

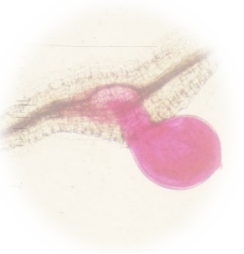
Integrated Nematode Management:

Edible Crops

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CTAHR

May 2024




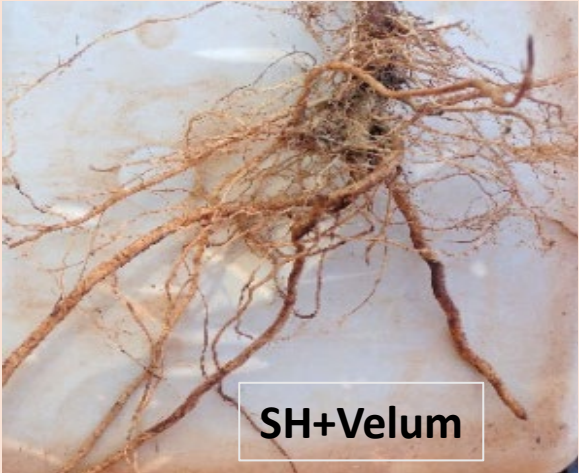




iStock
Credit: Godruma







COOPERATIVE EXTENSION
UNIVERSITY OF HAWAII AT MANOA
COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES



Nematode Damage

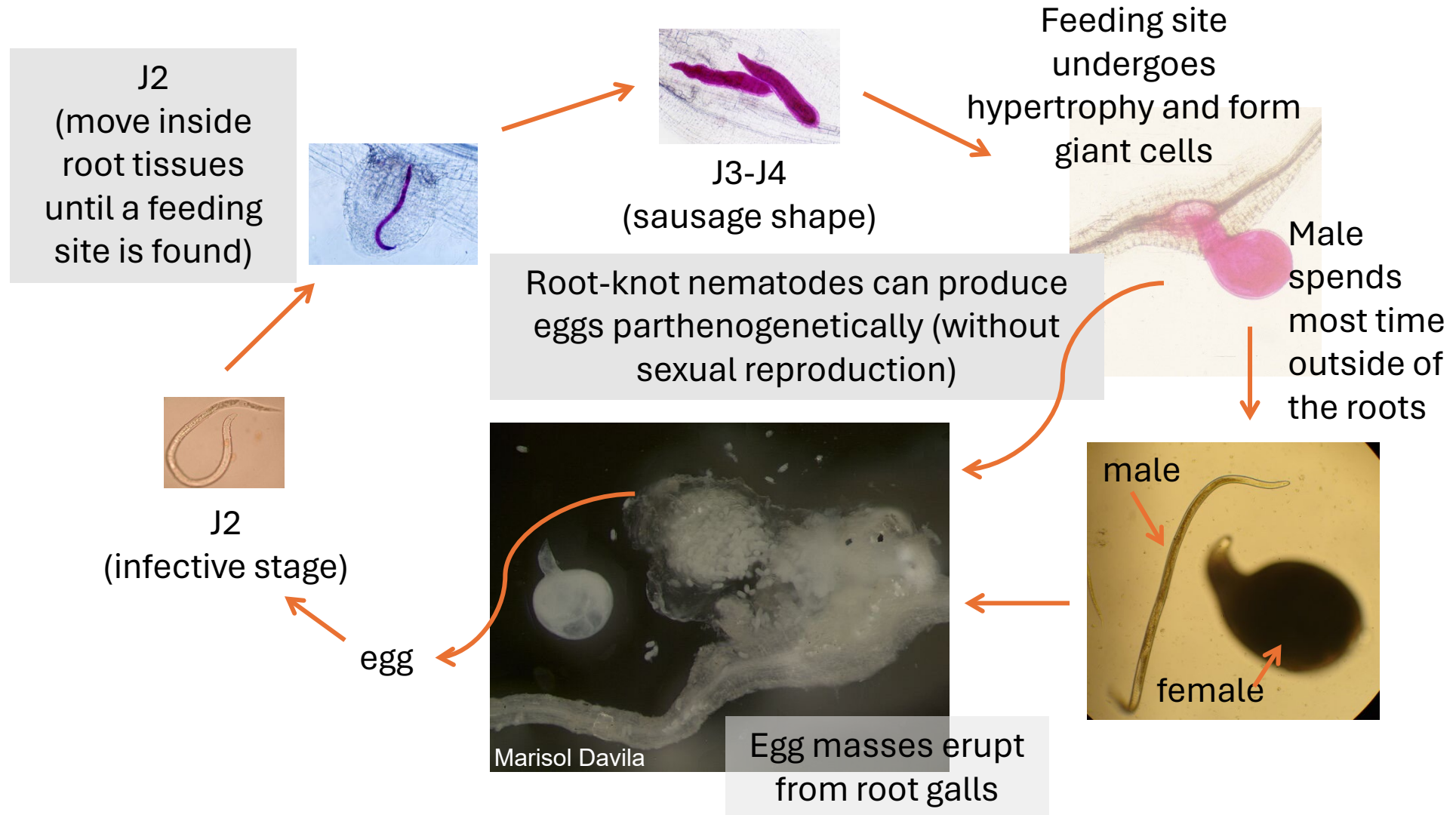
	Healthy roots	Infected by root-knot nematodes	Yield loss (%)
Tomato (Komohana, root-knot resistant var) 	 SH+Velum	 Control	53
Zucchini ('Felix') 	 Velum I	 Control	72 (Wang et al., 2017)

Nematode Damage on Sweet Potato

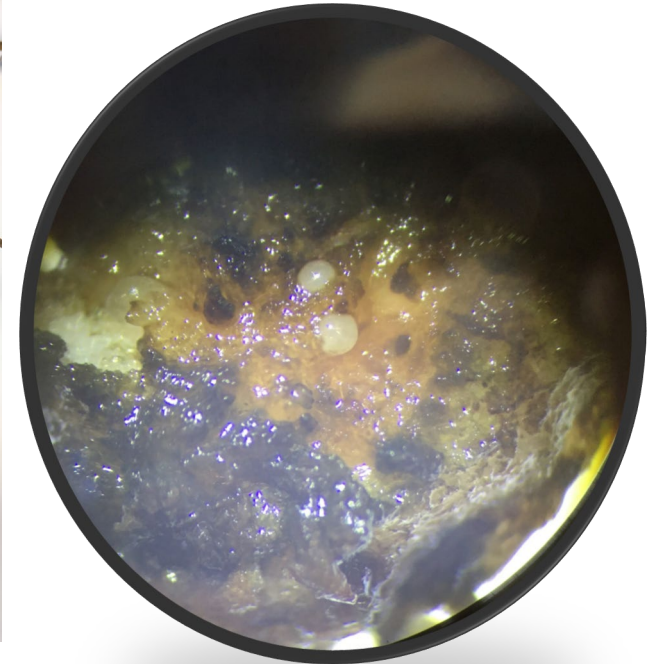
PPN/symptoms	Healthy roots	Infected by nematodes	Yield loss (%)
<p>Root-knot nematodes</p> <p>Root cracking</p>	 <p>SH+Velum</p>	 <p>Control</p>	<p>Marketable yield = 81.6%</p> <p>Total yield = 47.3%</p>
<p>Reniform nematodes</p> <p>Delay storage roots development</p>	 <p>Velum I</p>	 <p>Control</p>	<p>Marketable yield = 35.6 %</p> <p>Total yield = 36%</p>

(Waisen, Wang et al., 2019)

Root-knot nematode (*Meloidogyne* spp.)

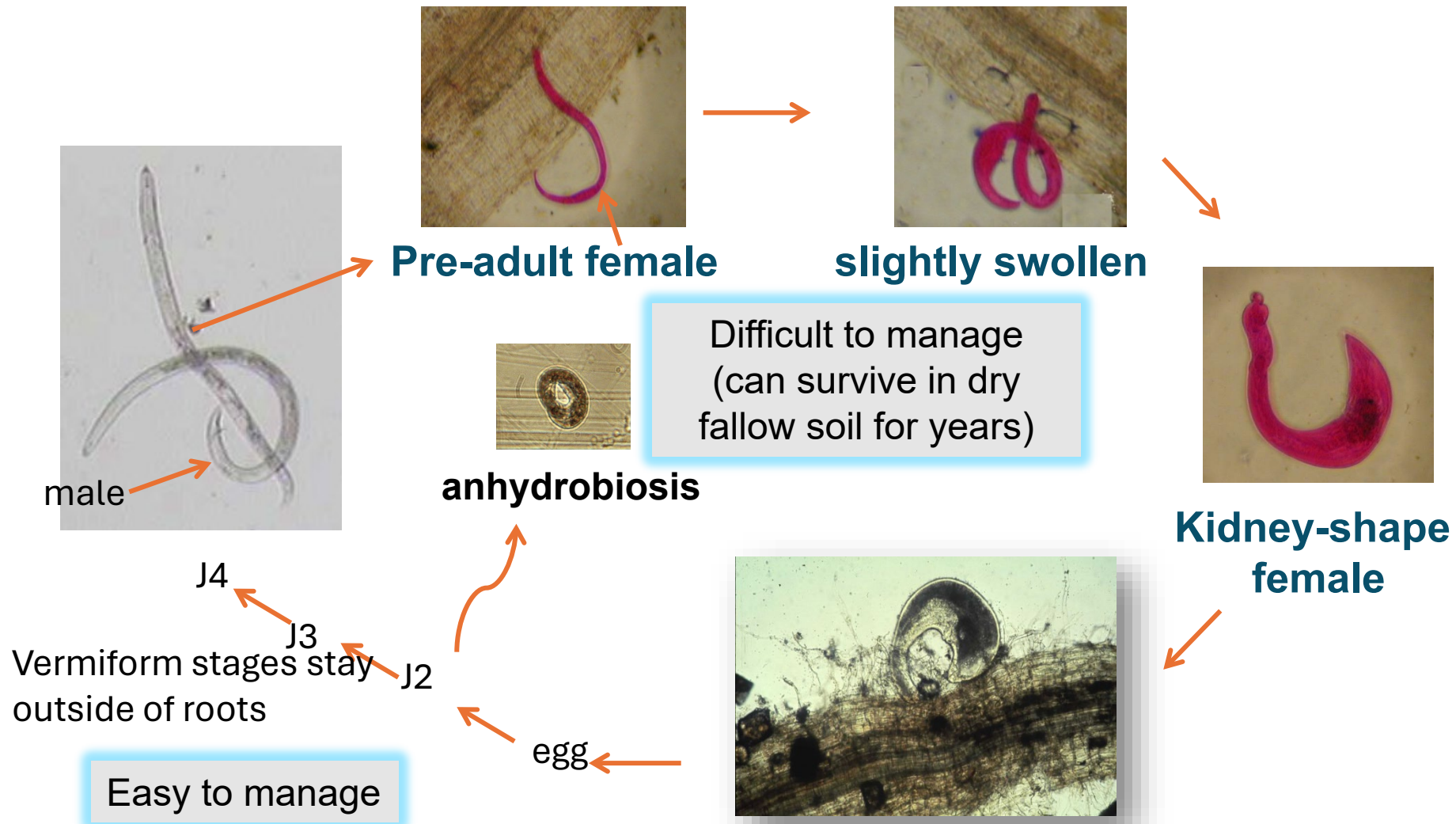


Root Galls formed by Root-knot Nematodes



Picture: Koon-Hui Wang

Reniform Nematode (*Rotylenchulus reniformis*)



Reniform nematode has a broad host range



Pineapple



Picture: Koon-Hui Wang



Papaya

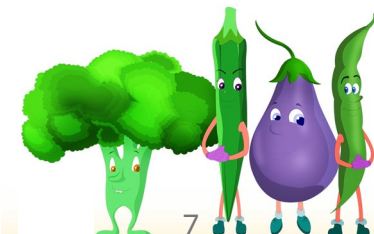


Cowpea

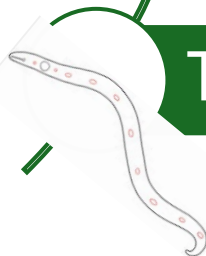
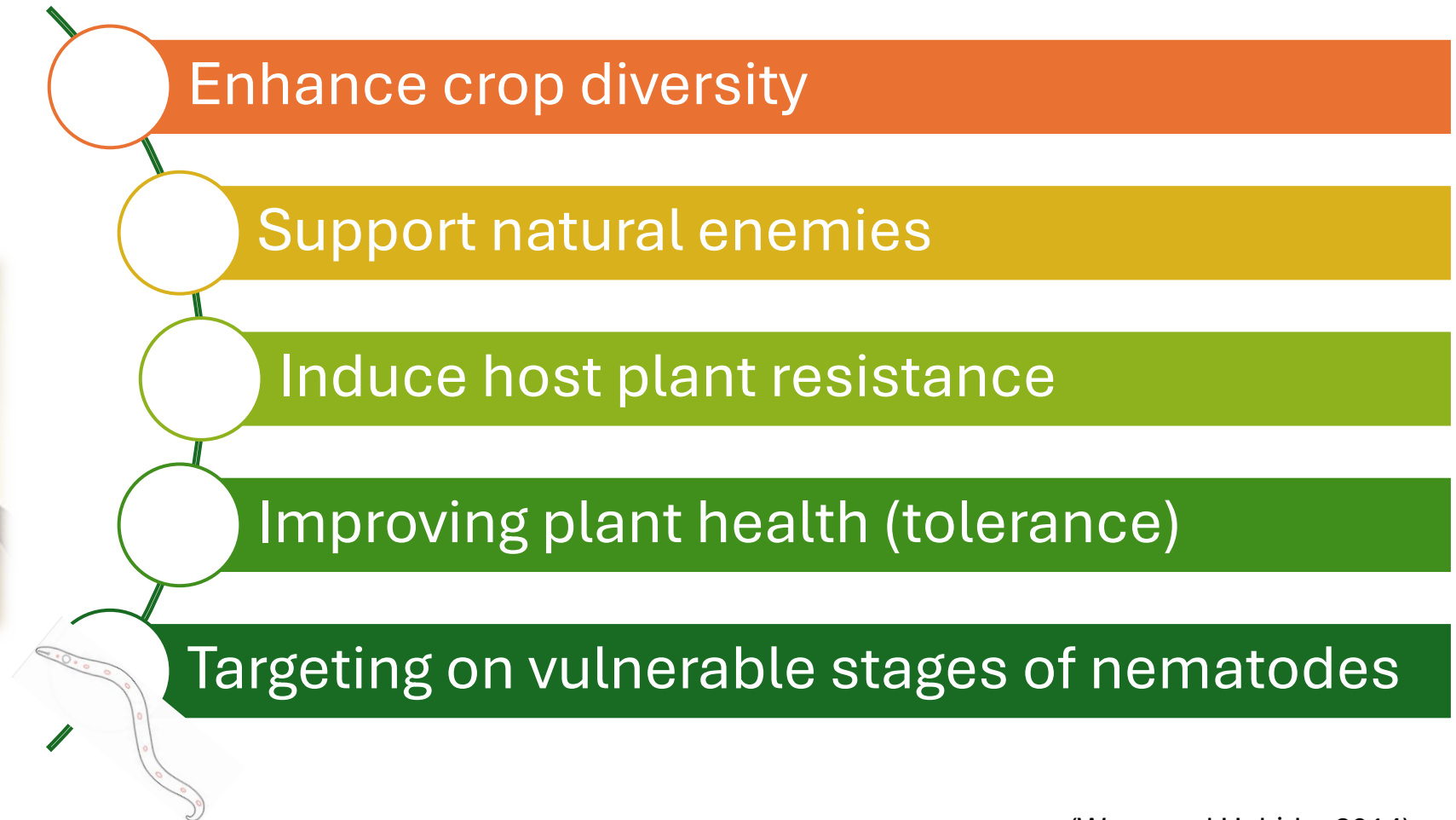


Sweet potato

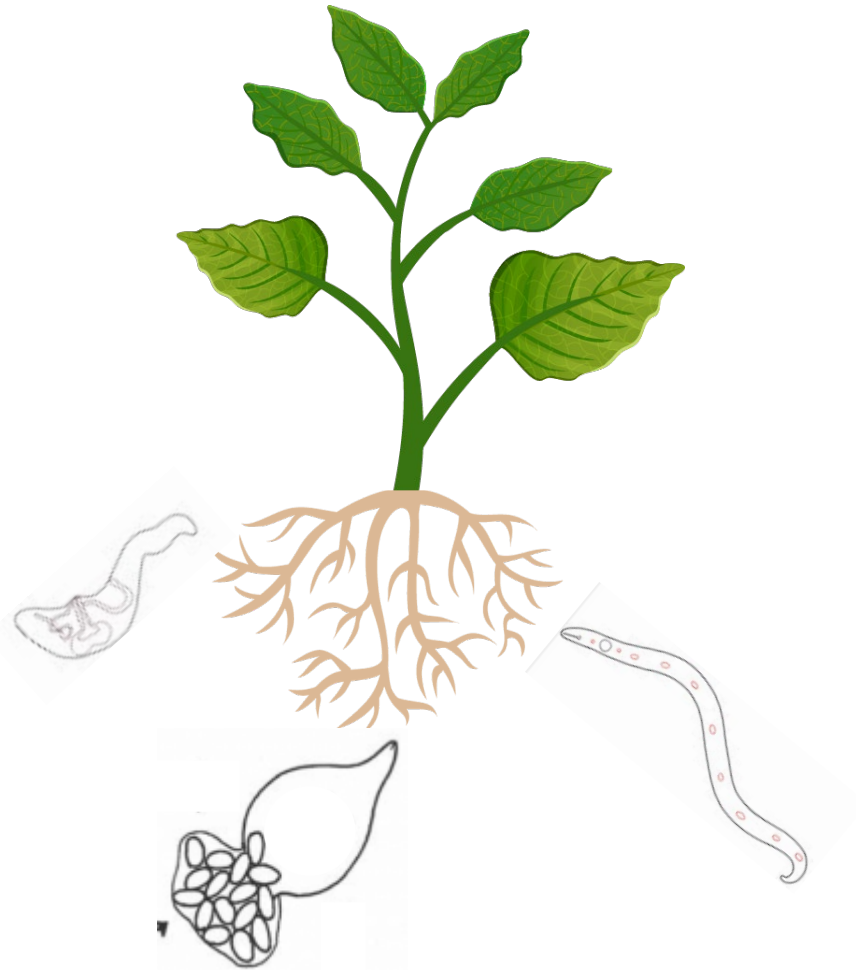
...and wide
range of
vegetable
crops



Principals of Sustainable Nematode Management



Integrated Nematode Management



- Pre-plant rotation
- Soil amendment
- Post-plant drenching
- Host plant resistance
- Suppressive soil

Preplant rotation

Soil amendment

Post-plant drenching

Induce Systemic Resistance

Suppressive soil

Cover Crops Allelopathic against Plant-parasitic Nematodes



Sunn hemp
Crotalaria juncea
-- monocrotaline

T. erecta and *T. polynema* are resistant to root-knot but very susceptible to reniform nematodes.



French Marigold
Tagetes patula
-- α -terthiynyl



Brown mustard
Brassica juncea
-- glucosinolate



Sorghum-sudangrass
-- Dhurrin



Velvet Bean
(*Macuna prupriens*)
-- L-DOPA

Preplant rotation
Marigold

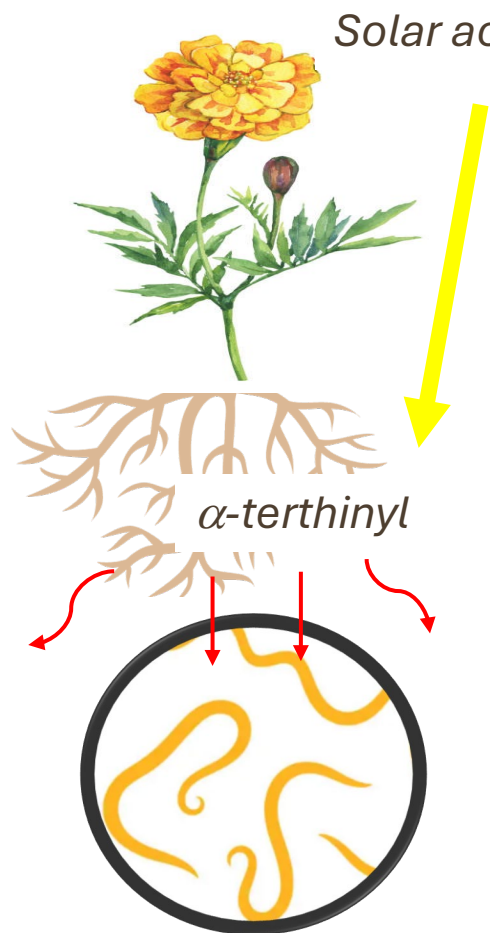
Soil amendment

Post-plant drenching

Induce Systemic Resistance

Suppressive soil

How to manage nematode efficiently using marigold?



Vulnerable stage



Marigold | Nema-Gone | 2000 See...
\$9.95
Burpee Gardening



Preplant rotation

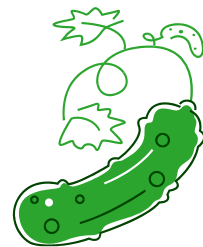
Sunn hemp

Soil amendment

Post-plant drenching

Induce Systemic Resistance

Suppressive soil



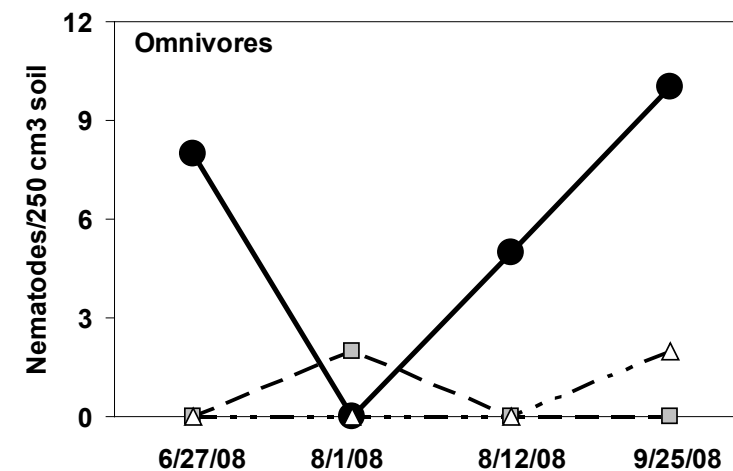
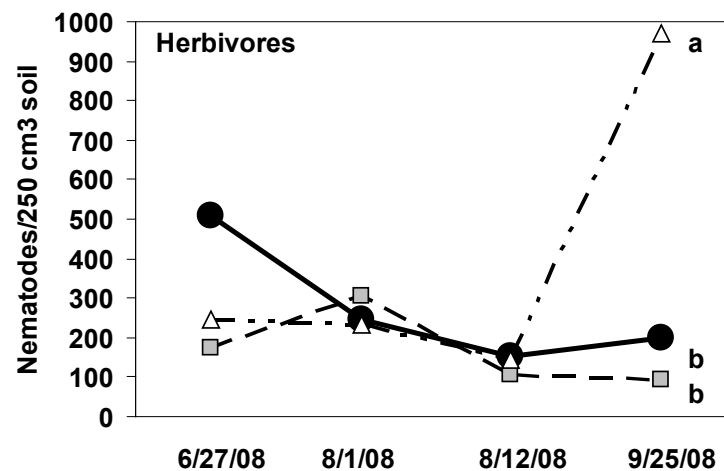
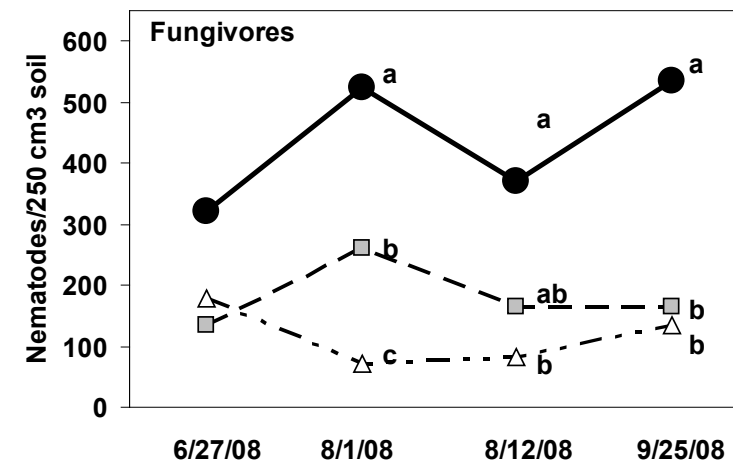
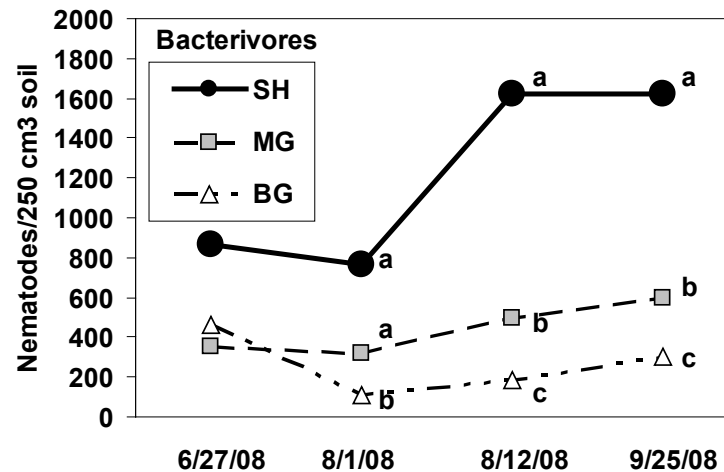
Sunn hemp Strip-Till Cover Cropping

Preplant Treatment:

- ☐ Sunn hemp (SH): 40 lb seeds/acre
- ☐ Marigold (MG): 2.6 lb seeds/acre
- ☐ Bare ground (BG): fallow with weeds



Most toxicity from SH is in the leaves of 2- to 3-month-old plants.



(Wang et al., 2011)

Preplant rotation
Brown mustard

Soil amendment

Post-plant drenching

Induce Systemic Resistance

Suppressive soil

'Caliente 199' Brown Mustard Biofumigation



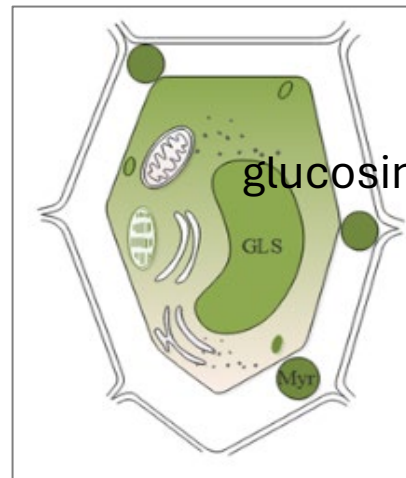
T=till

M = Maceration

BP = Black plastic

Brown mustard is very susceptible to root-knot nematodes.

Grow for 5 weeks.



Mustard leaf tissues

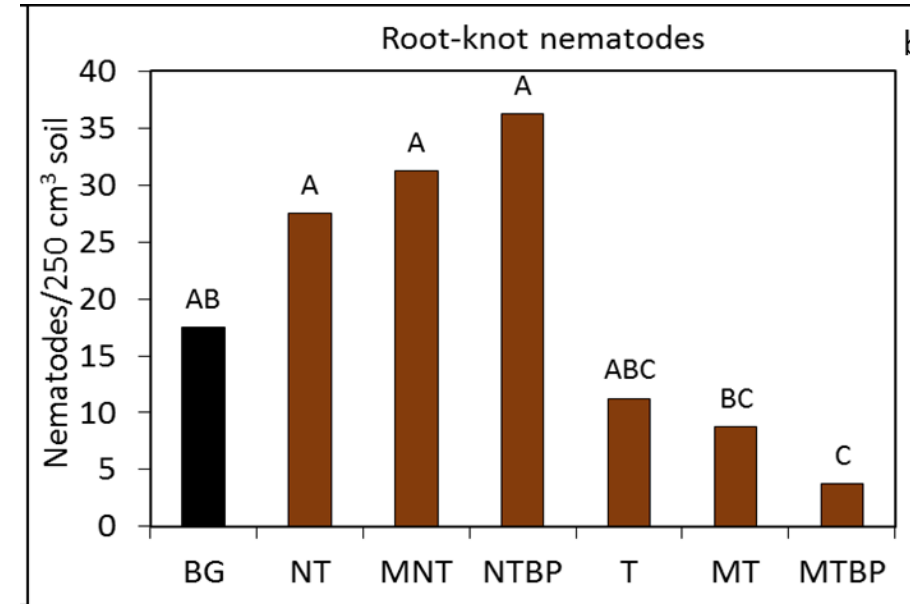
glucosinolate

maceration



Isothiocyanate

Vulnerable stage



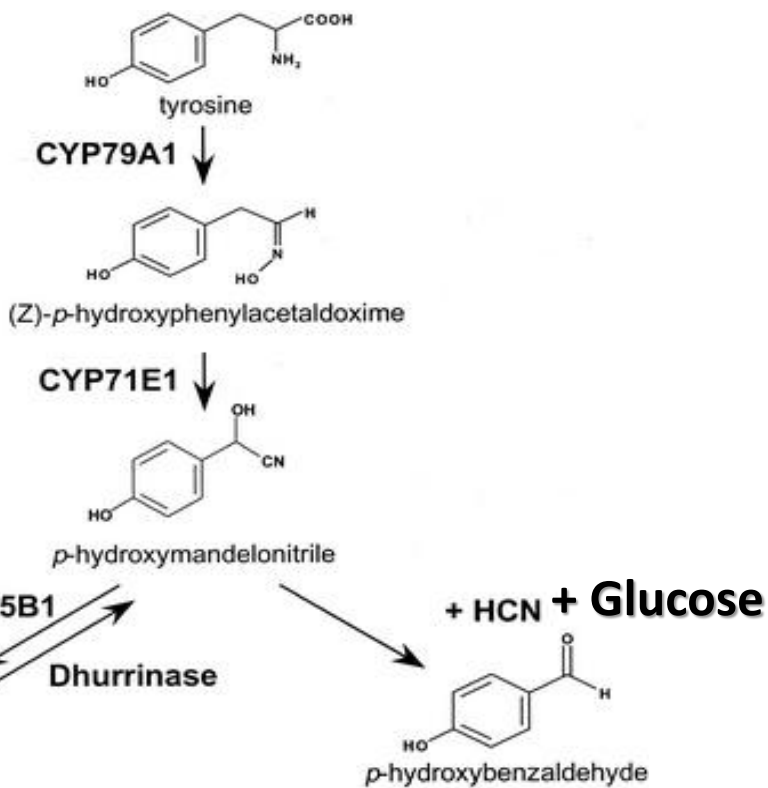
Preplant rotation
Sorghum

Soil amendment

Post-plant drenching

Induce Systemic Resistance

Suppressive soil

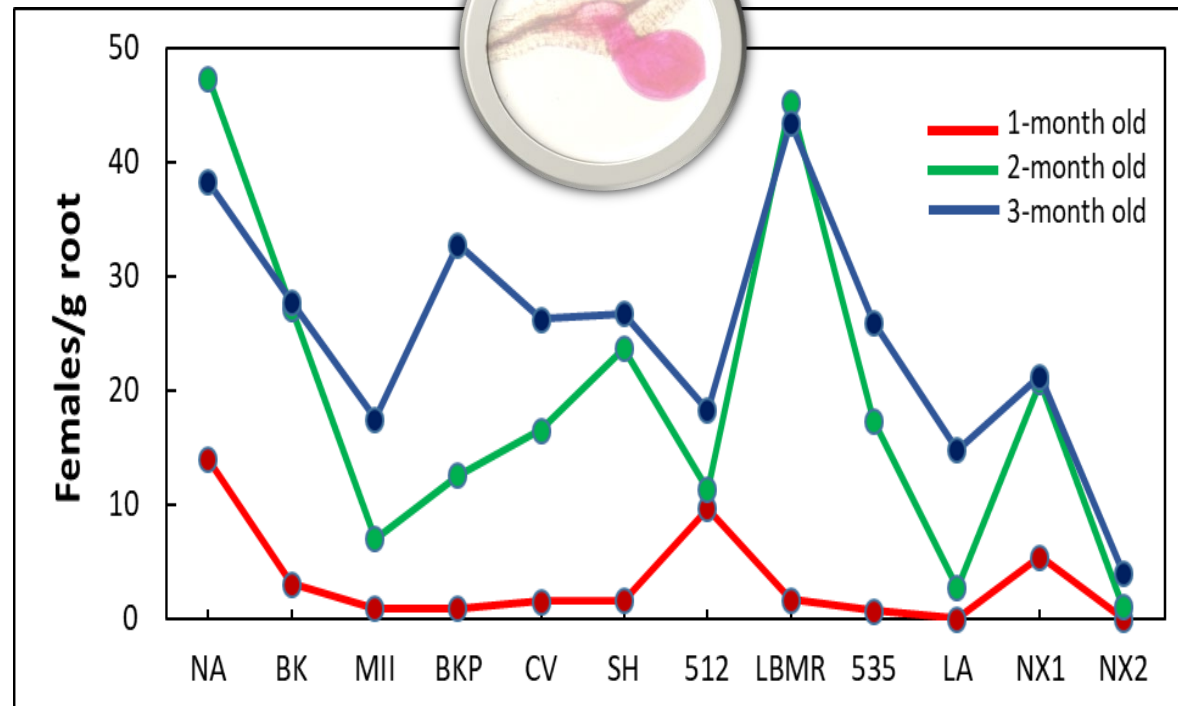
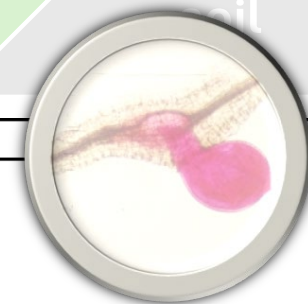


Dhurrin

Busk and Moller, 2002



HCN



- Suppress root-knot female development
- Most varieties are not suppressive > 2-mon old except for NX-2 (NX-D-61).
- NX-2 generated > 40 tons/acre in 2.5 months.

Preplant rotation
Velvet bean

Soil amendment

Post-plant drenching

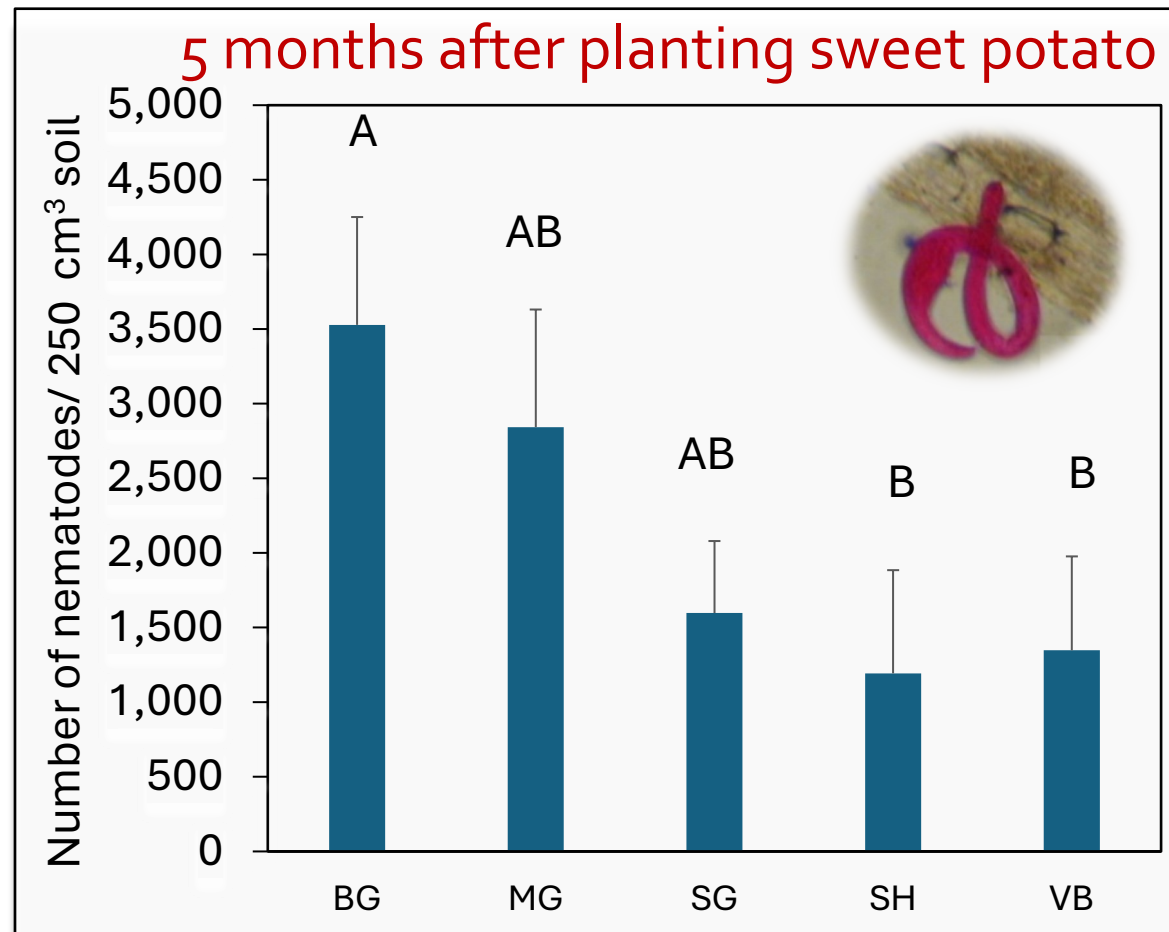
Induce Systemic Resistance

Suppressive soil

Velvet bean against reniform nematodes



L-dopa, a neurotransmitter, paralyzed nematodes



BG = Bacre ground, MG=Marigold, SG=Sorghum, SH=Sunn hemp, VB = Velvet bean

Preplant rotation

Soil amendment

Post-plant drenching

Induce Systemic Resistance

Suppressive soil

vapam HL

methyl isothiocyanate (MITC)



Brassica spp.

(e.g. *Brassica juncea*, brown mustard)



Carica papaya
(Papaya fruit)

Papaya Ground Seeds (PGS)



PGS

1

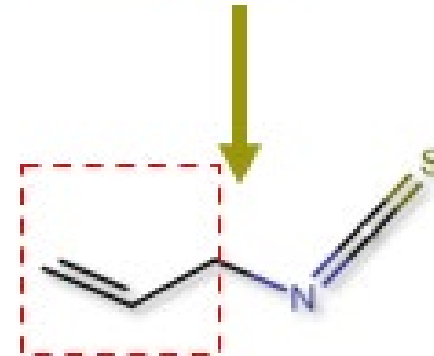


Boiling water
(100 °C)

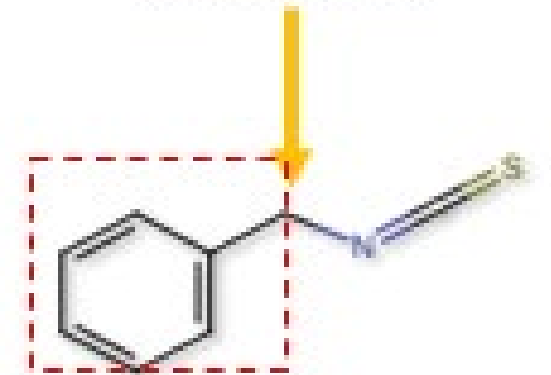


Centrifugation

PGS Crude Extract



allyl isothiocyanate (AITC)



benzyl isothiocyanate (BITC)

Preplant rotation
Sunn hemp

Soil amendment

Post-plant drenching

Induce Systemic Resistance

Suppress soil

MeloCon[®] LC
BIOLOGICAL NEMATOCIDE

Chemigation



Neem product



a.i. Azadirachtin



untreated



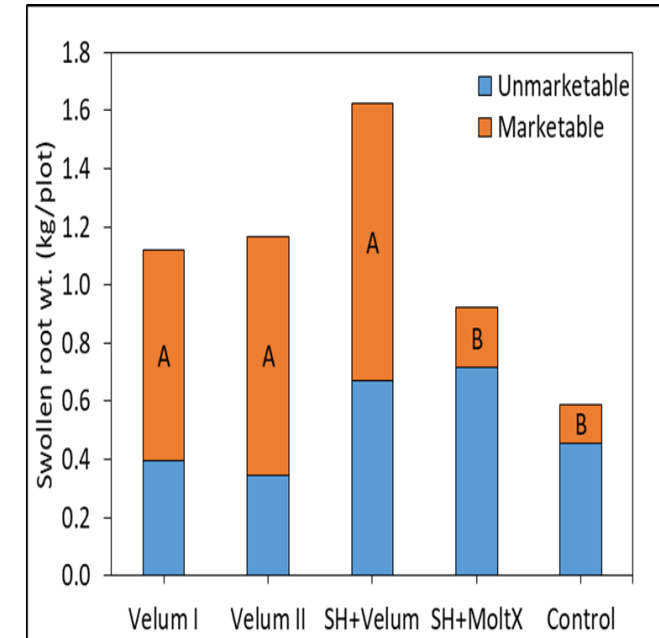
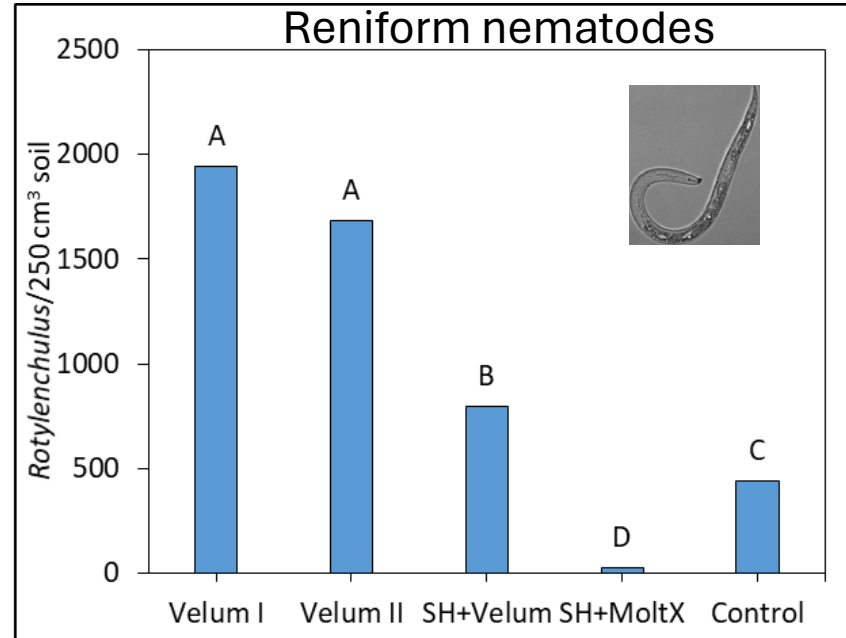
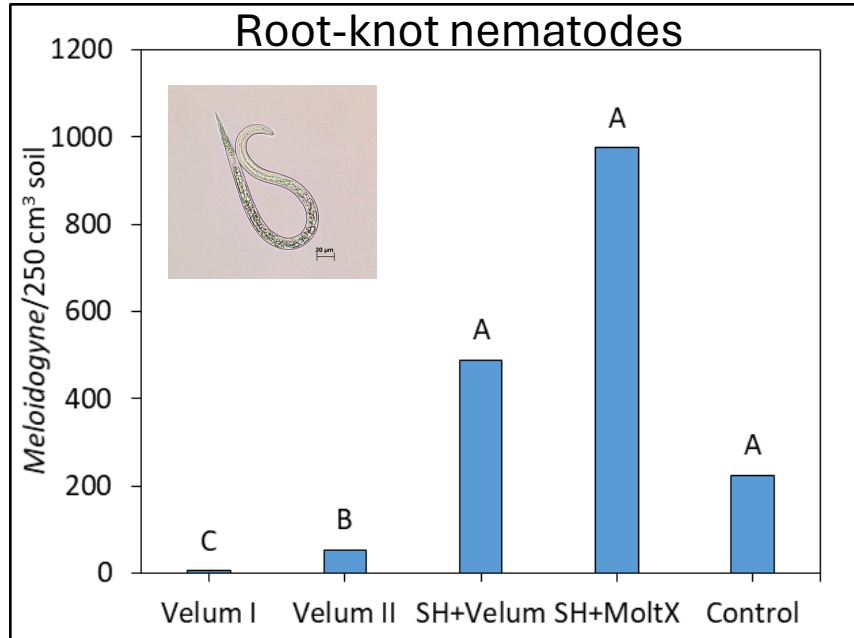
Sunn hemp + Molt-X

Velum One alone



Purpureocillium (Paecilomyces) lilacinum strain 251
– egg parasite

Sunn hemp + Molt-X only effective against reniform nematodes



Velum 0 = apply at planting;
 Velum 1 = apply 1 wk after planting;
 SH +Velum = Preplant of sunn hemp
 (SH)+Velum at 1 wk;
 SH+Molt-X = SH+ monthly injection of
 Molt-X
 Control = no treatment

Velum suppressed root-knot, Molt-X suppressed reniform nematodes.

- Root-knot affected sweet potato yield more than reniform nematodes.
- Sunn hemp improved yield in SH+Velum.

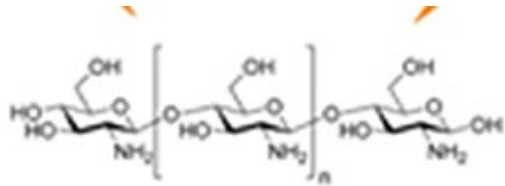
Preplant rotation

Soil amendment

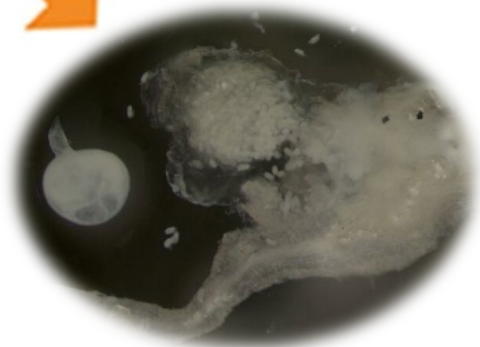
Post-plant drenching

Chitin

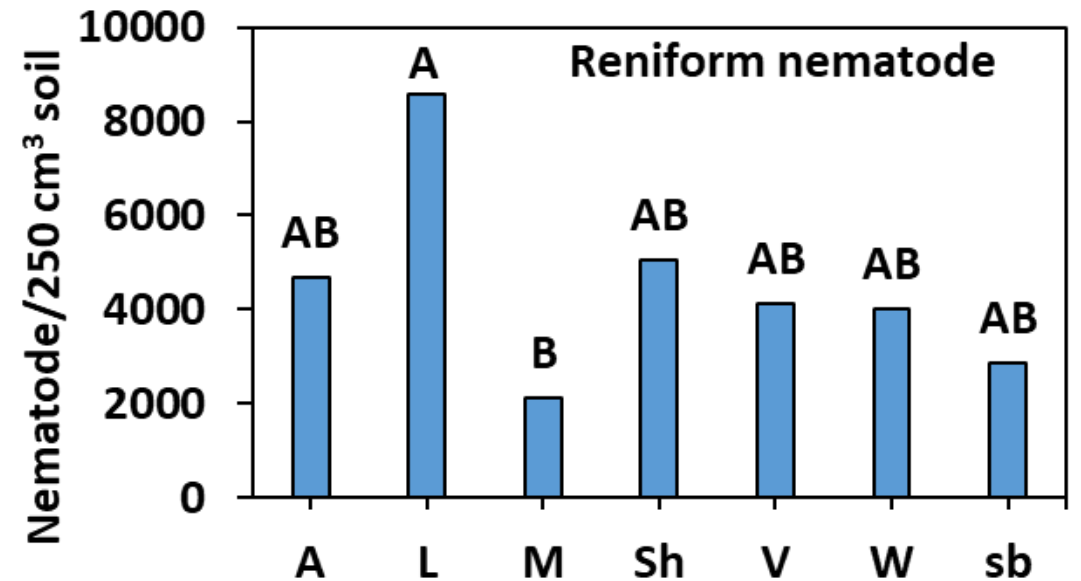
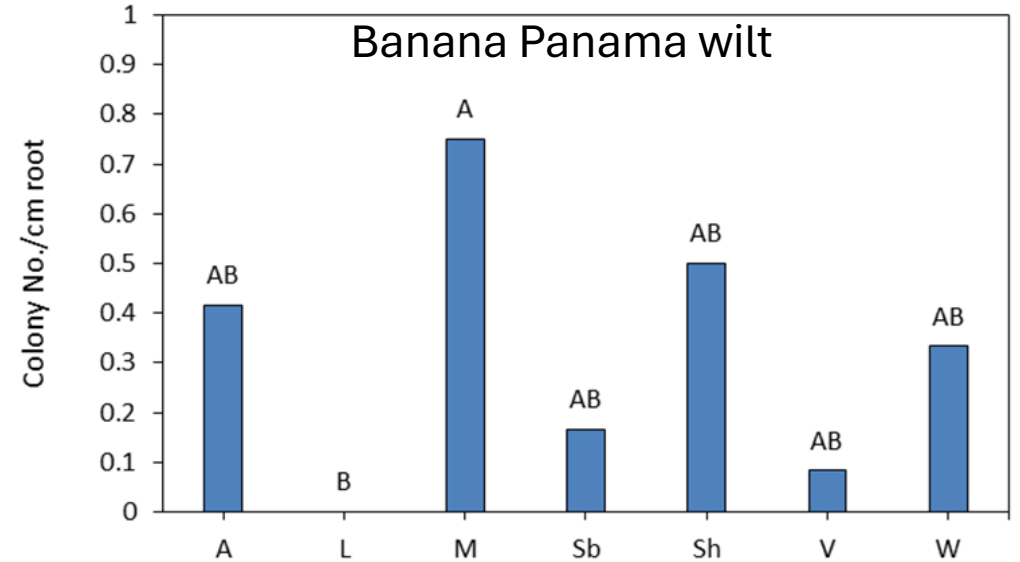
- A = Actinovate (*Streptomyces lydicus*),
 - L = Lobster meal,
 - M = Mustard (ground),
- Sb = Subtilex (*Bacillus subtilis*),
 - Sh = Shrimp shell meal,
 - V = Vermicompost tea,
 - W = Water



Chitosan



FOC Purple Colonies on Komada Medium



Preplant rotation

Soil amendment

Post-plant drenching

Induce Systemic Resistance

Suppressive soil



- **Actinovate AG** is a high concentration of a patented beneficial organisms on a 100% water soluble powder.
- a.i. = *Streptomyces lydicus* strain WYEC 108
- An effective preventative spray for many soil-borne and foliar fungal diseases.
- Effect on nematode suppression is not convincing.



- Shrimp shell meal is a slow-release organic fertilizer (5% N, 8% P, 15% Ca & 18% chitin & trace minerals), derived from ground-up shrimp shells.
- Used in Asia for its nematicidal properties.
- Enhance beneficial soil chitin-feeding microbes.
- Nematode egg shell is composed of chitin.

Preplant rotation

Soil amendment

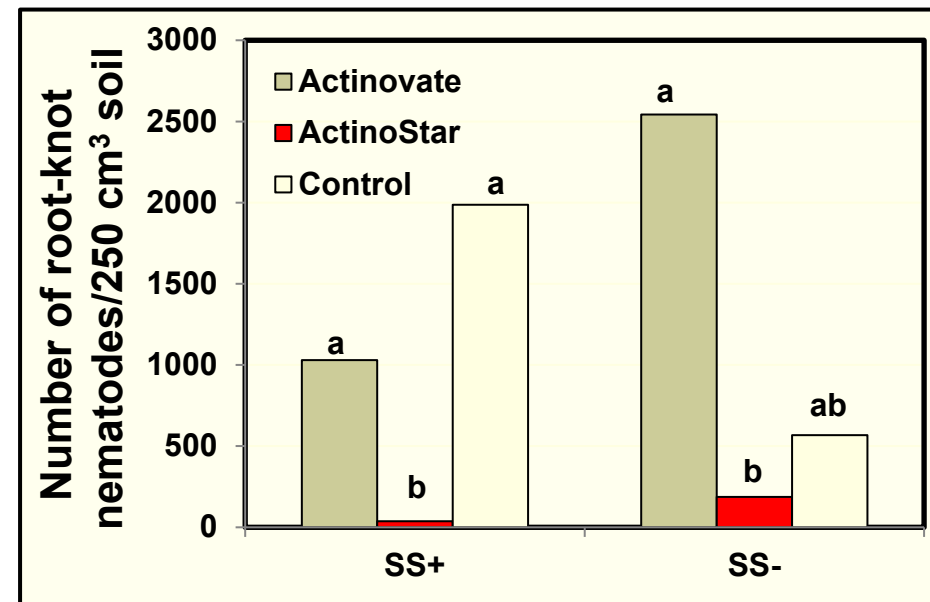
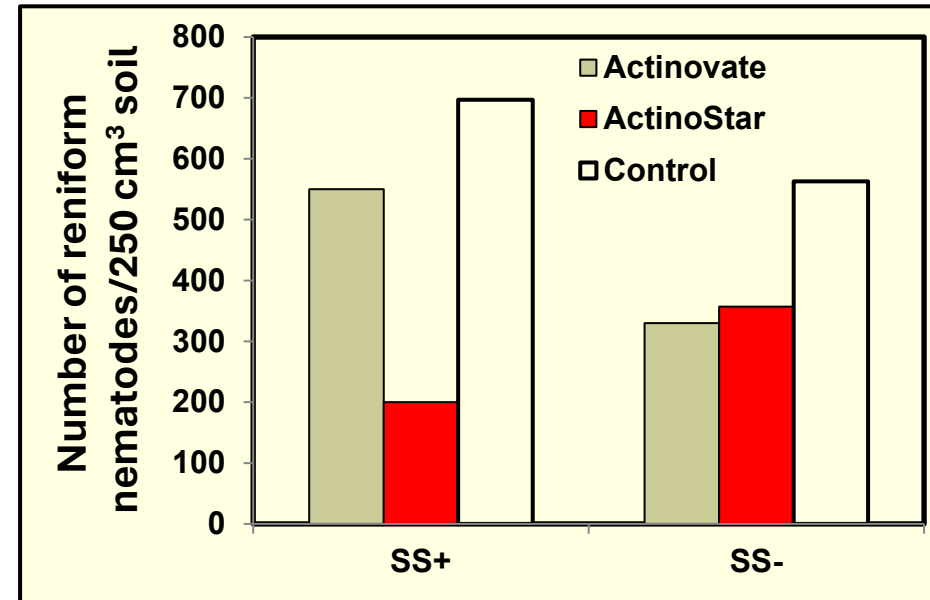
Post-plant drenching

Induce Systemic Resistance

Suppressive soil

ActinoStar / Shrimp shell meal

- Shrimp shell meal (SS) +/- (35 lb/1000 sq ft)
- Actino-Star (AS) 6 oz/acre
- Actinovate (AG) 6 oz/acre
- Untreated control (C)



Preplant rotation

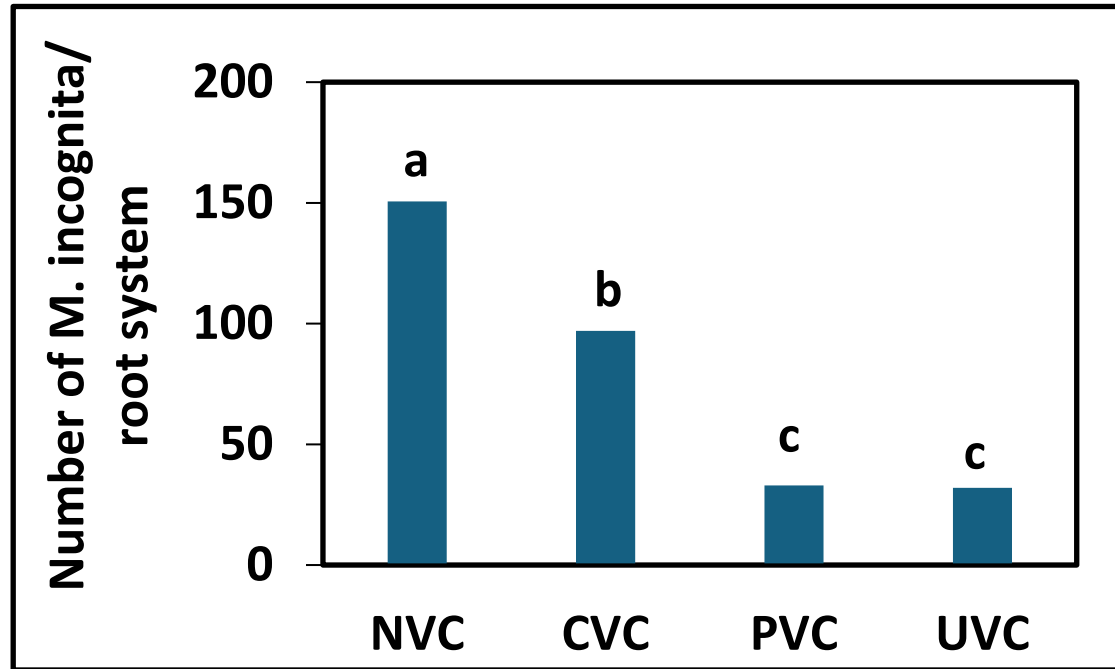
Soil amendment

Post-plant drenching

Induce Systemic Resistance

Suppressive soil

Vermicompost Tea



- UVC and PVC consistently suppressed RKN penetration, but CVC occasionally suppressed RKN penetration.



NVC: Water

CVC: completely cured VC (> 2 months)

PVC: partially cured VC (1-1.5 months)

UVC: uncured VC (< 1 week)



Preplant rotation

Soil amendment

Post-plant drenching

Resistance

Suppressive soil

Root-knot nematode Resistant varieties (ADSC)



N-5, N-63, N-65,
Komohana



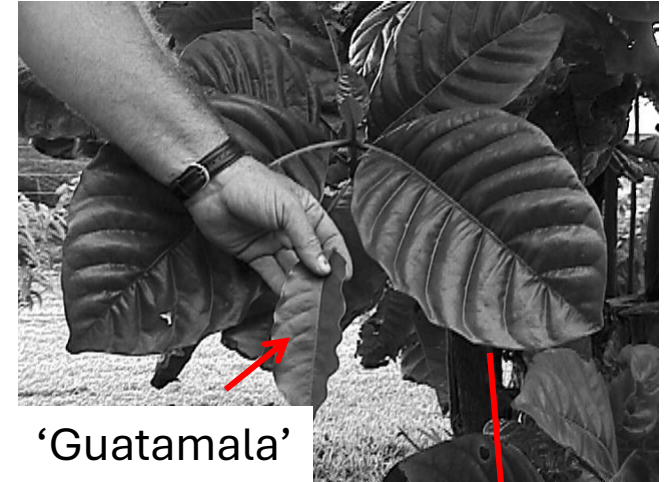
Healani,
Kewalo



Poamoho Pole
Bean



Grafting clips used for
securing the graft



'Guatamala'

Fukunaga root stock

- Coffee farmers in Hawaii graft commercial coffee variety, Kona typica (*Coffea arabica* 'Guatamala') to root-knot nematode resistant root stock, Fukunaga (Bittenbender et al., 2001).

Preplant rotation

Soil amendment

Post-plant drenching

Resistance

Suppressive soil



Omnivore
Eukyrtalus carteri



Predator
Clarkia papillata



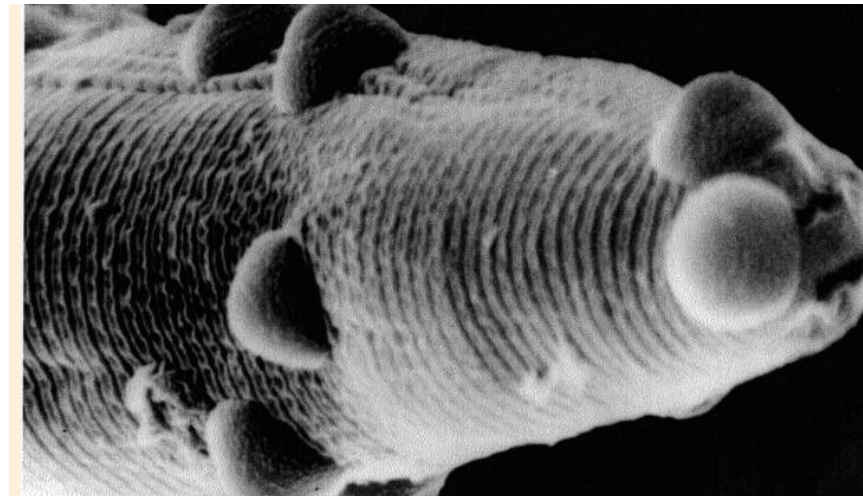
MYCORRHIZA

RHIZOBACTERIA

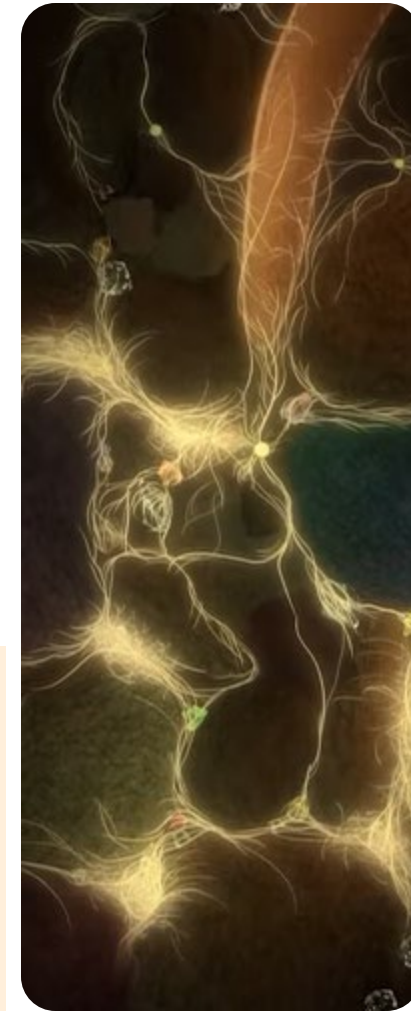
HEALTHY CO₂
RICH SOIL



Nematode-trapping fungi



Pasteuria penetrans endospores



Mycorrhizae

Summary:

Sustainable Nematode Management



Enhance crop diversity

Support natural enemies

Induce host plant resistance

Improving plant health (tolerance)

Targeting on vulnerable stages of nematodes



Mahalo

- NIFA OREI (HAW09705-G),
- NRCS CIG (NR1992510002G001 and NR2192510002G002).
- CTAHR Plan of Work (POW16-964), Multi-state (HAW09034-R) and Hatch (HAW09048-H).
- Roshan Paudel, Philip Waisen, Ben Wiseman, Lauren Braley, Jensen Uyeda, Josh Silva, Donna Meyer, Farm Crews from Poamoho Experiment Station, Koaloa Ranch.

Please complete a survey at:

https://docs.google.com/forms/d/e/1FAIpQLSc4p6-IDFZleX7zdkxpqD1ihxyqyqjch8OyKZ13VLe3_mYTZg/viewform

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