Managing Strawberry Root Problems For Improved Profitability and Sustainability on NYS Berry Farms: Using Entomopathogenic Nematodes to Control Strawberry Root Weevil Complex

Laura McDermott[1], Elson Shields[2], Tony Testa[2], Lindsey Pashow[3], and Amy Ivy[4]
[1]Cornell Cooperative Extension, Eastern New York Commercial Horticulture Program, Hudson Falls, NY
[2]Cornell University, Department of Entomology, Ithaca, NY
[3]Cornell Cooperative Extension, Harvest New York Regional Agriculture Program, Malone, NY
[4]Cornell Cooperative Extension, Eastern New York Commercial Horticulture Program, Plattsburgh, NY

Strawberries, blueberries and raspberries are high value crops, with the cost of establishment ranging from $3,700–$8,500 per acre. Small fruit industry working groups have identified strawberry root disease complex, plant parasitic nematodes and soil insects as the biggest barriers behind weed control to continued success with strawberry production in the northeast United States. The inconspicuous nature of larval root feeding and its associated yield loss and plant death is often missed, or misdiagnosed as root disease, until large insect populations have developed and widespread crop losses are being suffered by the farmer (Figure 1). Root weevils have also been found in blueberry and raspberry plantings, but the extent of the problem in these crops is undocumented. The current lack of effective insecticides to control the weevil pests compounds the complex issue of root loss and related plant death. It is often difficult for farmers to separate the effects of insect damage from the very similar symptoms caused by a variety of nutrition/pathogens/pest issues. Successful management requires an integrated approach utilizing identification, education, recommendations and applications. This article explains a two-year study, supported by the New York Farm Viability Institute (NYFVI). The first goal of the study is to catalogue the soil-borne barriers in strawberry plantings showing poor vigor using a thorough survey of soil and plant tissue characteristics. Future articles in the Fruit Quarterly will detail those findings.

> **"The goals of this study are to catalogue the soil-borne barriers in strawberry plantings showing poor vigor using a thorough survey of soil and plant tissue characteristics (and)... to introduce native entomopathogenic nematodes to strawberry fields infested with root weevils."**

Figure 1. Strawberry field in northern NY. The middle of the rows at left show poor growth due to heavy infestation of black vine weevil. Rows at right are not infested and appear more vigorous with better spring regrowth. (Photo: A. Ivy).

Understanding weevil pests

The second goal of this project is to introduce native entomopathogenic nematodes to strawberry fields infested with root weevils. These nematodes parasitize certain soil insects. Significant progress has been made in the control of strawberry root weevil complex in those plantings where populations have been very high and insecticides are not effective. Root weevils are beetles in the snout beetle family in the genus *Otiorhynchus*. They are all serious pests of agricultural crops, and feed on the roots of over 100 different plants. They are difficult to control and manage, even with the use of soil insecticides. The three common root weevils affecting berries are rough strawberry root weevil, *O. rugosostriatus*, strawberry root weevil, *O. ovatus*, and black vine weevil, *O. sulcatus*. Black vine weevil has been a known pest of ornamental nursery plants for many decades.

All root weevils in the genus *Otiorhynchus* look similar in the adult form and as larvae. Adults are brown or black (Figure 2) and range from 0.2 inches in length (strawberry root weevil) to 0.4 inches in length (black vine weevil). The larvae are white or cream-colored and legless (Figure 3). The adults feed on foliage, and leaves a very distinctive half-moon chewing damage on leaves (Figure 4), while the larvae of all species feed on roots and actually cause the most damage. The adults reproduce parthenogenetically, meaning that virtually all of the adults are females. The elytra (forewings) are fused, leaving the adults flightless. This characteristic helps explain some of the tactical approaches to management. It also helps explain how the insects are moving from seemingly disparate strawberry production regions. It technically could take only the introduction of a single

insect to start a new infestation on a farm. This introduction can occur through potted nursery stock brought onto the farm, or shared farming implements, etc. Farms that have nursery stock as part of their retail offerings, or those that have strawberry fields in close proximity to nursery fields or retail nursery sales yards, seem more prone to having infestations. Weevil insects also tend to prefer sandy soils to heavier loam soils (Loeb 2007). It is really an issue of drainage, rather than soil type. Heavy soils with tile drainage also have problems.

Figure 2. Adult root weevil, *Otiorhynchus* sp.

Due to the secretive nature of the adults, which feed only at night, and the root feeding of the larvae, new infestations go unnoticed for several years until the population has grown large enough to cause dieback in significant portions of the berry planting. Soil insecticides do not eradicate the population, but repeated applications of insecticides are able to keep populations at a tolerable economic level.

Management using biocontrol

The use of native entomopathogenic nematodes that are able to overwinter in cold climates came to northern NY berry growers' attention because of a related *Otiorhynchus* species that attacks alfalfa in nine northern NY counties. Research and on-site application has shown that these nematodes can control devastating populations of the alfalfa snout beetle (*Otiorhynchus ligustici*) a close relative of the strawberry pest weevils. Over the past 25+ years, research has been focused on developing an effective biological control program for this insect using native persistent entomopathogenic nematodes isolated in NNY. The focus of this program was to develop a biological control program where entomopathogenic nematodes were introduced a single time for multiple year suppression of the alfalfa snout beetle. Techniques have been developed for farmers to rear their own nematodes and apply them through commercial spray equipment requiring only slight modifications. To date, approximately 14,000–16,000 acres have been treated with these native nematodes, which has resulted in control of the alfalfa snout beetle in northern NY.

Since the root weevil complex attacking berries is also known to be sensitive to entomopathogenic nematodes, research and extension efforts have broadened to crops attacked by black vine weevil and strawberry root weevil. In two northern NY farms, native entomopathogenic nematodes were introduced a single time, and they are persisting for multiple growing seasons, causing a decline of the root weevils to a sub-economic level. There is an important difference between the native entomopathogenic nematodes and the commercially available nematodes. The native nematodes are able to overwinter, requiring far fewer applications and resulting in a cost savings.

Research has shown that the native nematodes need to be applied only once, at a cost of $150/acre (producer-reared; $300/acre if purchased ready to apply), and they continually suppress the soil insect complex for many years. Subsequent research has shown the same strategy is effective against the root weevil complex in upland cranberry production, and is being tested against white grubs in both grapes and in turf. These successes encouraged the development of this research project in the berry production system.

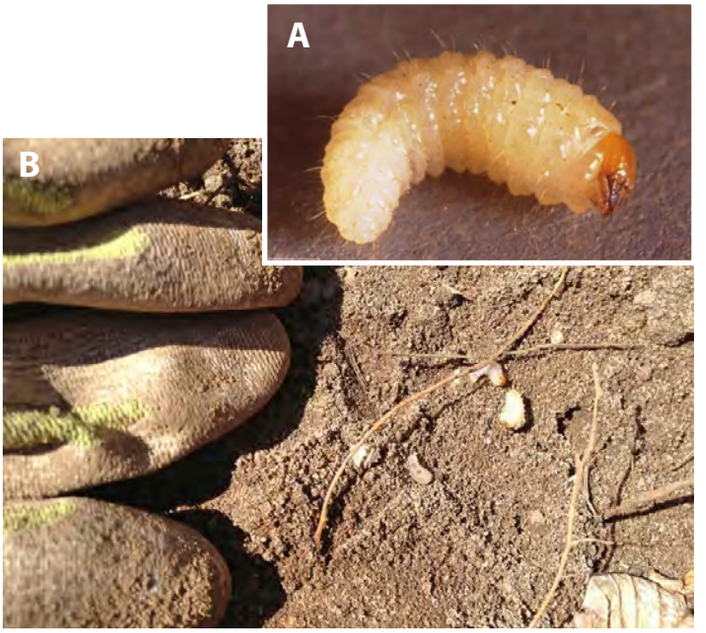

Figure 3. A, Root weevil larva; B, Glove tips (left) provide perspective on size of root weevil larvae (right) (Photo: A. Ivy).

Figure 4. Leaf notching done by black vine weevil adults (Photo: L. Pashow).

Application

The beneficial parasitic nematodes used in the berry farm applications were raised in Dr. Elson Shields' Cornell University laboratory, but a lab environment is not a requirement for raising these biocontrol agents. Several dairy farmers in northern NY have successfully raised their own nematodes for the purpose of controlling alfalfa snout beetle. The nematodes are introduced into cups of wax worms, which they promptly parasitize and are then able to reproduce. The cups of wax worms need to be kept at temperatures between 65–75°F for approximately 3 weeks. When juvenile infective nematodes emerge from the deceased wax worms, the field application process can begin. Mary DeBeer, a partner with her father Ronald in DeBeer Seeds and Spraying,

Figure 5. Extension Specialist Amy Ivy rinsing beneficial nematodes through a screen into a solution prior to field application (Photo: L. McDermott).

Figure 6. Evening application of insect-attacking nematodes to control black vine weevil larvae is made using boom sprayer with filters and screens removed from nozzles (Photo: L. McDermott).

Moira, NY, started a business raising the nematodes to make them available commercially to farmers that want to apply but not raise their own biocontrol agents.

The first application step is to screen the wax worms and media out of the nematode mix. This involves rinsing the substrate through doubled window screen, to wash the nematodes into a solution that will be applied to the field (Figure 5). The best results are achieved if application is in the evening, as this helps prevent nematode death from UV exposure from the sun and desiccation from warm temperatures. The nematode solution can be made using a normal, thoroughly rinsed, boom sprayer with all filters and screens removed from the nozzles. The grower in our demonstration left a control plot to gauge effectiveness against the nematode application site (Figure 6).

Scouting for root weevil infestations

Root weevil larvae are easiest to see in the spring. Adult root weevils can be present after harvest; however, traditional chemical control measures of the adults should be taken early, before egg laying begins in late spring. Eggs that were laid in the soil prior to or during harvest will hatch into young larvae that begin feeding on roots in the fall. Root weevil larvae overwinter 2–8 inches deep in the soil. You can scout for root weevil larvae in the fall, but they are even smaller than in the spring and very difficult to see. Black vine weevils (BVW) can be found throughout the state, while strawberry root weevil (SRW) has been found in the primary fruit growing regions and less consistently. Still, these pests seem transient. Ongoing surveys for root problems in strawberries has revealed inconsistent and unpredictable populations in eastern NY.

To scout for these pests, follow the protocol below:

- In the spring, watch for areas of weak growth. Dig in the root zones, checking for the white grub-like root weevil larvae.
- When weevil adults emerge, watch for leaf notching, especially on sucker growth near the ground.
- After dark on warm, calm nights, scout fields with a flashlight. Black vine and strawberry root weevils will be found feeding on top of the foliage.
- Look for adults in the dead plant material and weeds at the base of plants.
- In the fall, check areas that show weak growth and redden prematurely. The larvae can be found in the fall, but are much smaller than in the spring.

References

Loeb, G. 2007. Overview of the biology and management of root weevils. The New York Berry News online Newsletter. 5(11): 18–20.

Laura McDermott and **Amy Ivy** are Specialists with Cornell Cooperative Extension, Eastern NY Commercial Horticulture Program. **Elson Shields** is a field crops entomologist at Cornell University in Ithaca, NY, and **Tony Testa** is a research support specialist in Dr. Shields' program. **Lindsey Pashow** is an Ag Business Development and Marketing Specialist in the Harvest New York Program based in Northern NY.