Use of Entomopathogenic Nematodes for Borer Control

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Biology:

Peachtree borer

Synanthedon exitiosa

Hosts: peach, plum, nectarine, cherry, apricots, almond.

• One generation / season. Adults emerge from May to October.

• Eggs are laid on the lower 15 cm of the trunk and nearby soil. Eggs hatch in about one week.

• Larvae chew through the bark to the cambium at the ground level. Wounds or breaks are not needed for the entry.

• Female can lay from 200 to 800 eggs. Larval stages overwinter under the bark.

Peachtree borer

Injury:

- **Larvae feed on the cambium, and inner bark of the tree from a few inches above to 6 inches below the ground line. Trees exude gum with frass.**

- **Feeding can girdle older trees and injury can serve as an entrance to pathogenic fungi.**

Peachtree borers kill more peach trees in the United States than any other insect.

Peachtree borer control

*** Handgun application of insecticides to lower part of trunk to reduce infestation.**

Issues:

- **Insecticide should be timed to coincide with egg hatch – once under the bark, chemical control is not effective.**
- **Insecticides have re-entry and pre-harvest intervals.**

*** Mating Disruption**

Issues:

- **Works best on blocks 5 acres or larger.**
- **Infestation of edge rows may occur, especially near woods.**

*** Need for additional / alternative methods**

Dogwood borer
Synanthedon scitula

Biology:

Hosts: apple, ornamental trees.

• One generation /season. Adults active from June to August.

• Eggs are typically laid on or near burr knots

• Larvae bore into tissue between the root initials and begin feeding.

• Larvae may take 13-22 months to complete development.

Picture from: James Solomon, USDA Forest Service, www.forestryimages.org

Dogwood borer

Injury:

- **Feeding is initially confined to the burr knot but may spread to healthy bark.**

- **Consecutive years of infestation may reduce yields, girdle the tree, and/or eventually kill the tree.**

- **Reddish frass is usually visible.**

Dogwood Borer Management

Monitoring:

- Check under tree guards for active infestations.
- Pheromone traps

Control:

- Prior to egg laying, apply undiluted white latex paint to lower part of trunk to reduce infestation.
- Trunk sprays with insecticides:

Additional / Alternative Controls Desirable:

- Mating disruption

Biological Control of Borers

Entomopathogenic Nematodes (A.K.A. Insect Parasitic Nematodes)

***Steinernema* spp. and *Heterorhabditis* spp.**

- **Lethal to many important soil insect pests.**
- **Totally safe for plants and animals.**
- **Rapid kill : 24 - 48 hours**
- **Many species are commercially available**

Packet containing 25 million live nematodes.
They must remain viable until time of application.

Examples : Nematodes as Biological Insecticides in Commercial Crops

Crop	Pest	Nematode
Artichokes	Plume moth	S. carpocapsae
Berries	Root weevil	H. bacteriophora
Citrus	Root weevil	S. riobravis
Cranberry	Root weevil	S. carpocapsae
Mushroom	Sciarid fly	S. carpocapsae
Ornamentals	Root weevil Wood borers	H. bacteriophora S. carpocapsae
Turf	Fungus gnats Scarabs Mole crickets	S. feltiae H. bacteriophora S. riobravis

“It is quite simple to apply a pesticide or utilize a high-yielding resistant variety to manage plant diseases, but one has to know a great deal about the biology of a situation in order to use cultural management.” - Thurston (1992)

This is also applies to the use of biological control methods.

“The user needs to understand the biology and ecology of these nematodes as the first step to an effective pest control program.” – H. Kaya

Entomopatogenic Nematode Biology / Life Cycle

- **Non-feeding infective juvenile seeks out an insect host. (Only stage found free in soil)**

- **Enter insect through body opening or thin part of cuticle.**

- **Release symbiotic bacteria:**

The bacteria multiply rapidly causing death of the insect and produce antibiotics that suppress secondary invaders of the cadaver.

- **Nematodes feed on bacteria and liquefying insect.**

Nematodes pass through 3rd and 4th juvenile stage to become adults.

Entomopatogenic Nematode Biology / Life Cycle

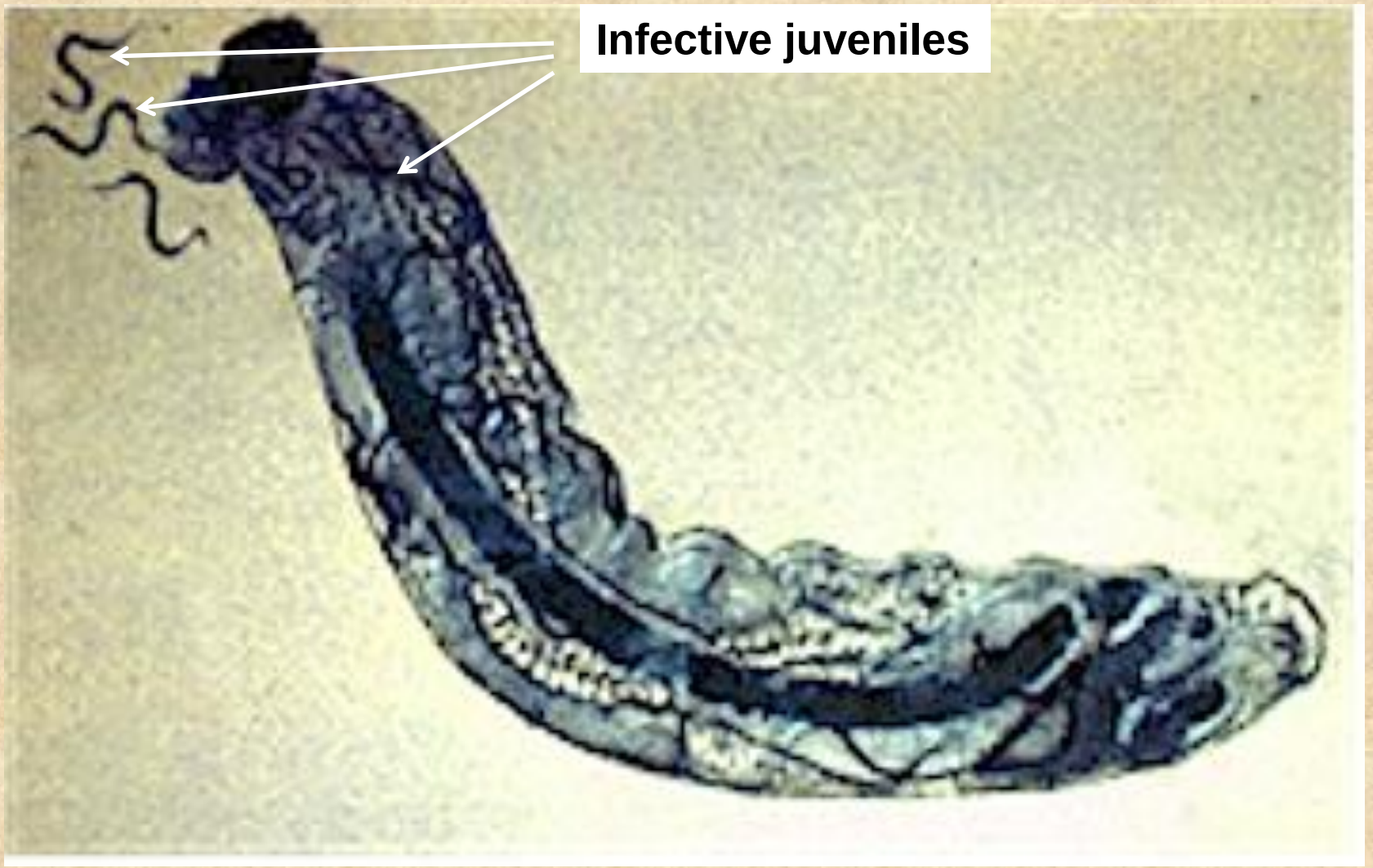
- Adult nematodes reproduce. One or multiple generations depending on the size of the host.

- The life cycle is complete within a few weeks.

- Infective juveniles retain a supply of symbiotic bacteria before they leave the insect cadaver.

- Infective juveniles are remarkably hardy and depending on storage conditions can remain alive for months or up to a year.

- However, nematodes can not survive desiccation and / or ultraviolet light.



Sclarid fly maggot infected with entomopathogenic nematodes


Adult female Steinernema
Adult male Steinernema

Parasitized wax moth larva releasing infective juvenile stage of an entomopathogenic nematode.

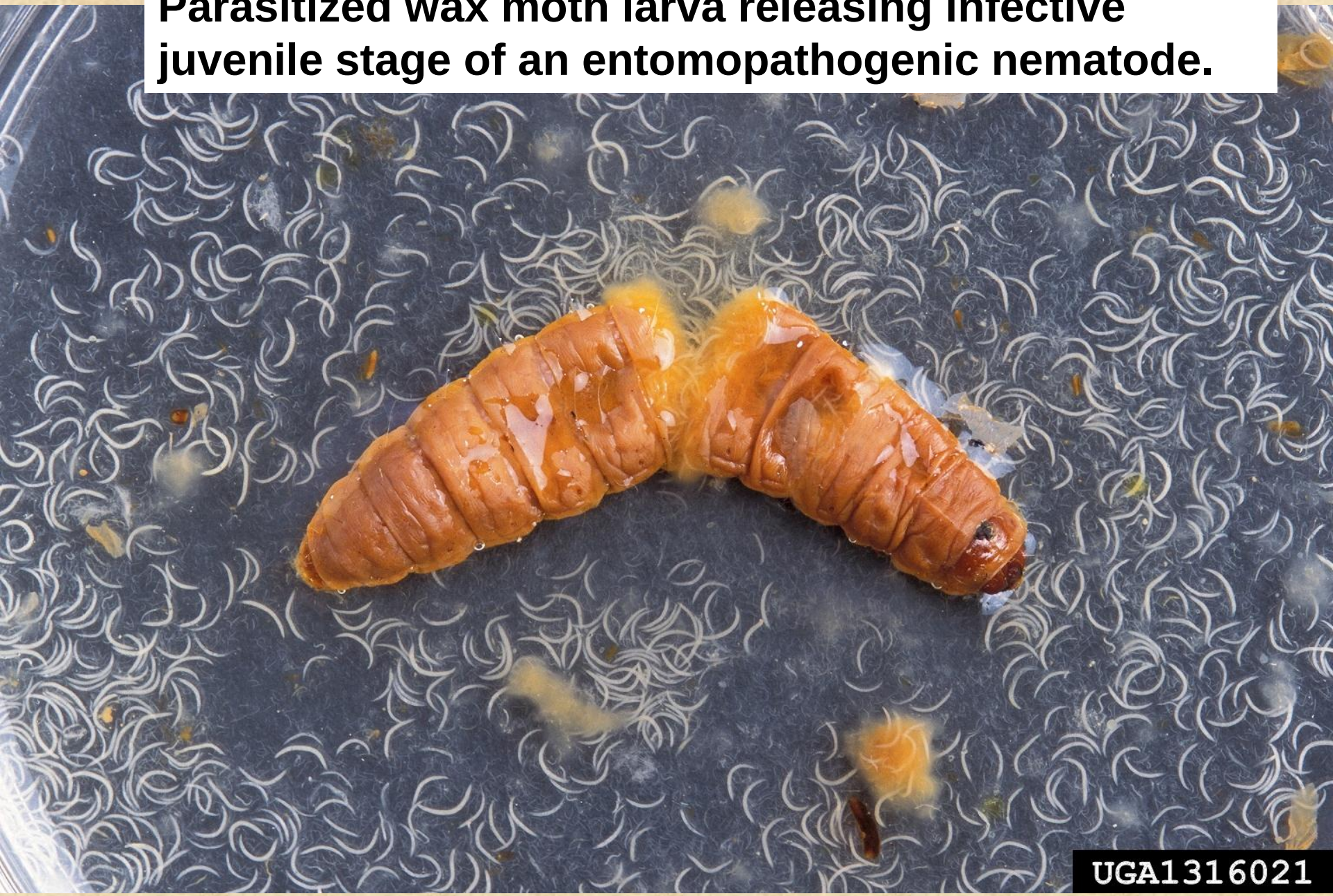


Image – Peggy Greb, USDA, ARS

Photo courtesy Sbibion

Black current Borer infected with *Steinernema feltiae*

Juveniles are mobile and can infect boring insects within their galleries.

EPN for control of PTB

Previous research has documented the efficacy of Entomopathogenic nematodes to control PTB and LPTB *(Kain and Agnelo, 1999; Shapiro-Ilan et al. 2006)*

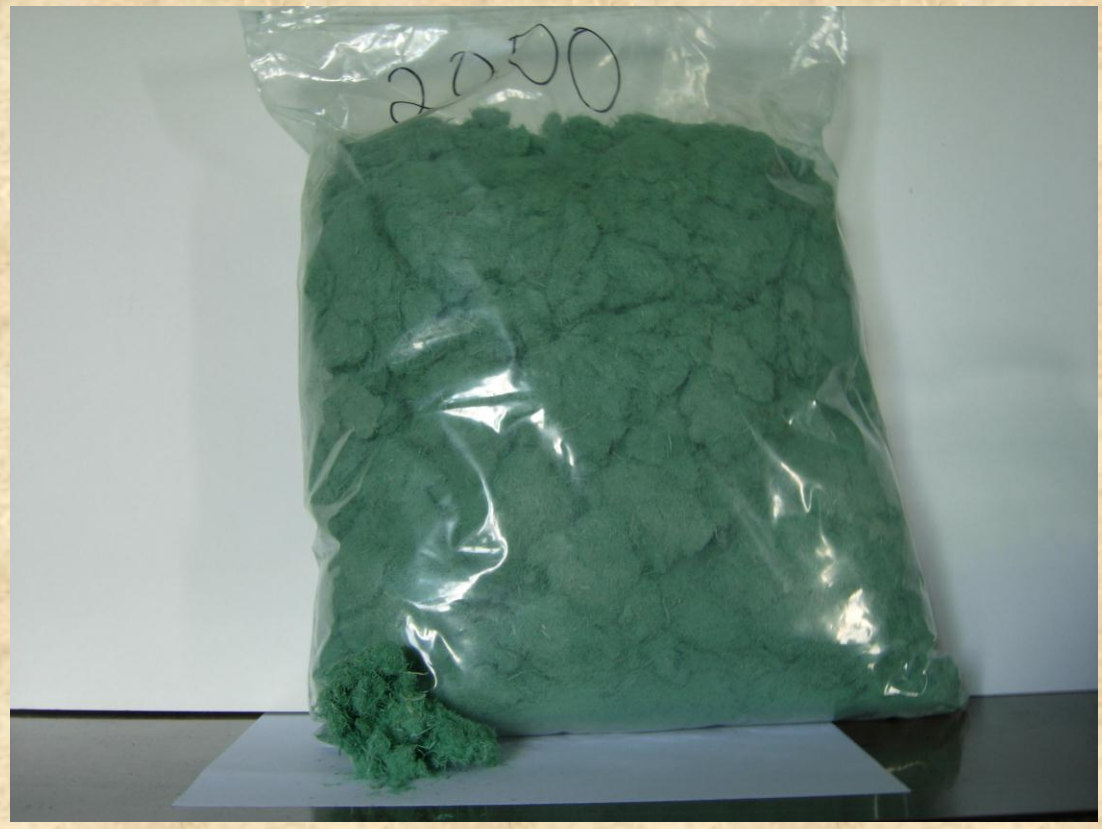
***Sterneinema carpocapse* and *S. feltiae* are very effective in laboratory and initial field studies against LPTB and PTB.**

The most important considerations are (1) adequate moisture, (2) proper temperature, and (3) product viability and specificity.

Delivery and survival in the field are a challenge for practical application.

Application of “Foam Mulch”

Foam Mulch retained moisture for one - several days depending on conditions

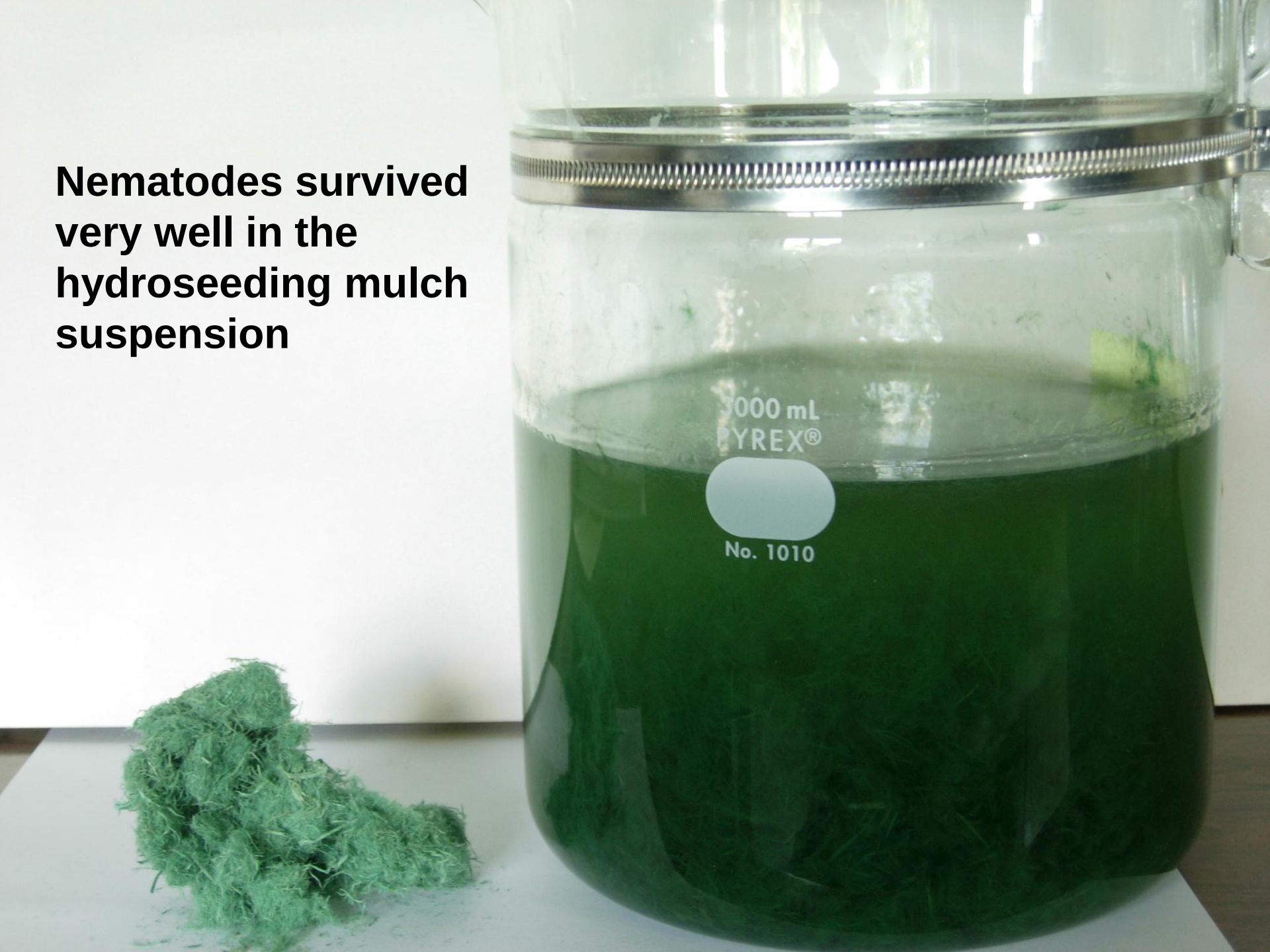


Fiber Mulch

Binding Agent

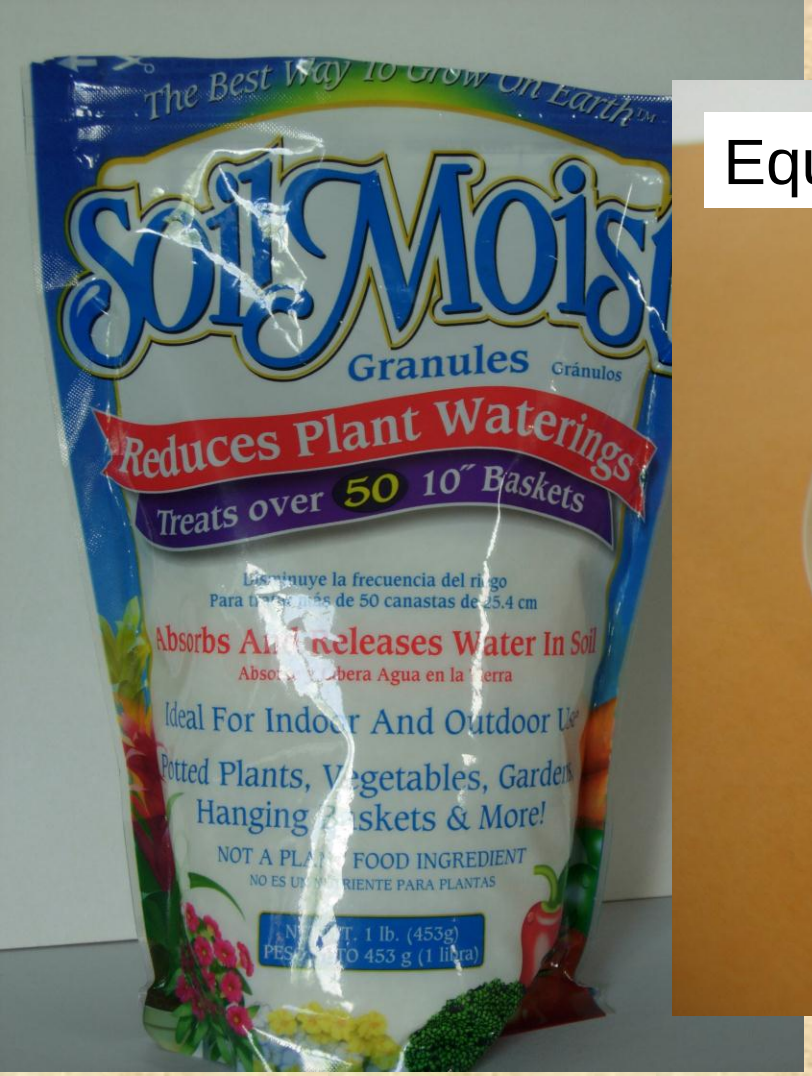
Materials used for hydroseeding roadside banks to prevent erosion

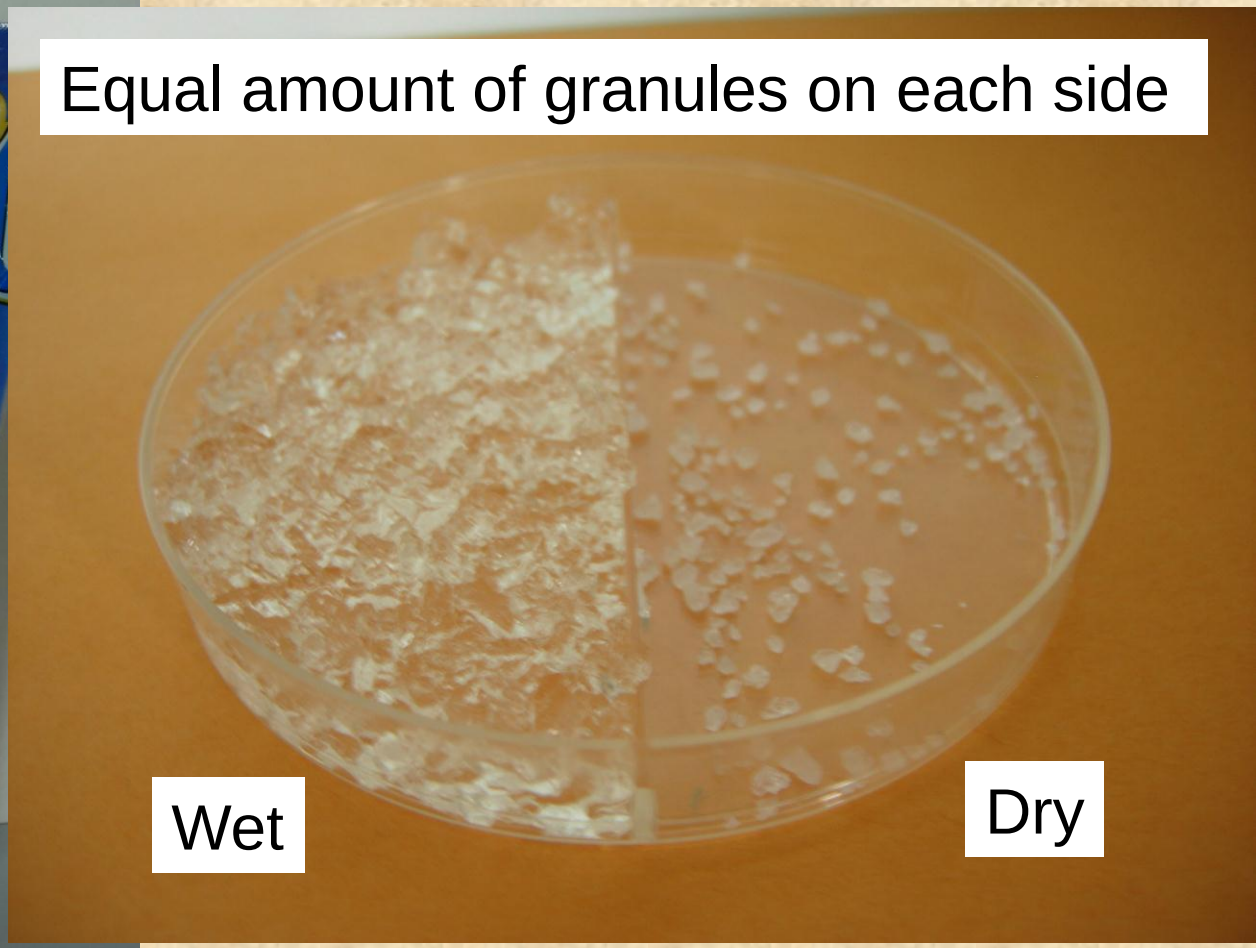
Nematodes survived very well in the hydroseeding mulch suspension



Bioassays evaluating nematode efficacy against Borers and Codling Moth larvae using fiber and shredded paper mulch

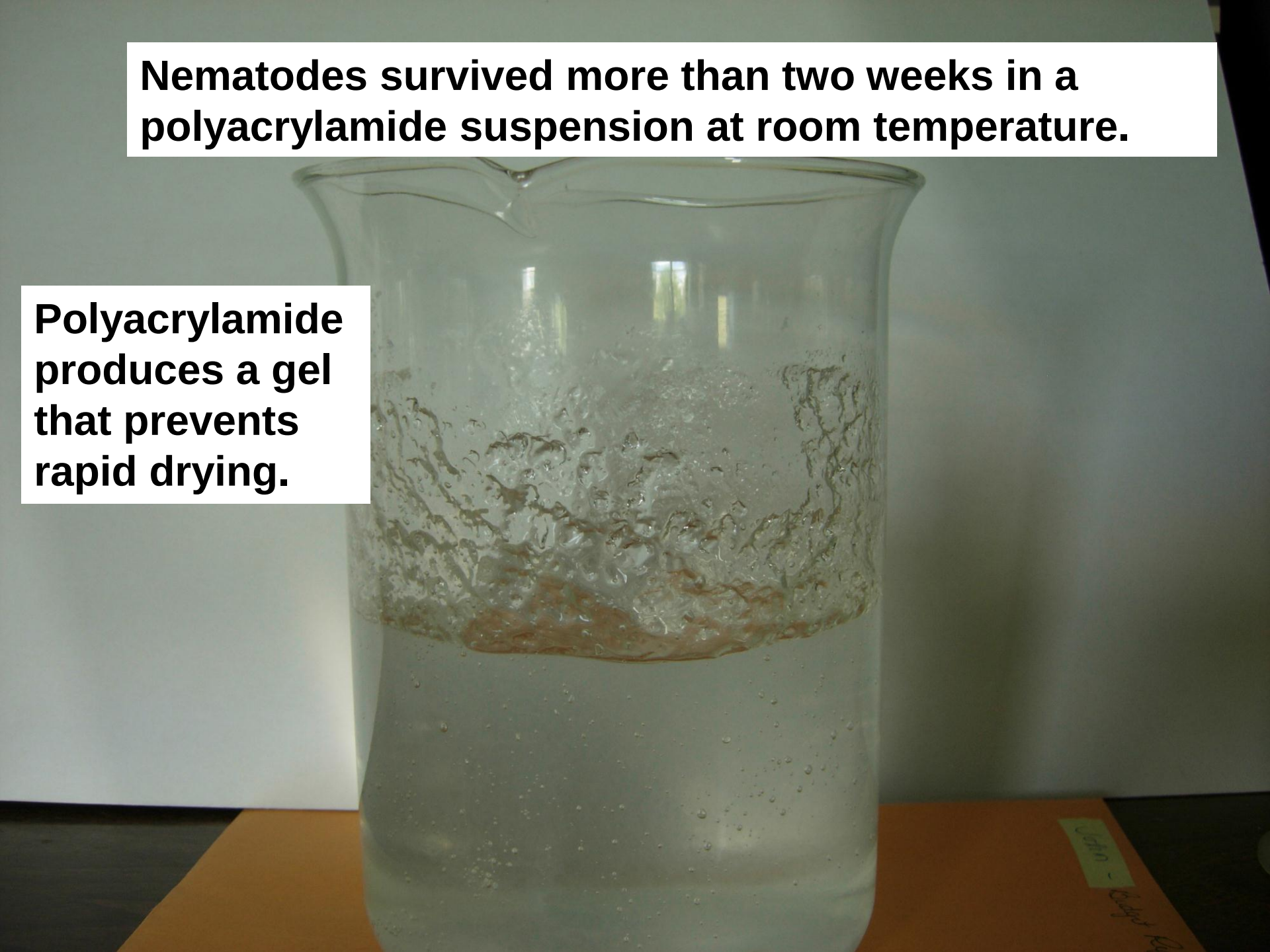
100 % mortality of Borers and Codling Moth larvae .





Polyacrylamide granules absorb many times their weight in water and release it slowly under drying conditions.

Nematodes survived more than two weeks in a polyacrylamide suspension at room temperature.



Polyacrylamide produces a gel that prevents rapid drying.

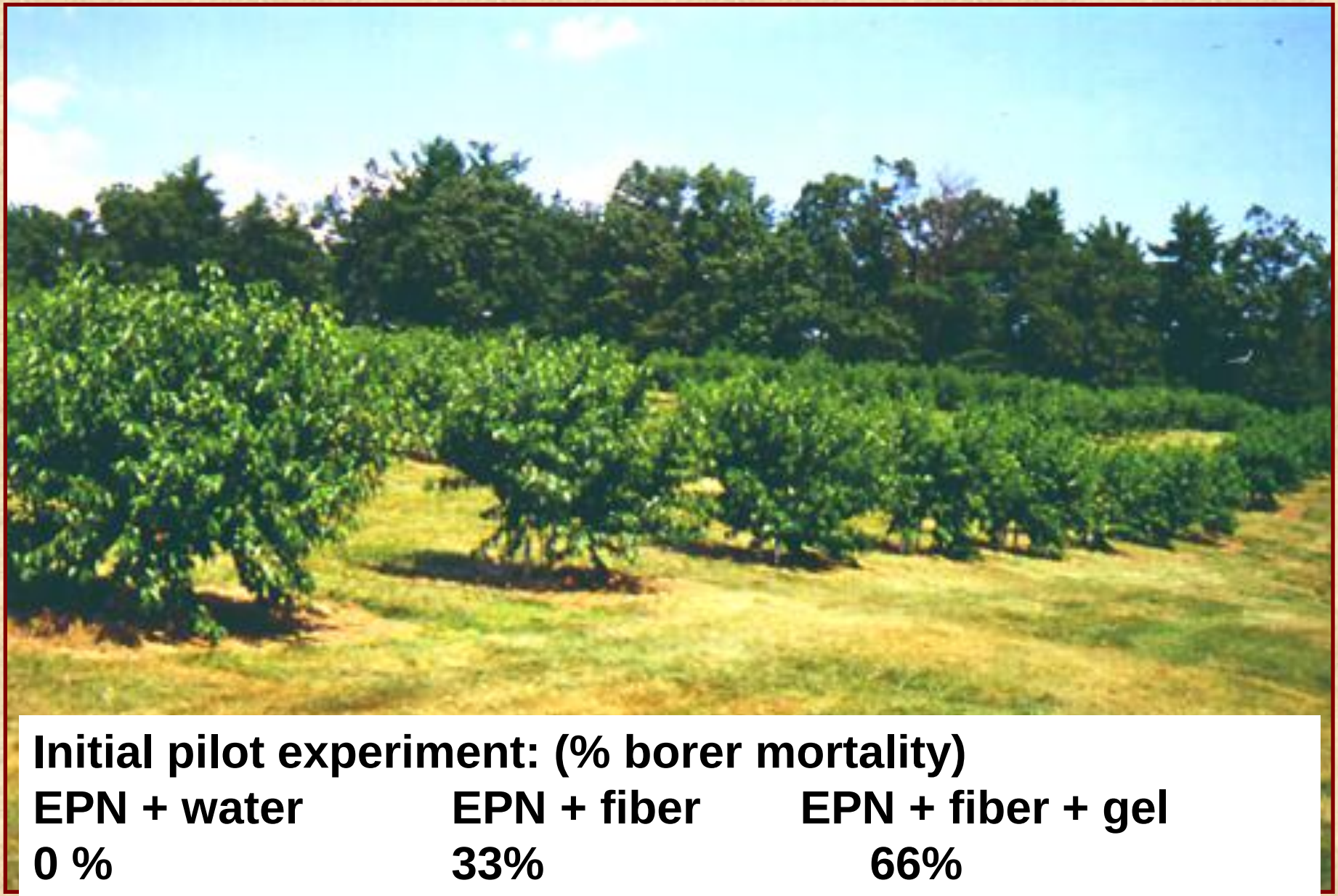
Large scale application requires heavier equipment and a small hydroseeder works very well.

HYDROMULCH RECIPE

- 50 gal water
- 25,000,000 nematodes (@ 500,000 nematodes per gal.)
- @ 6 lb commercial fiber mulch
- one cup of Turbosorb (Polyacrilimide)
- 4 oz ounces Witches Brew (Binding agent)


Application of EPN / mulch

Mulch samples taken 24 and 48 hours after application all contained viable infective juveniles



Initial pilot experiment: (% borer mortality)

EPN + water	EPN + fiber	EPN + fiber + gel
0 %	33%	66%

2012 - Commercial Orchard Experiments

4 Apple Orchards infested with Dogwood Borers
3 Peach Orchards infested with Peach Tree Borers

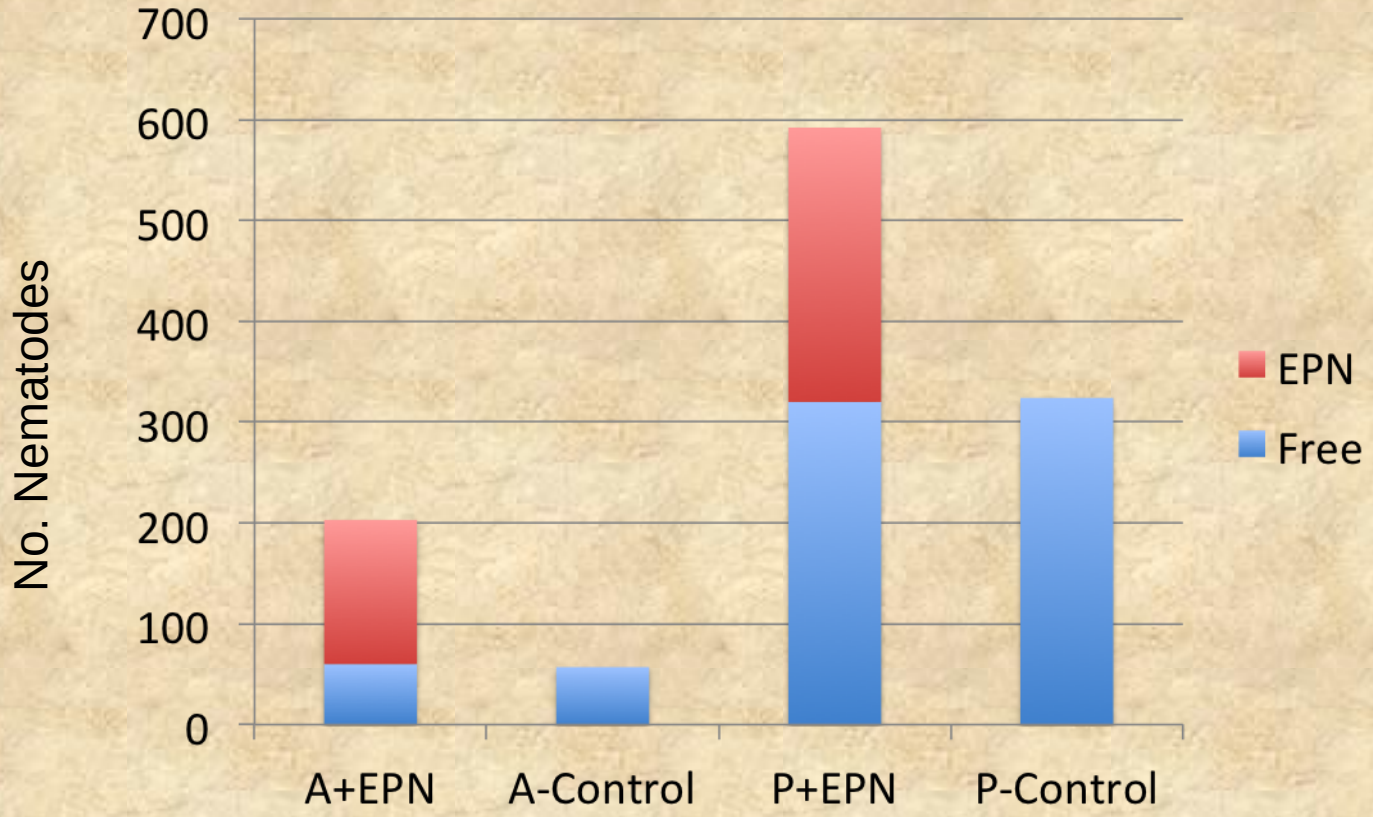
Treatments applied 2nd + 3rd week of May:

- **Turbomulch with nematodes**
- **Turbomulch without nematodes – control**

Random samples collected 2nd and 3rd week of August and checked for presence of EPN

No. Samples:	Treatment:
76 Apple	Mulch with nematodes
57 Apple	Mulch without nematodes
131 Peach	Mulch with nematodes
29 Peach	Mulch without nematodes

Average Number of Nematodes recovered from Treated and Untreated Apple and Peach



No. Trees	76	57	131	29

Dr. David Shapiro-Ilan evaluating a fire-gel (Barricade®) and entomopathogenic nematodes for control of Lesser Peach Tree Borer.

Photo courtesy USDA/ARS

Estimated Cost of Materials

*** Cost based on calculating amount of material needed to cover an acre and prorating to a per tree basis.**

Mulch		Fire-gel	
50 bales mulch =	$500	65 gal barricade =	$4,160
Turbosorb =	45		
Witches Brew	70		
Nematodes	7,500		7,500
Total	$ 8,115		$11,660

Appoximately 12,500 gal of material
Using ½ gal of material / tree = 25,000 treated trees

	@ $ 0.33 / tree	@ $ 0.47 / tree
300 trees per acre =	$ 99	$ 141
600 trees per acre	$ 198	$ 282

Summary:

We have developed a novel technique to apply EPN to tree trunks that provides protection from desiccation and UV light.

The nematodes remain viable and active for days allowing them to find and enter borer galleries.

Optimum application conditions such as fog, mist or cloudy days should prolong viability and improve efficacy.

QUESTIONS?

We would like to thank:

- **The State Horticultural Association of Pennsylvania (SHAP) for supporting the early stages of this project this project.**

- **Northeast SARE for subsequent funding allowing us to scale up to a commercial level.**