



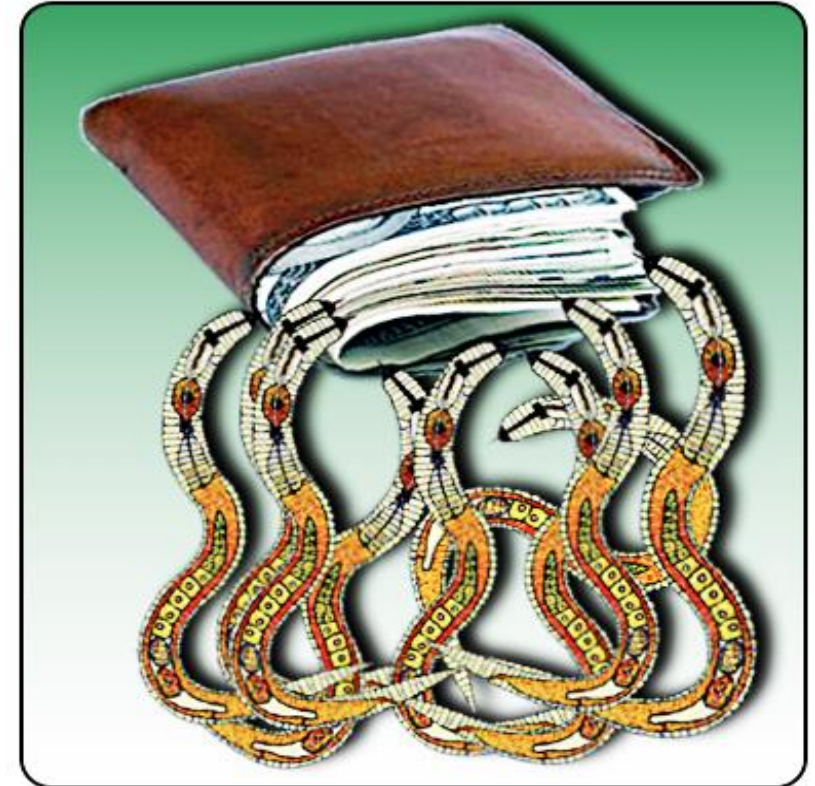
MANAGING PLANT-PARASITIC NEMATODES USING ORGANIC FARMING APPROACHES

Philip Waisen and K.-H. Wang

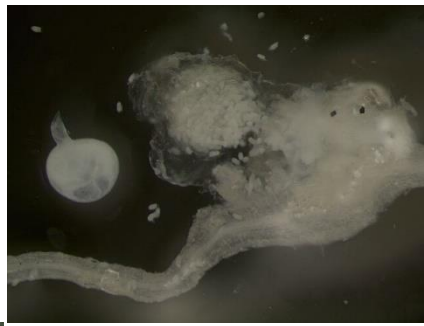


Root-knot and Reniform Nematodes

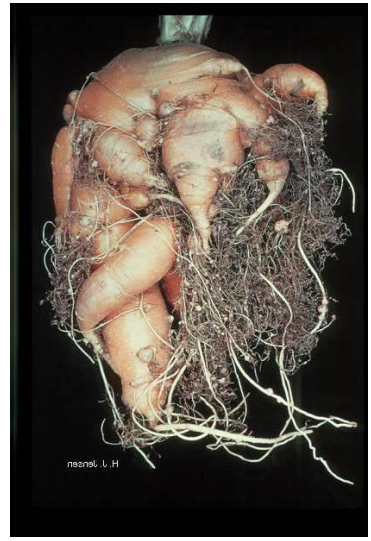
- Worldwide there are > 4,100 species of plant-parasitic nematodes.
- \$100 billion/yr loss worldwide.
- \$10 billion/yr loss in USA.
- Root-knot nematodes can cause 20-38% crop loss.



Root-knot Nematodes



Blemishes on cross section of a potato tuber



Split roots of carrot

Picture: Society of Nematologists

Kona root-knot nematodes on coffee



Picture: Koon-Hui Wang

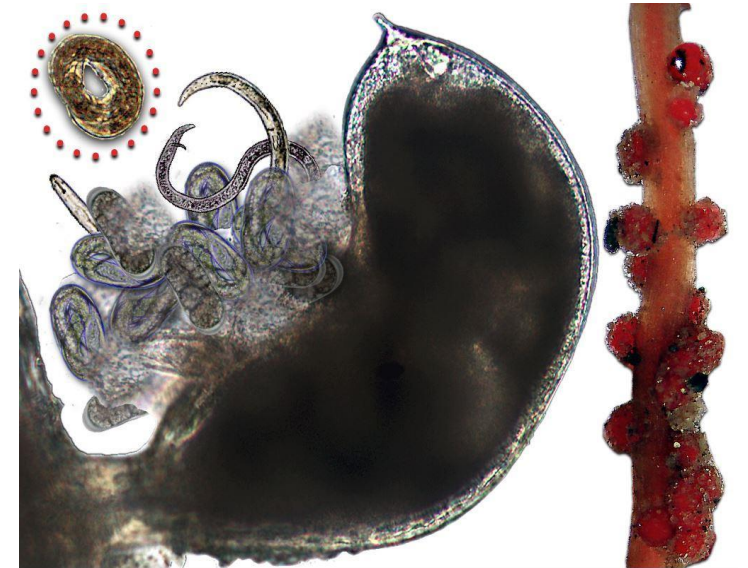
Cucurbit crops are most susceptible

Reniform Nematodes

Crops in Hawaii most damaged by Reniform nematode



Pineapple



Papaya



Cowpea



Sweet potato

Broad host range



Cover Crops Suppressive to Plant- parasitic Nematodes



✓ Sunn hemp
Crotalaria juncea
-- monocrotaline



French Marigold
Tagetes patula
-- α -terthinyI



Sorghum-sudangrass
-- Dhurrin



Radish and mustard
-- glucosinolate

The Secret of Sunn Hemp in Suppressing Plant-parasitic Nematodes



Mechanisms:

1. Serves as a poor host
2. Allelopathic
3. Enhance nematode-trapping fungi
4. Enhance beneficial nematodes and soil arthropods, increase plant tolerance

Sunn hemp superhero video:

http://www.youtube.com/watch?v=AG_CYsVmQ4

Hānai‘Ai

The Food Provider



Sustainable and Organic
Agriculture Program

College of Tropical Agriculture and Human Resources

Hānai‘Ai Newsletter June-July-August 2012.

<http://www.ctahr.hawaii.edu/sustainag/news/articles/V12-Wang-Allelopathic.pdf>



Effect of crop age, tissues, and biomass amount on SH allelopathic effects



1 month



2 month



3 month

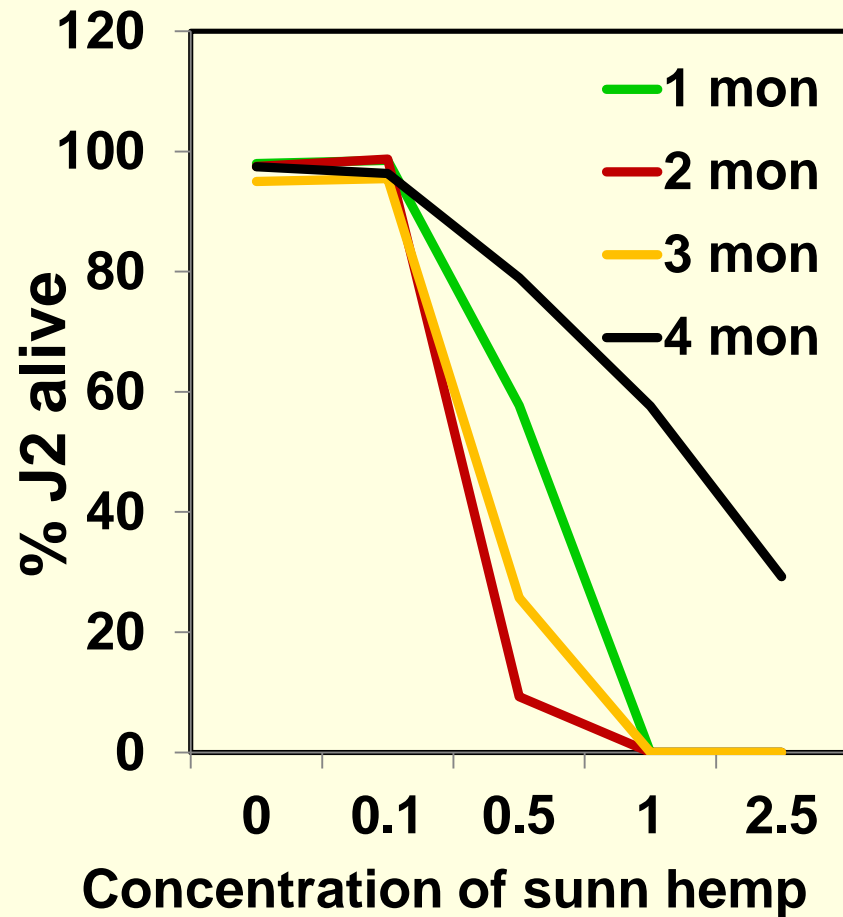


4 month

4 ages ×	4 tissues ×	5 Concentration
	Leaf	2.5%
	Stem	1.0%
	Flower	0.5%
	Roots	0.1%
	Whole plant	0

**4 dishes
2 trials**

Effect of crop age, tissues, and biomass amount on SH allelopathic effects

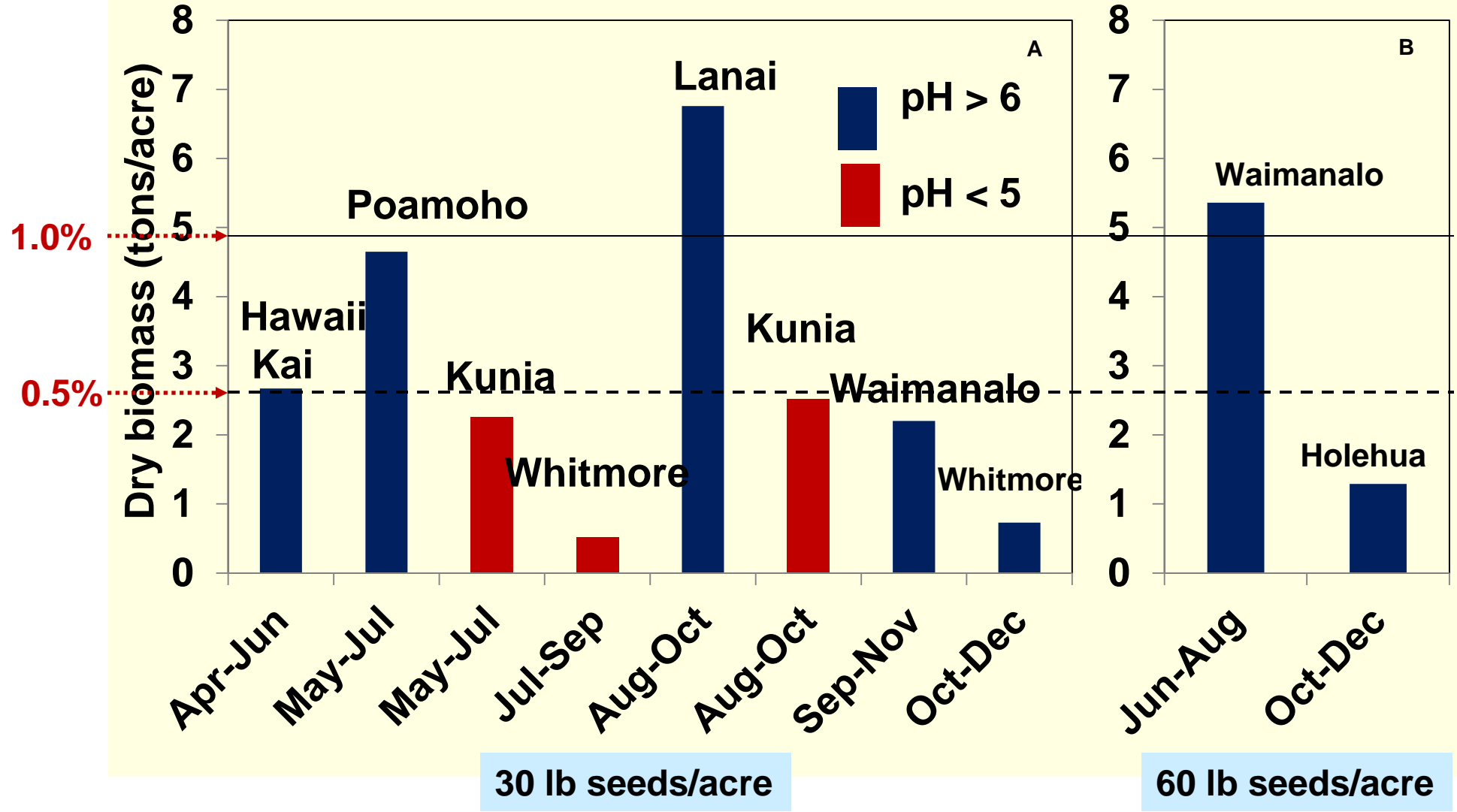


- SH Leaf tissue was most suppressive, and the result resembled those in the whole plant tissues.
- Suppressive effect of SH is most significant at 2- and 3-month old.

Conc (%)	Dry Biomass (tons/acre)
0.1	0.5
0.5	2.5
1	5
2.5	12.5

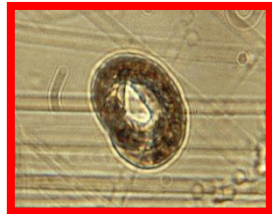


Can we achieve 2.5 to 5 tons dry biomass in Hawaii?

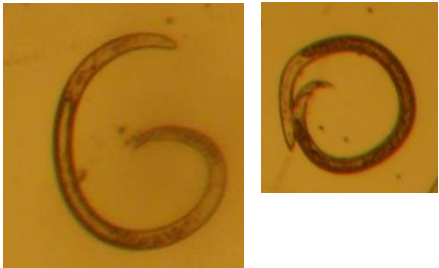


Managing Reniform Nematodes with Sunn Hemp

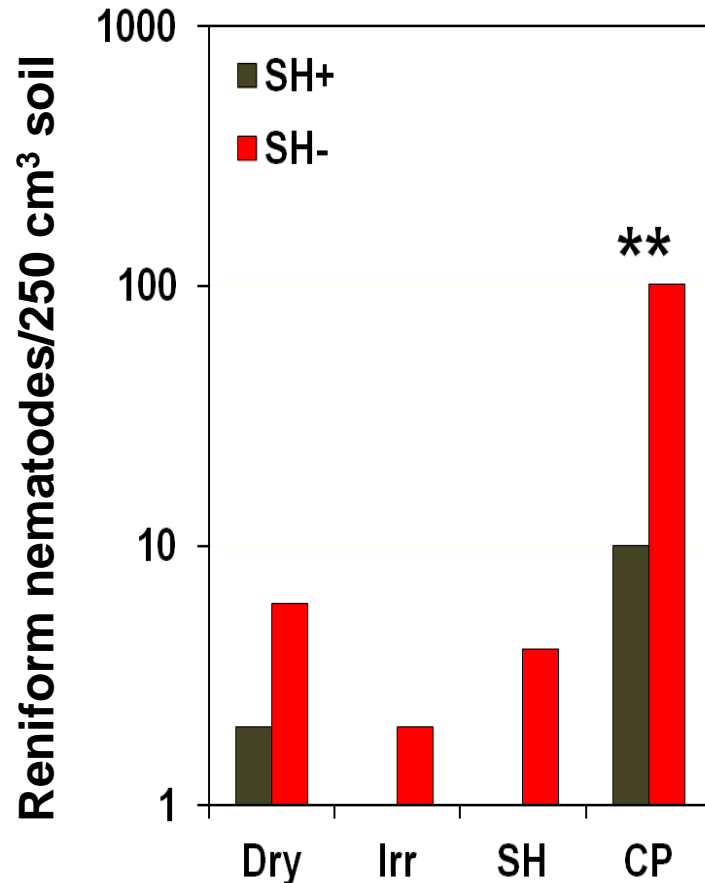
- Vermiform stage of reniform nematodes are easier to kill than the anhydrobiotic stage.



anhydrobiotic



Vermiform stage



SH+ = Soil amended with sunn hemp
Irr = land irrigated
SH = planted with sunn hemp
CP = planted with cowpea



Thus, farmers should plant sunn hemp soon after termination of a sweet potato crop.

Cover Crops Suppressive to Plant- parasitic Nematodes



Sunn hemp
Crotalaria juncea
-- monocrotaline



French Marigold
Tagetes patula
-- α -terthinyI



Sorghum-sudangrass
-- Dhurrin



Radish and mustard
✓ -- glucosinolate

MANAGING PLANT-PARASITIC NEMATODES USING TRAP CROPPING AND BIOFUMIGATION

Philip Waisen* and K.-H. Wang



Plant-parasitic Nematodes

- > 4,100 species of plant-parasitic nematodes are known
- \$100 billion/yr loss worldwide
- \$10 billion/yr loss in USA
- Root-knot nematodes can cause 20-38% crop loss
- Especially damaging to cucurbit crop (no resistant cultivars)
- Cover crops provide great potential to suppress plant-parasitic nematodes.



Sunn hemp
Crotalaria juncea
-- monocrotaline



French Marigold
Tagetes patula
-- α -terthinyll



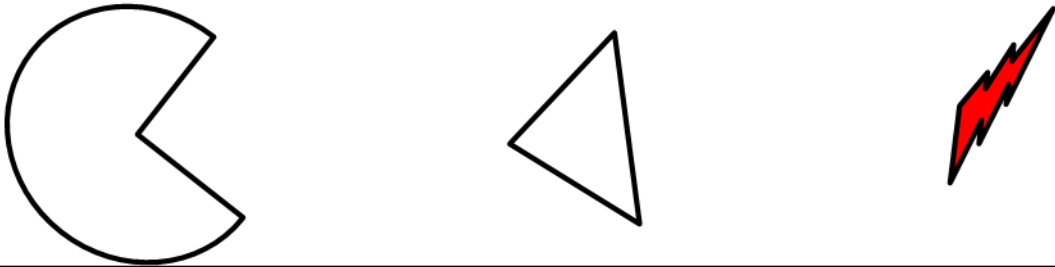
Sorghum-sudangrass
-- Dhurrin



Radish and mustard
✓ -- glucosinolate

Oil Radish and Mustard as Biofumigants

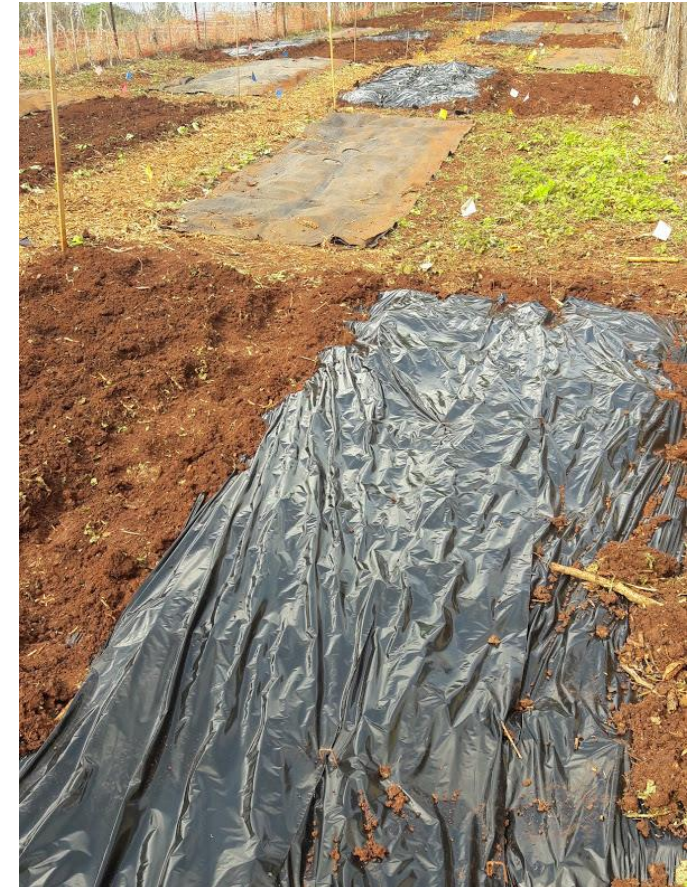
Glucosinolates + Myrosinase = Isothiocyanates



Cover with black plastic

Weed whacked

Soil incorporated



Glucosinolates

Isothiocyanates

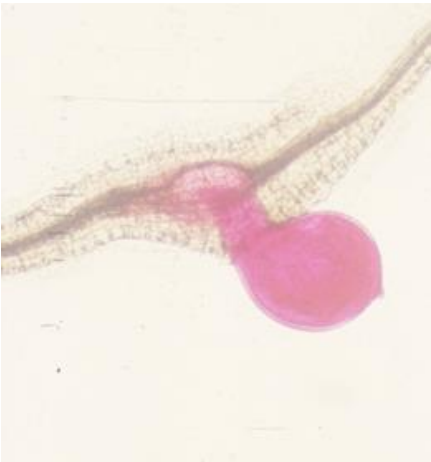
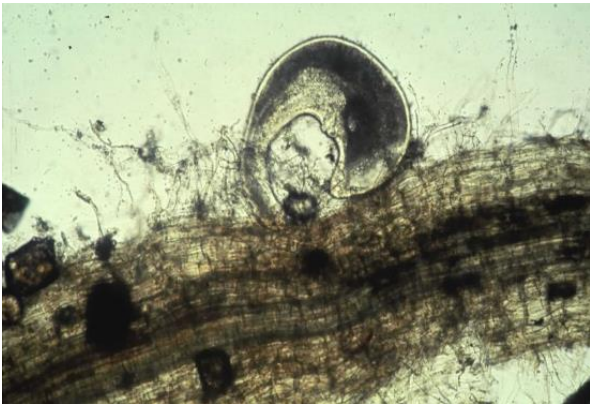
More isothiocyanates

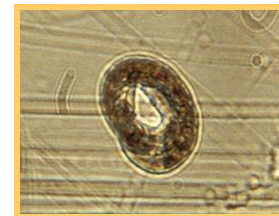
Trap isothiocyanates

Oil radish and Mustard as Trap Crops

Trap crop



	Root-knot nematode	Reniform nematode	Trap cropping effect
			
Oil radish	Poor host	Poor host	Slightly
Mustard	Excellent host	Non-host	Good for root-knot



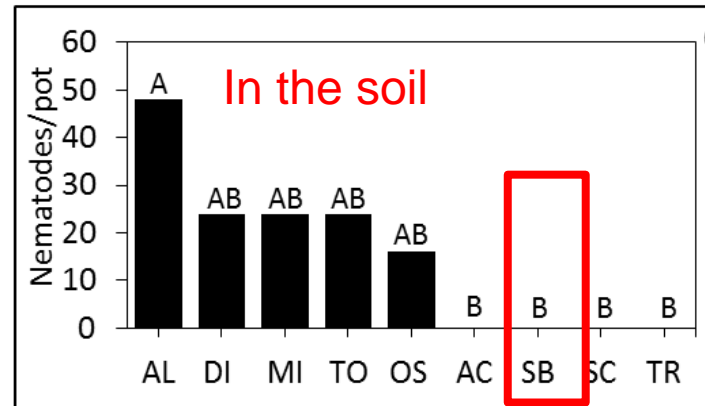
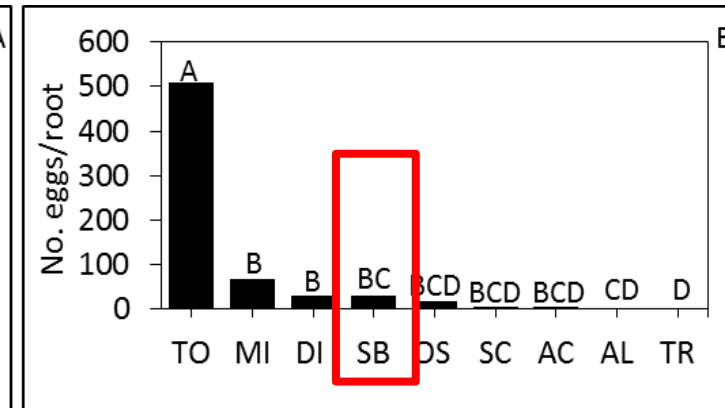
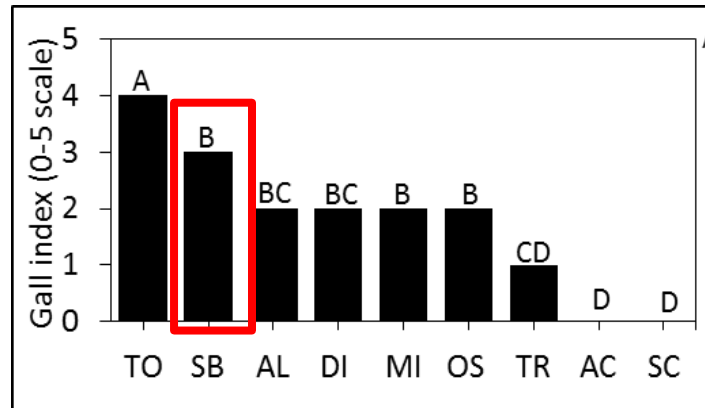
Anhydrobiotic

Objectives

- To screen oil radish and mustard cultivars for trap cropping and biofumigation effects against root-knot and reniform nematodes.
- To determine best termination time of oil radish in a field trial.
- To determine best cultural practices for biofumigation effects.

1.1 Susceptibility of radish cultivars to *M. javanica*

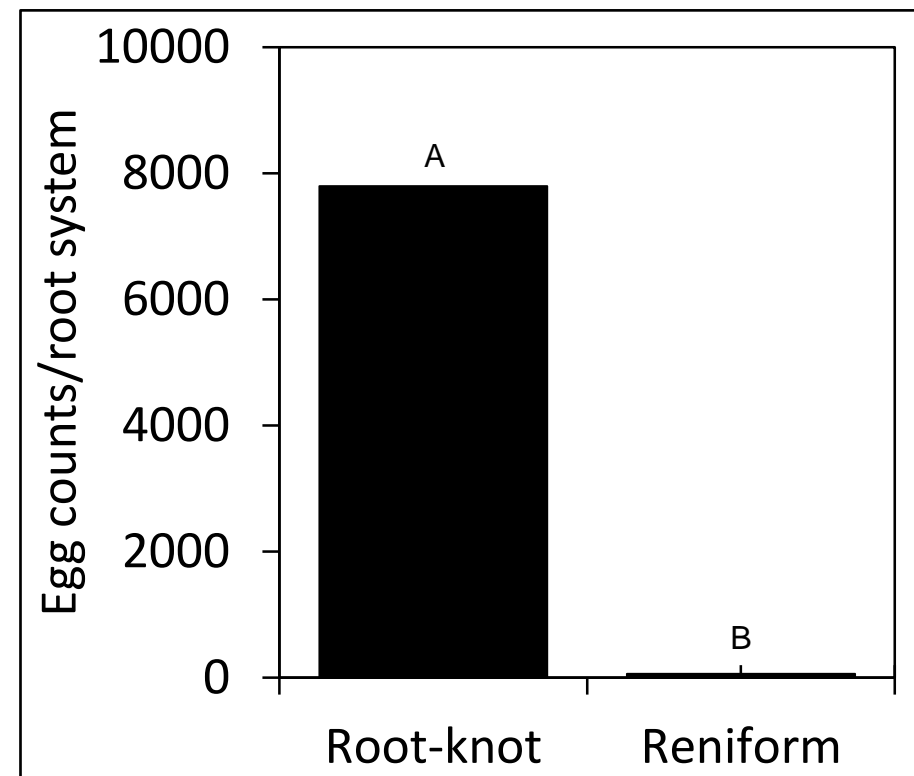
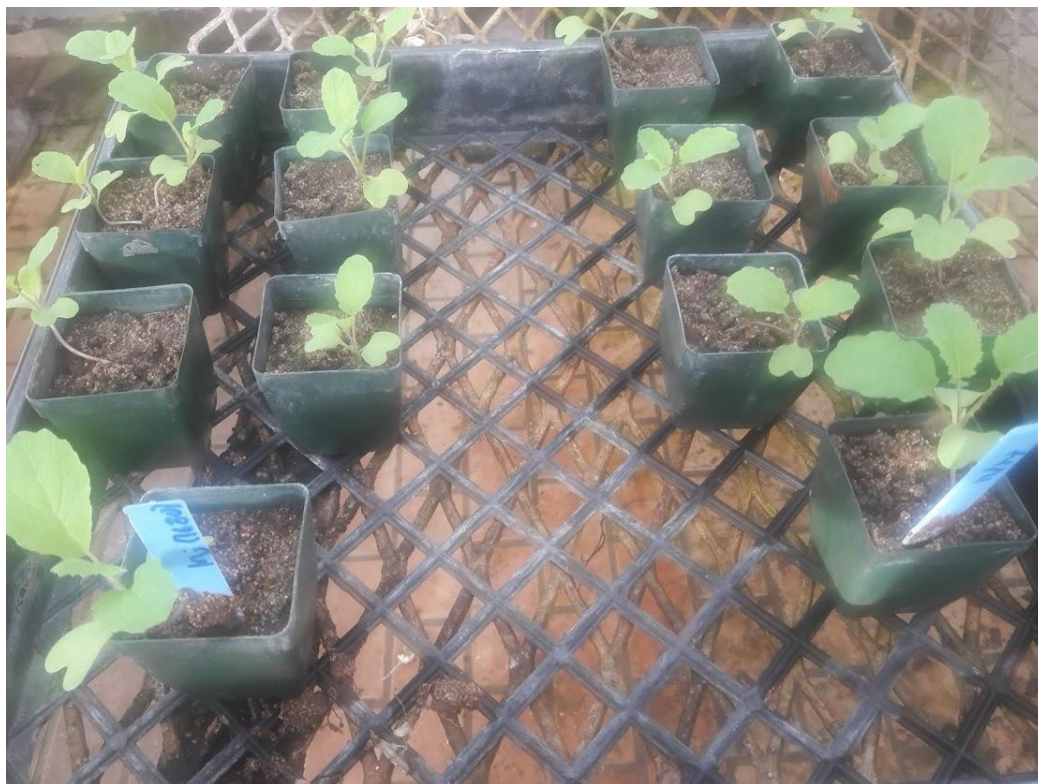
Radish cvs	Price
Alpine	\$98.22/lb
April Cross	\$112/ 10 million seeds
Discovery	N/A
Miyashige	\$76.50/lb
Oshine	\$169.95/lb
Sodbuster	\$2.25/lb
Summer Cross	\$147.90/lb
Tillage Radish	\$3.72/lb



8 oil radish cvs + 'Orange Pixie' tomato inoculated with root-knot nematodes, examine for 1 month.

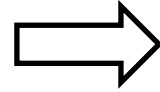
A) Radish gall index; B) Nematodes/250 cm³ soil; C) Nematodes/4-L pot

Susceptibility of 'Caliente 199' mustard to root-knot and reniform nematodes



'Caliente 199' mustard is an excellent host for root-knot nematode (*M. javanica*) whereas it is a poor host for reniform nematode ($Pi=1000$ IJ2s)

Biofumigation Effect



Nematode infested soil was amended with 1% (w/w) residues of 8 oil radish cvs. and compared to unamended control, 'Orange Pixie' tomato was used as bioassay crop.

Starting nematode populations

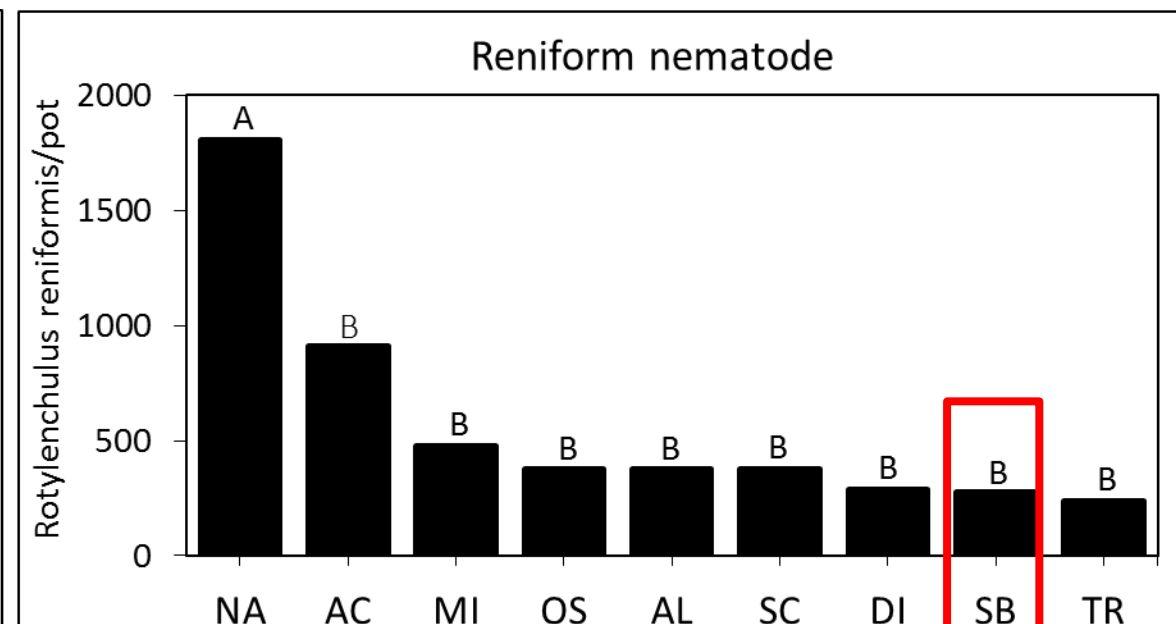
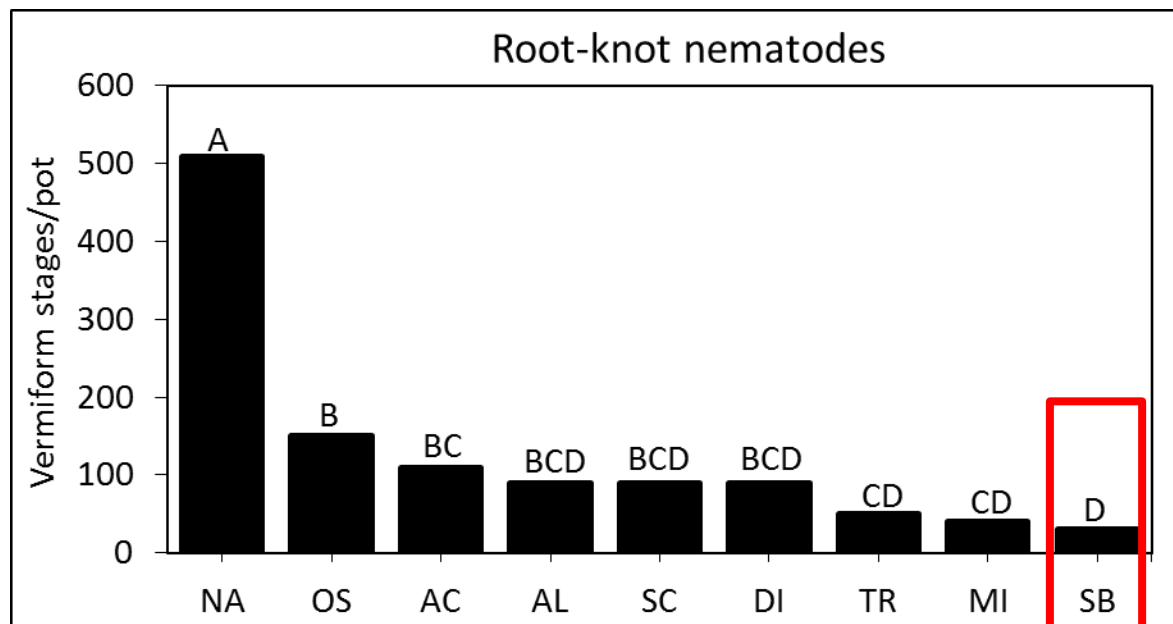
Root-knot = 2130

Reniform = 2270



Plant growth difference on tomato 'Orange Pixie'

Biofumigation Effect of Oil Radish to root-knot and reniform nematodes



NA = no amendment; AC = April Cross; AL = Alpine; MI = Miyashige; OS = Oshin; SB = Sodbuster; SC = Summer Cross; TR = Tillage Radish

Objectives

- To screen oil radish and mustard cultivars for trap cropping and biofumigation effects against root-knot and reniform nematodes.
- To determine best termination time of oil radish in a field trial.
- To determine best cultural practices for biofumigation effects.

Field Trial

Growing period of Oil Radish as a
Cover Crop

8 weeks

6 weeks

4 weeks

2 weeks

0 week

Termination of oil radish



2 weeks



6 weeks



4 weeks



8 weeks



Oil radish was planted for different length of time (0, 2, 4, 6 and 8 weeks). Experiment was arranged in RCBD with 4 replications. Pumpkin was planted after oil radish (OR) termination and incorporation, nematodes were sampled at OR termination and at 4 weeks after pumpkin planting.

Severity of pumpkin root galls by root-knot nematodes

Root Gall Index based on 0 – 12 scale

RGI = 0



RGI = 6



RGI = 9



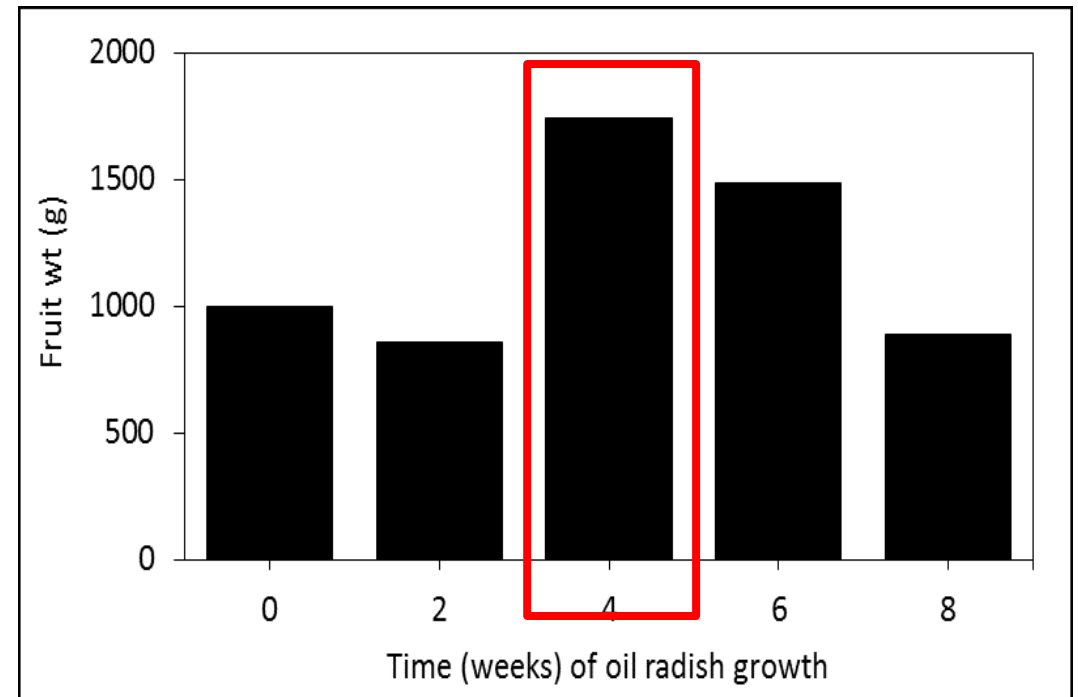
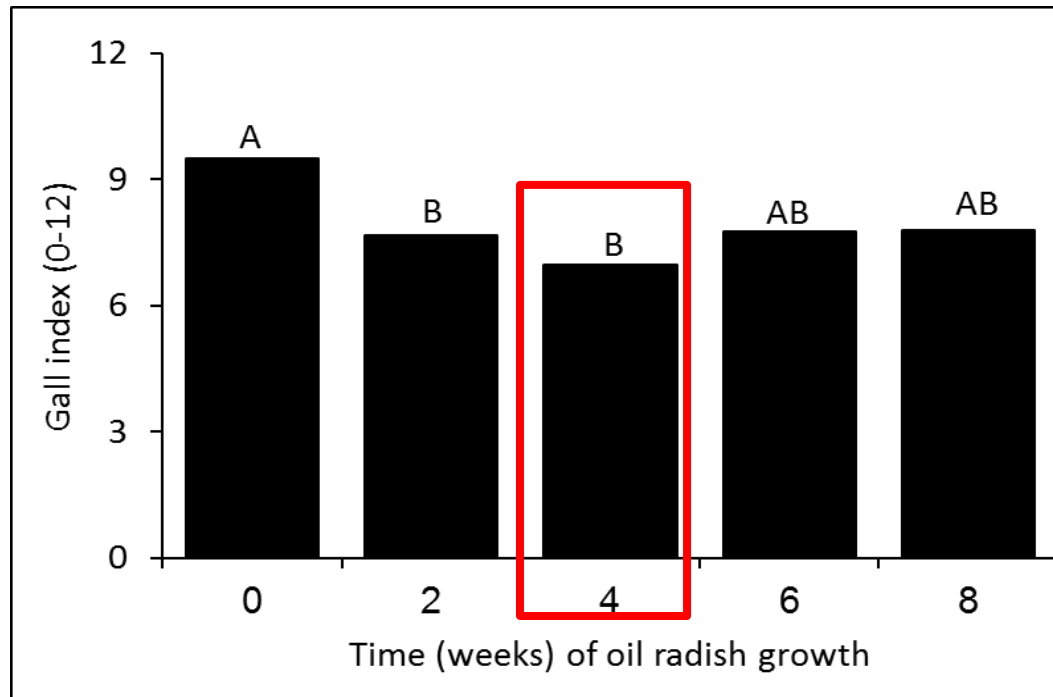
RGI = 12



Oil radish did not suppress PPN in the soil but reduce root galls on pumpkin

Repeated measure over 3 sampling dates at monthly interval

Herbivores	Nematodes/250 cm ³ soil				
	0	2	4	6	8
Root-knot nematode	178 A	140 A	213 A	160 A	467 A
Reniform nematode	371 A	256 A	874 A	168 A	312 A
Stubby root nematode	36 A	20 A	32 A	22 A	33 A

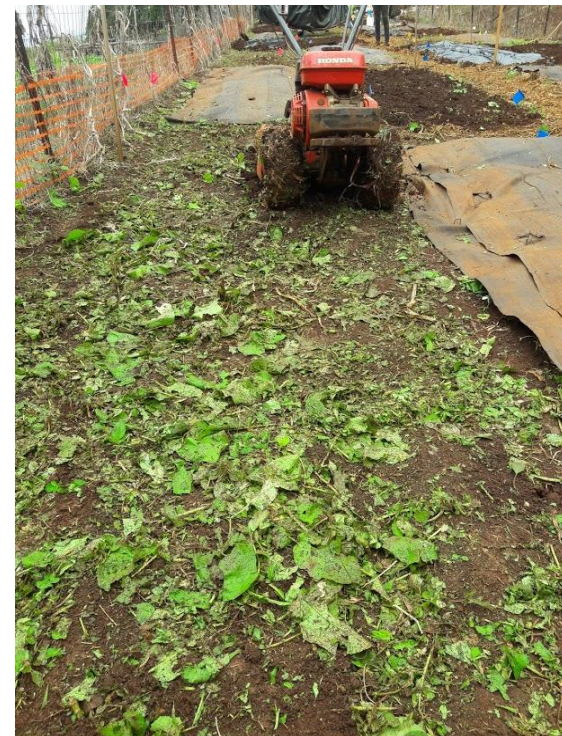


Objectives

- To screen oil radish and mustard cultivars for trap cropping and biofumigation effects against root-knot and reniform nematodes.
- To determine best termination time of oil radish in a field trial.
- To determine best cultural practices for biofumigation effects.

Materials and methods

Cover crop termination and biofumigation



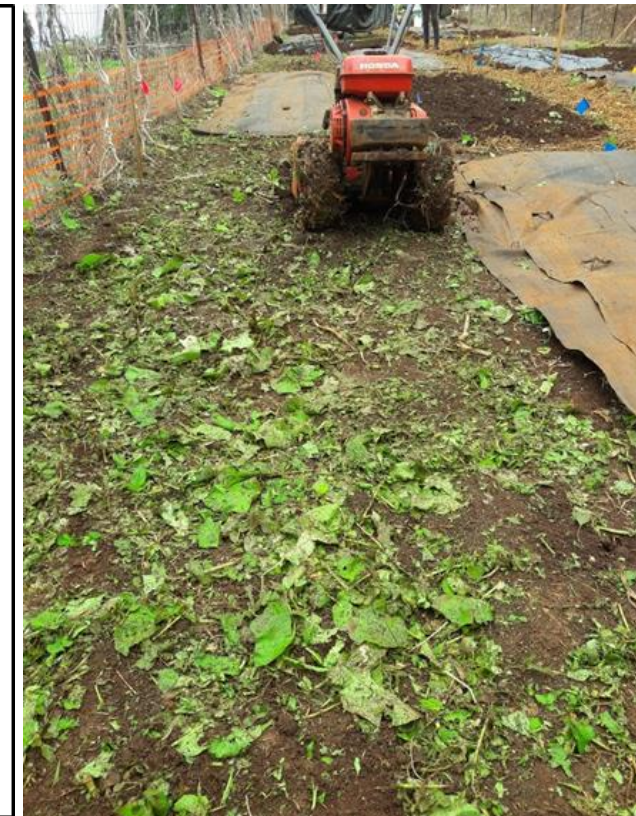
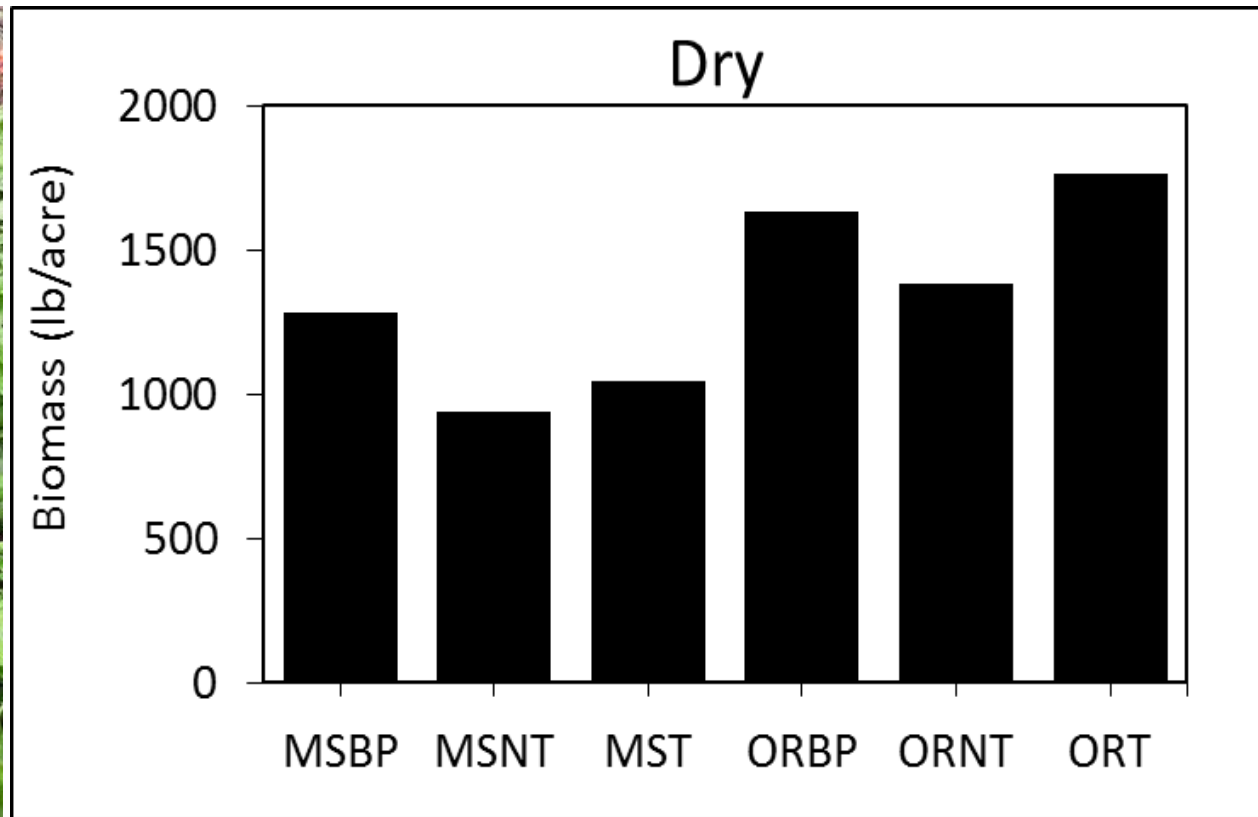
7 Treatments

- 1) ORT=oil radish + weed whack + till
- 2) ORBP=oil radish + weed whack + till + black plastic
- 3) ORNT=oil radish + sickle + weed mat (=NT)

- 4) MST=mustard + weed whack + till
- 5) MSBP=mustard + weed whack + till + black plastic
- 6) MSNT=mustard+sickle + weed mat (NT)
- 7) BG=Bare ground

Materials and methods

Biomass production



- 1) ORT=oil radish + weed whack + till; 2) ORBP=oil radish + weed whack + till + black plastic; 3) ORNT=oil radish + sickle + weed mat; 4) MST=mustard + weed whack + till; 5) MSBP= mustard + weed whack + till + black plastic; 6) MSNT=mustard + sickle + weed mat; 7) Bare ground control

Materials and methods

Cover crop termination and biofumigation



1 week after covering weed mat

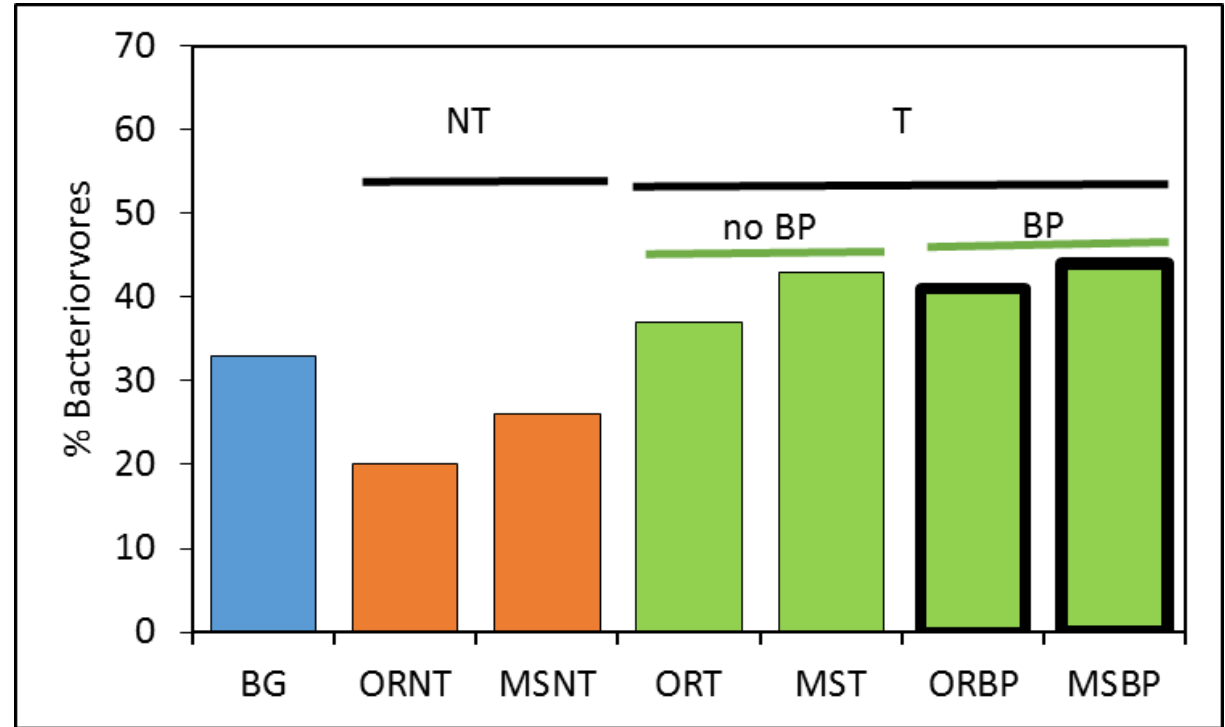
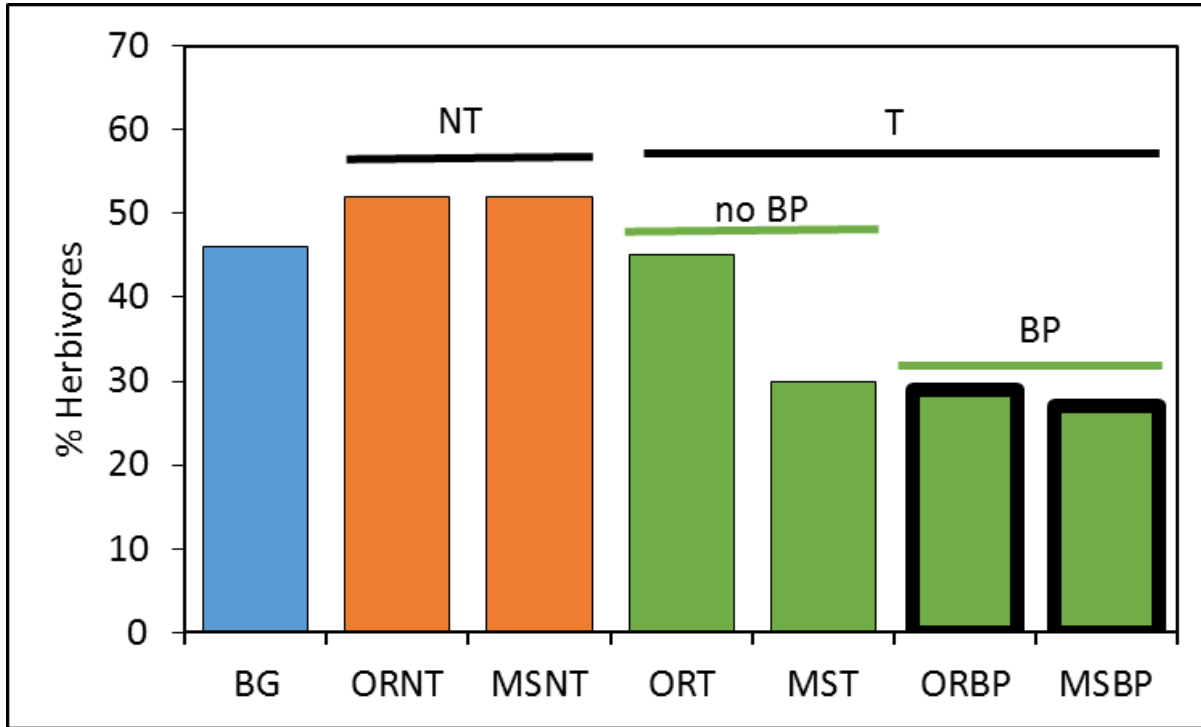


1 week after covering black plastic



'Felix' zucchini transplanted at 3 ft spacing

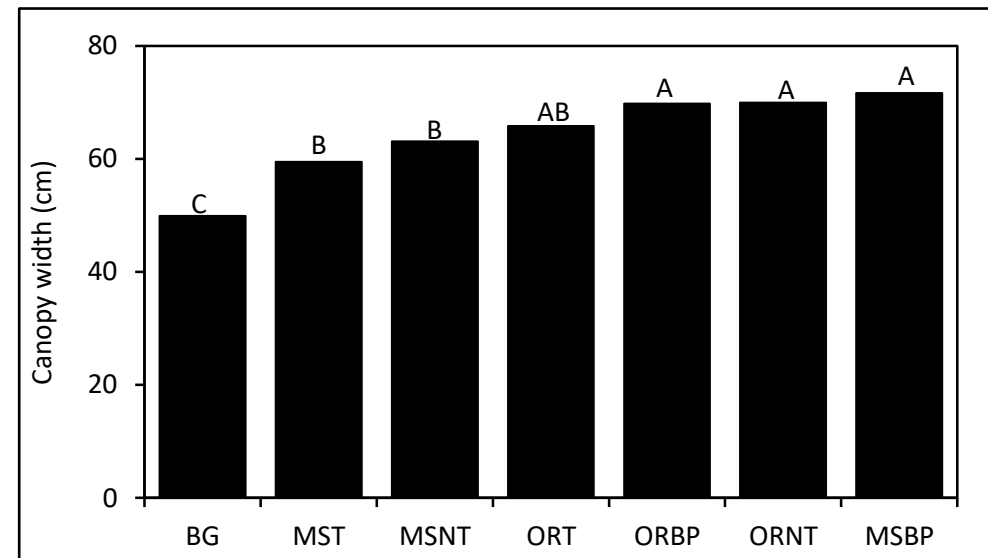
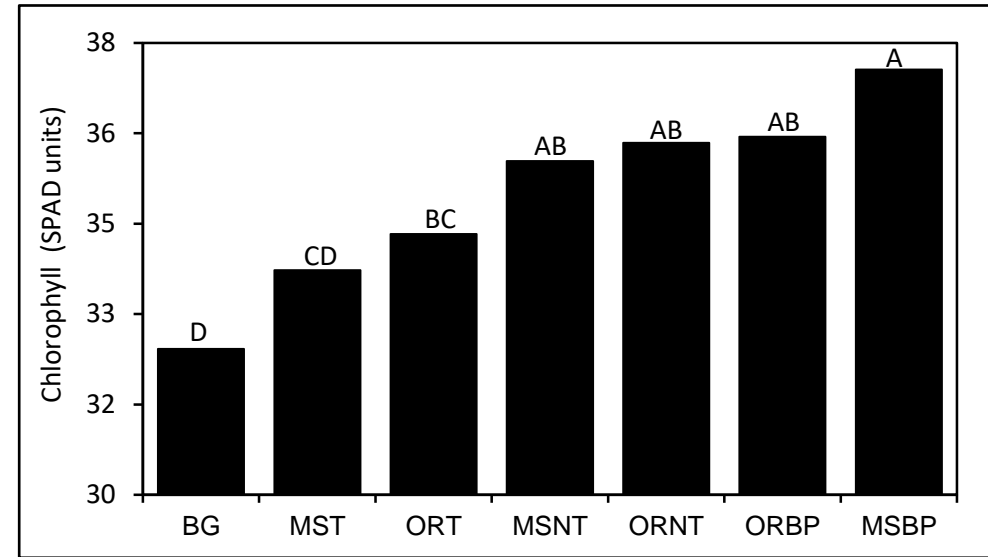
Biofumigation effects of oil radish and mustard on nematodes



1) ORT=oil radish + weed whack + till; 2) ORBP=oil radish + weed whack + till + black plastic; 3) ORNT=oil radish + sickle + weed mat; 4) MST=mustard + weed whack + till; 5) MSBP= mustard + weed whack + till + black plastic; 6) MSNT=mustard + sickle + weed mat; 7) Bare ground control

Plant growth after incorporation of radish and mustard green manures

2 weeks after planting



Conclusions

- 'Sodbuster' oil radish is a potential conventional trap crop and a good biofumigant cultivar against root-knot and reniform nematodes.
- Terminating oil radish at 4 weeks reduced galling on pumpkin and increased the total fruit weight (**74%**).
- Weed whacking oil radish or mustard + till + covering black plastic for 1 week reduced plant-parasitic nematodes by **39%**.

Acknowledgements

Funding source



Sustainable Pest Management Lab
University of Hawai'i at Mānoa,
College of Tropical Agriculture and Human Resources

Adviser: Dr. Koon-Hui Wang

Dissertation committees: Dr. Brent Sipes, Dr. Zhiqiang Cheng, Dr. Joe DeFrank and Dr. James Leary

Technical support staff: Donna Meyer, Gareth Nagai and Steve Yoshida

Poamoho Experiment Station: Farm crew Jari Sugano

Extension Agents: Jari Sugano and Jensen Uyeda

Shelby Ching
Josiah Marquez
Jonathan Kam
Bishnu Bandari

