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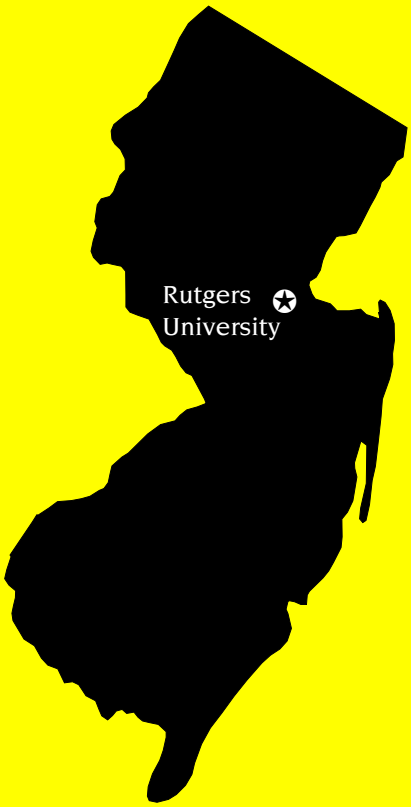

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The first section includes lecture notes of papers presented at the 1999 New Jersey Turfgrass Expo. Publication of the New Jersey Turfgrass Expo Notes provides a readily available source of information covering a wide range of topics. The Expo Notes include technical and popular presentations of importance to the turfgrass industry.

The second section includes research papers containing original research findings and reviews covering selected subjects in turfgrass science. The primary objective of this section is to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

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Dr. Ann B. Gould, Editor
Dr. Bruce B. Clarke, Coordinator

ANNUAL BLUEGRASS WEEVIL: KISS YOUR *POA* AND BENTGRASS GOOD-BYE

Patricia J. Vittum[1]

The annual bluegrass weevil (ABW), *Listronotus maculicollis*, is one of the most challenging insect pests for golf course superintendents to manage in the Northeast. Also known as the "Hyperodes weevil," the ABW feeds in the stems and crowns of turf plants and can cause severe damage throughout June, July, and August, particularly on greens, tees, collars, and fairways. Until recently, we believed that the insect fed only on annual bluegrass (*Poa annua*), but in the past three years I have occasionally observed damage on some bentgrass fairways. Meanwhile, we are raising adult weevils very successfully on non-endophytic perennial ryegrass in the laboratory. In this session, I plan to review the life cycle of the insect and discuss the current status of biological and chemical control alternatives.

LIFE CYCLE

The ABW normally completes two or three generations each year in most of the metropolitan New York area, including New Jersey. The first generation is relatively easy to characterize, but later in the summer the picture is less clear because there is a lot of overlap. The end result is that a golf course superintendent often sees all stages of development at the same time whenever sampling in July or August.

Weevils spend the winter as adults, often in leaf litter under white pine trees. However, we have found that weevils also overwinter very successfully in clumps of high grass near the edge of woods and even in patches of moss in the wooded understory. In the spring, adult weevils begin to move toward low-mown grass. Although they are capable of flying, they normally walk across the rough and settle down shortly after reaching a fairway, tee, collar, or green. Females begin to lay eggs in mid- to late April in New Jersey (a bit later further north), usually inserting one, two, or three eggs, end-to-end, inside a leaf sheath. After about 1 week to 10 days, the eggs hatch into tiny larvae that bore inside the stem for about 10 days. Eventually, the larvae become too large to remain in the stem, and they move down to the base of the plant, where they feed on the crown.

Larvae pass through five developmental stages, or instars, in a period of 4 to 6 weeks. Usually in early to mid-June, the larvae then pupate (in the top inch of soil) for about a week (the pupa often wriggles a bit inside a "cell" of soil but does not feed). Pupation usually does not occur until the second half of June in areas north of New York City. New young adults emerge in mid- to late June and are ready to mate and repeat the cycle within a week or so. However, because some individuals get an early start in the spring while others are much later, the appearance of large larvae and appearance of new adults is not perfectly synchronized. Therefore, from mid-June through mid-September, a turf manager can find each and every stage on any given date. In late June, most of the adults would be the new ones, while most of the middle sized and large larvae would be "laggards" from the first generation. Things get even more confusing in August, when there are some

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laggards of the second generation overlapping with third generation insects.

In general, however, new adults lay eggs in early July, and the larvae that emerge subsequently complete their development in about four weeks. These larvae then pupate (often in late July or early August in New Jersey, and a few days later in areas further north), and the resulting adults appear in August. In warm years, some of these adults lay eggs for a third generation. Usually by the beginning of September, though, weevil activity begins to diminish.

FEEDING ACTIVITY AND DAMAGE

While adult weevils occasionally nibble on the edges of grass blades, their damage is considered to be inconsequential. The larvae (creamy white feeding sacks with small brown heads and NO LEGS), however, feed inside stems during their earliest stages of development and later destroy the crowns of plants. Studies conducted at Cornell in the early 1970s indicated that a single larva can kill 10 or more plants during its lifetime.

In the spring, turf damage is most apparent along the edges of fairways, collars, tees, or greens. This makes sense because the adults migrate in from overwintering sites and settle down almost immediately after they reach the short cuts of grass. However, the subsequent generations (and their damage) can occur anywhere in the short cuts, including the centers of fairways. Whereas most damage occurs on annual bluegrass, we have seen instances where certain bentgrasses have sustained damage. In addition, we are intentionally rearing weevils on perennial ryegrass in the laboratory and they are thriving at least as well on the ryegrass as they do on annual bluegrass. Fortunately, we have not seen any evidence of activity on perennial ryegrass in the field yet, but the potential certainly exists.

Nikki Rothwell, a Ph. D. candidate in my laboratory, is conducting several studies to refine our understanding of the range of grasses on which ABW will feed. At the very least, we have reason to believe the weevil prefers *Poa annua* but will feed on at least some other grasses as well.

TOLERANCE LEVELS

In any integrated pest management system, a turf manager must try to determine what the tolerance level is for any given pest. Of course, the tolerance varies with the overall growing conditions, as healthy turf often can withstand attack more readily than can stressed turf. Not surprisingly, we find the tolerance level for ABW is higher in the spring than it is in the late summer, primarily because summer temperatures often are high enough to stress the turf considerably whereas spring temperatures tend to be more moderate and less stressful. In summers like 1999, drought added further stress to the turfgrass (and to the turfgrass managers!).

The guidelines we currently suggest for ABW are 30 to 80 larvae per ft^2 in the first generation (damage in late May or June). If there are more than 80 larvae per ft^2, you almost certainly will see damage, while if there are less than 30 larvae per ft^2, you probably will not see damage. The challenge comes in fine tuning the tolerance levels for those intermediate populations. Some courses will sustain damage with 50 larvae per ft^2, while others will come through without any problems.

Tolerance levels for summer activity are almost always lower. Based on field observations from the past several years, we believe those thresholds are around 15 to 30 larvae per ft^2 for the second or third generation in many locations, particularly if the turf is under high temperature or drought stress. Some courses are able to use higher threshold guidelines, even in the summer.

CULTURAL CONTROL STRATEGIES

Because the ABW prefers annual bluegrass, any renovations that reduce the *Poa annua* population will reduce the food supply for the weevils and force them to look elsewhere. In

addition, some superintendents have removed litter from underneath white pines and feel that after a few years of cleaning up the litter, the overwintering populations of adults are reduced. While we do not have any scientific "proof" that removing pine litter will help, there are numerous anecdotal reports, and intuitively, it would seem to make sense. (Just remember that white pines contain a lot of resin, so do not try to burn the litter around the base of a tree!)

CHEMICAL CONTROL STRATEGIES

The most reliable options for managing ABW at this time involve various combinations of insecticides. As with any insect, the egg and pupa stages are not vulnerable to any insecticides that are currently available commercially. Timing of application is usually arranged to coincide with adults just as they begin to lay eggs. The object is to kill the adults before they have a chance to lay eggs. Most of the insecticides used in this manner have enough residual to remain active as the young larvae first emerge.

Spring Generation

The first generation develops each year after overwintering adults return to the short grass. Insecticide applications made between forsythia full bloom and dogwood full 'bract' usually are very effective. In a prolonged spring (when forsythia blooms and holds color for 10 or more days), delay your application. In fact, we find that delaying until forsythia is "half green, half gold" (when leaf buds are beginning to expand) usually works very well. Our field trials, conducted over the past several years, have shown that any of the pyrethroids (such as Battle™, Scimitar™, Tempo™, Talstar™, or Deltagard™) can be very effective. We have applied these materials at full labeled rates and in split applications, and both approaches work well. Normally, spring applications can be limited to perimeters, or the edges of fairways, greens, tees, and collars. This is because overwintering adults usually begin laying eggs as soon as they encounter the shorter cuts of grass, and visible damage seldom extends more than 15 or 20 ft into a fairway in the spring.

Dursban™ continues to be very effective in most instances, although our trials suggest there is a slight advantage to using the older EC formulations rather than Dursban Pro. Some superintendents in the metropolitan area have suggested that Dursban is not as effective now as it was 10 years ago, but I suspect this is a function of timing of application rather than any problem with resistance. The "window of opportunity" for applying Dursban may be a bit smaller than the window for the pyrethroids. We sometimes see a drop off in performance with granular formulations. Finally, some superintendents recommend making applications late in the day, in part because Dursban is somewhat sensitive to breakdown in sunlight.

We have also looked at several tank mixes, normally combining a pyrethroid with either Dursban or Merit™. All of the combinations have been outstanding. In most cases the pyrethroid by itself provides very good control, but adding Dursban or Merit to the mix results in a slightly higher mortality. The difference usually is not statistically significant, but it is satisfying! Note that Merit by itself is not particularly effective against ABW, but when used in combination with a pyrethroid it is very effective and remains in the turf to provide protection against white grubs later in the year.

Spring applications should be watered in lightly, just enough to move the material off the blades and into the thatch. Avoid treating when the ground is saturated.

Summer Generations

Many golf course superintendents experience significant damage from ABW during the spring, although fortunately that damage often is restricted to a few areas on the course. If damage is sustained in late May or June, a follow-up application of an insecticide may be appropriate in early July. We are in the process of

refining a growing degree day model that helps predict the ideal timing for such an application, but for northern New Jersey, it often falls very close to the July 4th holiday. Dursban or any of the pyrethroids should be quite effective. Note that all of these insecticides are at least somewhat sensitive to either sunlight or high temperature or both, so applications should be made as late in the day as possible during the summer months. In addition, the application should be watered in lightly (perhaps one or two passes of the sprinkler head).

Some superintendents feel they need to make an additional application in early August to protect against any late summer activity. My experience has been that timely applications in spring and early summer normally remove a substantial portion of the population so that damage in late summer is minimal. However, there have been a few isolated instances where a golf course did encounter damage from the weevils in late summer. Certainly a superintendent who is in the first year at a new location might want to be conservative, but as the weevil patterns become better identified on a given golf course, late summer applications can be minimized.

BIOLOGICAL CONTROL STRATEGIES

There are several biological control agents that have the potential to suppress annual bluegrass weevil populations. Back in the 1970s when I was studying the weevil for my Ph. D. dissertation, I observed larvae in the field that had died and were an unusual coral color. An insect pathologist at Cornell University confirmed that those weevils had been attacked by a nematode that is now known as *Steinernema carpocapsae*. Over the past three years we have conducted field trials with this nematode, which is available commercially under a variety of trade names. The results have been disappointing, but my personal suspicion is that the air, soil, and water temperatures were too cold at the time of application (a brisk day in April!). So we will be repeating the trial in 2000, but will delay application until soil temperatures are above 50°F and will use slightly warmer water if necessary.

We hope to conduct field trials during 2000 using a variety of other biological control alternatives, including a strain of *Bacillus thuringiensis* that is used against other beetles in vegetable crops. We also hope to look at *Beauveria bassiana*, a fungus that is available commercially as Naturalis-T™. While the companies that manufacture these products normally do not support field trials, we hope to generate support from within the golf course industry to enable us to complete these studies.

SO WHAT'S NEXT???

The annual bluegrass weevil continues to be a major challenge to golf course superintendents. Nikki Rothwell has just begun a long term study that will expand our knowledge of the biology of the insect. For example, she hopes to determine just how many generations DO occur in a given year and to identify how air or soil temperature drives the system. She is already studying the development of the reproductive system, which will help us determine the physiological state of the weevil during the growing season. Nikki is also trying to identify the preferred overwintering sites, which may eventually enable us to try some innovative approaches to population suppression. She is also trying to establish a set of "risk factors" that will help us predict where weevil activity is likely to be most severe. Nikki will be testing feeding preference in the laboratory and eventually in the field. We continue to test traditional and non-traditional insecticides in the field. With patience and perseverance, we should eventually gain the upper hand.

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