Using entomopathogenic nematodes to manage codling moth in organic apple orchards in Michigan

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Introduction

Entomopathogenic nematodes are tiny soil-dwelling parasites of insects that kill their hosts with only a few hours after infection. In organic pest management, the nematode's infective juvenile stage is sprayed on crops in a water mixture using standard application equipment. The codling moth (*Cydia Pomonella* [L.]) is a serious pest of apples worldwide and is of critical concern in commercial apple production. Codling moth larvae pupate and overwinter in silk cocoons under cracks in the bark on tree trunks or under orchard litter near the soil surface. Entomopathogenic nematodes have potential for management targeting codling moth larvae, because they actively search out insect hosts in protected locations.

We have been evaluating the entomopathogenic nematodes species, *Steinernema feltiae* (Filipjev), at three Michigan organic apple orchards to test its effectiveness for codling moth management. Our research to date indicates that nematode applications are more effective in orchards planted with smooth-barked tree varieties, presumably because the codling moth larvae in these orchards are forced to overwinter near the soil where they are more susceptible to nematode infection. This poster presents research testing the hypothesis that codling moth larvae near the soil surface are more susceptible to nematode applications than those in cocoons on the tree trunk.

Soil microorganisms

Healthy soil contains a diversity of microorganisms that perform essential functions such as aeration, decomposition, and biological control. Entomopathogenic nematodes are already present in most healthy soils. Applying them to a crop boosts the natural population to increase their impact on crop pests.

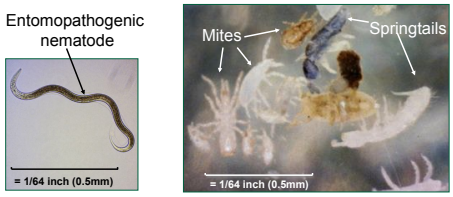


Figure 1. Digital photographs of soil microorganisms taken through a light microscope. Scale bar represents 1/64th of an inch (0.5mm).

Nematode life cycle

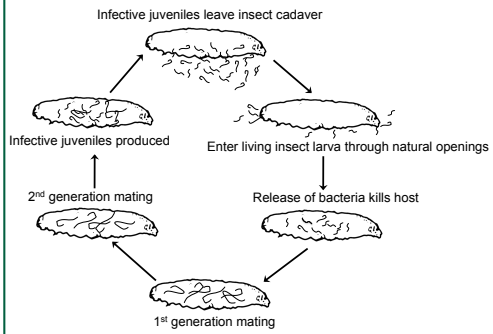


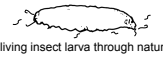
Figure 1. The life-cycle of *Steinernema feltiae,* a species of entomopathogenic nematode, shown here infecting an insect host larva. Figure adapted from Kaya and Stock (1997)*.

How to grow your own nematodes

1. Infect wax worms with nematodes

Infective juvenile stage nematodes (*S. feltiae*) in water were introduced into filter paper lined petri dishes containing wax worms (a commonly used live fish bait). Then they were incubated in **complete darkness** for 7-10 days at **room temperature**.

Life cycle stage:

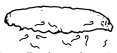


Enter living insect larva through natural openings

2. Collect infective juveniles ⇩

Petri dishes (from step 1) containing nematode infected wax worms were floated in larger dishes containing water to make a trap for the emerging infective juvenile nematodes. These traps were held in **complete darkness** at **room temperature** and checked daily for emerging nematodes.

Life cycle stage:



Infective juveniles leave insect cadaver

3. Store until application ⇩

Air pump

5 gallon container

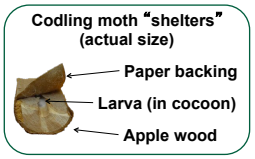
Infective juveniles collected during step 2, were placed in a 5 gallon jug equipped with an aquarium bubbler to provide aeration. Infective juvenile nematodes were held in this container for 3 weeks at **55°F** in **complete darkness** before being applied to orchard plots.

4. Spray ⇩

Infective juveniles were applied **at night** before, during, or after a **rainfall** event using a backpack sprayer at a rate of 600 million infective juveniles/acre/20 gallons of water.

Field Efficacy

Experimental Methods: Codling moth larvae were allowed to build cocoons in wooden "shelters" in the lab. Shelters simulated natural overwintering locations for codling moth on the orchard floor (Ground) or under tree bark (Trunk) where they are typically found. Shelters were placed in orchard plots at our three study sites and half of those plots received nematode applications. Three days after application codling moth larva survival in the shelters was assessed.



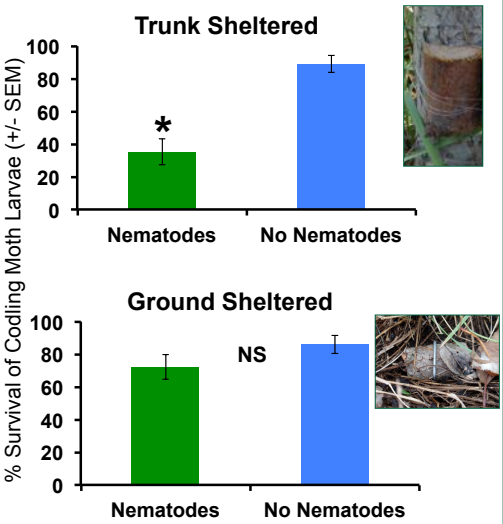


Figure 3. Percentage survival of Codling Moth larvae in wooden shelters placed in different locations in apple orchard plots that received nematode applications (Nematodes) or did not (No Nematodes).

*Larvae in nematode treated plots had a significantly (P<0.05) lower percent survival than those in the same location in untreated plots.

NS No significant difference (P>0.05) was found between the percent survival for larvae in shelters on the ground in nematode treated vs. untreated plots.

Conclusions

- The entomopathogenic nematode species, *S. feltiae* can be reared on a small-scale using commonly available materials.
- *S. feltiae* can effectively infect and kill codling moth larvae in orchards.
- More research is needed to determine why larvae in shelters on the ground were not infected.
- Higher application rates may be needed in some orchards to reach larvae that build cocoons under dense layers of undergrowth.

*Kaya, H. K., and S. P. Stock. 1997. Techniques in insect nematology, pp. 281-324. In L. A. Lacey [ed.], Manual of techniques in insect pathology. Academic Press, San Diego.

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