Entomopathogenic Nematodes Control Annual Bluegrass Weevil

By Benjamin A. McGraw and Albrecht M. Koppenhöfer

The annual bluegrass weevil (*Listronotus maculicollis*, formerly *Hyperodes maculicollis*) (ABW) is a pest of golf course turf in the northeastern United States and eastern Canada. Damage caused by larval feeding is most apparent on short turf (<0.5"), and can be extensive in turf stands with high percentages of annual bluegrass (*Poa annua*). The predominant management strategy is to target overwintered adults as they appear on the playing surfaces in spring. If adult populations go uncontrolled, mated females will deposit eggs between the leaf sheaths of the turfgrass plant. Upon hatching, young larvae bore into the plant, and feed relatively protected from most chemical insecticides. Older larvae (3rd through 5th instars) emerge from the plant to feed externally on crown, and thus cause the most severe turf loss.

Due to the low tolerance for ABW damage to high-valued turf areas and the inability to effectively control the larva once inside the stem, superintendents may make several preventive chemical applications against emerging adults. However, the over-reliance on and overuse of insecticides, particularly of the pyrethroid class, has led to the development of pesticide-resistant populations on many golf courses. The reliance on preventive chemical insecticides and the possibility of the development of resistant populations has increased the need for less toxic and more sustainable approaches to controlling ABW.

We sought to determine if ABW populations are impacted by natural enemies (e.g.

Damage caused by larval feeding is most apparent on short turf.

Two species of entomopathogenic nematodes infect annual bluegrass weevil larvae in fairways and can reduce a weevil generation by 50 percent.

PHOTOS COURTESY: BEN MCGRAW, PH.D.

pathogens, predators, parasites) residing in the golf course environment, and, if so, whether the natural enemies could be isolated and applied as biological control agents. In 2005, entomopathogenic nematodes (EPNs) were found infecting ABW larvae and pupae on several fairways in a statewide survey of New Jersey golf courses. EPNs are microscopic, insect-parasitic roundworms that have an infective juvenile (IJ) stage capable of locating and infecting soil-dwelling insects. Further studies conducted on three golf courses in New Jersey indicated that two species [*Steinernema carpocapsae* (Sc) and *Heterorhabditis bacteriophora* (Hb)] regularly infect ABW larvae in golf course fairways and can reduce a single weevil generation by up to 50 percent.

The objective of this study was to determine if EPNs could be applied to turf to reduce ABW densities below damaging levels. We screened commercially available species in the laboratory against different ABW stages and followed these studies with multiple field trials to assess their efficacy under field conditions.

Laboratory screening

Five commercial EPN strains supplied by Becker Underwood (Sussex, UK) [Sc, *Steinernema kraussei* (Sk), *S. feltiae* (Sf), Hb and *Heterorhabditis megidis* (Hm)] and two native strains [Sc (PB) and Hb (PB), isolated from infected ABW larvae and pupae found in fairways] were tested in laboratory trials.

Adult susceptibility to EPNs was low to moderate (11–65 percent mortality) even under optimal laboratory conditions and at a high EPN rate. Therefore, EPNs do not show promise for the preventive control of ABW. However, larvae were moderately to highly susceptible to EPN infection, with fourth instars tending to be more susceptible than fifth instars. Despite high ABW densities in the laboratory trials (~80/ft^2), high control rates of fourth instars were observed for the commercial strains of Sf (89 percent) and Sc (81 percent) with somewhat lower rates for Sk (72 percent) and Hm (69 percent). Native and commercial nematode strains did not differ significantly in virulence to any ABW stage tested. These observations suggest that EPN field applications should be targeted against the early fourth instars to maximize control rates and minimize the potential for turf damage.

Field trials

Field trials were conducted in 5x6-foot (2.78-square-meter) plots on golf course fairways, arranged parallel to the edge of the rough-fairway border. Application times were based on peaks in larval densities estimated by weekly core sampling in adjacent plots and timed to target the larval population entering the soil (early peak in fourth instars). Nematodes, either reared in the laboratory (native strains) or formulated commercial product, were suspended in water and applied with watering cans followed by a rinse for a total of 0.125 in (3.1 mm) of irrigation.

In 2006, high levels of ABW control (63–94 percent) were observed with rates of 1 billion IJs/acre (standard EPN field rates) to moderate ABW infestations (~ 25/ft^2). Sf provided the greatest control (94 percent) but was not statistically different from the other treatments (Figure 1).

The 2007 field trials included an additional commercial strain (Hb) and two application rates (1 and 0.5 billion IJs/ac) for each species. Trials were conducted on fairways where the larval densities in the untreated control plots (>65 larvae per square foot) exceeded commonly accepted thresholds for damage (>40 larvae per square foot). Though higher EPN application rates led to greater control

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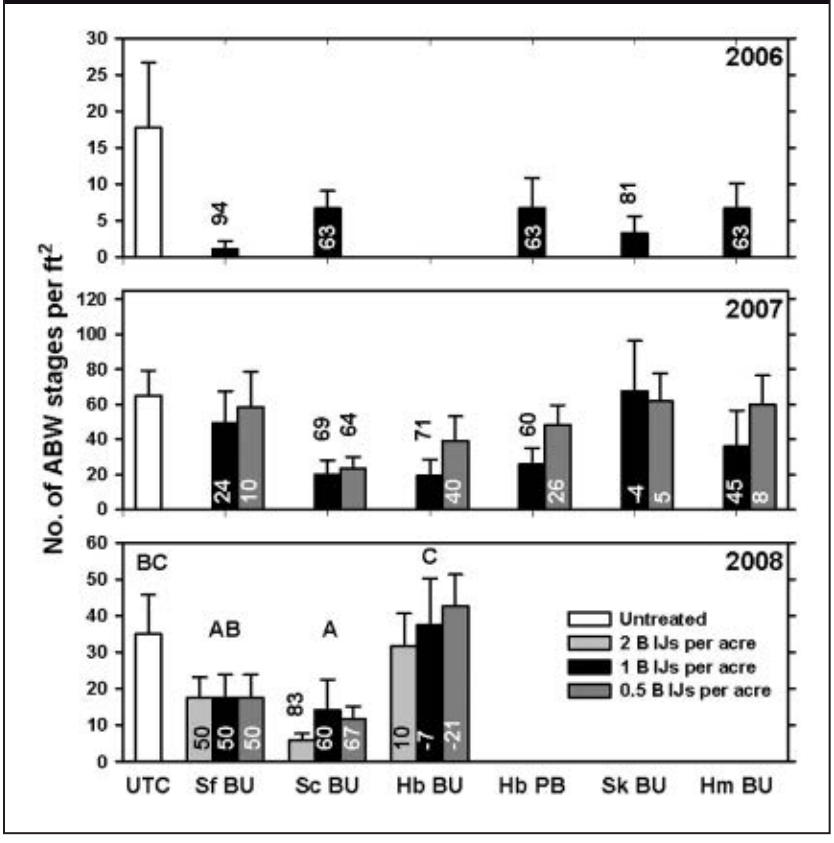
FIGURE 1: EPN IMPACT ON ABW DENSITIES



Effect of EPN species/strain and application rate on ABW densities. Numbers above or within columns indicate percent reduction relative to the density in the untreated control. Letters above columns (2008) indicate significant differences (Tukey's pairwise comparison test, P<0.05) between EPN species when all rates were combined.

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in most instances, control was more variable (0–71 percent) than in 2006, and likely attributable to higher ABW densities. Between the two application rates, Sc provided the most consistent control (64–69 percent).

In 2008, the previous top-performing species (Sf, Sc and Hb) were tested at three application rates (2, 1 and 0.5 billion IJs per acre) to intermediate ABW densities (~ 35-40 ABW/ft^2). Sc provided the highest and most consistent control (60–83 percent), however, without clear dose effect and not significantly better than Sf.

Conclusions

Our findings in laboratory bioassays and evidenced in select field trials suggest that ABW larvae are very susceptible to several commercially available EPNs and that curative control of ABW with EPNs may be feasible.

Our results indicate that Sc and Sf could provide control comparable to chemical insecticides (>80 percent) when applied at standard rates (1 billion IJs per acre) to moderate larval densities. Although each species demonstrated the capability of high control in the field, the range of control (Sf = 10–94 percent; Sc = 60–83 percent) is currently far too variable for reliable use on valuable turf. Additionally, we observed a significant decrease in susceptibility between fourth- and fifth-instar ABW larvae in laboratory bioassays, which may indicate that the application of nematodes must be precisely timed to achieve high levels of control. Future studies will investigate the role that pest density and application timing have on control levels to reduce the variability in control.

Dr. Ben McGraw is an assistant professor in the Department of Golf and Plant Sciences at the State University of New York (SUNY) at Delhi, NY. Dr. Albrecht Koppenhöfer is a professor and turfgrass extension specialist in the Department of Entomology at Rutgers University in New Brunswick, NJ. Reach McGraw at mcgrawba@delhi.edu.

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