Landscape Ecology and Management of Strawberry Sap Beetle in the Northeast

A. Team members:

Greg English-Loeb, Project Director. Associate Professor, Department of Entomology, NY State Ag. Exp. Station, Cornell University, Geneva, NY. 14456. Phone: 315-787-2345. Fax: 315-787-2326. Email: gme1@cornell.edu.

Kathy Demchak, Co-Project Director. Senior Extension Associate, Department of Horticulture, The Pennsylvania State University.

Sonia Schloemann, Co-Project Director. Small Fruit Specialist, UMass Extension Fruit Program, Dept. of Plant and Soil Science, University of Massachusetts.

Wendell Roelofs, Cooperator. Professor and Chair, Department of Entomology, NY State Ag. Exp. Station, Cornell University.

Rebecca Loughner, Graduate Research Assistant. Ph.D. Candidate, Department of Entomology, NY State Ag. Exp. Station, Cornell University.

States involved: New York, Pennsylvania, Massachusetts
Years funded: 24 months (2004-2005) with six month extension
Funding amount: $127,355 (includes both research and extension funds)

B. Non-technical Summary

Strawberry sap beetle (SSB) is of great concern to strawberry growers in the Northeast because 1) adult feeding and larval infestation of harvestable fruit cause significant economic losses where beetles are abundant, 2) pesticides need to be applied just prior to harvest and are generally not effective, and 3) grower and consumer complaints about damage and contamination of fruit from SSB are on the rise. Although primarily a pest of strawberries, SSB feeds and reproduces on the un-harvested fruits of a number of other crops. The trend for increased diversity of fruit and vegetable crops grown on farms in the Northeast to support lucrative farm stands and U-pick operations, where maintaining good sanitation is difficult, may greatly contribute to SSB problems. We argue movement among crop and non-crop habitats and the use of alternative food plants are of critical importance to understanding SSB population dynamics and the development of alternative management strategies. The following specific objectives were addressed in this project: 1) Assess quality of overwintering habitat in the vicinity of strawberry plantings; 2) Quantify SSB use of, and population growth on, alternative foods sources; 3) Identify aggregation pheromone used by SSB, and in combination with host volatile cues, field test as bait to attract and kill overwintered adults before they colonize a strawberry field; and 4) Evaluate resistance/susceptibility of different strawberry cultivars and timing of renovation as management tactics to reduce SSB populations in strawberry fields.

C. Introduction

Strawberry sap beetle, *Stelidota geminata*, is a serious emerging threat to strawberry growers in the Northeast. Strawberries are an important crop in the region (economic value in NY in 2002 = $8.8 million and $10 million in Pennsylvania) with high public visibility (National Agricultural Statistics Service 2003). The adult beetle feeds on the underside of ripe and overripe berries creating holes. Of more significant concern, larvae contaminate harvestable fruit leading to consumer complaints and the need to prematurely close fields at great cost to the grower. Although strawberry sap beetle (SSB) has been reported in the Northeast for over 50 years and is widely distributed, only recently has it risen to high priority among growers. Understanding why SSB reaches high densities on some farms and not others is a key goal of our current research since it should provide insights into new management strategies.

Current recommendations for control of SSB are good sanitation (i.e. removing ripe and overripe berries from the field to reduce survival of SSB larvae) and application of insecticides just prior to harvest. Keeping fields sufficiently clean of ripe and overripe fruit is nearly impossible, especially for U-pick operations, and the effectiveness of the two labeled pyrethroids in the field is highly variable (Rhainds and English-Loeb 2002). Adult beetles tend to feed on the underside of fruit, making contact with insecticide difficult. The repeated use of these broad-spectrum insecticides can also disrupt biological control of other secondary pests such as spider mites.

It is not atypical to find strawberries, raspberries, cherries, apples, melons, and sweet corn, all potential food sources for SSB, growing on the same farm to support direct marketing of produce through roadside stands, U-Pick operations, and farmer's markets. These alternate food sources potentially help promote large overwintering populations of SSB that then colonize strawberry plantings in the late spring, causing economic damage.

Some possibilities for reducing SSB damage include: 1) altering management practices to lower susceptibility of fruit to SSB, 2) planting strawberry a sufficient distance from alternate food sources and overwintering sites to minimize access to resources that contribute to a larger overwintering SSB population, and 3) developing traps that would attract and kill adults before they enter strawberry fields in the late spring/early summer. Traps baited with a pheromone and a co-attractant odor have successfully minimized fruit damage from related sap beetles (*Carpophilus spp.*) when traps were placed around the perimeter of small blocks of stone fruit plantings (James et al. 2001). Effective deployment of such traps in strawberry depends on understanding how management practices and habitat surrounding strawberry fields, including overwintering sites and alternate food crops, influence SSB population dynamics.

D. Objectives

1) To assess quality of overwintering habitat in the vicinity of strawberry plantings.

We compared abundance of overwintering SSB in woods, strawberry fields, and other perennial crops including raspberry and blueberry. A wide range of crops on farms throughout New York, Pennsylvania, and Massachusetts were sampled in 2004 for overwintering adults. Overwintering sampling in 2005 focused on a more limited number of crops at one farm in each state to increase the number of beetles collected within a farm.

2) To quantify SSB use of and population growth on alternative food sources.

We surveyed the distribution and abundance of SSB on crop residues for selected commercial farms in New York, Pennsylvania, and Massachusetts. As in the overwintering sampling, a sampling of a large number of crops in 2004 was concentrated in 2005 on blueberry, raspberry, and strawberry. A no-choice assay was also conducted to evaluate SSB population growth on six potential food sources.

3) To identify aggregation pheromone used by SSB, and in combination with host volatile cues, field test as bait to attract and kill overwintered adults.

We have collected chemical volatiles from male SSB and presented the volatiles in combination with whole wheat bread dough odor in a flight tunnel and in a preliminary field trial with the collected volatiles. Work to generate a synthetic version of the attractive material is still in progress. The SSB antennae has been difficult to work with due to it's shape and small size, however improvements in the GC-EAD system have been continuous and we anticipate being able to identify candidate compounds for testing in the flight tunnel and in the field.

4) To evaluate resistance/susceptibility of different strawberry cultivars and timing of renovation as management tactics.

We used cultivar trial plots at NYSAES and Penn State University to correlate SSB damage with cultivar growth habit. Also, we tested the effect of prompt renovation and renovation compared to none at all at sites with a history of SSB problems. To further test the hypothesis that cultivar growth habit can impact the SSB population, an experimental manipulation of plant structure was conducted.

E. Approach

The ability of strawberry sap beetle to feed on multiple food sources may be important in understanding the relationship between the beetle's increasing pest status and crop diversification on small fruit farms. Although a pest primarily on strawberry, SSB has been reported on a number of crops. It is not atypical to find strawberries, raspberries, cherries, apples, melons, and sweet corn, all potential food sources for SSB, growing on the same farm. It is first necessary to assess whether any or all of these crops are suitable hosts for SSB, then to determine whether the SSB population that damages strawberry is feeding and reproducing on these alternate host crops later in the summer. These alternative food sources potentially help promote larger overwintering populations of SSB that then colonize strawberry plantings the following spring, causing economic damage. The focus of this research has been to evaluate multiple avenues of improving SSB control and pursuing further development of those possibilities with the most potential to reduce the SSB population in an economical manner. Three states have been involved in the project to draw from a wider number of farms with SSB problems and to recommend management decisions that are appropriate for an area beyond New York.

F. Progress

Work in the last year has primarily focused on objective 3. An effective system has been developed for collecting male produced volatiles in small quantities, however further improvements are necessary to collect a quantity of volatiles sufficient to identify candidate compounds which may be the pheromone. In absence of a synthetic pheromone blend, these collected volatiles were used to conduct flight tunnel assays and a preliminary field trial to assess the attractiveness of the pheromone to SSB. A second priority has been data analysis and manuscript preparation for the other three objectives. Two manuscripts, one developed from objectives one and two and the other from objective 4, are close to submission for review in the Journal of Environmental Entomology and the Journal of Economic Entomology, respectively.

G. Results

Berries held off the ground were less damaged than those contacting the soil when SSB were present, suggesting that the plant structure found in certain cultivars has some role in reducing accessibility of fruit to SSB. Year, and not treatment, was the primary factor contributing to variation in SSB emergence from strawberry plots treated with prompt or delayed renovation. Overall, the potential for reducing SSB populations by modifying cultivar grown or time of renovation is limited. No overwintering beetles were found in strawberry, indicating that overwintering adults come from outside strawberry fields in the spring. Adults were found overwintering not only in wooded areas, but also in blueberry and raspberry. An up to 70 fold increase in mean number of SSB in no-choice cages indicates that considerable reproduction can occur on blueberry, cherry, raspberry, and strawberry and sampling of crops including summer-bearing raspberry, peach, blueberry, and cherry confirms that the beetles are present, often in high densities (up to 109 SSB per m^2), in commercial fields during fruiting. In summary, the beetles are able to feed, complete development, and overwinter in habitats other than strawberry. An effective integrated pest management program to control SSB will need to consider the type of habitat surrounding strawberry fields. Preliminary field trials suggest that mass-traps containing an SSB aggregation pheromone, food odor, and an insecticide have the most potential of options evaluated in this research to reduce the SSB population in a cost effective manner. Moreover, this approach would likely result in reduced environmental impacts.

H. Impacts

This research has raised awareness of SSB as a pest, the limitations of currently available control strategies, and the importance of considering habitat near the strawberry fields in management. Good sanitation practices such as burying cull piles can avoid worsening problems, although sanitation alone probably is not sufficient to control SSB. These findings have been reported through talks at multiple grower meetings in the three states involved, during visits with growers as part of the data collection process, at the annual meeting of the Entomological Society of America, and through the *New York Berry News*, an electronic newsletter put out monthly by the Department of Plant Pathology, NYSAES [http://www.nysaes.cornell.edu/pp/extension/tfabp/index.html].

Additional impacts have been 1) to identify development of an attractive mass-trap that contains insecticide as the key area for further research and 2) to increase collaboration between faculty and extension personnel with small fruit responsibilities in New York, Pennsylvania, and Massachusetts. More and more, growers and extension educators rely on regional expertise for information. Our collaborations on this project have resulted in increased interactions on other regional pest management problems such as grape berry moth. Also, the collaborative nature of this project focused on the influence of the landscape on population biology of strawberry sap beetle has laid the groundwork for future collaborative projects with other generalist arthropod pests. Problems with pests such as tarnished plant bug and western flower thrips may be exacerbated by more diverse agriculture and our work on use of alternative habitats should help us develop more informed management practices specific to SSB but also relevant to these other generalist pests.

I. Appendices

We are in the process of putting together a powerpoint presentation that summarizes much of the progress we have made on this project, although it does not include the most recent results on the aggregation pheromone. We can provide this presentation to NEIPM upon completion in the next month.

We also have two manuscripts ready for submission to discipline-based journals (listed below) and a third manuscript in preparation.

Loughner, R.L., English-Loeb, G., Demchak, K., and Schloemann, S. Evaluation of strawberry sap beetle (Coleoptera: Nitidulidae) use of habitats surrounding strawberry plantings as food resources and overwintering sites. To be submitted to *Environmental Entomology*.

Loughner, R.L., English-Loeb, G., Demchak, K., and Schloemann, S. Evaluation of cultural practices for potential to control strawberry sap beetle (Coleoptera: Nitidulidae). To be submitted to *J. Economic Entomology*.

Works cited

James, D.G., B. Vogele, R.J. Faulder, R.J. Bartelt, and C.J. Moore. 2001. Pheromone-mediated mass trapping and population diversion as strategies for suppressing *Carpophilus* spp. (Coleoptera: Nitidulidae) in Australia stone fruit orchards. Ag. Forest Entomol. 3:41-47.

National Agricultural Statistics Service. 2003. Noncitrus Fruits and Nuts 2002 Summary, http://usda.mannlib.cornell.edu/reports/nassr/fruit/pnf-bb/

Rhainds, M. and G. English-Loeb. 2002. Ecology and management of strawberry sap beetle (Coleoptera: Nitidulidae). J. Entomol. Sci. 37:300-307.