Interpreting and Forecasting Phenology of the Annual Bluegrass Weevil in Golf Course Landscapes

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Objectives:

1. Describe patterns of variation in population fluctuations and phenology of annual bluegrass weevils.
2. Describe the overwintering strategy by establishing the factors that affect site selection and success.
3. Document the relationship between overwintering sites and developmental sites.
4. Develop and validate a degree-day model to forecast phenology.

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The annual bluegrass weevil (ABW), *Listronotus maculicollis*, is a major insect pest on short-mown *Poa annua* turf throughout the Northeast and Mid-Atlantic regions. Small larvae feed within the stem and large larvae feed on crowns, causing highly visible damage on prominent areas of the course, such as fairway edges and putting green collars. Until recently, management options were largely limited to pyrethroids, and applications may be made two to five times a season. More effective control will depend on better targeting the insect.

We are defining the association between ABW and the golf course landscape. Our goal is to better understand the spatial, temporal, and dynamic aspects of the relationship between overwintering and developmental sites, and how this might be exploited to improve integrated pest management. We surveyed populations over three years on two fairways in upstate New York. Data were collected weekly by extracting larvae from soil cores and flushing adults with a soapy disclosing solution. All larvae were identified to instar, and all adults were identified as male and female, callow and mature.

Most population parameters (e.g., fluctuation curves, abundance, synchrony, number and timing of generations) varied more between years than between sites. In terms of insect load, larvae and adults were eight to nine times more abundant on the fairway than the rough. Across the fairway itself, abundance was consistently greater near the edge at one site, but insects were evenly distributed across the fairway at the other site. Therefore, insect distribution does not fully explain the prevalence of damage on fairway edges.

Field surveys showed that overwintering adults tend to settle along the tree line adjacent to the fairway, establishing up to 60 m from the fairway and 10 m into the woods. Little or no overwintering occurs on the fairway or adjacent rough. In a choice experiment, we showed that white pine litter is not a preferred overwintering substrate. Given a choice, adults preferred to settle in rough-mown grass and a combination of pine and deciduous litter over fairway-mown grass and pine litter alone.

We used linear pitfall traps to document the activity and directionality of adult movement. Captures were greatest in spring, coinciding with the emergence of overwintered adults and their dispersal toward short-mown turf. In the fall, however, there was no indication of movement back toward overwintering sites. We proposed that adults largely fly toward overwintering sites in the fall, orienting to and settling along defined tree lines away from fairways.

We are developing predictive models to test the linkage between insect development and degree-day accumulations. The fit of several models was tested on 3 years of population data. Overall, degree-day was a statistically better predictor than calendar date. The resultant model described population accumulations of overwintered adults and larvae of the first generation well, but not the second generation.

In 2008 and 2009, we partnered with collaborators across New York to validate the applicability of this model for other populations of the insect in different climate areas. Data were gathered from each site to construct fluctuation curves showing the progression of the five larval instars over the course of the spring generation in relation to local temperature. The model must be further refined and adjusted before it can be considered a sufficiently robust tool for ABW management across its geographic range.

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Summary Points

- Studies on the biology of ABW in overwintering and developmental habitats have refined our understanding of how this insect pest exploits and damages susceptible golf course playing surfaces.
- It is hypothesized that adults immigrate to fairways in spring largely by walking with orientation to low-cut turf, but they emigrate in fall largely by flying with orientation to defined tree lines where they settle into preferred overwintering substrates.
- On short-mowed *P. annua* turf, there is more variation from year to year than from site to site in terms of population parameters such as shape of the fluctuation curve, number of generations, and generation time.
- Degree day is a statistically better predictor for ABW phenology than calendar date, and a preliminary model has high predictive power for the first generation.
- With further refinement, a nonlinear degree-day model has the capacity to predict the timing of ABW developmental stages across a wide geographic area.