Exploring Biocontrol of Annual Bluegrass Weevil

Rutgers University scientists investigate if insect-parasitic nematodes can provide biological control of this serious insect pest.

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Above: The annual bluegrass weevil, *Listronotus maculicollis* (formerly called Hyperodes), principally feeds as larvae on annual bluegrass. Adults mostly overwinter in protected areas along the edge of woods or in the rough.

Left: With two to three generations per year, this weevil can build to astonishing populations (small patches may reach 1,200 larvae per square foot) that can stress or kill annual bluegrass in greens and fairways.

OBJECTIVES

- Conduct surveys for entomopathogenic nematodes in annual bluegrass weevil (ABW) infested areas and adult annual bluegrass weevil hibernation sites on golf courses.
- Determine the virulence to annual bluegrass weevil of entomopathogenic nematodes in laboratory bioassays.
- Determine the field efficacy of promising entomopathogenic nematodes.

Start Date: 2006

Project Duration: Three years

Total Funding: $69,532

The annual bluegrass weevil, *Listronotus maculicollis*, formerly "Hyperodes weevil," is a serious and expanding pest of close-cut annual bluegrass on golf courses through much of the Northeast. At the latitude of New Jersey, adult annual bluegrass weevils emerge from overwintering sites in leaf litter and tall rough in early April and migrate to short mowed turfgrasses (greens, tees, fairways) to feed and mate. Females lay eggs directly into the stem of the turfgrass plant from late April through May.

The young larvae are initially stem borers, feeding internally on the plant, ultimately tunneling through the crown and destroying the turfgrass plant. Later instars feed externally on crowns and roots, which leads to the most extensive turf loss, typically around early to mid-June. Damage caused by the second and third generations is usually less severe and more localized as peak larval densities tend to be lower than in the first generation.

Two species of entomopathogenic nematodes (EPNs), *Steinernema carpocapsae* and *Heterorhabditis bacteriophora*, were found regularly infecting annual bluegrass weevils in golf course fairways not treated with insecticides for weevil control. Endemic EPN populations were capable of reducing a single weevil generation by up to 50%. However, the density of EPNs and

Above: Over the past few years, the annual bluegrass weevil has become one of the most difficult insect pests to manage on golf courses.

Right: Entomopathogenic nematodes are microscopic roundworms found in the soils of most ecosystems. They attack insects by entering through natural openings or in some instances directly through the insect's cuticle. Once inside the insect's body cavity, entomopathogenic nematodes release symbiotic bacteria that assist in killing the insect, usually within 48 hours.

their impact on weevil populations were negatively affected by extreme environmental conditions (e.g., low soil moisture, high temperatures). Therefore, EPN populations will need to be augmented to provide more consistent control of annual bluegrass weevil populations on golf courses.

The virulence of commercial and endemic strains of EPNs to annual bluegrass weevil larvae and adults was examined in the laboratory. Moderate levels of adult control (50-60%), even under optimal laboratory conditions, suggest that the adult stage is a poor target for EPN. Conversely, fourth and fifth instar larvae were highly susceptible to nematode infection (65-100%) in field-infested turf cores in the laboratory. *Steinernema feltiae* and *S. carpocapsae* provided the greatest level of control to both stages of the insect (>90%). Because control decreased between fourth and fifth instar stages, timing of applications in the field is likely to affect the level of control.

Multiple field trials have been conducted with endemic strains and commercial EPN products against first generation annual bluegrass weevil immature stages between 2005 and 2008. No significant differences in efficacy or persistence were detected between commercial and endemic EPNs. Standard rates (1 billion infective juveniles per acre) of *S. feltiae* and *S. carpocapsae* provided over 85% control against low to moderate weevil densities (20-40 per square foot). In the 2007 but not in the 2008 trials, treatments consisting of combinations of species and applications split into half doses applied in consecutive weeks provided higher levels of control than the 1 billion infective juveniles per acre rate alone. Overall, control levels were inconsistent, with the most consistent result observed with *S. carpocapsae*. Nevertheless, there is evidence for potential high levels of control with several species of EPNs when applications are timed appropriately. Products based on *Steinernema feltiae*, *S. carpocapsae*, and *Heterorhabditis bacteriophora* have been chosen for closer examination since they have provided at least 70% control in past field trials.

The inconsistent control levels are likely due to numerous abiotic (e.g., weather, soil type) and biotic (e.g., EPN formulation, nematode persistence, annual bluegrass weevil density) factors. Another year of field trials will be conducted to solve some of the inconsistencies in control of annual bluegrass weevils with EPNs.

SUMMARY POINTS

- Entomopathogenic nematodes can provide significant control of annual bluegrass weevil larvae. However, in field trials, control has been inconsistent between years.
- The level of suppression achieved in the field is likely affected by factors such as nematode concentration, annual bluegrass weevil larval densities, and timing of application.
- An additional field season should help clarify the effects of application timing and concentration and annual bluegrass weevil density on the ability of nematodes to suppress annual bluegrass weevils below damaging thresholds.

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CONNECTING THE DOTS

An interview with Drs. Albrecht Koppenhöfer *and* Benjamin McGraw *regarding their work with biological control of annual bluegrass weevils.*

Q: *How does your work with ABW integrate into the overall strategy of the Northeast Regional Hatch Project 1025, which is investigating anthracnose and annual bluegrass weevil damage of annual bluegrass? Are you participating with other northeastern universities in any cooperative projects?*

A: A major objective of the regional project is to find alternatives to synthetic pesticides, and nematodes are alternatives that could be applied on a curative base. Another objective is to reduce pesticide use in general. We are also working on developing better tools to predict if and where ABW larval densities may warrant control. If we can optimize both nematode efficacy and prediction tools, it would be possible to not only drastically reduce the need for applications, but also use a biological control agent for the remaining treatments. This could increase the impact of naturally occurring ABW natural enemies, which in turn might decrease the need for applications. And, yes, we have been cooperating with Drs. Vittum (U.Mass.) and Cowles (U.Conn.) on some aspects of the nematode work and developing better ABW sampling techniques.

Q: *Some researchers have reported that ABW can also feed on bentgrass. Have you ever seen this in your work with ABW?*

A: We have not conducted specific feeding studies, but we certainly find the rather immobile ABW larvae in patches of pure creeping bentgrass. Our work on ABW ecology and monitoring suggests that mowing height may be a more important factor than grass species in determining where the females lay eggs. But we also found that creeping bentgrass can tolerate several times higher ABW larval densities than annual bluegrass. Therefore, damage appears much earlier in annual bluegrass, which could be erroneously interpreted as host preference.

Q: *For years, the standard method for controlling ABW was a pyrethroid insecticide application in early spring, as the adults are migrating from their overwintering sites. Isn't this still the main control strategy, and is it still effective in controlling ABW?*

A: Preventive broadcast sprays of pyrethroids are still the main control strategy and probably still work in most cases. There is, however, increasing evidence for pyrethroid resistance in ABW populations, and continued overuse of this chemical class will only exacerbate the problem. There are some very effective newer insecticides from different classes (Acelepryn, and anthranilic diamide; Provaunt, an oxadiazine; Conserve, a spinosyn), but there is also some limited evidence that pyrethroid-resistant ABW are less susceptible to some of these products. Rotation of insecticide classes is a good tool for resistance management, but reducing insecticide use to what is really necessary in time and space is just as important.

Q: *It would seem that the use of entomopathogenic nematodes (EPNs) to control ABW would need to be very target oriented. To what extent does this control strategy require timely scouting and accurate record keeping by superintendents?*

A: Because of their relatively short residual, nematodes have to be applied in a curative mode, ideally when the majority of ABW larvae are in the third and fourth stage. Earlier, too many larvae would still be protected from nematode attack inside the plants, and later would increase the risk of grass damage. This seems to coincide quite closely with full to late bloom of the popular hybrid rhododendron *Rhododendron catawbiense*. Superintendents should keep records of where they have had ABW problems. Then they could start scouting for ABW larvae in at-risk areas just before full bloom of the hybrid rhododendron and apply nematodes (or other curatives) when they start seeing significant numbers of larvae in the soil.

Q: *How long is the migration period of ABW adults from overwintering sites, and does an extended migration period cause problems in trying to contol this pest? Are there degree-day models for ABW to help predict the optimum application period for insecticides, as there are for other turfgrass pests?*

A: We typically detect the first adults emerging on fairways around early April in northern New Jersey. Our studies, along with other independent studies throughout the Northeast, have detected a bi-modal emergence of adults. Our first peak occurs around the third week of April and the second peak in the first week of May, suggesting at least three weeks of significant emergence. However, the duration of emergence or adult movement is likely to be affected by temperature, and it is possibly confused by the distance between overwintering sites and short-mown playing surfaces. Control may be less than optimal if action is taken against the first wave of adults, especially if the product used has a short residual.

Degree-day models for ABW have been examined in at least three separate studies, with each study using slightly different methodologies and arriving at different degree accumulations for predicting development. In our studies in New Jersey, calendar date rather than degree-day accumulation seemed to be the better predictor for ABW development. Incorporating other variables in addition to temperature could increase the accuracy of degree-day models for population development. Nonetheless, superintendents should scout or monitor population development, so that population density and development are weighed before action is taken, rather than applying solely based on calendar date.

Q: *Albrecht, you've done some excellent work with EPNs to control white grubs (e.g., larvae of scarab beetles). How much does the research with EPNs and ABW parallel the white grub work, and how has it differed substantially?*

A: With ABW, hardly any work has been done before, and we had to essentially start from scratch. Accordingly, for the virulence/efficacy studies, we have primarily used commercial nematode products, no different from what a superintendent would be using. White grubs, on the other hand, are among the best studied targets for EPN. Accordingly, my white grub studies were more in-depth, isolating and developing new and better EPN species and developing more effective ways of using them.

Q: *If superintendents are to rely solely on EPNs to control ABW larvae (and perhaps white grubs), is it reasonable to expect "boom and bust" cycles so typical of predator-prey populations in nature?*

A: This could well happen if they would rely solely on natural EPN populations, and our studies of interactions between natural EPN and ABW populations suggest that natural EPN cannot be relied upon to prevent turf damage by ABW. But "boom and bust" is irrelevant for inundative applications of EPNs for curative ABW control.

Q: *Currently, how many species of EPNs are commercially available, and how well do EPNs fit into an IPM approach that may involve chemical pesticide use?*

A: There are at least seven species available in the USA and a few additional ones in other countries. EPNs fit very well into IPM in general, as they have no negative effects on other insect natural enemies. There are some chemicals that need to be applied several weeks earlier or later than the nematodes (obviously nematicides), but most can be applied at the same time, and some are even tank-mix compatible. Several chemicals have been shown to interact synergistically with EPN on the mortality of some insect pests, in particular imidacloprid (Merit) and chlorantraniliprole (Acelepryn) with EPNs for curative white grub control.

Jeff Nus, Ph.D., *manager, Green Section Research.*