Recent developments in nematode management in horticultural crops

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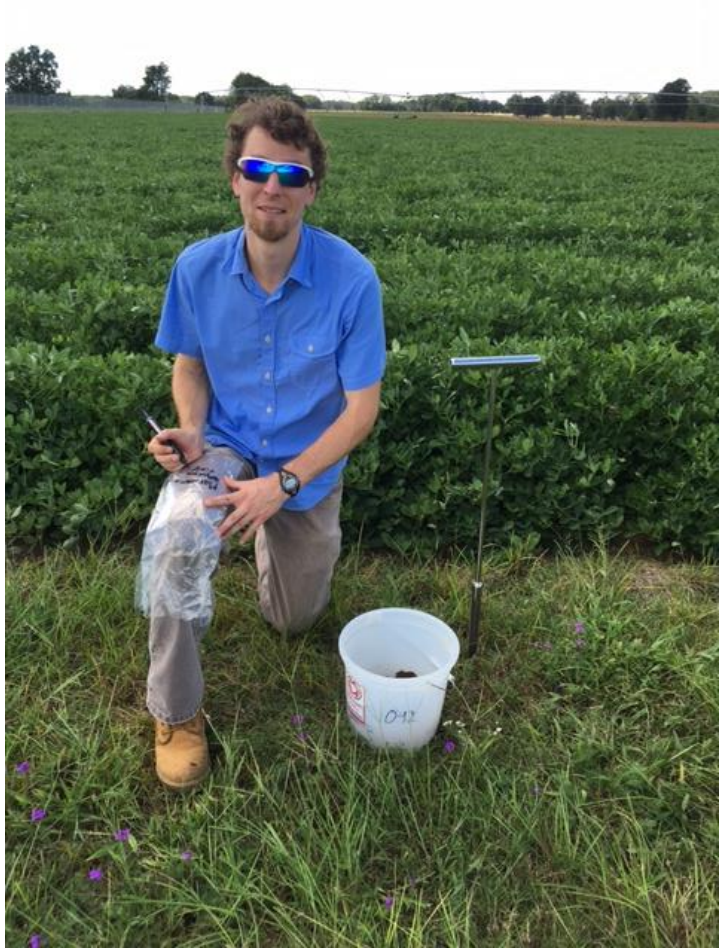
UF | UNIVERSITY of FLORIDA

Outline

1. UF nematology resources
2. Recognizing nematode problems
3. Nematode management
   - Sanitation
   - Crop rotation
   - Resistant cultivars
   - Nematicide application

Dr. Zane Grabau (zgrabau@ufl.edu)



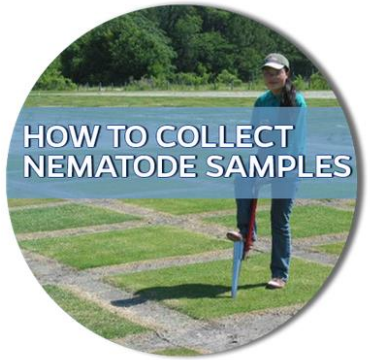
- North Florida agronomic and horticultural crops
- 70% research, 30% extension
- Research on nematode management and ecology
- Who is the nematologist for my crop/location?

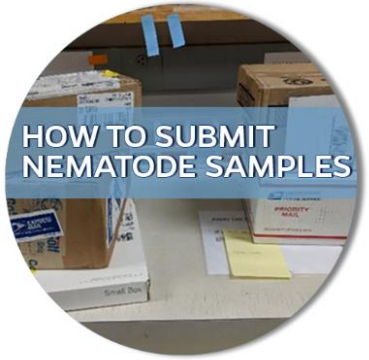
Dr. William Crow. wtcr@ufl.edu
Statewide landscape nematologist (E-R-T)
Gainesville

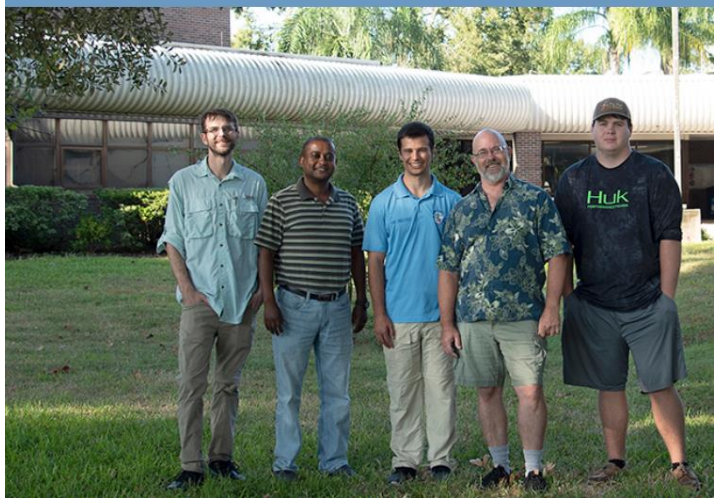
Dr. Johan Desaeger. jad@ufl.edu
Horticulture and ornamentals (R-E)
GCREC (central Florida)

Dr. Abolfazl Hajihassani. ahajihassani@ufl.edu
Tropical/subtropical crops of south Florida (R-T)
FLREC: **Started February 1, 2022**

Dr. Larry Duncan. lwduncan@ufl.edu
Citrus and tree crops (R-T)
CREC







NEMATODE ASSAY LAB, UF/IFAS, ENTOMOLOGY AND NEMATOLOGY DEPARTMENT

The University of Florida Nematode Assay Lab is a service clinic of the UF Institute of Food and Agricultural Sciences and the Entomology and Nematology Department.

Our mission is to provide accurate and timely diagnosis and management recommendations for plant-parasitic nematodes that threaten our agriculture and landscapes.

Phone: 352-392-1994

Email: nemalab@ifas.ufl.edu

Twitter: @NemaAssayLab

http://entnemdept.ufl.edu/nematology-assay-lab/

NAL runs Extension diagnostic samples free

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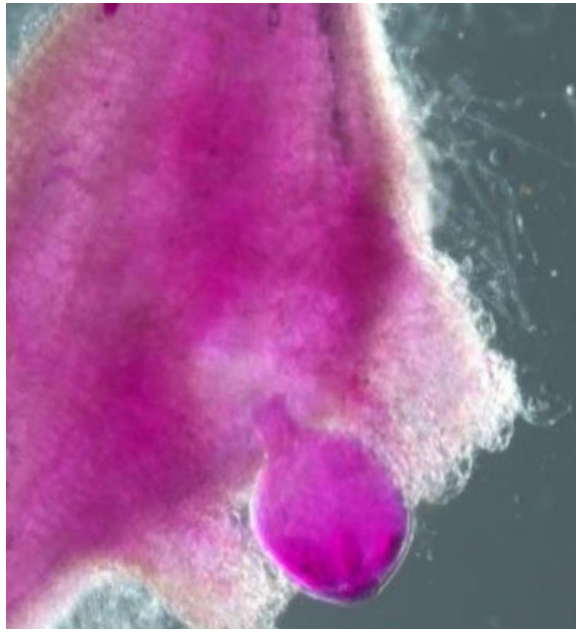
1. UF nematology resources
2. **Recognizing nematode problems**
3. Nematode management
   - Sanitation
   - Crop rotation
   - Resistant cultivars
   - Nematicide application

What are plant-parasitic nematodes?

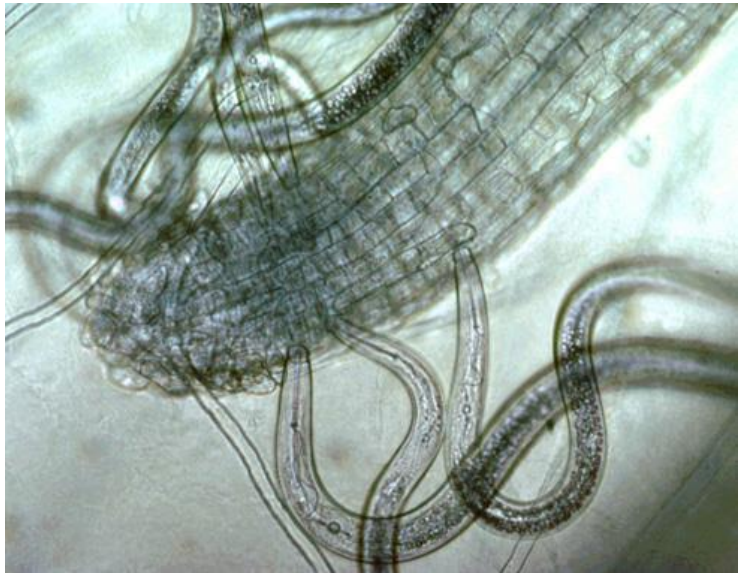
Microscopic, non-segmented worms



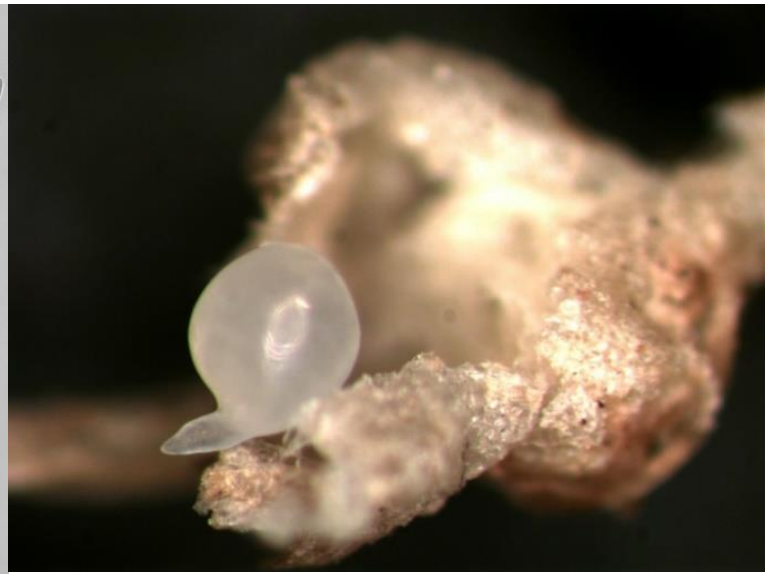
Obligate parasite of plants (usually feed on roots) that decrease crop productivity

Many different genera/species of nematodes: Identity can affect management

Nematodes of most concern in Florida vegetables



Sting nematode



Root-knot Nematode

juvenile (left) and adult female (right)

Sting nematode

- Severe damage to many crops
- Requires very sandy soil (80% or more)
- Symptoms often appear early in season

Patchy stunting and reduced stand in peanut due to sting nematode infestation. **Patchiness is typical of nematode infection.**

Patchy stunting and reduced stand from sting nematode infestation in cabbage

Green beans at harvest stunted, reduced stand, yellow from sting nematode

Sting nematode damaged (left) vs. healthy corn root (right). Note general stunting and necrosis (brown, dying regions). Stubby lateral roots.

Close-up of sting nematode damage on artichoke roots.

Root-knot nematodes

- Also affect a wide range of crops
- Range of soil, worst in sand
- Many species, host range varies by species (primarily row crops)
  - Peanut root-knot nematode
  - Southern root-knot nematode
  - Northern root-knot nematode (strawberries)

Severe root galling on long beans, characteristic symptom of root-knot nematode infection

Meloidogyne enterolobii (guava root-knot nematode)

- Invasive quarantine pest
- More virulent, overcomes resistance
- Detected in Florida in 2012
  - Most frequent in ornamentals, small growers in central Florida

Sweetpotato vines collapsing due to guava root-knot nematode Infection of a nematode-resistant cultivar

Guava root-knot nematode: severe galling from this pest on sweetpotato tubers

Galling on napa cabbage from peanut root-knot nematode. Gall size increases with age, nematode density, and temperature.

Yellowing of napa cabbage from root-knot nematode

Patchy foliar stunting in napa cabbage from root-knot nematode. Symptoms worsen as season progresses.

Late season tomato wilting due to root-knot nematode and fusarium.

Many other nematodes of varying concern!

- Stunting and crimping of strawberry due to foliar nematodes

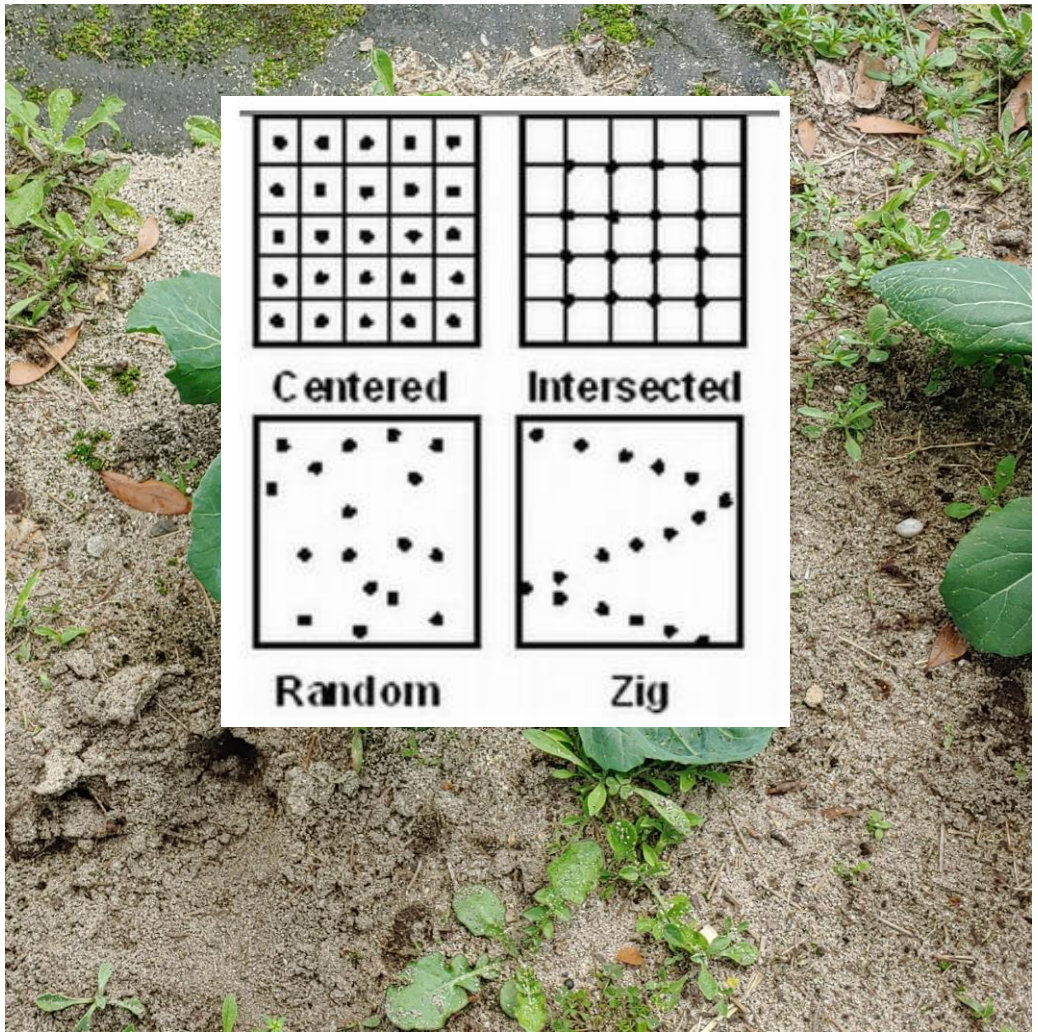
- Reniform nematode stunting cotton
- Horticulture crops and cotton in panhandle and Homestead areas

Sample to confirm nematode problems: UF Nematode Assay Lab

1. Always send soil
   - Add plant roots if convenient
   - Pictures always useful
2. Multiple small cores (6-12)
3. Sample in rooting zone!
4. Avoid drying and heating
   - Out of sun ASAP, refrigerate if storing overnight
   - Don’t add water

Instructions on lab website!

(EDIS nematode management too)



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3. **Nematode management**
   - **Sanitation**
   - **Crop rotation**
   - **Resistant cultivars**
   - Nematicide application

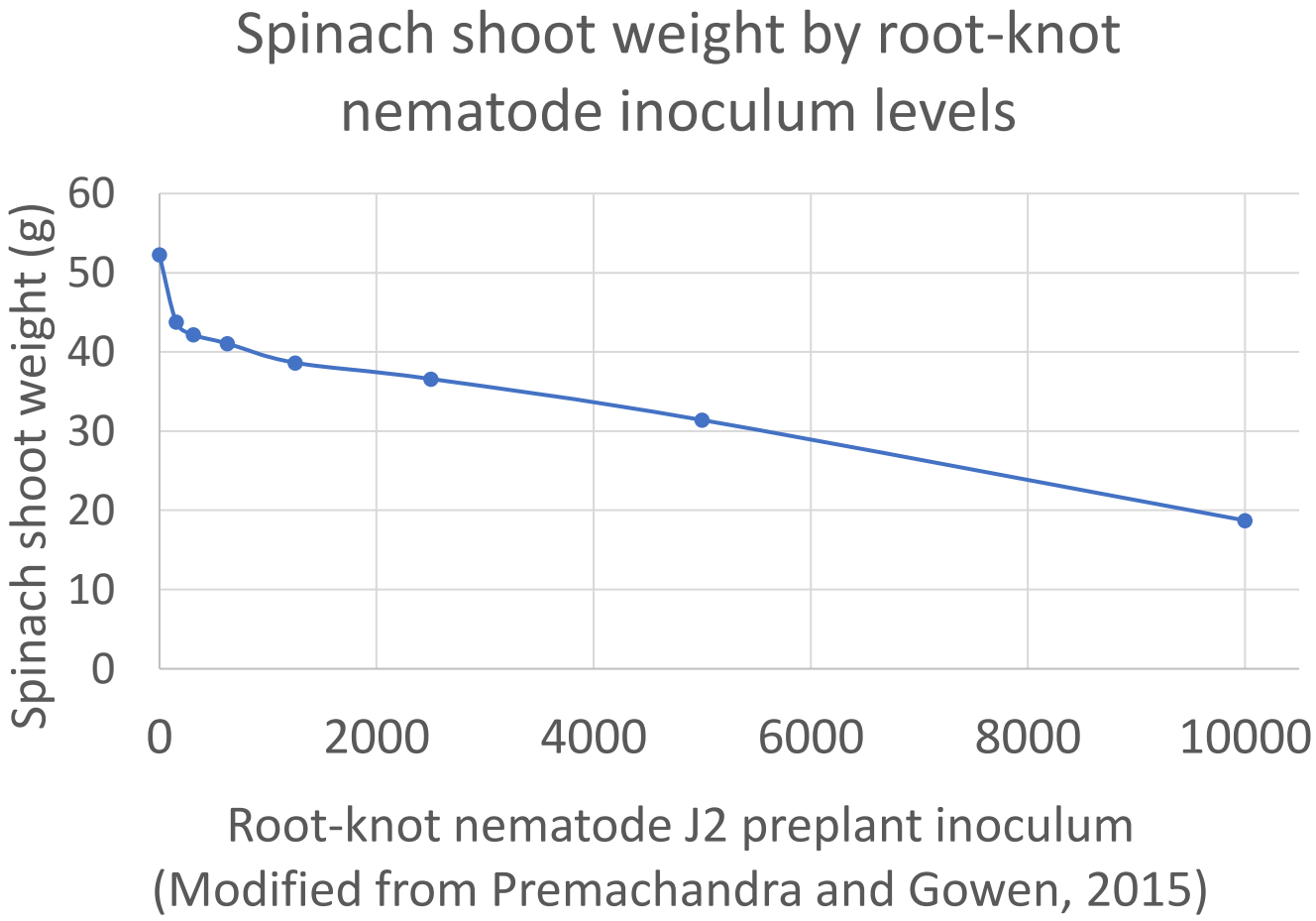
Nematode management goals

1. Prevention
   - Avoid introducing nematodes (*sanitation*)
   - Most sites already have nematodes

2. Avoidance
   - Plant *resistant* line or non-host
   - Avoids damage (or reduces amount)

3. **Initial population reduction**
   - Fewer nematodes, less damage (*rotation, nematicide*)
   - Eradication not feasible
   - **At- or pre-planting nematicide key**

- Important to employ multiple strategies



(Modified from Premachandra and Gowen, 2015)

Poor sanitation undermines nematode management

- Use clean planting material
  - From seed in sterile media
  - Certified source if field-grown
- Avoid spreading other material (soil, roots) from field to field

- Critical for minimizing guava root-knot nematode spread
  - Planting material culprit in many cases

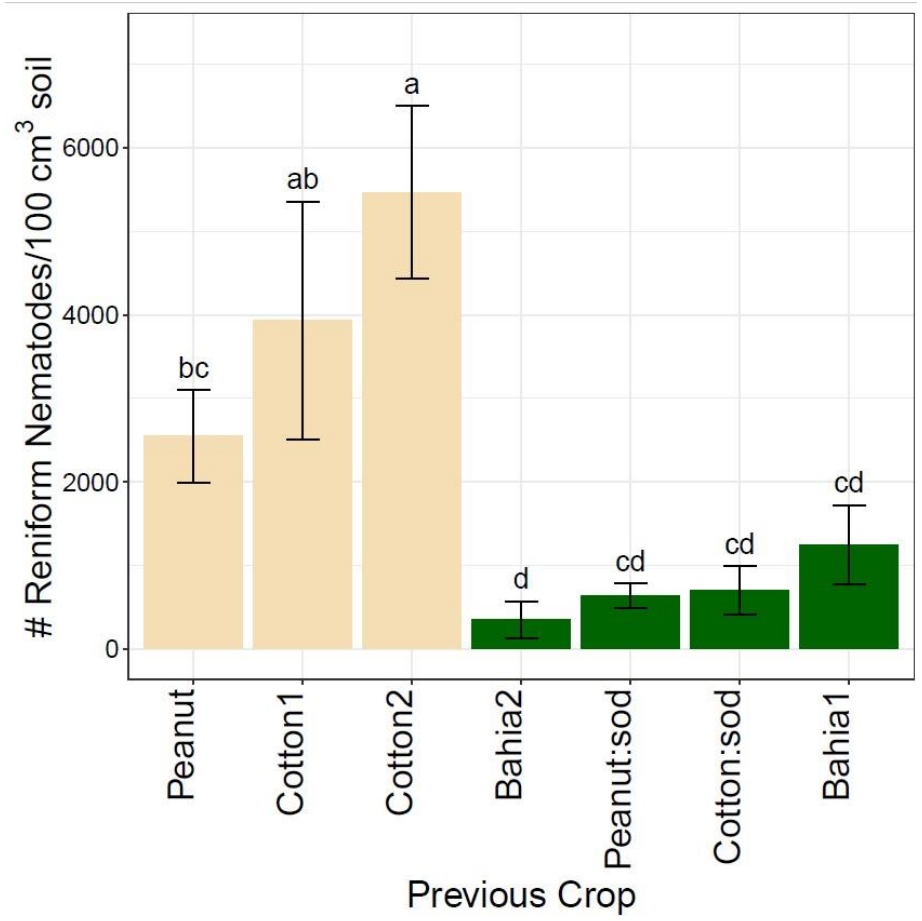
- Can’t remedy infested transplants, so undermines other management

How does rotation manage nematodes?

- Grow crop that a nematode can't reproduce well on (poor host)
- Populations decline, minimizes damage for susceptible crop
  - More effective longer poor host grown
- Some cover crops have nematicidal compounds (Brassicas, sunn hemp)
  - Lab vs. field efficacy
- Interaction varies by nematode-crop

Rotation example: sod-based rotation in agronomic crops

- Long-term rotation site at Quincy, FL
- Infested with reniform nematode
- Conventional rotation (tan)
  - Cotton-cotton-peanut
  - Cotton host, peanut not
- Sod-based rotation (green)
  - Cotton-2 years bahiagrass-peanut
  - Bahiagrass not host



Spring 2017

Rotation choices by nematode

Nematode	Peanut root-knot	Southern root-knot	Guava root-knot	Sting
Best choices	sunn hemp, cotton, corn	sunn hemp, sorghum-sudangrass, resistant cowpea, peanut	Sunn hemp, grasses (corn, rye, etc.), peanut	Sunn hemp, Watermelon? Avoid grasses.
Worst choices	Most vegetables, cowpea	Most vegetables (unless resistant cultivar)	Most vegetables (regardless of resistance)	Grasses (corn, rye, etc.), most vegetables

Resources for nematode rotation choices

COVER CROPS FOR MANAGING ROOT-KNOT NEMATODES[1]

Harsimran K. Gill and Robert McSorley [2]

https://edis.ifas.ufl.edu/publication/IN892

- And other cover crop articles

askifas powered by EDIS 25th Anniversary

NEMATODE MANAGEMENT IN COLE CROPS[1]

Z. J. Grabau and J. W. Noling [2]

https://edis.ifas.ufl.edu/publication/NG024

- Level of detail varies by guide

NEMATODE MANAGEMENT IN POTATOES (IRISH OR WHITE) [1]

Zane J. Grabau and J. W. Noling [2]

https://edis.ifas.ufl.edu/publication/NG029

Horticulture resistant cultivars

- Current resistant cultivars only target root-knot nematode
  - Traditional or grafting (more expensive)
- Level of resistance varies by cultivar-crop
- Crops: tomato, pepper, sweetpotato, watermelon (graft), squash (graft)
  - See EDIS and specialists for details

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   - **Nematicide application**

How do nematicides work?

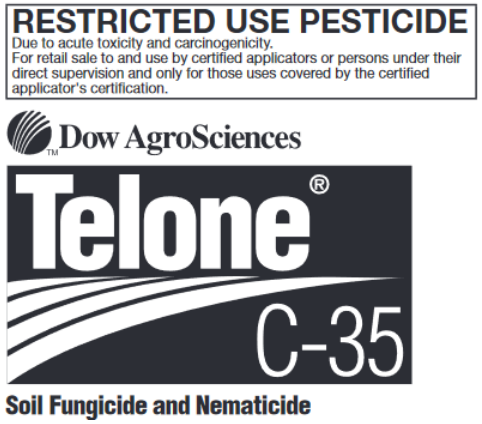
- Kill nematodes, reduce populations early in season

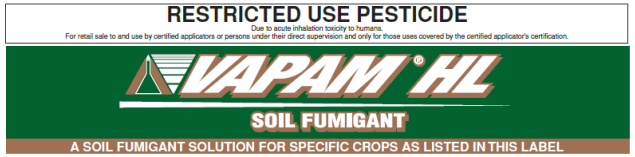
- Protects from damage (preventative), increase yield
  - **At or before planting most important timing**

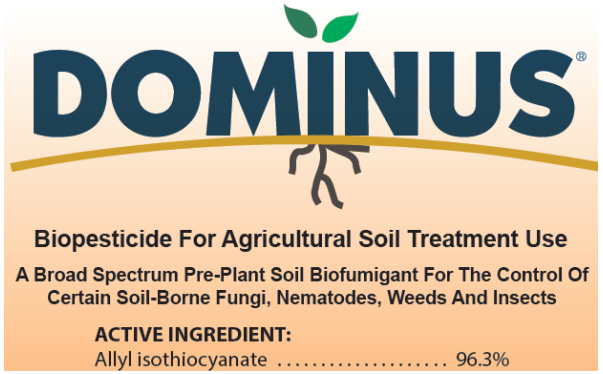
- Populations often increase by end of year
  - Not long-term control, do yearly or combine with other strategies

What products are available?

Fumigant nematicides (gas): All older chemistries







- Require extensive training/documentation
- Typically specialized equipment
  - Preplant as shank or chemigation (under plastic)
- Widely-labelled (available for most crops)
- Most effective category but most expensive

Exception: Dominus labelled as biopesticide. Availability?

Trade Name (example)	Active ingredient	Nematode activity	Other activity	Other notes
Telone II	1,3-Dichloropropene	Good to excellent	Minimal	
Chlor-O-pic	chloropicrin	Poor	Disease, some weeds	
Telone C-35	1,3-D and chloropicrin	Varies based on mixture	“”	
K-PAM	Metam potassium	Poor to Good	Disease and weeds	Poorly mobile, closer shank spacing
VAPAM	Metam sodium	Poor to Good	Disease and weeds	Poorly mobile, closer shank spacing
Dominus	Allyl isothiocyanate	Poor to Fair	Disease and weeds	

Non-fumigant nematicides (liquids or granular)

Old chemistries

RESTRICTED USE PESTICIDE
Due to acute toxicity and toxicity to birds and mammals.
For retail sale to and use only by certified applicators or persons under their direct supervision and only for those uses covered by the certified applicator's certification.

OXAMYL | GROUP 1A | INSECTICIDE

DuPont™ Vydate® L

INSECTICIDE/NEMATICIDE

NOTIFICATION
352-372
The applicant has certified that no

COUNTER® 20G
SMARTBOX®

SYSTEMIC INSECTICIDE – NEMATICIDE
SMARTBOX® CLOSED LOADING SYSTEM
FOR USE IN FIELD CORN (including FIELD CORN containing in-plant corn rootworm protection traits, such as YieldGard®, Herculex® and Agrisure® traits), FIELD CORN GROWN FOR SEED, POPCORN, SWEET CORN, SUGAR BEETS, AND GRAIN SORGHUM

ACTIVE INGREDIENT: By Weight
Terbufos: S-[[(1,1-dimethylethyl)thio]methyl]0,0-diethyl phosphorodithioate 20.0%

RESTRICTED USE PESTICIDE
DUE TO ACUTE DERMAL, PRIMARY DERMAL, AND PRIMARY EYE TOXICITY
For retail sale to and use only by Certified Applicators or persons under the direct supervision of a Certified Applicator, and only for those uses covered by the Certified Applicator's certification.

mocap® nematicide • insecticide

MOCAP® 15% Granular Nematicide-Insecticide

ACTIVE INGREDIENTS:
Ethoprop: (O-Ethyl S, S-Dipropyl Phosphorodithioate) 15%

New chemistries (safer, more convenient)

BAYER

VELUM®

Net Contents:
1 Gallon

GROUP 7 FUNGICIDE

Broad-spectrum fungicide and nematicide for use as a soil treatment for control or suppression of certain crop diseases and control or suppression of plant pathogenic nematodes.

For uses on: Brassica (cole) leafy vegetables (group 5); Bulb vegetables (group 3-07); Citrus (group 10-10); Corn, field, grain; Corn, pop, grain; Cotton (subgroup 20C); Cucurbits (group 9); Fruiting Vegetables (group 8-10); Leafy vegetables (except watercress) (group 4); Legume Vegetables (except cowpea and dried peas); Peanut; Pecan; Pome fruit (group 11-10); Small Berries (caneberries and bushberries) (subgroups 13-07A and 13-07B); Stone Fruits (group 12-12); Strawberry and other low-growing berries, except cranberry (subgroup 13-07G); Sweet Corn; Sweet Potato; Tobacco.

ACTIVE INGREDIENT: Fluopyram: EPA Reg. No. 264-1078

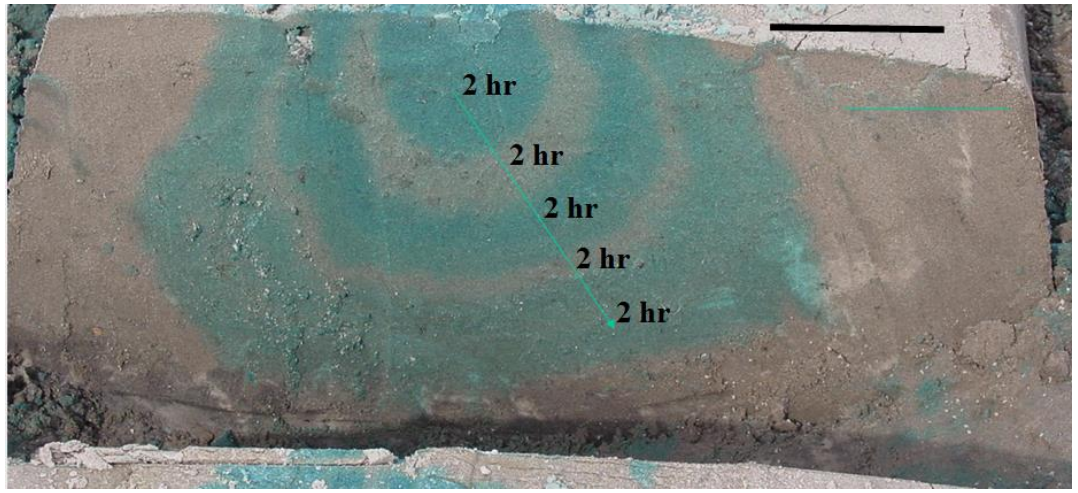
NIMITZ®

Nematicide

For control of nematodes in: Crop Group 8-10, Fruiting vegetables, including tomatoes, okra, eggplant, and peppers (bell and non bell); Crop Group 9, Cucurbit vegetable, including cucumbers, melons (cantaloupes, watermelon, honeydew), and squash; Crop Group 5, Brassica (Cole) leafy vegetables; Crop Group 4, Leafy vegetables (except Brassica vegetables); Crop Group 13-07G, Low growing berries, including strawberry

Others on way: Salibro 2023?

Non-fumigant nematicide application methods



Chemigation through drip line
(most common method in plasticulture)

Preplant boom spray
(incorporated with tillage or irrigation)

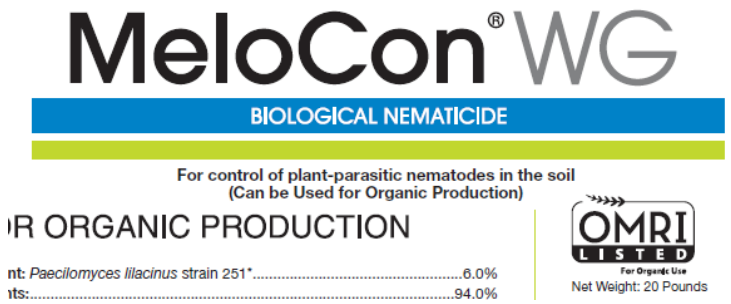
Shank (mixed with fumigant, exploratory)

- Flexible application methods/timing
- Typically cheaper than fumigation
- Narrower range of crops for older products

Trade Name (example)	Active ingredient	Signal word	Other activity	Cost	Range of labelled crops
Velum	Fluopyram	Warning	Fungicide (group 7)	$	Broad
NIMITZ	Fluensulfone	Caution	Minimal	$$$	Broad (restrictive preplant intervals for some)
Vydate L	Oxamyl	DANGER (RUP)	Insecticide	$	Moderate
Counter 20G	Terbufos	DANGER (RUP)	Insecticide	$	Sweet corn
MOCAP	Ethoprop	DANGER (RUP)	Insecticide	$$	Moderate

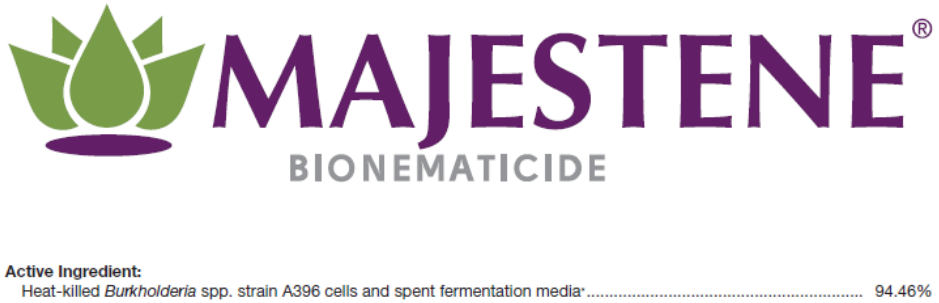
Biological (organic nematicides)

Older active ingredients

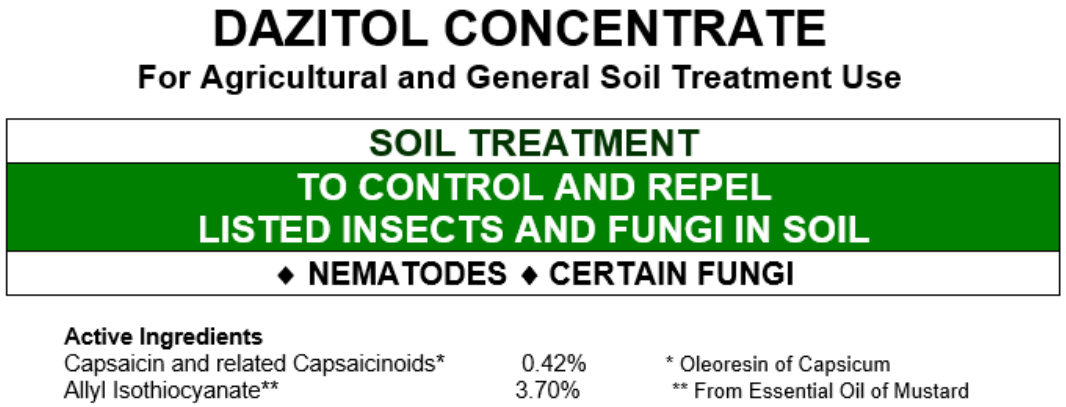


Live *Paecilomyces lilacinus* (fungi)

Newer products



Dead *Burkholderia* bacteria



- Generally less effective than chemical nematicides
- Broadly labelled, flexible
- Many other products. Most untested

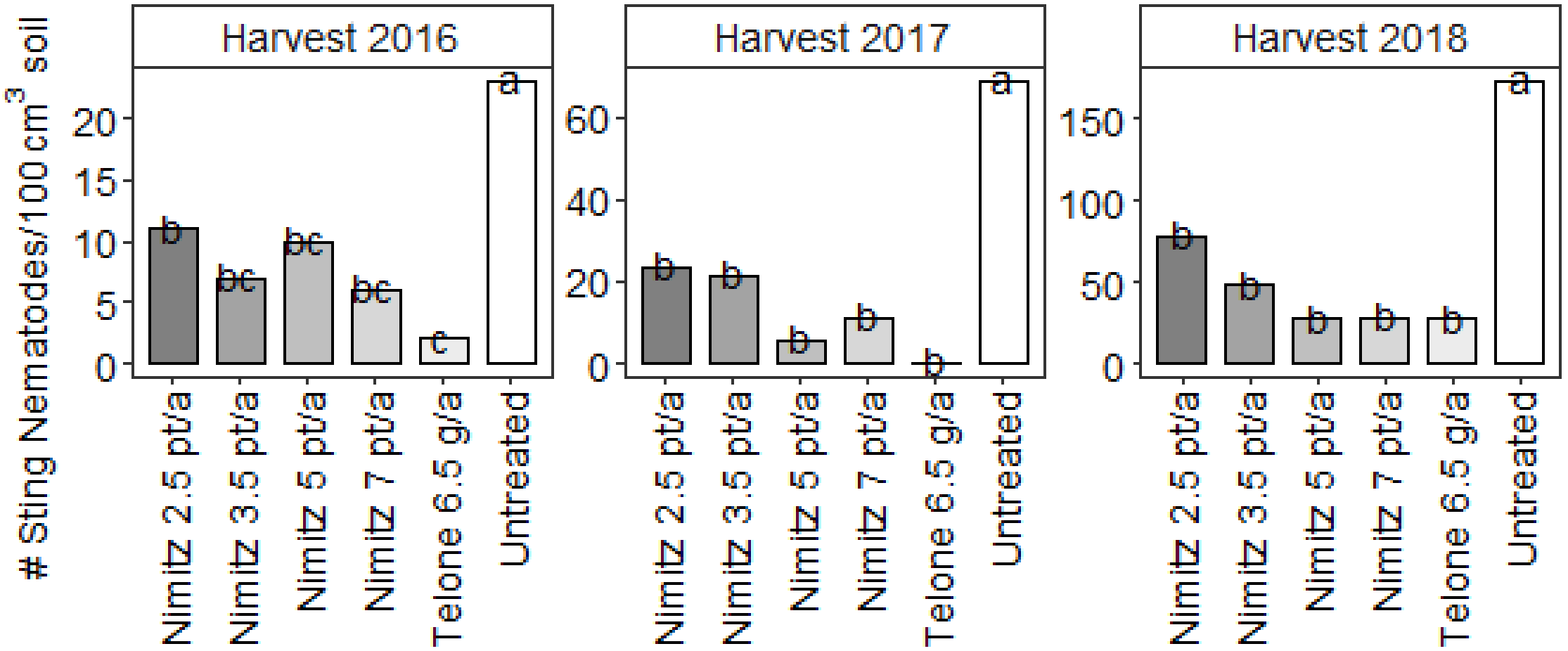
How effective are new products?

NIMITZ example in potato

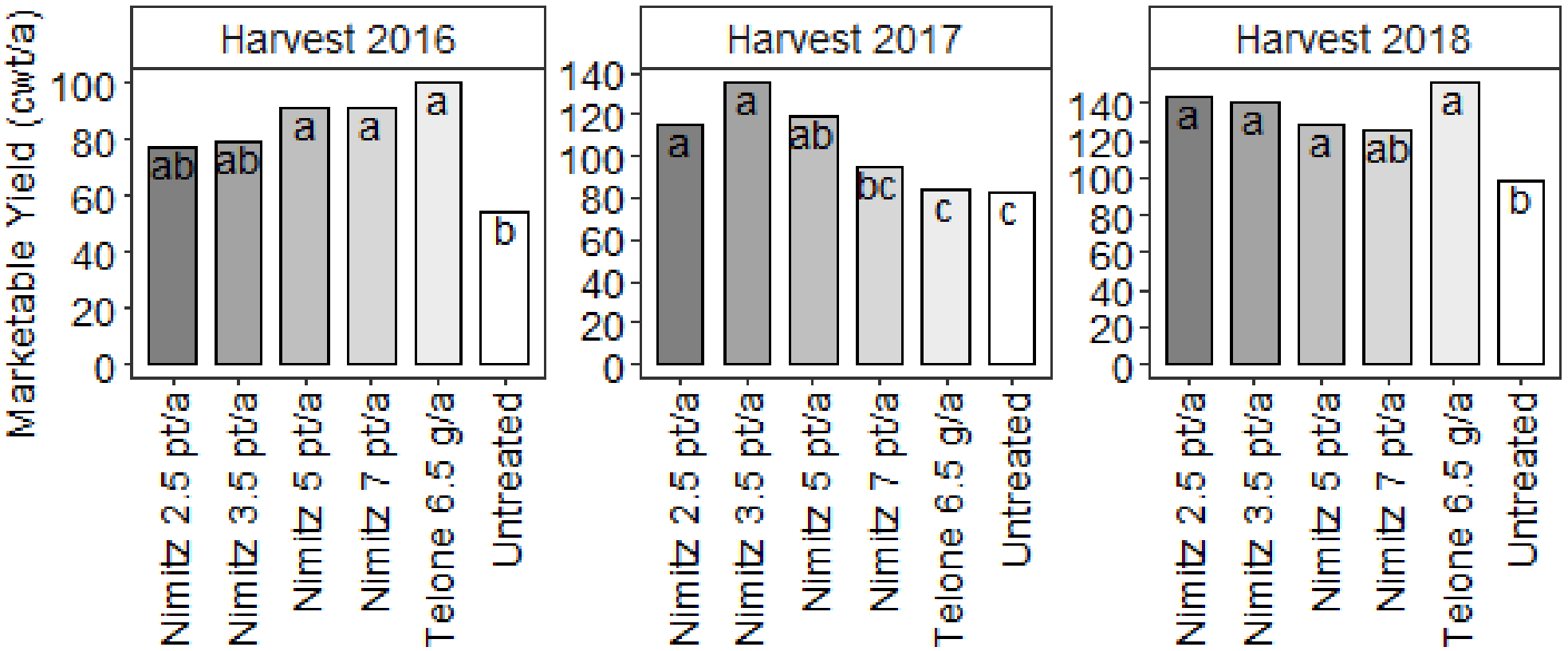
- Small plot trials at Hastings over 3 years (RCB, n=6)
- NIMITZ at various rates
- Telone II 6.5 gpa as shank application concentrated in bed
- Untreated control

NIMITZ was applied as a broadcast spray 3 weeks before planting and incorporated with tillage

NIMITZ or Telone II controlled sting nematode

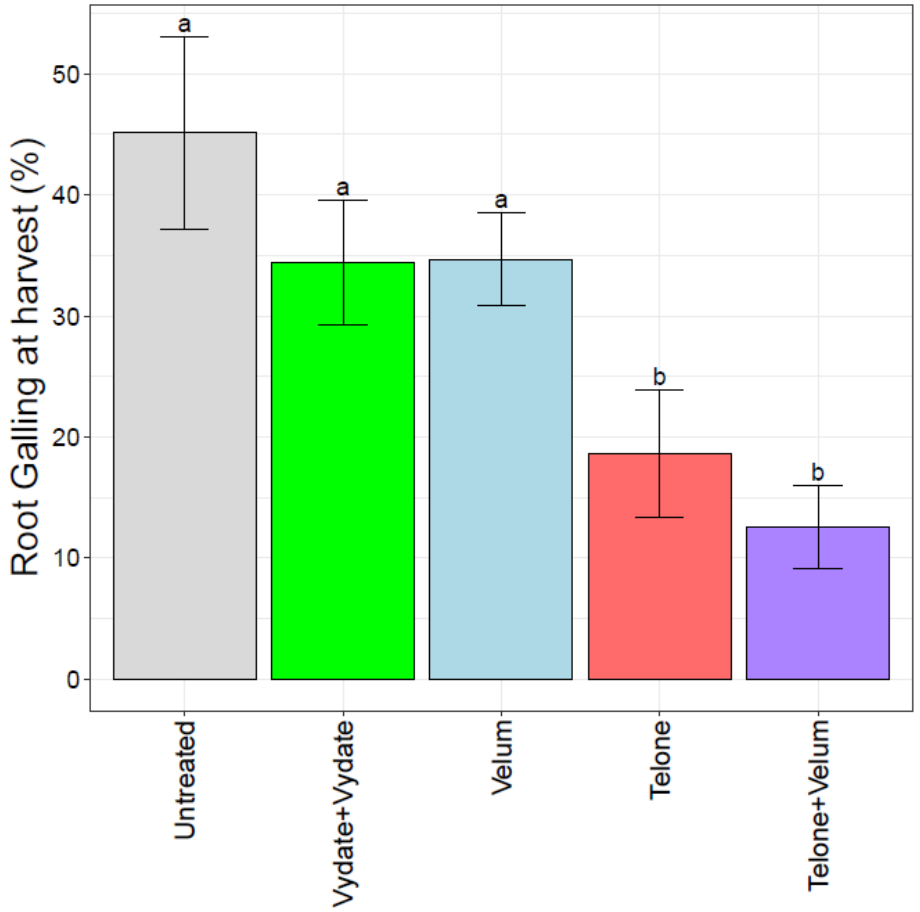


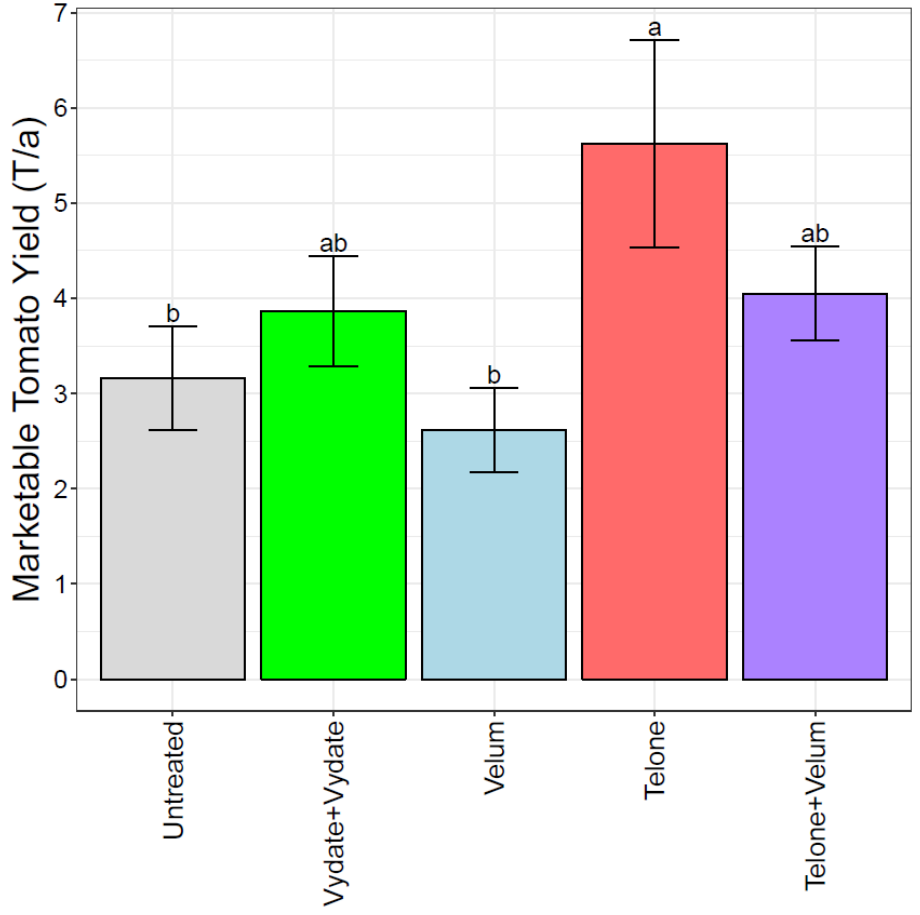
NIMITZ or Telone II usually increased yield



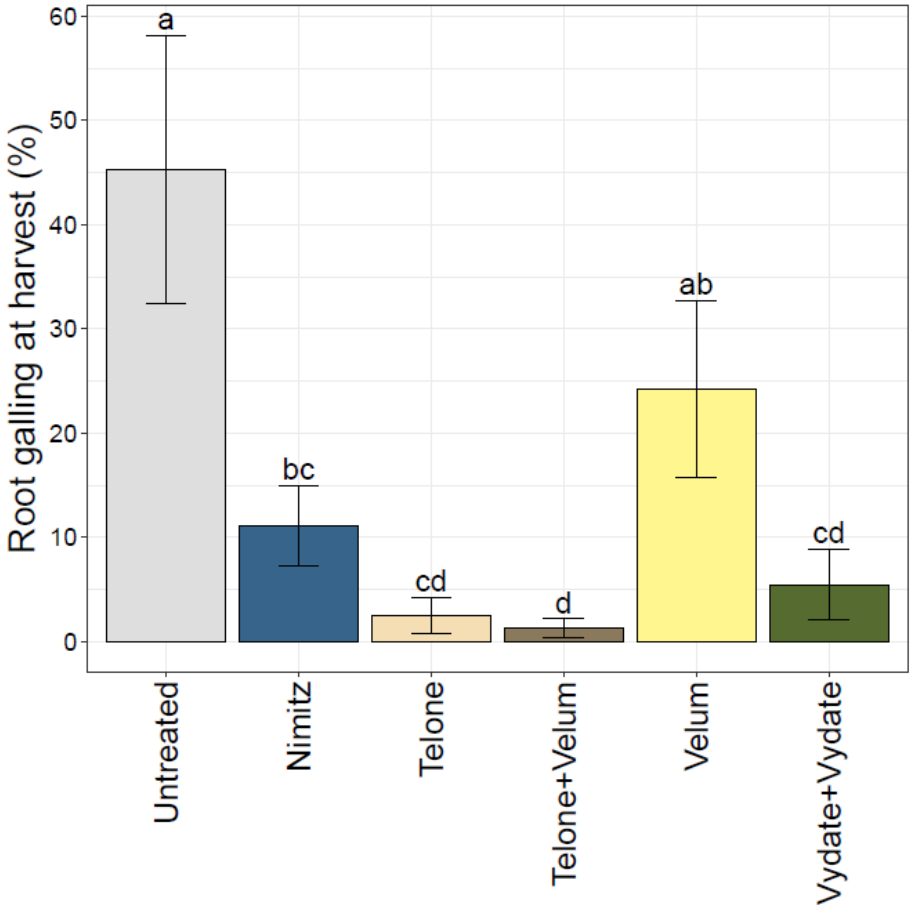
Fumigant (shank) and non-fumigant nematicides (chemigation) in tomato

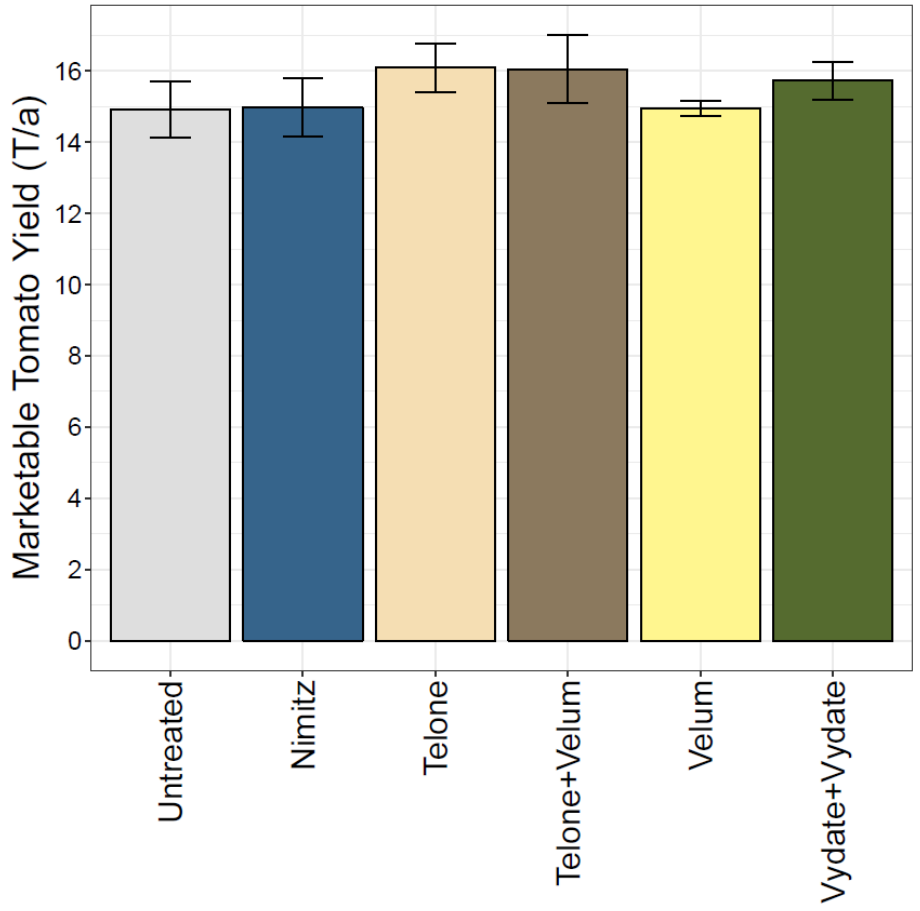
2019 Tomato trial: Live Oak, FL



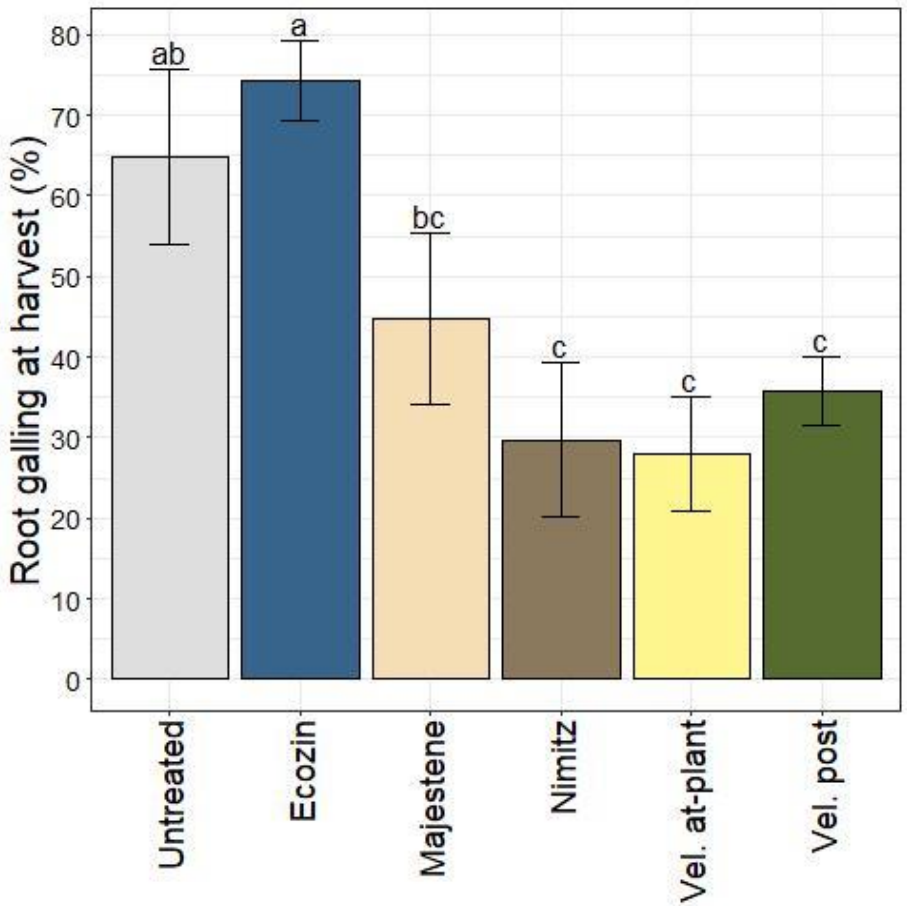


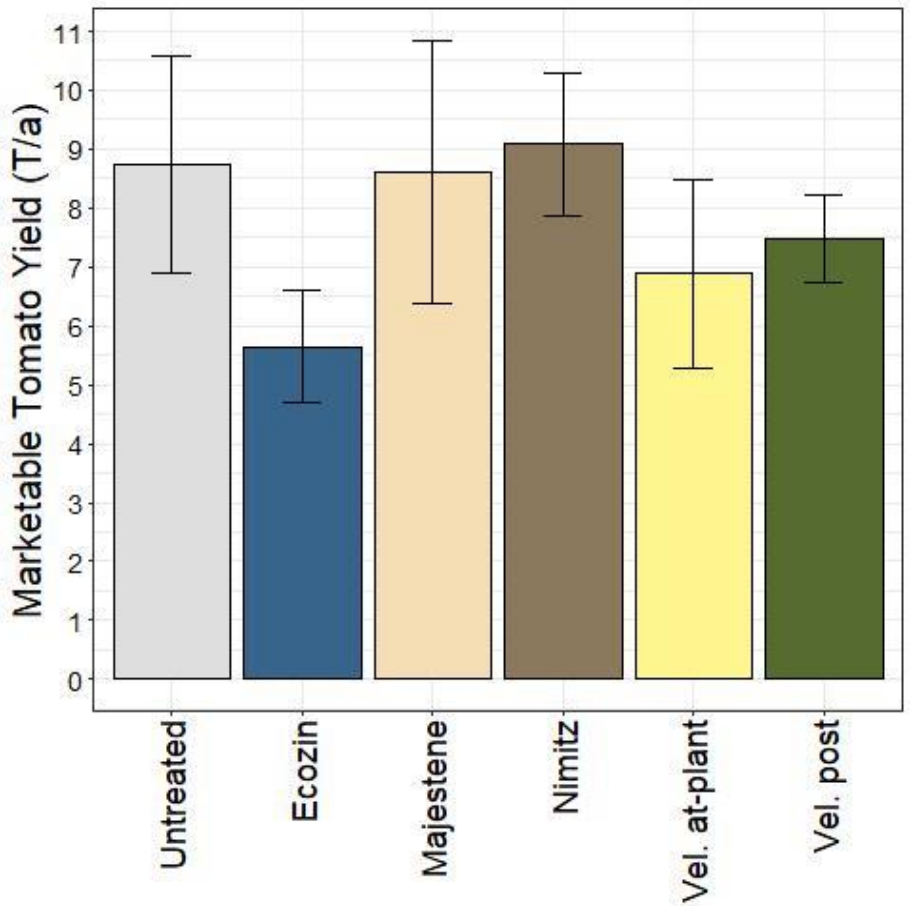
2020 Tomato Trial: Live Oak FL





2021 Tomato trial: Live Oak FL





Resources on nematicide options/efficacy

Contact extension specialist for latest information and always read label!

NON-FUMIGANT NEMATICIDES REGISTERED FOR VEGETABLE CROP USE[1]

T. T. Watson and J. A. Desaeger [2]

Table 2. Chemical nematicides registered for specific vegetable crop use.

Vegetable	Chemical Nematicide						
	MOCAP 15G	MOCAP EC	COUNTER 20G	VYDATE L	VYDATE C-LV	NIMITZ	VELUM PRIME
Beans	yes						
Carrots				yes		yes	
Celery				yes		yes	
Corn, sweet	yes		yes				
Cabbage	yes					yes	yes
Brussels sprouts						yes	yes
Broccoli						yes	yes
Cauliflower						yes	yes
Cucumber	yes			yes		yes	yes
Melons				yes		yes	yes
Leafy vegetables						yes	yes
Squash				yes		yes	yes
Okra						yes	yes
Potatoes	yes	yes			yes	yes	yes
Potatoes, sweet	yes	yes		yes		yes	yes
Eggplant				yes		yes	yes
Strawberry						yes	yes
Tomato				yes		yes	yes
Pepper				yes		yes	yes

https://edis.ifas.ufl.edu/publication/NG033

- Nematicide lists and basic properties

VEGETABLE PRODUCTION HANDBOOK OF FLORIDA, 2021–2022 EDITION

Mathews L. Paret, Peter J. Dittmar, Shinsuke Agehara, and Hugh A. Smith, editors

https://edis.ifas.ufl.edu/pdffiles/cv/cv29200.pdf

NEMATODE MANAGEMENT IN COLE CROPS[1]

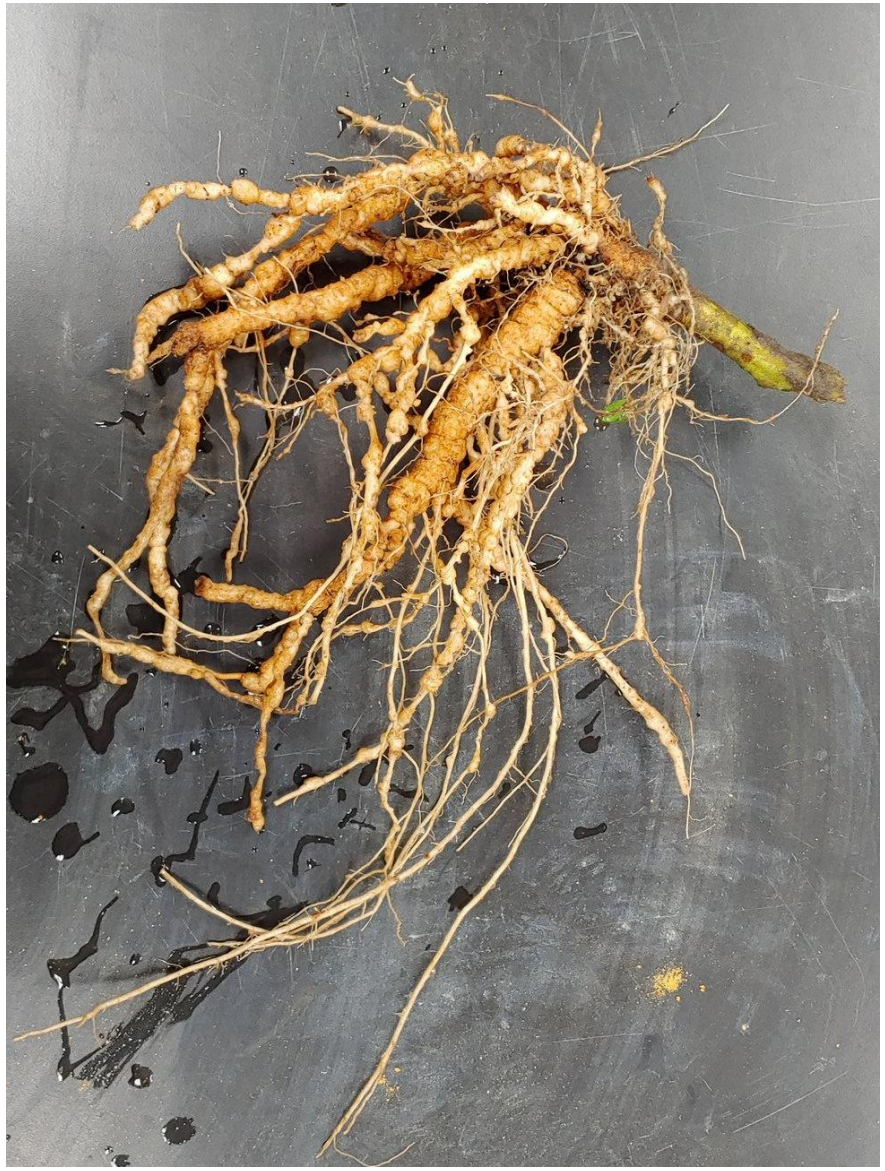
Z. J. Grabau and J. W. Noling [2]

https://edis.ifas.ufl.edu/publication/NG024

- Recently updated crop nematode management guides have **efficacy** guides as well as labelling information

Summary

- Recognize nematode symptoms and sample to confirm
- Sanitation, rotation, resistance and nematicides to manage
- Choose proactive management that will work for your nematodes and situation



Questions?

- Find the Grabau Lab on Twitter & Facebook: **@UFcropnematodes**
- zgrabau@ufl.edu

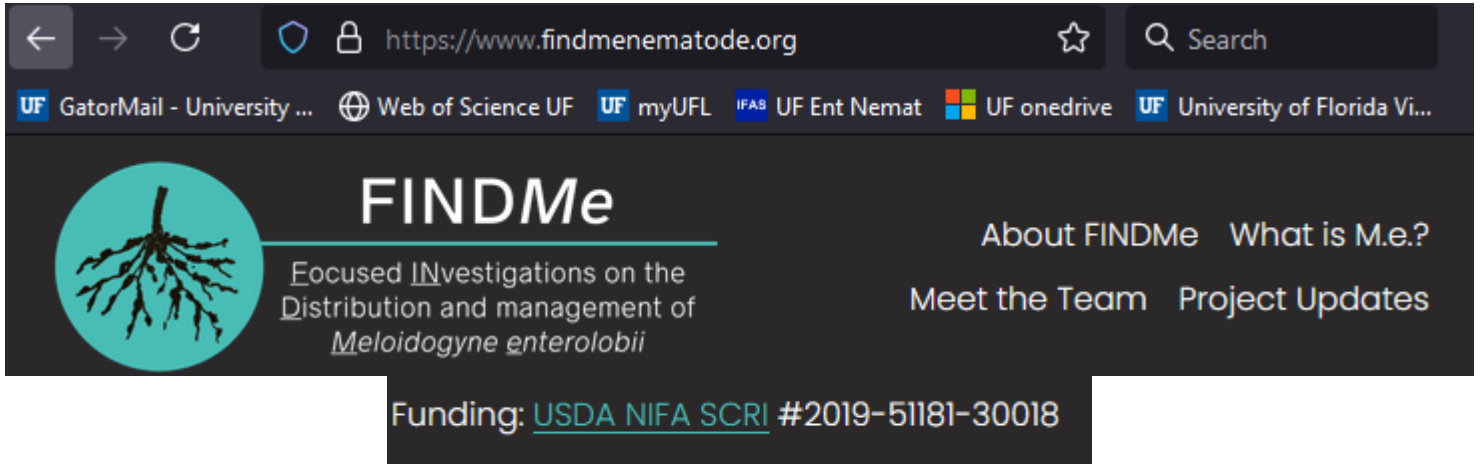
Funding:

SARE Southern Sustainable Agriculture Research and Education

AMVAC An American Vanguard Company

ADAMA

BAYER



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