NNY Agricultural Development Program
2006-2007 Project Report

Biological Control of Alfalfa Snout Beetle with Entomopathogenic Nematodes

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Franklin County: Eugene Poirire, Carolyn McNamara/Dick Eakins

Background:

Alfalfa snout beetle, within the infested counties, continues to be the single most contributing factor to alfalfa death and stand loss in NNY. Snout beetle related stand loss is often mistakenly identified as winter kill because the majority of plant death occurs after the growing season during the fall and early winter. This insect was introduced into NNY at the port of Oswego between 1848 and 1896, when the first individual was collected and identified. Snout beetle became a major pest problem after alfalfa was introduced into NNY in the 1920s. Attempts were made to control this insect from the 1940s to 1972 with the widespread distribution of poison baits. During this time, snout beetle continued to spread. Widespread baiting ended in 1972, due to environmental concerns and the snout beetle population exploded in the early 1980s. Research focused on the use of biological control to suppress snout beetle was initiated in 1990 and has been supported in part by NNYADP since its initiation.

In 2002 and 2003, the snout beetle population on the Peck Farm (Great Bend, Jefferson Co.) crashed from about 1 million beetles per acre to an extremely low level. Subsequent research has shown that the entomopathogenic (insect attacking) nematodes released on the farm in a series of small plots during 1993-98, have been moved throughout the farm by farming practices and caused the population crash of snout beetle. A small rebound of beetles was observed in a field bordering a neighbor's heavily infested farm in 2007. John Peck's farm has progressed from having the alfalfa stands completely killed out during the first production year from snout beetle feeding to actually plowing alfalfa plants down at the end of an alfalfa stand's life (5 years). With the establishment of 6 different small test plots on the Peck farm, it required nearly 10 years for the nematodes to spread throughout the farm and control snout beetle.

The question is: "How can we move the biological control success on the Peck Farm to the rest of the infested farms in the NNY?"

Since the entomopathogenic nematodes used as the biological control for snout beetle are adapted to NNY, a farm or field only needs to be inoculated once for the establishment of the nematodes in the field. If only a single field per farm is inoculated, the farmer will move the nematodes around the farm with the movement of soil during normal farming operations, but it will take years for the nematodes to become established in all of the affected fields on the farm and control the population of snout beetle on the farm. However, if a farmer friendly method could be developed to rear the nematodes on the farm and a method of application be developed compatible with on-farm equipment to inoculate individual fields, then each farmer could more rapidly spread the biocontrol nematodes throughout their fields for faster control of snout beetle.

In 2007, we shifted our research focus to address the problems associated with large-scale application of nematodes for wide scale control of snout beetle. Field plots were established in 13 different fields located on 7 farms across 4 - NNY snout beetle infested counties.

Methods and Results:

Field inoculation techniques:

Two field sites were located in southern Jefferson County on the Doug Shelmidine farm to evaluate field inoculation methods into established alfalfa fields compatible with current farming practices.

At each site, four different soil inoculation techniques were tested. The plots consisted of four rows of flags. The flags within the row, were separated by 10 ft and the rows were separated by 20 ft to allow the farmer to cut the alfalfa between the treatment rows. At each flag within a row, the same type of nematode inoculation was placed. The inoculation methods tested were 1) nematode infected insect cadaver placed on the soil surface, 2) nematode infected insect cadavers placed four inches under the soil surface (a natural condition), 3) nematodes suspended in water and applied to the soil surface (a method used in experimental plots for more than 10 years) and 4) nematode infected soil placed at each flag. Soil samples were collected at the flags at 6 inch intervals within a treatment to document nematode establishment and spread from the point of inoculation. Soil samples were collected 22 days, 69 days and 109 days after the June 6, 2007 inoculation date. After soil samples were collected from the field, the samples were bioassayed for the presence of nematodes in the laboratory at Cornell.

As we all remember, the 2007 growing season was noted as one of the driest on record with a significant lack of rain and very dry soil conditions. In spite of the difficult environmental conditions, nematodes became established at both sites. The level of establishment was much lower than expected but considering the dry soil conditions, we are pleased that nematode establishment even occurred. The best establishment rate for both of the nematode species tested was the buried cadaver, a natural condition of nematode attack of soil insects. The second best establishment was the suspension of nematodes in water and applying the water to the soil surface. The placement of the cadaver on the soil surface and the placement of nematode infested soil on the surface were both disappointing with their establishment results. Nematode

movement from the inoculation site was 42 inches over the 109 days of the growing season. Movement may actually have been greater but the difficulty of collecting soil samples in extremely dry soil may have underestimated the actual nematode movement. An example of the nematode establishment and movement data is displayed in Figure 1.

High Nematode Concentration Plots:

In past research plots, a high concentration of nematodes were applied to guarantee nematode establishment in the field. This technique was scaled up from the small 10 ft x 20 ft research plot to an 8 ft x 70 ft strip oriented across the grain of the field. The orientation of the inoculated area was important because the movement of soil during the plowing and other soil preparation work will move the nematodes into the rest of the field. Two different species of nematodes were applied to each plot at a rate of 12.5 million nematodes of each species per plot (total of 25 million nematodes). The 25 million total nematodes were suspended in 3 gals of water and sprayed on the soil surface of the plot. An additional 6 gals of water were sprayed on the plot to assist the nematodes in entering the soil. The spray boom was equipped with fertilizer stream nozzles spaced on 12 inch centers. A total of 45,000 nematodes were applied to each square ft of plot area (22,500 of each species). A different combination of nematode species was applied in each of the 3 different counties.

Field plots were located in Lewis County (Mark Karelus and Bernie Goehlert farms), St Lawrence County (Mark Akins and 'Skip' Putney farms) and Franklin County (Eugene Poirier and Carolyn McNamera/Dick Eakins farms). On the Lewis County farms, the nematode combination of *Steinernema carpocapsae* 'NY001' and *Heterorhabditis bacteriophora* 'Oswego' was used. In St Lawrence County, the nematode combination of *S. feltiae* 'Valko' and *H. bacteriophora* 'Oswego" was used and in Franklin County the nematode combination of *S. carpocapsae* NY001' and *S. feltiae* 'Valko' was used. All three of the nematode combinations showed positive results in field plots on the Peck Farm.

Nematode establishment was documented at all field sites in spite of the extremely dry soil conditions throughout the summer. Establishment rates of 10-35% was lower than expected, but the dry soil conditions and very dry summer influenced our ability to collect good representative soil samples for bioassay. The actually establishment rate may be much higher. The plots will be re-sampled in the spring of 2008 to verify the actual establishment rate. The rate of spread from these sites will be documented during the2008 growing season. Data from three of the farm sites is displayed in Figure 2.

Low Nematode Concentration Plots:

In this set of plots, the concept of applying the biocontrol nematodes at a very low concentration over a much larger area was examined. Using this method, a field would become completely colonized much quicker, if the low density of nematodes became established in the soil. These low concentration plots were applied by mounting an 8 ft spray boom on the back of a pickup truck with 2-55 gal tanks mounted in the truck. Fertilizer stream nozzles were mounted on the boom on 6-inch centers and the application rate of the boom was 5 gals per min. With a truck speed of 6 mph, and concentrating the water into 2 inch bands every 6 inches, the water application rate was 0.5 ounces per linear ft. The force of the water exiting the fertilizer stream nozzle at 40 psi blasted the water stream through any alfalfa canopy present and deposited the

nematodes on the soil surface in a good stream of water. Nematodes were applied at three different densities. On the Doug Shelmidine farm (southern Jefferson Co.), nematodes were applied at 900,000 nematodes per gal of water or 1100 nematodes per square ft. Nematodes were applied on the Bernie Gohlert farm (Lewis Co.) at 3 million nematodes per gallon or 4000 nematodes per square ft. An intermediate nematode concentration of 1.8 million nematodes per gal or 2200 nematodes per square ft were applied on the Mark Akins and 'Skip' Putney farms (St Lawrence Co.) and Carolyn McNamera/Dick Eakins farm (Franklin Co.)

Areas of the truck applications were sampled once after application to verify nematode establishment. Nematodes became establish at all sites in spite of the very dry soil conditions and conditions "hostile" to nematode establishment. At the Shelmidine site and the Putney site, only one of the two species applied were detected. Since Hb.'Oswego' cruises deeper in the soil and the dry soil conditions prevented a deeper soil core, Oswego may have become established at both of these sites. Our years of experience with this nematode on the Peck farm would suggest that establishment did occur even though we were unable to detect it. All 2007 application plots will be re-sampled in May-June 2008 to re-affirm nematode establishment. We believe this type of low nematode concentration has excellent potential for use by individual farmers to inoculate their own fields. A sample of the establishment data from these application trials is displayed in Figures 3 and 4.

Conclusions/Outcomes/Impacts:

The 2007 research identified that the best method of inoculating infested fields is to suspend the nematodes in water and spray the nematodes onto the soil surface in a high volume of water using fertilizer stream nozzles. The application trials will give us a good starting point to estimate the most efficient method to inoculate fields with the bio-control nematodes. Spreading out a 100 million nematodes using a lower concentration of nematodes in the water carrier will enhance the spread of nematodes throughout the field and reduce the time required to control snout beetle in each field. This information will allow the farmers to apply their own nematodes through their own spray with minor modifications.

Outreach:

No extension presentation were requested about snout beetle research and progress in 2007. Presentations are scheduled for March 12, 2008 in Canton and March 13, 2008 in Carthage. No presentations have been scheduled to date for Franklin County The topic of these presentations will be a research update about alfalfa snout beetle.

In addition, there was a news release titled: Cornell Researchers and Farmer Report More Progress Against Pest Peculiar to Northern NY. Released 5/21/07

Next steps:

The focus for 2008 has to be directed in perfecting a farmer-friendly nematode rearing method so nematodes can be reared on the farm and dumped into the spray tank with minimal labor.

Acknowledgments:

This research has been supported by NNYADP and Cornell University Agricultural Experiment Station.

Reports:

An article about the history of alfalfa snout beetle in NNY and the success of the biological control effort with nematodes was submitted to the "American Entomologist" in early January. Reprints of the article will be made available for general distribution when the article is published. The contents of the article has already been made available to NNYADP Publicist Kara Dunn for possible use.

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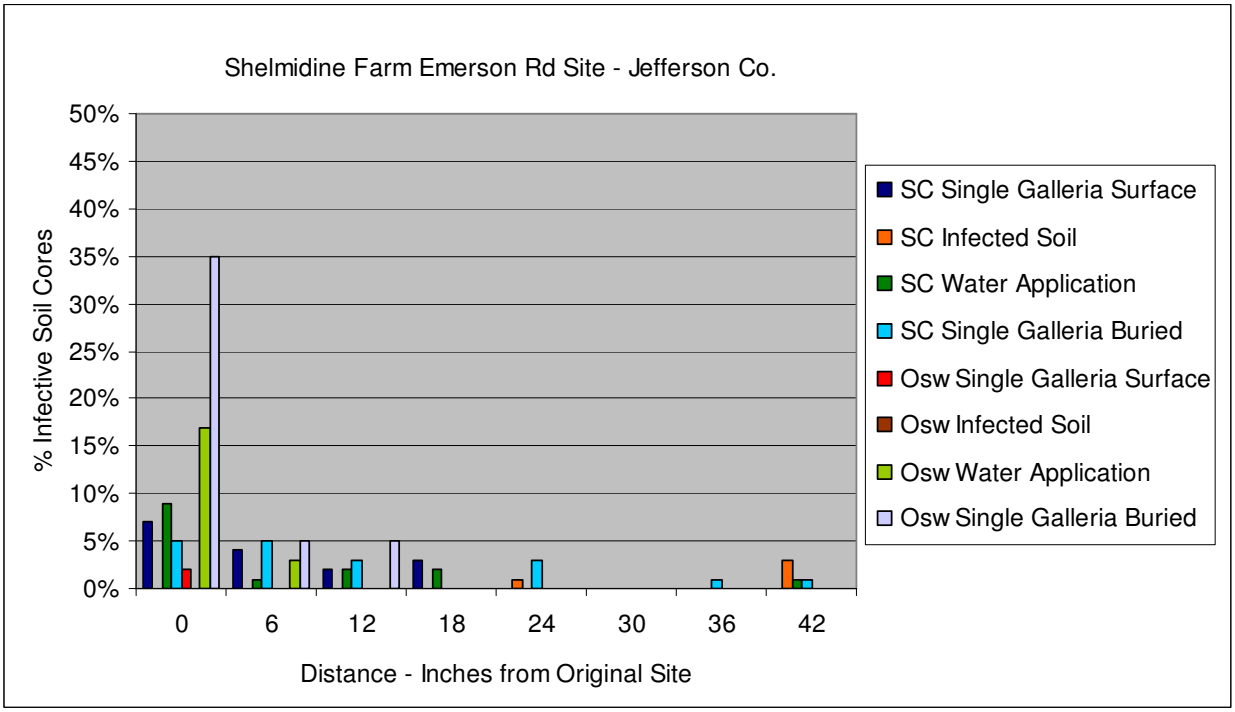
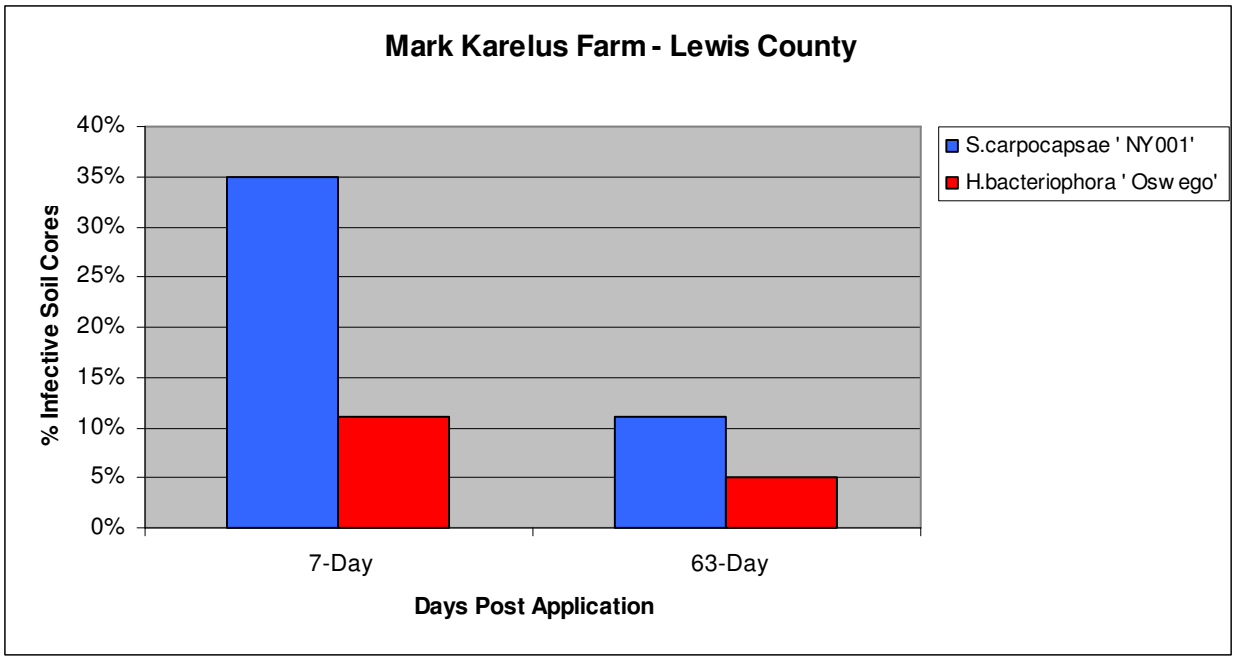


Figure 1. Establishment of S. carpocapsae 'NY 001' (SC) and H. bacteriophora 'Oswego' (Osw) using four different inoculation methods in the field.



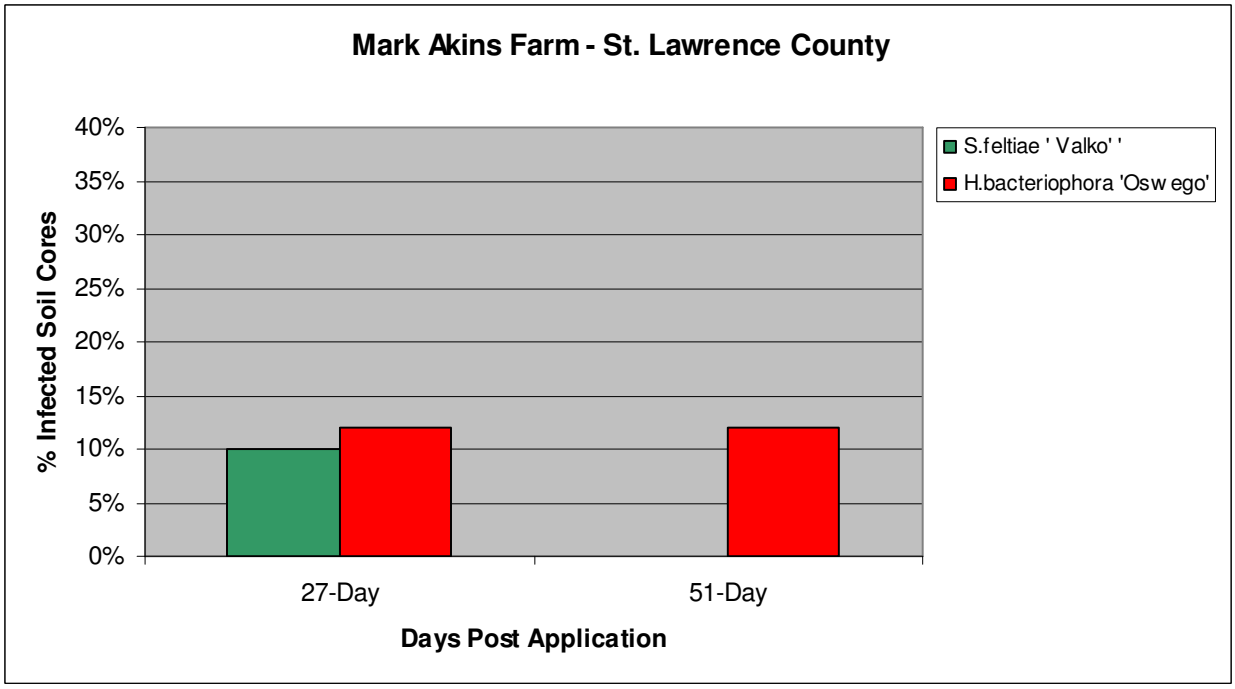


Figure 2. Establishment of three species of bio-control nematodes using an eight foot hand boom with a high concentration of nematodes in water used as carrier.

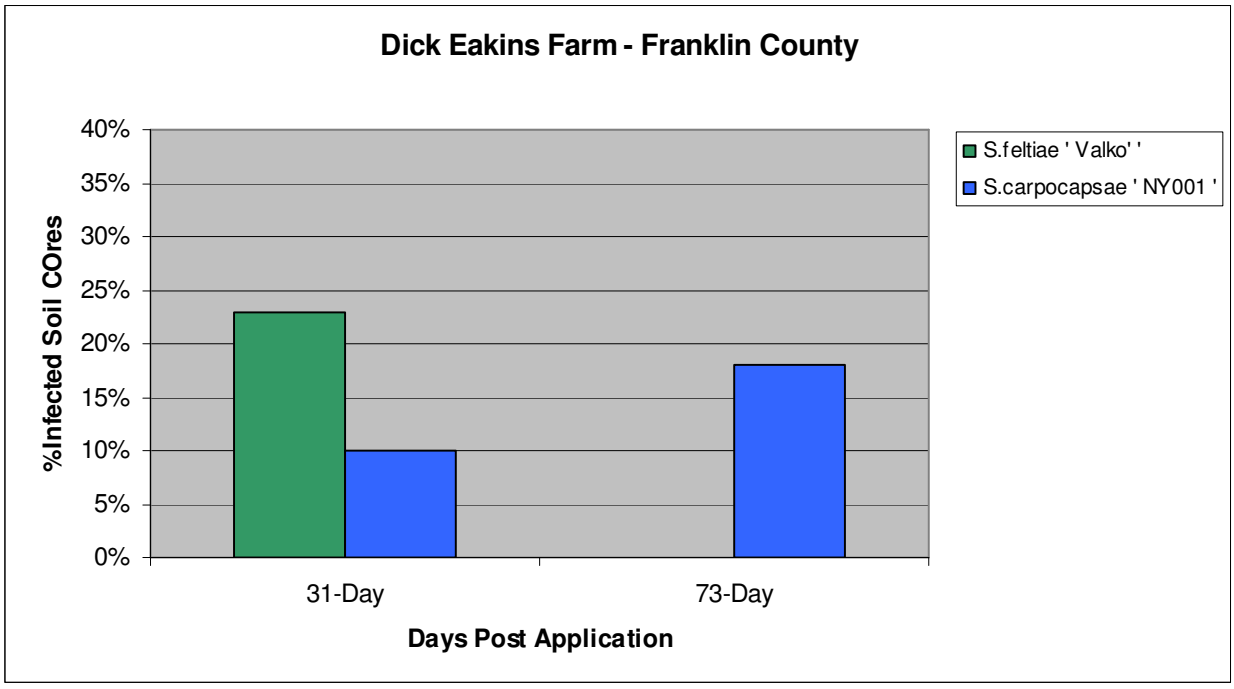
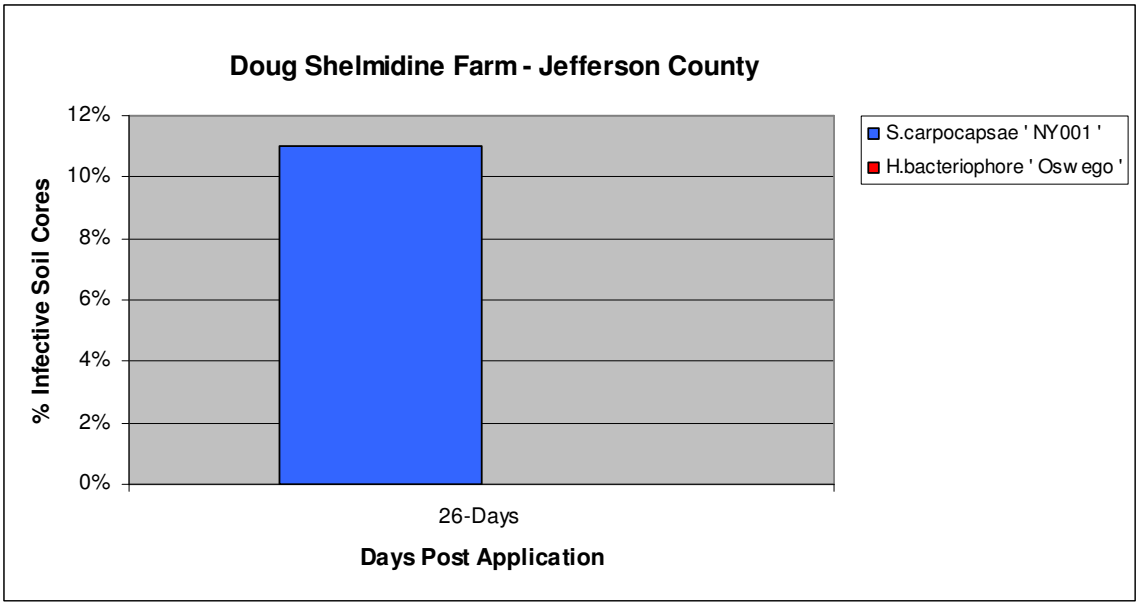


Figure 2 cont. Establishment of three species of bio-control nematodes using an eight foot hand boom with a high concentration of nematodes in water used as carrier.



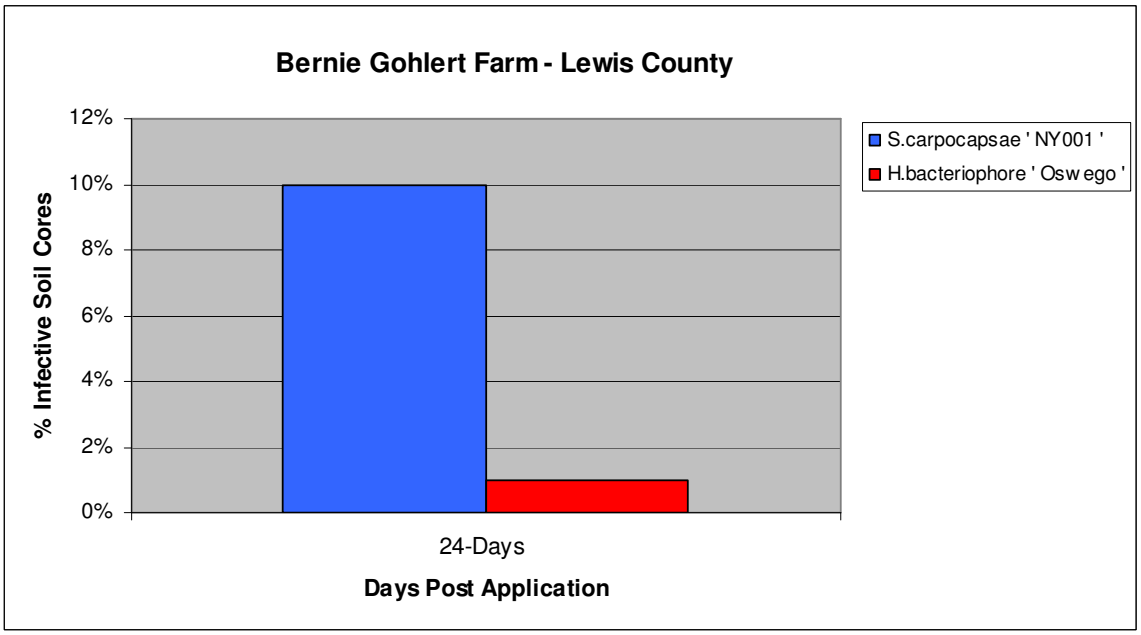
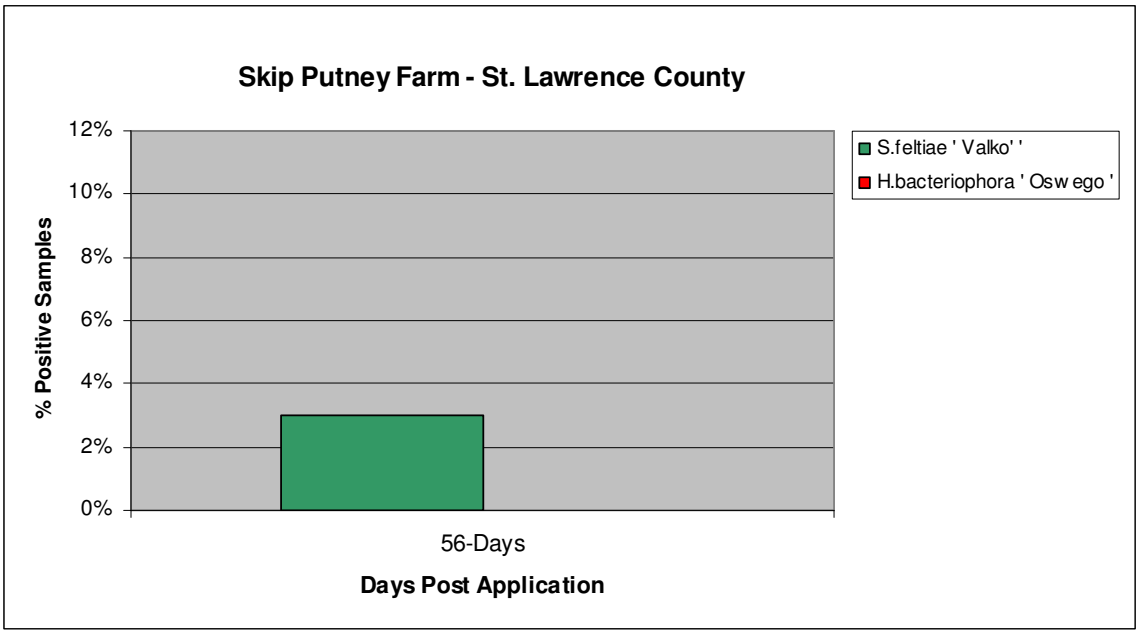
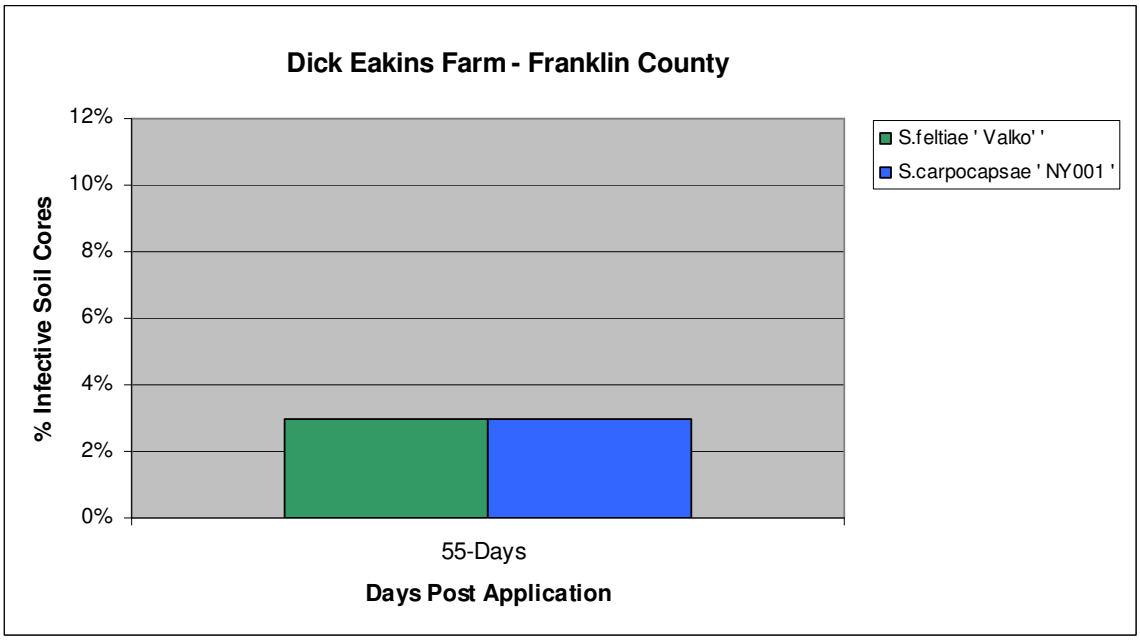


Figure 3. Establishment of bio-control nematodes using a low concentration of nematodes in a high volume of water applied through an eight ft boom mounted on a truck.





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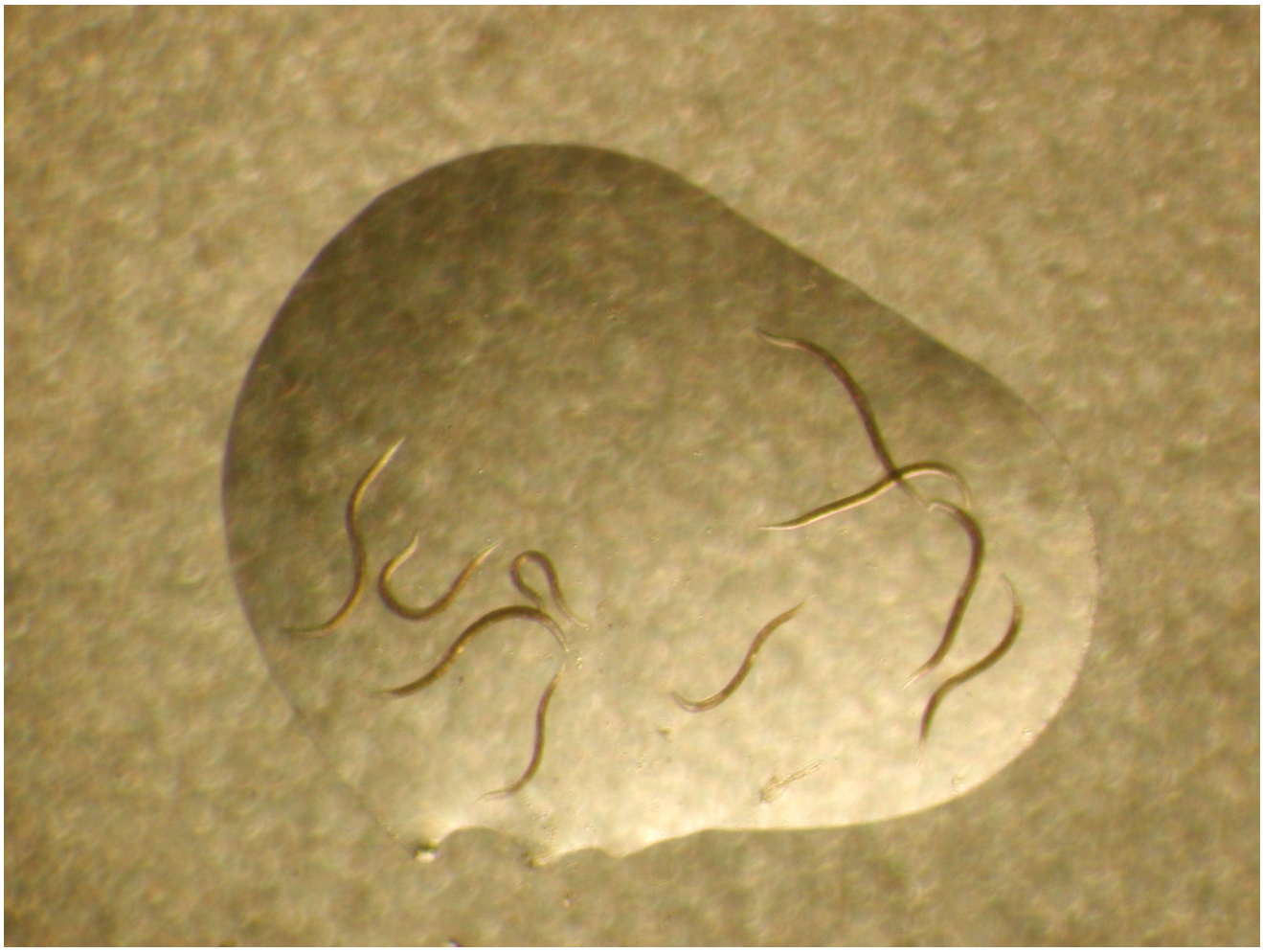

Picture of the infective stage of the alfalfa snout beetle bio-control nematode.

Field application of bio-control nematodes in a high concentration of nematodes per volume of water.