Oviposition Scars

Managing Plum Curculio in Tree Fruit with Entomopathogenic Nematodes and Fungi

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Introduction: Plum curculio is a pest of several cultivated fruits. In apples, cosmetic damage reduces the value of fruit. In softer fruits, larvae can remain in fruit on trees.

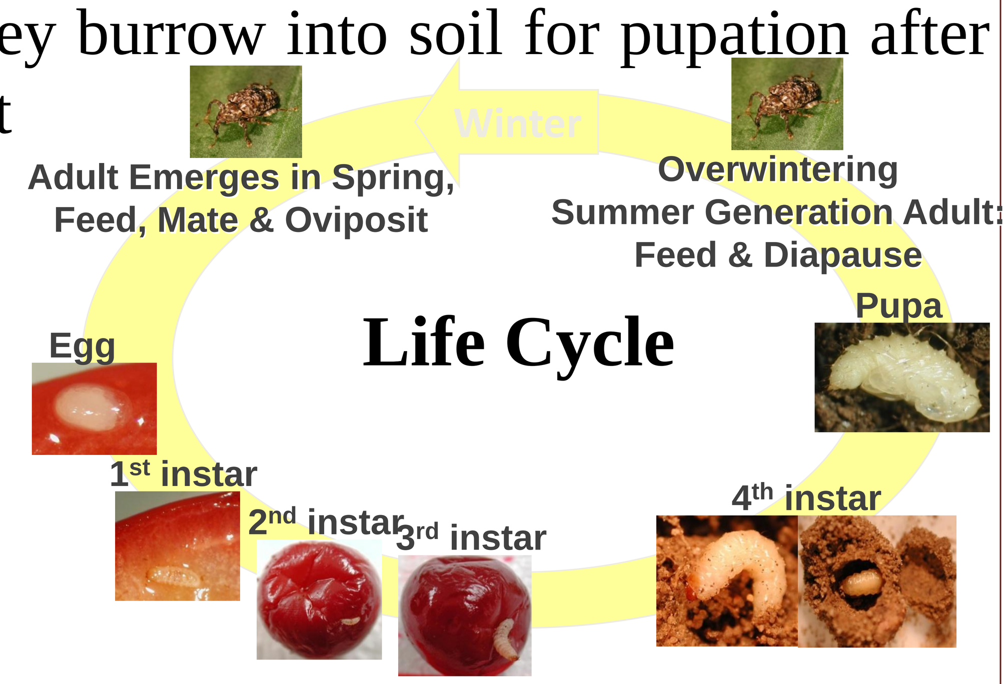
As the US Environmental Protection Agency reviews the use of chemical insecticides, there is increasing interest in using bioinsecticides.

Insect pathogenic fungi (like *Beauveria bassiana*) can penetrate the bodies of insects and cause death. Nematodes are microscopic, colorless, unsegmented roundworms which can be beneficial or pests depending on the species' feeding habits. Beneficial insect pathogenic nematodes release bacteria into insect bodies on which they feed and reproduce in the insect's body. Repeated applications are likely required for an inundative application method since persistence of these microorganisms, especially the nematodes, is short-lived.

Insect life stages (larva, pupa, adult) can be differentially susceptible to different strains of these beneficial organisms, as studies in Georgia and Utah suggest. Here we summarize our 2008 trial targeting the larvae as they burrow into soil for pupation after exiting fruit. Reducing the summer-generation adult population should result in a reduction of damage the following season.

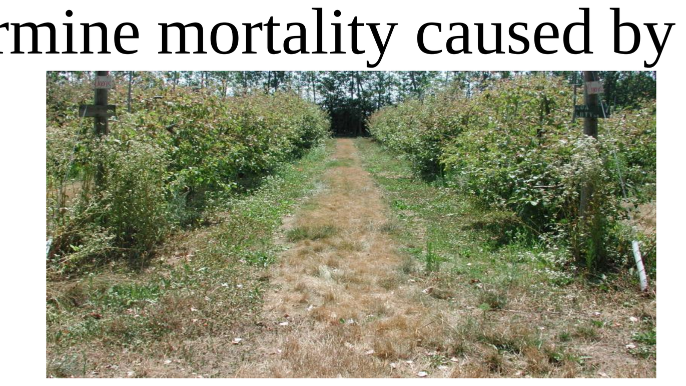
Plum curculio larvae
Light = Healthy
Dark = Infected with Nematode

Plum curculio larvae
B. bassiana in center



Methods

The experiment was carried out at three conventional tart cherry orchards and two organic apple orchards in central and NW Michigan. Under trees, undisturbed soil cores were placed in pots underground. The lids were sealed with a weevil trap top to collect emerging adults. We introduced plum curculio larvae (10 per pot) to the pots -10, -5, 0, 5, 10, 15, or 20 days from pathogen application. We recorded the number of adults that emerged from the pots, and compared the values in the treatments and controls to determine mortality caused by the pathogen treatments.



Apple orchard drive row showing dripline area

Experimental Pathogen Application

Setup of pots under tree dripline

Pathogens:	Rates:
-FUNGUS *B. bassiana* GHA (Mycotrol-O®)	(1) 5x10^{13} conidia/ha
-NEMATODE *H. bacteriophora* (Utah, unformulated)	(2) 1x10^{9} or 4x10^{9} IJ/ha
-NEMATODE *S. riobrave* (355 strain, Biovector®)	(2) 1x10^{9} or 4x10^{9} IJ/ha
-Control (water)	

Timings: -Introduce larvae to soil -10, -5, 0, 5, 10, 15, or 20 d from pathogen application

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Results and Discussion

-Only the nematode *S. riobrave* at the high rate gave adequate control of plum curculio.

-Although *B. bassiana* suppressed plum curculio in similar trials in 2006 in heavier soils, it was not effective in 2008.

-Suppression by *S. riobrave* was greatest in soils with higher sand content; there is evidence that nematode mobility is improved with coarser soils.

-The application area in an orchard could be reduced to reduce the amount of nematodes purchased. This might be accomplished by the "push-pull strategy," wherein a grower attracts springtime adults to border rows or a "trap crop" with plum essence and benzaldehyde scents, while pushing them out of orchard interiors with kaolin clay. Potential nematode application areas can be identified by scouting for high oviposition densities.

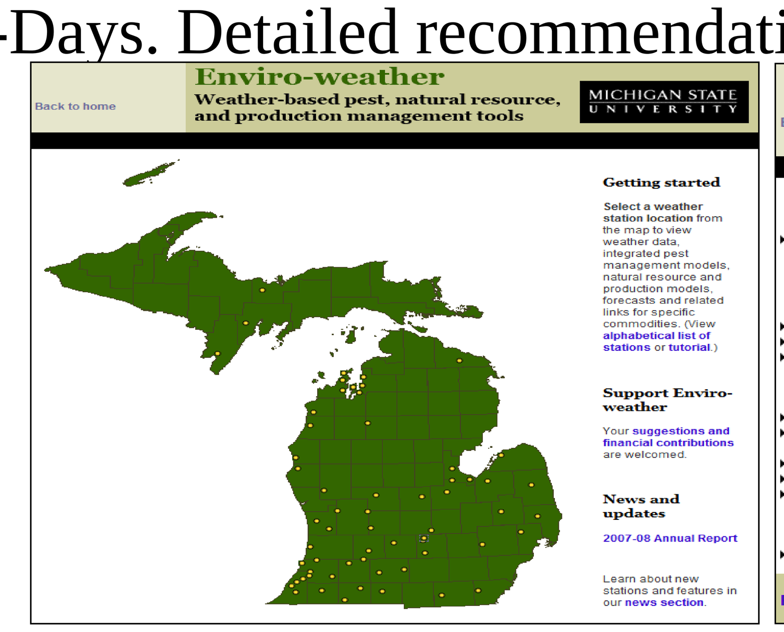
- Emergence of plum curculio from wild hosts or nearby orchards could result in damage if only the orchard of concern is treated. We must test larger areas to record the reduction of damage the following spring.

Table
Percent control of plum curculio
With the nematode, *Steinernema riobrave*, at the high rate.

	Larva addition timings (days from pathogen application)						
	-10 d	-5 d	0 d	5 d	10 d	15 d	20 d
All Orchards	25	66	50	27	36	8	-18
Loamy Sand	48	89	56	-22	25	-26	12
Sandy Loam	45	69	70	70	41	55	43
Loam	14	65	82	44	36	15	-24
Clay Loam	33	50	4	16	56	4	-79
Loam, High Org.	34	17	21	-10	50	-18	10

Delivery to Growers and Future Work

-We are developing a Degree-Day model to predict the timing of larval emergence from apple, cherries, and blueberries in Michigan. The model will be used to make spray timing recommendations based on Degree-Days. Detailed recommendations to be posted for growers on: http://www.enviroweather.msu.edu



-Soil moisture is a key factor in bioinsecticide performance. We want to pursue bioinsecticide applications with micro-jet sprinkler irrigation. This method is used in conventional orchards with *S. riobrave* against citrus root weevil and pecan weevil. We also have preliminary data that this type of sprinkler is essential for control of borers with the nematode *S. carpocapsae*.

-We are engaged in discussions with the company that produces this particular *S. riobrave* strain (Becker Underwood) about the potential for a future release of the nematode in a certified-organic formulation.

-Plum curculio adults are susceptible to *B. bassiana* and *M. anisopliae*. We are pursuing practical application methods against adults to prevent damage by targeting plum curculio adults in overwintering habitat and in orchards in spring prior to the onset of oviposition.