



## **Northern NY Agricultural Development Program 2004 Project Report**

### **Biological Control of Alfalfa Snout Beetle: A small-scale field trial**

#### **Project Leader(s):**

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#### **Collaborator(s):**

John Peck, Farmer, Great Bend, NY

#### **Background:**

Alfalfa snout beetle (ASB), *Otiorhynchus ligustica*, is the most destructive insect pest of alfalfa in Northern New York (NNY). Evidence strongly suggests that ASB was introduced in sailing ship ballast at the Port of Oswego between the 1850s and its discovery by a naturalist in 1896. Those 1896 collected insects are preserved in the US National Museum. Trading patterns suggest the origin of the US snout beetle population is England.

ASB was first identified as a problem insect when alfalfa was introduced into Oswego County, New York, in the late 1920s. By the early 1930s, snout beetle was found in approximately 3,000 acres in Oswego and Jefferson Counties. In the intervening years, snout beetle has spread into 500,000 acres of NNY cropland across nine counties and crossed the St. Lawrence River at Prescott, Ontario, Canada. Recently, a new infestation was identified in the Malone area and this insect continues to spread throughout NY's productive alfalfa region.

New infestations are often mistaken for winter injury since the majority of plants die after the last harvest and before spring growth. This pest causes severe yield and stand losses on alfalfa by larval feeding on alfalfa roots.

Extensive insecticide trials conducted in the mid-1990s indicated that this insect could not be controlled with the use of conventional insecticides. While the beetle is easily killed with insecticide, the non-feeding behavior of the beetle during egg-laying coupled with the dispersal behavior of the beetle during this same time period make it difficult to expose the beetle to insecticide applied to the foliage of the alfalfa plant. Insecticide applications to the surface of soil have short effective periods due to binding with organic matter or leaching due to rain.

To date, there are no effective methods of controlling or reducing the population of this destructive insect pest other than growing alfalfa on a 3 year rotation. Farmers have a difficult time accepting a 3-year alfalfa rotation due to the poor economics of the rotation.

Without the insecticide option to manage ASB, the choices are limited to:

- 1) do nothing,
- 2) stop growing alfalfa,
- 3) attempt to identify and establish biological control agents keeping this insect in check in its native home (Europe),
- 4) develop resistance varieties of alfalfa, and/or
- 5) identify exotic biological control organism which need frequent application as a bio-pesticide because of limited adaptation to survive in NNY.

This report covers progress investigating the natural biological control organisms controlling ASB in Hungary. Don Viands' 2004 NNYADP Project Report: Breeding Alfalfa Snout Beetle Resistant/Tolerant Alfalfa Varieties covers the efforts to locate potential resistance in the alfalfa gene pool and Janice Thies' 2004 NNYADP Project Report: Biological Control of Alfalfa Snout Beetle Using the Insecticidal Fungi *Metarhizium anisopliae* and *Beauveria bassiana* covers the exotic biological control efforts.

Entomopathogenic nematodes are effective natural biocontrol agents for soil insects. Soil surveys in Hungary in 2002 identified three different species of entomopathogenic nematodes (*Steinernema carpocapsae*, *S. feltiae*, & *Heterorhabditis bacteriophora*) present in areas where ASB was not an economic problem. Two of those species are present in NNY in isolated areas (*S. carpocapsae*, *H. bacteriophora*) while the third

species (*S. feltiae*) was absent. However, *S. feltiae* is present in other areas of the US in agricultural environments.

Field trials in NNY in the mid-late 1990s with *H. bacteriophora* 'Oswego' showed this nematode was an effective persistent biocontrol agent, but it needed some additional assistance from a second mortality source (resistant alfalfa or a second species of nematode) to improve effectiveness to an acceptable level.

The use of multiple nematode species to attack a single insect pest is discouraged in previous research on other soil insects due to the competition between the nematode species for the insect host. However, research in my laboratory indicates that the multi-species approach has promise with ASB since the ASB larvae occupy different depths of the soil profile during different times of the growing season and ASB larvae are slow developing, thus giving nematodes a wide window for attack.

All three nematode species have been shown to be effective on ASB in laboratory and greenhouse trials. The following field experiment was designed to test the multi-species approach in a real world setting.

**Methods:**

All field trials involving the control of ASB with mortality agents (chemicals, biocontrol agents or resistant plants) require 2-years. This unfortunate circumstance is imposed on us by the 2-year lifecycle of the insect.

Year 1 (2004):

A field trial was initiated on John Peck's farm in Jefferson County in a first-year production alfalfa field to test the effectiveness of various combinations of entomopathogenic nematode species on ASB. Eight different treatments of nematodes were applied to plots measuring 10' x 20' using a 10' CO<sub>2</sub> powered spray boom outfitted with fertilizer stream nozzles to apply the nematodes onto the soil surface through the alfalfa canopy. Each treatment was replicated four times (32 total plots).

The total nematodes applied per plot were equal to the standard application rate of 1 billion nematodes per acre. If two species of nematodes were applied to a plot, each species was applied at the rate of 0.5 b nemas/acre and if three species were applied to a plot, each species was applied at 0.33 nemas/acre. Nematodes were applied in early May, during the spring emergence and migration of the ASB adults.

Alfalfa and clover crown counts were taken in each plot after 1<sup>st</sup> cutting to establish the plant populations in each plot prior to ASB damage later in the growing season. Soil samples (10) were taken in each plot before nematode application to verify the absence of any nematodes prior to application. In addition, soil samples (10) were taken in each plot every two weeks to verify the successful establishment of nematodes in each plot and to track the population changes throughout the growing season as the nematodes recycled through available insect hosts located in each plot.

All soil samples were taken back to Cornell and bio-assayed for the presence of each nematode species in the soil samples. Each sample date required the collection and bio-assay of 320 individual soil samples. Soil sampling continued until mid-October. At this time, ASB larvae are beginning to finish their feeding and are beginning to move down through the soil profile to their hibernation/overwintering site which is located between 18"-24" deep. A total of 5,120 soil samples were collected and bio-assayed during the 2004 season.

Year 2 (2005):

The majority of research data is collected in year two of the study. Shortly after the alfalfa greens up in the spring, crown counts will be taken in each plot to document plant loss during the fall and winter. In addition, the plants from a section of each plot will be dug and the roots will be rated for ASB larval feeding damage. During the summer, 5 – 1 ft x 1 ft x 2 ft sections of the plot will be carefully dug, screened to separate the larvae and the surviving larvae will be counted. This portion of the study is very important and very labor intensive. The data collected will give direct information on the effectiveness of the treatment, and the number of ASB larvae surviving the biocontrol agents in each plot.

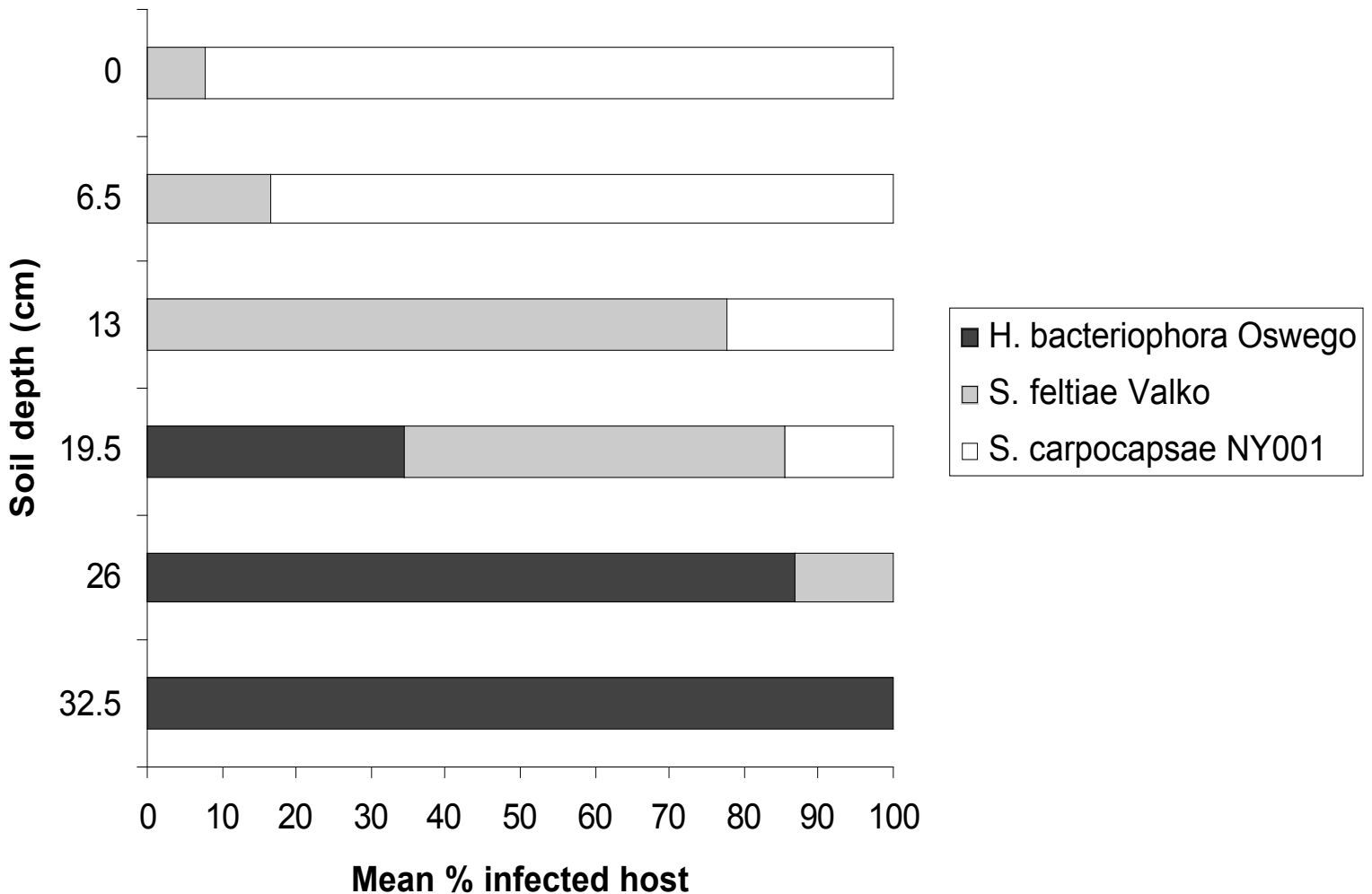
### **Results:**

The three species of nematodes used in this study partition the soil profile when the other species are present (Figure 1). As you can see, *S. carpocapsae* occupies the top layer, *S. feltiae* occupies the middle layer and *H. bacteriophora* occupies the lower layer of the soil profile. As the ASB adult pass through each level of the soil profile during spring emergence, summer-early fall larval development and larval movement down to the overwintering zone, the insect is exposed to each nematode species within their preferred soil zone. This ASB behavior and the nematode's partitioning of the soil profile is the reason we believe that combinations of nematode species will be more effective than a single species alone.

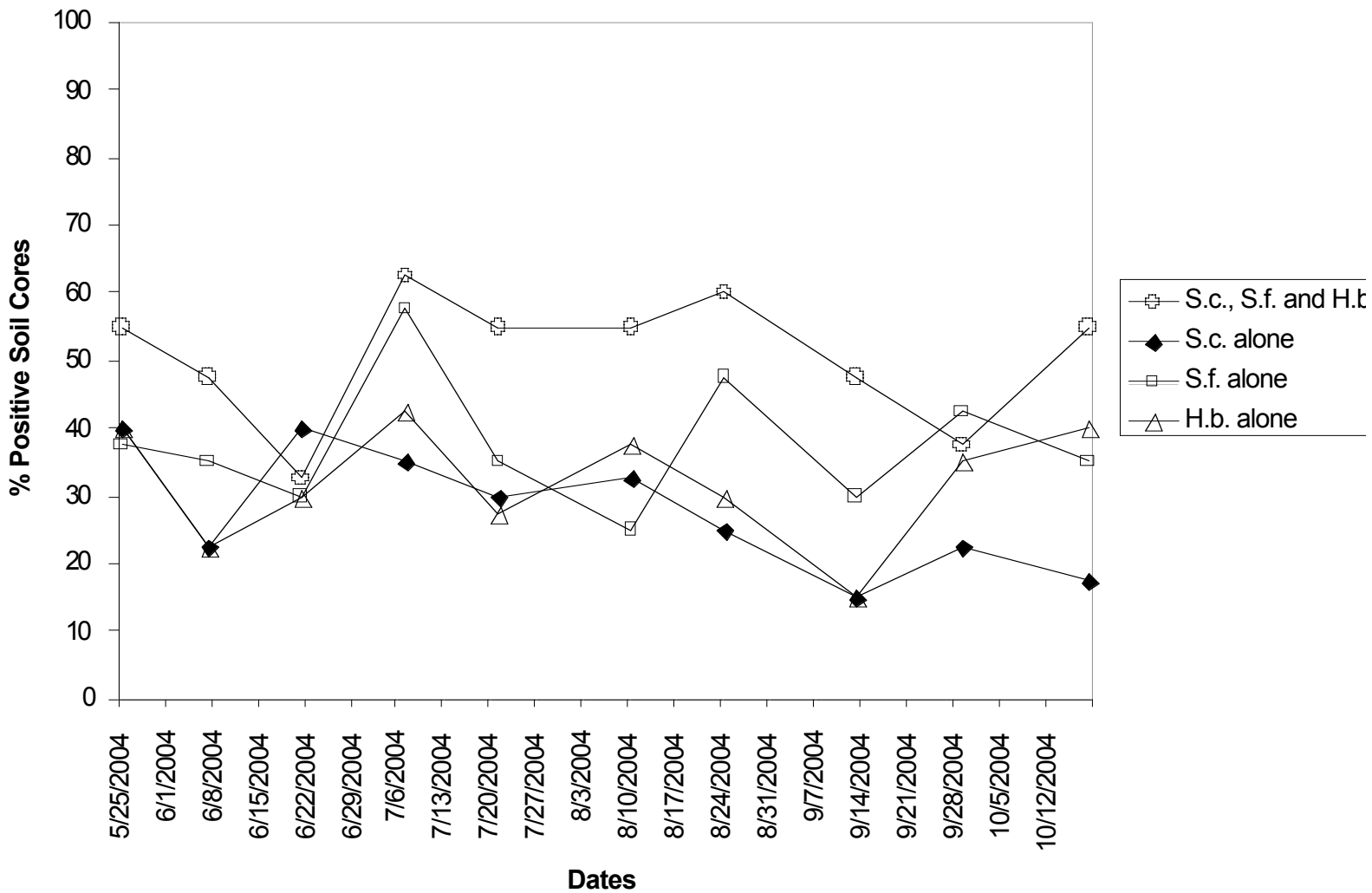
The research data collected in 2004 positively shows that the nematodes applied in early May became established in the plots. The data also shows the level of nematodes was maintained and increased in some plots during the growing season (Figure 2). The peaks and valleys in the nematode numbers indicate the nematodes are finding host, attacking hosts and maintaining or increasing their numbers. We were very excited to see the levels of nematodes higher in the 3-species plots than the single species plots. We are hopeful that this increased presence of nematodes will carry over into reduced levels of ASB damage and reduced numbers of ASB larvae surviving the presence of these nematodes in the soil profile.

The research data on the effectiveness of each of the treatments will be collected during the 2005 growing season.

**Figure 1.** Partitioning of the soil profile by the entomopathogenic nematodes, *Steinernema carpocapsae*, *S. feltiae* and *Heterorhabditis bacteriophora*. During the growing season, ASB adults and larvae move across this entire soil profile, exposing them to attack from all three species of nematodes.



**Figure 2.** The levels of nematodes in the soil during the growing season as expressed in the percent of the soil cores with nematodes present and capable of insect attack. Even though the same number of nematodes were applied to every plot, the plots with the 3 species had more positive soil cores which should correlate with a high level of nematode attack on ASB larvae and adults. The peaks and valleys in the nematode numbers indicate the nematodes are finding host, attacking hosts and maintaining or increasing their numbers.



**Conclusions/Impacts:**

At the mid-point in the field study, we feel the research holds a lot of promise. However, conclusions from the study cannot be drawn until the entire data set is collected. We should be able to draw significant conclusions for the 2005 report.

**Next steps if results suggest continued work is needed.**

The next logical step in this research is to reduce the number of treatments and increase the study to a 0.5 acre plot size. The expansion will do a better job to emulate a large field situation where ASB is moving in from one side of the field. It is a real possibility that the effectiveness of the biocontrol agents are being masked by the small plots size since ASB adults can become infected within a plot, walk outside the plot area and die some distance from the plot. A field trial on a much larger basis would minimize this effect. However, a significant increase in field trial size substantially increases the cost of the trial. The 2-major sources of cost increases will be nematode production prior to plot inoculation and labor. The large plot trial also has the potential of being a 3 year study depending on the magnitude of ASB invasion.

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**Northern New York Agricultural Development Program:**

The Northern New York Agricultural Development Program provided funding for this alfalfa snout beetle research project. The Northern New York Agricultural Development Program is a farmer-driven research and education program specific to New York state's six northernmost counties: Jefferson, Lewis, St. Lawrence, Franklin, Clinton and Essex.

Thirty-three farmers serve on the Program board led by Co-Chairs Jon Greenwood of Canton (315-386-3231) and Joe Giroux of Plattsburgh (518-563-7523). For more information, contact Jon, Joe or R. David Smith at 607-255-7286 or visit [www.nnyagdev.org](http://www.nnyagdev.org) # # #