White Grub Management in Blueberries

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Insects that feed on blueberry roots

The principal insects that feed on the roots of blueberry plants are white grubs, the larvae of scarab beetles. The adults of our most common scarabs: Japanese beetle, oriental beetle, European chafer, and Asiatic garden beetle, are easily identified. Japanese beetles have copper-colored wing covers, white patches of hair near the end of the abdomen, and a green head and prothorax. Japanese beetles feed extensively during the day. Oriental beetles are the same shape and are slightly smaller than Japanese beetles. They usually are a drab tan with darker brown splotches on the wing covers. Their color is variable though, and some are nearly black overall. Oriental beetle adults feed very little as adults. European chafers are the largest of these species. The adults have a roughly rectangular shape, are a yellowish brown, and do not feed. Asiatic garden beetles are a VW beetle shape and are a cinnamon-brown color. Adult Asiatic garden beetles feed extensively on foliage at night. The larvae of white grubs have six legs, which distinguish them from root weevils (See my article 'Black vine weevil management in strawberries'). Large numbers of white grubs can compromise the function of roots, which then leads to plant stunting, induced nutrient deficiencies, wilting, and occasionally plant death. Blueberry foliage is a favored food for adult Japanese beetles. Since Japanese beetles are active at the same time as when blueberries ripen, they can be a nuisance while harvesting, and become a fruit contaminant among mechanically harvested blueberries.

There are differences between these species that point toward oriental beetle becoming the dominant species in blueberry fields. Oriental beetles prefer laying their eggs in moist, high organic matter soil, which describes the environment of the mulch area around most blueberry plantings. Japanese beetles are very specific in requiring grasses to stimulate egg laying. Therefore, Japanese beetle grubs feeding on blueberry roots probably result from larvae moving from a grassy strip between blueberry rows, or from grassy weeds growing within the row. European chafer and Asiatic garden beetle preferences for egg laying habitat is not well known, but these species have not yet been implicated as being damaging to blueberries.

Being able to determine which species of larvae are feeding on your blueberry roots is important. Effective control measures may differ among these species, so an option for controlling one species may not work for controlling another. White grub larvae are identified by using a 10x hand lens to look at the shape of the anal slit and the pattern of bristles on the underside of the grub at its posterior end. Japanese and oriental beetle larvae resemble each other in size and in having a straight, transverse (side-to-side) anal slit. The pattern of bristles for Japanese beetle is shaped like a "V", whereas for oriental beetle the rows of bristles are arranged as two parallel rows. European chafer has a "Y" shaped anal slit and is larger than either Japanese or oriental beetles. Its bristles are arranged as parallel rows that diverge to form a "Y" at the end of the abdomen. Asiatic garden beetle larvae are the smallest of these species. The anal slit appears to be vertical, and the bristles form a crescent across the abdomen.

Monitoring methods. To determine whether your plantings have problems with white grubs, use a shovel to dig a square core of soil from within the root zone of the blueberry plant.

Sift through the soil with a trowel to observe how many larvae are present. If you cut a standard-sized core (e.g., a 6 inch cube of soil) and record your data, you can compare different areas of fields to each other, or compare one year to the next. I am not aware of economic thresholds having been established for white grubs on blueberries, so each grower has to correlate grub counts to loss of plant vigor. Obviously, this kind of sampling will injure the shrub to some extent, so limit sampling to a few shrubs per planting.

Control Strategies

Foliar sprays to kill adults. The only scarab species that feed on foliage to any significant degree are Japanese and Asiatic garden beetles. Foliar sprays may kill feeding beetles, but may not kill immigrating adults landing on the soil to lay eggs. This is especially true of Japanese beetles, which move from adult host plants to lay eggs elsewhere around grasses. Foliar sprays to kill adult scarabs may also kill beneficial insects and mites, making management of spider mites and aphid pests more difficult. In short, a foliar spray program to manage white grubs cannot be expected to be successful.

Chemical control of larvae in soil. Imidacloprid has an excellent 10-year track record for control of most species of white grubs in a number of different environments. The exception is Asiatic garden beetle, in which only about 50% mortality can be expected. To be effective, imidacloprid (1) must be applied to the soil at the time of adult flight or during the first larval instar, and (2) must be watered into the soil (because it breaks down quickly on exposure to sunlight). Before using imidacloprid, the yields from blueberries between 1993 and 1997 in NJ ranged from 3,890 and 4,550 lb/ac, with an average yield of 4,420 lb/ac. After the introduction of imidacloprid, yields in 1998 and 1999 (the only additional years for which I have data) increased to 4,800 and 5,200 lb/ac. This represents a yield increase of ~20% associated with white grub control.

In 2002, Connecticut followed New Jersey's lead in obtaining a Section 18 (emergency use exemption) for applying imidacloprid (Admire) for controlling white grubs in blueberries. In 2003, registration via a new Section 3 label was expected for blueberries, and a Section 18 for blueberries was not pursued. When the label was published, virtually every berry crop was included but blueberries. The inclusion of blueberries on the Admire label doesn't look as though it will be coming soon.

> "Blueberries have not yet been added to the Admire label. EPA temporarily withdrew consideration of establishing tolerances for imidacloprid on blueberry. As you know, use of imidacloprid on blueberry, and the Bushberry Crop Sub-Group was an IR-4 initiative and was to be included with all the minor-use crop tolerances that were approved this summer.
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> "According to EPA, the removal of blueberry from this package was because of negative comments received by the EPA from the Natural Resources Defense Council (NRDC) over a year ago. These comments related to concerns over children's safety that could be at risk with the Agency's issuance of a Section 18 exemption for the use of

imidacloprid on blueberry. Although EPA is working on satisfying NRDC's concerns, they have not been able to address all of them. Once this happens, the EPA will be able to establish tolerances and grant registration on blueberries. However, at this time there is no indication as when this is likely to occur."

Karen Cain, State Regulatory Affairs Team Lead, Bayer CropScience, 10/24/2003

Another controversial subject regarding the imidacloprid is its impact on pollinators. Sunflower growers in France claim that seed treatment of sunflowers with imidacloprid caused honeybees to become disoriented and to not return to hives. Also, Bayer removed pre-bloom uses of imidacloprid from tree crop labels to avoid bee toxicity and pollination problems. Controlled studies recently showed that foliar-applied residues of imidacloprid can interfere with bumblebee foraging behavior on clover, but imidacloprid washed into soil following foliar application (equivalent to a soil-directed systemic treatment) had no impact on their foraging or the health of the hive. The reasonable conclusion from these studies and from NJ blueberry yield data is that imidacloprid applied to the soil for control of white grubs is safe with respect to pollinator behavior.

Biological control to suppress larval populations. Please read the abstract for 'Black vine weevil management in strawberries' for more information on the biology of insect pathogenic nematodes. Biological control of white grub larvae with insect pathogenic nematodes (EPNs) is not likely to be as effective an option as it has been for control of root weevils in strawberries. White grubs have many defenses against infection by insect pathogenic nematodes, including structures that protect against entry of nematodes into their spiracles (the openings to their respiratory system), a high defecation rate, which prevents nematodes from entering through the anus, and grooming behaviors that remove nematodes.

Species of nematodes belonging to the genus *Heterorhabditis* are claimed by their producers to be able to infect white grubs, because they possess a tooth that can permit direct entry through soft cuticle. Laboratory and field studies demonstrate that infection with *Heterorhabditis* species is possible, but the dosage of nematodes required to overwhelm the grubs' defenses is too high to allow cost-effective use of these nematodes against white grubs. Furthermore, species of white grubs vary in their susceptibility to infection by nematodes. Japanese beetle is relatively easy to infect with *Heterorhabditis* spp., oriental beetle and Asiatic garden beetle are fairly difficult, and European chafer is nearly immune to infection.

One potential solution for using insect pathogenic nematodes would be to find a species that is more virulent to white grubs. This would permit application of fewer nematodes to effect control. Albrecht Koppenhöfer, at Rutgers University, found a species now named *Steinernema scarabaei* that is exceptionally virulent to all our non-native species of white grubs, but surprisingly is relatively ineffective against the native northern masked chafer. This species can provide exceptional control of oriental beetle in blueberries, but is not yet available commercially.

Two other factors may affect how well insect pathogenic nematodes may work in blueberries. (1) The root system of blueberries is quite deep, so nematodes would have to move

through a larger volume of soil, and into deeper, cooler soil, to contact the entire white grub population. Trials of nematodes with deeply rooted crops generally have had poor results. (2) The soil needs to be maintained with moderate moisture to permit nematode migration to hosts. Blueberries are often irrigated with a drip system, which may provide too uneven a distribution of water to permit optimal nematode dispersal. Nematodes should not be applied through drip irrigation (because they settle in the tubes). If overhead irrigation is not available, application of nematodes has to be done in the rain to guarantee that they have an opportunity to move into the soil.

Pheromones and white grubs. Sex attractant pheromones have been identified for both Japanese beetles and for oriental beetles. For both of these species, females produce a chemical odor that attracts males from a distance. Males fly upwind during the day within an odor plume to contact its source (the female), whereupon they mate. With Japanese beetles, this sex pheromone can be combined with floral attractant odors, so that both males and females are captured in traps. Do not use Japanese beetle traps in plantings where you want to eliminate their populations. Japanese beetles are behaviorally programmed to land on any edible foliage while flying in an upwind flight to the floral attractant odors. If they start eating this foliage, this becomes increasingly attractive for other beetles to land in their proximity. Yes, you may catch beetles in the trap, but you'll also end up with increased feeding activity of beetles in foliage anywhere downwind of the trap!

Feeding attractants are not known for oriental beetles, so the attractant used for this species will only trap males (to monitor the population levels). The pheromone has also experimentally been applied in a microencapsulated formulation and in dispensers over test areas to determine whether mating can be disrupted. Male beetles flying in an area with lots of pheromone are unable to home in on an authentic calling female, and the two sexes cannot mate. Trials in 2003 (in New Jersey) demonstrated dramatic reductions in larval counts in areas treated with oriental beetle pheromone. Mating disruption has a higher chance of success with oriental beetle than with Japanese beetle, because oriental beetles tend to lay eggs close to where they emerge as adults. Therefore, this minimizes the chances that mated females will fly in to lay eggs in a blueberry planting from surrounding areas. However, in a drought situation, female oriental beetles will travel some distances to lay eggs where there is adequate moisture, and we can anticipate greater problems with the mating disruption technique during dry summers.

Summary

There is currently an unfortunate situation for blueberry growers in which we know that white grubs are damaging, we know how we may be able to manage their populations, but the tools are currently unavailable for effecting control. A Section 18 registration for Admire might be possible, but if NRDC's concern is related to excessive residues in fruit, then the US EPA cannot grant a tolerance and the Section 18 becomes unavailable. The nematode option would be an excellent and possibly long-term solution for white grub problems, but the inability of researchers to mass-produce this nematode puts this out of reach. Pheromone disruption of oriental appears to be the most accessible option if a manufacturer produces dispensers for this material. Removable pheromone dispensers (like twist tie formulations used to control codling moths) are exempt from EPA registration. The mating disruption strategy, however, would probably only be practical where oriental beetle is the dominant white grub species.