BIOLOGY AND MANAGEMENT OF STRAWBERRY SAP BEETLE

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The strawberry sap beetle (SSB), *Stelidota geminata*, is a significant insect pest in strawberry and a few other fruit crops in the North East and Great Lakes regions. In strawberries, they have the greatest potential for causing damage where the berries are grown as a perennial in matted rows. The small, brown adults are approximately 1/16 inch in length and appear in strawberry fields as the berries ripen. The adult beetle feeds on the underside of berries creating holes. Beetles prefer to feed on over-ripe fruit but will also damage marketable berries. 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. Current recommendations for control include insecticides (mainly pyrethroids) and field sanitation. Neither approach is working very well. For example, we assessed effectiveness of the pyrethroid fenpropathrin [Danitol 2.4 E.C.] when applied at different timings. Figure 1 shows that for fruit touching the ground, which is where most of the damage occurs, larval contamination was unacceptably high even for plots treated twice during the fruiting period. In another trial, conducted by Harry Humphries at ACDS Research, Inc., even three applications of Danitol, using 200 gallons per acre, did significantly reduce larval or adult populations. The beetles are not resistant to pyrethroids but rather tend to feed underneath fruit where they are unlikely to be contacted by insecticide. Keeping strawberry fields clean of overripe and damaged fruit would probably help reduce SSB problems, but this is difficult to achieve, especially for U-Pick operations. In this article we summarize the results of three years of research to better understand the ecology of SSB and test alternative approaches for management.

Overwintering habitat

SSB spends the winter as an adult. When we started our research, we were not sure where they overwinterd, however. In particular, we wanted to know if they overwinted in the strawberry fields. In the early spring of both 2004 and 2005 we took leaf and soil samples from several different habitats on farms with a history of SSB problems. A total of 5 adult SSB were found in the 220 soil cores collected from wooded areas in spring 2004, while no SSB were present in the 480 samples taken from fields of other crops during the same time period. All beetles in the samples came from wooded areas at one farm known to have high densities of SSB. More beetles were found in 2005 after increasing the area sampled from 0.16 m^2 (wooded area) or 0.26 m^2 (crops) in 2004 to 2.03 m^2 in 2005. Beetles were found in both of the two wooded areas sampled, in blueberry, and in raspberry for

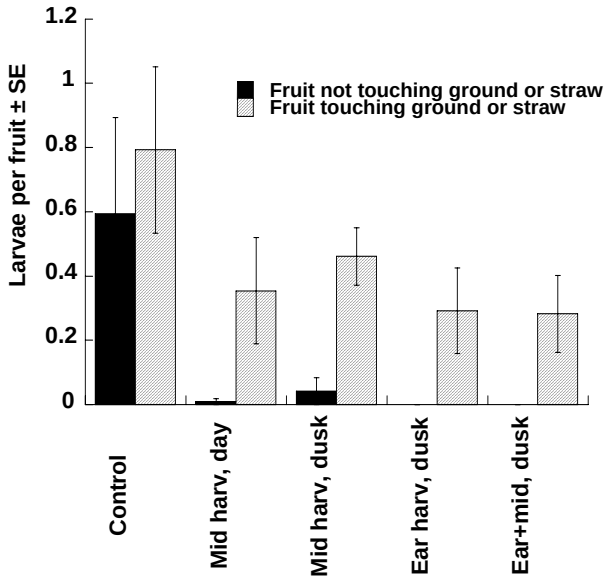

Figure 1. Results of insecticide trial conducted in 2001. Danitol applied at different times during the harvest period and at different times of the day. Larve were counted for fruit not touching the ground and fruit touching the ground.

samples collected before fruiting occurred in the late winter/early spring and after fruit residue was present during the field season (Table 1). No SSB were found in any of the three strawberry fields for the overwintering sample, but beetles were found in samples collected when fruit began to ripen in the field. The absence of SSB from early season samples in strawberry confirms that most, if not all, beetles move into berry fields as fruit ripens. This has important management implications. First, it makes no sense to apply insecticides for controlling SSB before fruit ripening. Second, we may be able to exploit this colonization pattern by intercepting the beetles before they enter the field using traps baited with an attractive lure and an insecticide (see below).

Table 1. Mean total SSB ± standard error and range for adult SSB collected over the total area (2.8 m^2) sampled in each crop or wooded area in 2005.

Crop/Habitat	N	Mean Total SSB[a] (before frt)	Range (before frt)	Mean Total SSB[a] (fruit)	Range (fruit)
Blueberry	3	2.3 (1.2)	0-3	223 (52)	131-312
Raspberry (summer)	2	0.5	0-1	908	566-1251
Raspberry (fall)	1	1.0		194	
Strawberry	3	0.0 (0.0)		178 (149)	25-475
Wooded areas	2	21.5	5-38	NA[b]	NA[b]

[a]Standard error of the mean shown only for crops with >2 fields sampled
[b]Late season samples were collected only from crops and not wooded areas

SSB alternate food use

The summer generation of adult SSB emerging from strawberry fields may 1) stay in the strawberry field to overwinter, 2) return to woods to overwinter, or 3) search for other sources of food. Beetles emerging from strawberry fields could produce a second generation of beetles if they are able to find an adequate food source. SSB is not considered to be an economically important pest in crops such as apples, raspberries, blackberries, blueberries, cherries, pumpkins, melons, and various vegetables, however SSB adults and sometimes larvae have been reported in these crops. Two studies were conducted to better understand whether SSB reproduction in late season crops contributes to SSB damage in strawberry the following spring: 1) a laboratory assay to evaluate SSB reproduction on potential alternate food crops and 2) a field study to quantify the number of SSB adults per unit area in various crops.

In the laboratory assay, 20 adult SSB were provided with one of the following food sources continuously: apple, blueberry, corn, cherry, raspberry, or strawberry. The larvae, pupae, and adults in each cage were counted after 5 weeks. Although reproduction was much lower on apple and corn, the beetles reproduced on all food sources (Figure 2). The 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. Sampling of crops with ripe fruit, 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 (see Table 1). 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.

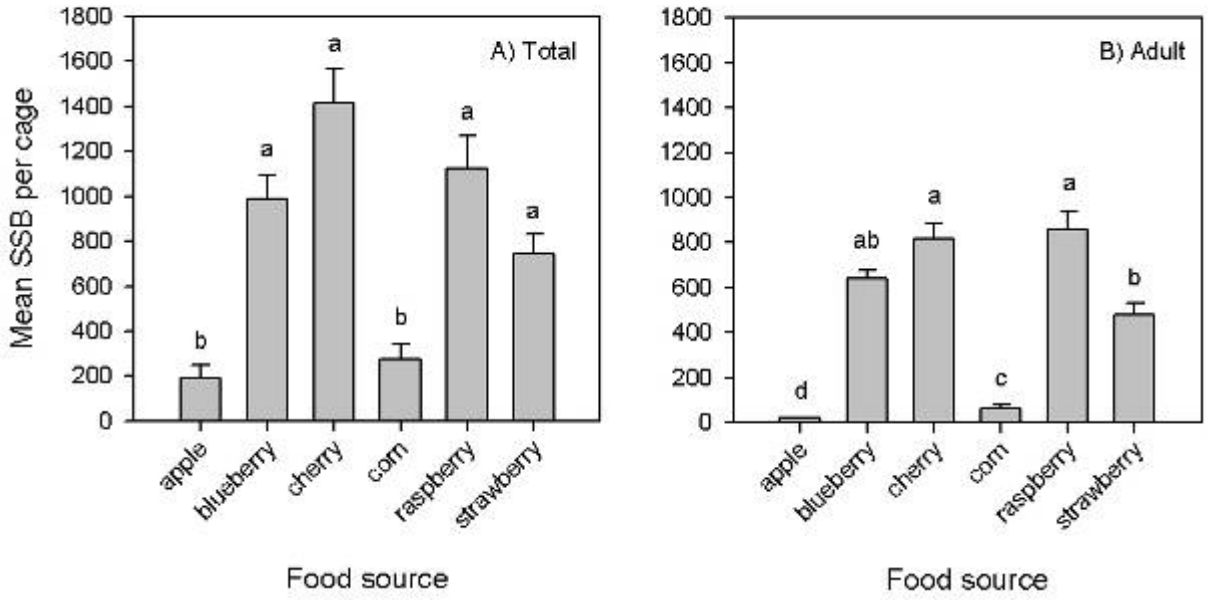

Figure 2. Mean ± standard error of the mean for A) Total and B) Adult strawberry sap beetles in a no-choice feeding assay. Bars with the same letter are not significantly different at $P < 0.05$.

Time of strawberry plot renovation

A manipulative experiment was used to investigate the effect of time of renovation on the number of SSB emerging from strawberry with the idea that rototilling may kill or wound SSB larvae and pupae before they have time to complete development and leave the field. Plots within a strawberry planting at NYSAES were randomly assigned to either rototilling immediately after mowing (prompt renovation) or rototilling 7 to 10 days after mowing (delayed renovation). Emergence cages were placed in both treatments on the same day and the cages in the delayed rototilling removed briefly on the day tilling was done. Emerging adults were captured with attractive baits in the cages and the total number of adult beetles emerged over five weeks was determined.

Year was the primary factor contributing to variation in the total number of SSB adults emerging, while time of renovation had no statistically significant effect. Peak emergence occurred from late July to early August 2004, while emergence in 2005 resulted in much less of a peak with a smaller number of beetles overall. In contrast to data from Maryland (Dr. Galen Dively, University of Maryland) that showed significantly fewer beetles emerging from plots renovated promptly following harvest, this study suggests that prompt renovation does not consistently reduce the number of emerging SSB, at least in New York. Although prompt renovation does not appear to reduce the number of beetles in the next generation, current recommendations to renovate promptly still have value given other benefits such as improved weed control.

Development of trap-and-kill technique

The finding that SSB does not overwinter in strawberry offers an alternative approach to SSB management. Sap beetles have a male-produced aggregation pheromone that could be included in a trap along with a food odor and insecticide. These traps should be attractive to male and female beetles and would be placed near fields in spring to capture and kill SSB before they enter strawberry fields. In laboratory flight tunnel assays, female SSB are more attracted to whole wheat bread dough when male SSB are present with the dough. We have also had some female response in the flight tunnel of female beetles to volatiles collected from male SSB feeding on bread dough. We are currently working to collect enough of the attractive material to be able to identify the chemical components of the SSB specific aggregation pheromone and to begin testing blends of synthetic pheromone in our flight tunnel. The research summarized here will be used to guide placement of attract-and-kill stations to maximize the impact of traps in reducing the SSB

population and fruit damage, while minimizing the cost of using the traps for controlling the beetle.

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