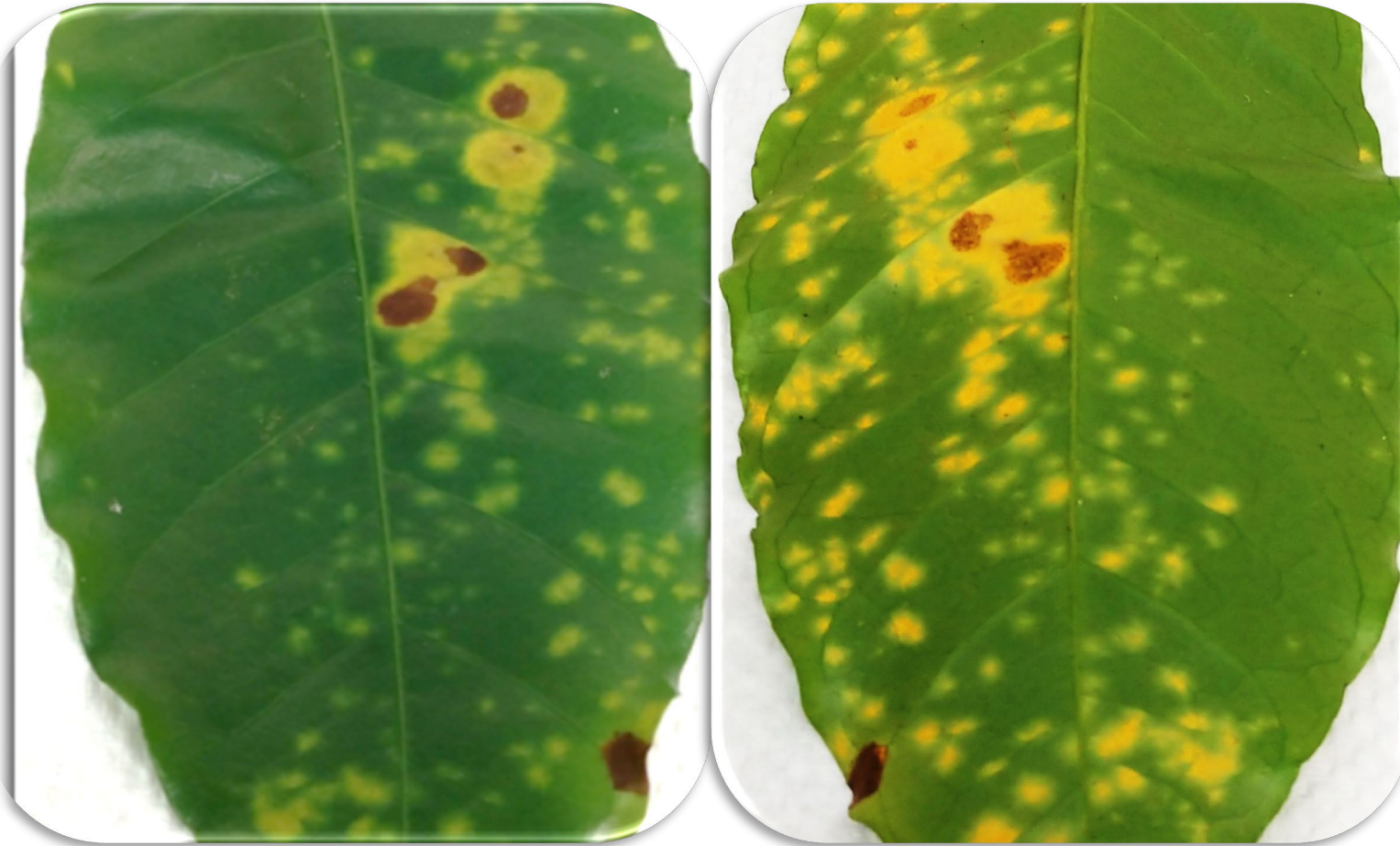


Coffee Leaf Rust

HCA, 11/19/20



Lisa Keith

Research Plant Pathologist

USDA

Agricultural Research Service

PBARC, Hilo, HI

Lisa.Keith@usda.gov

CLR Teamwork!



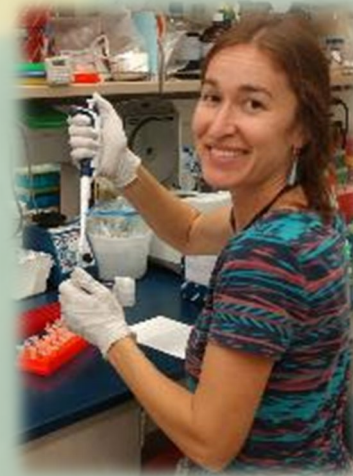
Growers



Lionel Sugiyama



Eva Brill



Karma Kissinger

And Many Others



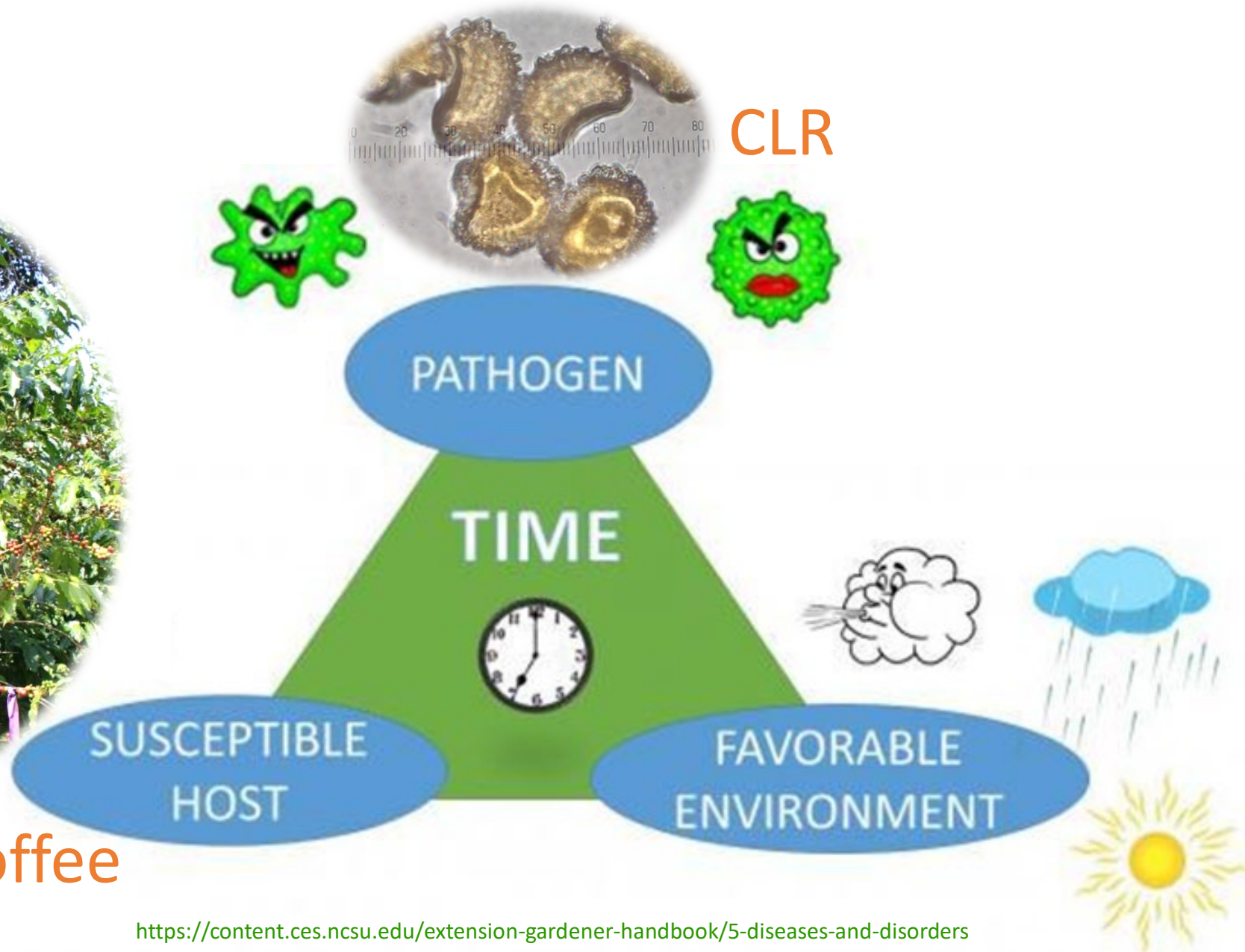
Coffee Leaf Rust

- Biology
 - Disease Cycle
- Symptoms & Signs
 - Epidemiology
 - Management
 - Hawaii

How is Disease Caused in Plants?

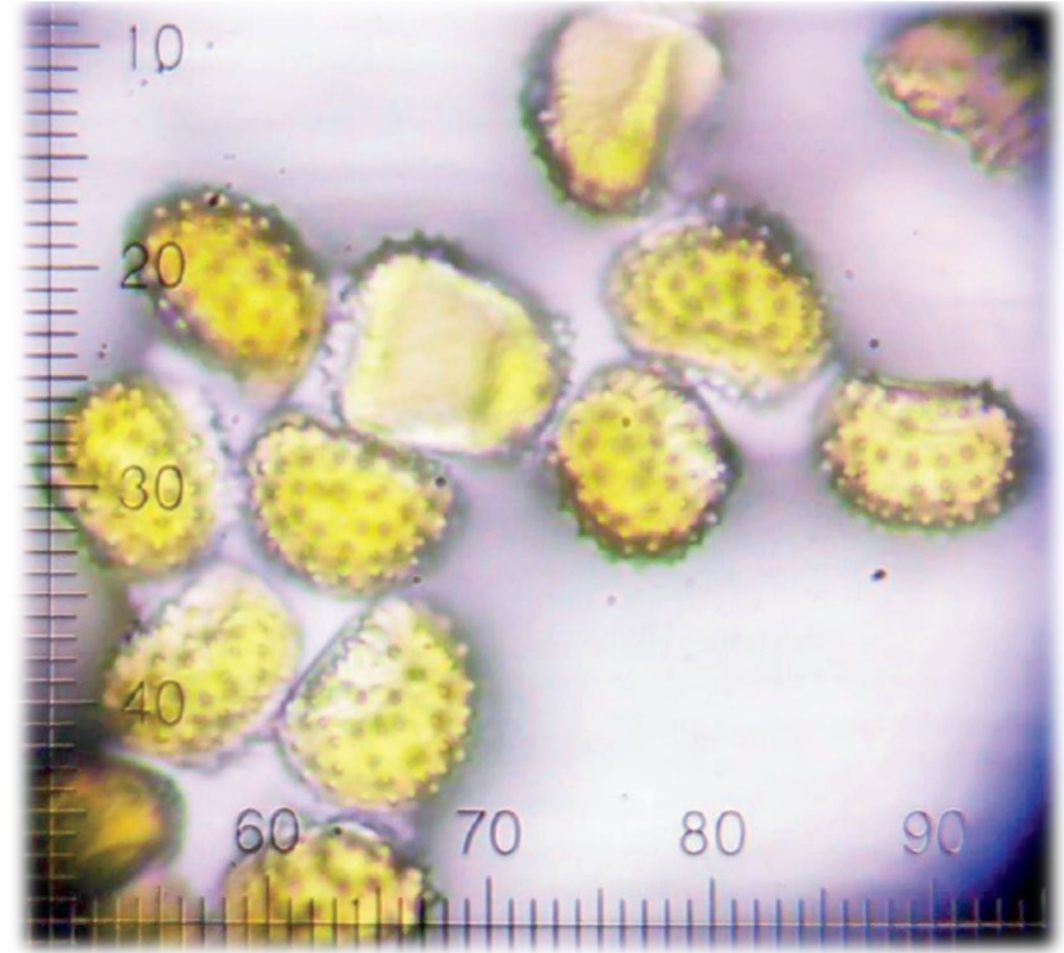


Coffee



Coffee Leaf Rust: Biology

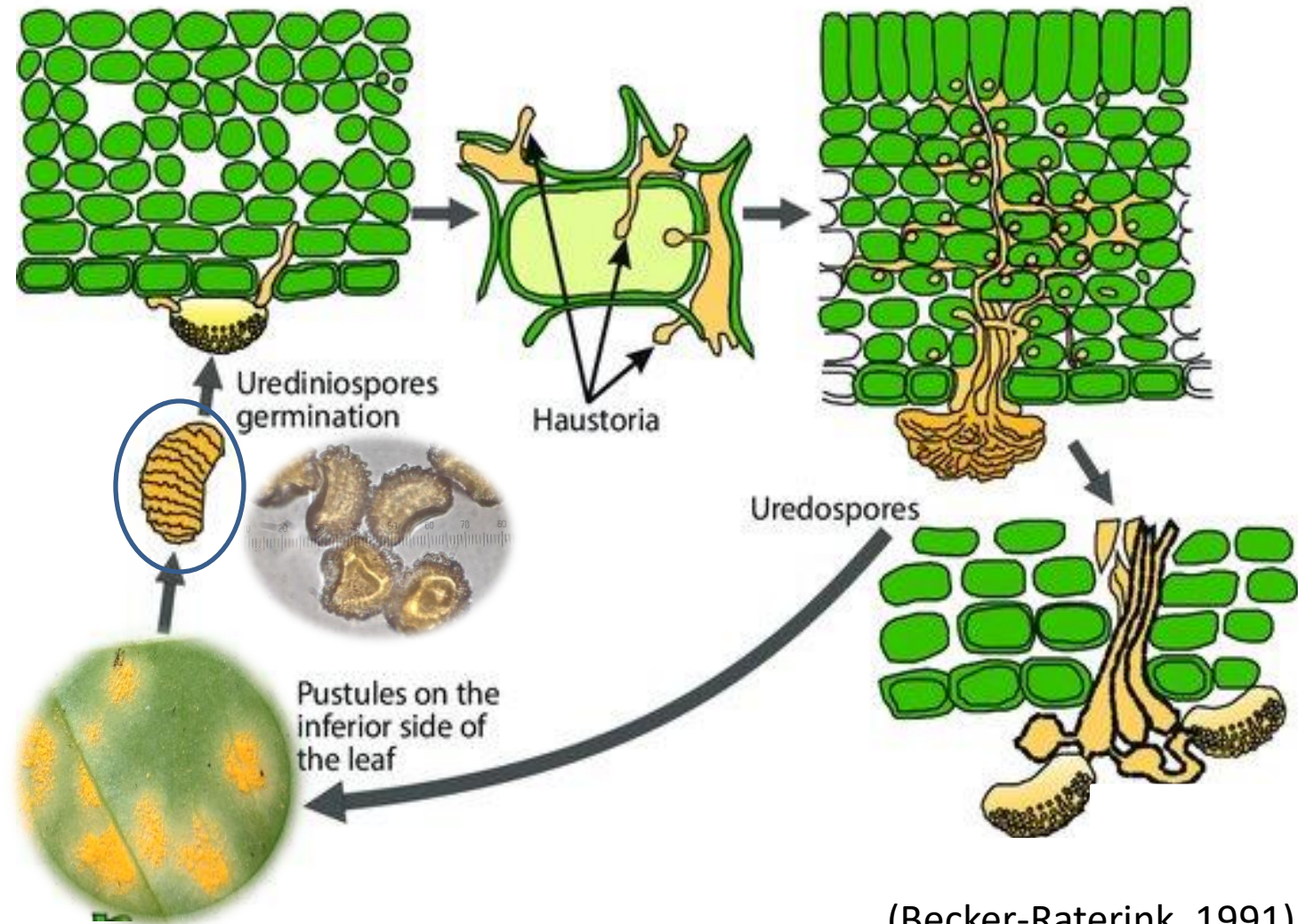
- *Hemileia vastatrix* (half-smooth, devastating)
- Unique spore shape (urediniospores)
- Obligate parasitic fungus
- Coffee is the only host; no alternate host is necessary
- Once a spore lands on a leaf, it waits until conditions are right to germinate



Magnification of the uredospores of coffee leaf rust (x400).
Photo: Isabelle Merle

Coffee Leaf Rust: Disease Cycle

- Urediniospores initiate infections that develop into lesions that produce more urediniospores
- Some fluctuation from season to season, depending on rainfall
- Adhesion to the host surface, urediniospore germination, appressorium formation over stomata, penetration and inter- and intracellular colonization

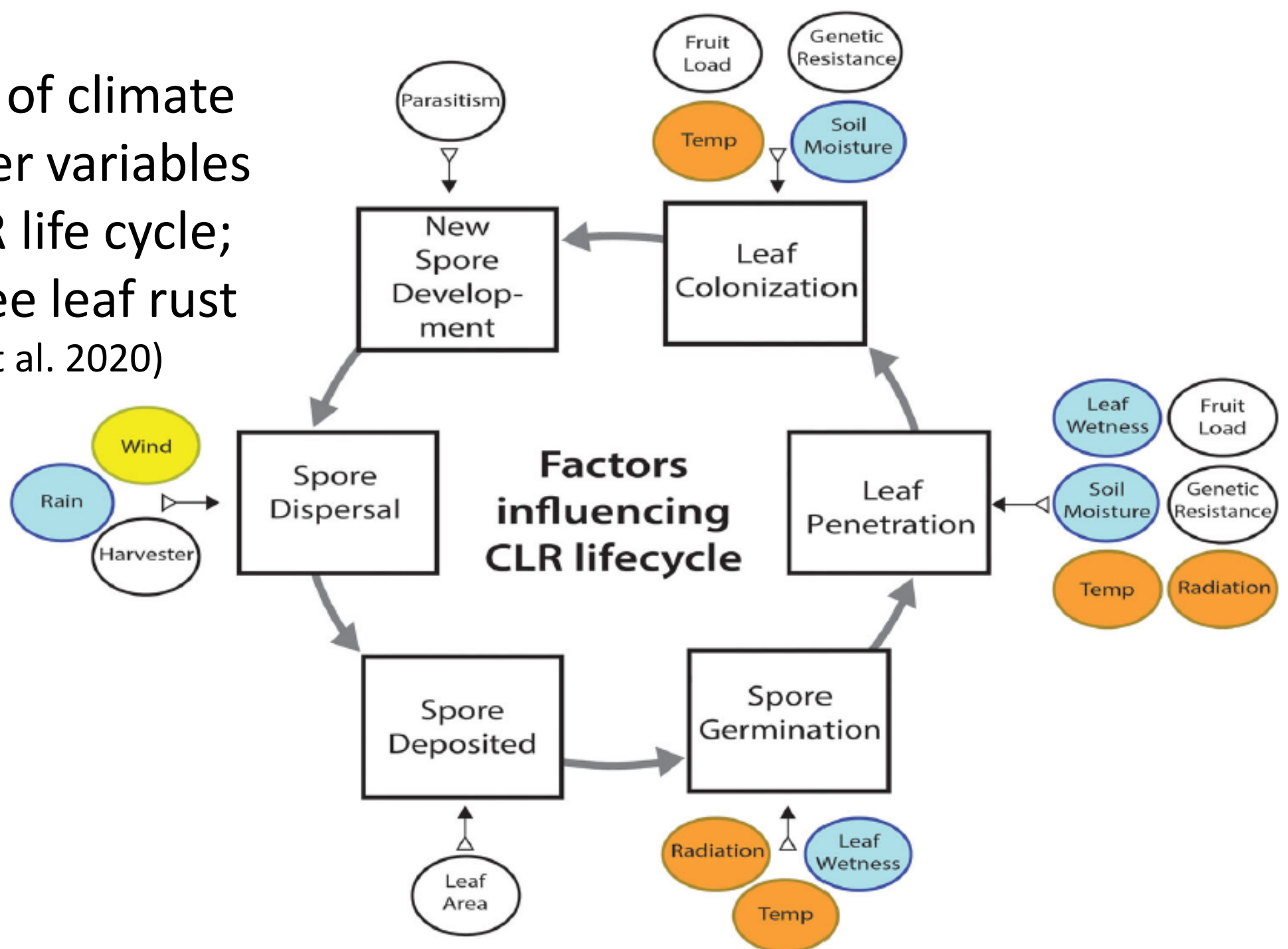


(Becker-Raterink, 1991)

Coffee Leaf Rust: Disease Cycle

- Spore dispersal: Wind, rain and worker activity
- Infection through stomata; 24 to 48 hours water; 15-30°C/59-86°F, optimum ~21-25°C/70-77°F
- Sporulation: 10-14 days from infection; Lesions enlarge over 2 to 3 weeks; A single lesion will produce ~300,000 urediniospores over 3 to 5 months
- Survival: primarily as mycelium in the living tissue; urediniospores can survive ~ 6 weeks

Influences of climate
and weather variables
on the CLR life cycle;
CLR = coffee leaf rust
(Rhiney et al. 2020)



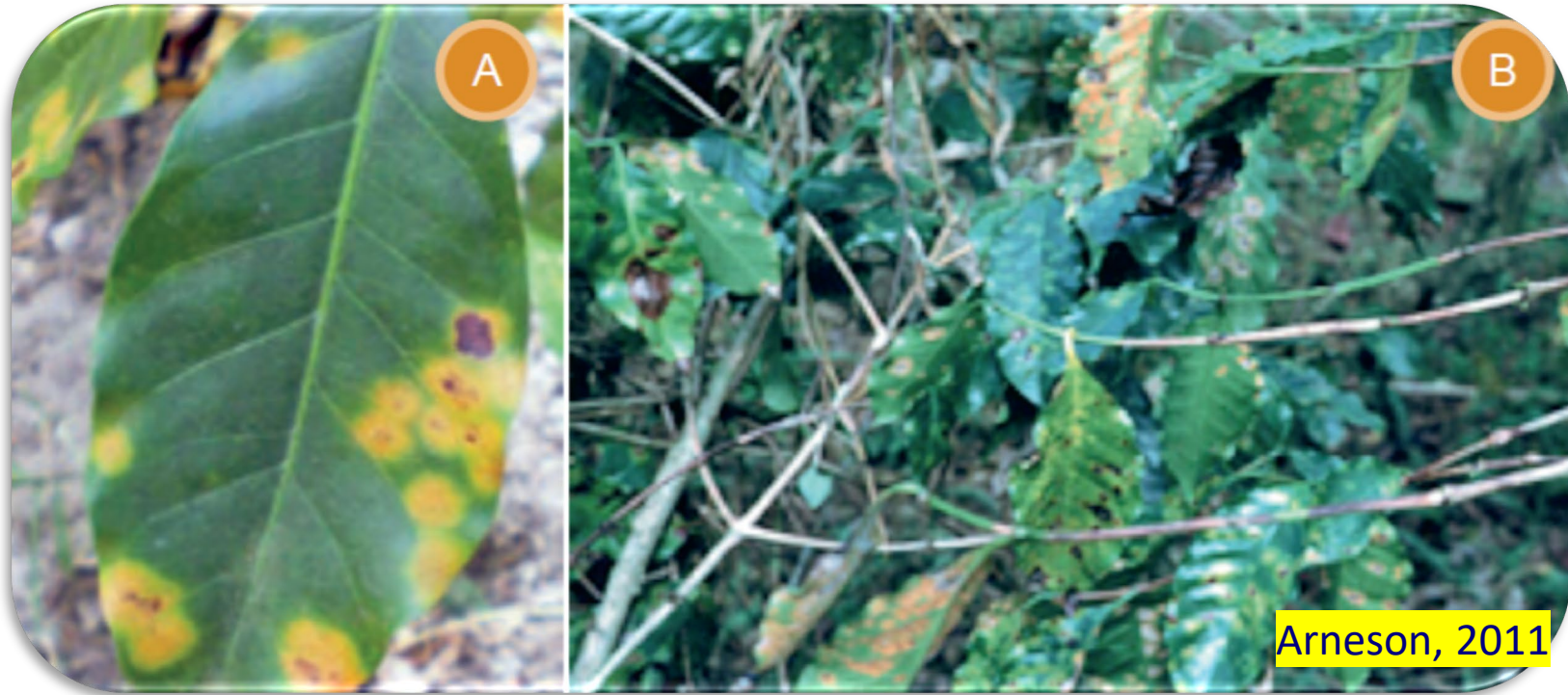
Coffee Leaf Rust: Symptoms & Signs

- First observable symptoms: small, pale yellow spots on the upper surfaces of the leaves (A)
- Spots gradually increase in diameter; masses of spores appear on the undersurface (B)
- CLR sporulates through the stomata rather than breaking through the epidermis
- Powdery lesions on the undersides of the leaves can be orange-yellow to red-orange in color; considerable variation from one region to another (C)



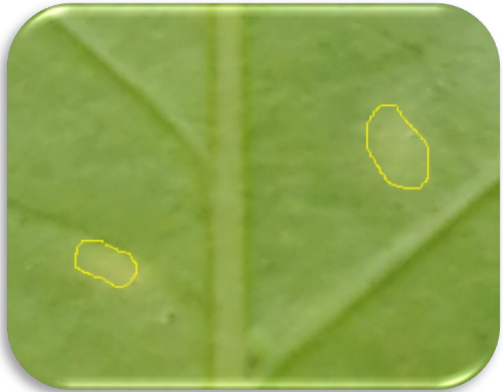
Coffee Leaf Rust: Symptoms & Signs

- Lesions can develop anywhere on the leaf; tend to be concentrated around the margins
- Centers of the spots eventually dry and turn brown, while the margins of the lesions continue to expand and produce urediniospores
- Early in the season, the first lesions usually appear on the lowermost leaves
- Infection slowly progresses upward in the tree
- Leaves drop prematurely, leaving long expanses of twigs devoid of leaves



Arneson, 2011

Coffee Leaf Rust: Symptoms & Signs



Lesions without spores



First spores emerge



Increase of rust area
with spores



Coffee Leaf Rust: Epidemiology

- Race and level of inoculum are the most important pathogen factors influencing disease development
- More than 50 races are known, only a few occur regularly
- Important host factors: planting density, host susceptibility, and predisposition of host due to high prior year yields
- Damage is the result of reduced photosynthetic capacity of infected leaves and premature defoliation
- Survival of inoculum from the previous season depends on disease severity that season and the extent of defoliation
- The impact of rust can be long term

Coffee Leaf Rust: Management

- Coffee leaf rust must be managed as a continuous epidemic on a perennial crop
- Any factor that can reduce sporulation, spore dispersal, or infection can mitigate the epidemic
- Good cultural management is vital
- Protectant and systemic fungicides (important tools; determine when and what to spray)
 - UH Guide (Product rotation is highly recommended to reduce the risk of pesticide resistance by coffee leaf rust and other diseases)
 - Mention of trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the U.S. Dept. of Agriculture and does not imply its approval to the exclusion of other products or vendors that also may be suitable

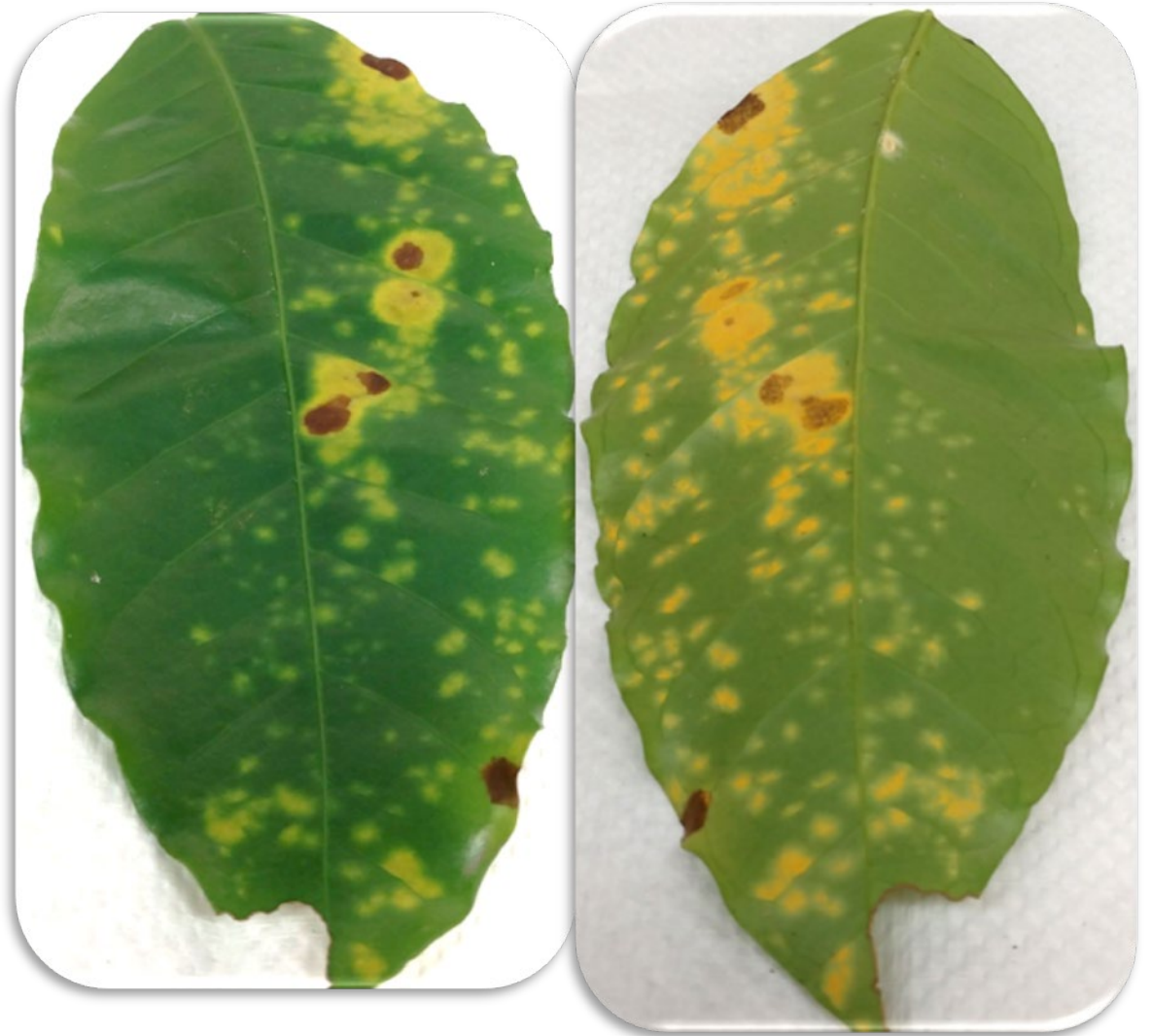
Natural Enemies of Coffee Leaf Rust

- *Lecanicillium* sp.
- *Bacillus thuringiensis*
- *Pseudomonas* sp.
 - Yeasts
- Chemical inducers
(Not practical
under field conditions)

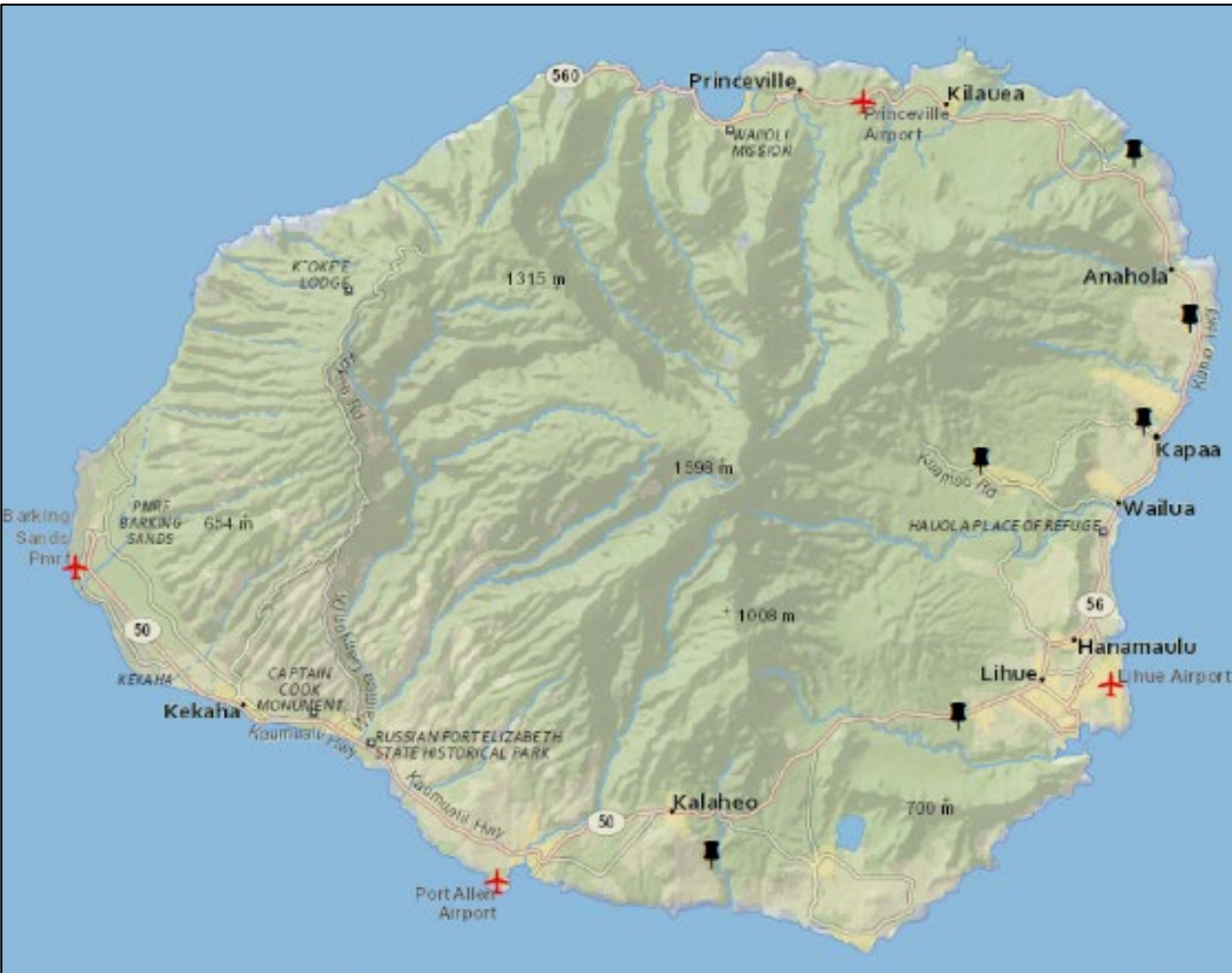


Lecanicillium l. (white fungi over the coffee leaf rust) and *Mycodiplosis sp.* (fly larvae found on top of the coffee leaf rust) natural biological control agents of the coffee leaf rust. Photos: Shaline Fernandes

Coffee Leaf Rust in Hawaii



Kauai/Oahu Coffee Leaf Rust Survey (HDOA)



Negative

Map Created By: Kamran Fujimoto
HDOA/PPC/CM
11/13/2020

Maui Coffee Leaf Rust Survey (HDOA)

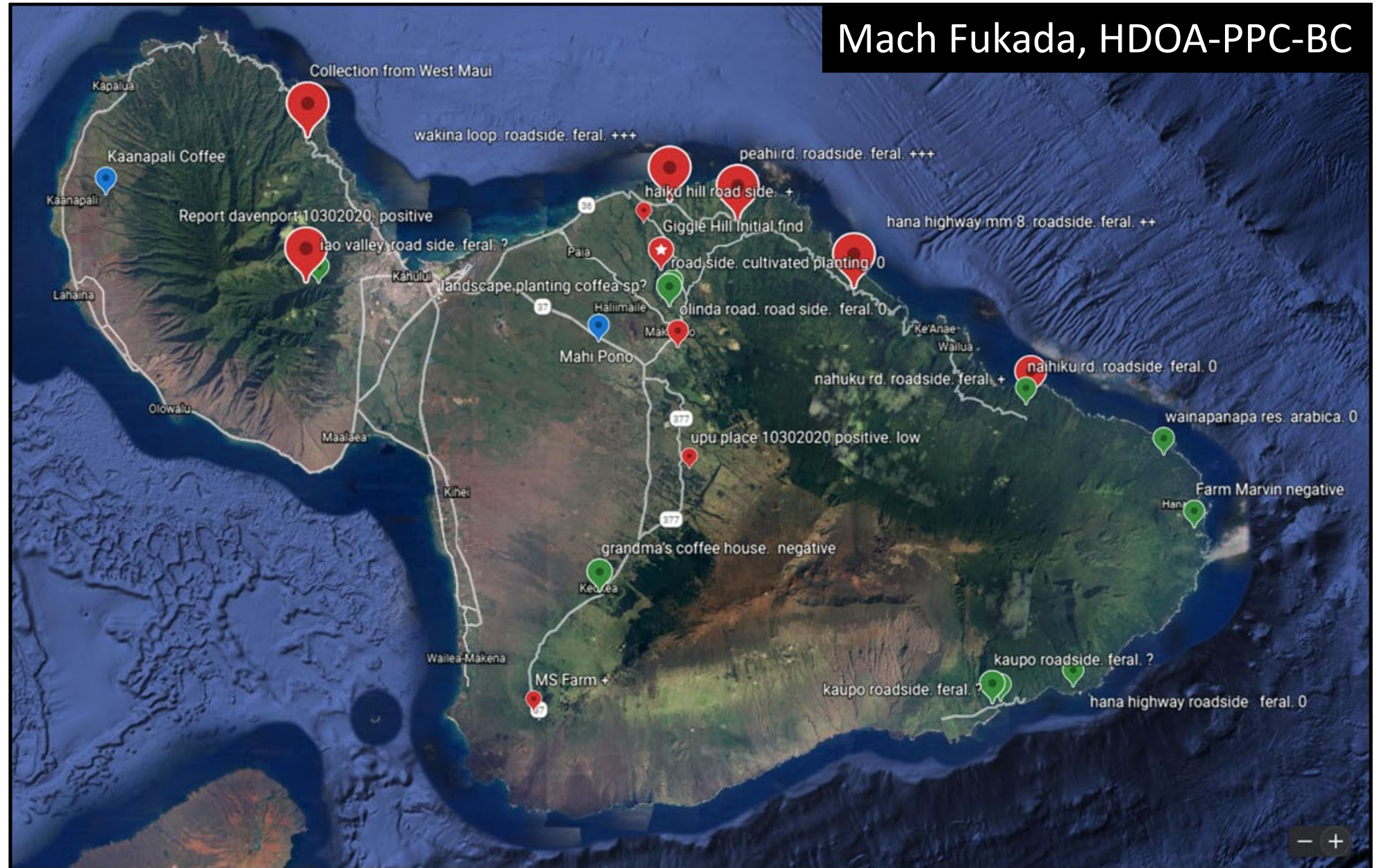
Mach Fukada, HDOA-PPC-BC

*Size relative
to level of
infestation

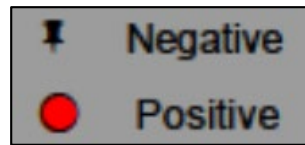
Positive



Negative



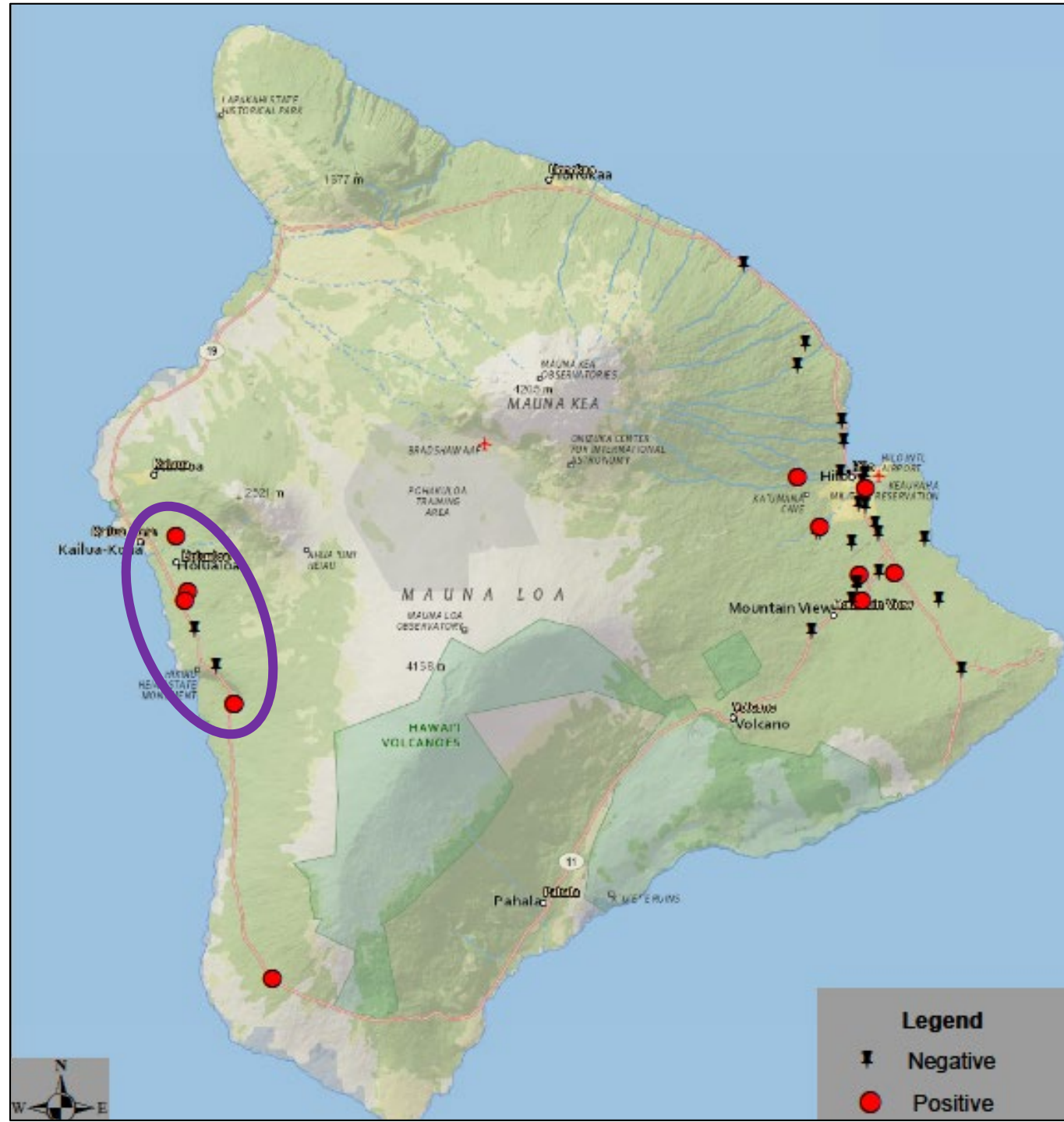
Hawaii Island CLR Survey (HDOA)

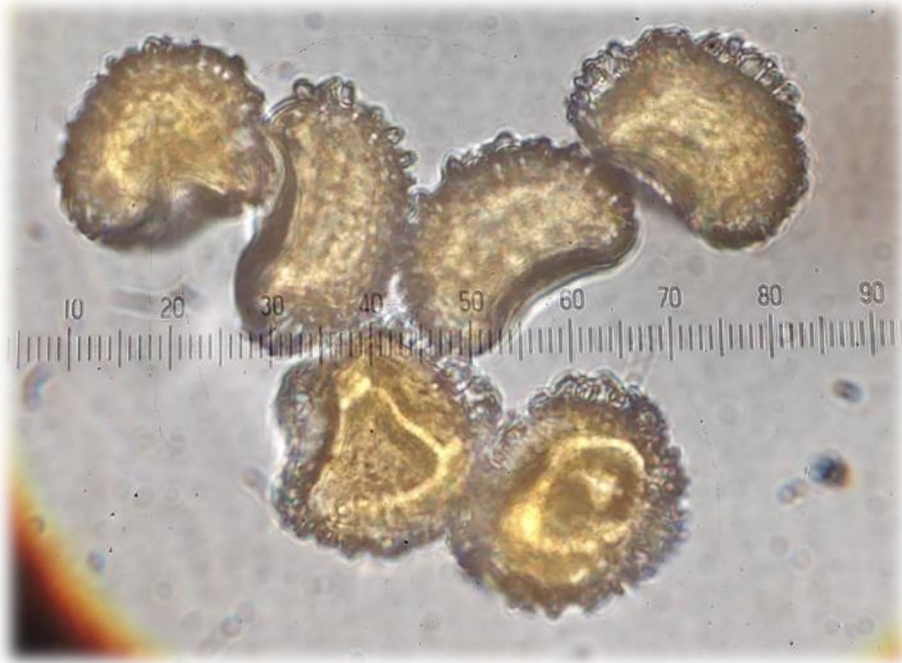


● Spores

○ Visible Symptoms

Map Created By: Kamran Fujimoto
HDOA/PPC/CM
11/13/2020



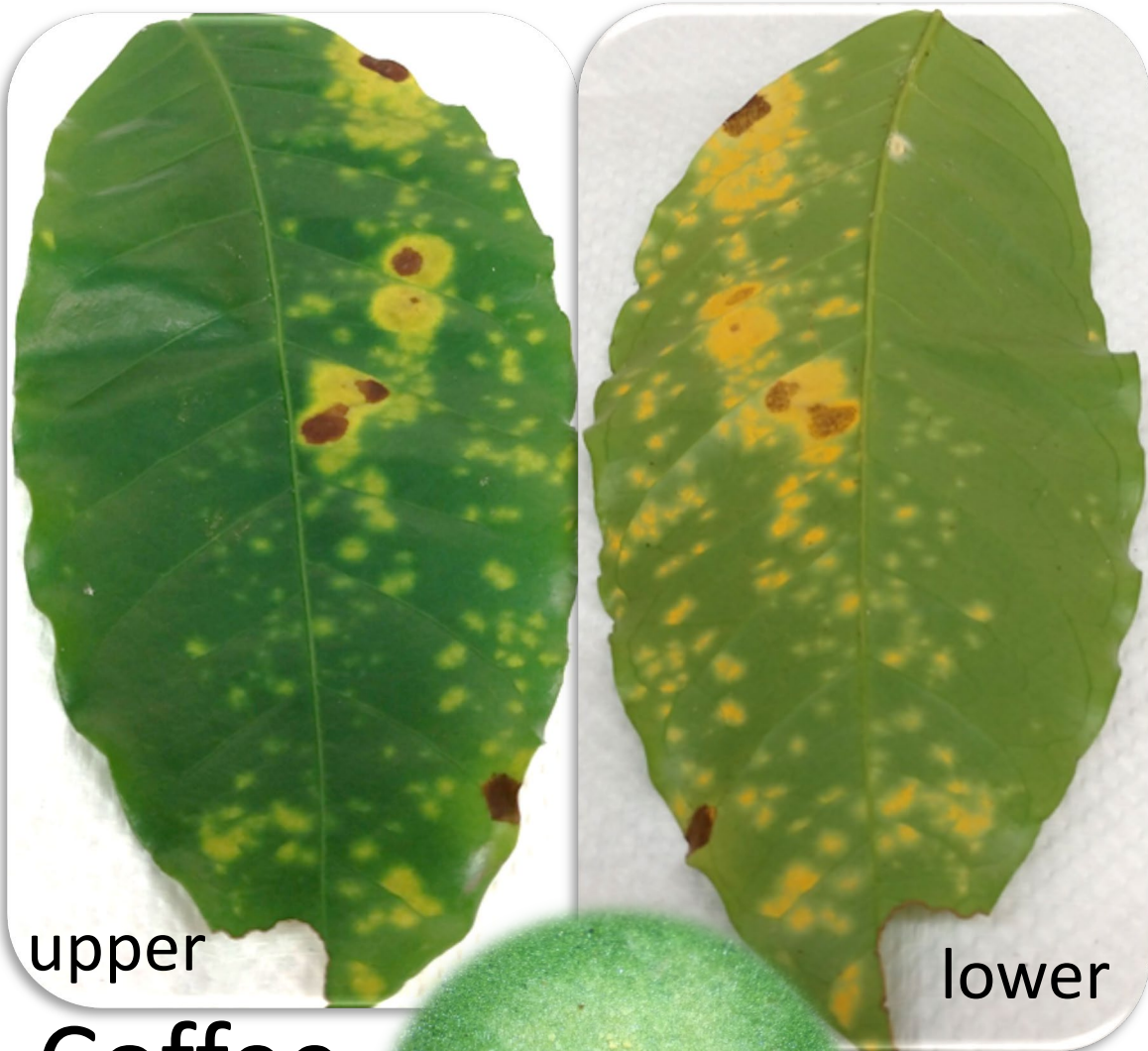


Coffee Leaf Rust Kona (Holualoa, Honaunau)



NOT
Coffee
Leaf
Rust





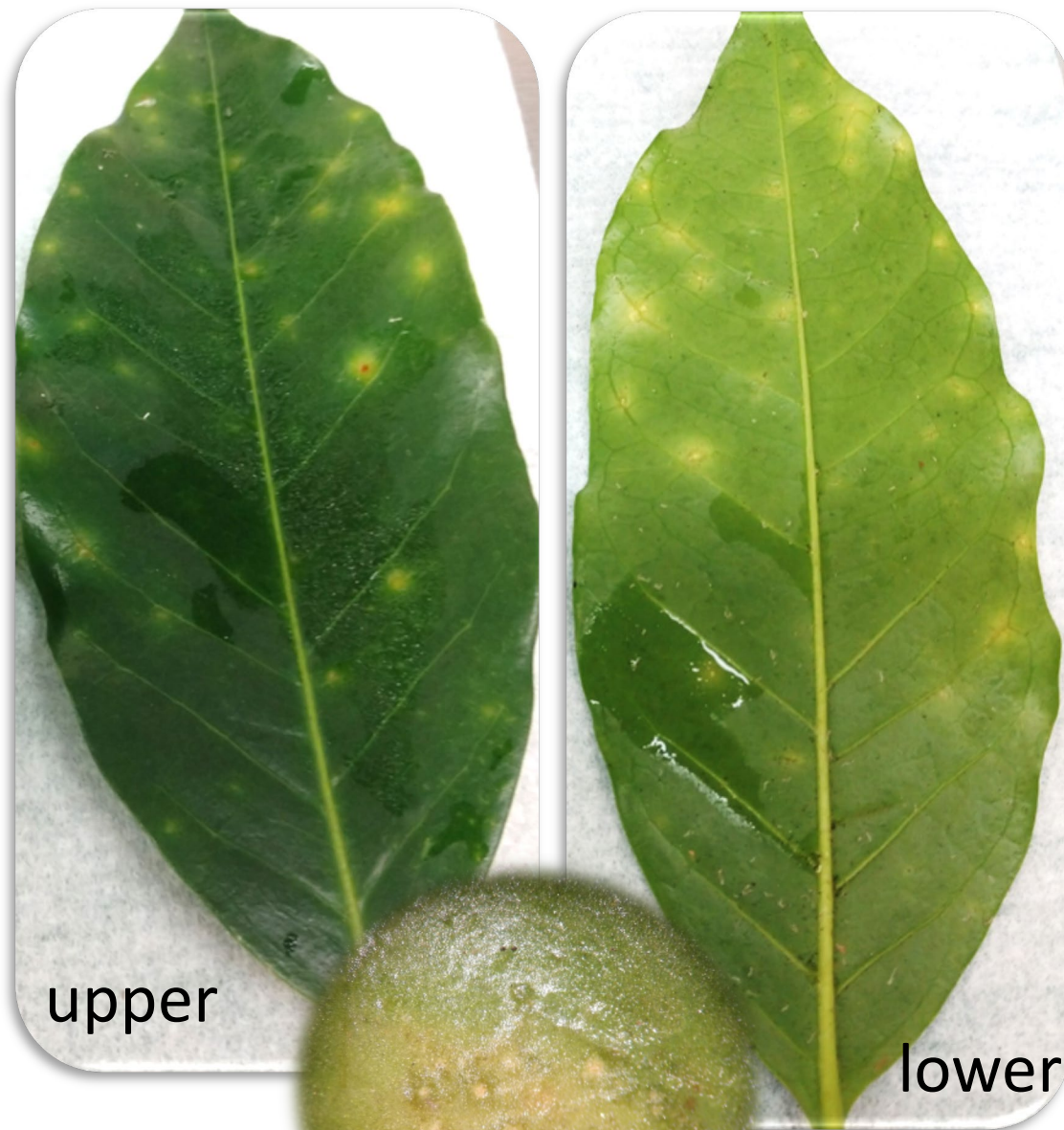
upper

lower

Coffee
Leaf
Rust



lower



upper

lower

NOT CLR



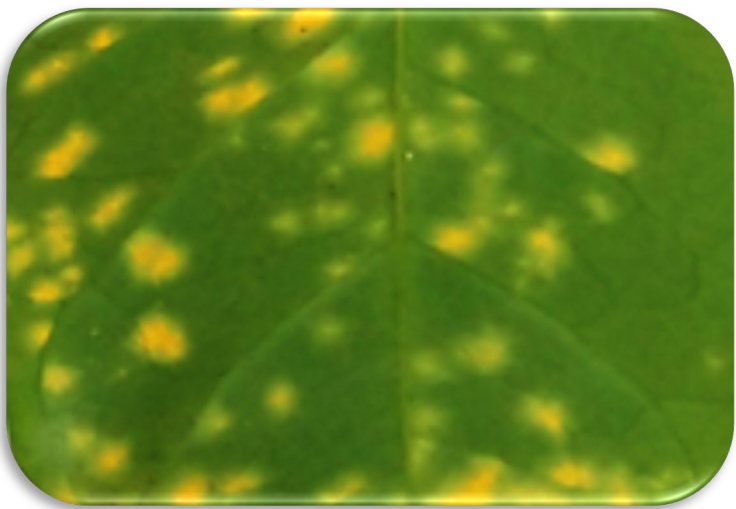
lower



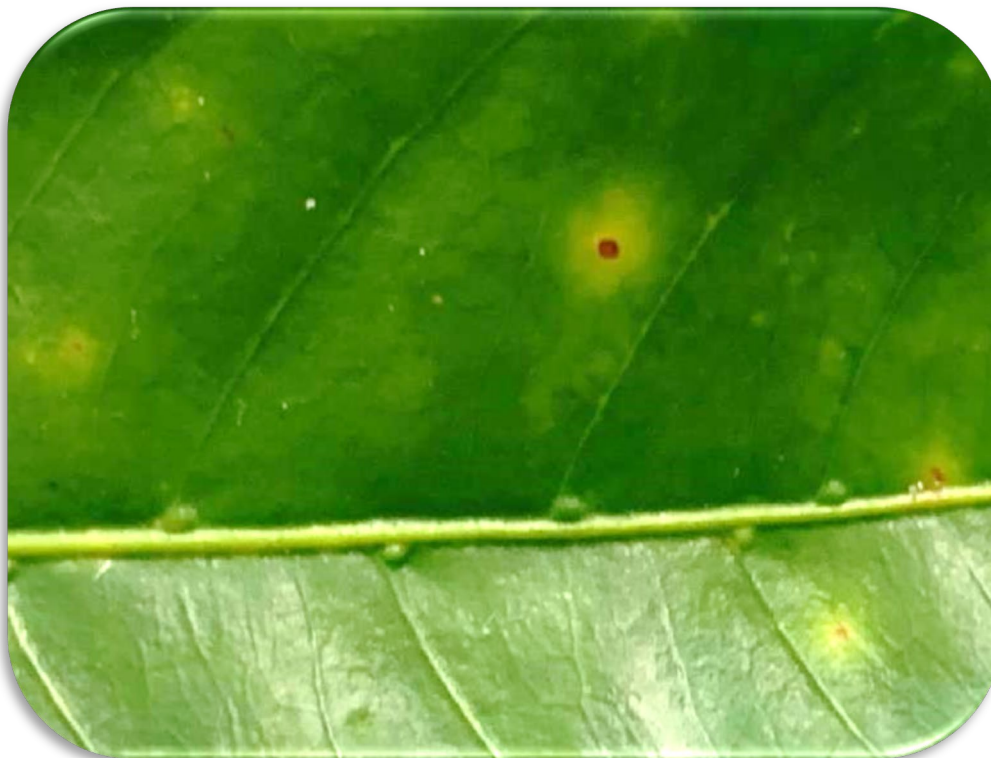
upper



lower



CLR



upper



lower



NOT Coffee Leaf Rust

upper



lower



CLR

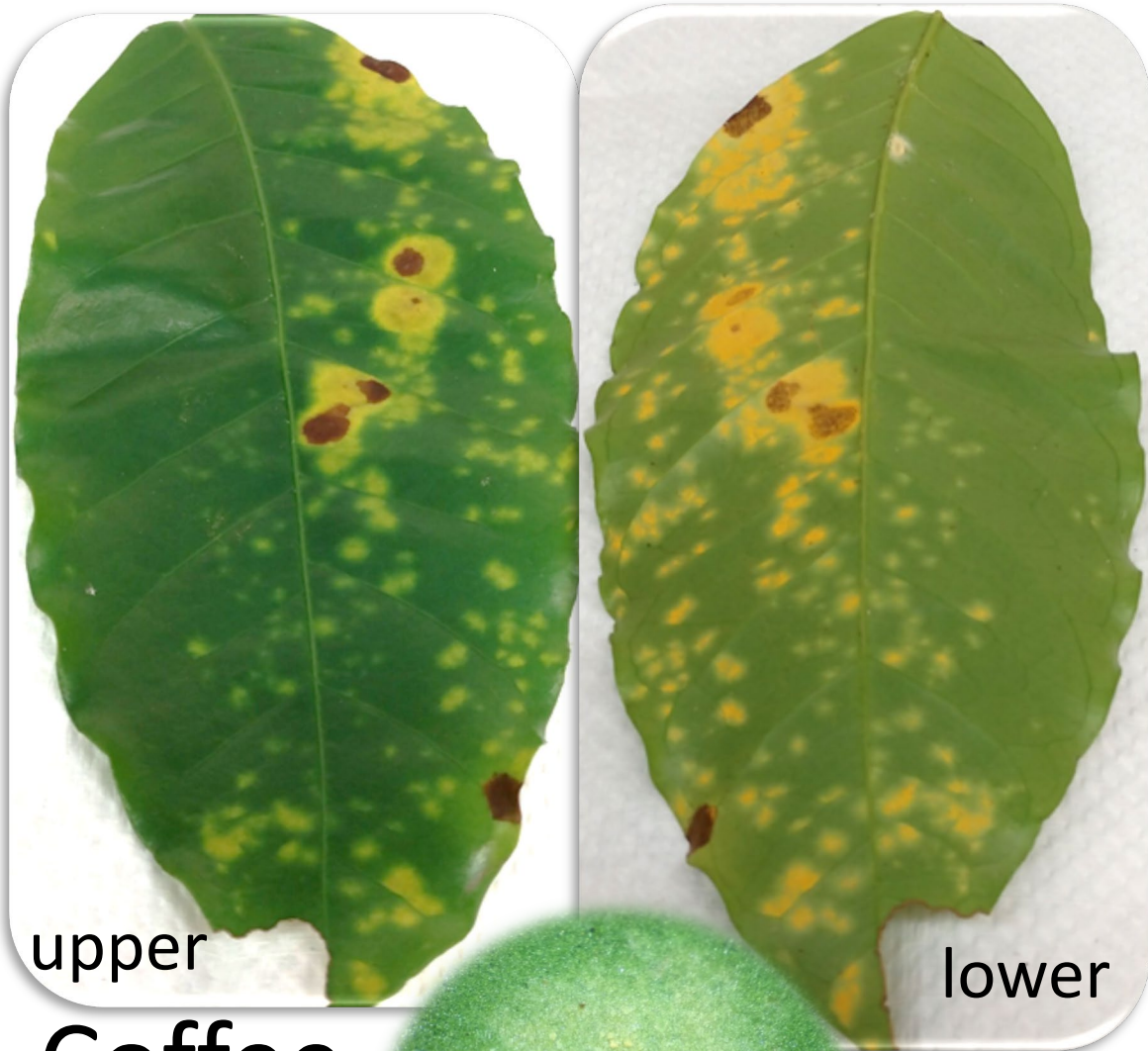


upper



lower

NOT Coffee Leaf Rust



Coffee Leaf Rust



CLR Symptoms

- Small, irregular, pale yellow spots (2-4 mm) on the upper surface of the leaf
- Can be anywhere on the leaf where stomates are
- Tend to be concentrated around the margins
- All stages of leaf development are susceptible
- No pustule formation

Signs

- Powdery spores
- Mycelium is completely within the leaf tissue

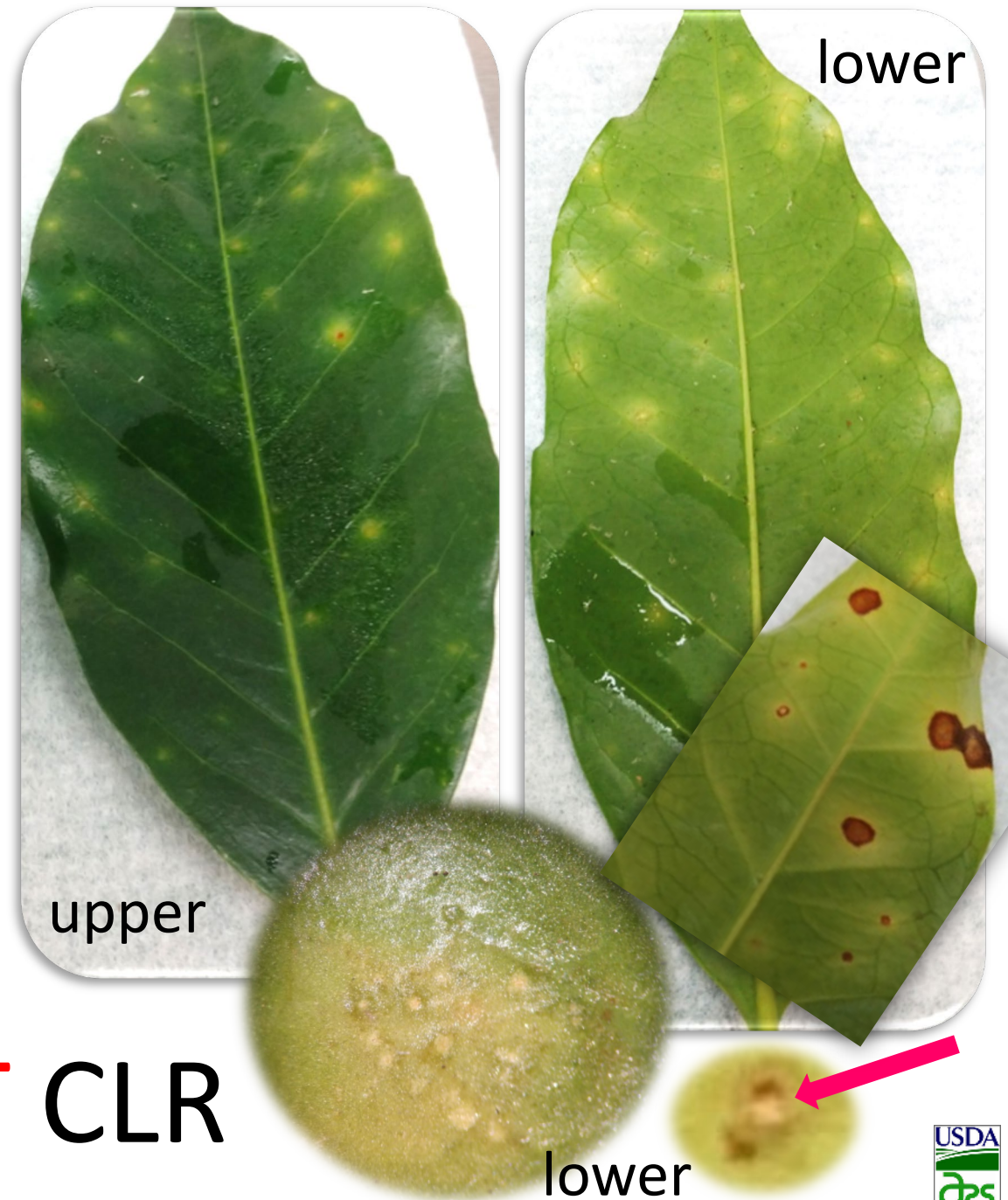
Cercospora Spot Symptoms

- Small, circular, brown/necrotic spots (1-3 mm) on either surface of the leaf
- Spots are surrounded by a light-yellow halo
- Can be anywhere on the leaf
- All stages of leaf development are susceptible
- Sometimes has concentric rings
- After tissue invasion, the plant tissue collapses (see pink arrow)

Signs

- Spores are not powdery

NOT CLR



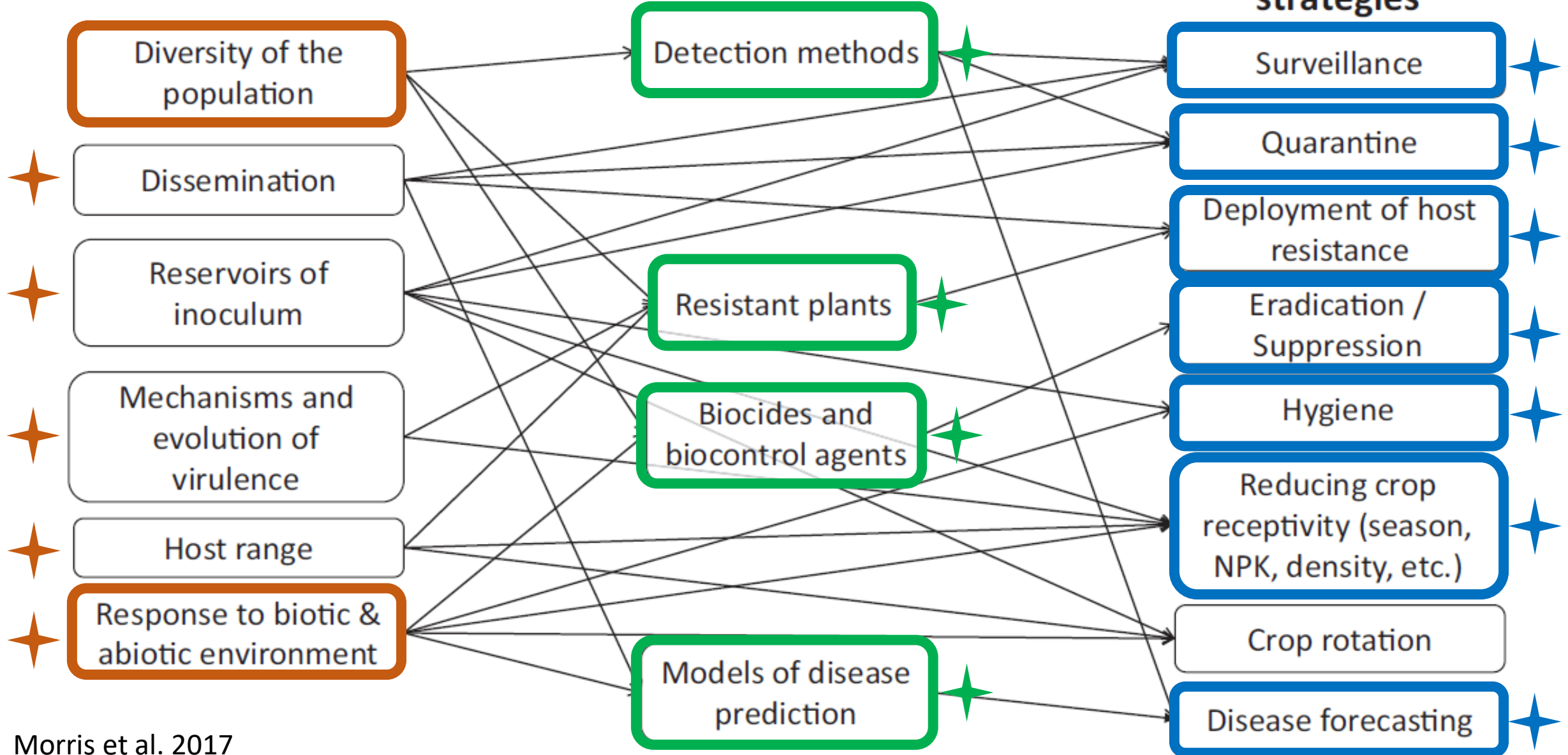


CLR

Pathogen life history

Tools / Resources

Disease management strategies



Short Term Research for CLR in Hawaii

Goal: limit the spread and severity of CLR caused by *H. vastatrix* in HI

- Investigate the ecology and epidemiology of CLR
- Genetically characterize isolates
- Develop methods for early detection
 - (visual guides for ID; molecular techniques; spore trapping)
- Develop and/or deploy disease management strategies
 - (eradication; suppression; hygiene)
- Create education and outreach materials for growers (UH CTAHR)

Characterization of Coffee Leaf Rust in Hawaii

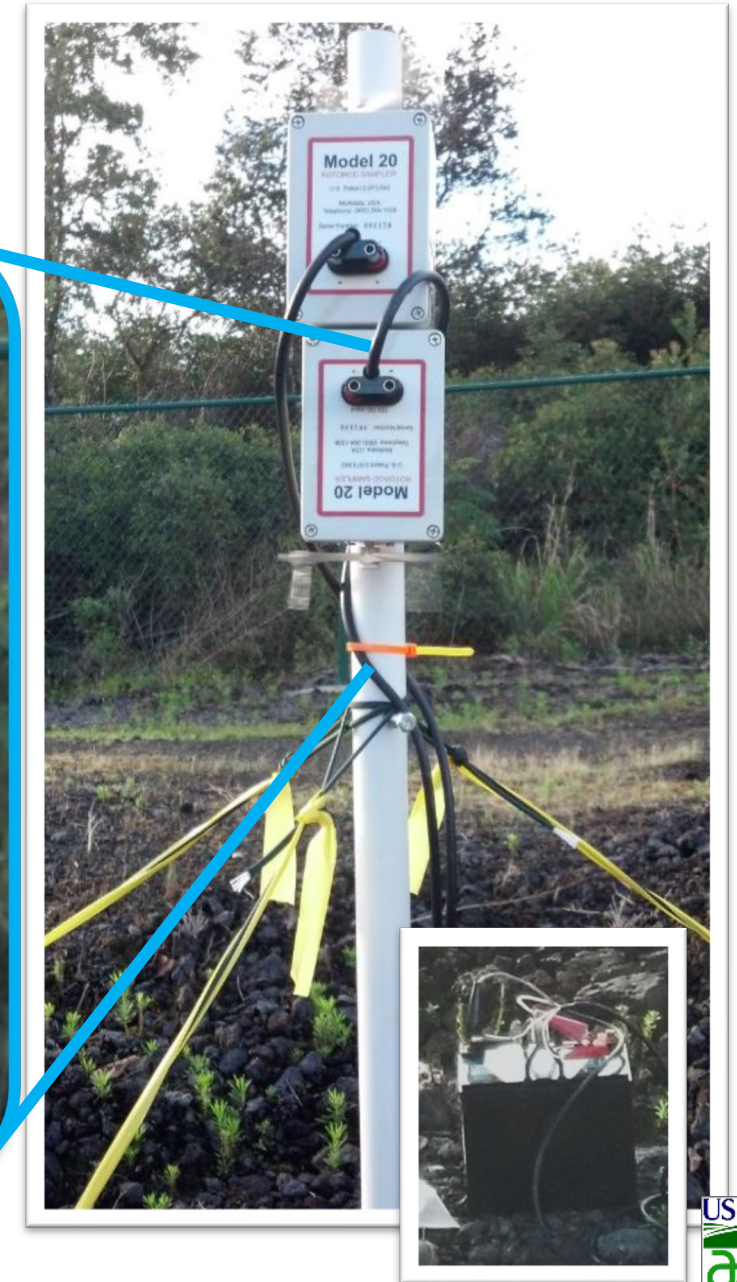
- Where did it come from? Single or multiple introductions?
- ARS PBARC Lab: Rapid molecular detection and basic ID
 - Similarity to isolates from Mexico (preliminary)
- Genotyping (Dr. Aime, Purdue University)
 - Molecular analysis
 - Geographical location/may suggest race
- Race identification (Dr. Vítor Várzea & Dr. Maria do Céu Silva, University of Lisbon, Portugal)
 - Screening a set of coffee plant differentials that contain various resistance genes; Currently unknown in HI
- ARS PBARC Lab: Utilize leaf disc assays to gather information



Coffee Leaf Rust Spore Traps

Rotorods

- Battery powered
- Function on duty-cycle timers (or other triggers, e.g. wind speed, direction)
- Can be used directly for molecular identification of the fungal pathogen



Maui Coffee Leaf Rust Spore Traps (DLNR/MISC)

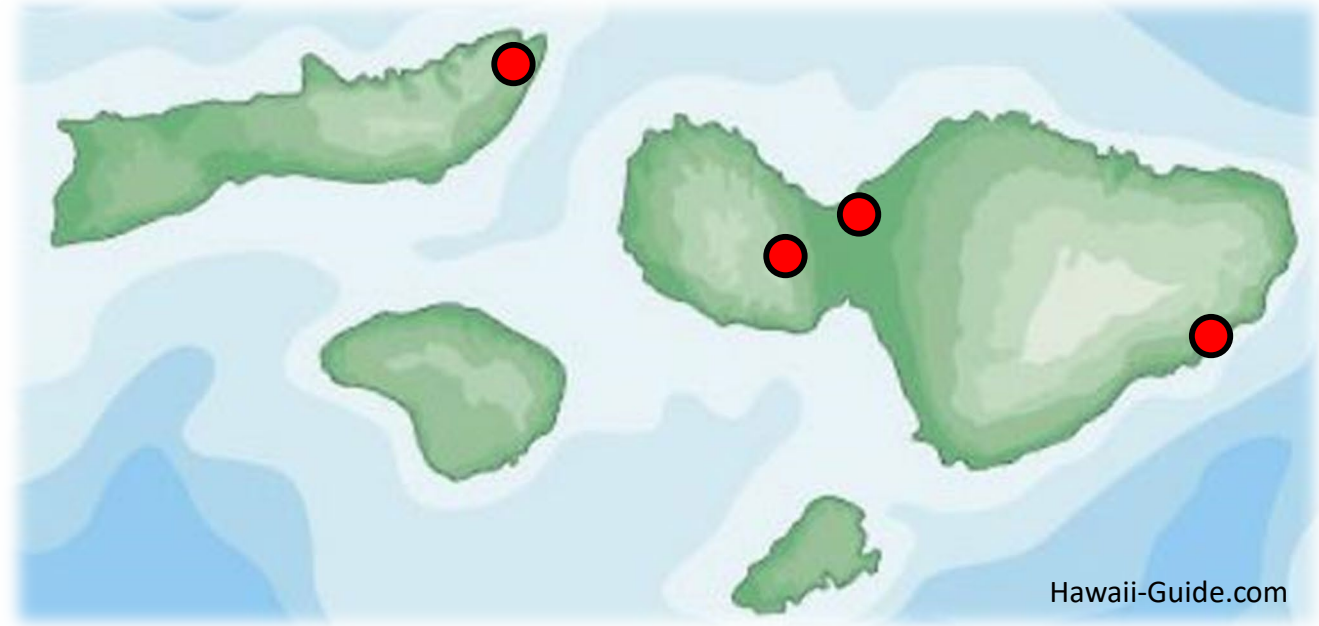
Maui

DLNR Baseyard: 10/29/19; 11/7/19; 12/6/19; 1/7/20;
2/24/20; 8/15/20; 10/20/20

Koali: 11/15/19; 12/17/19; January 2020; 2/24/20;
7/29/20; 8/15/20; 10/20/20

Koali: (passive traps) 7/11/19; 7/23/19; 8/19/19;
10/18/19; 11/15/19

Hanaula: 2/20/20; 8/15/20; 10/20/20



Molokai

Puu O Hoku: 6/2/20; 7/7/20; 8/6/20; 9/2/20;
10/18/20

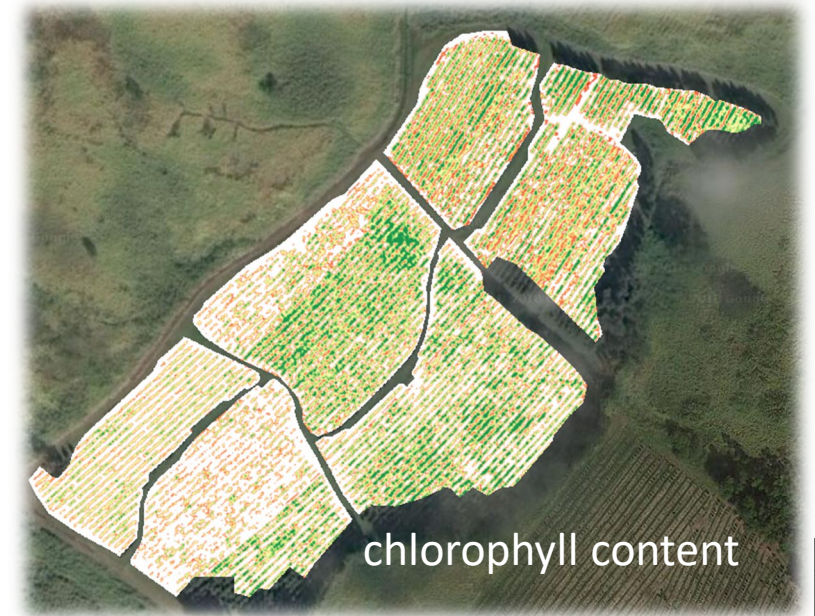
*** No Coffee Leaf Rust** was detected in any spore trap

Monitoring (Dr. Melissa Johnson)

- Methods adapted from area-wide CBB program
- Aim: determine the environmental conditions & management strategies that limit/promote CLR incidence and severity
- Incidence and severity of CLR estimated bi-weekly
 - Farms in Kona (4), Ka'u (3) and Hilo (1)
 - Farms span a broad elevational range (200-800 m)
- Microclimate factors that affect CLR incidence and severity
 - Temp, RH, rainfall, wind speed/direction (sensors already in place)
 - Leaf wetness (sensors to be added)
- Management strategies recorded
 - Fungicides: products used, spray timing, application rate
 - Sanitation: leaf removal, pruning
 - Plant health: fertilization regime, crop yield & quality
- Early (pre-visual) detection:
 - Remote sensing technology to detect areas with poor plant health
 - Ground-truthing to verify correspondence to CLR damage



Remote weather station



Evaluation of CLR-Resistant Coffee Varieties for Tolerance or Resistance to Kona Coffee Root-knot Nematode

CURRENT

(Dr. Roxana Myers)



Screening Obata and
Tupi Cultivars in a
Potted Plant Bioassay



FUTURE

Screening CLR-
Resistant Varieties
from World Coffee
Research for RKN
Susceptibility



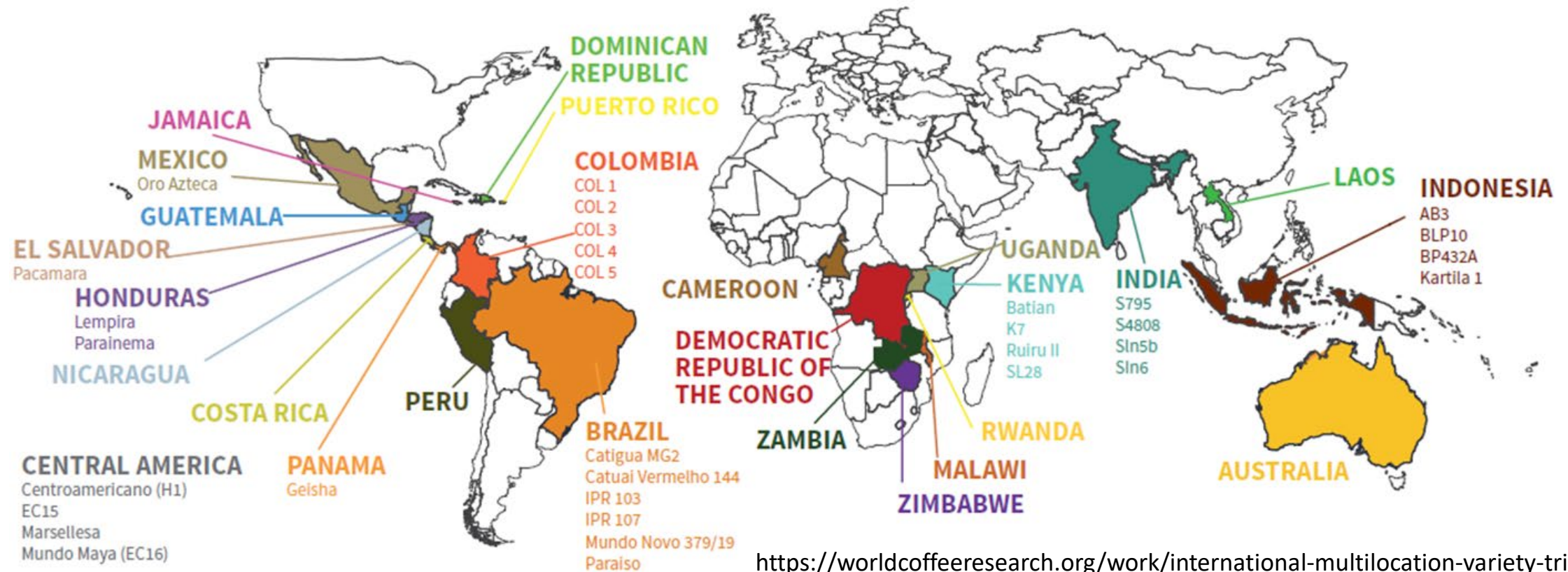
Field Evaluation of CLR-Resistant
Varieties Grafted on Nematode
Tolerant Rootstocks



HARC (Dr. Chifumi Nagai) and USDA ARS PBARC (Dr. Tracie Matsumoto) participating in World Coffee Research International Multilocation Variety Trial

22 countries host IMLVT sites

NOTE: Countries/regions with varieties listed provided seeds and received plantlets.
Countries without seeds listed are variety recipients only.



<https://worldcoffeeresearch.org/work/international-multilocation-variety-trial/>

Summary

- CLR has been around for ~140 years
 - Studied and managed
- For Hawaii: Where is it? What race is it? What works best?
 - Healthy plants
 - Eliminate inoculum
 - Minimize spread of CLR
- Short- & Long-term strategies

Thank you
Questions?