

How to Control Soil Insects with Beneficial Nematodes

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Using Microbials in IPM

- **Do not have to change everything about crop management**
- **Many microbial insecticides fit into current production plans with minimal effort and change**
- **They require specialized information about their use**

Insect pathogens can be effective

- **Naturally occur**
 - **Even in intensively managed systems**
- **Have an impact on insect populations at natural levels**

Necessary information: Products

- **Shelf life**
- **Storage conditions**
- **Resting stage?**
- **Viability in field**
- **Host range**
- **Time to kill**
- **What does an infected insect look like?**

Recognized Species of Entomopathogenic Nematodes

H. bacteriophora

H. brevicaudis

H. hawaiiensis

H. indica

S. kraussei

S. arenarium

S. bicornutum

S. carpocapsae

S. caudatum

S. ceratophorum

S. cubanum

S. feltiae

S. glaseri

S. intermedium

S. affine

H. marelatus

H. megidis

H. zealandica

H. argentinensis

S. kariii

S. kushidai

S. longicaudum

S. monticolum

S. neocurtillae

S. oregonense

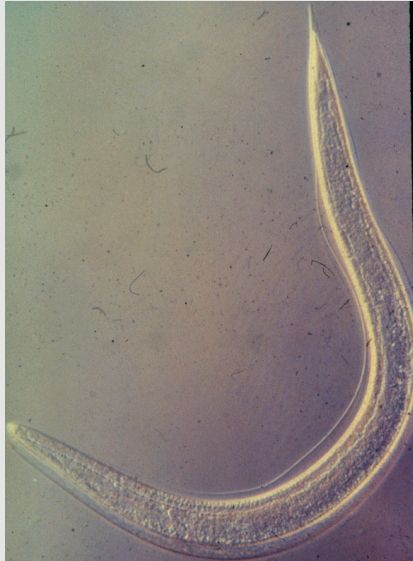
S. puertoricense

S. rarum

S. riobrave

S. ritteri

S. scapterisci



Infective Juveniles

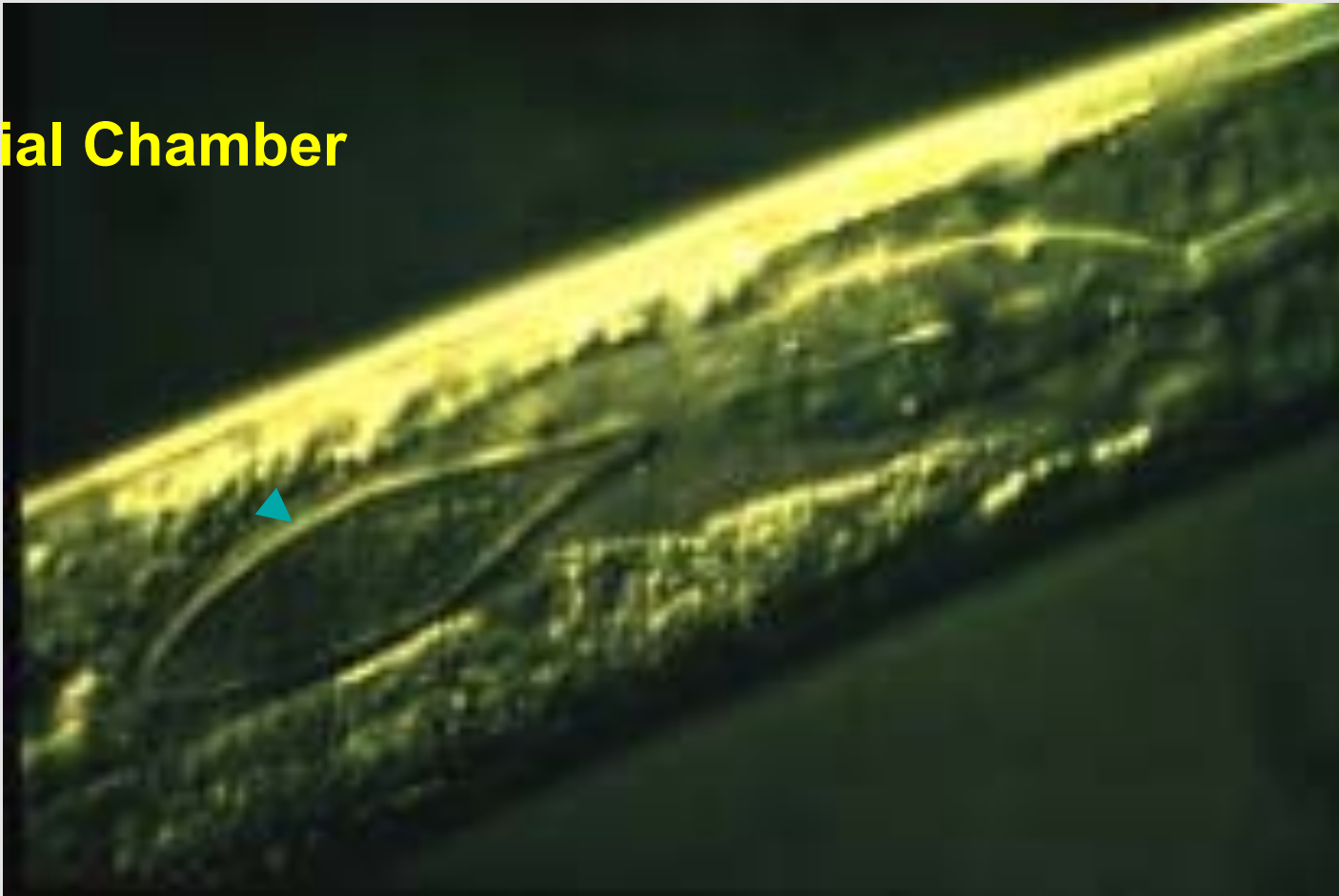
- Resistant to Environmental Extremes
- Only Function is to Find A New Host
- No Feeding
- No Development
- No Reproduction
- Only Life Stage Outside the Host

Infective Stage Juvenile
Steinernema carpocapsae



Symbiotic Bacteria Released

Bacterial Chamber



Mating for *Steinernema* spp.



Two to three generations occur in a single host.

About 6 days after the original infection, this is the appearance



New Infective Juveniles in 10 Days



Entomopathogenic Nematodes Can Control:

- **Weevils:**

Diaprepes root weevil, *Diaprepes abbreviatus*

Blue green weevils, *Pachnaeus* spp.
Otiorhynchus spp.

Bill bugs

- **Fungus gnats:** e.g., Sciaridae

Entomopathogenic Nematodes Can Control:

- **Scarab larvae:** e.g., Japanese beetle, *Popillia japonica*, Chafers, etc.
- **Lepidoptera:**
Black cutworm, *Agrotis ipsilon*
Codling moth, *Cydia pomonella*
Leafminers, *Liomyza* spp.
Banana moth, *Opogona sacchari*
Navel Orangeworm, *Amyelois transitella*
- **Other:** fleas, mole crickets

Some Things to Remember About Entomopathogenic Nematode Products

Products Can Be Deceiving

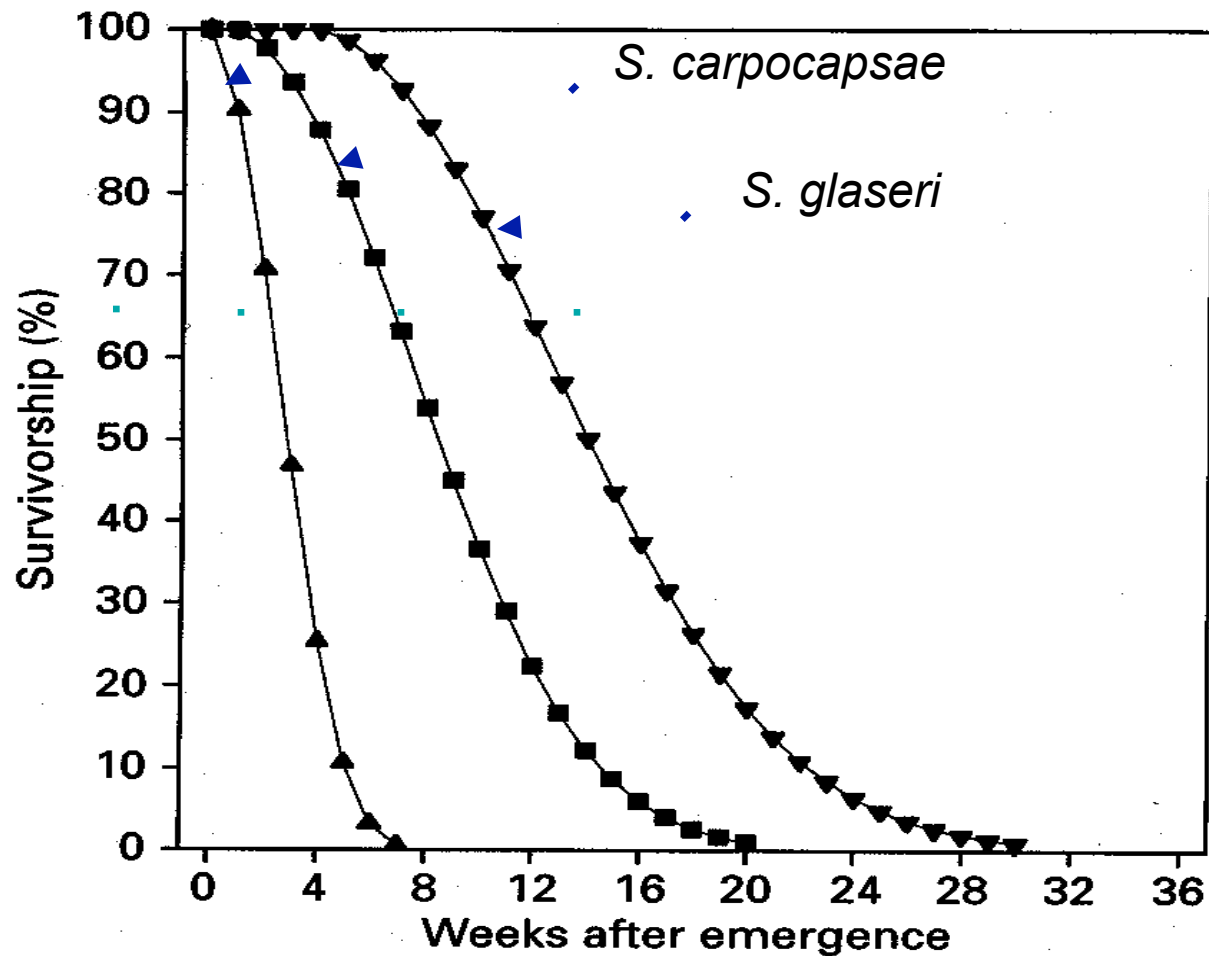


Live Infective Stage Nematode



Infective Stage Survival

• *H. bacteriophora*



How Long Do They Last?

Formulation

Shelf-life (storage method)

Sponge

2 Months (Refrigerated)

Vermiculite

3-5 Months (Refrigerated)

Dispersable Granule

2-5 Months (Room Temperature)

How Do We Figure Out Where and When to Use them?

- Climate
- Soil Types

Special considerations for applying microbial

- **Not chemical pesticides**
 - **Storage**
 - **Application**
- **Special habitat requirements**
- **Realistic expectations**
 - **Kill slower than chemicals**
 - **Will not (usually) completely eliminate pests**

Case Study

- Entomopathogenic nematodes to manage *Diaprepes abbreviatus* (citrus root weevil) in Florida and California



Citrus Root Weevil Adult



***Diaprepes* Damage**



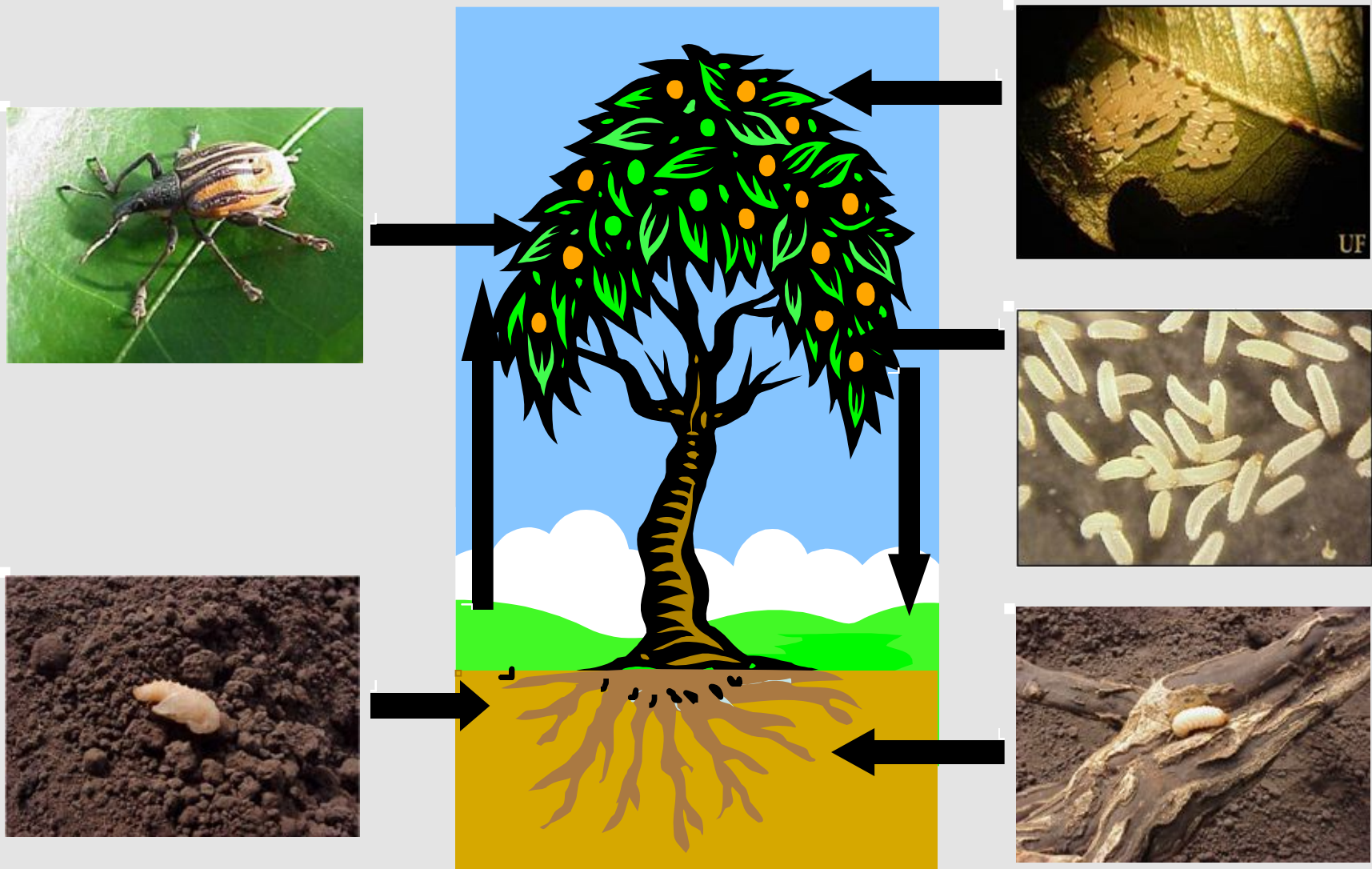
Southport Grove, Osceola County, FL



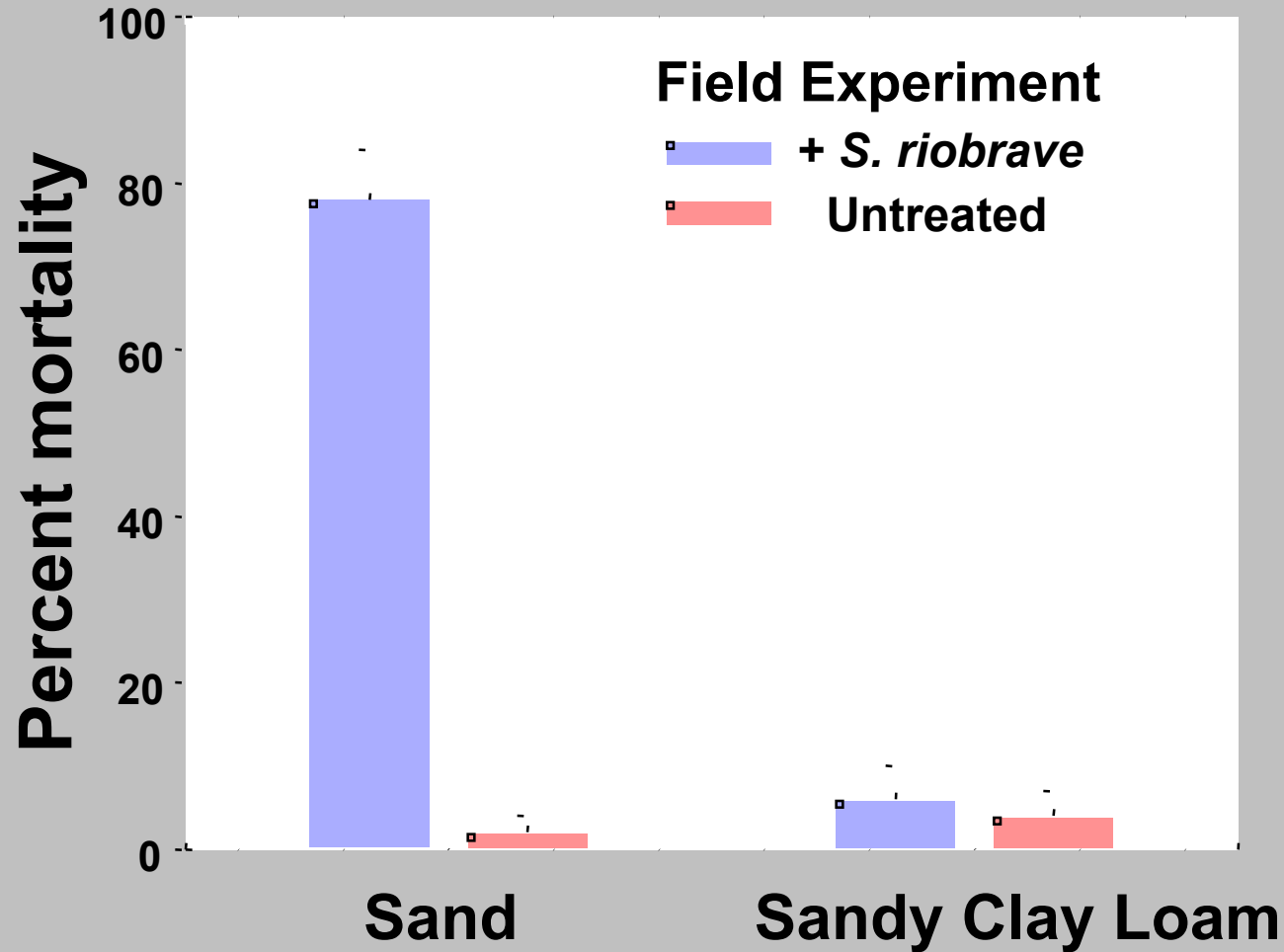
What makes *Diaprepes* difficult to control?

- **270 known host plant species**
- **asynchronous, complex, variable life history**
- **high fecundity, protected egg masses**
- **many pesticides are ineffective against soil-dwelling larvae**
- **many natural enemies have limited, patchy distributions**

Diaprepes abbreviatus Life Cycle



Nematodes Most Effective in Coarse Sandy Soils



(Duncan et al., unpublished)

What to do in California?

- Soil type has major impact on efficacy
- Soils in California much more diverse than in Florida

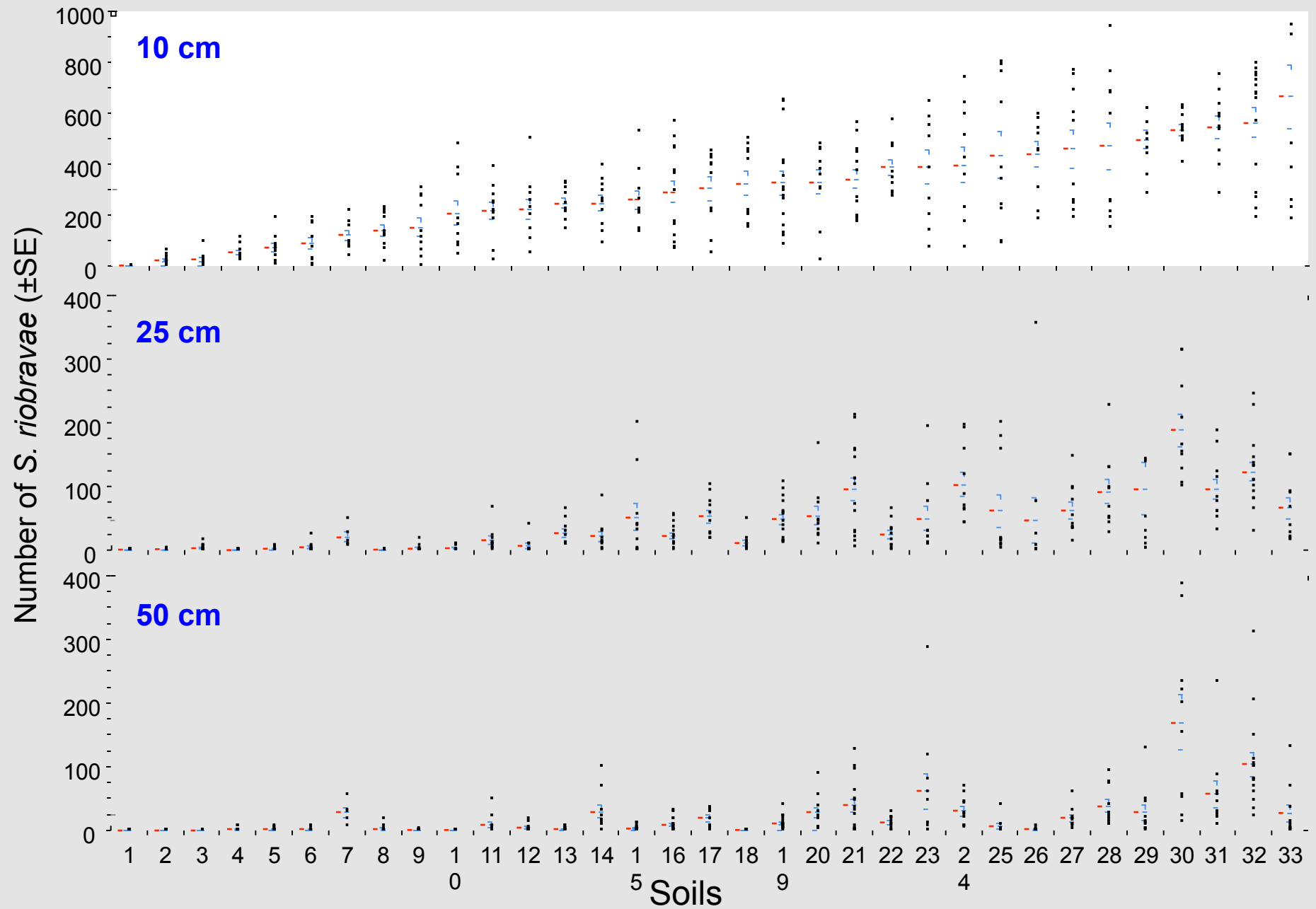
Objective

- Develop methods to determine whether or not entomopathogenic nematodes will be effective biological control agents of citrus root weevils in CA citrus

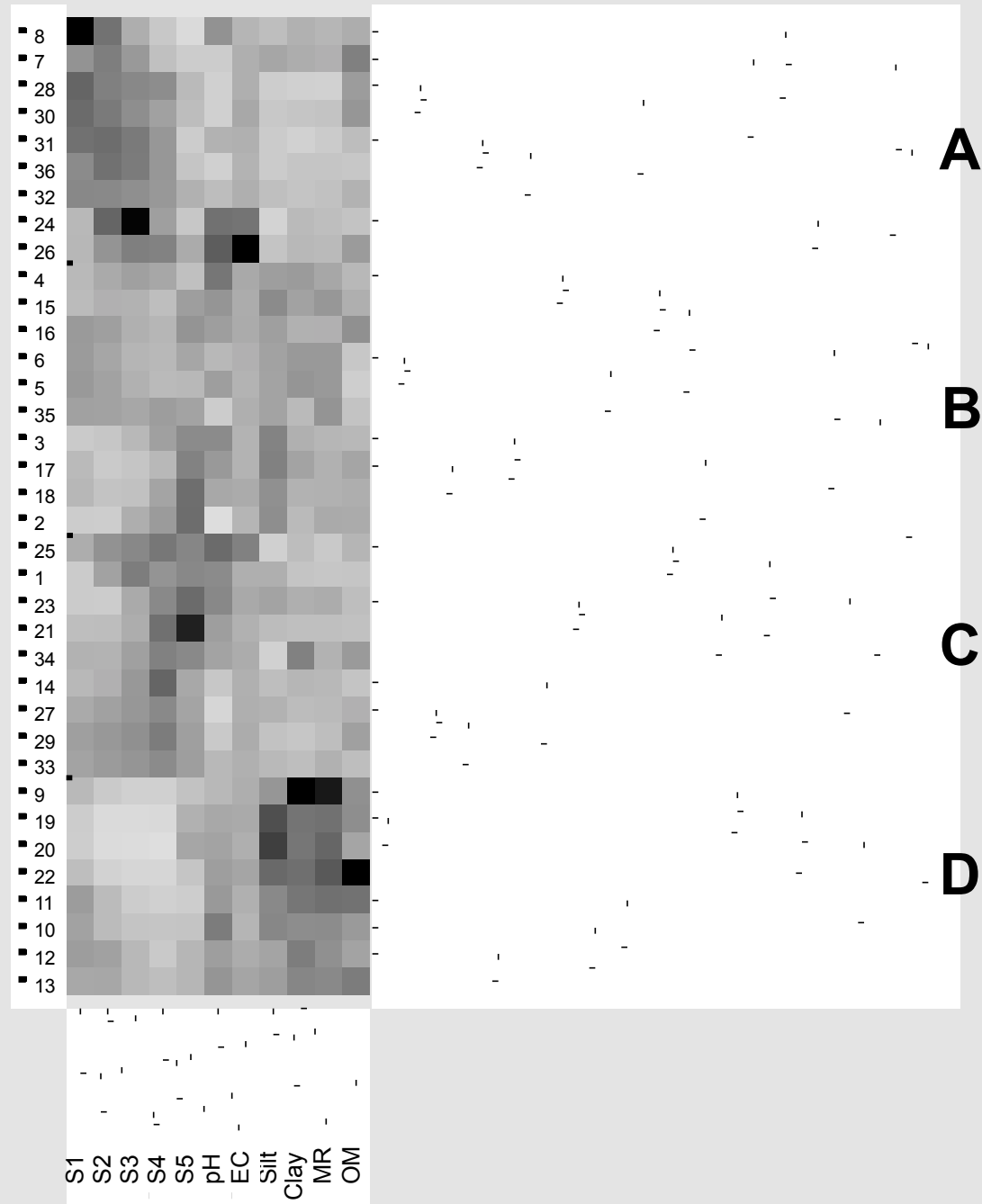
Column Assay Units



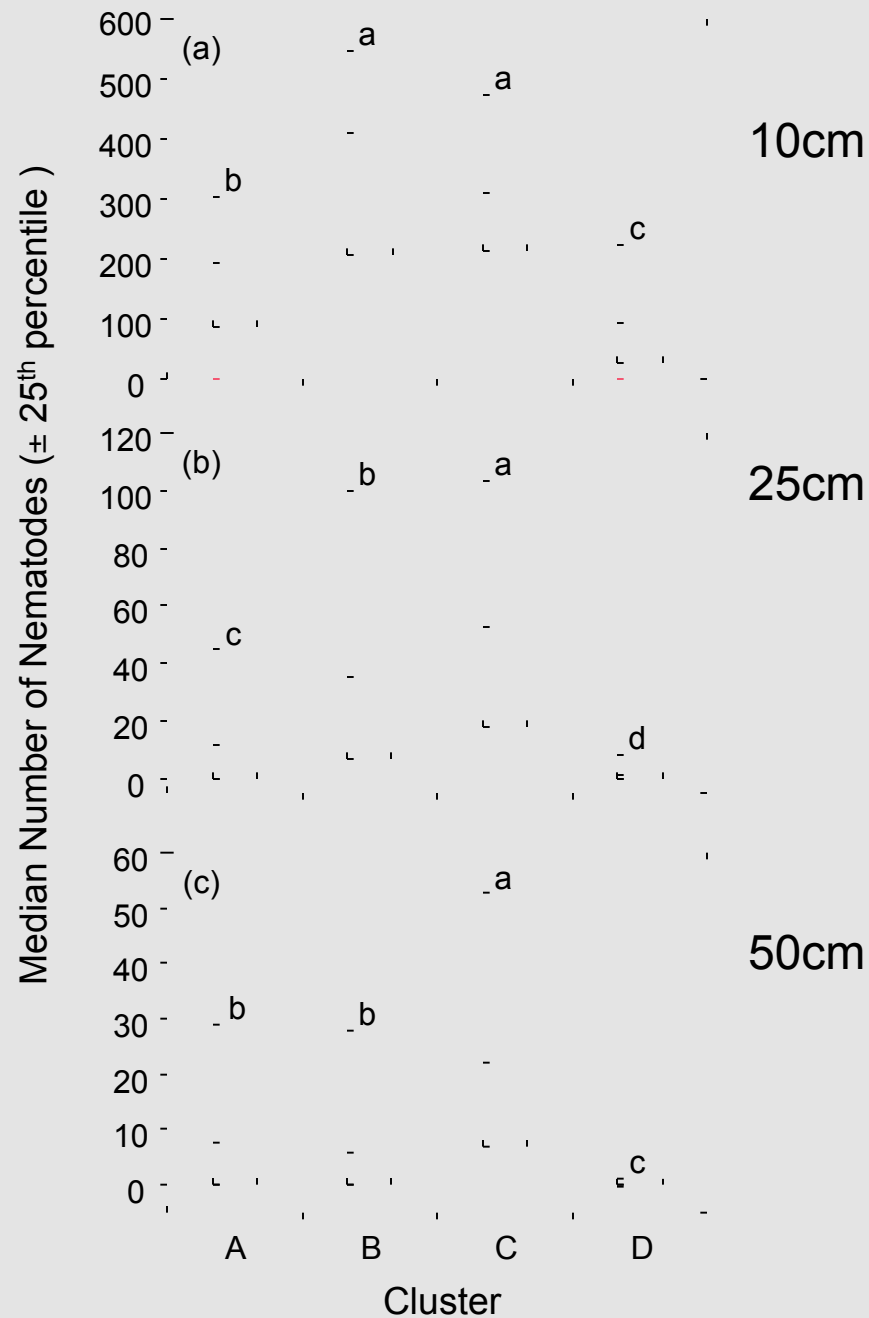
S. riobrave – Efficacy Bioassay



Cluster
analysis:
grouped
similar soils
based on
physical and
chemical
characteristics

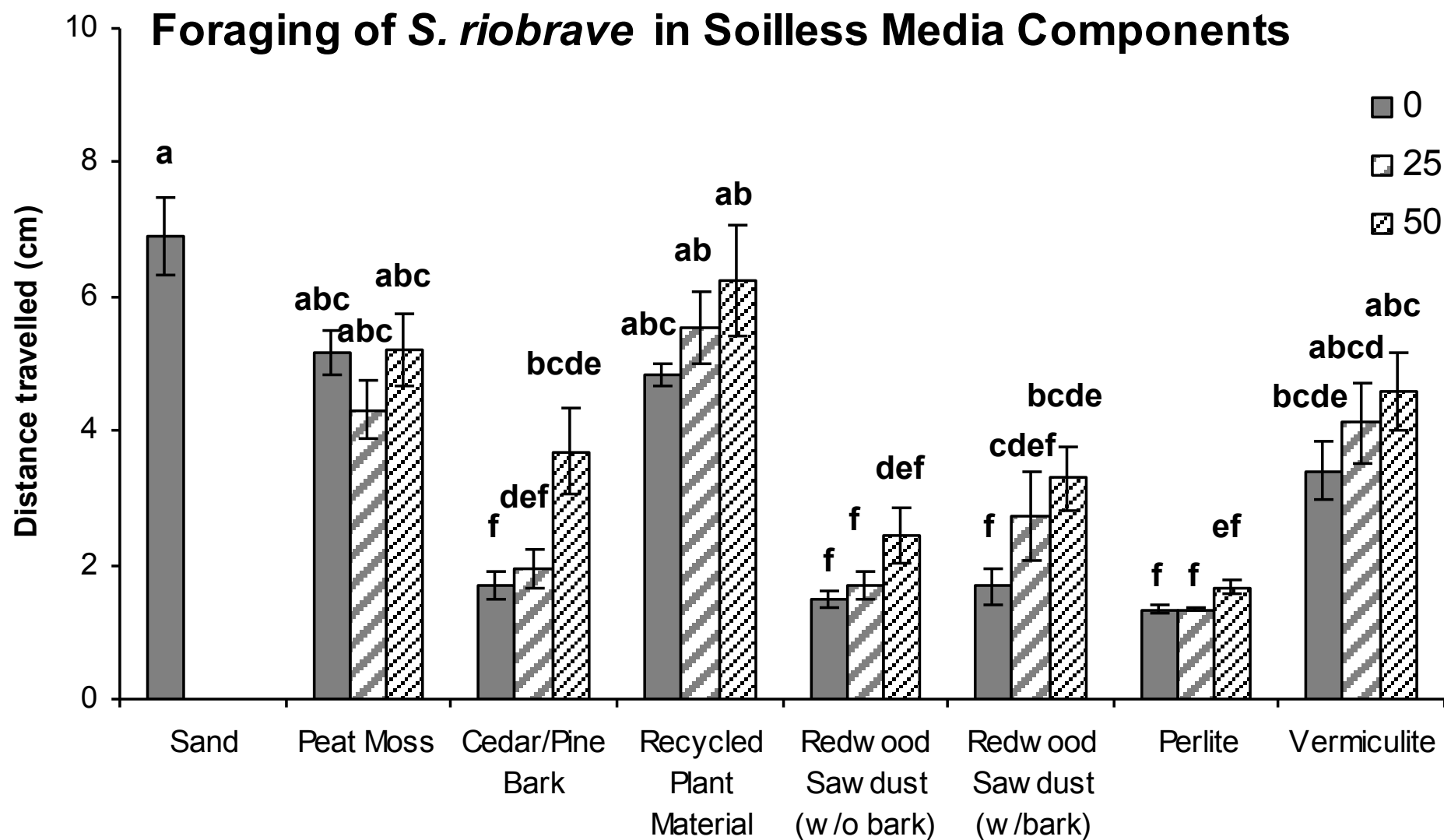


Efficacy of EPNs in different clusters



Using This Information

Can soilless media be constructed to enhance persistence and efficacy of microbial insecticides?



How to Make EPNs Work?

- Product quality
- Product suitability
- Application rates
- Application timing
- Environmental conditions
- Substrate conditions