Final Project Report to the NYS IPM Program, Agricultural IPM 2003-2004

TITLE: **Determining potential of crop residue in diverse production systems to increase strawberry sap beetle populations in strawberry fields**

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Abstract

Strawberry sap beetle is ranked by New York strawberry growers as the most serious insect pest in strawberries. The beetle is a generalist herbivore and has been captured on various crops other than strawberry. Adults are thought to overwinter primarily in wooded areas surrounding strawberry fields. The purpose of the this project was to identify food sources that SSB can use as alternate hosts, determine if SSB overwinter within strawberry fields to any significant extent, and develop a mark and recapture technique that can be used to quantify SSB movement between crops in the field. Female SSB oviposited while feeding on all of the 8 food sources offered, although initial oviposition occurred approximately 6 days later with apple compared to the other food sources. It seems that all foods provided are suitable for SSB reproduction to occur. SSB were caught in traps in woods bordering strawberry fields about 1.5 weeks earlier than in the strawberries and a steady progression of beetles from the woods into the fields was seen in at least two of the fields, indicating that most beetles do not overwinter in the strawberry field. Fluorescent resin marks remained visible on the adult beetles for at least 24 h after marking, making the technique a viable option for quantifying SSB movement in the field over short periods of time. The availability of a mark and recapture technique will allow investigation of the impact of alternate food sources in the field on SSB population dynamics in future field seasons.

Background and Justification

The strawberry sap beetle (SSB) is a pest of growing concern among New York strawberry growers. The beetles are widespread throughout New York, being present in all of 37 fields across 14 farms included in a 2002 statewide sampling for SSB, and are considered the number one arthropod threat to strawberries by New York Berry Growers Association members. The two pyrethroid insecticides labeled for use have variable effectiveness in the field and are broad spectrum, potentially interfering with IPM practices such as maintenance of predatory mite populations for spider mite control. 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 crop residues potentially attract SSB and enable the insect to reproduce until late in the growing season. While reports of SSB feeding on a variety of crops are numerous (Blackmer and Phelan 1992), no conclusive information is available as to which crops the beetles are capable of reproducing on other than strawberries.

The long-term objective is to determine where the beetles are going after strawberries are no longer available. A first step in understanding this critical between-crop movement is determining what crops SSB can survive and reproduce on and roughly how far adult SSB are capable of moving. The potential of a crop to support additional generations of SSB depends on food source quality, ability of the insect to access the food source, and proximity of the residue to the SSB population. Adult SSB may visit certain crops to feed, but not oviposit because the food source will not last long enough for the larvae to develop or is of insufficient nutrient value. A thick outer layer on fruit such as apples or melons may deter SSB from feeding on an otherwise suitable food source unless the fruit is damaged. At present, it is unclear just how mobile adult SSB are in the field. By studying adult SSB movement in the relatively homogenous environment of a strawberry planting, we can develop methods of quantifying sap beetle movement that can be applied to larger scale movement between crops.

Objectives

1) Identify crops that strawberry sap beetle feeds and reproduces on

2) Evaluate the extent of adult strawberry sap beetle movement within strawberry fields and the potential of quantifying beetle movement using pitfall traps

Procedures

Objective 1:

Egg production for a cohort of similar aged adult strawberry sap beetle was evaluated on 6 different foods: apple, blueberry, corn, melon, raspberry, strawberry, tart cherry, and strawberry sap beetle diet. The strawberry sap beetle diet was mixed according to directions in Peng and Williams (1990). Raspberries and tart cherries were harvested from plots at the New York State Agricultural Experiment Station while the other foods were purchased at a local grocery store. Corn was husked and all foods except diet were surface sterilized in a 5% bleach solution for at least 5 min, then allowed to dry. Items were cut for immediate use in the experiment or stored in the refrigerator.

SSB larvae were collected on 16 July 2003 from a laboratory colony maintained at 27^{o}C and 60% relative humidity with a 16 h day/ 8 h night cycle. Larvae were kept in the same conditions in a 14 cm diameter x 11.5 cm high plastic container with a 154 cm^2 opening covered with muslin. Approximately 2 cm of moistened sand lined the bottom of the containers to provide a suitable environment for larvae to pupate. Additional water was added every 2-3 days to prevent the sand from drying. A container of SSB diet was placed in the container but removed before any adults eclosed from pupation.

Two male and 2 female adult SSB were placed in each 163 mL plastic container on 26 July 2003 with a food source and a moist paper towel as an oviposition substrate. An excess of food was supplied in each container: one-tenth of an apple, 3 blueberries, one-sixth of a corn ear, approximately 22 g melon, 2 raspberries, 1 large strawberry, 2 tart cherries, or approximately 2.5 g SSB diet. Muslin cloth was placed over the opening of the container and secured with rubber bands to allow adequate ventilation. Containers were arranged in a completely randomized design with 10 replications of each food source in an controlled environment chamber set at

27°C and 60% relative humidity with a 16 h day/ 8 h night cycle. A small amount of water was used to moisten the paper towel in each container daily.

The number of eggs on the paper towel was counted every two days for 12 days and a new paper towel was placed in the container. If any beetle was found dead, the sex of the dead individual was noted and it was removed from the container. The number of eggs per living female was calculated for each time interval.

Objective 2:

Two experiments were conducted to address this objective. The first involved sampling for adult SSB along transects running from surrounding wooded habitat into strawberry fields to determine if SSB overwinter to any significant extent in the strawberry field. The second experiment evaluated the potential of assessing beetle movement in the field by marking SSB adults with fluorescent resin and recapturing marked individuals.

Four to 6 transects were placed 15 m apart in each of 5 strawberry fields bordered by wooded edges on 14 April 2003. Traps were placed at four locations along each transect: edge of wooded area, edge of strawberry field, 27.6 m into the field, and 40.8 m into field. The nitidulid inventory traps were modified from those used by Williams et al. (1994). A 0.95L polypropylene deli container was baited with approximately 30g of whole wheat bread dough wrapped in nylon fusible knit interfacing material (HTC-Handler Textile Corp, Secaucus, NJ) and secured with a rubber band. The opening of the container was screened (7 holes/cm) to exclude larger species of arthropods. A golf course cup cutter was used to create a hole in which the top of the trap was placed at soil level (Williams et al. 1994). A 30.5 x 30.5 cm piece of roofing shingle served as a rain shield and was placed over the trap and held in place with either rocks or soil. Traps were checked daily for SSB adults from 15 April to 29 May 2003, after which traps were checked every 3 days. Bait was exchanged at 3 day intervals. Traps remained in the field until 22 June. The number of male and female adults per trap were counted. All females in a trap were dissected to determine presence of eggs until 7 June when a maximum of 5 females per trap were dissected.

For the second experiment, adult SSB were captured from a strawberry field and surrounding wooded area known to have a large SSB population. Nitidulid inventory traps baited with whole wheat bread dough were left in the field for 3 days and collected on 19 June 2003. Traps were divided into 6 groups with approximately equal numbers of beetles. The mean number of beetles per trap was estimated by counting all SSB in 6 randomly selected traps. The estimated total number of SSB captured for the experiment was 10,070 with approximately 1,680 adults released in each of the 6 sites described below.

Solutions of pink, yellow, and blue fluorescent resin (South Australian Research and Development Institute, Australia) were mixed with 1 part dye to 100 parts water and applied to beetles with 180 mL pressurized aerosol spray bottles (Nalge Nunc International, Rochester NY). A different resin color was used to mark beetles to be released at each of the three sites within a single habitat type. The lid was attached and the container left in a ventilation hood for approximately 10 min. Once dry, beetles were transferred into either 0.95 L polypropylene deli containers or 15 x 15 x 5 cm plastic containers. A moist paper towel was placed in each release container to prevent desiccation of the beetles. Release containers with beetles were placed in a cooler with a small amount of ice for transport to the field.

SSB were released at a central point within a site. Each release point was surrounded by 6 transects of 5 traps emanating outwards for a total of 30 traps associated with each point. Traps in each transect were 1.10, 2.48, 3.86, 5.24, and 6.62 m from the release point. Three of the sites were located in strawberry plantings and 3 were in a mowed fallow field. Two of the strawberry plantings were first year fruiting Cavendish and Earliglow, alternating cultivars every three rows with a total of 12 rows in each planting. The third strawberry planting was second year fruiting Honeoye and Jewel, alternating cultivars every three rows with a total of 12 rows in the planting. Beetles were released on 20 June 2003 at 11 am. Containers were placed into the soil such that the container opening was approximately level with the soil.

Adults were removed from traps at approximately 24, 48, and 72 h after release and examined for presence of fluorescent resin using a UV spotlight and a dissecting scope. All beetles caught in the trap were classified as marked with one of the three resin colors or unmarked. Unmarked beetles either had no resin mark, not enough marking to clearly identify the color, or multiple colors.

Results and Discussion

Objective 1:
Female SSB oviposited while feeding on all eight food sources (Figure 1). In general, there was an increasing trend in number of eggs per female until about day 8. The exception to this was apple where very few eggs were produced before day 8 and the mean number of eggs was still increasing when the study was ended on day 12. A similar trend in delayed egg production when feeding on apple was seen in picnic beetle by Peng and Williams (1991) and could indicate that apple is a lower quality food source for nitidulids. It is obvious that SSB are willing to feed on and capable of reproducing on a wide range of crops, including many that are frequently planted adjacent to strawberry fields in New York. The extent that the beetle population is using these crops in the field will require further investigation. Crops on which SSB survival is high and the beetles are able to reproduce should be the focus of efforts to reduce the size of the overwintering SSB population. Possibilities of management strategies include a more thorough removal of crop residue near strawberry plantings or relocation of crops when possible such that strawberries are planted further away from alternate food sources, making residue in other crops unavailable to SSB.

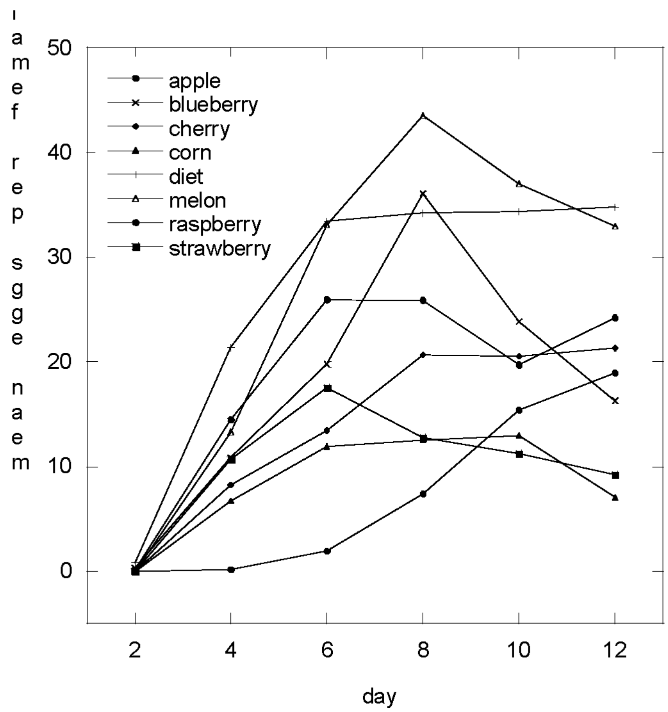

Figure 1. Mean number of eggs oviposited per female SSB over two day intervals. A cohort of 2 male and 2 female beetles were placed on one of eight food sources on day 0. Eggs were oviposited onto a moist paper towel included in a ventilated cup containing an excess of a particular food source. n=10 containers per food source.

Objective 2:

SSB were caught in traps in woods bordering strawberry fields about 1.5 weeks earlier than in the strawberries and a steady progression of beetles from the woods into the fields was seen in at least two of the fields, indicating that the beetles do not overwinter in the strawberry field to any significant extent (Figure 2). A drop in the number of SSB caught was seen after application of a pyrethroid on day 61 of the sampling. Similar trends were seen in other fields. However, this drop only lasted 2 to 3 days before trap counts returned to the previous or higher levels. A large part of the reason for the drop in SSB capture may have been a decrease in minimum temperature associated with the decreased trap counts rather than insecticide application. Even if the insecticide was the cause of the decreased trap counts, any benefits were not long-term and likely had little impact on damage to the fruit. The movement of the beetles into the field may offer an opportunity to intercept the SSB population as it colonizes strawberry fields in the spring using attract and kill traps along wooded edges.

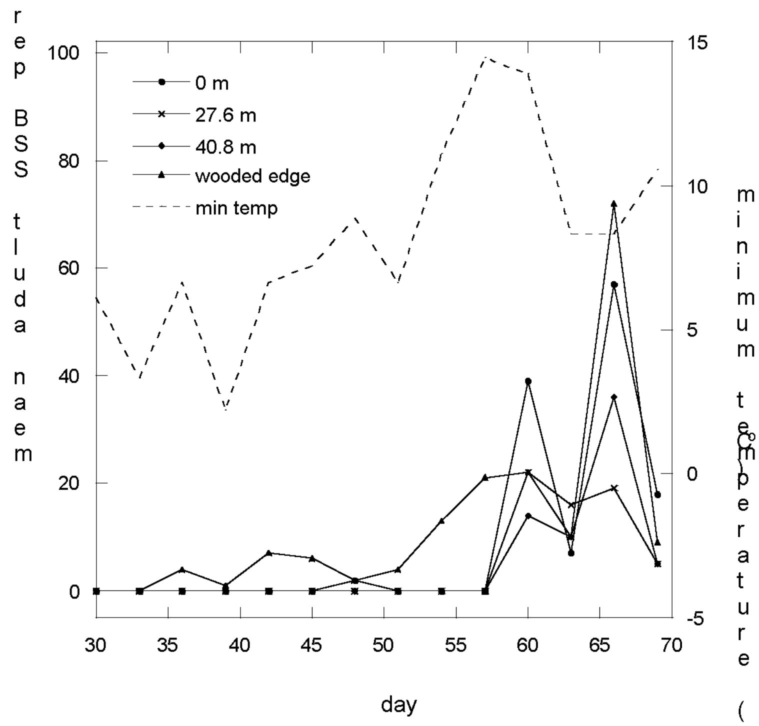

Figure 2. Mean number of strawberry sap beetle caught in traps baited with whole wheat bread dough at one of three distances along a transect into a strawberry planting or in the edge of a wooded area adjacent to the planting. One of five fields sampled is shown. Means are shown beginning 14 May 2003 and ending 22 June 2003. Four to six traps were placed at each distance or wooded edge in each field. A pyrethroid insecticide was applied on day 61.

The portion of the objective evaluating the potential of fluorescent resin for marking adult SSB indicated that the resin remains visible on the insects for at least 24 h after marking. A heavy rainfall 3 to 4 h after release made clear identification of the marks impossible after the 24 h collection in this study. Insects that were clearly marked at 24 h would likely have been in traps before the period of rainfall. Mean total number of SSB captured and the mean number marked at time of capture decreased with distance from the release point (Figure 3), with the majority of the beetles captured in the traps closest to the release point. The number of marked individuals captured was similar to the total number of individuals recovered in the first 24 h (Figure 3). Marking with resin appears to be a viable option for assessing movement of SSB over short periods of time. The technique can now be used to evaluate and quantify the impact of alternate host presence on SSB population dynamics.

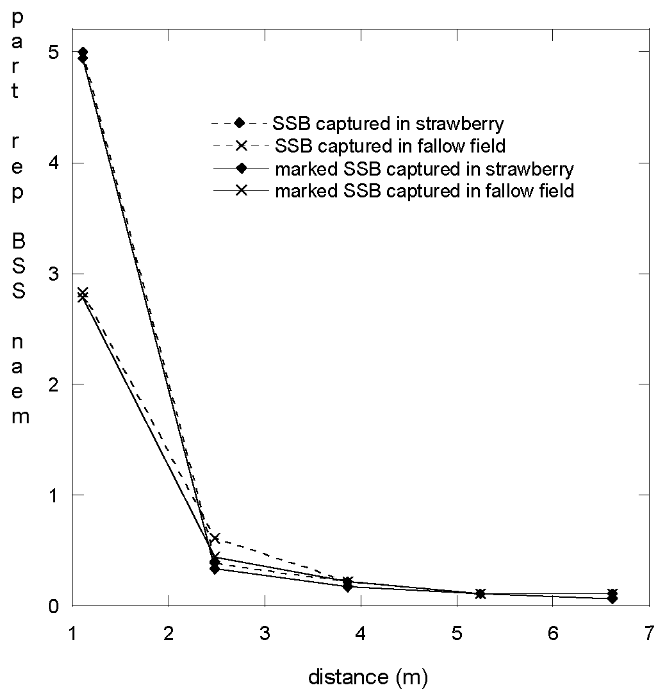

Figure 3. Mean number of marked SSB captured per trap at one of five distances along transects from a central release point in either a strawberry planting or fallow field. Approximately 1,680 adult beetles were marked with fluorescent resin and released at each site. n=3 sites per habitat.

Literature Cited

Blackmer, J.L. and P.L. Phelan. 1992. Chemical ‘generalists’ and behavioral ‘specialists’: a comparison of host finding by *Stelidota geminata* and *Stelidota octomaculata*. Entomol. Exp. Appl. 63:249-257.

Peng, C. and R.N. Williams. 1990. Multiple-species rearing diet for sap beetles (Coleoptera: Nitidulidae). Ann. Entomol. Soc. Am. 83:1155-1157.

Peng, C. and R.N. Williams. 1991. Influence of food on development, survival, fecundity, longevity, and sex ratio of *Glischrochilus quadrisignatus* (Coleoptera: Nitidulidae). Environ. Entomol. 20:205-210.