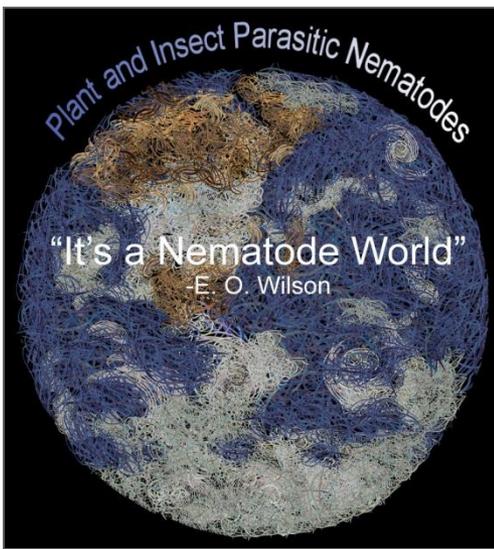


Coffee Root-knot Nematode

Roxana Myers

USDA ARS Daniel K. Inouye U.S. Pacific
Basin Agricultural Research Center

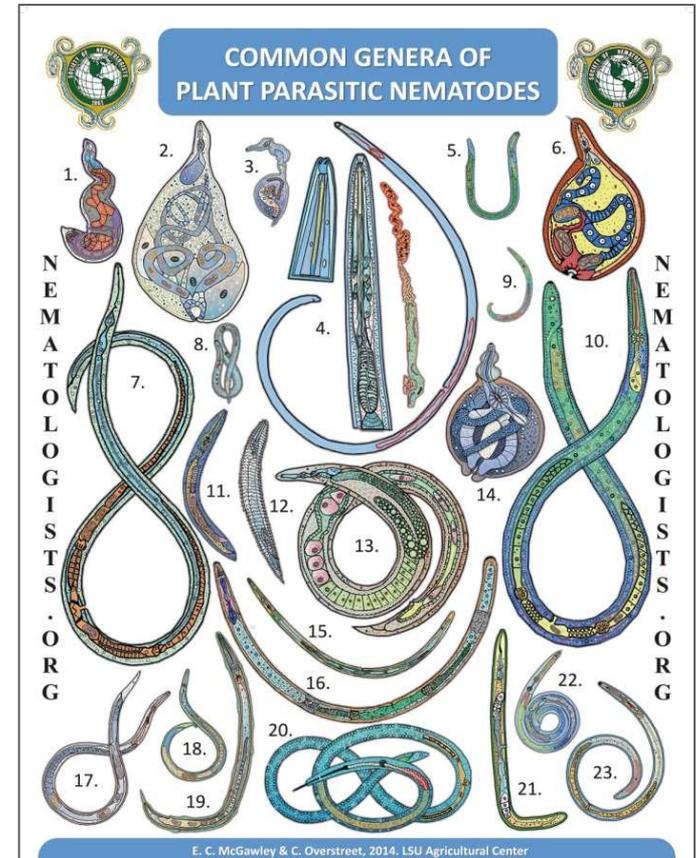




What are Nematodes?

Nonsegmented
ubiquitous
roundworms

- Free-living
 - Feed on bacteria, fungi, and other microorganisms
- Parasites
 - Feed on plants, animals, or insects



Plant Parasitic Nematodes

- Microscopic non-segmented worms
- Stylet mouthpart for piercing plant cells



- Cause billions of dollars in damage to agricultural crops worldwide

How Do Nematodes Damage Crops?

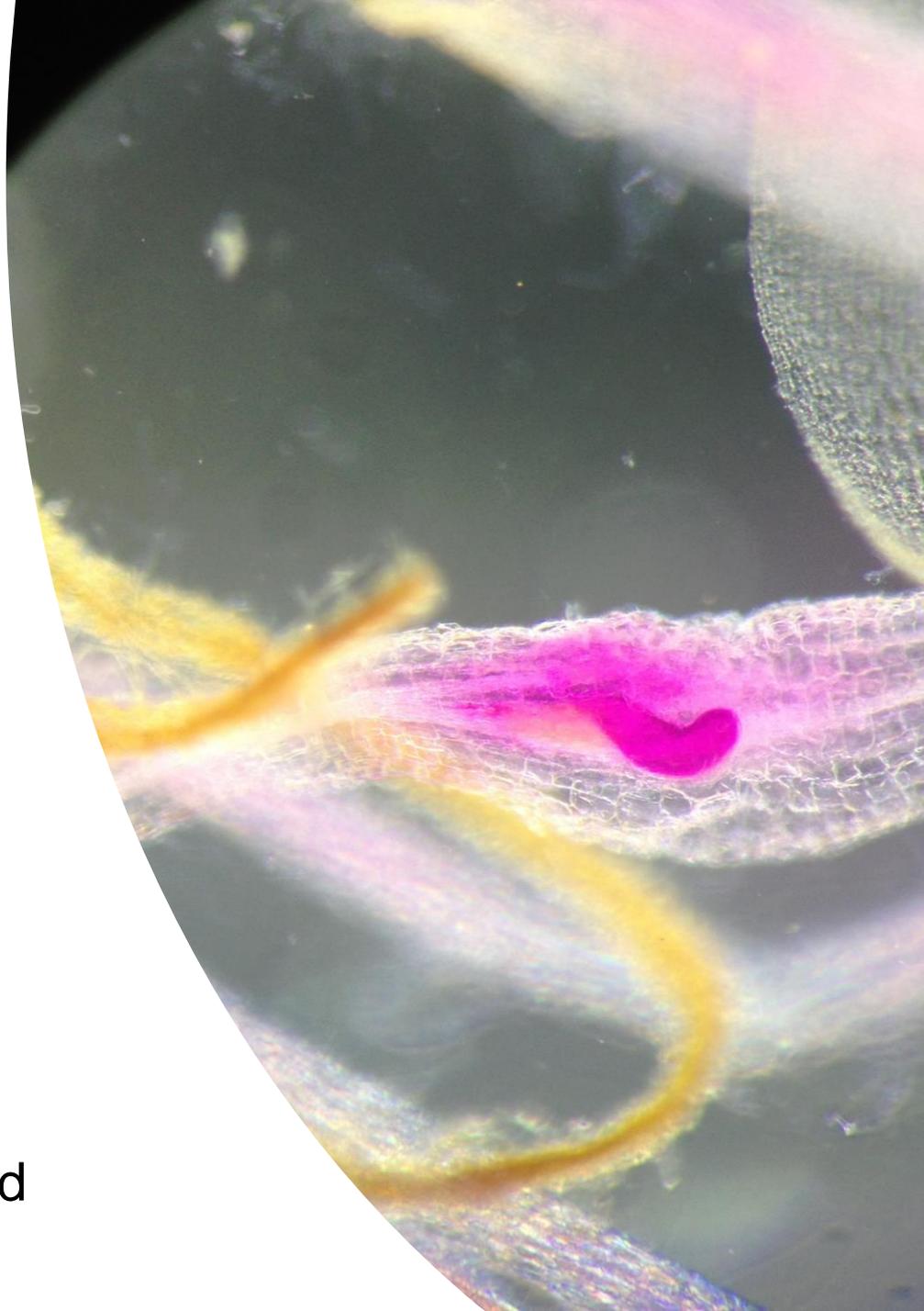
- Destroy & weaken root system
- Interfere w/uptake of water & nutrients
- Cause stunting of plants
- Poor crop yields



Coffee infested with root-knot nematode

Root-knot Nematodes

- 70 Species of *Meloidogyne*
- Wide host range including fruits, vegetables, grasses, and weeds
- Demonstrate stunting and nutrient deficiencies, sometimes death
- Infestations appear clustered



Root-knot Nematodes

- Attacks root tips, entering behind root cap
- Travels intercellularly through host
- Initiates a feeding site
- Creates a giant cell
- Feeds on cytoplasm
- 1 egg mass produces 500 – 1,000 eggs

Kona Coffee Root-knot Nematode

Meloidogyne konaensis

J. D. EISENBACK

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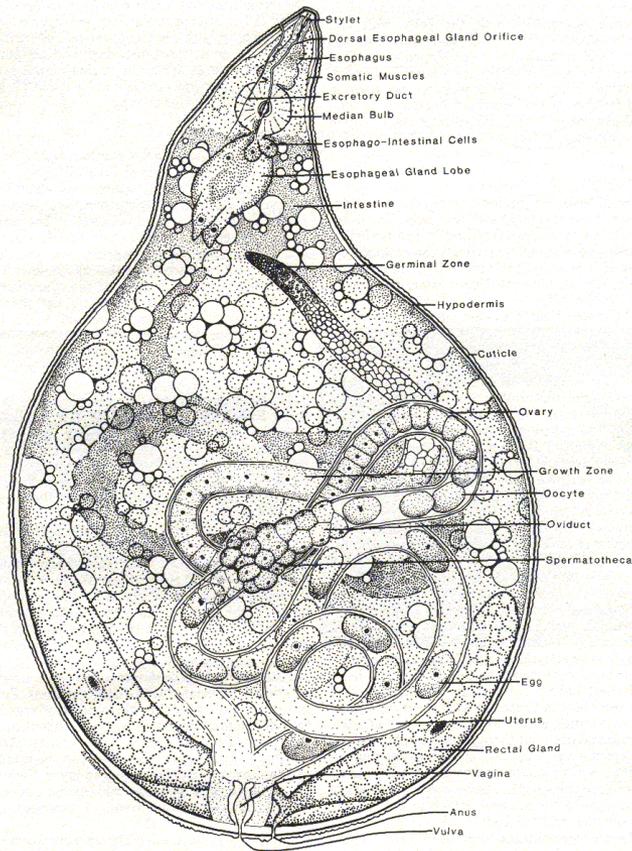


Fig. 30. Gross morphology and anatomy of a female root-knot nematode as revealed by light microscopy [Ovary after Triantaphyllou (47)].

J. D. EISENBACK

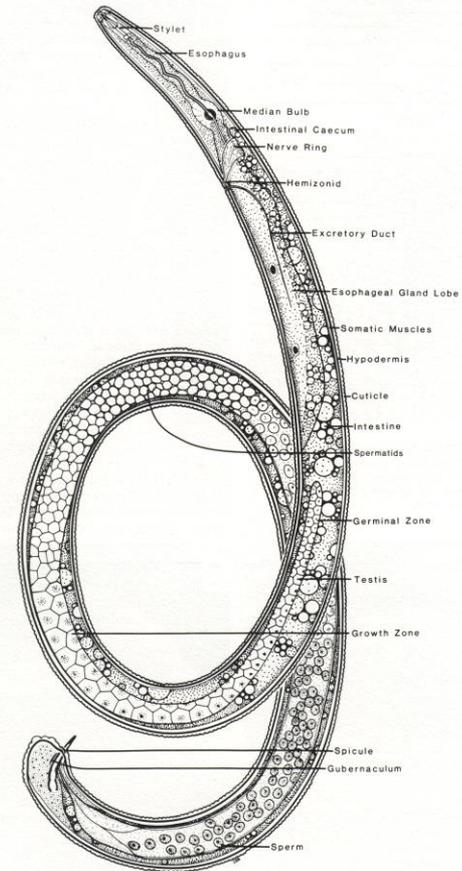


Fig. 16. Gross morphology and anatomy of a male root-knot nematode as revealed by light microscopy.

M. konaensis Female w/Egg Mass



Decline in *Coffea arabica* var. Typica 'Guatemalan' in Kona, Hawaii

- Trees become stunted, wobbly, and easily uprooted
- Yellowing and flagging of leaves
- Roots are galled, corky, cracked, necrotic with few feeder roots
- Young trees die after replanting



Brief history of RKN in Kona

- Mid-1950s - Eddie Fukunaga worked on solving a “replant” problem in Kona
- 70s-80s – Rootstock (from Brazil) trials with Fukunaga & Dr. Phil Ito
- 90s - Ito selects rootstock, *Coffea liberica* var. *dewevrei* - ‘Fukunaga’
- 90s and early-2000s - Mario Serracin, Drs. Don Schmitt, Scot Nelson, H.C. Skip Bittenbender, Virginia Easton-Smith and Kona Research Station continue research and outreach

Confirm diagnosis with laboratory assay

To confirm the presence of the Kona coffee root-knot nematode, collect a soil and root sample and send it for nematode assay and identification to CTAHR's Agricultural Diagnostic Service Center (ADSC) via the CTAHR Cooperative Extension Service (CES) office in your area.

Taking a soil and root sample for assay
With a shovel, pick, 9/8, or soil-coring device, sample the zone of soil where the coffee roots are found. To diagnose a suspected infection, sample two or three spots at the leaf canopy drip line of each of several trees that are showing symptoms, preferably early symptoms (yellow leaves, stunted trees). To assay infestation of nematodes in a field, take samples from about 20 spots. The samples should include roots.

Mix the subsamples together, and take about a pint of this mixture for the assay. Quickly put this sample in a plastic bag and keep it in an insulated cooler. Label the sample with your name, field identification number, date, and any other information that will be useful. Check with your local CES office to find out the best time to bring in a sample for prompt shipping to ADSC.



Healthy coffee plants (*Coffea arabica*). Coffee production is expanding rapidly throughout Hawaii.

... continued from inside

Nematize. Remove all volunteer coffee seedlings (*polynesian*) and weed hosts of the nematode.

Nematicides. No nematicide is currently registered for use in coffee. Research indicates that nematicides are relatively ineffective in older coffee plantings. Because nematicides are expensive and highly toxic, other options for nematode management are preferable. Also, registration is an expensive process, and agricultural companies are not likely to see much profit potential in pursuing approval of a product for use in coffee in Hawaii.

Seek expert advice. Contact your nearest CTAHR Cooperative Extension Service office.

Prevention and avoidance

- Don't transplant volunteer coffee seedlings.
- Don't plant coffee seeds in untreated soil; use only sterilized soil for potting.
- Remove *palupala* from around coffee trees (they harbor many nematodes in their roots).
- Avoid moving farm machinery from infested to noninfested fields.
- Don't irrigate indiscriminately. Excess soil moisture favors root rot in nematode-infested roots. Time irrigation according to the crop's needs.
- Eliminate other host plants of the Kona coffee root-knot nematode, such as bilgerass and amaranth (*peleia*).
- Minimize soil erosion and runoff.

Mario Serracin, Don Schmitt, and Scot Nelson
Department of Plant Pathology

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Coffee Decline

Caused by the
Kona Coffee Root-Knot Nematode

Coffee growers in Hawaii are able to grow their crop free from many of the world's most serious coffee diseases because our islands are isolated from other coffee-growing areas and the diseases have yet to be introduced here. However, during the past several years a serious disease has been observed in the Kona region of the island of Hawaii. This disease has been referred to in Kona as "transplanting decline," "replant problem," "nutritional stress," and "Kona wilt." It is characterized in coffee plantations by the occurrence of individual or clustered poorly growing or stunted coffee trees.

Why would coffee trees grow poorly, or be discolorated? The reason in this case is attack by small, plant-parasitic roundworms known as nematodes, which enter the plant's roots and cause serious plant damage and crop loss. Other factors that can worsen decline include nutritional deficiency or toxicity, moisture stress, herbicide damage, and attack by insect pests or plant diseases caused by bacteria, fungi, or viruses.

Nematode entry and feeding within roots disrupts plant growth processes and causes growth decline, so infection by them is considered a plant disease. Their damage also can allow secondary infection when other disease-causing organisms enter. Coffee trees with nematode-damaged roots grow weakly and slowly, suffer moisture stress more readily, often turn yellow, and eventually die.

The nematode causing the coffee plant decline in Kona has been named *Meloidogyne kawaiensis*, the Kona coffee root-knot nematode.

Coffee decline caused by the Kona coffee root-knot nematode



Drooping leaves, thin foliage

This stunted 3-year-old plant with poor crop also shows leaf yellowing (chlorosis).

Yellow leaves

Nematode-infested coffee trees with good crops can decline rapidly (2-3 months). A heavy crop makes demands on the tree, causing stress that may hasten the decline.

Dead tree

This tree died after 3 years in a coffee plantation.

The Kona coffee root-knot nematode is a microscopic roundworm that lives, feeds, and reproduces in plant roots. It infects coffee, many vegetables, and some ornamentals. It has been detected on coffee at 600-1800 ft elevation and to our knowledge is restricted to the Kona region at present.



Swollen taproot over-sized with corkiness



Swollen roots with corky texture, few feeder roots

How to diagnose coffee decline

The only sure method is lab assay of the soil, but you can look for these symptoms in the field.

Above ground

- Early symptoms
- leaves drooping and yellowed
- trees small, stunted, with thin trunks

Later symptoms

- wilting despite adequate irrigation and irrigation
- leaf loss (defoliation)
- woody by trees, easily uprooted

Below ground

- root system small
- roots rotting or dead
- feeder roots scarce
- taproot and root tips with slight to large swelling (galls)
- root texture corky



Infected roots Healthy roots
A healthy root system has many fine, fibrous roots.

If your farm has root-knot nematodes... Combined strategies are needed for nematode management. Following an recommendations from CTAHR researchers for managing coffee decline.

Control and recovery

Fallow. Fallowing means maintaining a field entirely free of any plants. A 6-9-month fallow period will reduce nematode numbers greatly; however, some will survive.

Replanting. Some farms may require extensive replanting, which should be done after a fallow or a rotation with a crop that is a confirmed nematode-free of the Kona coffee root-knot nematode. When replanting coffee, use only vigorous, nematode-free transplants at least one year old.

Replant with trees grafted onto tolerant rootstock. Graft coffee scions onto a nematode-tolerant rootstock known as *Coffea dewevrei*.

Organic soil amendments. Adding large quantities of organic amendments such as animal manure to the soil has been found to stimulate growth of soil organisms that may compete with and suppress nematodes. This technique has not yet been verified on coffee in Hawaii. Use of coffee cherry pulp as a soil amendment is being evaluated.

... developed by Don Blevins

Decline in *Coffea arabica* var. Typica 'Guatemalan' in Kona, Hawaii



Year 1



Year 2

Year 3

Do you
have root-
knot
nematode
in your
coffee
field?

- Where did your coffee trees come from?
- Between 2002 and 2004, Nelson and Hue et al. already determined that about 85% of Kona coffee acreage and 34% of Big Island farms (n=65) and were found to be infested by *M. konaensis*.

Sampling for Nematodes

Sample in a zigzag pattern

Collect roots and soil from
healthier trees

Place sample in a plastic bag

Label bag with detail

Keep away from heat and cold

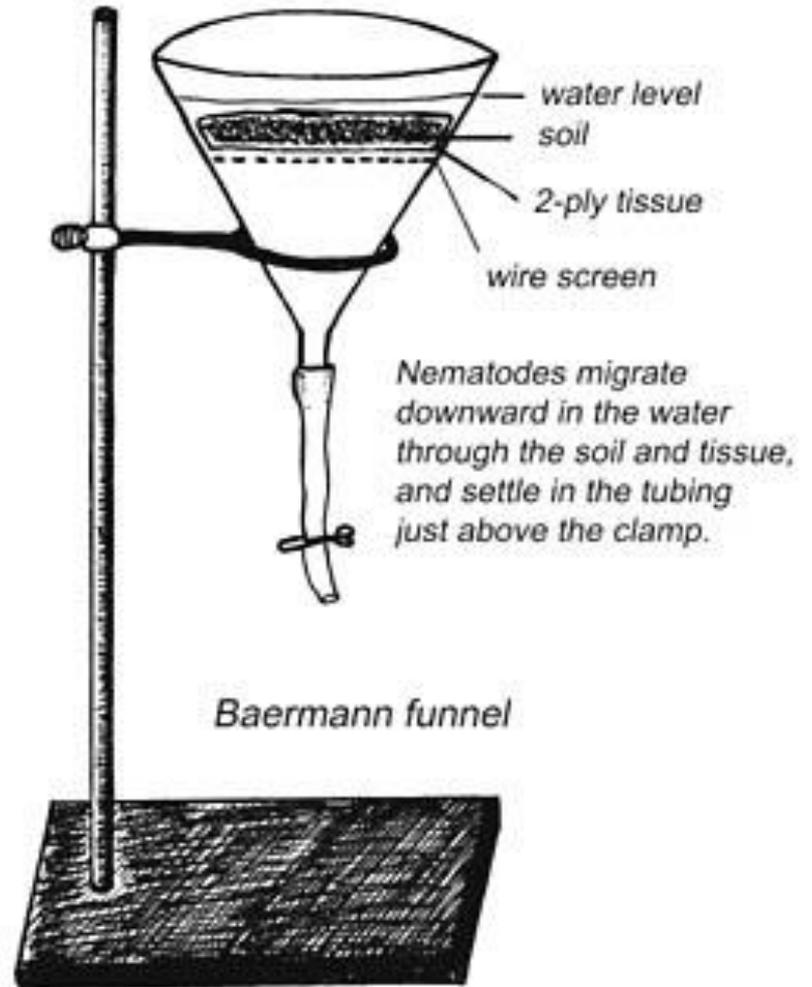


Composite sample



Nematode Extraction

- Elutriation
- Sieving and Rolling
- Blending
- Mist Chamber



When Is It a Problem?

- Damage Threshold
 - 1.5 *M. konaensis* eggs per 250 cm³ soil (1 cup)
- Severe Infestation
 - 150 eggs can cause galling and rotting in approx. 40% of roots

Start Clean, Stay Clean

01

Propagate plant material by seeds or cuttings

02

Use sterile potting media, tools, and pots

03

Grow nursery plants on benches

04

Train staff in good sanitation practices

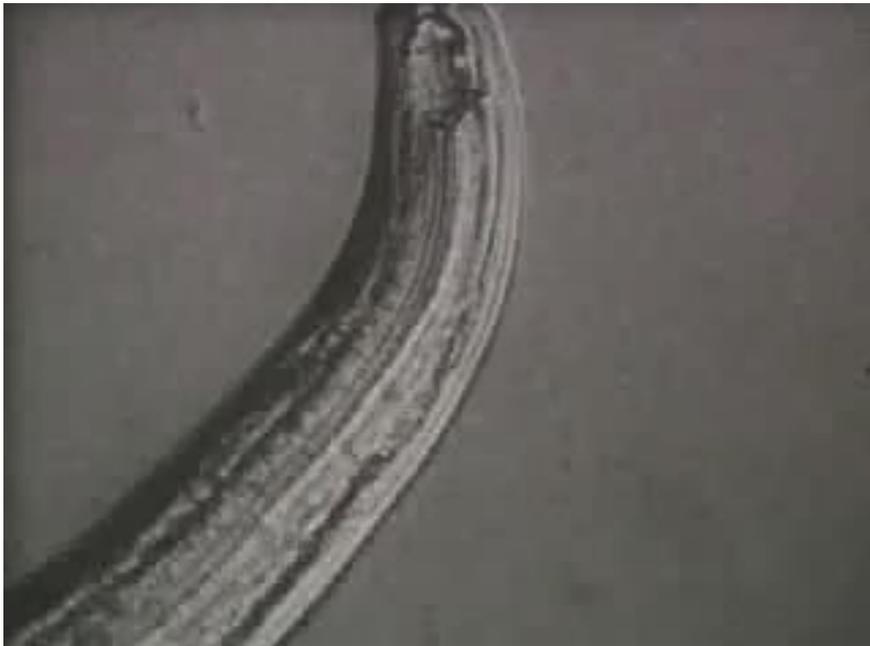
Predatory Nematodes

- Common in most Hawaiian soils
- Greater populations observed in soil with high organic material
- Frequently prey on plant-parasitic nematodes, including root-knot and reniform nematodes



Nematode Predators Found in Healthy Soils

Mononchus



Labronema



Tolerant Rootstocks Remain Vigorous Under Heavy Nematode Infestation

Coffea arabica cv. Typica

Nematode Susceptible



Coffea liberica var. *dewevrei*

Nematode Tolerant





214

212

209

206

B

207

205

204

G

200

197

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F

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11



The long-term effects of coffee rootstocks on root-knot nematodes in Kona Planted in 2006, first data in 2007-2008, continued data in 2016-2018



Panamanian dewevrei – grafts did not take on this rootstock (peach boxes)

Coffea arabica ‘Typica’ rootstock – In the first year, many of these trees were already showing signs of decline (blue boxes)

C. arabica ‘Purpurea’ rootstock – First year data showed pupurea to fare comparably with liberica and robusta rootstocks; however, in later years, purpurea did not continue to show resistance to root-knot nematodes (purple boxes)

Other rootstocks tested are: *C. liberica* cv *dewevrei* ‘Fukunaga’, *C. liberica* ‘Arnoldiana’, *C. robusta* ‘Nemaya’ and *C. robusta* ‘Apoata’.



General observations

- *C. arabica* 'Typica' rootstock does not have resistance to coffee RKN
- *C. liberica* 'Fukunaga' and 'Arnoldiana' rootstocks have tolerance to coffee RKN
- *C. canephora* (robusta) 'Nemaya' and 'Apoata' rootstocks may also have tolerance to coffee RKN
- *C. arabica* 'Purpurea' rootstocks may not have the level of tolerance as liberica and robusta after the first few years.

Questions?

Thank you!

- Roxana Myers
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- Volunteers

