SARE Project FNE-40 Final Report

1. To investigate the field efficacy of using commercially available beneficial nematodes to control the plum curculio, a serious apple pest. WITHIN-ORCHARD REPRODUCTION OF

2. Farm information is the same as in my application. Eight acres of vegetable and orchard land (4 rented), and 40 acres of managed woodlot, SMALL SHEEP FLOCK.

3. Ian Merwin of Cornell U. was my cooperator. He helped with advice and statistical analysis. Valuable advice on trap design was given by Gerald Chouinard of the Service de Phytotechnie de Saint-Hyacinthe, Quebec.

4. Please see the Materials and Methods section of the enclosed draft article. I will forward the final version of the article when it is ready.

5. Please see Results and Discussion section of the enclosed draft article.

6. Site-specific factors that influenced this experiment were the orchard layout, which made for confounded position and variety effects; and the relatively high resident PC population, which allowed enough PC captures for meaningful data analysis.

7. None.

8. Yes. Modified traps will be tried in 1995.

9. I probably will not use nematodes again for this purpose, although I may try some other strains if there is evidence that they may work.

10. I tell other producers that evidently the nematodes don't work, but that trapping seems to have potential.

11. So far I've done no outreach. However, I am giving a workshop on apples at the NOFA-NY Conference on March 5 and will present these results. Also, I will be participating in an organic and low-spray apple growers meeting on March 1 and will discuss these results in some detail. Finally, I hope to publish the enclosed article in some appropriate journal (I would welcome suggestions on this), and some more informal articles in the NOFA-NY News, NOFA's Natural Farmer, the North American Fruit Explorers' Pomona, etc.

12. Photos enclosed. I did not receive a slide ID form.
Top photo--showing how the funnel fit into the yogurt container.
Middle--shows an unbaited trap installed under a tree. The funnel-container unit is beneath the unshaded central part of the trap, which is elevated a few inches with wooden stakes. Bait of two apple halves, placed cut face down on screen above funnel, is not present.
Bottom--Baited traps installed in orchard, two per experimental tree.

I will have slides made of these and will forward.

I wish to thank the SARE Program and its administrators for a most stimulating and rewarding experience.

Brian Caldwell

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SARE Project FNE94-40 Final Report

Nematodes for Control of Plum Curculio

Abstract

Two strains of ~~beneficial~~ ENTOMOPATHOGENIC nematodes were applied at two rates under apple trees in an attempt to reduce in-orchard reproduction of plum curculio (Conotrachelus nenuphar). Emerging plum curculio adults under treated trees were not reduced compared to controls. Trapping success suggested an alternate approach to reducing plum curculio numbers.

Materials and Methods

This project was carried out at an apple orchard in Danby, NY managed by Hemlock Grove Farm. Populations of plum curculio are historically high in this orchard. The orchard is managed with organic methods in accordance with Northeast Organic Farming Association, New York Chapter's Standards for Organic Certification.

Apple trees were treated with two strains of beneficial nematodes, Steinernema carpocapsae and S. carp. 'Scanmask.' Each nematode type was applied at two rates, about 400 million ~~and 4~~ billion per acre. There was one tree per treatment, replicated four times (a different variety was used for each replication). A fifth, untreated tree of each variety served as a control. Treatments were staggered through the replications to minimize any effects due to proximity to the orchard edge. The trees were chosen to be about the same size and carrying about the same crop loads, within variety. Because the varieties were located in different orchard rows, any variety effect is confounded with a possible position effect. The varieties were Jonagold, Golden Delicious, Idared, and Melrose.

Treatments were made in the evening of June 24, 1995, early in a rainfall of about 3/4 inch. Nematodes were applied by hand using 2 gallon watering cans to distribute them evenly under the canopy of each experimental tree.

Forty traps to capture subsequent emerging plum curculio (PC) adults were constructed and placed, two under each tree, by August 1. The trap frames were 5'x5'x6", made from pine 1x6 boards. Across each frame top, a screen was stapled, then a piece of landscape fabric with a 12.5 inch diameter hole in the center was stapled on top (see photos). Lath was nailed around the top edges to provide a tight seal. Two traps were installed beneath each experimental tree canopy, usually oriented east-west with the rows. Gaps between the ground and the frame bottoms were stuffed with orchard grass clippings.

The center area of screen beneath the hole in the landscape fabric was braced up with wooden stakes so that it rose about 2 inches above the level of the outer frame. Under this, a one quart yogurt container (donated by Brown Cow Farm Yogurt Co.) was placed with an 8 inch diameter funnel fitted over the open top. The space between the funnel and the container was sealed with tangletrap. The yogurt container was dug into the ground slightly so it would not fall over.

The traps were baited by cutting an apple (of the same variety as the tree above) in half and placing both halves flat side down on the screen above the funnel. Bait was replaced frequently, usually at each sampling. Toward the middle of the sampling period, Golden Delicious apples only were used to replace all bait a few times.

Trap captures were sampled 13 times, from August 1 through September 21. The interval was about twice a week throughout August, after which it was lengthened. Numbers of plum curculios caught in each trap were noted, plus other weevils and unusual captures. Many specimens were kept in isopropyl alcohol. The distance from the tree trunk to the closest edge of each trap was also measured.

Results and discussion

There is only one generation of plum curculio per year in our area, with eggs laid in the small fruitlets until about a month after petal fall. Larvae burrow into the soil after the fruitlets fall off the tree and pupate there. Nematodes were applied at about the same time as the first PC larvae were entering the soil. Adults emerge in late July and August.

The traps worked on the assumption that PC adults emerging from within the framed area would be attracted to the undarkened area of screen in the center of the trap. There they would feed on the cut side of the apple through the screen. Eventually they would drop off, falling into the funnel and being caught in the yogurt container. Many thanks to Gerald Chouinard of the Service de Phytotechnie de Saint-Hyacinthe, Quebec for his excellent advice on trap design. A total of 144 PC adults were caught.

Captures of emergent PC adults subjected to the various treatments showed statistical differences, but in a pattern that is hard to interpret. The fewest were captured from under the control trees. About twice this number (statistically a real difference) were caught under trees with "low" nematode treatments of both strains. Intermediate numbers were found under the trees receiving "high" nematode treatments of both strains. That the same pattern showed for both nematode strains increases the likelihood that the trends are valid.

It would appear that a light application of these strains of nematodes actually increases the survival and emergence of adults, while a 10X greater concentration of nematodes may reduce it to near control levels. Perhaps important soil-dwelling PC predators are more sensitive to the nematodes than PC itself; or the results are in response to some other unknown factors not properly controlled in the experiment.

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Variety	3	65.8000	21.9333	2.9069	.0497
Treatment	4	66.3500	16.5875	2.1984	.0915
Residual	32	241.4500	7.5453		

Dependent: Seasonal Sum PC

Fisher's Protected LSD
Effect: Treatment
Dependent: Seasonal Sum PC
Significance level: .05

	~~Count~~ # TRAPS	Mean CAPTURES/TRAP	
Control	8	2.1250	a
Hi-Scan	8	2.5000	a b
i-S. carp	8	3.1250	a b
Lo-Scan	8	5.0000	b
o-S. carp	8	5.2500	b

One idea for another factor is that perhaps PC adults from outside the traps were crawling in under the trap edges, skewing the results. Since it is known that PC adults congregate at the bases of apple trees in the spring, this might also happen in August. Traps closer to the tree bases, therefore, might tend to catch more PC adults than those farther away. This would be reflected in a negative correlation between captures and distance between tree trunk and trap.

Except for the Melrose block, there was a negative correlation between distance and PC captures. When the Melrose block is removed (a statistically dubious practice), there is a barely significant -.31 correlation between distance to trunk and number of captures. So there is some faint support for this idea.

Also, while most traps were under the east or west areas of the canopy of their trees, three pairs were placed to the north and south because of lack of apples on the branches above the east and west quadrants. It turned out that captures from the north quadrants were significantly larger than those from the south and east, which were again larger than those from the west.

PC adult captures were not correlated with either an above trap "crop load" rating taken on August 3 or final tree yield figures. Since the trees were hand thinned (removing damaged fruit preferentially) in late June/early July, no harvest PC damage rating was done. Idared trees did not require thinning, while the Golden Delicious trees were thinned heavily. Jonagold and Melrose trees were thinned lightly.

If the "distance-to-trunk effect" and the "direction effect" are subtracted from the PC capture data, the same pattern of Control<High<Low remains. So it is possible that a major PC soil predator(s) is more sensitive to nematode attack than PC itself. Finding the identity of this presumed natural control would be quite worthwhile.

Clearly, though, the nematodes did not provide any reduction of PC in-orchard reproduction in this trial.

Some results of interest that were not related to the treatments were as follows:

--PC adults were captured into mid September. Besides the possibility that the adults were emerging at later times than expected, this could also be because some PC were not captured until weeks after they had emerged; or perhaps PC adults from outside the trap boundaries crawled under the sides and were then captured.

--The fourth replication, Melrose variety, had significantly far fewer PC captures (14 total) than the other reps (Jonagold 41, Golden 43, and Idared 46). I thought that this might be because they were not attracted to Melrose apple bait, since bait apples for the traps were taken from the same variety as the trees above them. But even when Golden Delicious bait was substituted captures did not increase. Because of the layout of the orchard, variety and position effects are confounded, so it is not clear that Melrose is necessarily unattractive or inhospitable to PC. However, I find in my notes that early season PC damage on Melrose was high. Thus, it seems possible that for some reason fewer adults are able to emerge beneath the Melrose trees, even if many PC eggs are laid. In this case Melrose would be a good variety to plant in organic orchards. Other varieties may show similar traits, or just the opposite. For instance, the experience of several growers and researchers shows that Liberty is very attractive for PC egg-laying; but nothing is known about actual reproduction levels under Liberty trees. This is a worthwhile area for study.

Conclusions

These results indicate that field application of nematodes was not effective in reducing in-orchard reproduction of plum curculio. In fact, application of nematodes at economically viable levels actually appeared to increase PC reproductive success.

However, this study suggests some promising approaches to non-pesticide control of PC. The traps used in this experiment could be modified and used in the spring to trap PC adults in the orchard, thus reducing egg-laying damage. They could be placed by perimeter tree bases from green tip through the end of June, then throughout the orchard in August and September to reduce PC pressure in the following year. Such traps could be smaller, open-sided, and baited in the same way as this trial. Also, some apple cultivars may be inhospitable to the reproduction of PC under their canopies. These cultivars, if any, need to be identified. They could then be used in perimeter rows to reduce in-orchard PC reproduction.