



Northern NY Agricultural Development Program 2013-14 Project Report

Biological Control of Black Vine Weevil/Strawberry Root Weevil Complex in Northern NY Strawberries and Other Berries with NY Native Persistent Biocontrol Nematodes

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- Hugh and Will Gunnison, Gunnison's Orchard, Crown Point, NY
- Iva Liebig, Liebig's Strawberries, Granville, NY
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Background:

Strawberries, blueberries and raspberries are high value crops with the cost of establishment ranging from \$3,700-8,500 per acre in strawberries, \$8,500 per acre in blueberries, and \$6,000 in raspberries. Black vine weevil (*Otiorhynchus sulcatus*) and strawberry root weevil (*O. ovatus*) are very severe pests of strawberry, blueberry and raspberry production. While adult weevils feed on the foliage, the economic damage is caused by larval root feeding resulting in reduced plant vigor and death.

The inconspicuous nature of the larval root feeding below ground is often missed until insect populations have increased to large economically-damaging populations and cause widespread crop losses. As a result, berry growers are often surprised with the widespread death of their high value crops resulting in significant economic losses.

The use of pesticides to control this root weevil complex has always been ineffective. Effective soil insecticides are no longer available to the berry producer and were only effective in suppressing the population within a treated area for a short period of time. Attempts at adult weevil control using foliar-applied insecticides are also ineffective due to the long emergence period of the adults and their limited-feeding behaviors after egg production is initiated.

This root weevil complex has been shown to be very susceptible to bio-control nematodes. Commercially-available strains of these nematodes are available and are utilized by some producers to manage the root weevil complex with limited success. Commercially-available nematode strains have been shown to be non-persistent in the soil profile (30-60 days), acting like a bio-pesticide, and require accurate application timing for effectiveness. In addition, commercially-purchased nematodes are expensive (around \$1,200/acre) and the viability of the delivered product is often variable.

Native NY strains of bio-control nematodes with the ability to persist in the NY soil environment for multiple years have been successfully used to manage a closely related species (*O. ligustici*) in alfalfa across Northern NY and black vine weevil in multiple cranberry fields near Williamstown, NY. These native bio-control nematodes were initially isolated in NNY and are adapted to survive NY conditions. Field persistence from nematode applications have been documented for seven years across four NNY counties in alfalfa and more than two years in cranberries (2012 application). The massive black vine weevil problem in multiple cranberry fields were brought under control in a single year after the producer reared and applied the NNY native bio-control nematodes. With the documented high level of nematode persistence in 2013 & 2014, any surviving black vine weevil would be under heavy attack during the growing season.

A 12-acre block of strawberries located on Rulfs Orchards, Peru, NY (Clinton County), which had been experiencing large-scale crop loss due to the presence of larvae feeding on roots, was chosen as a location to establish a demonstration plot in 2013. In 2014, we returned to the site to

evaluate the effectiveness of bio-control nematodes against black vine weevil throughout the strawberry planting. The evaluations on the site focused on documenting the reduction of insect levels feeding on the strawberries and the multi-year persistence of the persistent native biocontrol nematodes.

In 2014, our goal was to establish additional root weevil complex-demonstration sites in the NNY region by identifying producers with a weevil problem interested in participating with a research/demonstration bio-control nematode project. With assistance from our collaborators, field sites across NNY were scouted for the presence of larval feeding in late May and early June. Despite the interest from the producers and efforts by our collaborators, no evidence of grubs feeding within the berry farms surveyed were found so no demonstration plots were established this past year.

Throughout 2014, an effort was made to expand the current education and outreach plans for developing a whole farm approach to reduce the root weevil complex using biocontrol nematodes. Two strawberry schools were held to disseminate the results from the demonstration plot established at Rulfs Orchards (2013) during the winter meetings in 2014. A twilight meeting was held at Rulfs Orchards in July 2014. Attending producers were given the latest updates on the project. Additional meetings were held throughout NNY during the 2015 meeting season.

Additionally, a new brochure has been developed which addresses potential root weevil populations on farms and the opportunity for rearing bio-control nematodes for distribution at meetings across NNY/ENY, as well as for use by CCE educators for discussions or as a self-mailer to producers in their counties.

Methods & Results:

Rulfs Orchards Demonstration Plot

Documenting Root Weevil Populations

The presence and number of root weevil larvae were documented throughout the strawberry blocks by collecting numerous samples with a golf cup cutter and screening the samples onsite for the presence of insect larvae.

The location of each sample and the number of larvae present were recorded. Samples were removed within the blocks containing treated and untreated rows using a golf cup cutter and screened besides the plants for the presence of insect larvae in early May.

In each treated block, 25 plants were chosen with the location and number of insect larvae present recorded. Samples taken from the untreated blocks had 12 plants chosen recording once again the location and number of larvae present.

A second observation of the untreated strawberry blocks was done in early June where a 1'-square area around ten random plants was chosen and the number of larvae present there were recorded.

Table 1. Rulfs Orchards Larval Assay

Days Post Inoculation	Area Samples	Treated or Untreated	# Samples Collected	# Larvae Found	Average # Larvae Found per Sample
243	C-Block	Treated	25	72	2.88
243	C-Block	Untreated	12	6	0.50
243	E-Block	Treated	25	28	1.12
243	E-Block	Untreated	12	10	0.83
275	C-Block	Untreated	10	36	3.60
275	E-Block	Untreated	10	32	3.20

Documenting Bio-control Nematode Presence

Soil cores were collected within the treated strawberry blocks using a well-established protocol for the presence of bio-control nematodes. Soil cores were collected 40 days after application to determine establishment of *Steinernema carpocapsae* (Sc) and *Steinernema feltiae* (Sf) within the strawberry block. At each sample location a GPS point was recorded. A series of soil cores were collected during the 2014 growing season and bioassayed for the presence of nematodes. Using the recorded GPS locations from the 40-day sampling, samples were collected within the blocks containing treated and untreated rows 250 days after application and returned to Cornell University to verify persistence. The remaining treated rows were sampled 294-days after application again using the recorded GPS locations at the sample point and returned to Cornell University to verify persistence levels.

The spring 2014 bioassay showed that Sc had disappeared and Sf was lower than anticipated after 294 days. What was not anticipated was the high level of a native strain of *Heterorhabditis bacteriophora* ('Oswego') within the one block. The other block also had a level of 'Oswego' but at significantly much lower level.

Another series of soil samples were collected 330 days after application for a persistence check of Sc and Sf and were compared to the wax worm cadavers that had been placed in the soil profile as bait at similar locations. While the survey was labor intensive compared to typical soil bioassay, the results showed positive results as an indicator of nematode presence.

Twenty-five different locations were chosen in four of the six strawberry blocks for the survey. The percent total positive soil samples for Sc was 5%, Sf-10%, and Oswego: 0%. Comparing that to the 100 wax worms exposed in the soil profile, 47 of the 100 locations showed characteristics of being infected with one of the three EPN species: Sc-11, Sf-12, and Oswego (24 locations respectively).

Table 2. Percentage of positive samples in EPN persistence

Rulfs Orchards		40-Days Post Inoc		250-Days Post-Inoc			294-Days Post Inoc		
Treated Block	# Soil Samples	% Positive Soil Samples		% Positive Soil Samples			% Positive Soil Samples		
		Sc	Sf	Sc	Sf	'Oswego'	Sc	Sf	'Oswego'
A	100	9	24	-	-	-	0	37	0
B	100	7	29	-	-	-	3	39	1
C	100	6	34	0	19	0	-	-	-
D	100	8	26	-	-	-	3	41	6
E	50	14	20	0	9	24	-	-	-
F	50						0	16	16
Untreated Block	# Soil Samples	250-Days Post Inoc		-			-		
		% 'Oswego' Positive Soil Samples		-			-		
C	50	4		-			-		
E	50	34		-			-		

Table 3. Percentage of positive samples in persistent evaluation using corer vs. cage

Rulfs Orchards		330-Days Post Inoc		330-Days Post Inoc		
Treated Block	# GPS Locations Surveyed	% Positive Soil Samples		% Positive Cage Samples		
		Sc	Sf	Sc	Sf	'Oswego'
A	25	8	8	36	20	28
B	25	0	4	4	4	0
D	25	4	20	0	4	12
E	25	8	20	4	16	56

Re-application of demonstration plot using *Heterorhabditis bacteriophora* 'Oswego'

Evaluation of the larval samples collected in spring 2014, soil bioassays collected 40, 250, and 294 days after inoculation, and high levels of *H. bacteriophora* Oswego throughout the strawberry blocks led to a decision to re-apply native Oswego nematodes after bed renovation to boost current population at the orchard within strawberry blocks.

Bio-control Nematodes

Heterorhabditis bacteriophora (Oswego) that had been isolated from previous soil bioassays at the orchard were reared for the re-application of the 9-acre strawberry block at Rulfs Orchards. EPN infective juveniles (IJs) were applied at 4x rate. Each treated block received a total number of 400 million 'Oswego' IJs per treated block. A total of 3.6 billion nematodes were reared for the re-application at the Rulfs Orchards demonstration site.

Application of Nematodes

Application of nematodes was on August 18, 2014. The nematodes were applied using a crop sprayer equipped with fertilizer nozzles with screens and filters removed. The sprayer and tank were cleaned prior to the application to reduce any pesticide residue. The total time to apply the nematodes to the 9 acres was approx. 3 hours. There were no rows left untreated for this application.

Biocontrol Nematode Establishment Assay

Soil cores were collected 60 days after application to determine establishment of *Heterorhabditis bacteriophora* 'Oswego' within the 9 acres of strawberry blocks. A total of 300 samples were collected from the strawberry blocks treated on August 18, 2014, with a GPS point being recorded at each sample location. Samples were returned to Cornell University to verify a successful establishment. Each sample was removed from the soil and split into upper 2" and 3-6" portions that would be used to bioassay for nematode presence. Soil cores were returned to the laboratory and bioassayed using a standard technique with wax moth larvae as an indicator for the presence of biocontrol nematodes in the sample. The level of nematodes in each sample was also used as an indicator to the presence of host insects within the area of the field.

Table 4. Percentage of positive samples in EPN persistence and establishment at Rulfs Orchards

Rulfs Orchards				
Treated Block	# Soil Samples	% Positive Soil Samples		
		393-Days Post Inoc		60-Days Post Inoc
		Sc	Sf	'Oswego'
Section 1	40	3	30	25
Section 2	40	5	20	13
Section 3	20	0	25	25
Section 4	20	5	40	5
Section 5	40	0	30	15
Section 6	40	0	20	23
Section 7	40	15	10	25
Section 8	60	5	18	20
Total	300	4	23	19

Conclusions/Outcomes/Impacts:

Although the funding for this project has ended, the project will continue under the funding support of the NY Farm Viability Institute for the remainder of 2015. Robert Rulfs and Richard Howard reported to us that this year's strawberry crop generated more yield during the u-pick season despite still some areas showing loss due to black vine weevil feeding.

Despite poor levels of persisting populations being recorded using the traditional soil core collection/laboratory bioassay, the infield cage study indicated a significantly higher level of nematode persistence in the field. Additional comparison studies will be conducted to try to correlate the persistence data from both of the sampling methods.

The decision to augment the native *Heterorhabditis bacteriophora* Oswego species using a combination of Rulfs native *H. bacteriophora* Oswego and *H. bacteriophora* isolated from NY soils proved to be successful as overall percentage of soil samples positive for *H. bacteriophora* were higher overall than typically found in other cropping systems. The re-introduction of 'Oswego' within the 9 acres was met with a positive attitude and both cooperators continue to be engaged with researchers to improve the conditions at the berry farm to control their weevil population.

Documenting successful pest reduction on Rulfs Orchards has provided validation to support expanding the program to other strawberry producers throughout the NNY region suffering from economic losses from this root weevil feeding complex. The creation of informational brochures that describe the pest and the issues it can cause, along with reporting the results at grower meetings, has increased the awareness about the root weevil complex for NNY producers.

Outreach:

2014 NNY Meetings

Strawberry School @Paul Smith's College, March 4, 2014 (15 in attendance)

Strawberry School @ Gouverneur, March 5, 2014 (13 in attendance)

2014 Twilight Workshop

Berry Field Meeting @Rulfs Orchards, Clinton County, July 21, 2014 (15 in attendance)

2015 Empire State Producer Expo Berry Session, Syracuse, January 22, 2015 (150 in attendance)

McDermott, L. (2013, September 12). Managing for Root Weevil Complex in Strawberries. *Eastern NY Commercial Horticulture Program*, Vol 1. Iss. 13, 1-2.

Identifying Losses in Berry Production-Cornell Cooperative Extension Brochure-Lindsey Pashow (lep67@cornell.edu)

Black Vine Weevil and Strawberry Root Weevil Project-Facebook-
<https://www.facebook.com/blackvineweevilandstrawberryrootweevil?fref=ts>

NNYADP Weevil Complex Media Hits

February 1 2014 – March 31, 2015

02-26-14	Cornell Fruit News	02-26-14	Peru Gazette
02-26-14	NNY Local Regional Foods List	02-27-14	Morning Ag Clips
02-27-14	Watertown Times	02-27-14	HortiDaily International
02-28-14	The Grower	02-28-14	Cornell Entomology FB
02-28-14	Seneca Daily News Twitter		
03-01-14	Malone Telegram	03-01-14	Adirondack VIC website
03-02-14	Plattsburgh Press Republican	03-03-14	Country Folks
03-03-14	Peru Gazette	03-04-14	New York Ag Connection
03-06-14	Cornell Notes	03-18-14	Dairy Business

03-18-14	Morning Ag Clips	03-19-14	Morning Ag Clips
03-23-14	Plattsburgh Press Republican	03-28-14	Morning Ag Clips
04-04-14	CCE News Blog	04-09-14	Empire State Farmer
04-15-14	Morning Ag Clips	04-15-15	AgriForaging FB
04-15-14	North Country Now	04-15-14	Peru Gazette
04-20-14	Plattsburgh Press Republican	04-22-14	Adirondack Almanack
04-22-14	Adirondack Explorer	04-23-14	ADK Review Board.com
04-24-14	Empire State Farmer		
01-15-15	New York Ag Connection	01-15-15	Cornell Field Crops News
01-17-15	Plattsburgh Press Republican	01-18-15	Cornell Events
01-18-15	Agriculture Industry Today EIN	01-24-15	Dairy Agenda Today
01-24-15	Dairy Herd Management	01-26-15	Country Folks
02-24-15	Clinton County Farm Bureau FB	02-24-15	Morning Ag Clips
02-24-15	New York Ag Connection	02-24-15	US Ag Network
02-27-15	Empire State Farming		
03-01-15	Morning Ag Clips	03-02-15	CALS Notes
03-02-15	North Country Now	03-02-15	Greenhorns Blog
03-03-15	US Ag Network	03-03-15	Peru Gazette
03-03-15	New York Ag Connection	03-05-15	Cornell Field Crop News
03-08-15	Plattsburgh Press Republican	03-09-15	Focus on Farming
03-11-15	Morning Ag Clips	03-12-15	International Horti-Daily
03-14-15	Watertown Times	03-14-15	Lowville Journal
03-14-15	Malone Telegram	03-14-15	Carthage Republican Tribune
03-14-15	Massena-Potsdam Courier	03-14-15	Ogdensburg Journal

Next steps:

Research will continue with a NY Farm Viability Institute program (OAR 13 08) titled, “Biological Control of the Black Vine-Strawberry Root Weevil Complex: The Whole Farm Approach.” This program is funded through December 31, 2015. A second proposal titled “Managing Root Weevil Populations for Improved Profitability and Sustainability on Eastern NY Berry Farms” is under review by the NY Farm Viability Institute. This project, if funded, will run from December 2015 until November 2017.

Acknowledgments:

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For More Information (including farmers who have participated):

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Photos

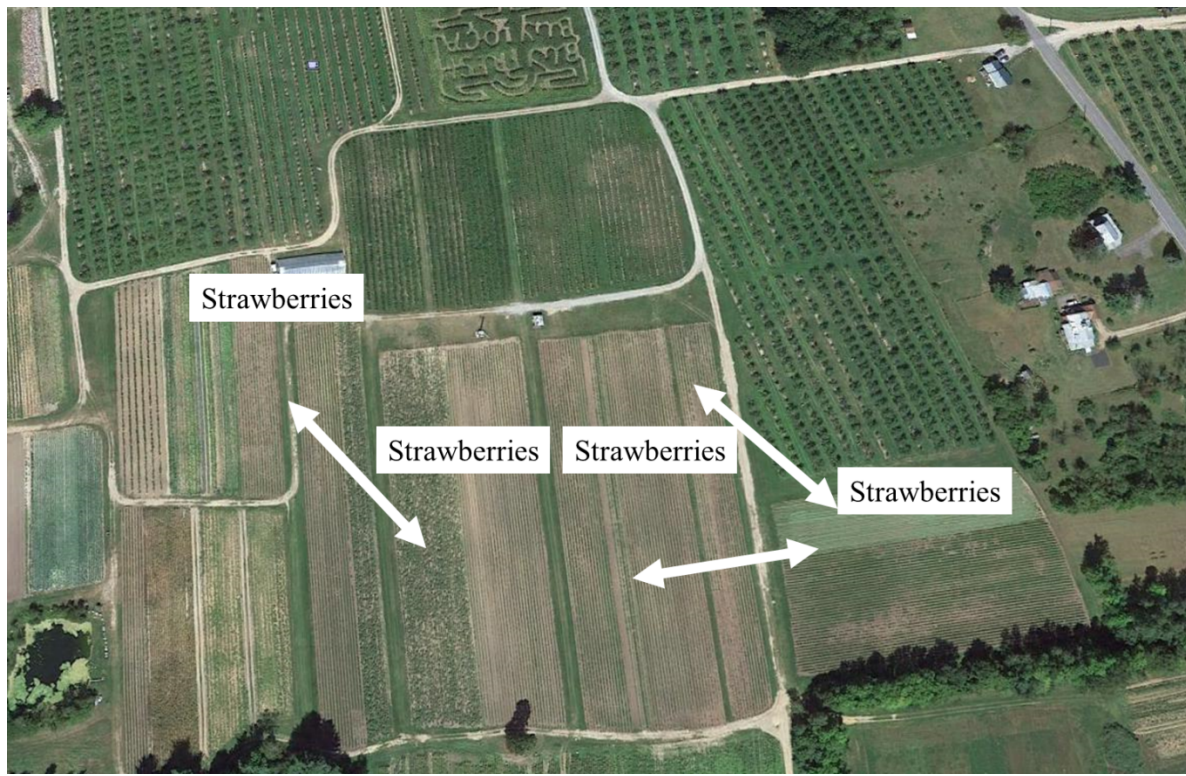


Fig 1. Rulfs Orchards Strawberry Blocks, Peru, NY, Clinton County.



Figure 2. Black Vine Weevil, left; Strawberry Root Weevil, right



Fig 3. Strawberry damage assessment in the spring



Fig 4. Documenting root weevil populations in May at Rulfs Orchards, Peru, NY, Clinton County.



Fig 5. Larvae and root damage found in strawberry blocks



Fig 6. Soil assay documenting nematode establishment for ‘Oswego’ at Rulfs Orchards in Peru, NY (Clinton County).