USDA ARS DKI PBARC Research Update

HCA Conference 2016

Coffee Berry Borer (CBB) Research

College of Tropical Agriculture
and Human Resources
University of Hawai'i at Mānoa

Insect Pests
March 2015
IP-33

Recommendations for Coffee Berry Borer Integrated Pest Management in Hawai'i 2015

Andrea M. Kawabata[1], Stuart T. Nakamoto[2], R.T. Curtiss[3]
[1]University of Hawai'i at Mānoa (UHM) College of Tropical Agriculture and Human Resources (CTAHR) Department of Tropical Plant and Soil Sciences, [2]UHM CTAHR Department of Human Nutrition, Food and Animal Sciences, [3]Hawai'i Department of Agriculture – Plant Pest Control Branch

The following document is a collaborative effort between the University of Hawai'i at Mānoa College of Tropical Agriculture and Human Resources, Hawai'i Department of Agriculture, United States Department of Agriculture Agricultural Research Service Daniel K. Inouye Pacific Basin Agricultural Research Center, and coffee grower groups. There is much information, some of it conflicting, on how to control the Coffee Berry Borer (CBB). In 2013, the first CBB Summit was held so those who are investigating control methods could provide industry with a single set of recommendations that synthesize and incorporate the best available information. Participants recognized that recommendations could change as new information becomes available, so they agreed to meet on a regular basis to update the information.

The results of the 2014 CBB Summit are outlined here. This summit again brought together researchers so that the best available information could be consolidated and transferred to growers. Our goal in drafting these recommendations is to provide farmers with up-to-date general guidelines to better manage coffee berry borer in Hawai'i. Foreign coffee-producing regions have proven that no single approach will control CBB. Not all recommendations will apply to all farmers, but we recommend following an integrated pest management approach, using as many of the suggestions—in the order listed—as possible for maximum effect. Reducing CBB levels and keeping population levels low are key to effective CBB management. This document starts with field sanitation, the most important step in reducing CBB population, followed by recommendations for the rest of the crop cycle: pruning, field monitoring and sampling, pesticide application, harvesting, and shipping. This document does not include an economic analysis of the recommendations. Producers should decide the most cost-effective methods for their farms using available information and business/financial records. For further CBB information, including local and international literature, please visit hawaiicoffee.weebly.com.

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CBB Control

Field Sanitation

Field Monitoring

Pesticide Application

Field Sanitation to reduce CBB between seasons

Without sanitation coffee berries will always be present in this field

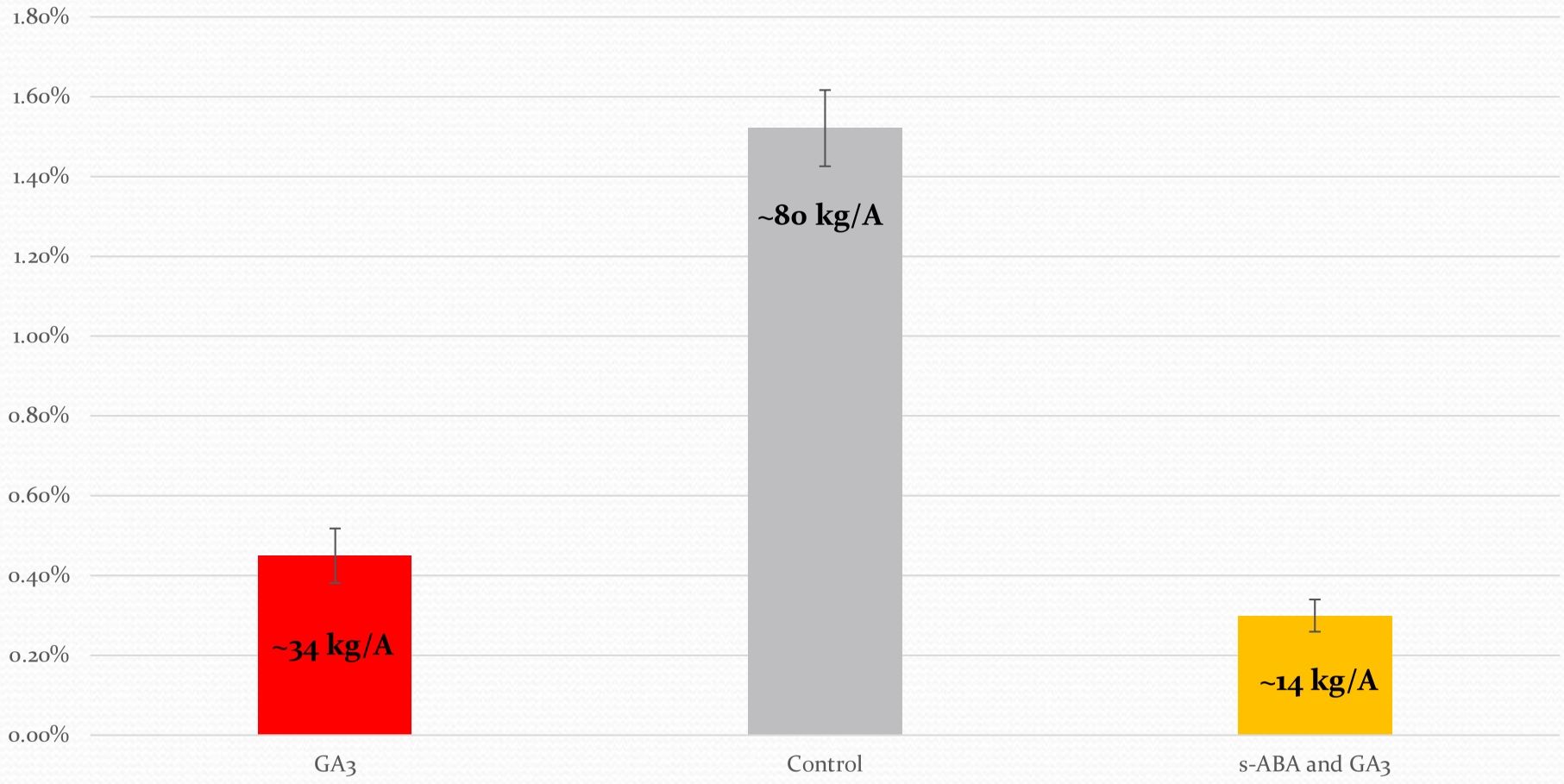
Plant growth regulators to reduce strip pick coffee

Untreated Control

300 ppm s-ABA foliar plus GA3 foliar* (1 app)

300 ppm s-ABA drench (4 apps) plus GA3 foliar*

Plant growth regulators reduce green berries at end of season in hand harvested coffee



PGR also reduce green berries at end of season in hand harvested coffee

Control

Ripe (52.92%)
Green: (11.28%)
Overipe (35.80%)

GA

Ripe (71.02%)
Green: (6.53%)
Overipe: (22.45%)

GA and ABA

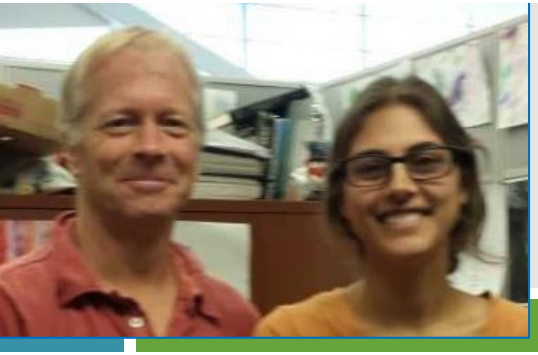
Ripe (43.55%)
Green: (6.13%)
Overipe: (50.32%)

Separate cherry into

- Overripe (brown)
- Ripe (red)
- Green

CBB in overripe and raisin coffee

Photo by S. Wraight



Flat bark beetle studies

Follett Lab (USDA -ARS)

How many CBB do predators eat?

- Sleeve cage tests
- Cage CBB-infested berries with and without predators

Sleeve cage

Predator beetle eating CBB larva

CBB predators

Can we attract and propagate predators on the farm?

- Breeding station studies using attractants

Stations hang in trees

Robert G. Hollingsworth

Mite predator of CBB larvae (play video)

Current research projects:

- Natural enemy surveys and bioassays with predatory thrips, bugs, and mites, and wasp parasitoids.

Nymph and adult of unidentified bug predator of CBB larvae

Phymastichus xylebori, a candidate for biocontrol of CBB already present in macadamia nut orchards

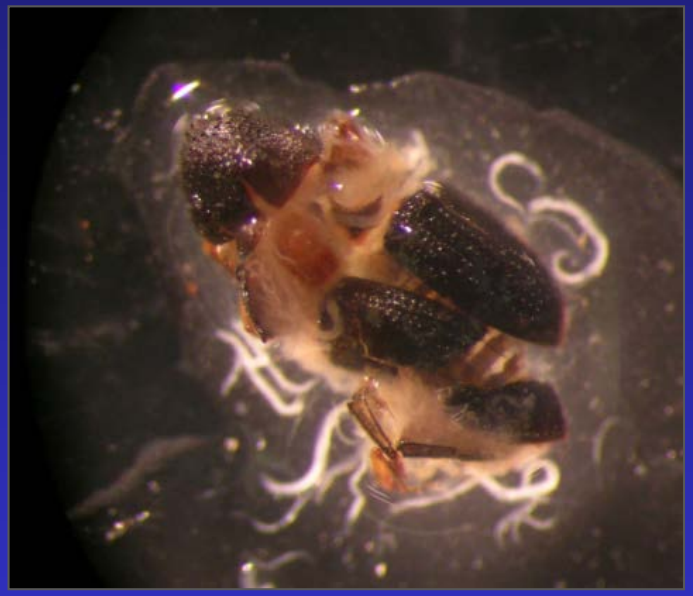
Karnyothrips flavipes, a known predator of CBB occasionally found in Hawaii

Photo credits (excepting *Karnyothrips*: Michael Sthreshley

CBB in fallen coffee berries

NEMATODES

- Insect-parasitic Nematodes
  - Ongoing: native strains of *Heterorhabditis indica* and *Steinernema feltiae* against CBB in fallen cherries



Manton *et al.*, 2012

Robert G. Hollingsworth, Research Entomologist
Research Team: John Ross, Michael Sthreshley, Austin Bloch

Current research projects:

- Fate of CBB in coffee berries on the ground as affected by **ground cover, environmental factors, and insect-killing nematodes**.

A nictating infective juvenile of S. carpocapsae

John Ross and Bob Nelson, setting up test with infested berries. Berries were placed on dry ground or in St. Augustine grass. Each week for ten weeks, sub-samples were collected, taken back to the laboratory and dissected.

Steinernema carpocapsae, an insect-killing nematode species with a possible role for controlling CBB in fallen berries

Results from Bare vs. Groundcover

Low elevation (less moisture)

Bob Nelson's Farm — Number of Adult Females --- immatures per 10 berries

Set up October 8, 2015

Adult Beetles		15-Oct	23-Oct	29-Oct	4-Nov	SUBTOTAL	Avg. Beetles/Berr
Plot 1	Bare	15 --- 3	39 --- 0	24 --- 6	26 --- 0	104 --- 9	2.6 --- 0.2
Plot 2	Grass	74 --- 60	11 --- 47	27 --- 32	7 --- 4	119 --- 143	3.0 --- 3.6
Plot 3	Bare	15 --- 1	20 --- 3	13 --- 0	27 --- 0	75 --- 4	1.9 --- 0.1
Plot 4	Grass	40 --- 115	7 --- 3	2 --- 2	1 --- 2	50 --- 122	1.3 --- 3.1

6 of 10 "rotten"

12-Nov	18-Nov	25-Nov	2-Dec	8-Dec	16-Dec	SUBTOTAL	Avg. Beetles/Berry	TOTALS	
20 --- 9	22 --- 0	28 - 144	37 --- 35	76 - 109	35 --- 60	218 --- 357	3.6 --- 6.0	322 --- 366	Bare
16 --- 8	7 --- 1	0 --- 9	3 --- 0	27 -- 44	9 --- 0	62 --- 62	1.0 --- 1.0	181 --- 205	Grass
21 --- 0	12 --- 0	2 --- 0	18 --- 0	47 -- 53	16 --- 15	116 --- 68	1.9 --- 1.1	191 --- 72	Bare
0 --- 0	0 --- 0	3 --- 2	4 --- 0	29 -- 51	0 --- 0	30 --- 53	0.5 --- 1.0	80 --- 175	Grass

Note: There was almost NO reproduction the first four weeks on bare soil! Counts of immatures counts were much higher over the following six weeks in berries on bare soil, and much lower for berries within ground cover.

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CBB Control

Field Sanitation

Field Monitoring

Pesticide Application

Coffee Berry Borer is an Unusual and Difficult Pest *Because*

the pest spends much of its life within the coffee bean, protected from insecticide sprays.

Hypothenemus hampei

Robert G. Hollingsworth, Research Entomologist
Research Team: John Ross, Michael Sthreshley, Austin Bloch

Current research projects:

- Using repellents and surfactants to enhance **control by *Beauveria* and pyronyl** (in collaboration with Luis Aristizabal)

Artificially infesting coffee to test duration of repellency

Adult beetles are exposed to Beauveria when they are on the move and before they bore down into the seed. Possibly surfactants and repellents will increase infection by Beauveria or death by pyronyl if these cause beetles to briefly leave the berries. Michael is counting the number of beetles exiting berries in response to sprays (upper right).

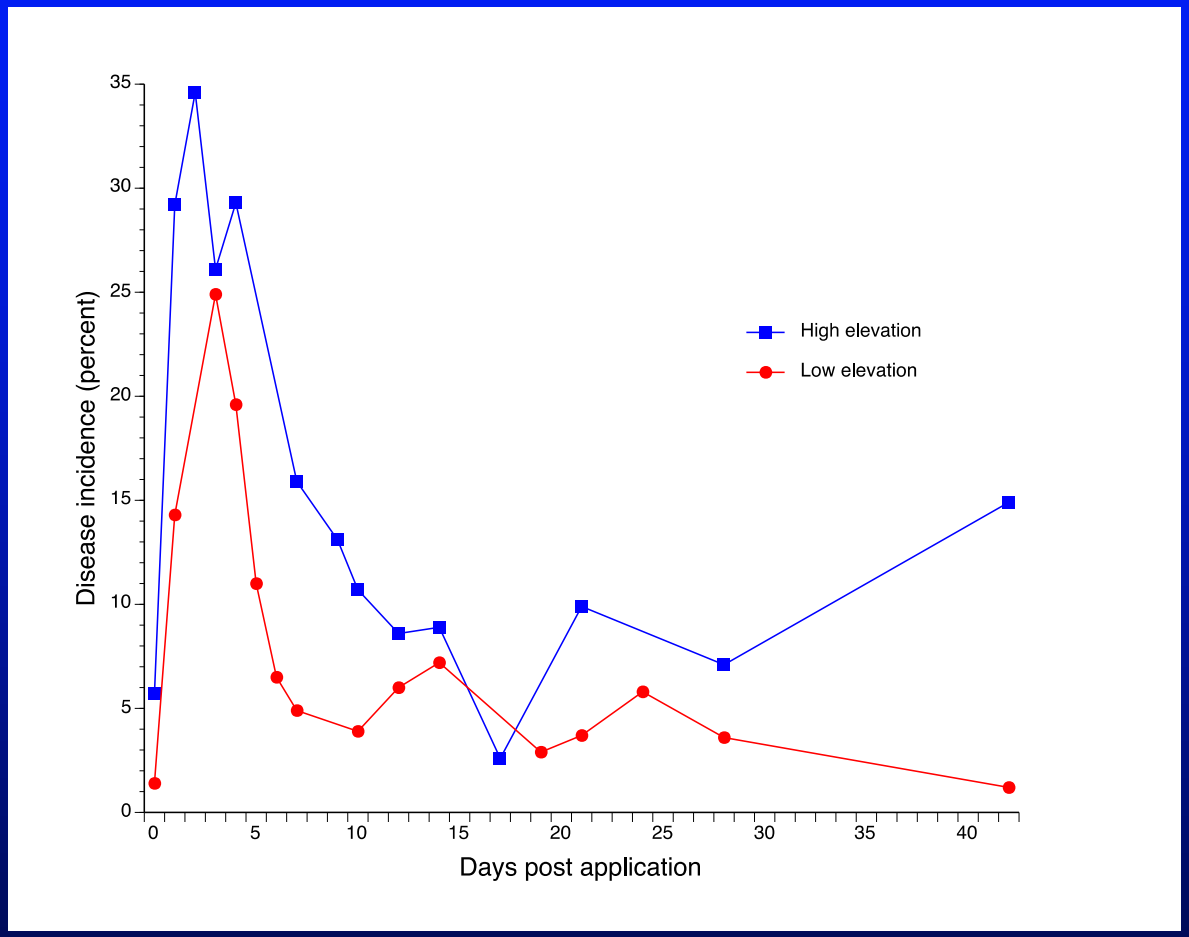
Optimization of *Beauveria bassiana* pesticide sprays

Photos by S. Wraight

Persistence & Efficacy of *B. bassiana GHA*

- Potential for using the commercially available *B. bassiana* GHA strain as a control method for CBB in Hawaii
- Goal: to optimize effectiveness and economics for farmers
- Determine how timing and frequency of commercial *Beauveria* applications effect persistence and efficacy
- Suppression sprays
- Strip pick
- Compare seasons
- Effect on quality/harvest

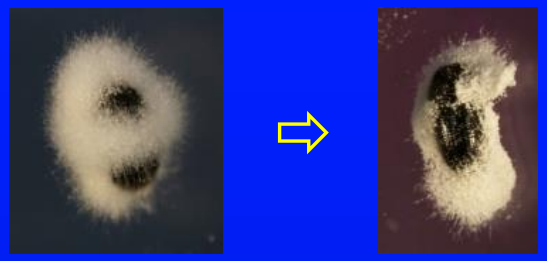
Assessing efficacy of early-season spray applications of *Beauveria bassiana* against coffee berry borer at low and high elevation.



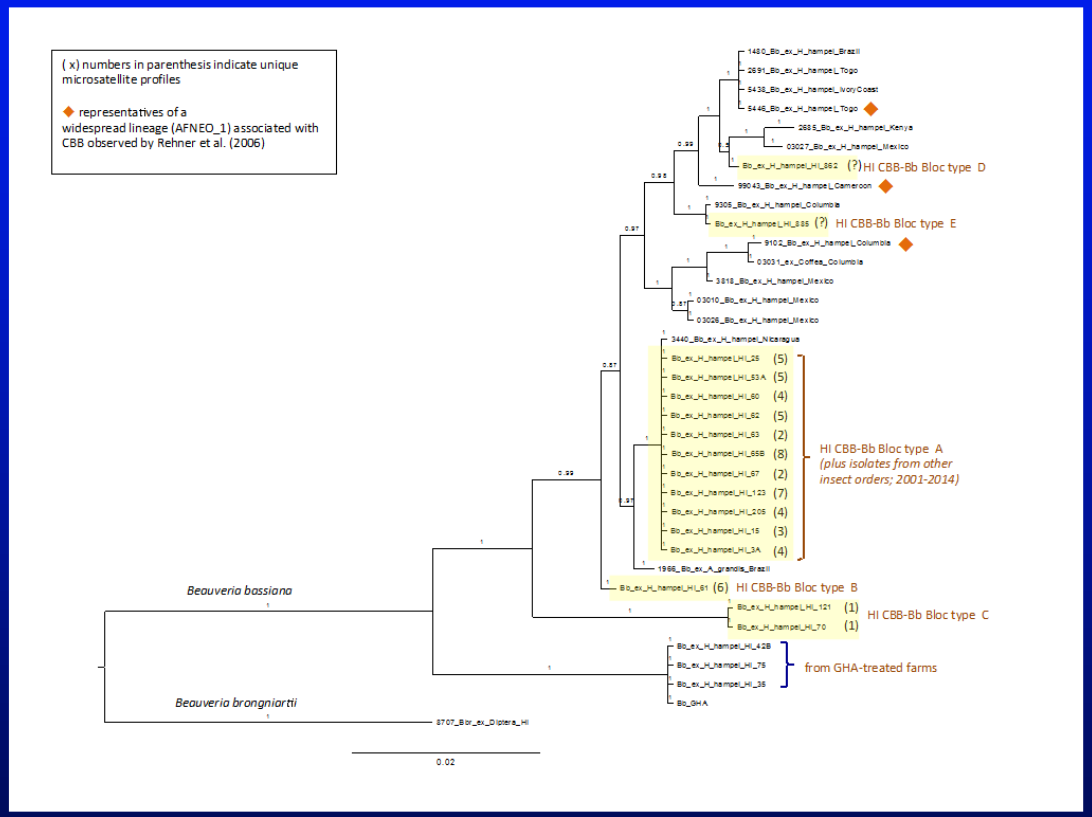
Stephen Wraight, Tracie Matsumoto, Lisa Keith (USDA-ARS)
Sandra Galaini-Wraight (University of Hawaii, Manoa)
Louela Castrillo (Cornell University)

Genetic and morphological characterization and virulence bioassays of *Beauveria bassiana* isolates from coffee berry borer.

GHA



Feral



Precise assessments of activity of naturally-occurring vs. commercially-available *Beauveria*.

Louela Castrillo (Cornell University)
Stephen Wraight, Rebecca Howes, Tracie Matsumoto, Lisa Keith (USDA-ARS)
Sandra Galaini-Wraight (University of Hawaii, Manoa)

Prediction Model:
Factors Affecting Persistence & Rate of Infestation
(w/Dr. Nick Manoukis)

Response: log(spores)

	Estimate	SE	*t*	*p*
(Intercept)	1.795	4.237	0.4	0.6723
log(days since spray)	-0.770	0.147	-5.3	3.86E-07
Cum. Rain	-0.058	0.042	-1.4	0.1681
Mean RH	0.062	0.015	4.1	5.34E-05
Mean Temp	-0.009	0.054	-0.2	0.8662
Field	0.800	0.430	1.9	0.0647

Multiple R-squared: 0.3963

** Significant effects of days since spray, RH*

** This model allows us to make predictions of active Bb in the field given weather and time since spraying*

How do we bring the field research/data together?

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CBB Control

Field Sanitation

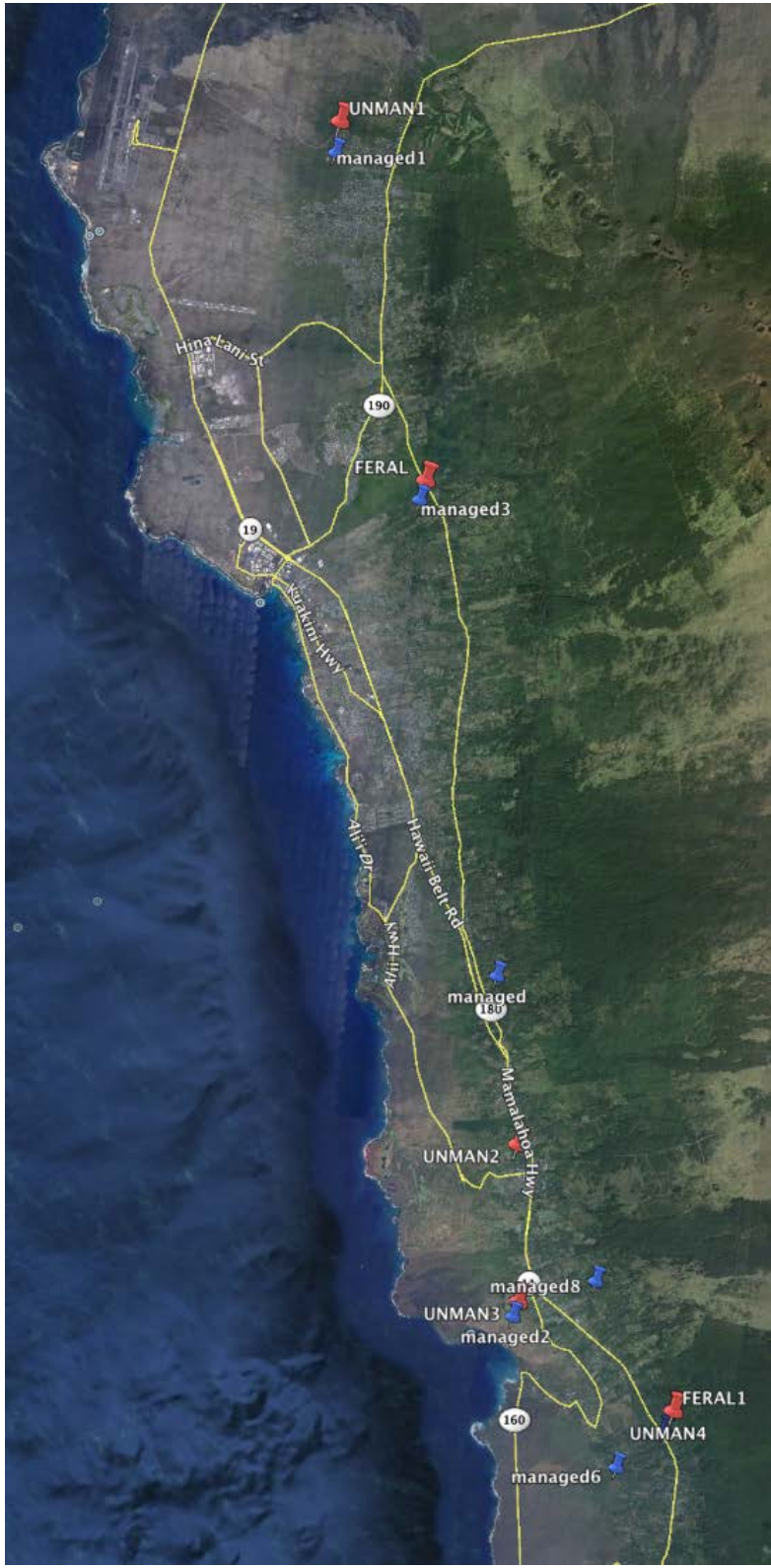
Field Monitoring

Pesticide Application

Area-Wide Field Data

- Data being collected for 8 managed farms, 2 unmanaged and 2 feral sites in Kona
- Visit each site every two weeks
- Checking:
  - CBB infestation level (in field, plus dissection)
  - Trap catch
  - Plant phenology
  - Weather
  - Management

Nick Manoukis
USDA-ARS



Robert G. Hollingsworth, Research Entomologist
Research Team: John Ross, Michael Sthreshley, Austin Bloch

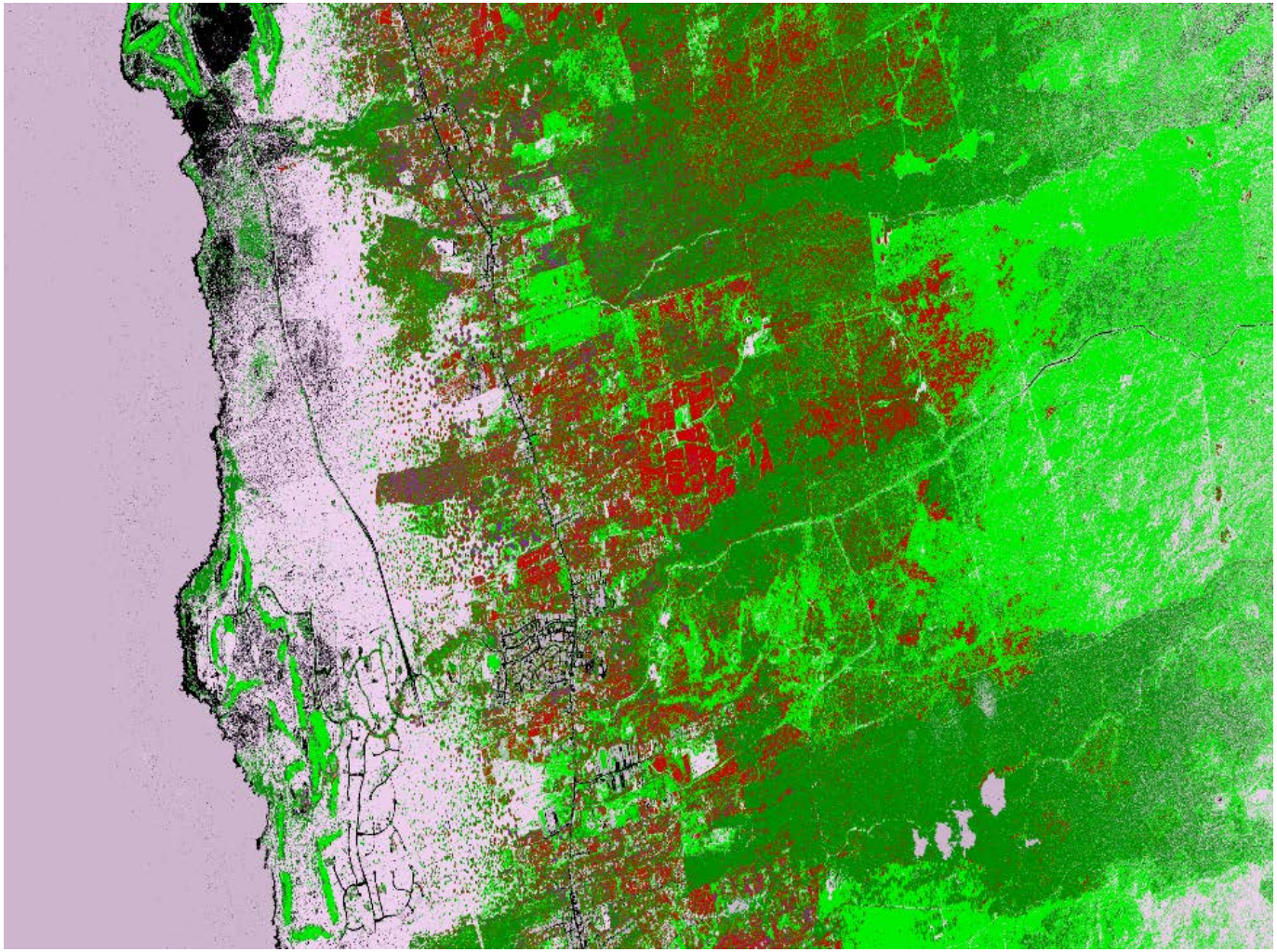
Current research projects:

- Area-wide study of CBB population growth and movement in the Kona District (trap counts, scouting and berry dissections) in relation to **temperature, rainfall, humidity, solar intensity, crop phenology, control measures and harvesting** (in collaboration with Nicholas Manoukis and Luis Aristizabal.)

Austin, Nick and Thomas Mangine setting up monitoring equipment

Austin, Luis and Michael taking a break after setting up a trial.

Detecting Coffee Patches in Hawaii

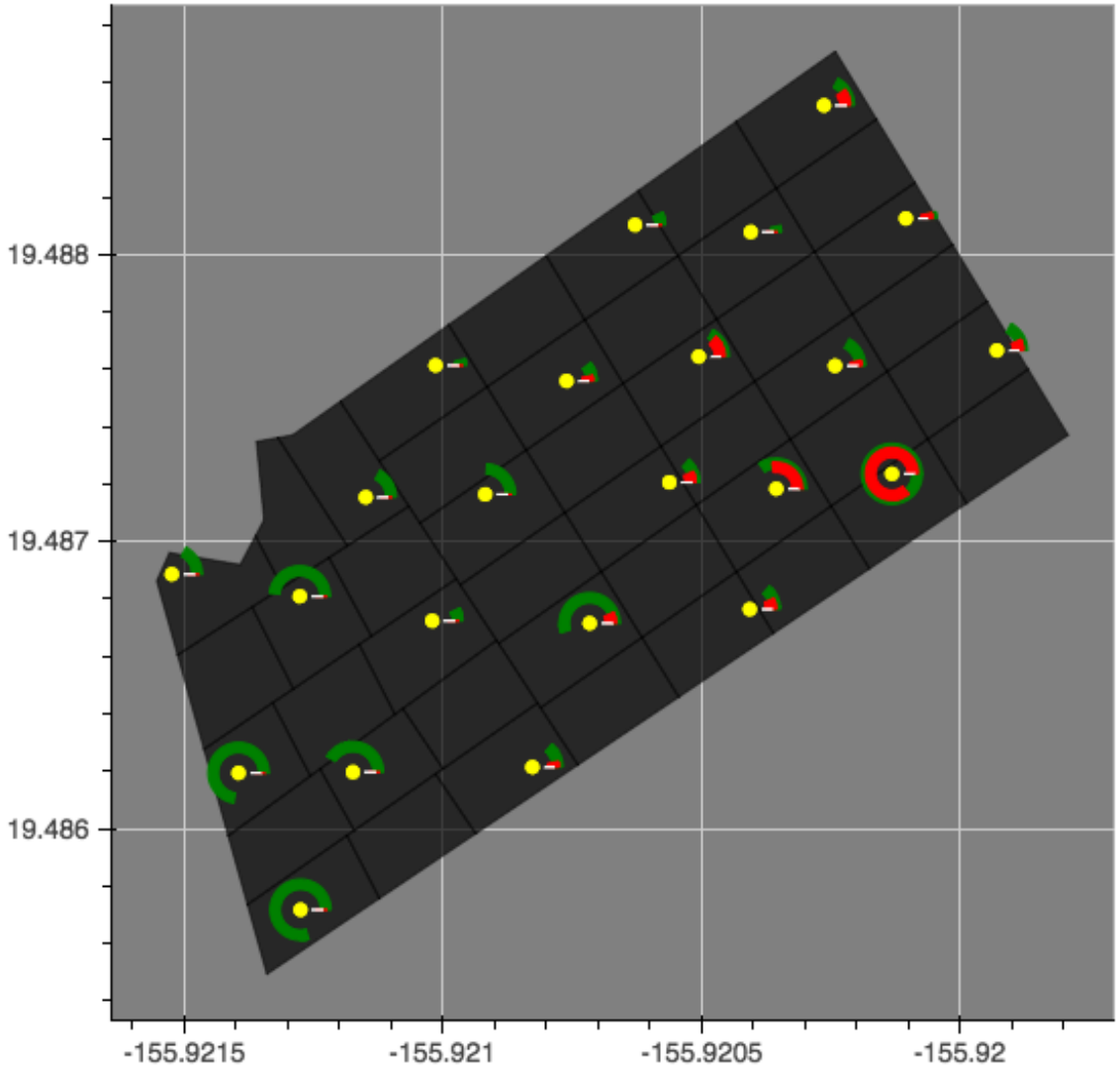


Method generated using WorldView-2 data (2012). Currently running on WorldView-3 data (2016) in collaboration with C. Potter and V. Genovese, Airborne Science Program, NASA-Ames Research Center

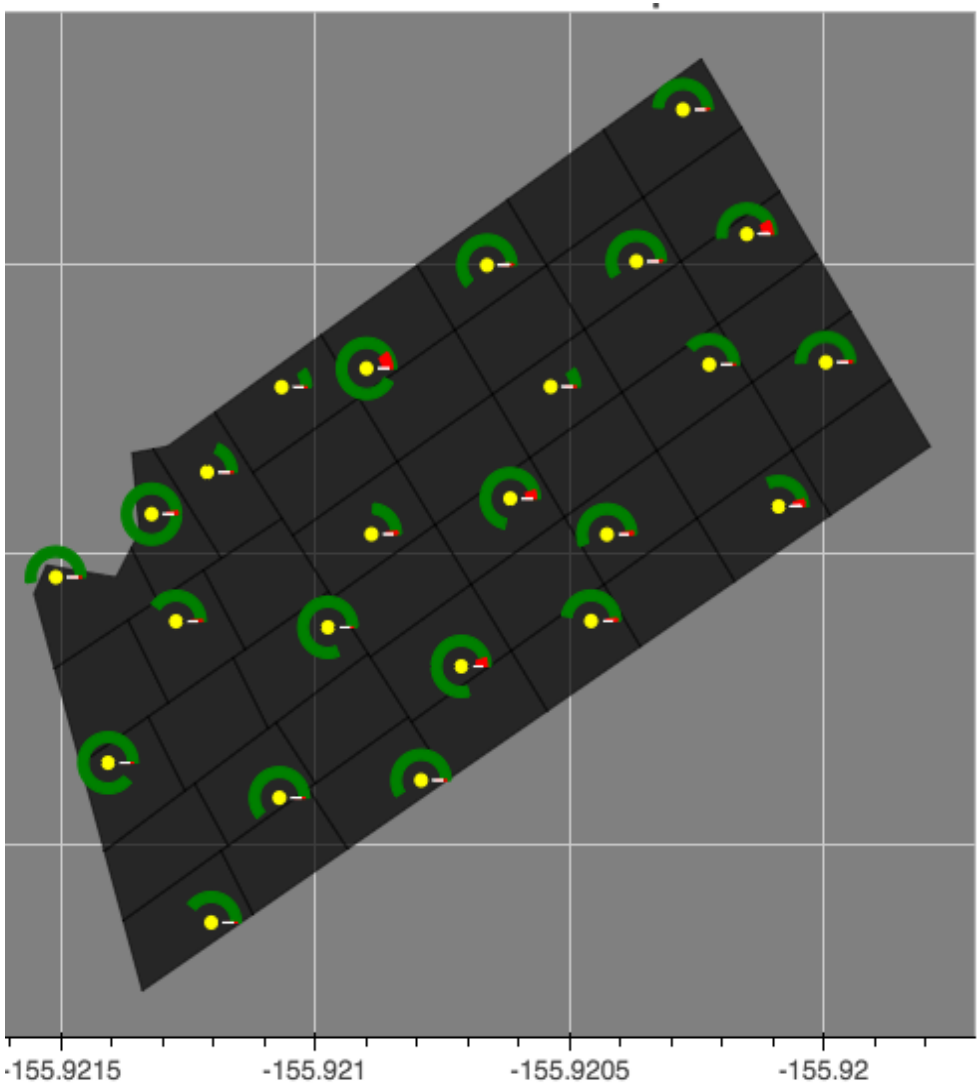
Nick Manoukis
USDA-ARS

Monitoring: Maps

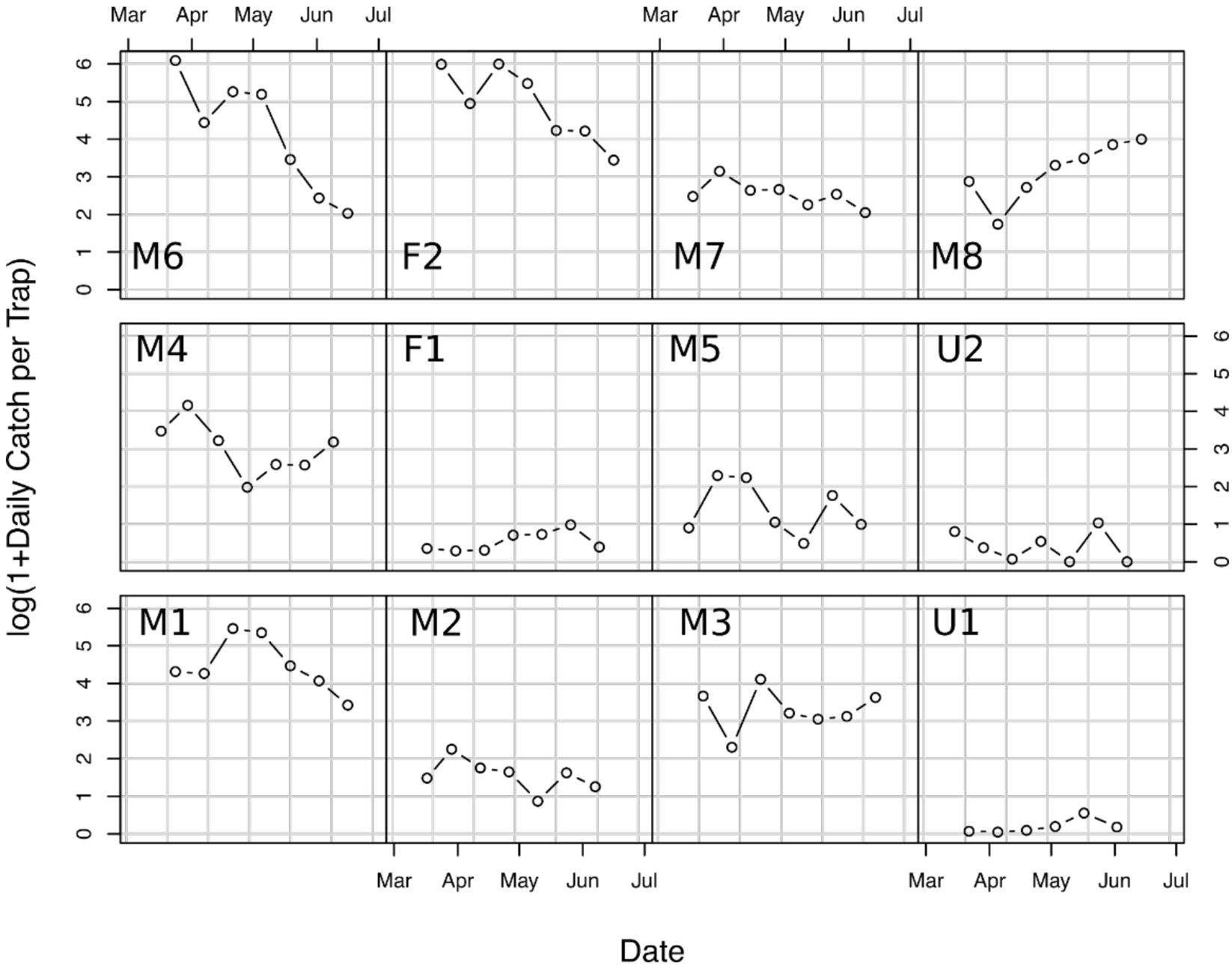
2016-03-28



2016-07-08



Initial Data: Trap Catch (2016)



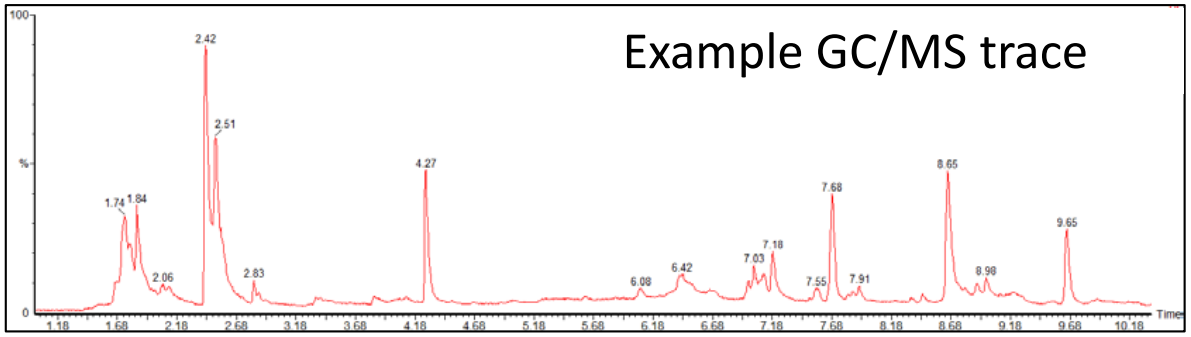
Methods to ensure Hawaii continues to produce high quality coffee

Odors from CBB damaged coffee

- Damaged & undamaged coffee analyzed from 3 farms
  - Green unground coffee (complete)
  - Roasted ground coffee (ongoing)
- Odors sampled & identified using headspace autosampler & GC/MS

Matthew Siderhurst

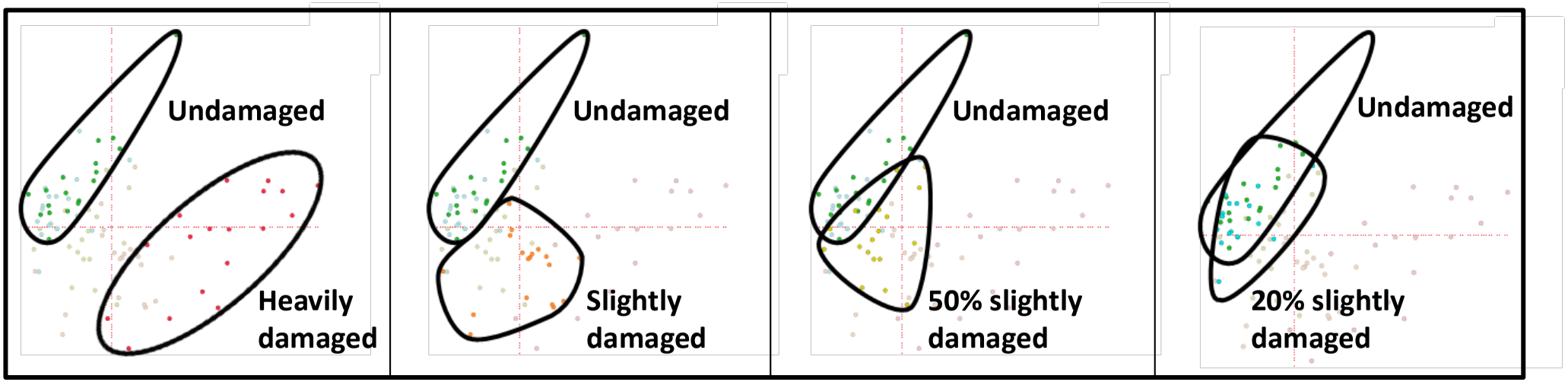
Marisa Wall



Headspace autosampler GC/MS

Odors from CBB damaged coffee

- Eight compounds used as damage indicators
  - Displayed using principle component analysis



- CBB damage to green beans readily detectable
  - Samples with 20% CBB damage indistinguishable from undamaged green unground coffee
  - Strong between farm variation was observed

Mahalo to

Department of Agriculture
STATE OF HAWAII

Proposal Title: Optimization of CBB control methods in mechanically harvested coffee operations in Hawaii

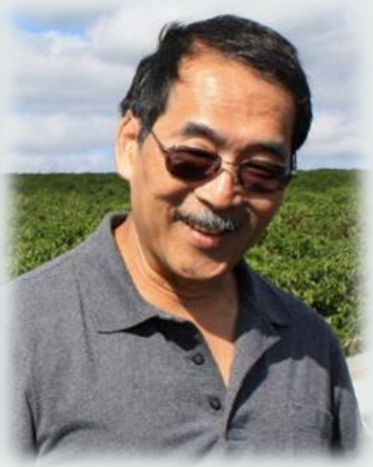
USDA
ARS DKI PBARC

HAWAII COFFEE GROWERS ASSOCIATION

UNIVERSITY OF HAWAII 1907 MĀNOA
UHM
CTAHR

Tracie Matsumoto
Nicholas Manoukis

Kimo Falconer



Andrea Kawabata
Stuart Nakamoto

Goals of Proposal

- Provide first hand observation on how CBB is dealt with in large scale mechanically harvested fields (trip to Brazil)
- To establish meaningful collaborative research projects with national and international expertise in CBB control ie. **Dr. Pablo Benavides Machado**, CBB Entomologist with Cenicafé, Colombia

Dr. Pablo Machado Benavides visits Hawaii coffee growers in October 2015

- Dr. Pablo Benevides Machado is in charge of the Department of Entomology at Cenicafe, the Research Branch of the Coffee Growers Federation.
- His department is responsible for the design and adoption of the IPM strategies on Coffee Pests for Colombia.
- The results of his research are transferred to the Coffee Growers Federation Extension Service, which passes the information to 540,000 coffee growers in Colombia

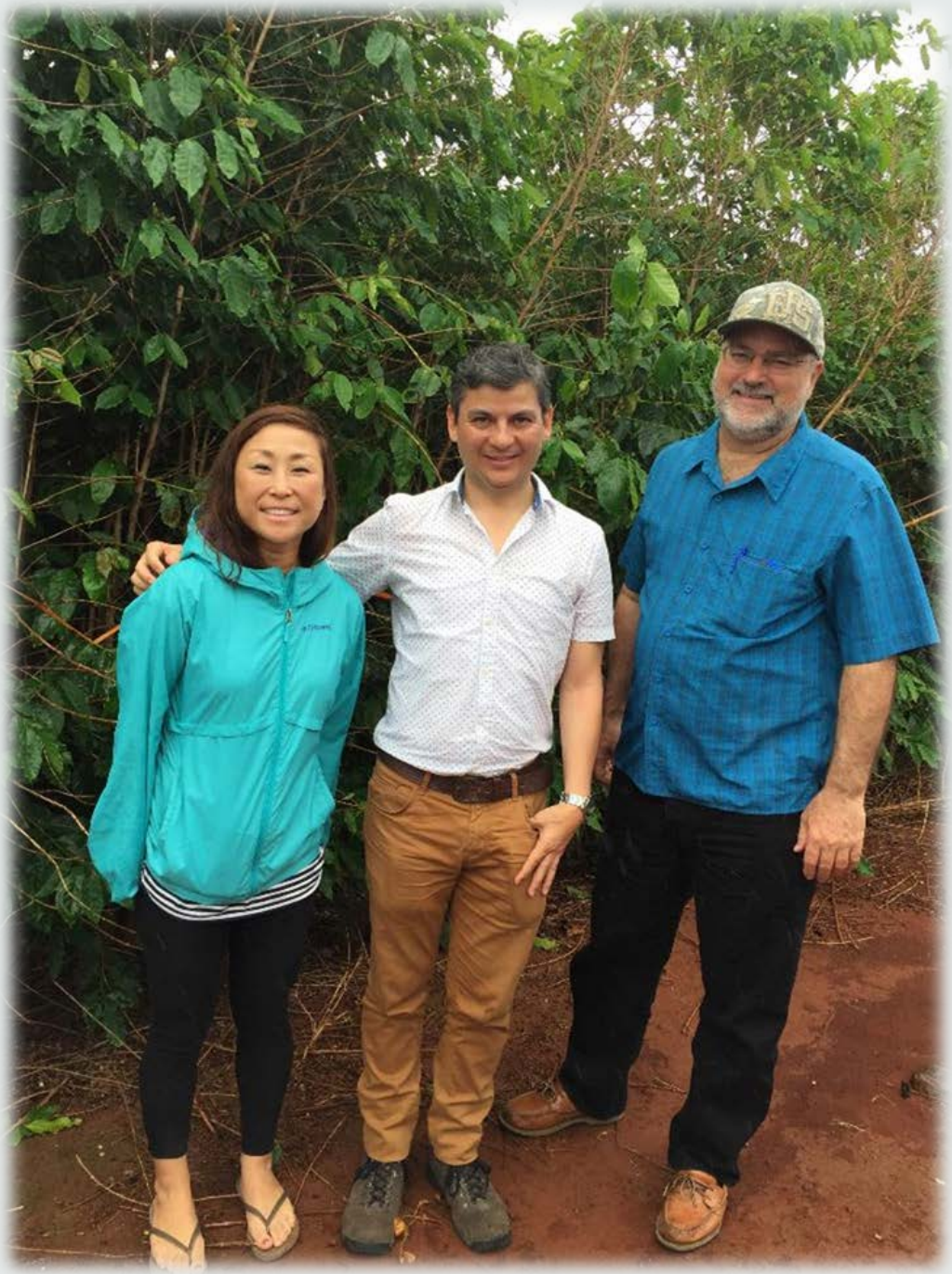
Dr. Pablo Machado Benavides visit to Oahu

University of Hawaii at Manoa

Hawaii Agriculture Research Center with Dr. Chifumi Nagai

Waialua Coffee with Derek Lanter

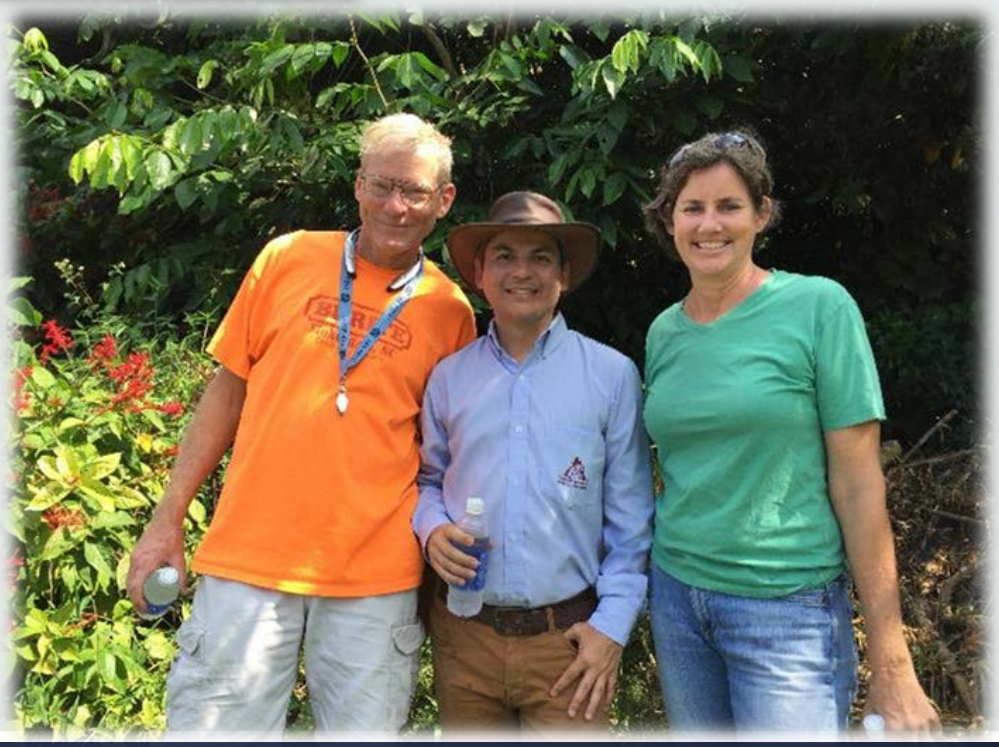
Hawaii Department of Agriculture



Dr. Pablo Machado Benavides visit to Kauai

Dr. Pablo Machado Benavides visit to Kona

Dr. Pablo Machado Benavides visit to Kona



Dr. Pablo Machado Benavides visit to Ka`u

Brazil Coffee

Hosts/Interpreters

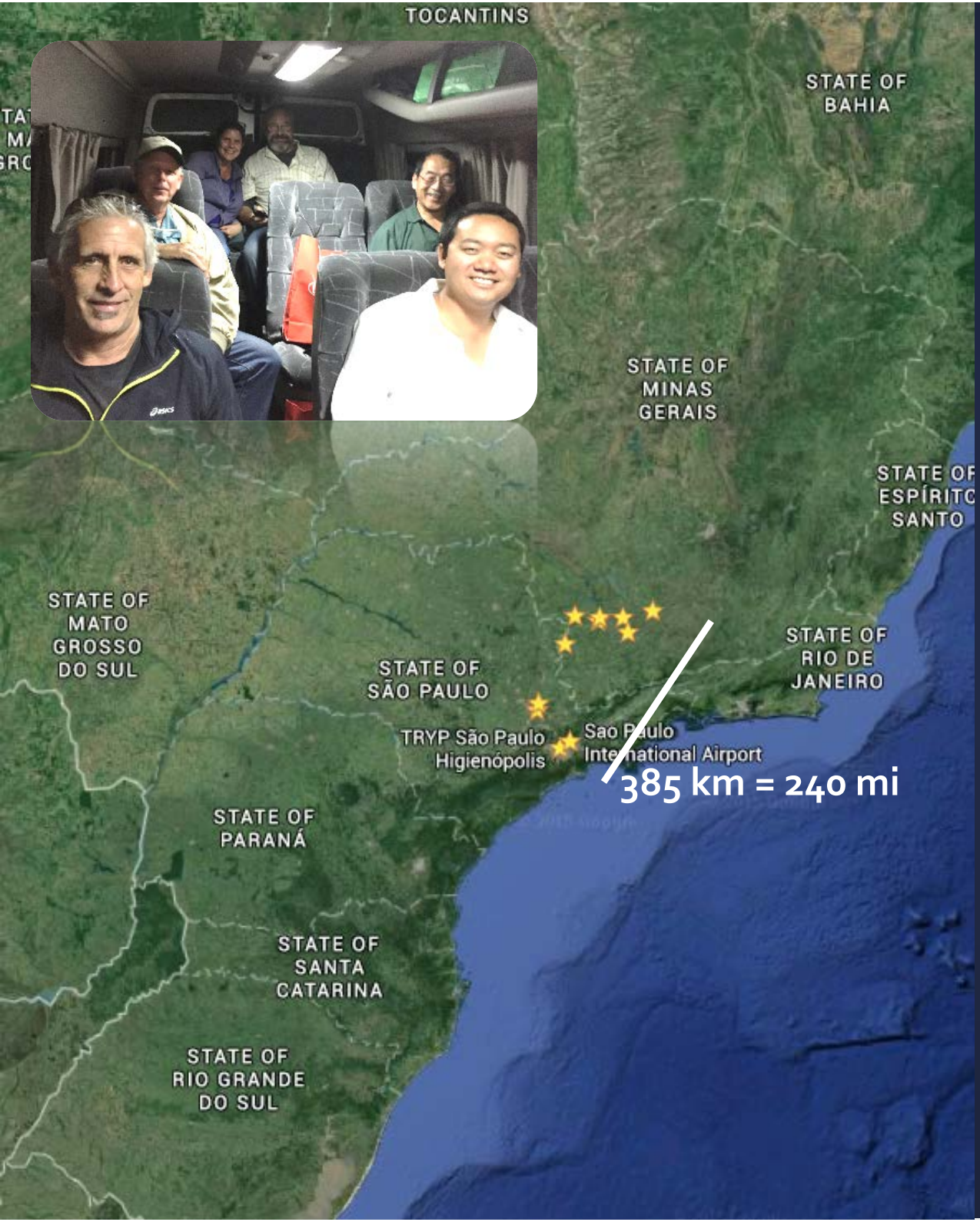
Pascoal D'Andréa
Fernando Augusto Vicentini
Wataru Mori

Hawaii Group

Kauai – Jon Ching
Kona – Tom Greenwell
Maui – Kimo Falconer
Oahu - Derek Lanter

Researcher/Extension

Andrea Kawabata
Stuart Nakamoto
Tracie Matsumoto



Research Institutions

IAC

Instituo Agronômico de Campinas

EPAMIG

University of Lavras

Inovocafe

Farms/Processing

Fazenda Tozan

Fazenda Campo Verde

Monte Alegre

Fazenda Passeio

NKG Fazenda Dalagoa

Ipanema Coffees Farm

Equipment

Pinhalense

Colombo

Expocafe

Dr Júlio César de Souza
CBB Expert, Epamig – Lavras

Field Monitoring

Field Sanitation

Instituto Agronômico de Campinas

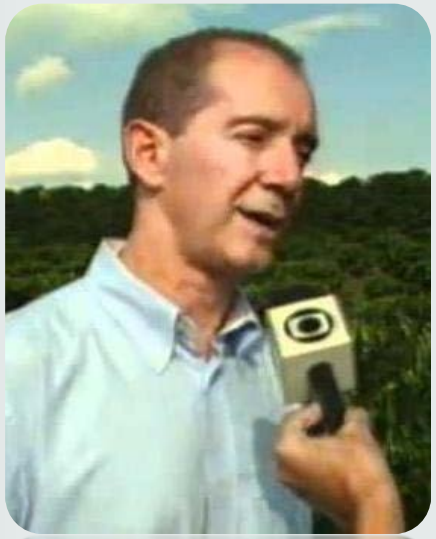
Developed the original coffee varieties for Brazil

- Bourbon
- Mundo Novo
- Catuai

Developing new varieties

- Icatu – rust
- Obata-Tupi –rust
- Apoata – nematode

Dr. Herculano Penna Medina Filho, Breeder
IAC Cafe



Dr. Carlos Henrique S. de Carvalho,
Breeder, EMBRAPA

Dr. Luiz Carlos Fazuoli, Breeder/Geneticist
Dr. Roberto Antonio Thomaziello, Agriculture Engineer/Extension

Dr. Mario Lucio Vilela de Resende, Dr. Antonio Nazareno Guilaraes Mendes, Dr. Julio Cesar de Souza
Universidade Federal De Lavras

Coffee Leaf Rust
Hemileia vastatrix

Most important disease in coffee

causes defoliation of the coffee tree

Coffee Leaf Rust
Hemileia vastatrix

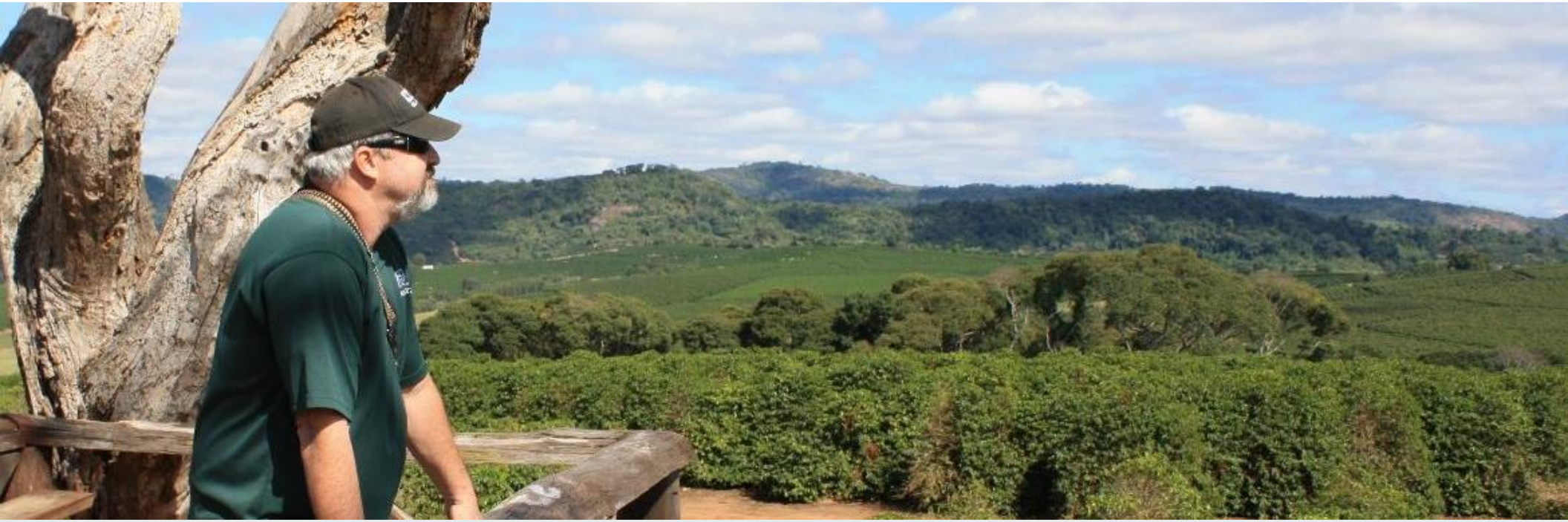
Field not sprayed with fungicide

New Potential Pest

Coffee Leafminer
Leucoptera coffeella

2nd most important pest of coffee (after Broca/CBB)

causes defoliation of the coffee tree



Take Home Lessons

General recommendations for CBB control similar to those in other countries, however climate in Hawaii is unique so techniques need to be optimized

Hawaii needs to be prepared for new and existing threats to the coffee industry

Coffee Germplasm in Hawaii

U.S. National Plant Germplasm System

Hawaii and Puerto Rico are the only two places in the U.S. with significant coffee production

Puerto Rico currently has both CBB and Coffee Leaf Rust

Advantages of Coffee Germplasm being assigned to Hawaii

- Provides stable funding to:
- Collect, conserve, evaluate and distribute new coffee disease-free germplasm to Hawaii coffee growers
- Breed and evaluate new material for disease resistance (ie. Coffee leaf rust, nematodes, leaf minor etc) while maintaining high quality of coffee for cupping
- Conduct research with HARC, UHM CTAHR and other agencies to address industry needs

NEMATODES

- Plant-parasitic Nematodes
  - New project: coffee cherry pulp for improving soil health and reducing damage by root-knot nematodes, *Meloidogyne konaensis*

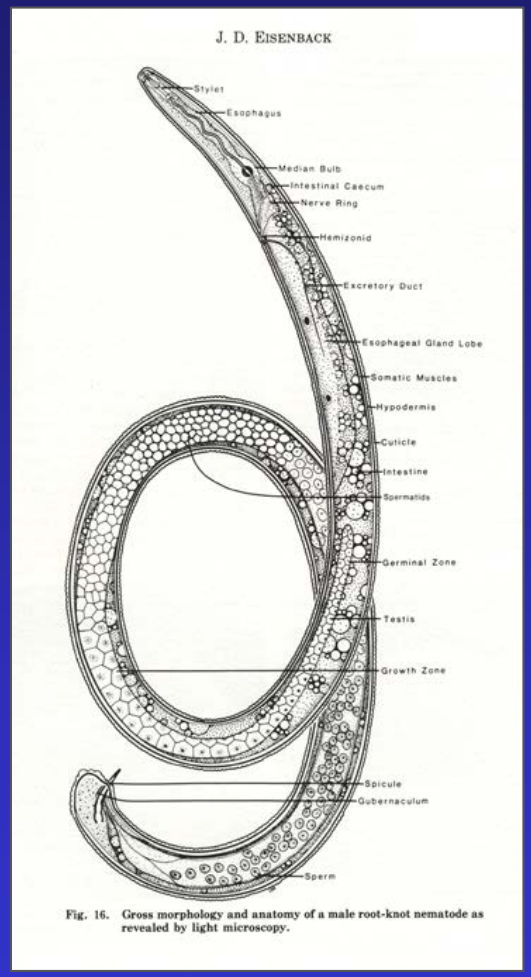


Fig. 16. Gross morphology and anatomy of a male root-knot nematode as revealed by light microscopy.

Acknowledgements

Collaborators
Hawaii Coffee Growers
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SHAC
UHM CTAHR
USDA ARS/Cornell

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USDA