



**Northern NY Agricultural Development Program
2016-2017 Project Report**

**Impact of Biocontrol Nematodes on Corn Rootworm
during the Corn Rotation**

Project Leader(s):

- Elson Shields, Department of Entomology, Cornell University, Comstock Hall, Ithaca, NY 14850; 607-279-1849, es28@cornell.edu
- Tony Testa, Department of Entomology, Cornell University, Comstock Hall, Ithaca, NY 14850; 607-591-1493, at28@cornell.edu

Collaborator(s):

- Mike Hunter, CCE NNY Field Crops Specialist, CCE Jefferson County, 315-788-8450, meh27@cornell.edu

Cooperating Producers:

- Dave & Lisa Magos, Morning Star Farm, Jefferson County

Background:

The application of biocontrol nematodes to combat alfalfa snout beetle (ASB) has been shown to be effective in reducing the impact of alfalfa snout beetle on alfalfa stands. Related research in Northern New York (NNY) has shown that not only do the populations of biocontrol nematodes persist in the field when the field is rotated to corn, but in many cases the populations actually increase during corn years 2-4. Since corn years 2-4 are the years when corn rootworm larvae are feeding on corn roots, it is suspected that the biocontrol nematodes are reproducing in the corn rootworm larvae.

NNY farmers have raised the question about the effectiveness of these resident biocontrol nematodes in controlling corn rootworm and whether or not the impact of these biocontrol nematodes is significant enough to eliminate the need for BT-rootworm corn or soil insecticide on conventional varieties. In a related study conducted at the Musgrave Research Farm (Aurora, NY) from 2014-present, biocontrol nematodes limited root feeding damage and the results were equal or a better level of root protection than with the best BT-CRW corn variety.

The 2017 trial was the second year of a multi-year study in NNY focused on the effectiveness of resident biocontrol nematodes for controlling corn rootworm (Fig 1).

The research planned for year 2 involved adding a second site: either a field where biocontrol nematodes populations were established or fields with a history of corn rootworm damage which were previously untreated with nematodes. To accurately measure the impact of these biocontrol nematodes on corn rootworm larvae, a comparison site(s) will need to be evaluated in this multi-year study. In the past, the locations of the ASB-biocontrol nematode demonstration plots that have both nematode-treated areas and untreated areas would be perfect, unfortunately, the producers of these fields were not ready to rotate to corn in 2017 or they had contaminated the untreated control plots with field tillage across the control plots. Therefore, this study will be conducted in phases over the next few years.

Methods & Results:

In 2017, the Shields lab returned to the field plots established on the Dave Magos Morning Star Farm in Jefferson County during 2016. Additional sites used previously for demonstration plots located in NNY were not available, thus only the Magos site was evaluated in 2017.

The Morning Star farm site was established in a 132-acre field (N 43.8612, W -76.1252) owned and operated by Dave & Lisa Magos, Adams, NY, in 2016. Using the multi-species approach, two native NY strains of bio-control entomopathogenic nematodes (EPNs), (*Steinernema carpocapsae* and *Steinernema feltiae*) were reared for the corn rootworm site, then applied to the first-year corn crop at plant emergence. Plot design included eight 0.5-acre blocks. Four blocks were treated with nematodes and the other four blocks remained untreated (Fig.2).

EPN infective juveniles (IJ) were applied at a rate of 75 million per species per treated block in 2016. Each treated block received a two-species combination, the total number of IJs per treated block were 150 million. A total of 600 million nematodes were reared for the Magos site. Plots were not assayed prior to nematode establishment on May 17, 2016, but experience has shown a low probability of a resident population. Soil cores were collected from the treated plots only to verify a successful inoculation on 60 days post-nematode application during year 1 of the study.

In 2017, the eight field plots were flagged, prior to planting of each 0.5-acre plot. Half of these plots were previously inoculated with ASB biocontrol nematodes and the rest of the plots were left untreated. Since the farm is no-till, movement of biocontrol nematodes with soil tillage is of lesser concern. Subsequent nematode sampling verified nematode persistence in the treated plots and the lack of contamination in the untreated field plots. Impact of biocontrol nematodes on the corn rootworm larval populations in each plot was measured throughout the summer.

In 2017, each plot area, treated and untreated, was split and planted with corn of similar maturity: conventional corn (non-BT) and CRW –BT varieties on May 20, 2017. The two different CRW-BT varieties, Dekalb and Seedway, were planted side by side in each plot creating a six-row block (Fig. 3).

Biocontrol Nematode Assessment:

Prior to corn rootworm larval hatch, soil cores were collected from treated and untreated plots on June 2, 2017, 380 days post-nematode application. Each sample was removed from the soil and split into upper 2” and 3-6” portions for bioassay for nematode presence. Soil cores were returned to the laboratory and bio-assayed 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 documented to show expected overwintering populations in the treated plots and the lack of nematodes in the untreated plots. The results from spring 2017 show no contamination within the untreated blocks while resident population of nematodes continue at expected levels (Table 1).

Table 1. Percentage of positive samples for 2017 pre-CRW larval hatch assay, Morning Star Farm, Jefferson County, NNYADP biocontrol nematodes project, 2017.

Magos CRW 2017	Days Post Inoc	# Soil Samples	% Sc Positive Samples	% Positive Sf Samples
Treatment Block I	380	25	0	16
Treatment Block II	380	25	0	28
Treatment Block III	380	25	0	24
Treatment Block IV	380	25	0	20

On August 9, 2017, 450 days post-nematode application, 80-soil cores were collected from each 0.5-acre biocontrol nematode-treated block. Samples within each treated block were split: 40 samples within non-BT and 40 samples within CRW–BT variety rows respectively. Each sample was removed from the soil and split into upper 2” and 3-6” portions to bioassay for nematode presence. Soil cores were returned to the laboratory and bio-assayed using a standard technique with wax moth larvae as an indicator for the presence of biocontrol nematodes in the sample. Resulting population levels were documented to show population levels entering the fall/winter (Table 2).

Table 2. Percentage of positive samples for 2017 post-CRW larval hatch assay, Morning Star Farm, Jefferson County, NNYADP biocontrol nematodes project, 2017.

Magos CRW 2017 Non-BT Rows	Days Post Inoc	# Soil Samples	% Sc Positive Samples	% Positive Sf Samples
Treatment Block I	450	40	0	30
Treatment Block II	450	40	0	20
Treatment Block III	450	40	0	20
Treatment Block IV	450	40	0	18
Magos CRW 2017 CRW-BT Rows	Days Post Inoc	# Soil Samples	% Sc Positive Samples	% Positive Sf Samples
Treatment Block I	450	40	0	28
Treatment Block II	450	40	0	23
Treatment Block III	450	40	0	23
Treatment Block IV	450	40	0	20

Corn Rootworm:

To measure the impact of biocontrol nematodes on corn rootworm larval populations, each plot area (treated and untreated) was evaluated in two ways: collection of emerging CRW adult beetles, and root damage assessment. Beginning July 10, 2017, within each plot (treated and untreated), two 10x10 screen houses were erected in each corn variety (BT, Non-BT) to capture the number of CRW beetles emerging from each 10x10 area (Fig 4). All screen cages (16) were set up by July 12). Observations for CRW adult emergence began on July 18; two male adults were observed and collected on July 24, 2017 (Fig 5). The screen cages were checked for adults 1-2 times/week; adults collected were returned to Cornell University and number and sex of those collected on each observation date were recorded (Table 3). Observations and collections of surviving CRW adults emerging within each plot (treated and untreated) concluded on August 18, 2017. Screen houses were removed from the field prior to fall harvest.

Table 3. CRW Adult Collection in Treated and Non-Treated Plots, Morning Star Farm, Jefferson County, NNYADP biocontrol nematodes project, 2017.

Magos 2017		Nematode Treated Plots-Total CRW Adult Collected							
Observation Date	Treated Plot 1		Treated Plot 2		Treated Plot 3		Treated Plot 4		
	BT	Non-BT	BT	Non-BT	BT	Non-BT	BT	Non-BT	
7-18	0	0	0	0	0	0	0	0	
7-21	0	0	0	0	0	0	0	0	
7-24	0	0	0	0	0	0	0	0	
7-31	0	0	0	0	0	3	3	2	
8-4	0	4	0	0	0	2	4	9	
8-7	2	4	0	0	0	3	7	7	
8-10	0	6	0	0	0	1	0	5	
8-14	0	0	0	0	0	0	0	0	
8-18	0	0	0	0	0	0	0	0	
Totals	2	14	0	0	0	9	14	23	
Magos 2017		Untreated Nematode Plots-Total CRW Adult Collected							
Observation Date	Untreated Plot 1		Untreated Plot 2		Untreated Plot 3		Untreated Plot 4		
	BT	Non-BT	BT	Non-BT	BT	Non-BT	BT	Non-BT	
7-18	0	0	0	0	0	0	0	0	
7-21	0	0	0	0	0	0	0	0	
7-24	0	0	0	0	0	0	0	2	
7-31	0	3	0	8	0	9	3	7	
8-4	3	2	0	15	2	8	0	4	
8-7	5	3	1	7	0	4	0	2	
8-10	2	2	0	14	0	6	2	0	
8-14	0	0	0	0	0	0	0	0	
8-18	0	0	0	0	0	0	0	0	
Totals	10	10	1	44	2	27	5	15	

Feeding Damage from CRW Larval Feeding Evaluation

On August 9, 2017, twenty corn roots per corn variety (BT vs. Non-BT) were dug within each of the eight 0.5-acre blocks located on the Magos field site., with a total of 40 roots per research block. Two rows were chosen, and, within each row, 2 locations were dug for evaluation; 5 corn roots per location (10 per row). Corn roots were returned to Cornell University; initial observations of the roots, along with the limited number of CRW adults present at the Magos location led to the decision not to wash and rate the corn roots. The very wet spring across New York State during the CRW hatching period was very detrimental to the CRW larval population, prevented any CRW damage in the untreated plots and resulted in very low adult emergence.

Conclusions/Outcomes/Impacts:

With the past successes of farmers who have adopted the biocontrol nematode program to control ASB on their farms in NNY, the opportunity to provide protection against corn rootworm seemed a logical next step as resident biocontrol nematodes populations in many cases have increased during corn years 2-4.

Ideally, this study needs to be conducted in multiple fields across the NNY region in fields where biocontrol nematodes have been established in alfalfa during proceeding years, while also conducting research in untreated areas with corn rootworm. To date, only one site located in NNY has met the criteria for the study as the producers of the established demonstration plots have yet to rotate into corn. A project in Western Texas, where CRW adult populations are very high, showed significant reduction in CRW adult emergence and root damage while maintaining a resident population of biocontrol nematodes. The project manager has secured additional funding to expand the project based on the results.

This trial in 2017 was the second year of a 3-4 year study; we had anticipated some measurable benefits from the nematodes established at the site in year 1 as rootworm adults laid eggs in the corn plot during the summer of 2016. In a similar study conducted at the Musgrave Research Farm (Aurora, NY), biocontrol nematodes limited root feeding damage and the results were nearly identical to the level of root protection achieved with the best BT-CRW corn variety beginning in year 2. However, the very wet spring across NYS during the CRW hatching period was very detrimental to the CRW larval population, prevented any CRW damage in the untreated plots, and resulted in very low adult emergence.

In year two, soil assays performed in the designated plots treated with biocontrol nematodes indicated a resident nematode population that would be used to measure any impact on corn rootworm larvae. Furthermore, an evaluation of the effectiveness of resident population in controlling CRW larvae to below-an-economically-damaging level was conducted. Surviving corn rootworm adults were collected during a six-week period and roots were dug for feeding damage assessment. However, in year two, the population levels of CRW adults were low at the site, which impacted the number of emerging adults to collect and identify and limited assessment of the feeding damage from CRW larvae.

Results from the three current corn rootworm study sites (Adams, Aurora, and Avon, NY) will be shared with the agribusiness community of NNY during winter cycles beginning in 2018. Additional sites may be established/introduced into the study in 2018 across NY if funding is attained. It is important to remember, however, that without the Northern New York Agricultural Development Program support of prior research in NNY on alfalfa snout beetle, the study to evaluate the potential to eliminate the need for BT-rootworm corn or soil insecticides on conventional varieties would not be possible.

Outreach:

2018 NNY Meetings:

February 12, 2018–Winter Forage Forum-Lowville Farmers CO-OP, Lowville, NY.

NNYADP ASB/CRW Media Hits

Dec 2017	Empire Farm and Dairy	ASB
11-23-17	Oswego Hometown News	ASB
11-23-17	Malone Telegram	ASB
11-23-17	Carthage Republican Tribune	ASB
11-23-17	Massena Potsdam Courier	ASB
11-23-17	Ogdensburg Journal	ASB
11-23-17	Watertown Daily Times	ASB
11-23-17	Lowville Journal	ASB
11-23-17	Batavia Daily News	ASB
11-18-17	Farm and Dairy	ASB
11-06-17	Focus on Farming	ASB
11-06-17	Country Folks	ASB
11-05-17	Plattsburgh Press Republican	ASB
11-04-17	Lancaster Farming	ASB
11-03-17	Farm and Dairy OH	ASB photo requested
11-02-17	Cornell Small Farms FB	ASB
11-01-17	Morning Ag Clips	ASB
11-01-17	New York Ag Connection	ASB
11-01-17	Progressive Forage	ASB
10-31-17	CCE Jefferson News	ASB
10-31-17	Dairy Business	ASB
10-31-17	Cornell Field Crops Blog	ASB
10-31-17	Blodgett Blog	ASB
03-13-17	Lancaster Farming	NNYADP CRW research
March 2017	Empire Farm and Dairy	NNYADP CRW Research
March 2017	Empire Farm and Dairy	NNYADP ASB Update
02-10-17	Ogdensburg Journal	NNYADP ASB Update
02-10-17	Massena Potsdam Courier	NNYADP ASB Update
02-10-17	Carthage Republican Tribune	NNYADP ASB Update
02-10-17	Malone Telegram	NNYADP ASB Update
02-10-17	Batavia Daily News	NNYADP ASB Update
02-10-17	Oswego News	NNYADP ASB Update
02-10-17	Watertown Daily Times	NNYADP ASB Update
02-10-17	Lowville Journal	NNYADP ASB Update
02-07-17	Seed Today	NNYADP CRW Research
02-07-17	American Agriculturist	NNYADP CRW Research
02-06-17	Country Folks	NNYADP CRW Research
02-05-17	Plattsburgh Press Republican	NNYADP CRW Research
02-04-17	Batavia Daily News	NNYADP CRW Research
02-04-17	Malone Telegram	NNYADP CRW Research

02-04-17	Carthage Republican Tribune	NNYADP CRW Research
02-04-17	Lowville Journal	NNYADP CRW Research
02-04-17	Massena-Potsdam Courier	NNYADP CRW Research
02-04-17	Ogdensburg Journal	NNYADP CRW Research
02-04-17	Watertown Daily Times	NNYADP CRW Research
02-04-17	Oswego News	NNYADP CRW Research
02-03-17	Time Warner Cable News	NNYADP CRW Research
02-03-17	Morning Ag Clips	NNYADP CRW Research
02-02-17	synergycap1.com	NNYADP CRW Research
02-02-17	newstimeti.com	NNYADP CRW Research
02-02-17	Farming	NNYADP CRW Research
02-01-17	Dairy Business	NNYADP CRW Research
02-01-17	Holstein World	NNYADP CRW Research

Next Steps:

For 2018 the Shields' Lab will continue its efforts in the next phase of the corn rootworm study at the Magos Farm study site and add a possible second location in NNY. At the Magos location, prior to corn rootworm larval hatch (mid-late May), all plot areas will be sampled for biocontrol nematodes to document the expected overwintering populations in the treated plots and the lack of nematodes in the untreated plots. Plot areas will be re-sampled prior to harvest to document the level of biocontrol nematodes entering the winter. The impact of biocontrol nematodes on the corn rootworm larval populations in each plot area will be measured in three different ways:

- Within each plot, two 10x10 screen houses will be erected in each corn variety (BT, Non-BT) to capture the number of CRW beetles emerging from each 10x10 area. Beetles will be collected 2x/week, counted, sexed, and recorded. Beetle emergence is expected to begin around July 15 and continue until late August.
- After larval feeding is finished (early August), a specified number of plants will be dug, washed, and the root feeding damage rated using the Iowa 0-3 scale.
- Before harvest, sections of each plot area will be rated for lodging as a result of CRW feeding damage. For the second location, previously a demonstration plot, four 0.25-acre blocks were treated with nematodes and four 0.25-acre blocks were left untreated. Subsequent sampling has documented nematode establishment and persistence in the nematode treated plots. This will prepare the site for studies to examine the impact of these biocontrol nematodes on corn rootworm that invades corn during its second year (2019).

Acknowledgments:

We thank Northern New York Agricultural Development Program and Cornell Cooperative Extension for their continuing support of our research and extension efforts.

For more information:

- Elson Shields, Department of Entomology, Cornell University, Comstock Hall, Ithaca, NY 14850; 607-279-1849, es28@cornell.edu
- Tony Testa, Department of Entomology, Cornell University, Comstock Hall, Ithaca, NY 14850; 607-591-1493, at28@cornell.edu
- Dave & Lisa Magos, Morning Star Farm, 13143 County Route 75, Adams, NY 13605, 315-771-0431