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Searching for Annual Bluegrass Weevil Resistant *Poa Annua*

Abstract

Impact from damaging infestations of the annual bluegrass weevil (ABW) is expanding dramatically in golf courses across the Northeast and Mid-Atlantic. Lack of control alternatives has led to reliance on pyrethroid insecticides, which are failing as a likely consequence of pesticide resistance. More durable management strategies are needed. Because improved annual bluegrass (*Poa annua*) cultivars are being developed at Penn State, we have an opportunity to assess host plant resistance. The susceptibility of these materials to insects is completely unknown. Here we propose to make the first screening of these materials with the goal of detecting and measuring any genetic variation in the performance of ABW or in the expression of injury.

Introduction

Listronotus maculicollis, widely known as the "annual bluegrass weevil (ABW)" is a burgeoning pest of turfgrass in the northeastern U.S. This native beetle is most prevalent and injurious in low-cut, high maintenance turf such as golf course greens, tees and fairways. The insect was first reported damaging turfgrass in Connecticut as early as 1931. Until the last 20 years or so, damage has been concentrated in the metropolitan New York area. Severe infestations, however, are now experienced across the Northeast and into the Mid-Atlantic, including north to Quebec and Maine, west to Pennsylvania and Ontario, and south to Maryland. It has also been identified within the last three years from Delaware, West Virginia and Virginia, and infestations observed in 2007 are the first reports for Ohio.

Larvae and adults feed primarily on annual bluegrass (*Poa annua*), a major component of many golf course playing surfaces. As an aggressive invader of new stands of creeping bentgrass, annual bluegrass was historically regarded as a weed by golf course superintendents. When it becomes the dominant grass species, however, superintendents resort to managing it, rather than eliminating it. Most impact is attributed to the larvae that bore into the stem when they are young and later reside at the soil surface where they feed on the crowns. ABW injury is generally expressed as growing areas of yellow and brown patches usually first noticed around the collar and perimeter of the greens, tees or fairways. High populations will cause substantial areas of dead turf that affect both the visual and functional quality of golf course turf.

Ideally, management is achieved through a well-timed perimeter application of an insecticide that targets adults as they reinvade short-mown turf from overwintering sites in the spring. Nevertheless, more and more courses end up making 3-5 applications in a season. One problem is asynchrony in population development that makes it difficult or impossible to interpret timing of the generation and to decide when to apply controls. Other limitations are the shortage of efficacious products labeled for larvae, and the overwhelming reliance on one class of insecticides (pyrethroids). Further complicating a successful control program is recent evidence showing that resistance to pyrethroids has emerged in some ABW populations in the Northeast, and that this may be linked to control failures. There are currently no non-chemical alternatives that can be recommended for

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Our overall goal is to detect and measure variations of ABW performance across P. annua cultivars. This proposal is technically feasible because we have recently established improved opportunities for maintaining and manipulating ABW under controlled conditions. The objective of this study was to detect and measure variation across improved Poa annua varieties in the performance and impact of its specialist herbivore, the annual bluegrass weevil

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ABWcontrol.

Since 1994, the turfgrass breeding program of Dr. David Huff at Penn State has been conducting research to develop improved cultivars of *P. annua*. Initial breeding has improved qualities related to shoot density, color, uniformity and tolerance to diseases and abiotic stress. As a result, a selection of 12 top cultivars is being evaluated in multilocational trials around the world. To date, however, none of these materials has been explicitly examined for resistance to insect pests. It would be a disservice to promote the adoption of any improved variety without some information on its susceptibility to ABW.

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Methods:

Natural field infestations. In 2005, a natural outbreak of *L. maculicollis* infested research plots at Cornell's Turf and Landscape Research Center, Ithaca, NY. This gave us an opportunity to collect data on their incidence across 20 cultivars and/or combinations that were maintained at greens height in replicated plots. Abundance of ABW life stages was measured across these plots in two ways.

Controlled laboratory studies. Two experiments have been conducted to date, each focusing on infestations made with adults weevils. The source of adults were collections made on infested fairways at the Robert Trent Jones Golf Course, Ithaca, NY. Adults were collected by hand or with an aspirator after using a soapy disclosing solution to drive them to the top of the sward where they could be seen and captured.

In the first experiment we compared the performance and impact of weevils on annual bluegrass, velvet bentgrass and creeping bentgrass.

In the second experiment, we compared the performance and impact of weevils across 10 varieties of greens-type turfgrass. These were obtained from replicated field plots maintained by the turfgrass breeding program of Dr. David Huff at Pennsylvania State University, State College, NY. These varieties were selected to represent a range of morphologies, geographic origin and susceptibility to anthracnose disease. Among these were eight accessions of annual bluegrass, a wild type annual bluegrass and PennCross creeping bentgrass.

In both experiments, ABW performance was measured in terms of adult survival (number of adults alive after infestation period) and number of larvae (number of larvae recovered 1 month after infestation). The impact of ABW on the host variety was measured in terms of chlorophyll index, grass height and area of green coverage (1 month after infestation).

Results and Discussion:

Natural field infestations. A total of 18 larvae, 36 pupae, 16 callows and 5 adults were recovered from soil core samples, yielding an overall density of 124 individuals/m2. A total of 345 adults and 2 callows were recovered from the soap flushes, yielding an overall density of 168 adults/m2. Because these densities were well below the commonly used damage thresholds of 320-860 adults/m2, no attempt was made to assess variation in the expression of injury.

For the soil core extractions, results showed a significant effect of variety on the abundance of pooled life stages (ANOVA; df = 19, 59; F = 2.22; P = 0.016). Abundance varied from 0 to 395 individuals/ft2 (Fig. 1). For the soap flushes, results also showed a significant effect of variety on adults (ANOVA; df = 19, 59; F = 2.21; P = 0.018). Abundance varied from 6.3-27.8 adults/ft2. Correlations between larval and adult densities have not yet been assessed. This is relevant because given differences in resource requirements and mobility, larval densities may be more tightly linked to variety than adult density.

Controlled laboratory studies. No larvae were recovered from any of the experimental evaluation units. This may be attributed to the high adult densities and the degree of injury they caused. Therefore under these experimental conditions, adults did not lay eggs, or the larvae all perished, making it impossible to assess ABW's establishment success across the varieties evaluated.

In the first experiment, there was no difference in adult survivorship among annual bluegrass, velvet bentgrass or creeping bentgrass. Survival rates ranged from 70.0 to 88.0% across the two trials and three varieties. The chlorophyll index declined with infestation level, confirming the visual injury caused by adults (Fig. 3). In the second experiment, there was a significant difference in adult survivorship among varieties (Fig. 4). Survival rates varied from 50 to 95%. A significant effect of infestation on the chlorophyll index was only detected for two varieties. As above, height and cover data confirm that result but have not yet been finalized.

For both experiments, initial analyses of data on plant height and cover also confirm that adult ABW cause significant damage to foliage results. A full assessment of those data has not yet been made. Plant health measures were made about a month after the end of infestation, because they were not contemplated before that point given our main interest in examining larval survival. If measurements had been made immediately after the infestation period (before any recovery of the grass), we anticipate that the plant health parameters would have revealed much more pronounced differences among the infestation levels.

Implications. Our results reveal that there may be meaningful variation across varieties in the survival of adult ABW. They also reveal that injury caused by adult ABW to host plants may be much more significant to grass health than previously recognized. We will therefore repeat these studies in the spring to confirm results of a varietal effect on adult survival. In addition, we will make a more detailed examination of adult injury to grass and

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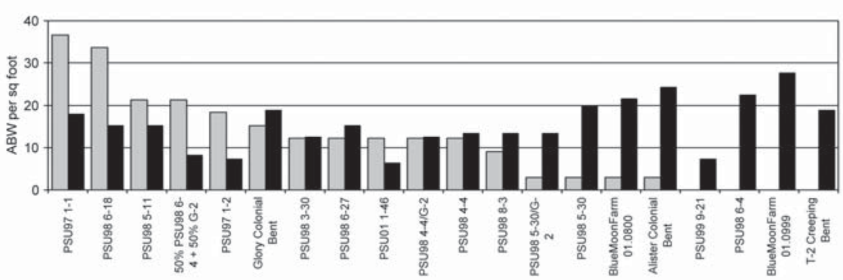
Figure 1

Variation in the incidence of natural annual bluegrass weevil populations across experimental field plots (4 replicates) of greens-type cultivars and combinations of *Poa annua* in 2005.



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thereby strengthen our understanding of how this insect can impact annual bluegrass and other short-mown turf varieties. Although we have not yet been successful in examining the performance of ABW larvae across grass varieties, we are currently refining protocols for an artificial diet that will serve as an important tool for those studies. Overall, given the success of breeding for greens-type varieties, and the high degree of expected adoption for some cultivars, Poa annua's susceptibility to its specialist insect herbivore must be ascertained. If evidence for resistance were to be found, it could be exploited as a desirable trait for selection criteria. On the other hand, if a close examination reveals that *Poa annua* varieties harbor no biologically relevant variation in resistance to the annual bluegrass weevil, then we can more confidently promote their adoption.

We do not yet know if *P. annua* cultivars harbor biologically relevant variation in resistance to ABW. Nevertheless, given the success of breeding for greens-type varieties, and the high degree of expected adoption for some cultivars, *P. annua's* susceptibility to its specialist insect herbivore must be ascertained. More importantly, if evidence for resistance were to be found, it could be incorporated as an additional selection criteria and thereby open the door to enormous environmental and economic rewards for golf courses and the communities in which they reside.

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Figure 3

Survivorship of adult ABW after a 7-day infestation on three grass varieties

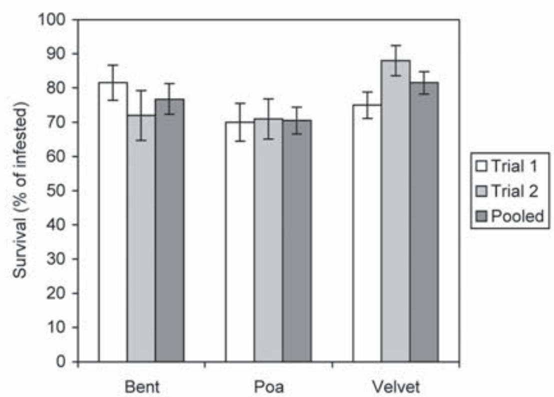

Figure 5

Injury of ABW adults on 10 varieties of greens-type turfgrass one-month after a 7-day infestation period.