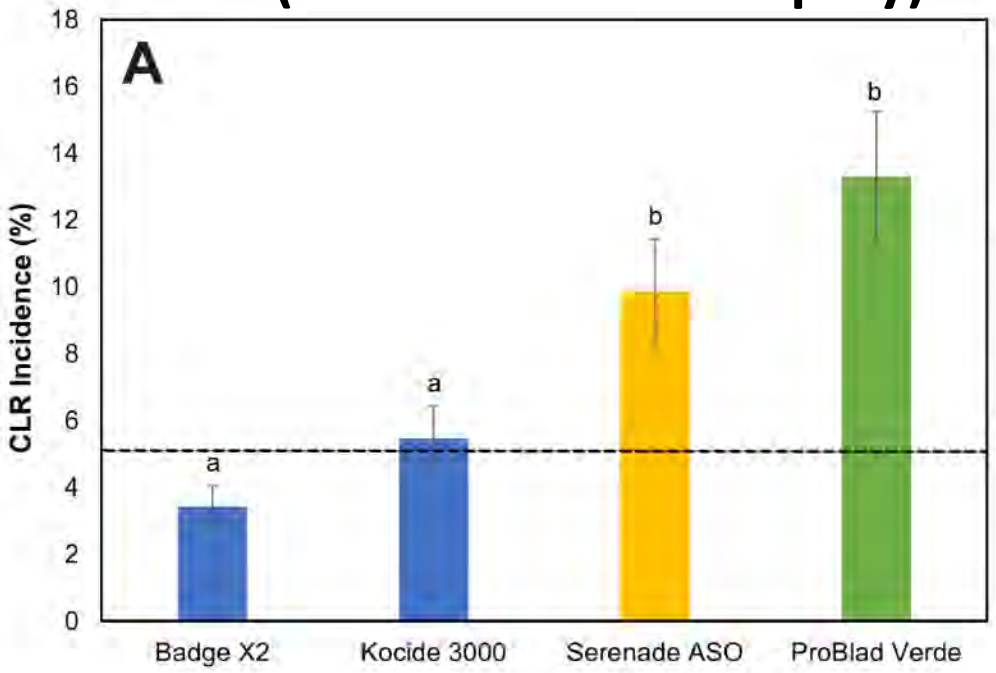




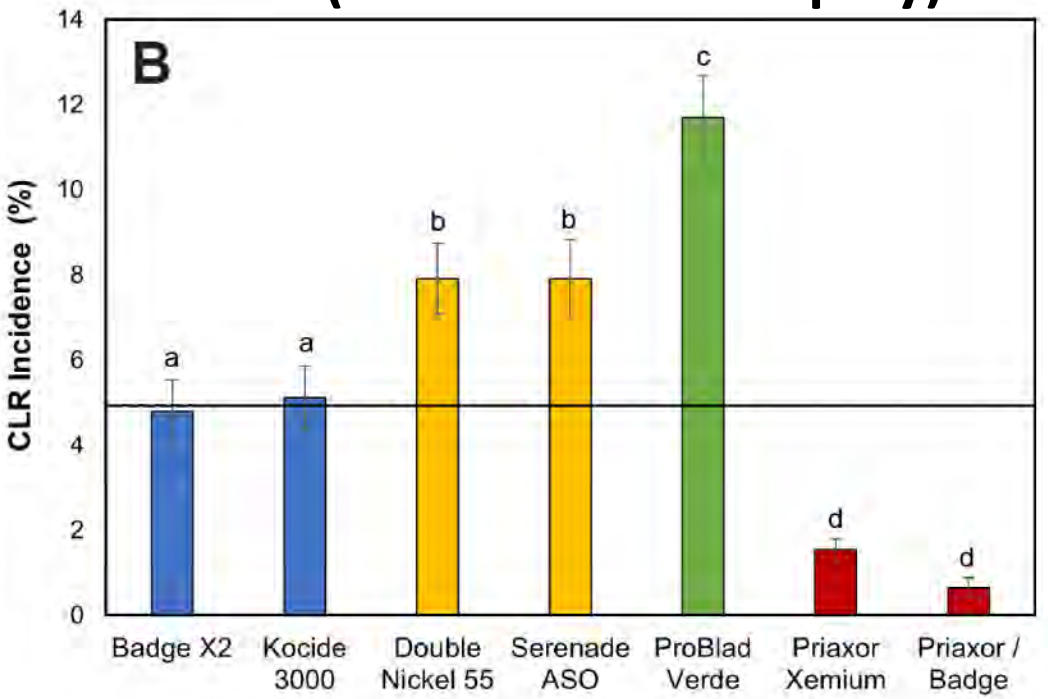
Duration of Protection

Comparison of fungicide treatments 7-10 weeks after the final application

2022 (10 wks after final spray)



2023 (7 wks after final spray)



Protection Over Time

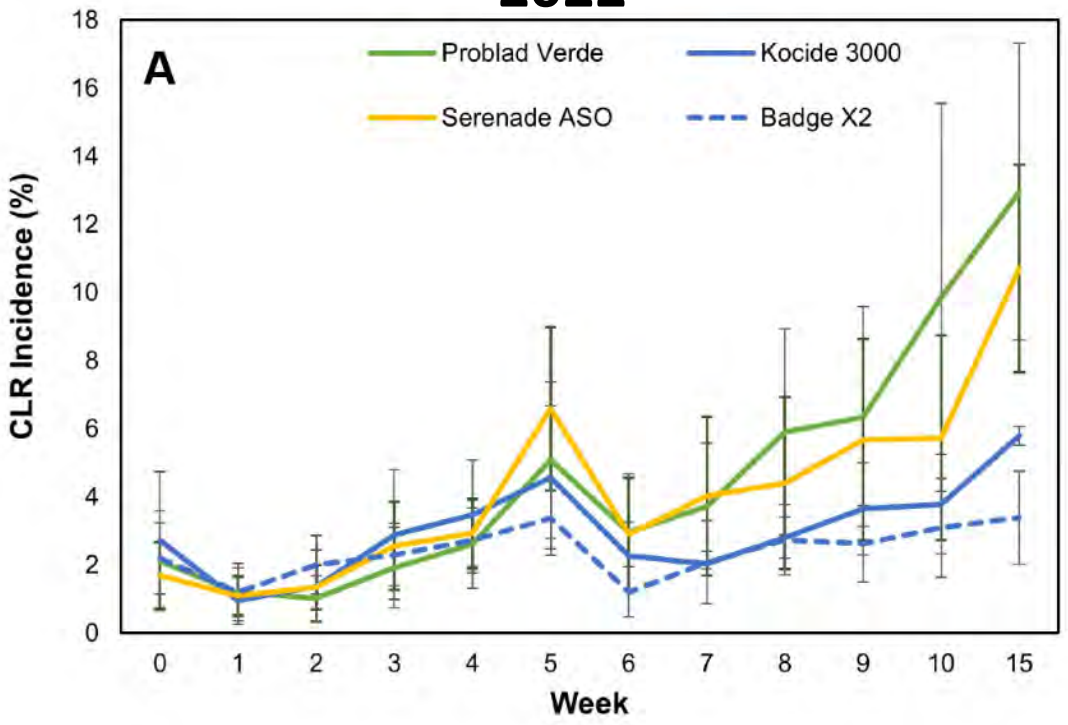
Priaxor: <2% incidence through Week 12

Badge X2 and Kocide: ≤5%

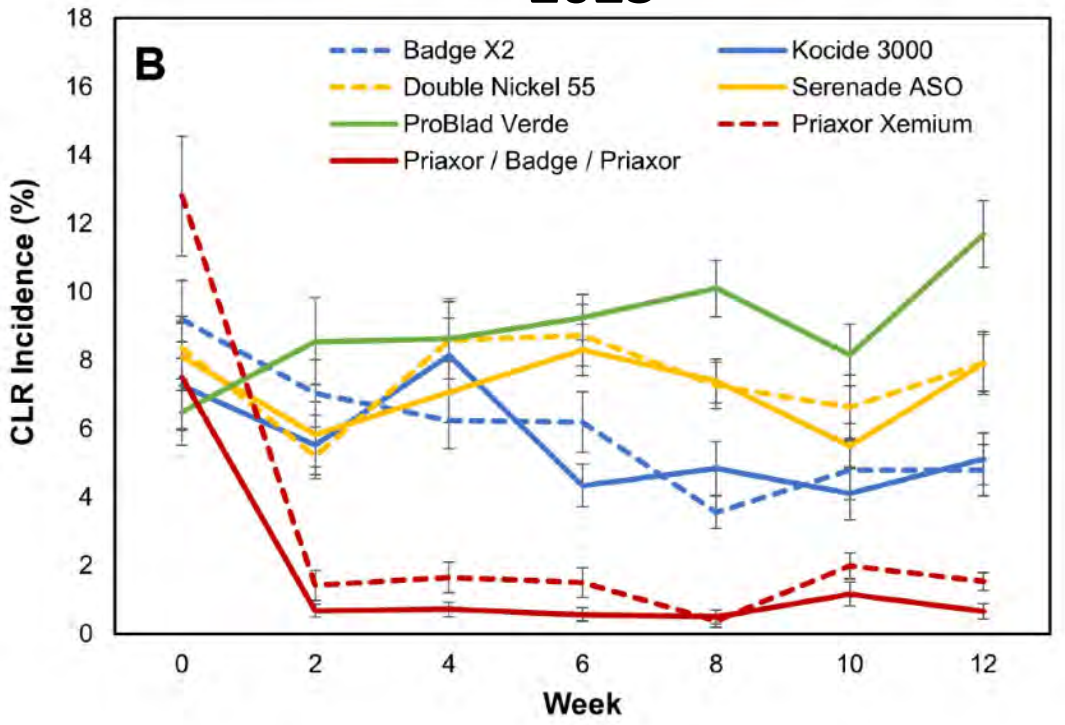
Serenade and Double Nickel: 8-10%

ProBlad Verde: 11-13%

2022



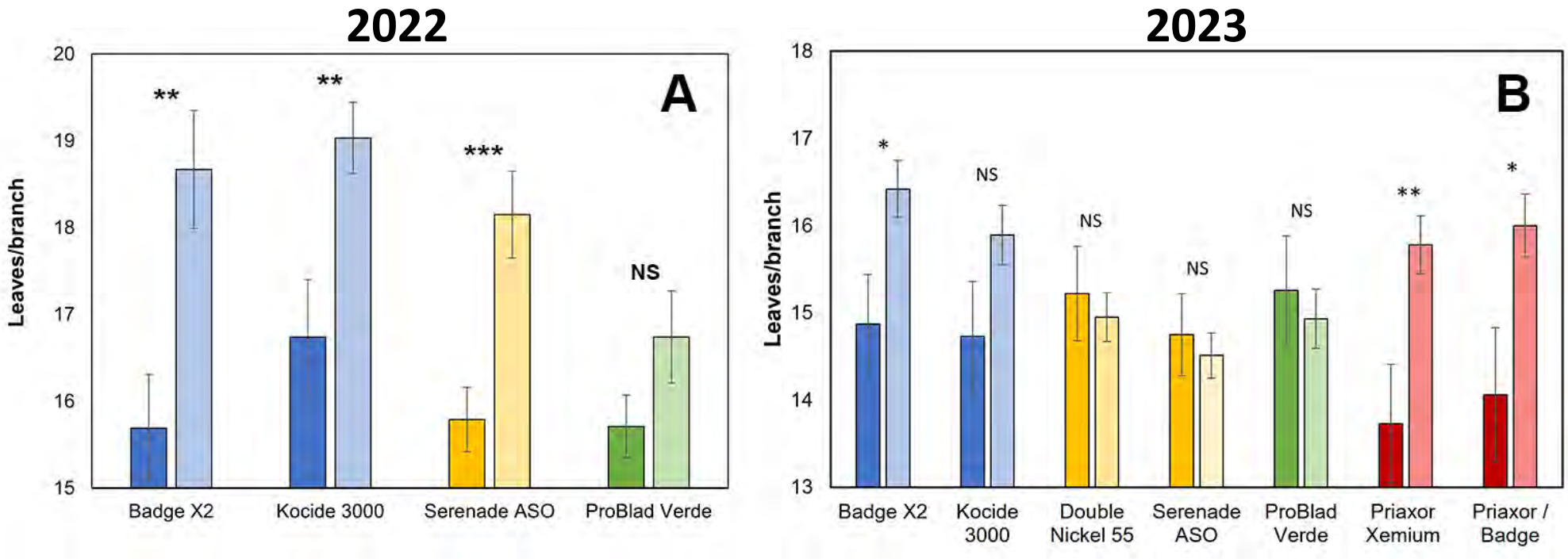
2023



Leaf Retention

2022: Significantly higher leaf retention in copper and Serenade treatments
2023: Significantly higher leaf retention in Badge and Priaxor treatments

Note: 2022 had lower average starting incidence (3%) relative to 2023 (9%)



Spray Costs

- Kocide & Badge: $126/acre
- Serenade ASO: $138/acre
- Priaxor Xemium: $140/acre
- Double Nickel: $168/acre
- ProBlad Verde: $198/acre
- Priaxor (2x)/Badge: $399/acre

Product	Kocide 3000	Badge X2	Serenade ASO	Double Nickel	ProBlad Verde	Priaxor Xemium	Priaxor/ Badge[a]
Rate/acre	1.5 lb	1.5 lb	64 Fl oz	1.5 lb	45 Fl oz	7 Fl oz	14 Fl oz + 1.5 lb
Cost/ acre	18	18	30	60	90	38	94
Farm	Cost (US$) per acre						
1	106	106	118	148	178	126	358
2	131	131	143	173	203	NA	NA
3	121	121	133	163	193	141	403
4	116	116	128	158	188	136	388
5	103	103	115	145	175	123	349
6	156	156	168	198	228	NA	NA
7	141	141	153	183	213	161	463
8	131	131	143	173	203	151	433
Average	**125.63**	**125.63**	**137.63**	**167.63**	**197.63**	**139.67**	**399.00**

Summary

Badge X2 and Kocide:

- Reduced CLR incidence to <5%
- Significantly increased leaf retention
- 6-8 weeks protection
- Most cost-effective at $126/acre

Serenade, Double Nickel, ProBlad Verde:

- CLR maintained at same level or significant increase in incidence
- Increased leaf retention at low starting incidence
- More expensive: $138-198/acre

Priaxor (1 spray or 3 spray combo)

- Both treatments (1 or 3 sprays) significantly reduced incidence (<2%)
- Both increased leaf retention
- 10-12 weeks protection
- 1 spray ($140/acre) is more economical and just as effective as 3 sprays ($399/acre)

Managing CLR with Fungicides

- Even when resistant varieties are available, fungicides are an important part of an IPM strategy to manage CLR

- In many growing regions around the world, preventative and curative fungicides are rotated to manage CLR

- 2 applications of a curative, and 2-4 applications of a preventative are rotated to prevent resistance
  - Colombia: 2-6 sprays
  - Brazil: 2-4 sprays
  - Kenya: 4 sprays

Example Rotation Programs

		Flowering			Berry Growth				Harvest				
Farm Type	**CLR Incidence**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Conventional	Low (<5%)			Priaxor		Badge		Priaxor		Badge			
Conventional	Medium (5-9%)			Priaxor		Badge		Priaxor		Badge		Serenade	
Conventional	High (10-20%)	OxiDate	Priaxor		Badge		Priaxor		Badge		Serenade		
Organic/ Year-round	Low (<10%)			Badge		Serenade	Badge		Serenade	Badge			
Organic/ Year-round	Medium (10-19%)	OxiDate		Badge		Serenade	Badge	Serenade	Badge		Serenade		
Organic/ Year-round	High (20-30%)	OxiDate	Badge	Serenade		Badge	Serenade	OxiDate		Badge		Serenade	

Priaxor Xemium

Badge X2

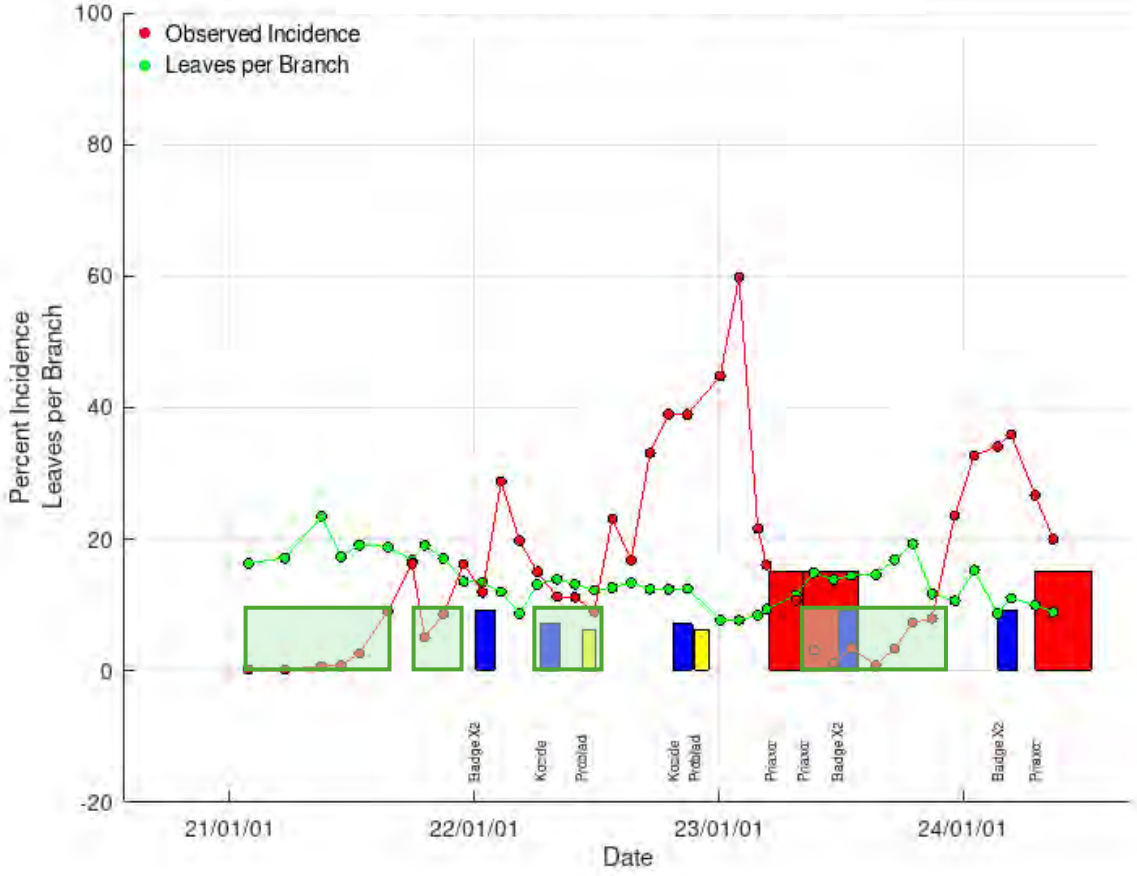
OxiDate

Serenade

Conventional Farms: 4-6 sprays
Organic or Year-round Farms: 5-8 sprays

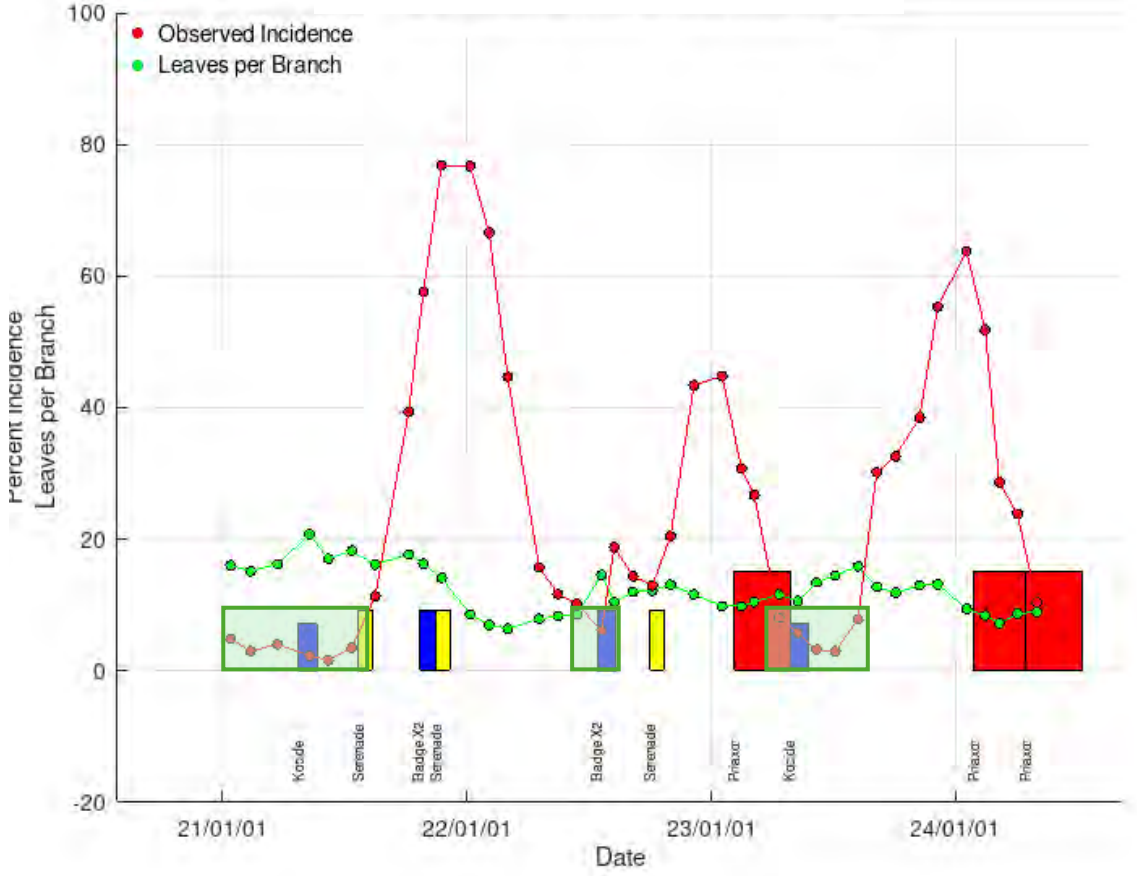
Kona low elevation

sprays done = 10
effective = 4



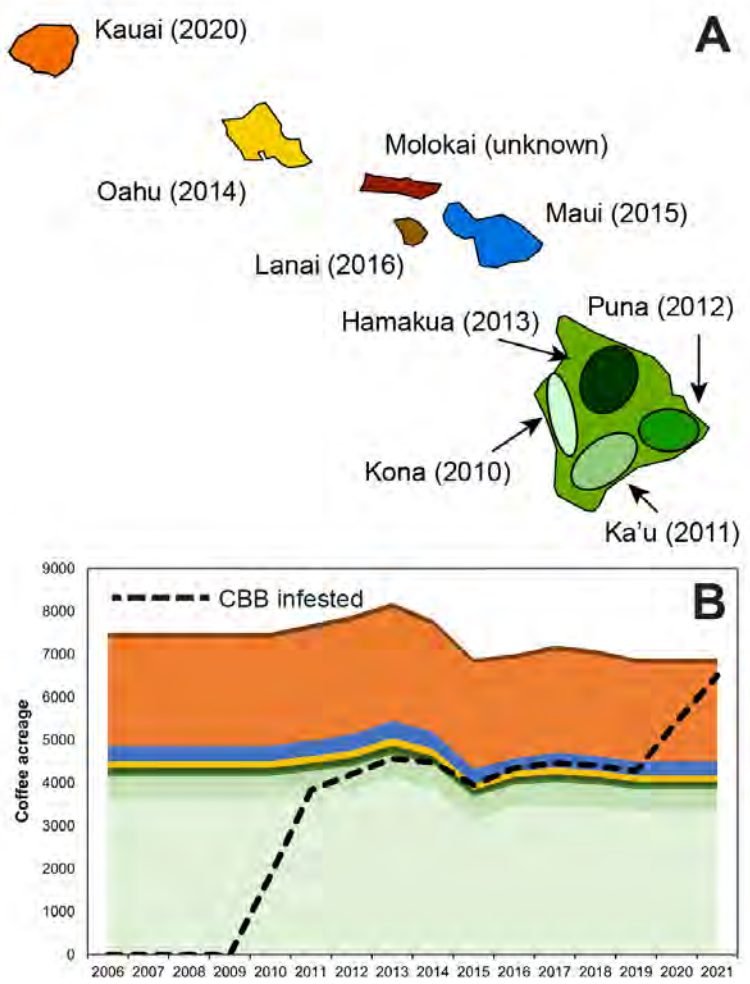
Kona high elevation

sprays done = 10
effective = 4



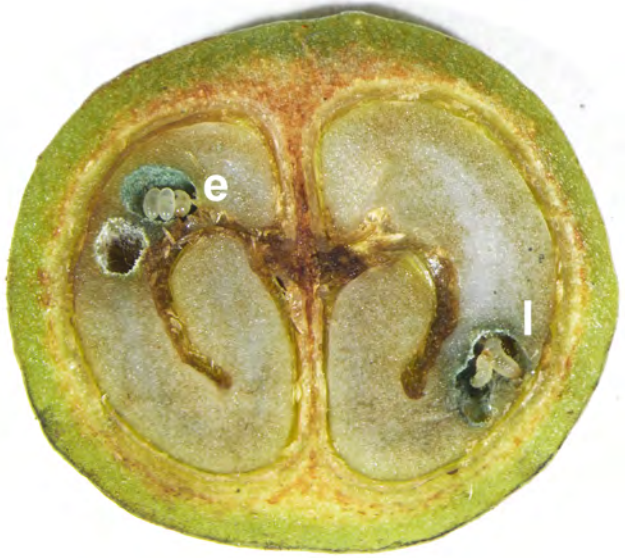
Coffee Berry Borer (CBB)

- Most serious pest of coffee worldwide
- First detected in Hawaii in 2010
- Challenges to implementing IPM:
  - Coffee landscape is variable
  - Cultural practices vary among farms
  - Production and labor costs are high
  - Severe labor shortage



CBB Management Strategy

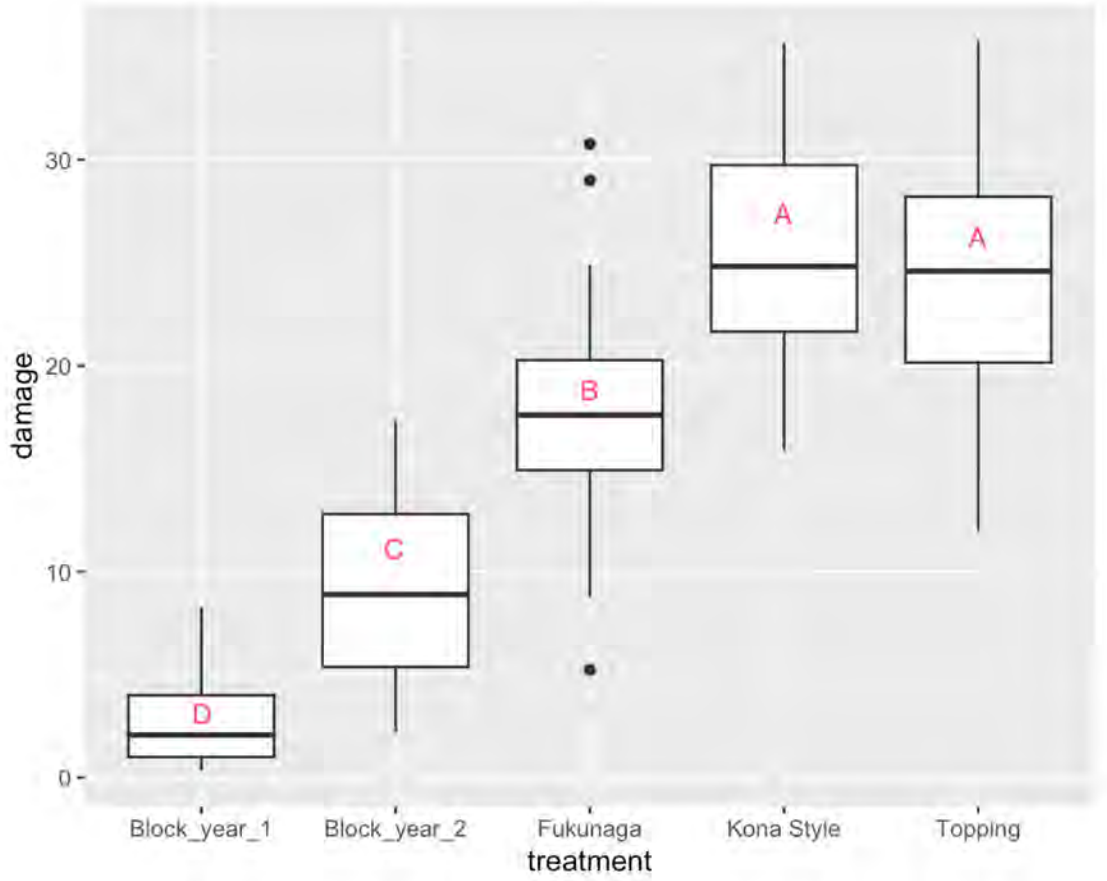
- Prune
- Scout
- Spray
- Sanitation



Pruning for CBB

Bean Damage

- Kona style = 25%
- Topping/umbrella = 24%
- Beaumont-Fukunaga = 17%
- Block-stump (yr 2) = 9%
- Block-stump (yr 1) = 3%



Aristizábal, Johnson, & Wright, In Prep.

Scout

- Informs best times to spray
- Start in March
- Alcohol-baited traps
  - Look for increased flight activity
- Berry infestation
  - Look for CBB in AB position

CBB Spray Calendar

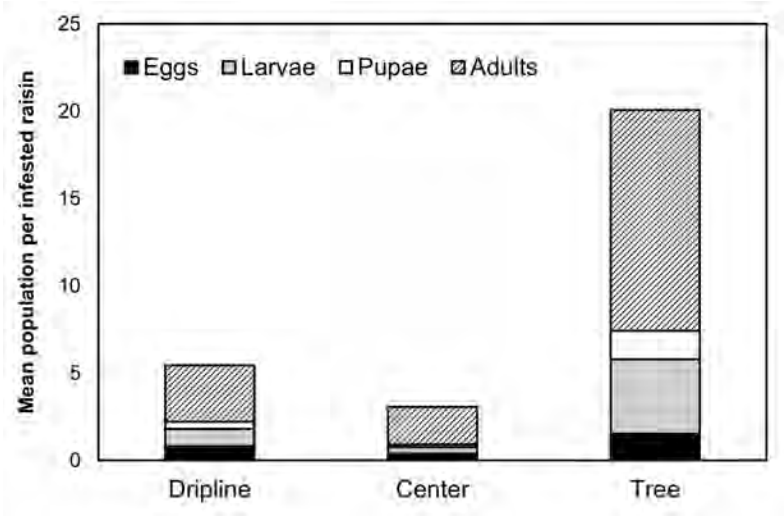
- Based on combined dataset for trap catch, infestation, CBB position (AB), and fruit production.
- Low, medium, high and critical refer to spray priority.

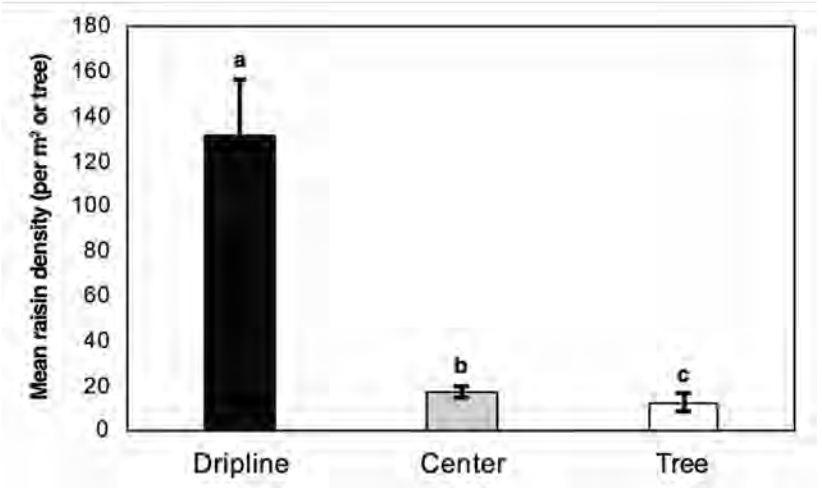
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kona Low	<1300 ft	Medium	High	Critical	High	Medium	Medium	High	Low	Low	Low
Kona Mid	1300-2000 ft	Medium	High	Critical	High	Low	Low	Low	Medium	Low	Low
Kona High	>2000 ft	Low	Medium	High	Critical	Low	Low	Low	Low	Low	Low
Ka'u Low	<1300 ft	Medium	High	Critical	High	Medium	Medium	Medium	Medium	Medium	Low
Ka'u Mid	1300-2000 ft	Medium	High	Medium	High	Medium	High	Low	Low	Low	Low
Ka'u High	>2000 ft	Low	Low	Low	Medium	Medium	Medium	Medium	Low	Low	Low

- In general, the number of sprays needed to control CBB decreases with increasing elevation
- Kona: 4–7 sprays optimal for low-elevation farms, 3–5 sprays for mid-elevation farms, and 2–3 sprays for high-elevation farms
- The optimal spray window for controlling CBB in Ka'u is slightly longer relative to Kona, reflecting the year-round season

Sanitation

- Early-season sanitation picks
- Frequent & efficient harvesting
- End of season strip-pick
  - ~92,000 CBB/acre in tree raisins
- Removal of ground raisins
  - ~96,000 CBB/acre in ground raisins
- High density trapping in post-harvest (10-12 traps/acre)

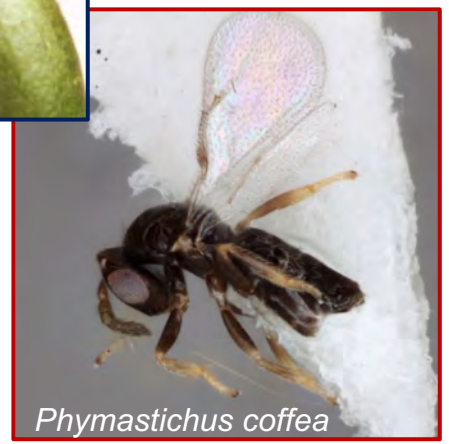




CBB Biocontrol

- Parasitoid *Phymastichus coffea*
- Native to Kenya
- Tiny wasp ~ 1 mm in length
- Attacks CBB when in AB position
- Mass rearing underway at USDA-ARS Hilo


CBB parasitization


Phymastichus coffea


Collecting parasitoids


CABI Kenya


Mass rearing

Acknowledgements

- MAHALO to the all the coffee growers for your continued support and collaboration
- Lab team: Colby Maeda, Jared Nishimoto, Karma Kissinger, Jessica George, Taya Brown, Frank Linam
- Administrative support: Suzanne Shriner (SHAC)
- Funding: USDA NIFA Specialty Crops Research Initiative, USDA-ARS Areawide grant

Contact: melissa.johnson@usda.gov