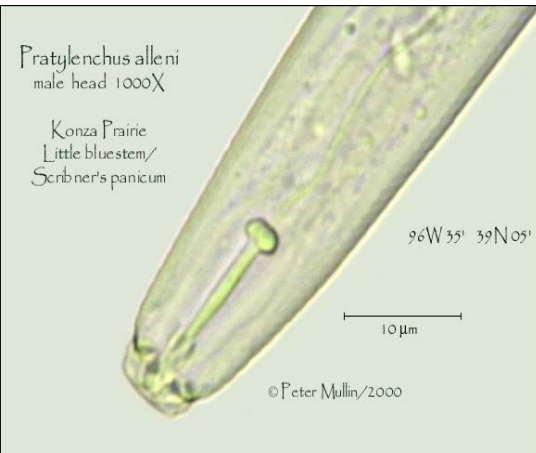


# Role of Cover Crops in Field Crop Nematode Management and Soil Health Enhancement

Fred Warner, Nematode Diagnostician

Mark Sylvester, Field Crop Grower

George Bird, Professor



# Presentation Overview

- Cover Crops, Nematode Management and Soil Health Enhancement: An Overview. George Bird
- Use of Cover Crops for Beet Cyst Nematode Control and Soil Health Enhancement on Sylvester Farms. Mark Sylvester
- Beet Cyst and Soybean Cyst Nematode Cover Crop Research Results. Fred Warner
- Questions/Discussion



# **Cover Crops, Nematode Management and Soil Health Enhancement: An Overview**

George Bird

Professor

Michigan State University

# Cover Crop Functions (n = 14)

*(Managing Cover Crops Profitably, SARE)*

- **Soil Builders**
- **Soil Looseners**
- **Soil Water Conservers**
- **Erosion Fighters**
- **Nutrient Sources**
  - **Nitrogen**
  - **20 essential elements**
- **Hay Crops**
- **Silage Crops**
- **Seed Crops**
- **Livestock Grazers**
- **Pest Managers**

# **Functions of Cover Crops as Pest Managers**

- **Weed Fighters**
- **Pest Starvers (Non-Hosts)**
- **Pest Trappers (Two Types)**
- **Toxicant Producers**
  - **Soil Fumigators**
- **Matter and Energy Resources for Biological Control Agents (Food for Your Friends)**

# Role of Cover Crops in Nematode Management

- Hosts vs Non-Hosts
- **Trap Crops** (Types 1 and 2)
- Biofumigant Crops
- **Soil Health Enhancement Through Increasing Nematode Diversity**

# Nematode Types

- Soil Nutrient Mineralizers
  - Bacterial Feeders
  - Fungal Feeders
- Plant Pathogens
  - Plant Feeders

# **Type 2. Nematode Trap Crop Communications (Signaling) Disruption**

***Heterodera schachtii*, Beet Cyst Nematode (BCN)**

**Host Crops: Beets and Brassicas**

**BCN Management Trap Crop**

**Oil Seed Radish (*Raphanus sativus oleiferus*)**

- Defender
- Adagio
- Colonel



# Radish Types, Names and Uses

Radish Type	Name	Use
Garden Radish	<i>Raphanus sativus sativus</i>	Vegetable
Oilseed Radish	<i>Raphanus sativus oleiferus</i>	Oil, Cover Crop and BCN Trap Crop
Daikon Radish	<i>Raphanus sativus longipinnatus</i>	Cover Crop, Vegetable
Wild Radish	<i>Raphanus raphanistrum</i>	Weed
Horse Radish	<i>Raphanus sativus niger</i>	Vegetable

# BCN Increase on Radish

Radish Variety	BCN Population Increase
Defender (Trap Crop)	0.25
Daikon	197
Tillage	262
Driller	211
Groundhog	184
Soil Buster	220
Graza	135

# Soil Health for Field Crops

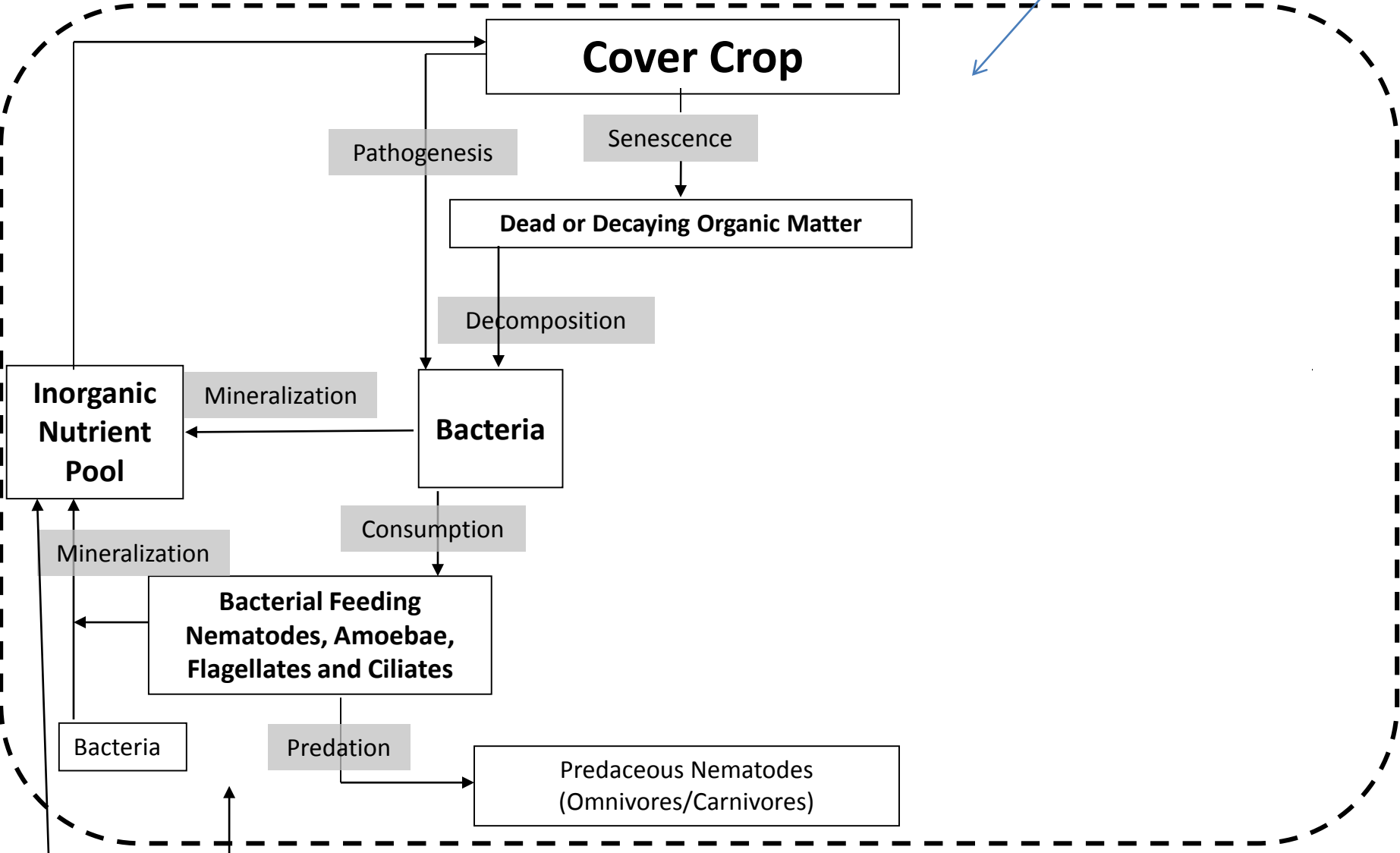
- Use of cover crop cultivars and blends that enhance soil health by increasing biological diversity through providing matter and energy resources for your soil-borne friends that create soil which resists degradation and responds to management in a predictable manner.

# Soil Health Indicators for Field Crops

(n = 15)

- Soil Health Indicators for Profitability
  - Water stable aggregates
    - >45%
  - Nitrogen mineralization potential
    - >10 $\mu$ g N per 1.0g dry weight soil per week
  - Active carbon
    - >450 ppm

Solar Energy and Water



**Inorganic  
Nutrient  
Pool**

**Cover Crop**

**Dead or Decaying Organic Matter**

**Bacteria**

**Bacterial Feeding  
Nematodes, Amoebae,  
Flagellates and Ciliates**

Bacteria

Predaceous Nematodes  
(Omnivores/Carnivores)

**N/P/K/S/pH Inputs**

**How Cover Crops Work**

Pathogenesis

Senescence

Decomposition

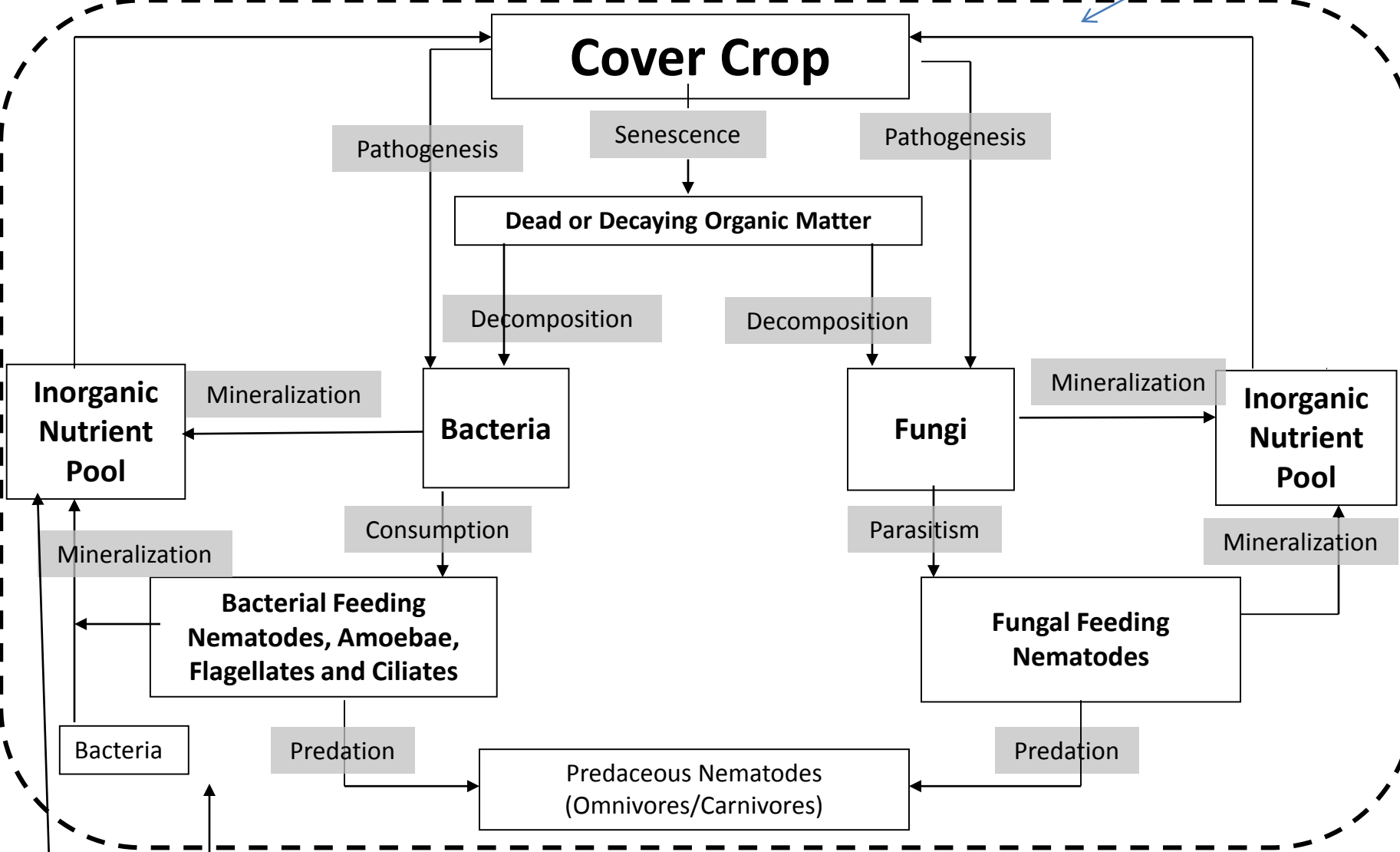
Mineralization

Consumption

Mineralization

Predation

Solar Energy and Water



N/P/K/S/pH Inputs

# How Cover Crops Work

# Cover Crops: The Bottom Line

- Highly significant potential.
- Significant current grower interest.
- Crop system objective specific.
- Plant species or species mix specific.
- Species cultivar specific.
- Management practice specific.
- Much remains to be learned.

# **Use of Cover Crops for Beet Cyst Nematode Control and Soil Health Enhancement on Sylvester Farms**

Mark Sylvester

Sylvester Farms

Fairgrove, Michigan Sylvester Farms

History



# **Sylvester Farms Crops**

## **Cash Crops**

- **Sugar Beets**
- **Corn**
- **Soybeans**
- **Wheat**
- **Pickles**

## **Cover Crops**

- **Oil Seed Radish**
- **Red Clover**
- **Cereal Rye**
- **Annual Rye Grass**

# Sylvester Farms Cropping System

- Crop Rotation Sequence
- Cover Crop Role
  - Oil Seed Radish
    - Beet Cyst Nematode Control
  - Red Clover, Cereal Rye, Annual Ryegrass
    - Soil Health Enhancement

# Sylvester Farms Goals

- Profitability
- Family and Community
- Environmental Stewardship
  - Soil Health
    - Enhancement/Remediation
    - Maintenance

# **Beet Cyst and Soybean Cyst Nematode Cover Crop Research Results**

Fred Warner

Nematode Diagnostician

Michigan State University

# Cover Crops and Nematode Control Color Scheme Terminology



**AVOID/STOP**

If nematode control is an objective



**USE WITH CAUTION**

If nematode control is an objective



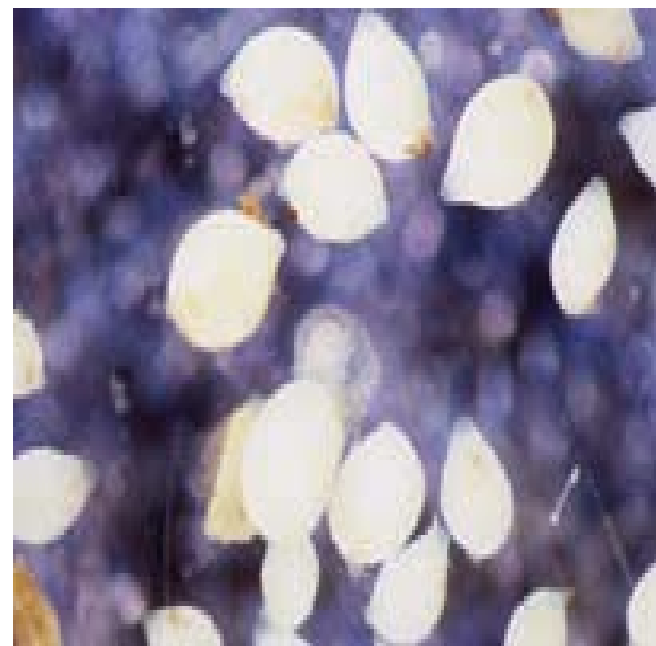
**PROCEED/GO**

If nematode control is an objective

# Nematode Development Assays (NDAs) for Cyst Nematodes

## Good Assays for Identifying Pest Starvers

- 1) Inoculum is prepared by crushing cysts to release eggs and second-stage juveniles.
- 2) Eggs and juveniles are counted.
- 3) Soil in cones or pots is inoculated with similar numbers of eggs and juveniles.
- 4) Seeds or seedlings of hosts are planted.
- 5) Cones or pots placed in a growth chamber or greenhouse for 6-8 weeks.
- 6) Plants destructively sampled and roots scrubbed to release cyst nematode females.
- 7) Females counted under a dissecting microscope.



Greg Tylka, Iowa State University

# BCN Management



>10 BCN females per root system  
using NDAs



1-10 BCN females per root system  
using NDAs



<1 BCN female per root system  
using NDAs

Average numbers of beet cyst nematode (BCN) females recovered per root system (number of trials in parentheses)



Species	Common Name	Cultivar	BCN Females
<i>Sinapsis alba</i>	yellow mustard	Idagold (1)	267.75
<i>Raphanus sativus</i>	radish, tillage (1)		262.00
<i>R. sativus</i>	radish	Soilbuster (1)	220.25
<i>R. sativus</i>	radish	Driller (1)	211.25
<i>R. sativus</i>	radish	Daikon (1)	197.25
<i>Brassica napus</i>	rapeseed	Dwarf Essex (3)	190.00
<i>B. rapa</i>	turnip, forage	Appin (3)	185.00
<i>B. vulgaris</i>	sugar beet	Prompt (1)	176.50
<i>R. sativus</i>	radish	Groundhog (3)	174.00
<i>R. sativus</i>	radish	Pile Driver (3)	173.58
<i>B. juncea</i>	brown mustard	Kodiak (3)	165.33
<i>B. vulgaris</i>	sugar beet	C-RR059 (1)	147.25
<i>B. rapa</i>	turnip, forage	Vivant (1)	137.75
<i>R. sativus</i>	radish	Graza (1)	135.25
<i>S. alba</i>	yellow mustard	Pacific Gold (2)	121.00
<i>R. sativus</i>	radish	GO-DRK (1)	87.00
<i>B. oleracea</i>	cabbage	Early Jersey Wakefield (1)	70.25
<i>B. vulgaris</i>	sugar beet	SX-1211NRR (1)	65.75
<i>B. vulgaris</i>	sugar beet	HM-50RR (1)	56.00
<i>Phaseolus vulgaris</i>	dry bean	Zorro (2)	26.58
<i>R. sativus</i>	radish	Carwoodi (3)	20.67





Average numbers of beet cyst nematode (BCN) females recovered per root system (number of trials in parentheses)

Species	Common Name	Cultivar	BCN Females
<i>Raphanus sativus</i>	radish	Cardinal (2)	7.00
<i>Phaseolus vulgaris</i>	dry bean	Puebla 152 (2)	5.88
<i>R. sativus</i>	radish	Toro (2)	5.75
<i>Sinapsis alba</i>	white mustard	Accent (3)	3.83
<i>R. sativus</i>	radish	Intermezzo (3)	2.40
<i>S. alba</i>	white mustard	Ludique (1)	1.75
<i>R. sativus</i>	radish	FumaRad (3)	1.33



Average numbers of beet cyst nematode (BCN) females recovered per root system (number of trials in parentheses)

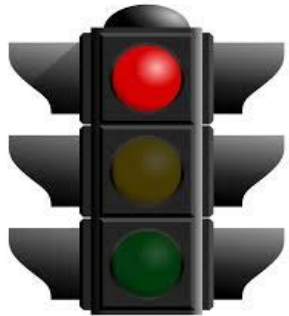
Species	Common Name	Cultivar	BCN Females
<i>Raphanus sativus</i>	radish	Mercator (1)	0.75
<i>R. sativus</i>	radish	Tajuna (3)	0.58
<i>R. sativus</i>	radish	Image (2)	0.37
<i>R. sativus</i>	radish	Cannavaro (1)	0.25
<i>R. sativus</i>	radish	Defender: home grown (2)	0.25
<i>R. sativus</i>	radish	Maximus (1)	0.25
<i>R. sativus</i>	radish	Respect (2)	0.25
<i>R. sativus</i>	radish	Defender: certified (3)	0.13
<i>Medicago sativa</i>	alfalfa	Foregrazer (1)	0.00
<i>Trifolium incarnatum</i>	crimson clover (1)		0.00
<i>T. pratense</i>	red clover	Dynamite (1)	0.00
<i>T. repens</i>	white clover	Domino (1)	0.00

Mean numbers of sugarbeet cyst nematode cysts, eggs and second-stage juveniles, eggs/cyst and males recovered from 100 cm<sup>3</sup> soil in a greenhouse study after 8 weeks.

		sugarbeet cyst nematodes/100 cm <sup>3</sup> soil						
		cysts		eggs + J <sub>2s</sub>		eggs/cyst	males	
species	Cultivar	X	SE	X	SE	X	X	SE
cabbage	Early Jersey Wakefield	70.00	10.37	16860.00	3305.89	222.14	47.00	11.73
white mustard	Accent	1.50	0.75	220.00	110.00	146.17	1.00	0.50
mustard	Caliente 199 Blend	28.50	5.14	6572.50	1249.04	208.33	25.00	6.08
brown mustard	Kodiak	38.50	0.85	8210.00	517.84	181.04	107.00	18.17
yellow mustard	Pacific Gold	49.00	3.68	11730.00	691.73	208.98	57.00	3.30
oilseed radish	Cannavaro	0.50	0.14	133.50	44.63	265.00	1.00	0.50
oilseed radish	Carwoodi	3.75	0.94	497.50	100.36	109.33	0.50	0.25
oilseed radish	Defender <sup>1</sup>	0.00	0.00	0.00	0.00		3.00	0.96
oilseed radish	Defender <sup>2</sup>	0.00	0.00	0.00	0.00		5.00	1.50
oilseed radish	FumaRad	0.25	0.13	25.00	12.50	90.00	0.00	0.00
oilseed radish	Ground Hog	24.00	2.09	3950.00	749.31	137.92	78.00	13.33
oilseed radish	Intermezzo	1.00	0.20	234.00	43.57	227.50	0.00	0.00
oilseed radish	Pile Driver	42.25	3.03	7280.00	805.15	146.04	98.00	4.65
oilseed radish	Respect	0.25	0.13	50.00	25.00	200.00	4.00	0.71
oilseed radish	Tajuna	1.00	0.29	132.50	40.49	122.50	7.00	2.50
oilseed radish	Toro	5.25	1.28	620.00	117.26	99.05	3.5	0.85
fodder turnip	Appin	31.25	6.66	5880.00	1475.81	165.44	81.00	13.91
turnip	Shogoin	14.00	1.21	2610.00	290.47	177.14	31.00	3.10

<sup>1</sup>certified seed; <sup>2</sup>home grown seed

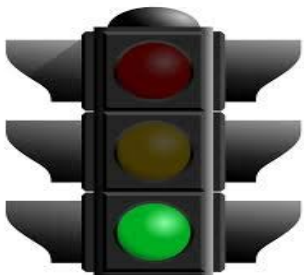
# SCN Management



>10 SCN females per root system  
using NDAs

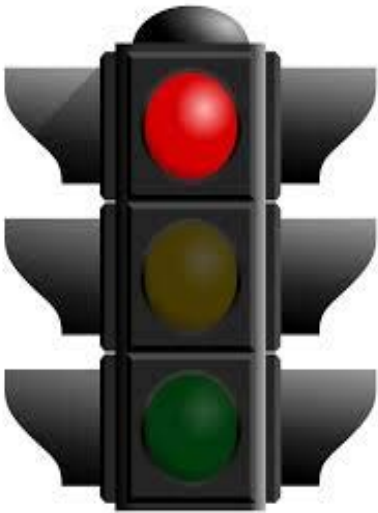


1-10 SCN females per root system  
using NDAs



<1 SCN female per root system  
using NDAs

Average numbers of soybean cyst nematode (SCN) females recovered per root system (number of trials in parentheses)



Species	Common Name	Cultivar/Line	SCN Females
<i>Glycine max</i>	soybean	Archer (1)	762.00
<i>Phaseolus vulgaris</i>	green bean	Kentucky Wonder (1)	398.50
<i>P. vulgaris</i>	dry/black bean	Zorro (2)	288.50
<i>P. vulgaris</i>	dry/black bean	Puebla 152 (2)	259.00
<i>G. max</i>	soybean	PI 88788 (2)	222.50
<i>G. max</i>	soybean	Pioneer 92Y91 (2)	160.75
<i>G. max</i>	soybean	Peking (2)	44.00
<i>Brassica rapa</i>	turnip, forage	Vivant (2)	13.37

Average numbers of soybean cyst nematode (SCN) females recovered per root system (number of trials in parentheses)



Species	Common Name	Cultivar	SCN Females
<i>Pisum sativum</i>	garden pea	Green Arrow (1)	2.25
<i>Medicago sativa</i>	alfalfa	L447 HD (3)	2.03
<i>Trifolium repens</i>	white clover	White Dutch (1)	2.00
<i>Raphanus sativus</i>	radish	Groundhog (1)	1.25
<i>M. sativa</i>	alfalfa	L449 APH2 (3)	1.17
<i>T. incarnatum</i>	crimson clover (1)		1.08
<i>Lolium multiflorum</i>	annual ryegrass	Gulf (2)	1.00

Average numbers of soybean cyst nematode (SCN) females recovered per root system (number of trials in parentheses)

Species	Common Name	Cultivar	SCN Females
<i>Melilotus officinalis</i>	yellow sweet clover	Yellow Blossom (1)	0.50
<i>Pisum sativum</i>	garden pea	Maestro (1)	0.50
<i>Raphanus sativus</i>	radish	Tajuna (1)	0.50
<i>Trifolium alexandrinum</i>	berseem clover	Frosty (1)	0.50
<i>T. incarnatum</i>	crimson clover	Kentucky Pride (1)	0.50
<i>T. michelianum</i>	balansa clover	Fixation (2)	0.375
<i>T. pratense</i>	red clover	Dynamite (2)	0.375
<i>T. repens</i>	white clover	Domino (2)	0.375
<i>Medicago sativa</i>	alfalfa	Foregrazer (3)	0.33
<i>T. repens</i>	white clover	Kopu II (3)	0.33
<i>Brassica napus</i>	rapeseed	Dwarf Essex (3)	0.25
<i>R. sativus</i>	radish	Cardinal (1)	0.25
<i>R. sativus</i>	radish	Image (1)	0.25
<i>Sinapsis alba</i>	white mustard	Ludique (1)	0.25
<i>T. pratense</i>	red clover	Gallant (2)	0.25
<i>R. sativus</i>	radish	Pile Driver (2)	0.125
<i>S. alba</i>	yellow mustard	Pacific Gold (2)	0.125
<i>T. pratense</i>	red clover	Medium Red (2)	0.125



# Trap Cropping

No experiments shown  
in this presentation were  
designed to examine  
plants as trap crops.



# Green Manure/Biofumigation Trial

## Greenhouse 2013

- 1) Trial initiated 3/12/13 using field soil w/ 112 SCN cysts, 10700 eggs and 2350 J2s/100 cc soil.
- 2) Seeds of crops planted; 4 replications/treatment.
- 3) Green manure incorporated on 5/23/13; 1.0 gram or root processed
  - a) soil stored in a plastic bag at room temp. to simulate tarping
  - b) green manure incorporated into soil and pots placed in greenhouse
- 4) All pots planted to soybean cv. Pioneer 92Y91 on 7/3/13.
- 5) Trial terminated on 8/14/13; 2.0 grams of soybean roots were processed for SCN as well as 100 cc soil.

Average numbers of soybean cyst nematode (SCN) cysts, eggs + second-stage juveniles per 100 cc soil on soybean (Pioneer 92Y91) following growth of the plants provided in the table (PI = 13050 SCN eggs + J2s).

Plant	Cultivar	Tarp (Y/N)	cysts	Eggs + J2s	Pf/Pi
African marigold	Crackerjack	Y	112.50	13090	1.003
African marigold	Crackerjack	N	86.00	11840	0.907
annual ryegrass	Gulf	Y	104.25	13080	1.002
annual ryegrass	Gulf	N	82.00	12090	0.926
crimson clover		Y	102.50	13600	1.042
crimson clover		N	73.75	8640	0.662
yellow mustard	Pacific Gold	Y	59.00	7430	0.569
yellow mustard	Pacific Gold	N	35.50	4665	0.357
oilseed radish	FumaRad	Y	108.00	15040	1.152
oilseed radish	FumaRad	N	50.75	6820	0.523
rapeseed	Dwarf Essex	Y	80.25	10360	0.794
rapeseed	Dwarf Essex	N	102.00	13160	1.008
soybean	Pioneer 92Y91	Y	91.00	12270	0.940
soybean	Pioneer 92Y91	N	92.75	15220	1.166
fallow			157.25	15335	1.175
red clover	Medium red	Y	79.25	11295	0.866
red clover	Medium red	N	37.25	5085	0.390

SCN females were not recovered from the roots of any of the plants grown except soybean

# CONCLUSIONS

Not all plant-parasitic nematodes are the same. There is no one magical cover crop that will control all types of these important plant pathogens.

Before choosing a cover crop, it is critical the types of nematodes present in any given location are properly identified. Proper cultivar selection is also important.

If managing plant-parasitic nematodes is not an objective, most cover crops will provide food for your friends unless you're trying to take them out using pest gassers. Respiratory poisons really don't discriminate.

# Thanks for Listening

*Mark, Fred, George and*

