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.
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) is a burgeoning pest throughout the Northeast and Mid-Atlantic regions. The stem-boring and crown-feeding larvae cause highly visible damage to short-cut *Poa annu*a, a major component of golf course playing surfaces. Management options are largely limited to pyrethroids, and applications may be made 2-5 times a season. Poor targeting often leads to control failures.

Detailed population surveys were conducted at two sites in Upstate NY to describe patterns of variation in population ecology across year, site, and habitat. Population data were collected from 2004-2006. Based on extractions of larvae from soil cores and collections of adults flushed by a disclosing solution, 3,838 larvae and 8,576 adults were sampled. Five larval instars were confirmed based on head capsule width. Because there is no overlap, instar can be determined with a simple measurement. Adults were also identified as male and female, callow and mature. Because there is no divergence in male and female population curves, assessing gender does not help to interpret adult fluctuations.

Most population parameters (e.g. fluctuation curves, abundance, synchrony, number and timing of generations) varied more between years than between sites.

Annual bluegrass weevil launching into flight from the top of a stick

Sex ratio and abundance varied between management habitats. For instance, males were more abundant in the rough where the mean sex ratio (male:female) was 1.7:1, versus 1:1 in the fairway. In terms of insect load, larvae and adults were 8-9 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.

An analysis of three years of population data shows that degree-day may be a better fit than Julian date at predicting occurrence of the first generation. Given low variation in R^2 values, using the most convenient base-temperature model may be feasible. In 2008, we partnered with collaborators across NY to validate this model through focused population surveys.

Field surveys showed that overwintering adults tend to settle along the tree line adjacent to the fairway, establishing up to 60 meters from the fairway and 10 meters 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. Adults preferred to settle in rough-mown grass and a combination of pine and deciduous litter over fairway-mown grass and pine litter alone. Captures in linear pitfall traps were greatest in spring. At one site, directional movement toward the fairway in spring was confirmed, but there was no evidence for reverse movement in the fall.

Results lead us to propose a new conceptual model of flux between habitats and overwintering site selection. Our theory is that spring immigration occurs mostly by walking, with orientation to low-mown turf. Fall emigration occurs through flight with orientation to defined tree lines. Through a "snow-fence" effect, adults stop flying at the tree line, drop to the ground,

Annual bluegrass weevil eggs laid in a stem of annual bluegrass

and settle into overwintering substrates according to preferences. In 2008, laboratory and field observations confirmed that ABW is capable of vigorous flights. Better targeting of ABW will depend on future studies that emphasize dispersal behavior, host plant associations, and habitat preferences.

Summary Points

- Most population parameters (e.g. shape of the fluctuation curve, number of generations, and generation time) vary more between years than between sites.
- Sex ratio and abundance vary dramatically between rough and fairway habitats. Across the fairway, insect distribution does not explain the prevalence of damage along the edge.
- Degree-day accumulation may be better than calendar date at predicting phenology, and a preliminary model has high predictive power for timing of the first generation.
- Overwintering adults tend to settle along tree lines adjacent to the fairway, as far as 10 m into the woods and 60 m from the edge of the fairway. Little to no overwintering occurs on the fairway and bordering rough. Pine litter is not preferred over other overwintering substrates.
- 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 overwintering substrates.