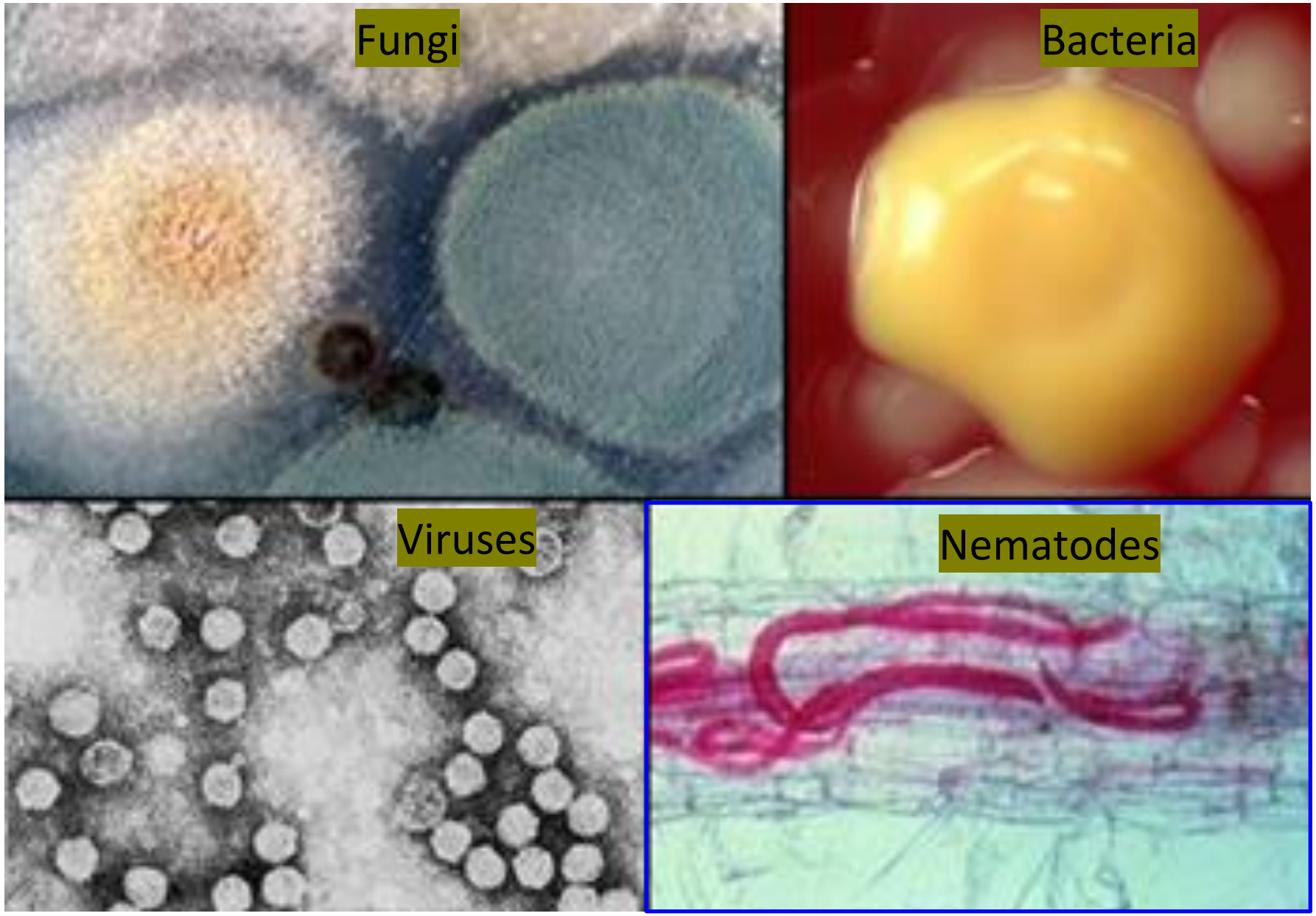
Nematode of Importance in Low Desert Crop Production

September 15, 2022

By Philip Waisen

Major Plant Pathogens



What are NEMATODES?

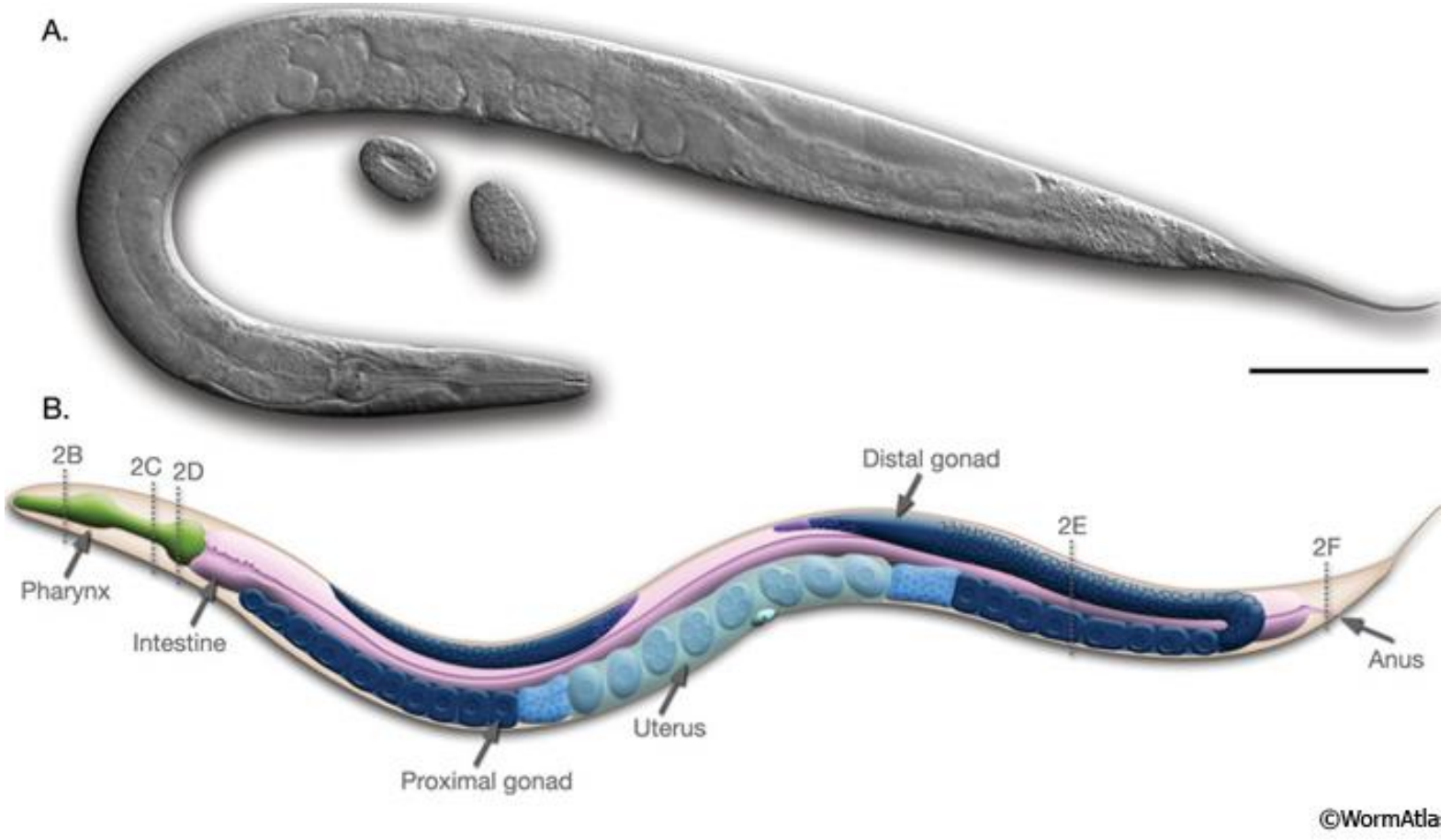
Microscopic (20-25 µm wide)

Unsegmented round worms

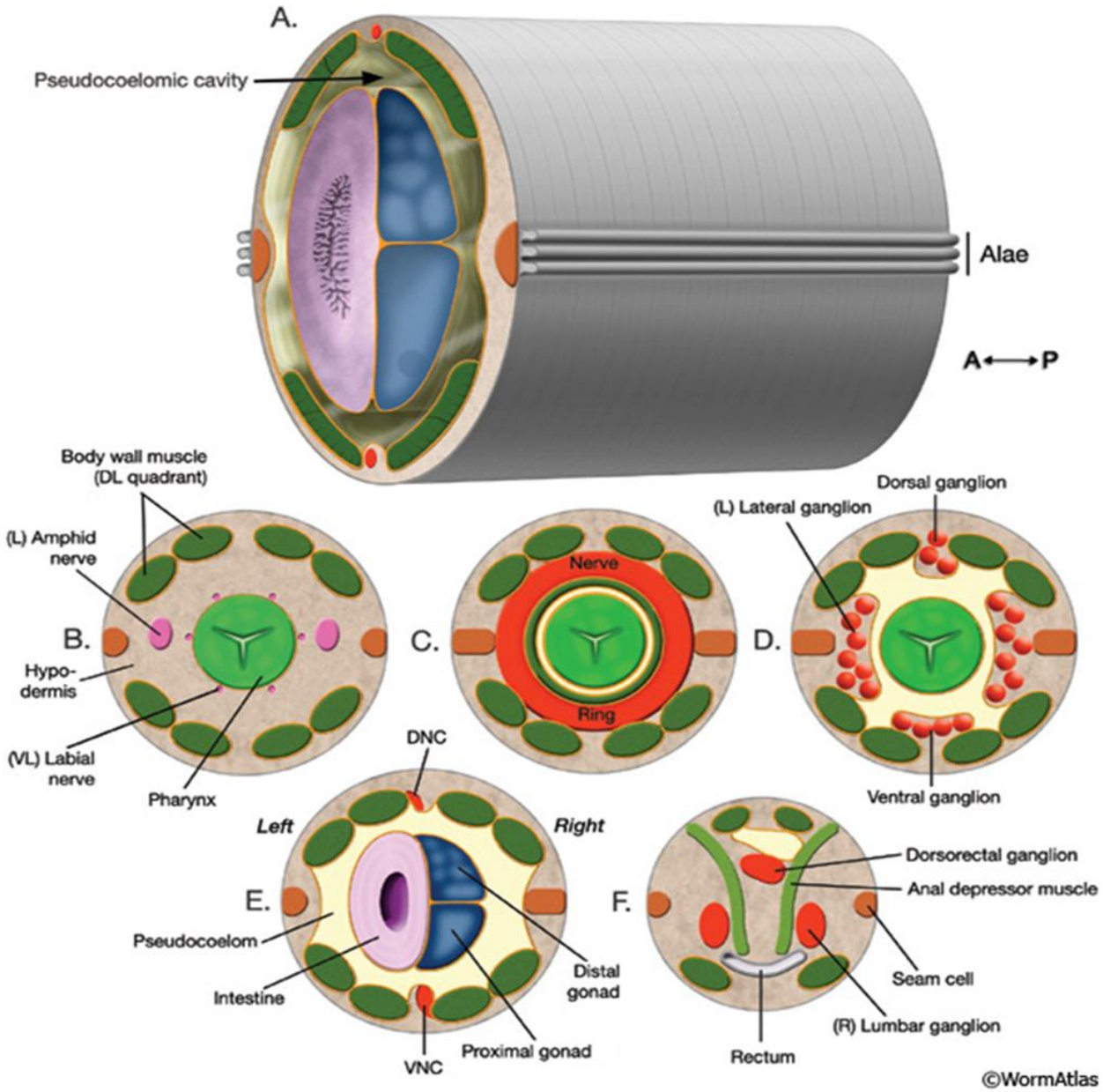
Thread-like (Vermiforms)

Bilaterally symmetrical

With digestive, nervous, excretory, reproductive, ~~circulatory~~, ~~skeletal~~, and ~~respiratory~~ systems

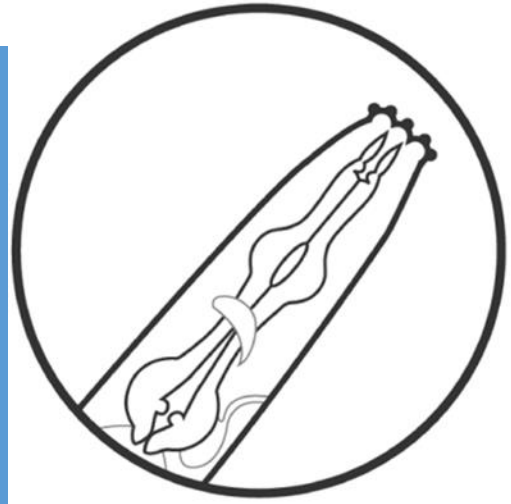


Pseudocoelom

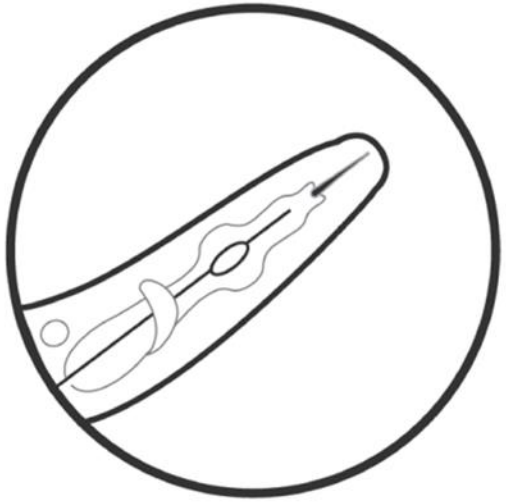


A fluid-filled body cavity lying inside the external body wall of the nematode that bathes the internal organs, including the alimentary and the reproductive systems.

Nematodes Community



Bacterial feeder
Rhabditis sp.



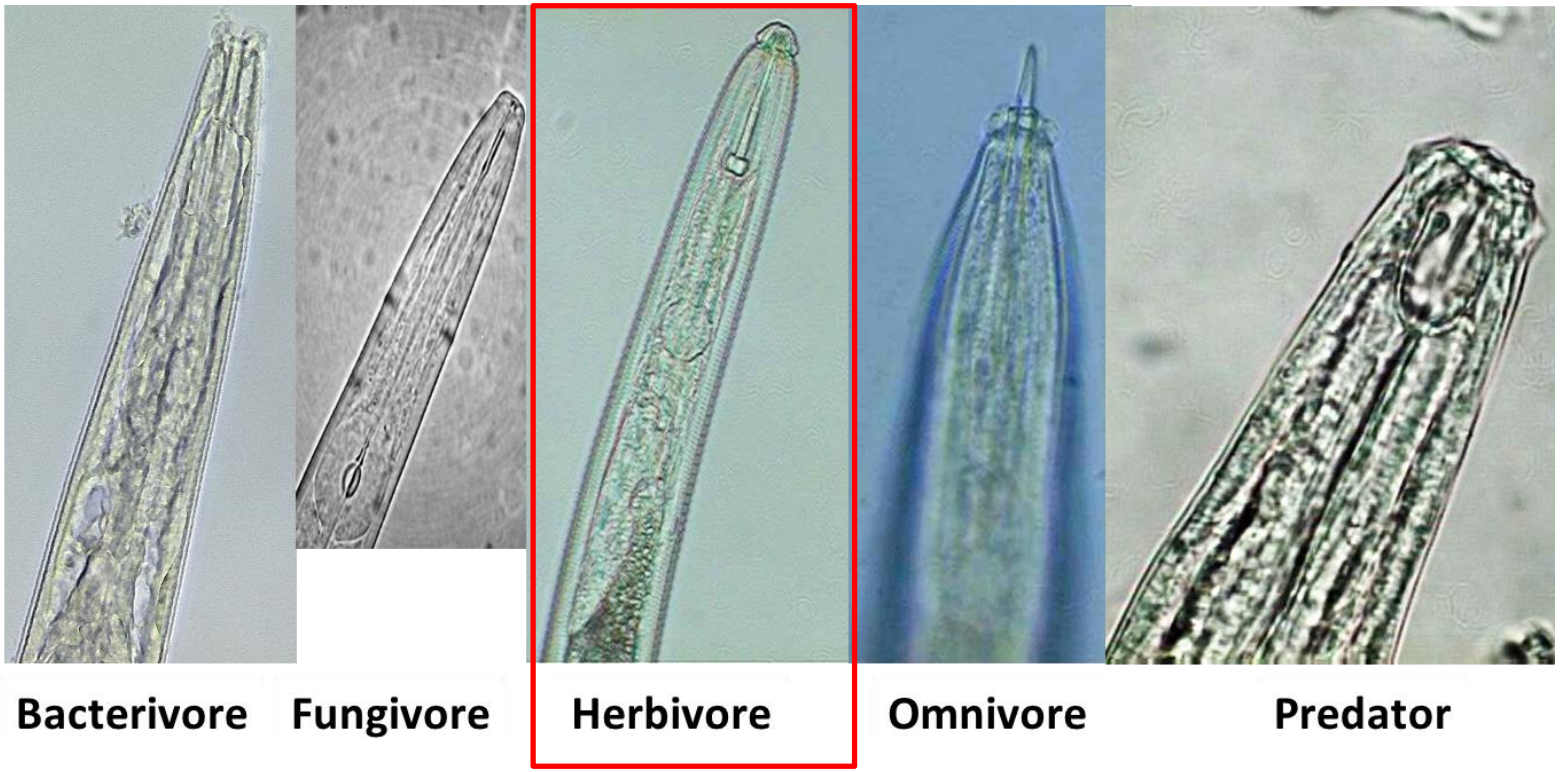
Fungal feeder
Aphelenchoides sacchari

Plant parasite
Pratylenchus penetrans

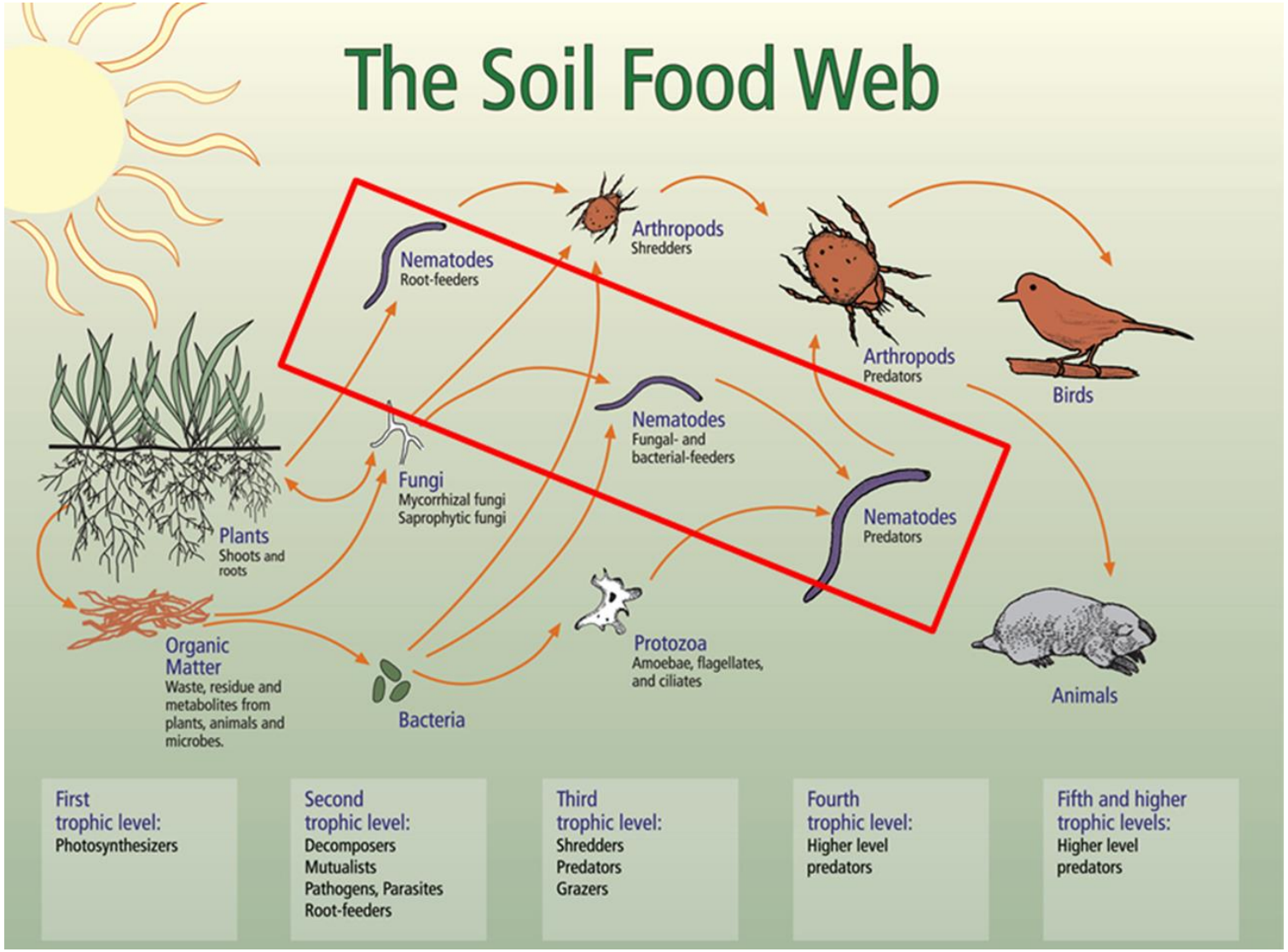
Omnivore
Eudorylaimus cateri

Predator
Clarkus papillatus

Nematodes Community



Nematodes Community

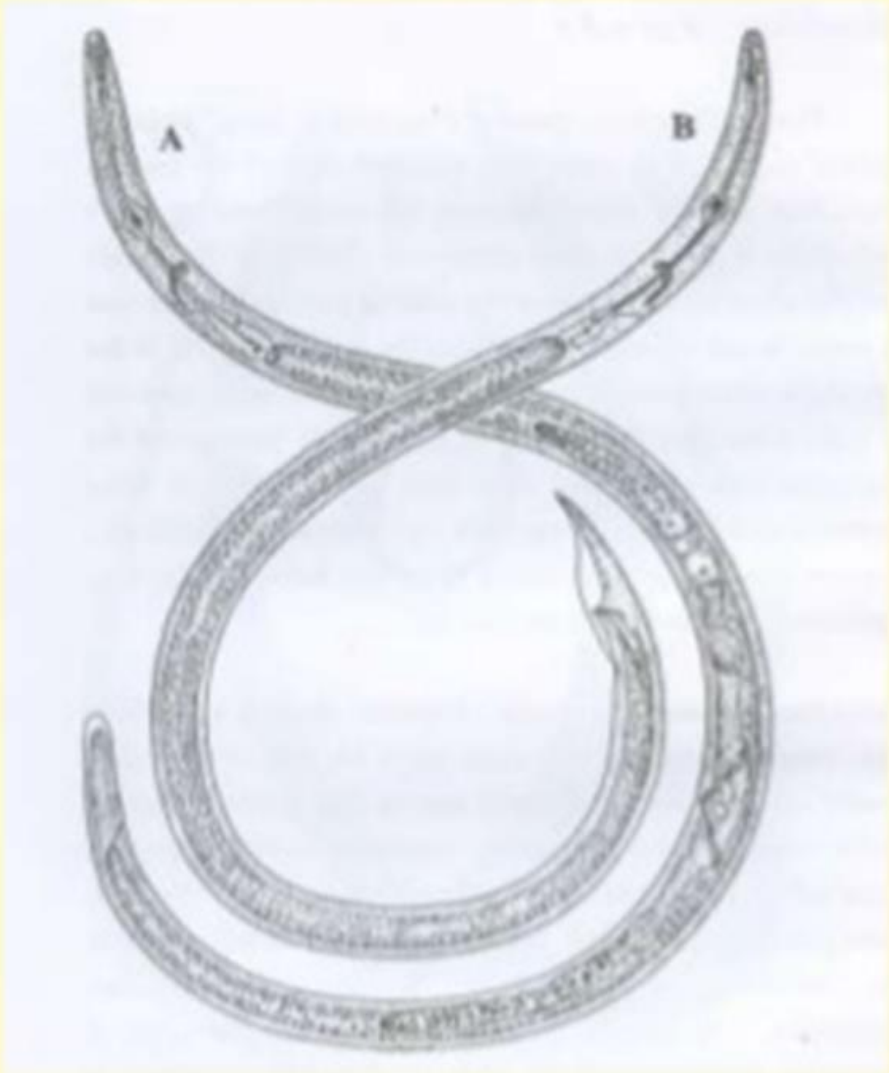


[Natural Resources Conservation Service - USDA]

Vermiform and Pear or Lemon-shaped

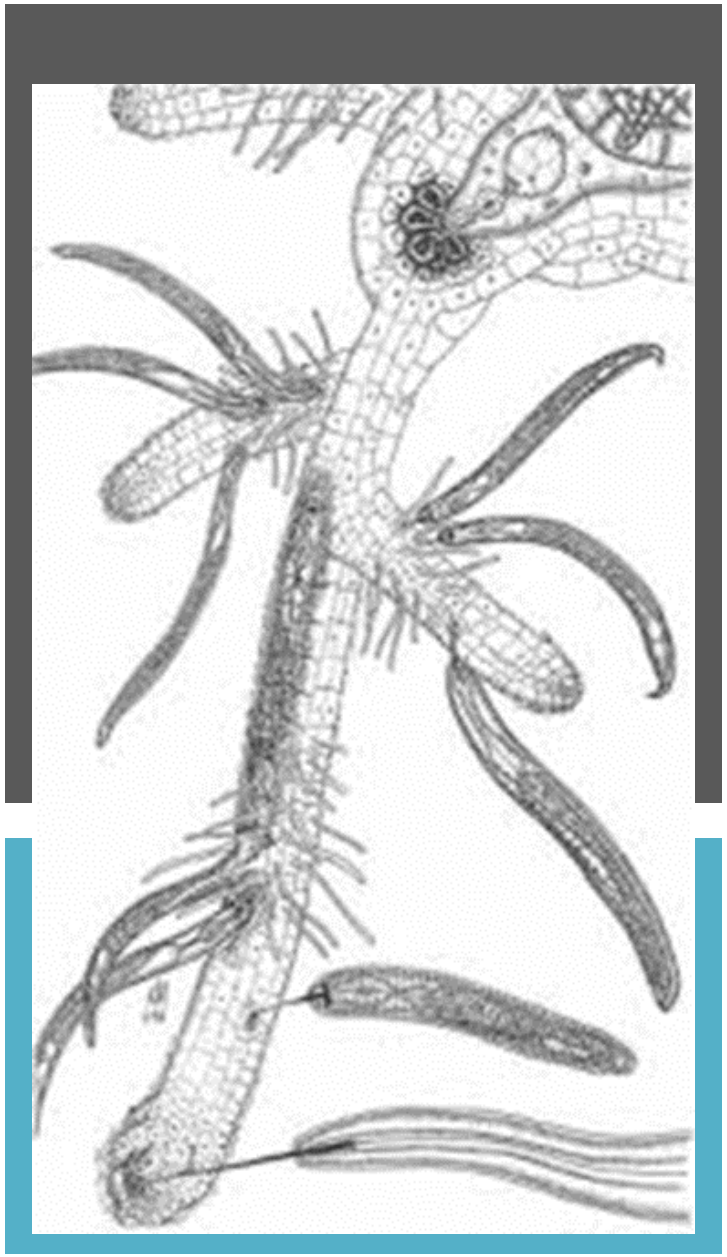
Normal shape

Vermiform



Sexual dimorphism

Understanding nematode feeding behaviors – Important for Management decision



Ectoparasites (Stubby-root, needle)

Endoparasites

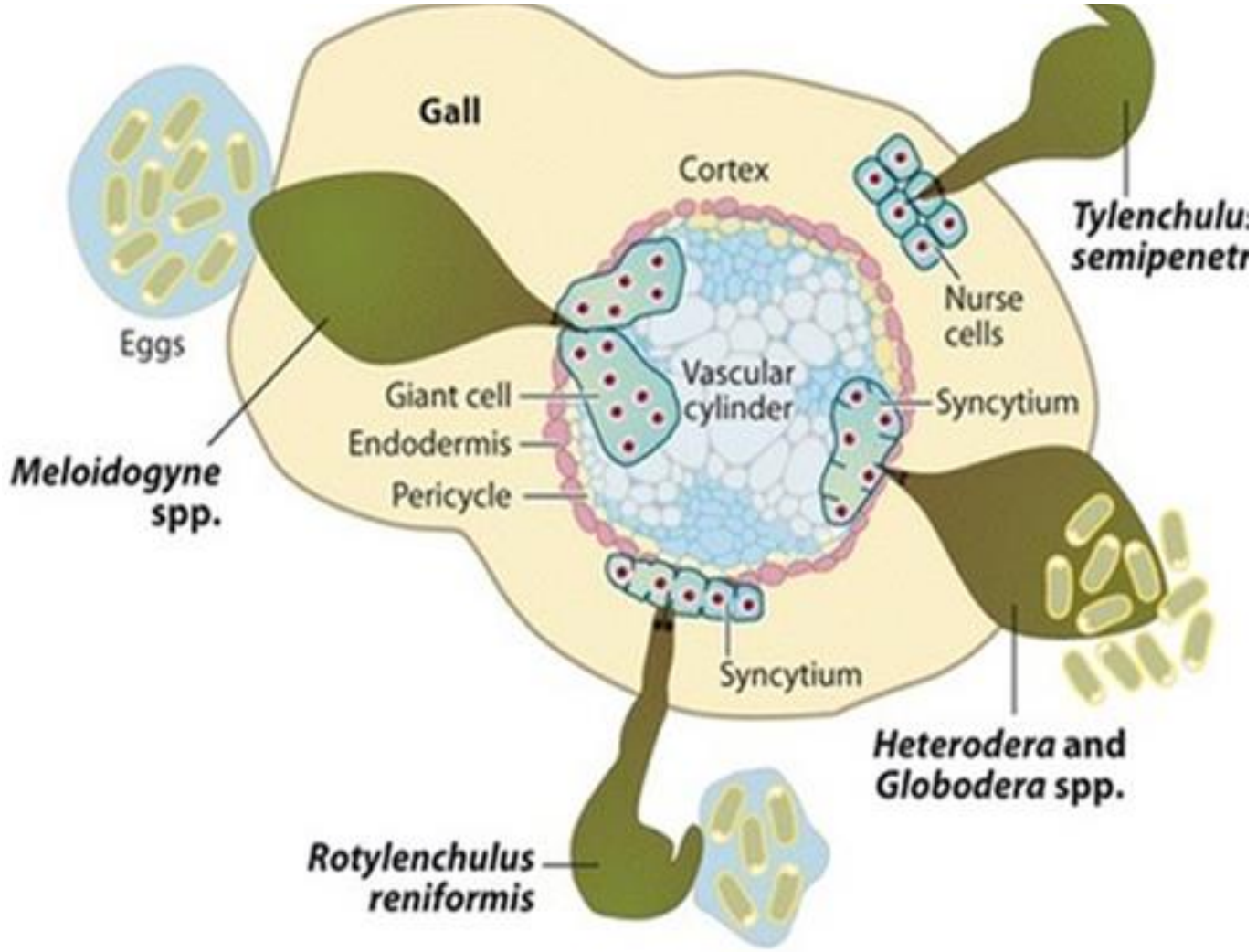
- *Sedentary (root-knot, cyst)*

- *Semi-endoparasite (citrus, reniform)*

- *Migratory (root-lesion, alfalfa stem)*

- **Sedentary endoparasites**
- **Semi-endoparasites**

Cross-section diagram of an infected root



Mitchum MG, et al. 2012.
Annu. Rev. Phytopathol. 50:175–95

Ectoparasite

Ectoparasite – Feeds from outside the roots

Major nematodes of low desert crop production

1) Endoparasites

– Sedentary:
  *Root-knot nematode *(Meloidogyne)*
– Semi-endoparasites:
  *Citrus nematode *(Tylenchulus)*

– Migratory
  *Root-lesion nematode (*Pratylenchus*)
  *Alfalfa stem nematode *(Ditylenchus)*

2) Ectoparasites

– Migratory
  *Stubby-root nematode *(Paratrichodorus)*
  *Needle nematode *(Longidorus)*

Major nematode of lows desert crop production

1) Endoparasites

– **Sedentary:**

Root-knot nematode *(Meloidogyne)

*Citrus nematode *(Tylenchulus)*

– Migratory

*Root-lesion nematode (*Pratylenchus*)

*Alfalfa stem nematode *(Ditylenchus)*

2) Ectoparasites

– Migratory

*Stubby-root nematode *(Paratrichodorus)*

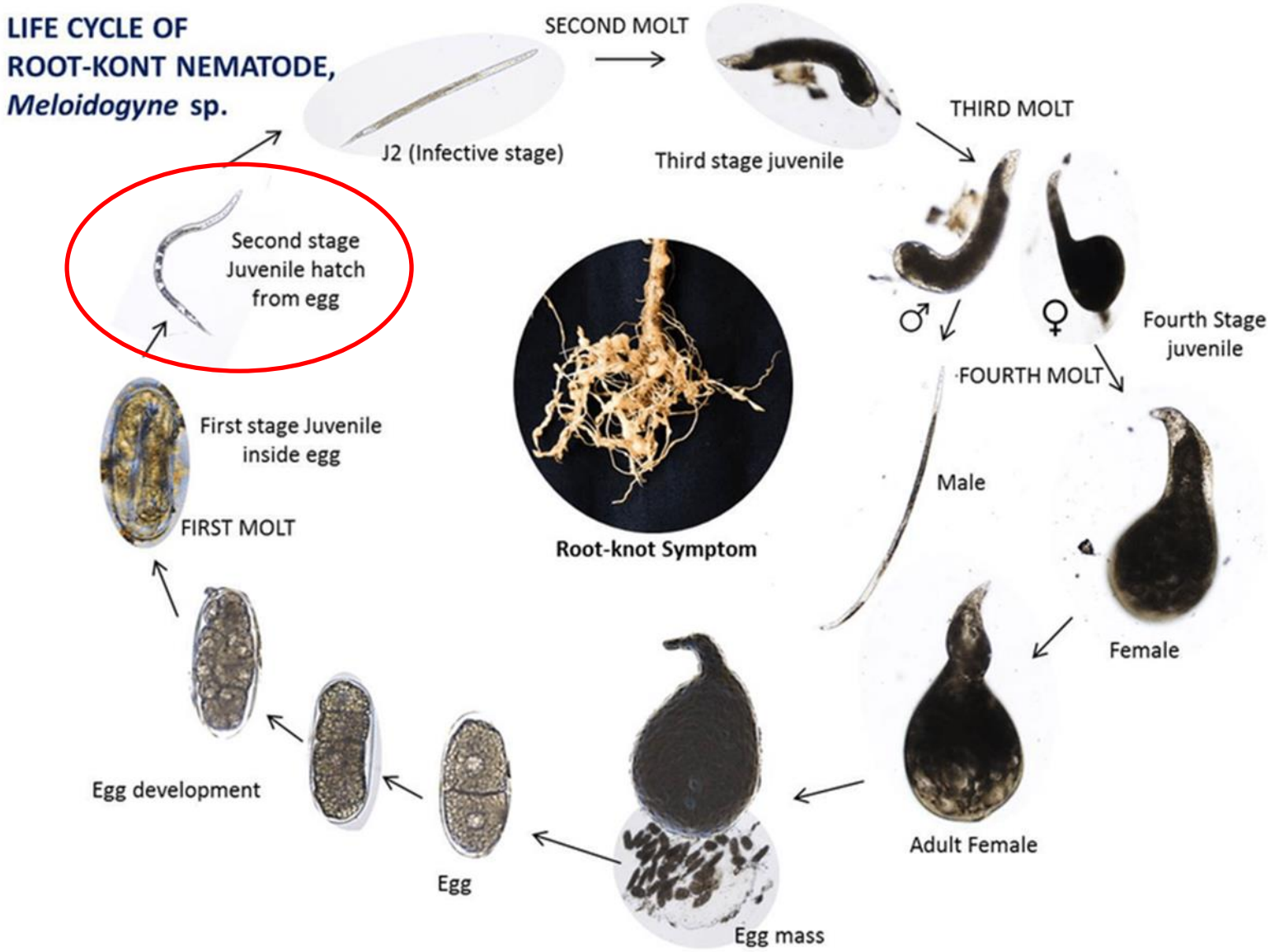
*Needle nematode *(Longidorus)*

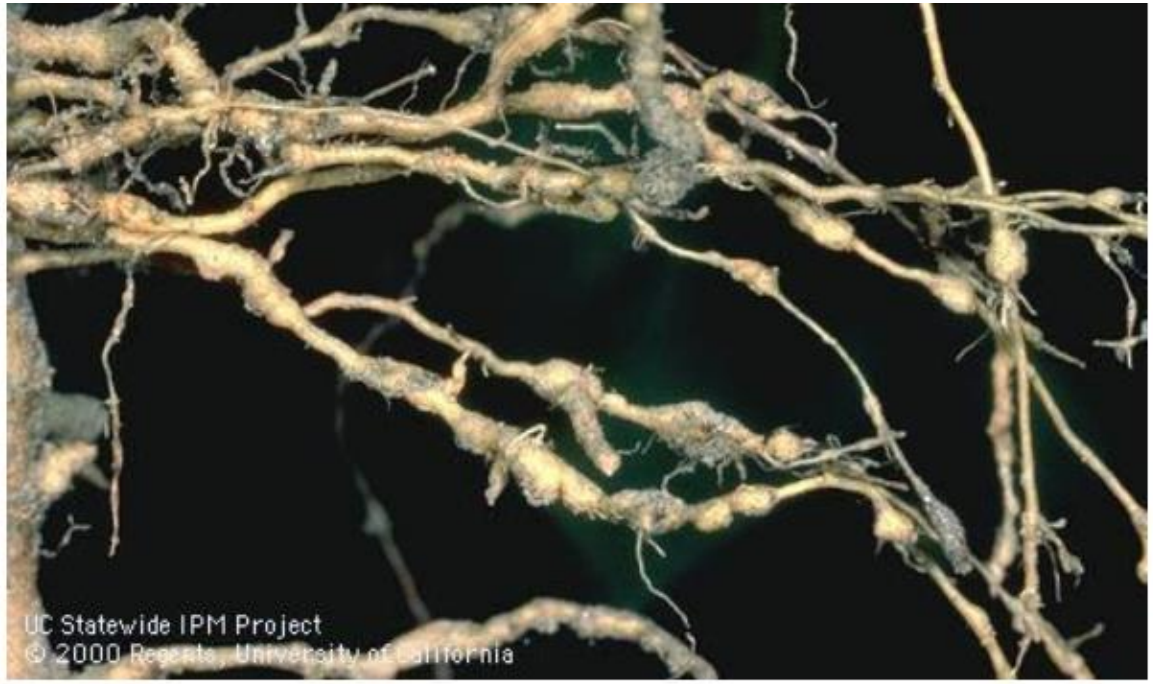
Life stages (sedentary nematodes)

1. Embryo – Embryogenesis (egg)
2. First-stage Juvenile (J1)
3. Second-stage Juvenile (J2)
4. Third-stage Juvenile (J3)
5. Fourth-stage Juvenile (J4)
6. Adult

Embryogenesis and Molting in nematodes

Root-knot nematodes *(Meloidogyne* spp.*)*





Root system heavily infested with root knot nematode

Photo by Jack Kelly Clark.

Root-knot nematode on cotton.

- A resistant variety of Acala cotton, NemX HY, developed in the San Joaquin Valley of California.

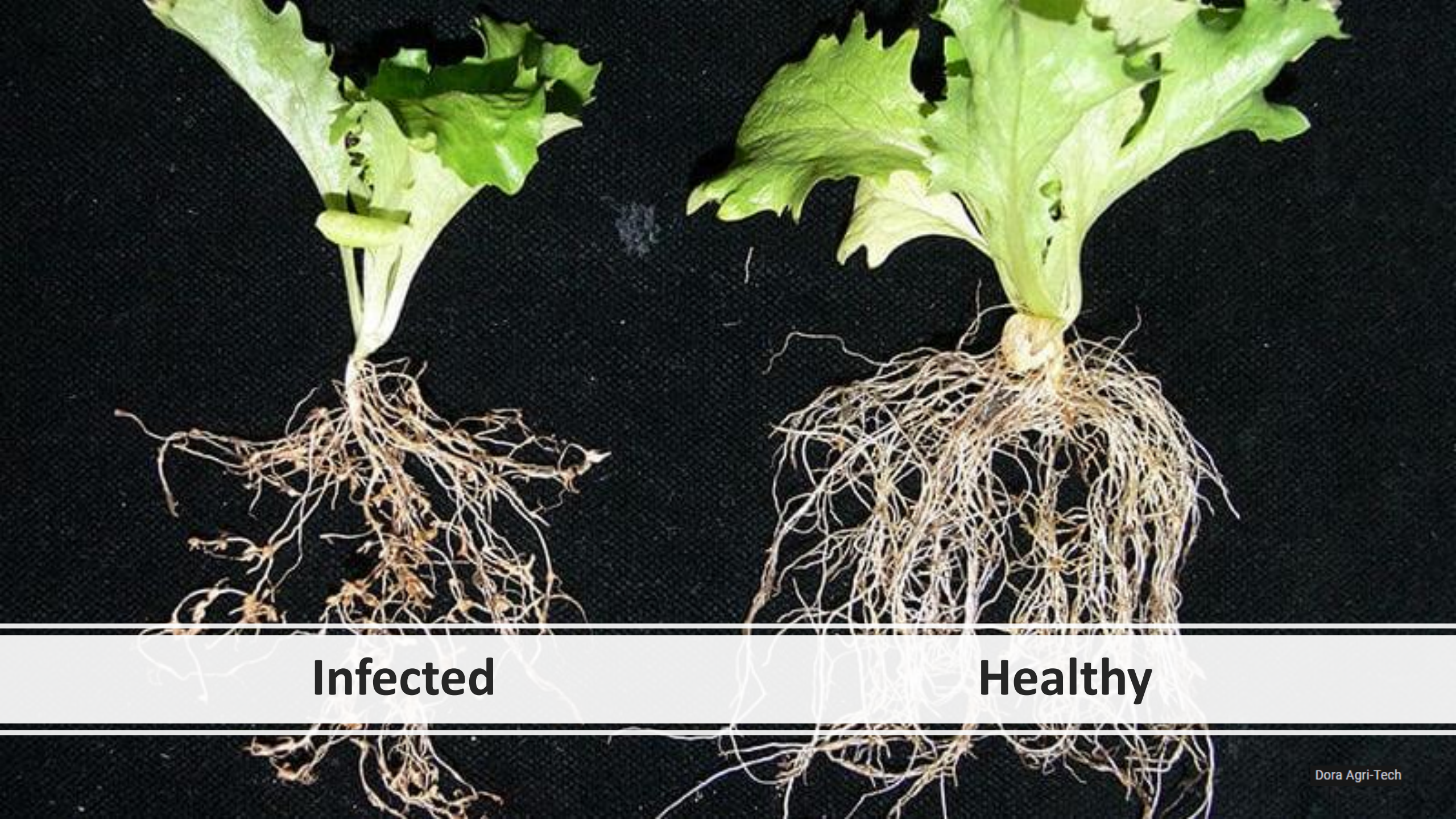
UC IPM - UC ANR

Root-knot nematode on alfalfa

Root-knot nematode damage on carrot

Healthy **Infected**

Gerald Holmes, Strawberry Center, Cal Poly San Luis Obispo, Bugwood.org


Infected
Healthy
Dora Agri-Tech

Bell pepper

showing above-ground symptom

Antoon Ploeg and Jose L. Aguiar

Healthy

Infected

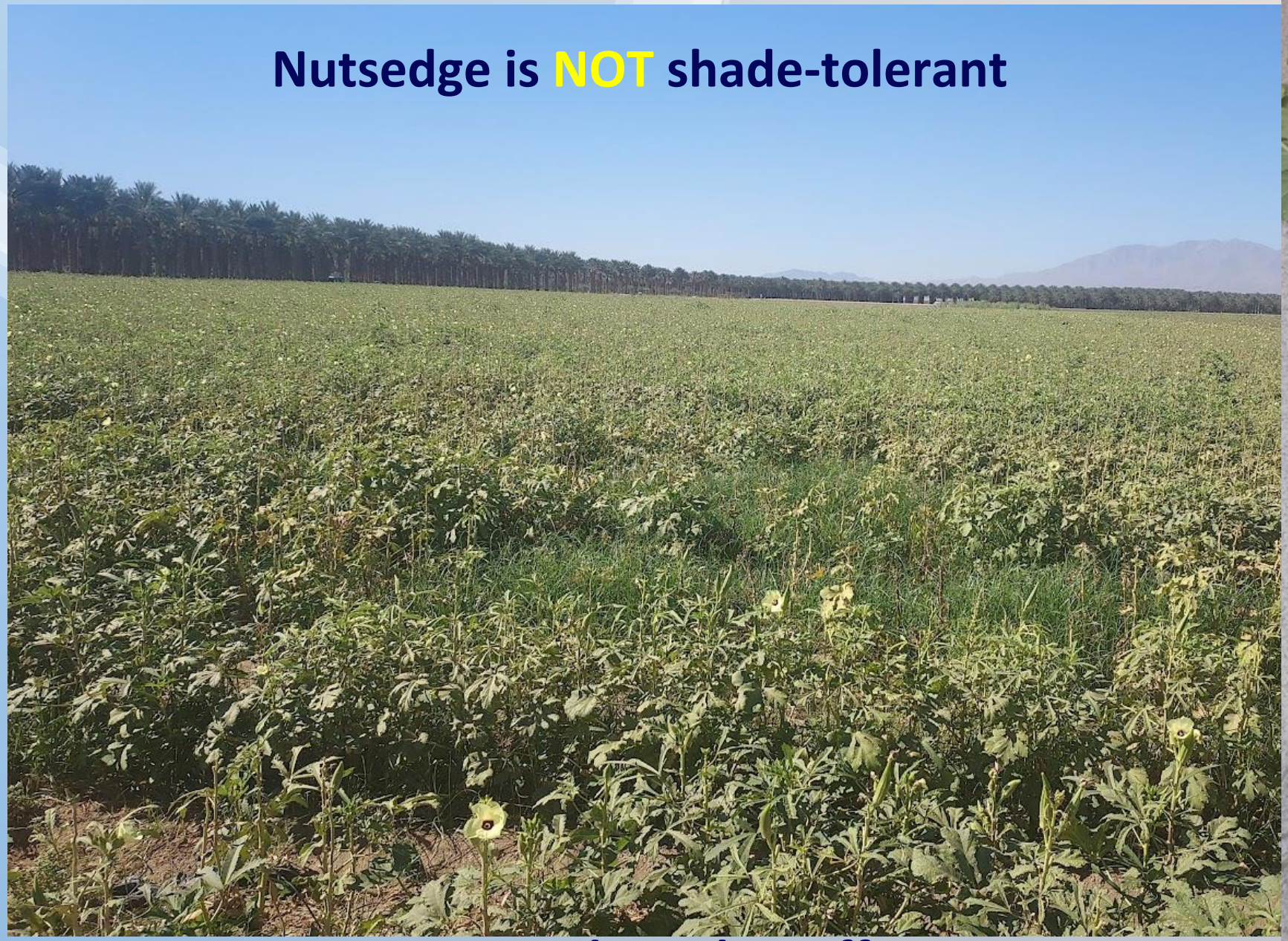
above ground

below ground

Infected

Healthy

Root-knot Nematode and Nutsedge



Nutsedge takes off

Major nematodes of low desert crop production

1) Endoparasite (semi-endoparasite)

– Sedentary:

*Root-knot nematode *(Meloidogyne)*

Citrus nematode *(Tylenchulus semipenetrans)

– Migratory

*Root-lesion nematode (*Pratylenchus*)

*Alfalfa stem nematode *(Ditylenchus)*

2) Ectoparasites

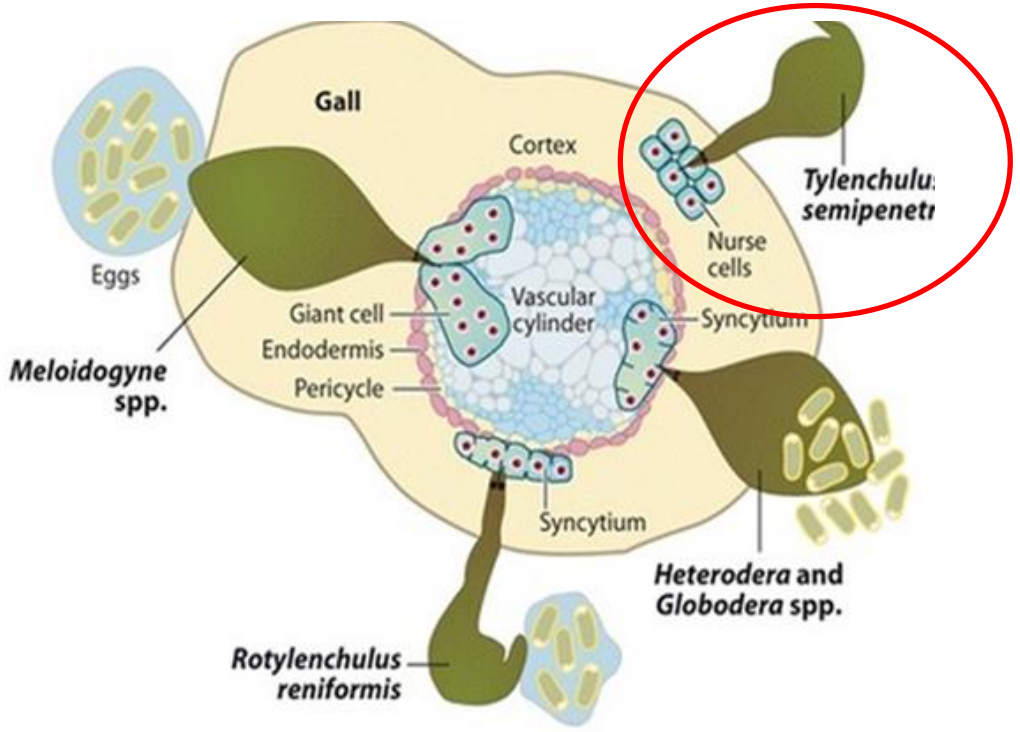
– Migratory

*Stubby-root nematode *(Paratrichodorus)*

*Needle nematode *(Longidorus)*

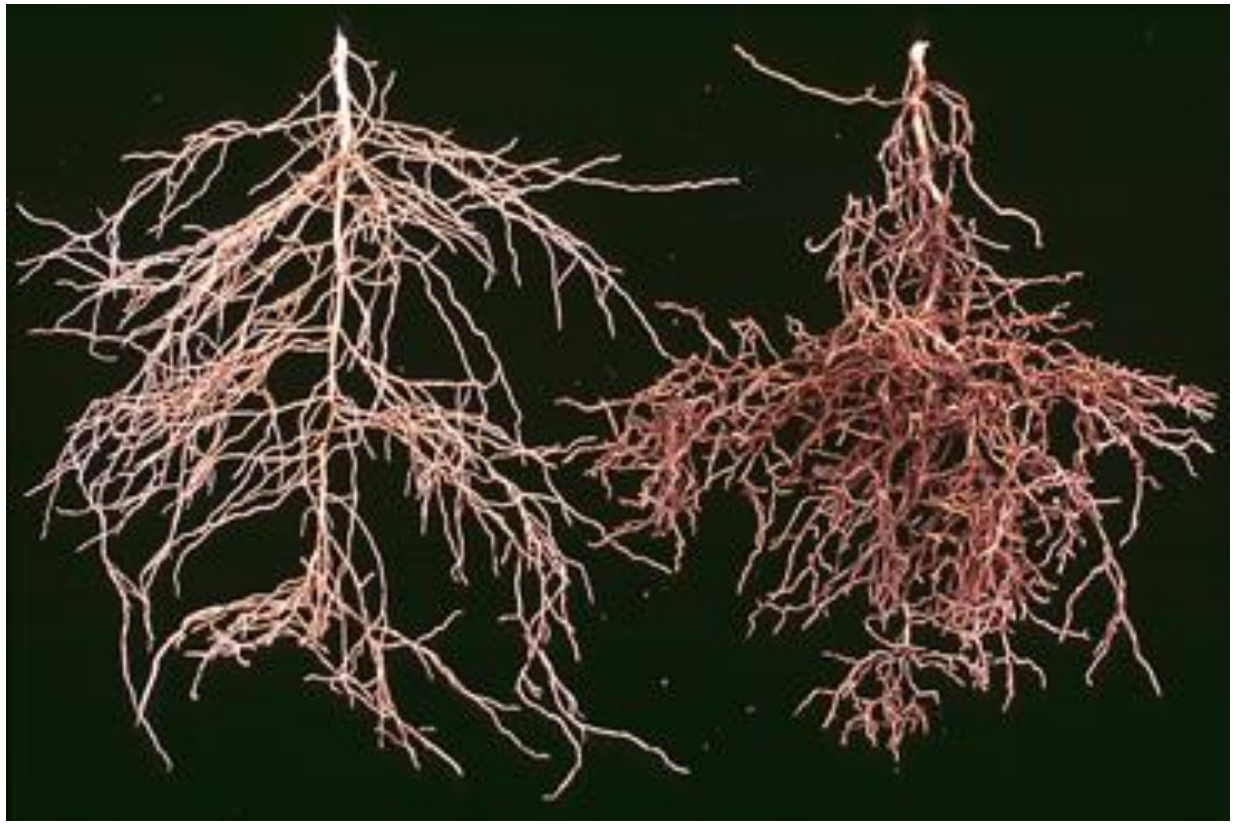
The citrus nematode is the only major nematode pathogen in California citrus.

Semi-endoparasite



Mitchum MG, et al. 2012.
Annu. Rev. Phytopathol. 50:175–95

A **darker** and **thicker** impression on heavily infested root is caused by soil particles encrusted with the egg sack gel.



Causes citrus slow decline

Advanced stage of citrus slow decline caused by the citrus nematode.

Photo by J. Ole Becker.

Management:

- Nematode resistant or tolerant rootstock
- Certified nematode-free planting material
- Nematode-free planting site

Major nematodes of low desert crop production

1) Endoparasite

– Sedentary:

*Root-knot nematode *(Meloidogyne)*

*Sugarbeet cyst nematode (*Heterodera)*

*Citrus nematode *(Tylenchulus)*

– Migratory

***Root-lesion nematode (*Pratylenchus*)**

Alfalfa stem nematode *(Ditylenchus)

2) Ectoparasites

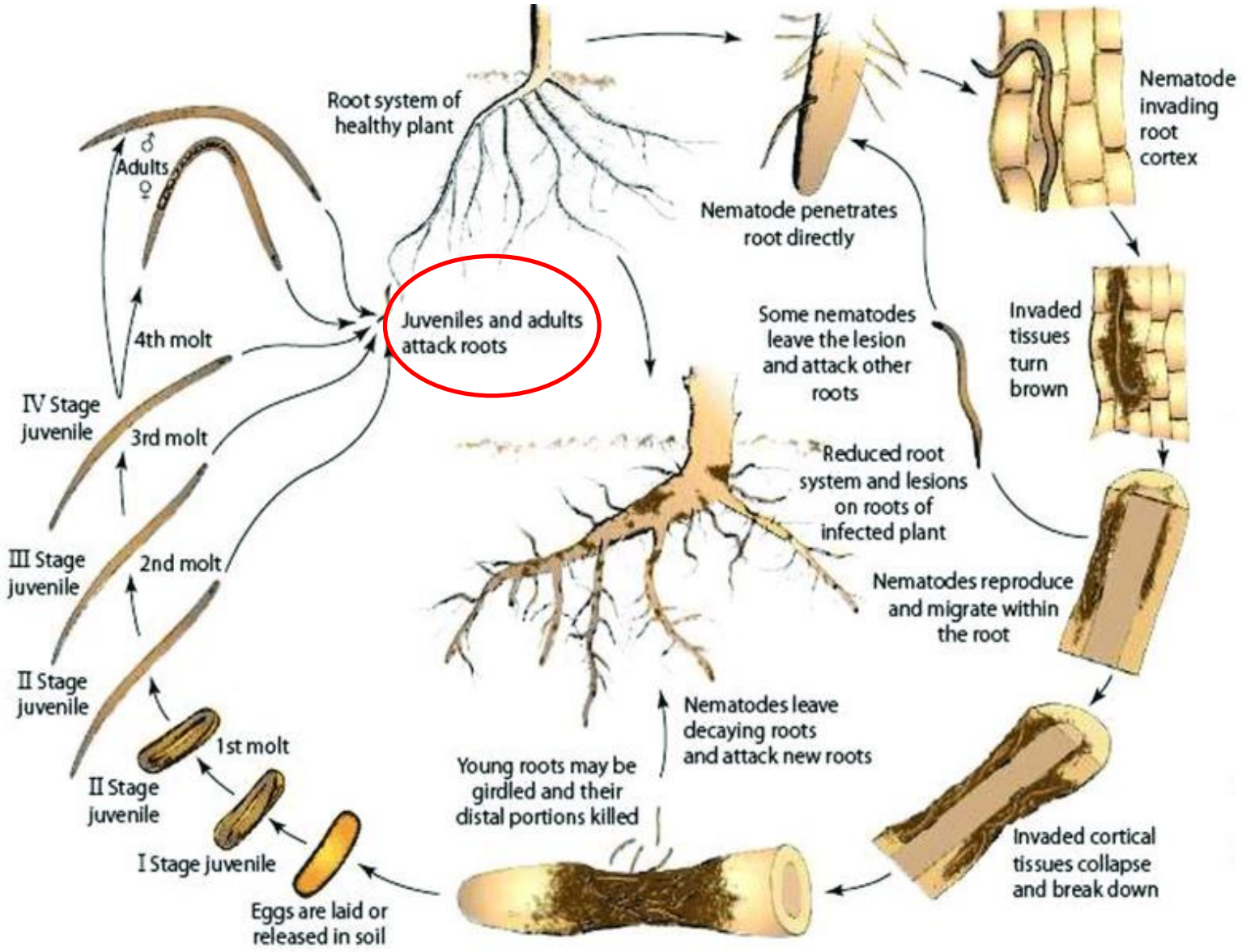
– Migratory

*Stubby-root nematode *(Paratrichodorus)*

*Needle nematode *(Longidorus)*

1. Embryo – Embryogenesis (e
2. First-stage Juvenile (J1) –
3. Second-stage Juvenile (J2)
4. Third-stage Juvenile (J3)
5. Fourth-stage Juvenile (J4)
6. Adult

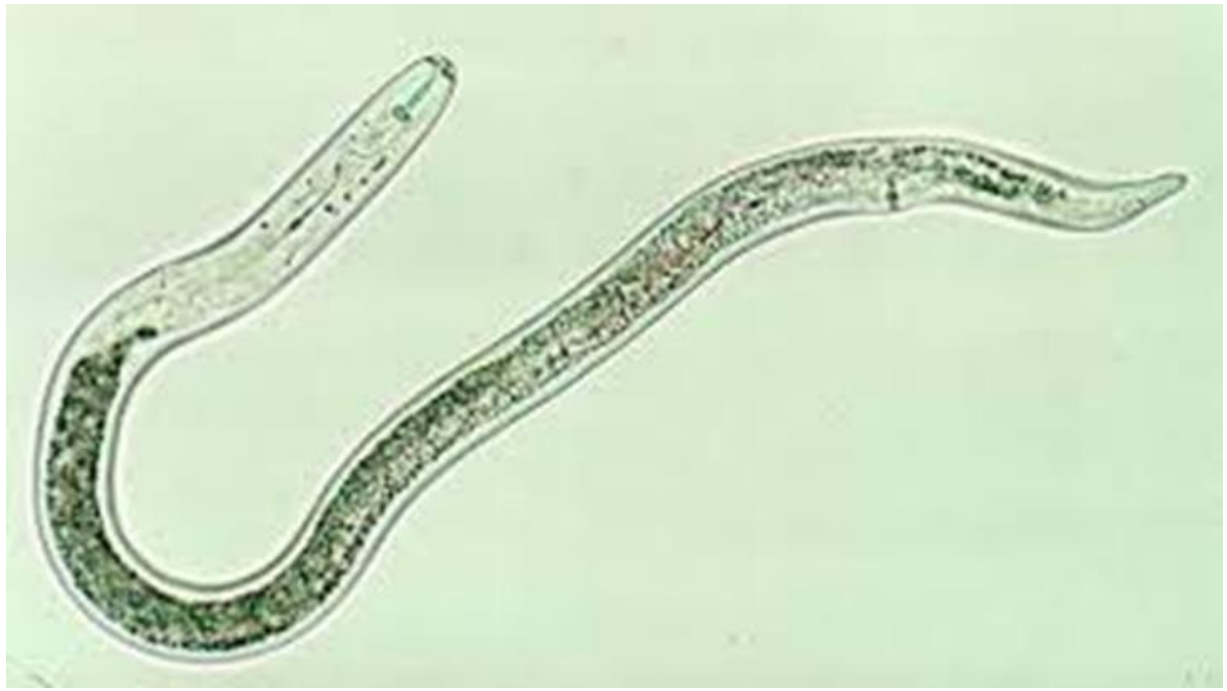
Life cycle – migratory endoparasites



Migratory endoparasites

Alfalfa stem nematode *(Ditylenchus dipsaci)*

Root-lesion nematode *(Pratylenchus)*



Alfalfa stem nematode *(Ditylenchus dipsaci)*

des from plants is easily done in a plastic baggie. With the bag held uprig
gate in the corner of the bag and can be seen with a 10X hand lens.

Nematodes found in California alfalfa fields

Common Name	Scientific Name
Nematodes Commonly Causing Injury	
Stem nematode*	*Ditylenchus dipsaci* (Kuhn and Filipjev)
Northern root-knot nematode*	*Meloidogyne hapla* Chitwood
Javanese root-knot nematode	*M. javanica* (Treub, Chitwood)
Southern root-knot nematode*	*M. incognita* (Kofoid and White) Chitwood
Peanut root-knot nematode	*M. arenaria* (Neal) Chitwood
Columbia root-knot nematode	*M. chitwoodi* Golden, O'Bannon, Santo, Finley
Other Nematodes Found	
Lesion nematode*	*Pratylenchus penetrans* (Cobb) Filipjev and Schuurmans-Stekhoven
Dagger nematode	*Xiphinema americanum* Cobb
Needle nematode	*Longidorus africanus* (Micol.) Meyl
Ring nematode*	*Mesocriconema curvatus* (Raski) Loof and DeGrisse
Stunt nematode*	*Merlinius brevidens* (Allen) Siddiqi
Stunt nematode	*Tylenchorhynchus* sp. Cobb
Spiral nematode	*Helicotylenchus* sp. Steiner
Stubby-root nematode*	*Trichodorus* sp. Cobb
Stubby-root nematode	*Paratrichodorus* sp. Siddiqi

*These nematodes have been shown to reduce yields in alfalfa.

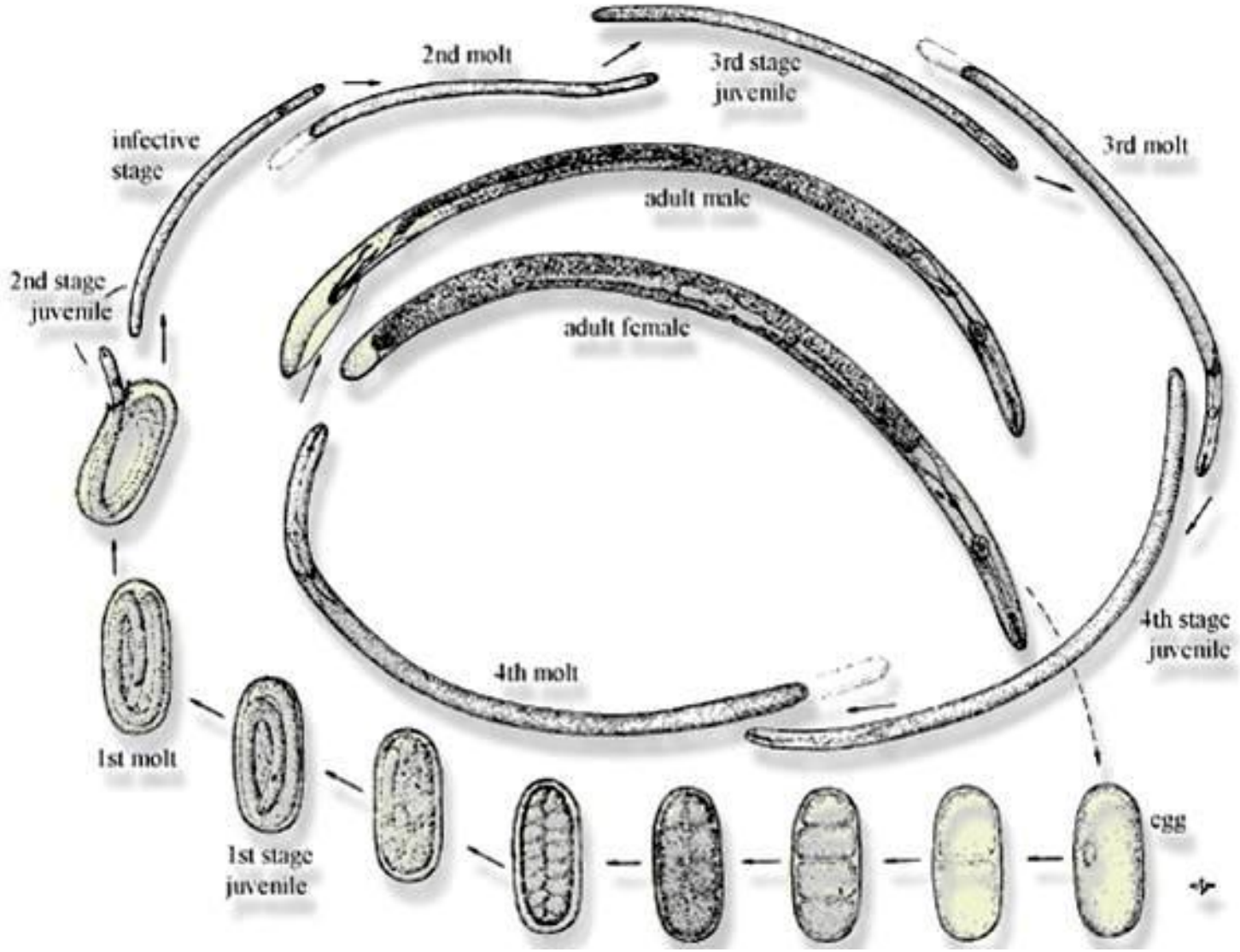
Alfalfa stem nematode *(Ditylenchus dipsaci)*

Becky B. Westerdahl

Root-lesion nematode damage on carrot

Life cycle - migratory ectoparasites

1. Embryo – Embryogenesis (e
2. First-stage Juvenile (J1)
3. Second-stage Juvenile (J2)
4. Third-stage Juvenile (J3)
5. Fourth-stage Juvenile (J4)
6. Adult



Stubby-root nematode *(Paratrichodorus)*

Stubby-root nematode damage on maize

Stubby-root nematode damage on carrot

Management

- Chemical Control
- Cultural Control/Host resistance
- Biological Control
- Integrated Nematode Management

Chemical Control - Nematicides

BAYER

VELUM® ONE

QUALI-PRO

NIMITZ® Pro G
Nematicide

For nematode control in Bermudagrass, St. Augustinegrass, Zoysiagrass, Centipedegrass, Seashore Paspalum, Tall Fescue, and Creeping Bentgrass on Golf Courses, Sports Fields, Commercial Turfgrass Areas, Sod Farms and Residential Turfgrass Lawns

Intended for use by a Commercial Applicator.

ACTIVE INGREDIENT:	% BY WT.
Fluensulfone: 5-chloro-2 (3,4,4-trifluoro-but-3-ene-1-sulfonyl)-thiazole	1.5%
OTHER INGREDIENTS*:	98.5%
TOTAL:	100.0%

KEEP OUT OF REACH OF CHILDREN
CAUTION/
PRECAUCION

EPA Reg. No: 53883-357
EPA Est. No: 37429-GA-001, 37492-GA-002

Manufactured for:
Control Solutions Inc.
A member of Adama Consumer and Professional Solutions

0 72693 40027 6

Net Weight: 40 Pounds

Molt-X

Molt-X

BioWorks®

OMRI LISTED
For Organic Use - OMRI.org

BAYER

MOVENTO®

MeloCon® LC

BIOLOGICAL NEMATICIDE

OMRI LISTED
For Organic Use - OMRI.org

vapam® HL™

Salibro®

Reklemel® active

NEMATICIDE

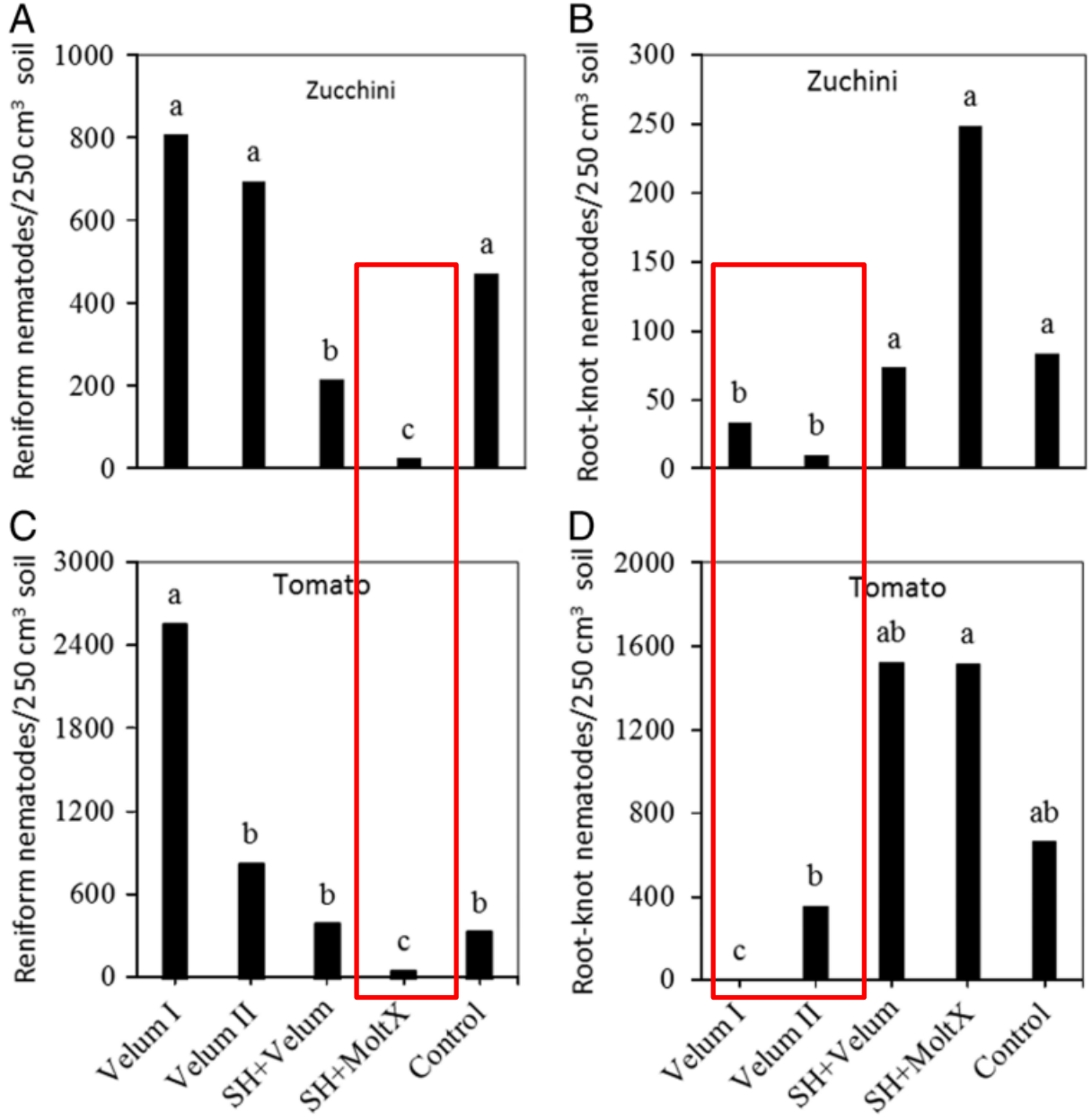
Chemical Control - Nematicides

Table 2. Effect of spirotetramat on *Rotylenchulus reniformis* on pineapple.

	Nematode population[x]		Plant weight[y]	
Spirotetramat[z] (g)	Soil (#/250 cm^3)	Root (#/g)	Root (g)	Shoot (g)
0	171 A	41 a	8.8 B	501.5 b
50	85 AB	21 a	10.7 AB	608.2 ab
100	139 AB	3 a	11.7 AB	544.5 ab
200	165 B	2 b	12.6 A	673.3 a

[x]Values with the same letter within a column are not different based on Waller-Duncan *k*-ratio (*k*=100) *t*-test.
[y]Dry root and fresh shoot weights of pineapple.
[z]Rates of spirotetramat in grams per hectare.

Chemical Control - Nematicides



Cultural Nematode Control

Figure 3. Application of transparent polyethylene film to solarize a field on an organic vegetable farm in the San Joaquin Valley, California. (Source: University of California)

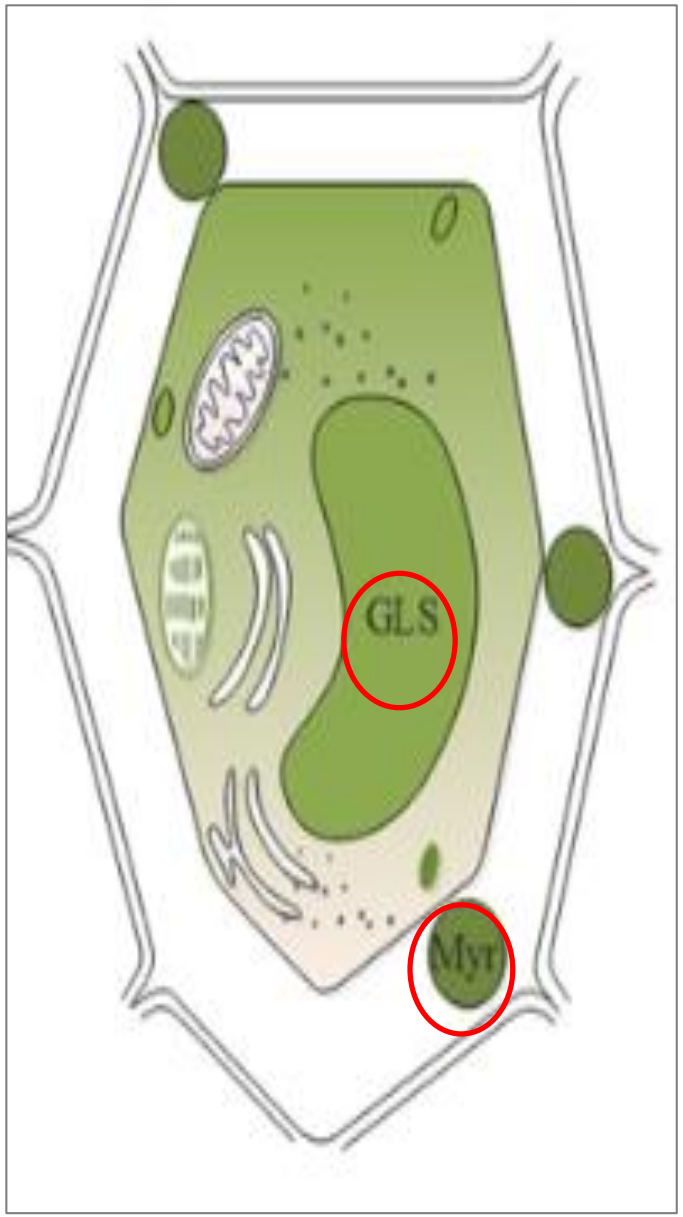
- Soil solarization
- Deep ploughing/tillage
- Wash equipment

- **Crop Rotation**

Cultural Control – Crop rotation/Cover Crops

Cover Crops with Allelopathic Effects - Biofumigation

Cultural Nematode Control



ELSEVIER

Applied Soil Ecology
Volume 154, October 2020, 103595

Effects of biofumigant crop termination methods on suppression of plant-parasitic nematodes

Philip Waisen [a], Zhiqiang Cheng [a], Brent S. Sipes [a], Joseph DeFrank [b], Sharadchandra P. Marahatta [c], Koon-Hui Wang [a]

Show more

+ Add to Mendeley Share Cite

https://doi.org/10.1016/j.apsoil.2020.103595

Get rights and content

Highlights

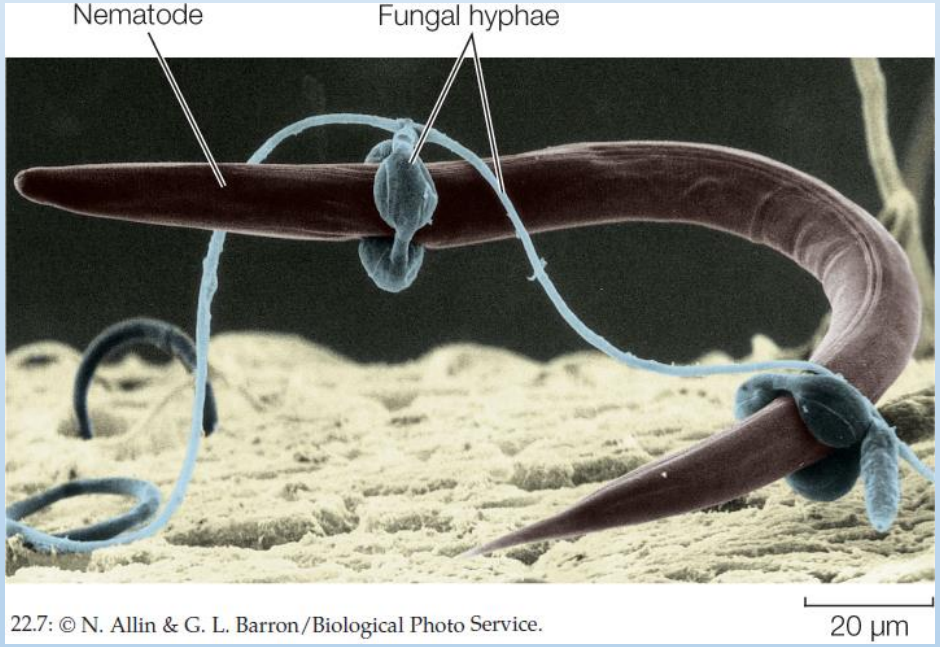
- Biofumigation effect is stronger with brown mustard than oil radish.
- Root-knot nematode is more sensitive to biofumigation than reniform nematode.
- Combining tissue maceration, soil incorporation and covering black plastic is suppressive to plant-parasitic nematodes.
- Soil sulfate is less sensitive to microbial degradation, thus a better biofumigation indicator.

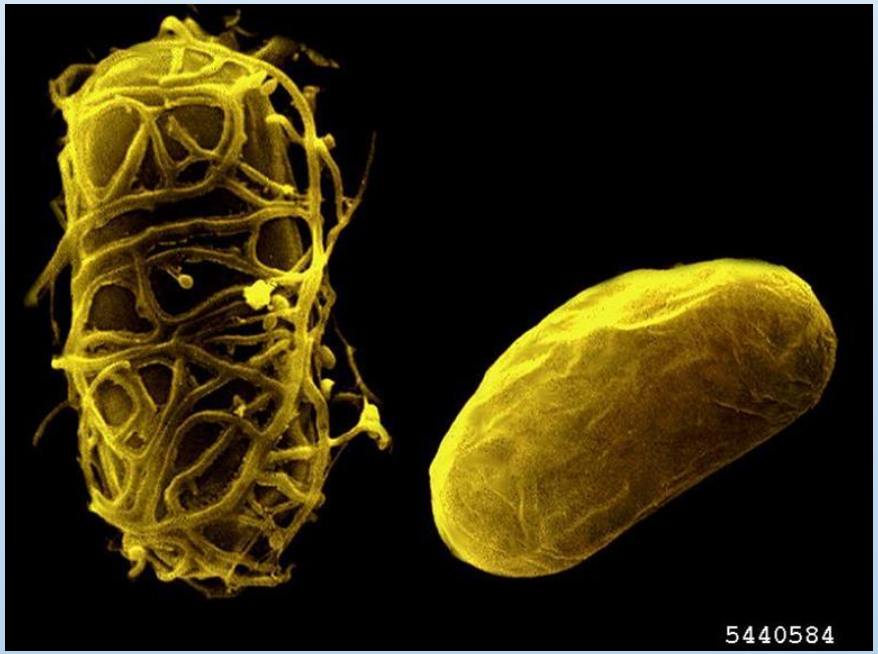
Biological Control of Nematodes

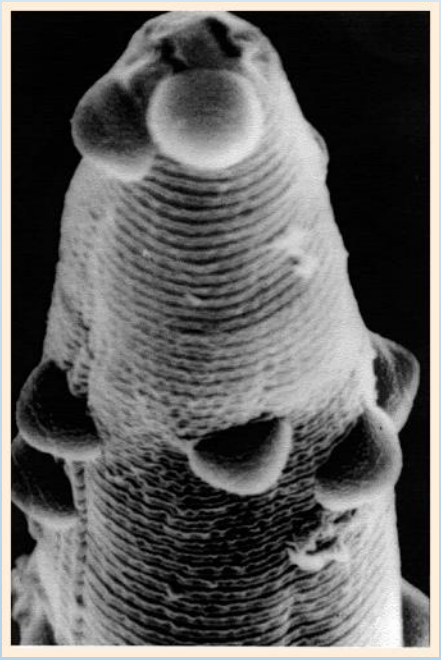
- Bacteria
- Fungi
- Nematodes (predators)
- Arthropods (mites)

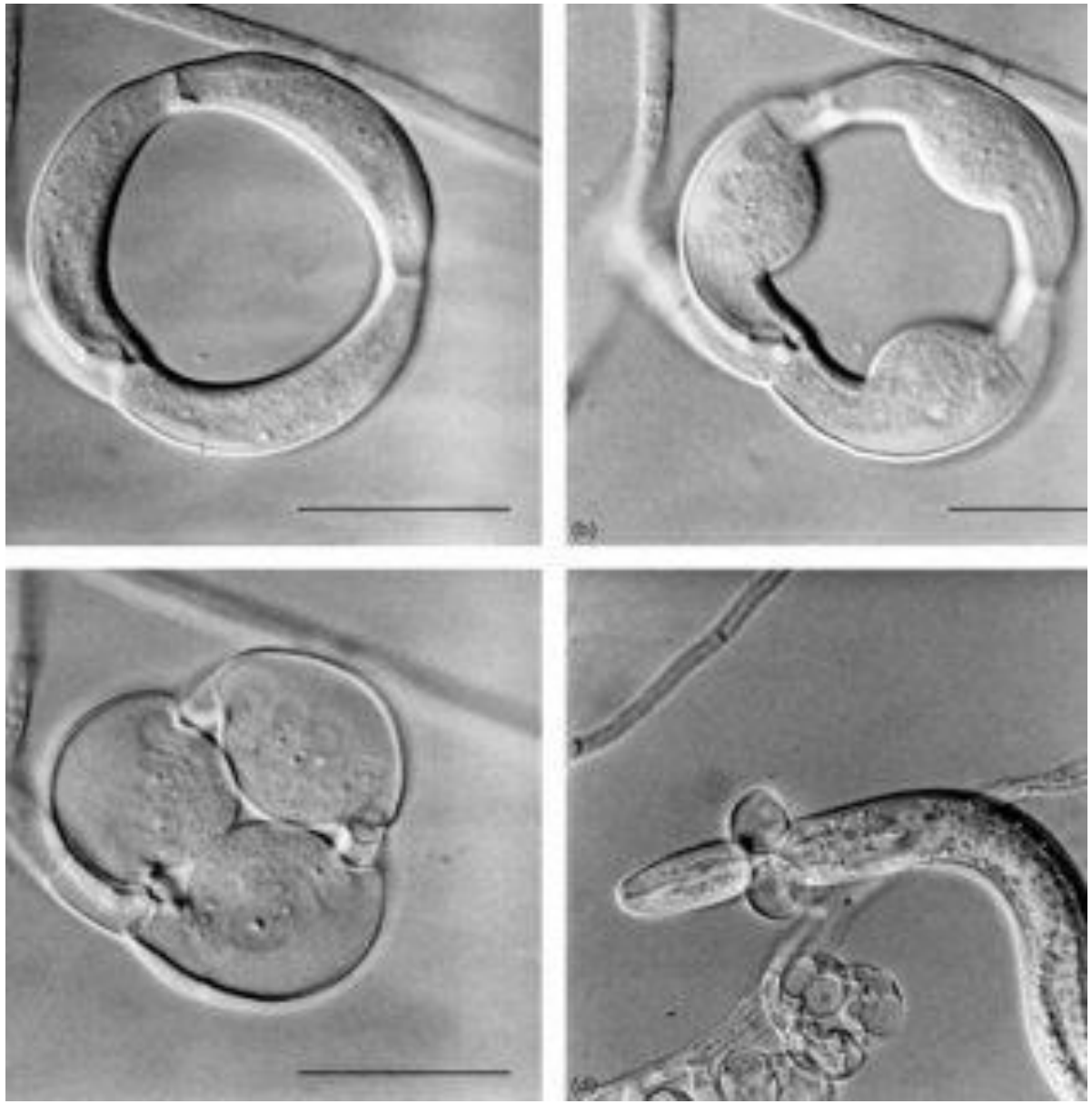
Natural enemies

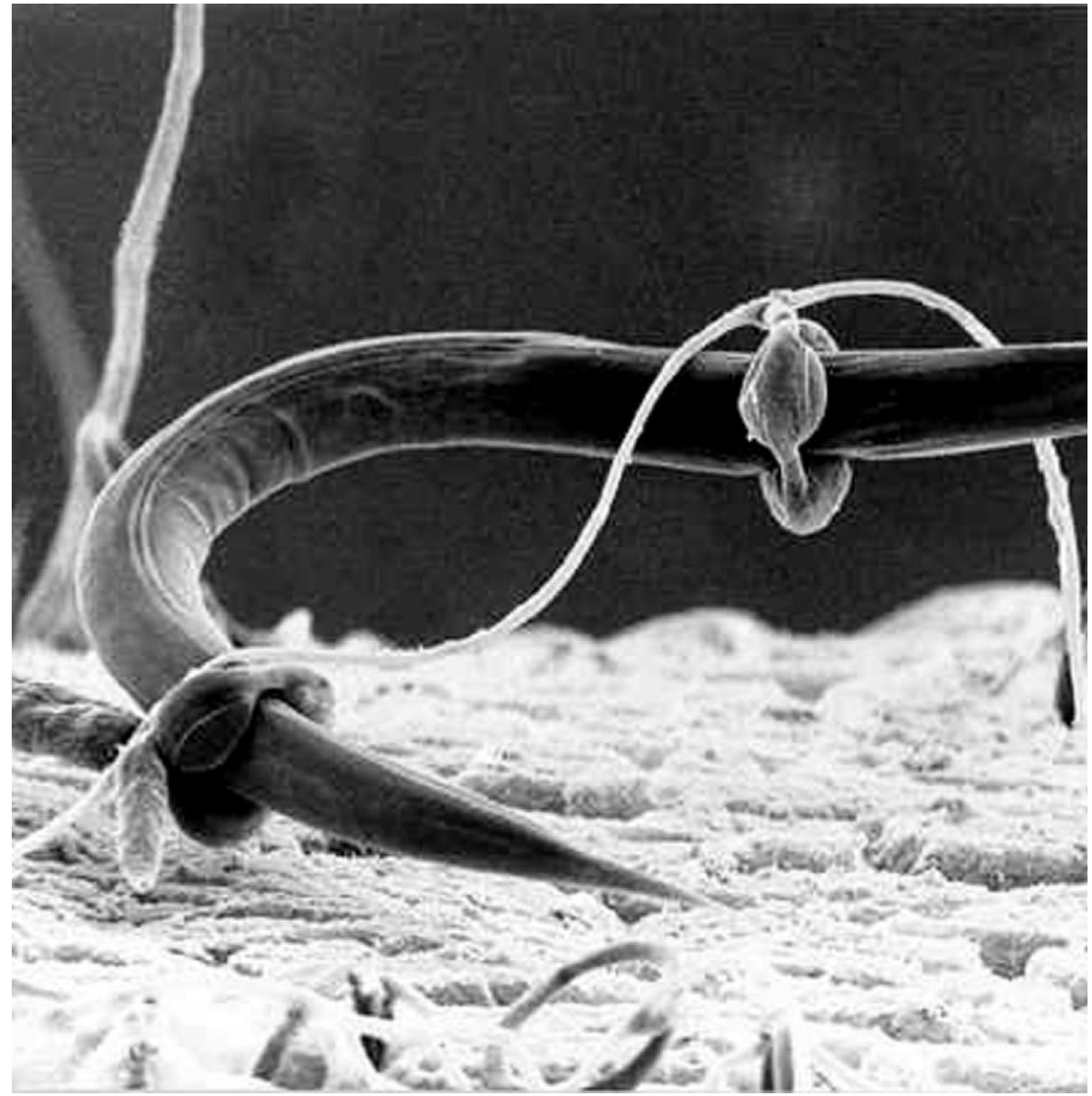
- Classical biocontrol
- Augmentative biocontrol
- Conservation biocontrol



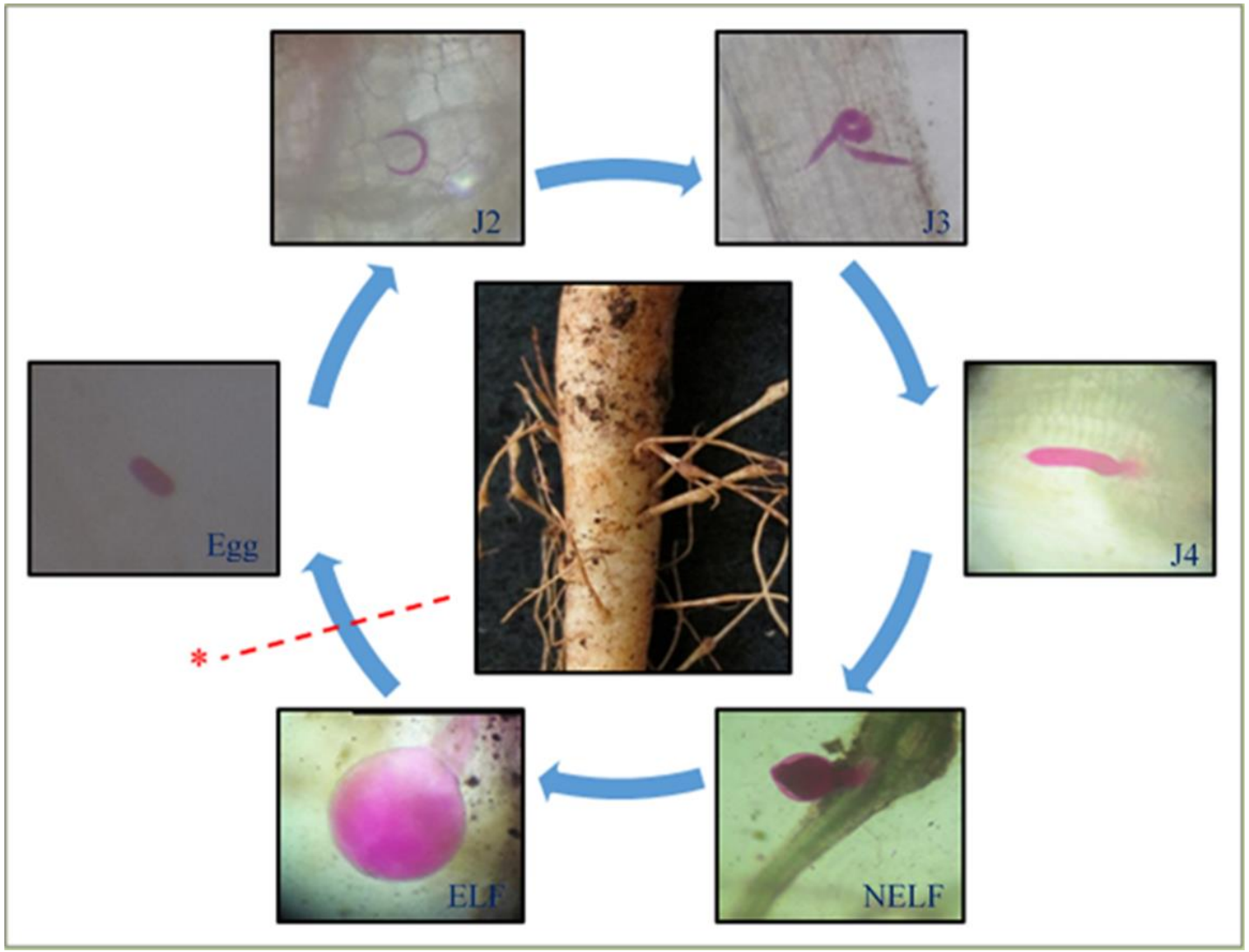






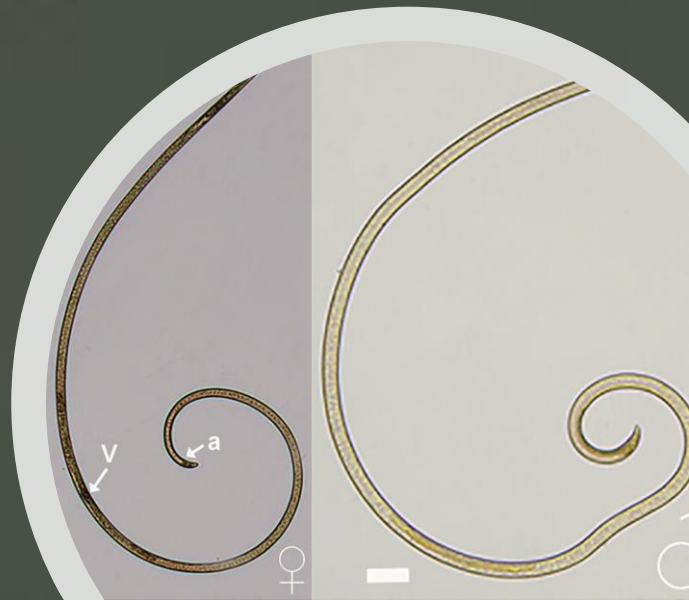


Cultural Nematode Control

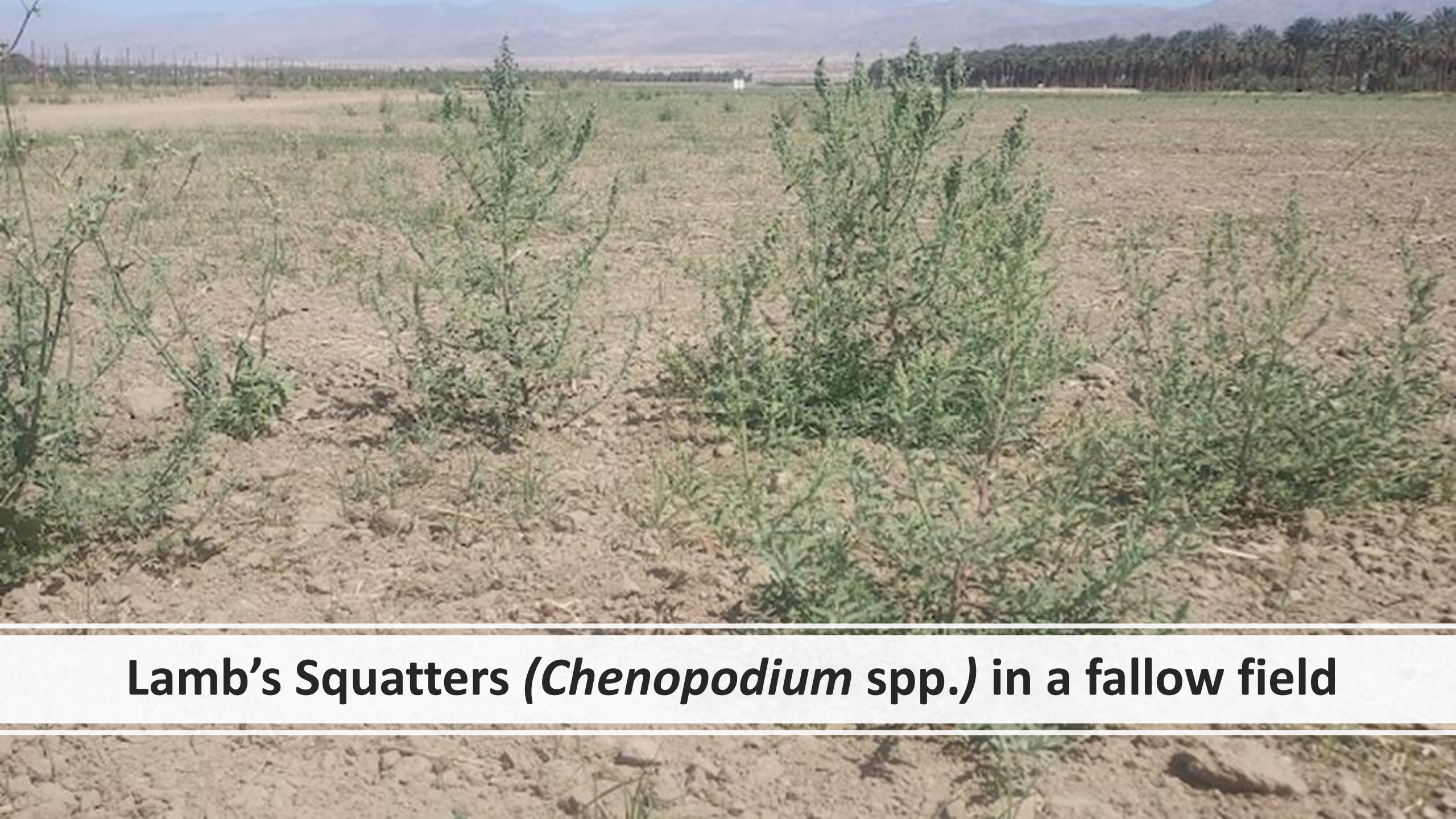


Field trial established on 08/08 - Salibro (Fluazaindolizine)

• Upcoming field trial - Salibro (Fluazaindolizine) on carrot in Imperial Valley.



Weeds can host nematodes during the off-season



Lamb's Squatters *(Chenopodium* spp.*)* in a fallow field

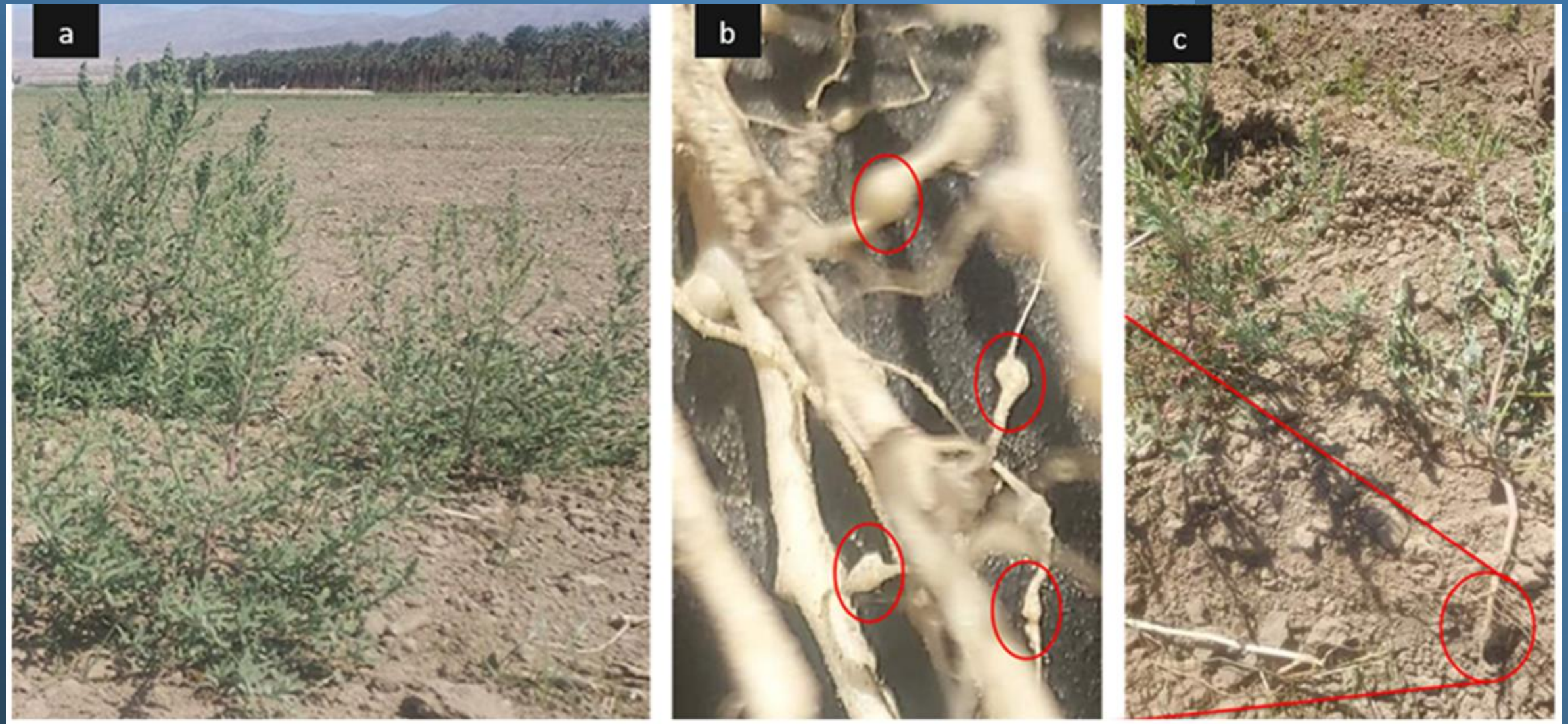


Figure 2. Lamb's quarters (*Chenopodium album*) a) plants colonized in a fallow field; b) roots exhibiting characteristic galls induced by *Meloidogyne* infections; and c) plant being uprooted and observed for *Meloidogyne*-

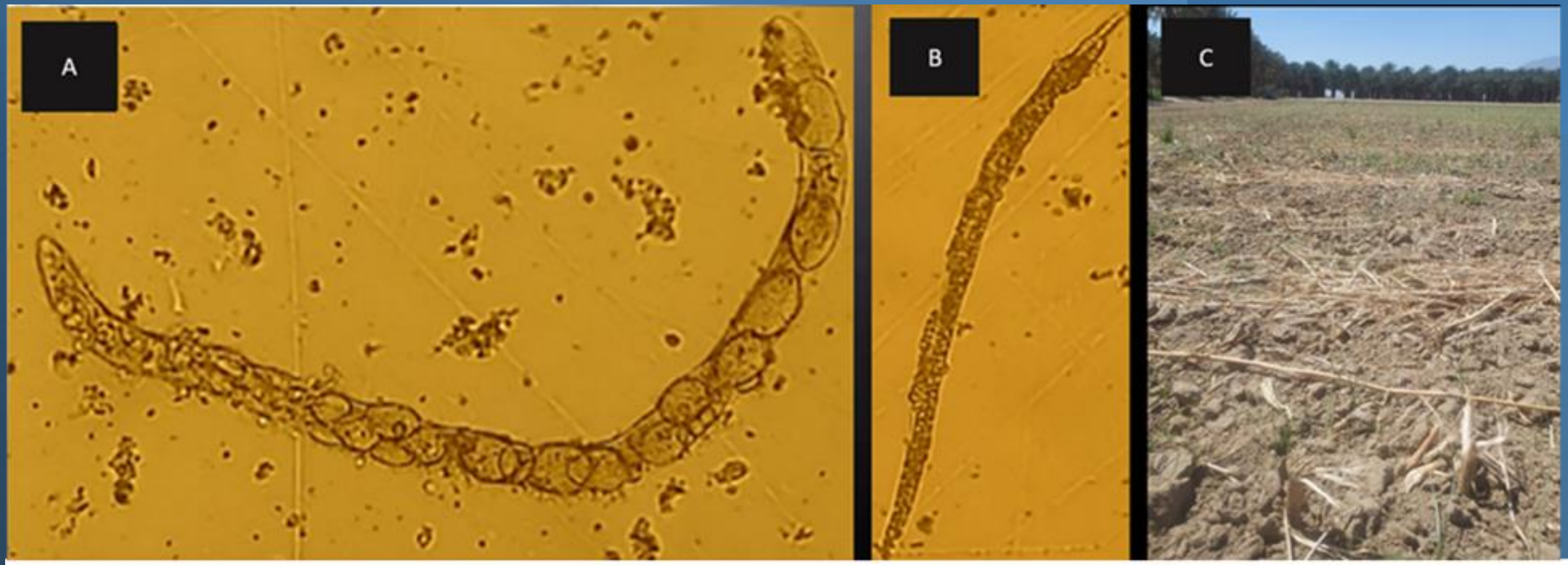
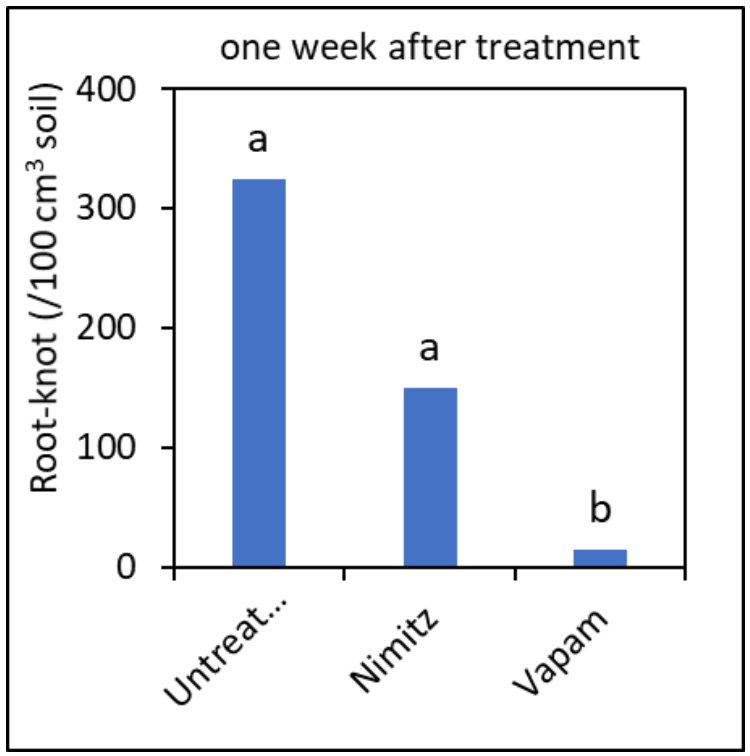
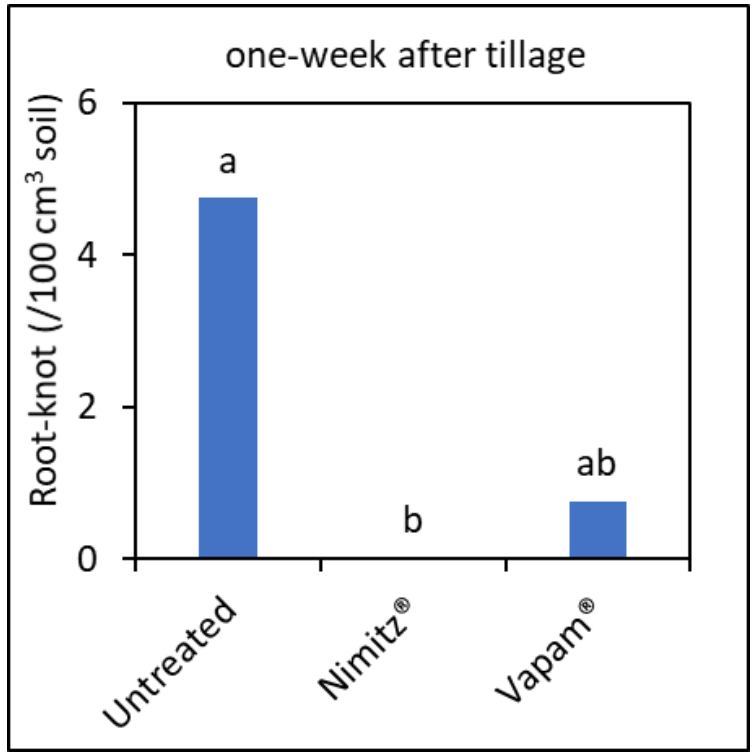


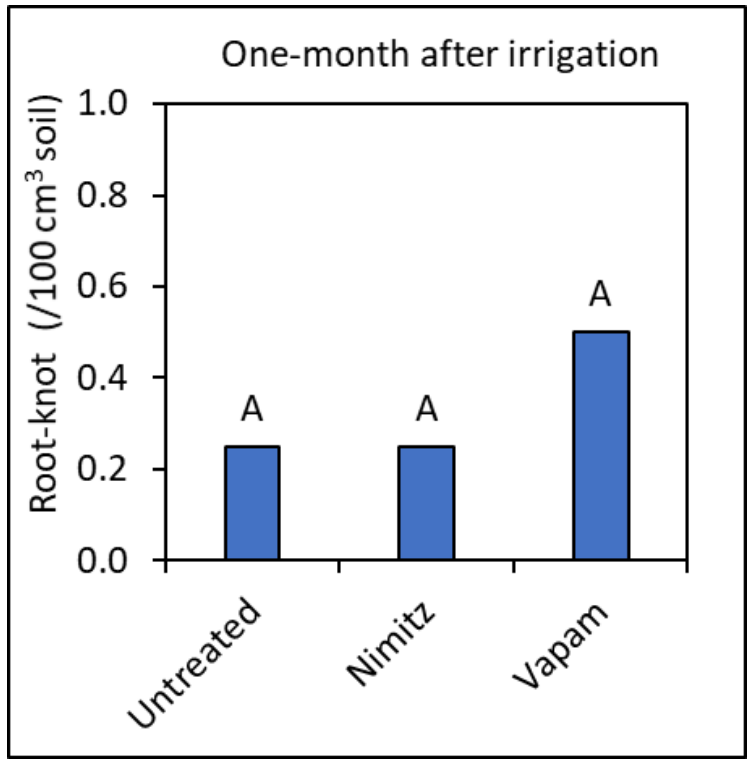
Figure 4. Biological control agents attacked and disintegrated A) omnivorous nematode and B) *Meloidogyne* juvenile (×100 magnification); C) A fallow field showing minimally tilled field and okra crop residue from the previous crop.

UC CE | UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources | Cooperative Extension

POST-HARVEST NEMATICIDE TREATMENT AND TILLAGE SHOWED PROMISE IN REDUCING THE INITIAL ROOT-KNOT NEMATODE POPULATION ON BELL PEPPER







Thank you

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

UC Cooperative Extension
Serving Riverside and Imperial Counties

Philip Waisen (Ph.D.)
Vegetable Crops Advisor
ceriverside.ucanr.edu
researchgate.net/profile/Philip-Waisen

UC
CE

80177 Indio Blvd., Suite H Indio, CA 92201
1050 East Holton Road Holtville, CA 92250
(760) 342-2467 *office*
(442) 265-7700 *office*
(760) 905-5204 *cell*
pwaisen@ucanr.edu