Advancing integrated management of annual bluegrass weevil

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Turfgrass and Environmental Research Online
Volume 13, Number 2 | March-April 2014

Objectives:

The overall goal is to develop a basis for more effective and sustainable methods for ABW management. This will be achieved through the following objectives:

1. *Determine tolerance/resistance to ABW larval feeding of bentgrass spp. and cultivars.*
2. *Develop effective and practical monitoring methods for ABW.*
3. *Develop alternatives to chemical insecticides for curative control of ABW larvae.*

Annual bluegrass weevil (ABW) is a serious and expanding pest of short cut turfgrass. *Poa annua* is considered to be the most suitable host plant for ABW and/or particularly susceptible to larval feeding, based on observations that severe damage is commonly occurs in areas with a high percent of *P. annua*. Clear evidence of bentgrass resistance or tolerance to ABW was obtained in our studies in 2011-2012: compared to P. annua bentgrasses were 1) less suitable and non preferred for oviposition; 2) less suitable for larval development; 3) could tolerate higher larval densities with less visible damage. However, females laid eggs in the bentgrasses even if *P. annua* was available, and ABW developped from eggs to pupae on all bentgrasses tested. Among all tested bentgrasses, creeping bentgrasses were most resistant and tolerant to ABW.

It is likely that grass is exposed to cumulative effects of adult and larval feeding and oviposition in the field. Thus, in a 2013 greenhouse experiment, three different adult densities were introduced in the pots with 8 bentgrass cultivars (3 species) and *P. annua*. Adults were removed after 1 week and pots remained in the greenhouse for larval development. Grass responses (quality and damage ratings) to ABW feeding were recorded for 4 weeks. Grass leaves and stems were clipped, oven dried and silicon and fiber content analyzed. Results of the 2013 experiment were consistent with our previous findings. *Poa annua* sustained significantly more damage than any of the tested bentgrasses (Figure 1). In the pots with *P. annua*, damage ratings ranged from 70 to 93% at the lowest and the highest densities, respectively. In contrast, even for most susceptible bentgrass (colonial ´Capri´ and ´Tiger´ and velvet ´Villa´ and ´Greenwich´) damage ratings were at most 24% and 40% at the lowest and the highest densities, respectively. Low damage ratings (on average < 20%) were observed in creeping bentgrasses (cvs. ´Penncross´, ´Declaration´ and ´007´) even with the highest adult densities. Silicon and fiber content of leaf and stem tissue did not correlate with the

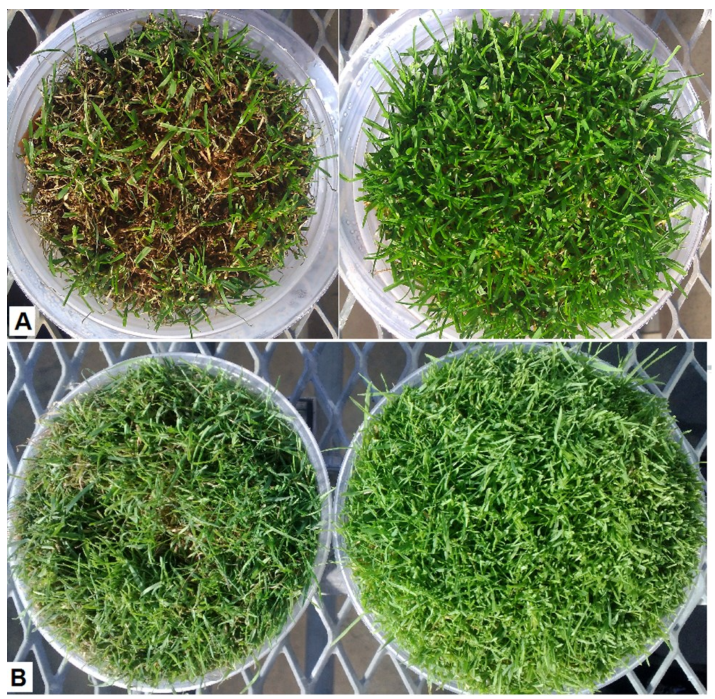

Figure 1. Cumulative damage 4 weeks after adult introduction at the highest ABW density (12♀ and 12♂) (left) compared to control (right) in *Poa annua* (A) and creeping bentgrass cv. ´Declaration´ (B).

TERO Vol. 13(2):42-43 | March-April 2014
USGA ID#: 2013-15-476
TGIF Number: 240138

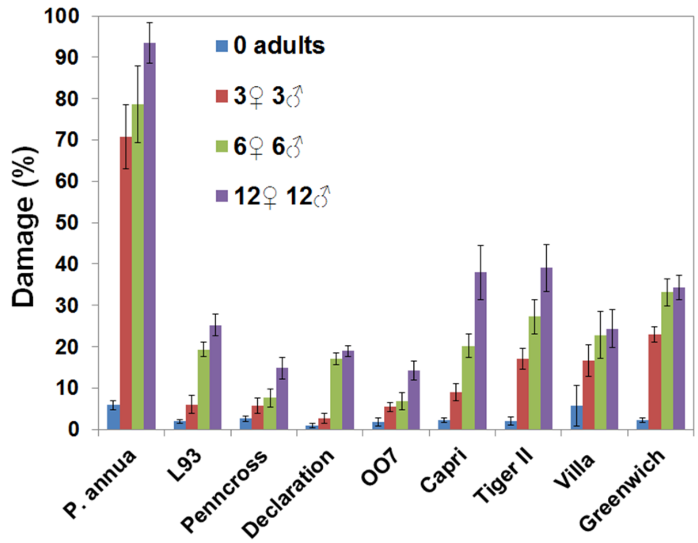

Figure 2. Tolerance of three bentgrass species (8 cultivars) to the cumulative effect of oviposition and adult and larval feeding at three different densities.

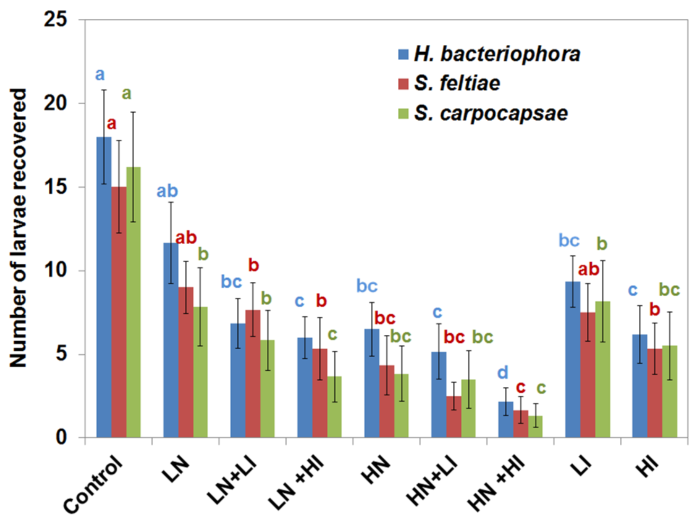

Figure 3. Efficacy of three nematode species (N) and imidacloprid (I) and their combination at high (H) and low (L) rates against late instar ABW larvae in greenhouse assays.

larval stages recovered in the tested grasses, suggesting that they are not involved in bentgrass resistance. In fact, *P. annua* and the most susceptible bentgrasses tended to have higher silicon and fiber concentrations in their tissues.

Combinations of entomopathogenic nematodes and imidacloprid for larval control. In greenhouse tests, a low and a high rate of the nematodes *Heterorhabditis bacteriophora*, *Steinernema carpocapsae* and *S. feltiae*, and of imidacloprid were tested alone and in combination against ABW fourth instars. In a field experiment, two rates of H. bacteriophora and S. carpocapsae were tested alone or in combination with imidacloprid at label rate. In both greenhouse and field, EPN+imidacloprid combination generally resulted in additive mortality (Figue 2 and 3). While ABW numbers tended to be lower in pots treated with combinations than pots treated with the respective single agent rates, the difference was statistically not significant in most cases. Future experiments will examine the effect of delayed and split application of

Summary Points

- Tested bentgrass species were more tolerant to ABW feeding than *P. annua*. However, at higher population densities some bentgrass cultivars showed damage with the most severe damage occurring in velvet and colonial bentgrasses.
- To eliminate risk of damage in bentgrasses, using most tolerant/resistant creeping bentgrass cultivars could be combined with biological control, which is one of the objectives of our future studies.
- Combinations of entomopathogenic nematodes and imidacloprid resulted in additive effects on ABW larval densities and, when applied against spring generation ABW larvae, may provide both curative control of ABW larvae and preventive control of white grubs.

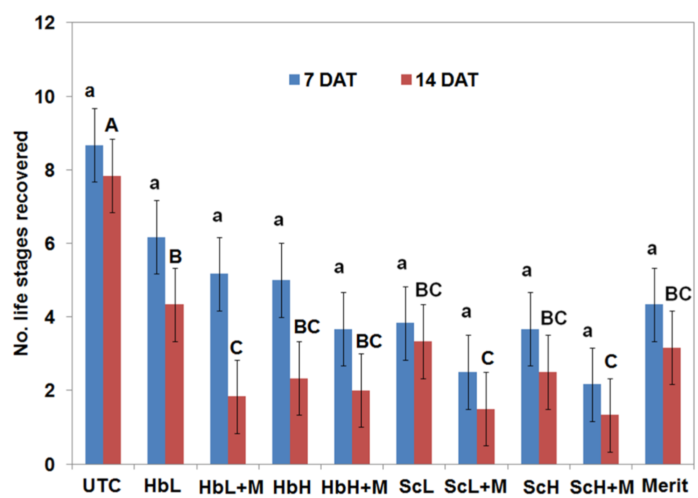

Figure 4. Efficacy of H. bacteriophora (Hb) and S. carpocapsae (Sc) at low (L) and high (H) rates, the neonicotinoid insecticide Merit (M), and their combination against late instar ABW larvae in a field test (application June 4, 2013).