Title: A trap crop system for managing tarnished plant bug damage in strawberries

Project Leaders:
Dr. Greg Loeb, Professor, Dept. Entomology, Cornell University, NY State Ag. Exp. Stat., Geneva, NY 14456; Phone: 315-872345; Fax: 315-787-2326; Email: gme1@cornell.edu
Dr. Marvin Pritts, Professor and Chair, Dept of Horticultural Sciences, Cornell University, Ithaca, NY 14853; Phone: 607-255-1778; Fax: 607-255-0599; Email: mpp3@cornell.edu

Summary

The goal of this project was to determine the potential of using an attractive trap crop to "pull" tarnished plant bug (TPB) away from strawberry thereby reducing their abundance and damage in strawberry. We proposed to 1) Evaluate winter canola cultivars and planting practices to optimize effectiveness as a trap crop and 2) Quantify influence of winter canola on TPB abundance and damage in strawberry under field conditions.

A winter canola variety trial was seeded in the fall of 2009 and evaluated in the spring of 2010. TPB densities were assessed on three occasions between 6 May and 27 May. Adult TPB were recorded on all three of the sample dates and no significant differences were found among cultivars. Immature TPB were not present in the first two samples but were recorded on the third sampling date. The only significant difference among six treatments (five different cultivars plus a mixture of the five) with regards to density of immature TPB was recorded between the cultivar Sitro, and the treatment containing the five cultivars as a blend. Phenology of the canola was measured between 29 April and 3 June. No stark phenological differences were found among cultivars that could impact the level of effectiveness as a trap crop with perennial strawberries. All cultivars had achieved a mean stage of development of flower initiation by the first assessment on 29 April. All cultivars had achieved a mean stage of open flowers between 5 May and 11 May. Open floretes were present for all cultivars through 3 June.

Two replicated experiments, one in at the Geneva Experiment Station and the other near Ithaca, were conducted in 2010 to evaluate the influence of a winter canola border on TPB abundance and feeding damage to strawberry fruit. Both trials contained four replicated plots of the strawberry variety Jewel, with and without a winter canola border. TPB adults were predominantly found in the winter canola boundary throughout the season. That effect was stronger for the Geneva site than the Ithaca site. Immature TPB were not found during the early season. In Geneva, middle season samples indicated that immature tarnished plant bugs were found to be in higher densities in the canola associated strawberry plots than the control associated strawberry plots. In late season samples from Geneva, the density of immature tarnished plant bug was found to be greater in the winter canola border than the strawberry plots. In Ithaca, middle and late season densities of immature tarnished plant bug were relatively similar between control and canola strawberry plots, and those densities were higher than those found in the winter canola border. Harvest data from both sites combined indicated higher levels of damage on the edge of plots in comparison to the interior of plots, but there were no differences between winter canola and non-canola plots.

Introduction

Plant bugs (tarnished plant bug *Lygus lineolaris* in much of the US and western tarnished plant bug *L. hesperus* in western US) are key pests of strawberries and many other crops. The focus of this project is on the tarnished plant bug (TPB), although the biology of both species is similar. Both adult and immature TPB use their piercing and sucking mouthparts to feed on young, actively growing plant tissue, including developing strawberry fruit. In strawberries TPB feeding kills achenes and leads to misshapened or catfaced fruit that is not marketable as fresh (Handley and Pollard 1993). Given the high value of strawberry fruit, the threshold for damage from TPB is quite low and insecticide control measures are often required (Kovach et al. 1993, Bostainian et al. 1994, Pritts 2009). In addition to expense, the insecticides generally have broad-spectrum activity and as such, can disrupt natural control of arthropod pests. Newer insecticides tend not to be very effective against TPB. Thus, there is a need and interest in developing alternative approaches to their management.

The goal of this project is to determine the potential of using winter canola as a trap crop for TPB with the idea that TPB will move into the trap crop instead of strawberry where it may stay on its own accord or be treated with an insecticide. We believe winter canola is an excellent candidate as a trap crop because it flowers early in the season, prior to June-bearing strawberry, and would attract over-wintered adult TPB looking for early-season feeding and oviposition sites. In addition, seed for winter canola is relatively inexpensive, easy to grow, and a number of insecticides are registered for use. Alfalfa has been successfully used as a trap crop for the western tarnished plant *L. hesperus*, a close relative of TPB, to manage damage in cotton (Sevacherian and Stern 1974, Godfrey and Leigh 1993). We believe a similar approach could work for strawberries using winter canola.

We initiated this multi-year project in the 2008 season with support from NASGA as well as the California Strawberry Commission. Briefly, we found or accomplished the following over the past two years: 1) Winter canola, for 10 varieties tested, formed flower buds and bloomed before June-bearing strawberry. 2) Overwintered TPB readily colonized winter canola and successfully produced offspring. 3) In Geneva in 2009 we showed that TPB readily colonized the winter canola adjacent to strawberry early in the season but not strawberry. 4) TPB and TPB damage to strawberry fruit was elevated at the edge of strawberry plots adjacent to canola compared to plots without canola indicating a spill over from the canola.

Methods

Methods for evaluating winter canola varieties

Working with Mike Stamm at Kansas State University (Project leader of Winter Canola National Variety Trial) we selected five winter canola varieties (Baldur, Kronos, Sitro, KS4022, Virginia) to test under NY conditions (Stamm et al. 2009). We evaluated the five cultivars, and one entry that consisted of a blend of the five cultivars, using a complete randomized block experimental design that was seeded 15 September 2009 at a rate of 5lb/A. A replicate plot was 15 feet in length and plots were separated by 10 feet of bare ground. In the spring we assessed tarnished plant bug densities using an agricultural backpack 2-cycle aspirator (John W. Hock Co., Gainesville, FL) on 6, 17, and 27 May.

Phenology of canola was followed between 29 April and 3 June for a subset of randomly chosen individual plants from each plot. Individual plants were characterized by the stage of development: rosette, flower head present, flower head raised, open florettes, open florettes with pods, or no open florettes with pods ripening.

Methods for quantifying influence of winter canola on TPB abundance and damage in strawberry under field conditions.

In Geneva, replicated plots of June-bearing strawberry (cultivar 'Jewel') were planted in the spring of 2008 following the experimental design shown in Figure 1. This is a matted row production system with 4-foot centers and planting density of one plant per 12 inches. There are 8 rows of strawberry per plot with each row roughly 25 feet in length (area of plot = 800 ft^2). Plots are separated from each other by 40' in all directions. Orchard grass was seeded around the plots and kept mowed weekly throughout the observation period. Winter canola was seeded on one edge of half the strawberry plots (6.25' by 32' = 200 ft^2) on 15 September 2009 using a mixture of five varieties (Baldur, Kronos, Sitro, KS4022, Virginia). In Ithaca (Freeville Farm, Cornell University), a second experimental planting analogous in design to the plots established in Geneva in 2008, was established in the spring of 2009. Differences from the Geneva design included the row orientation to the canola (parallel compared to perpendicular), inter-plot vegetation (alfalfa/timothy mix compared to orchard grass), maintenance of inter-plot vegetation (not mowed weekly out of concern for impacting tarnished plant bug distribution) and conventional border vegetation (bare ground compared to mowed orchard grass).

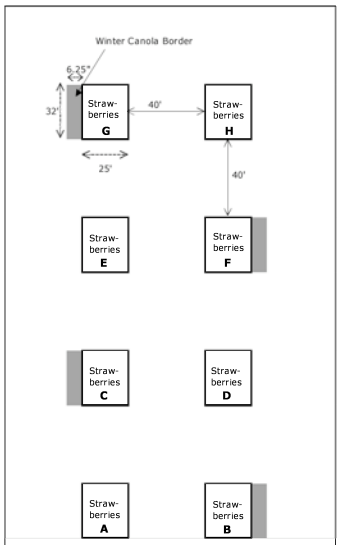


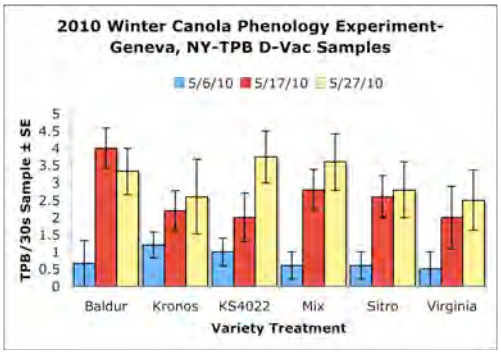
Fig. 1. Plot diagram for strawberry/canola trap crop

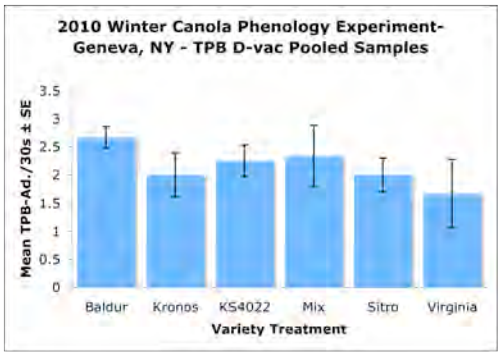
During the 2010 field season we assessed TPB abundance multiple times in canola, and at two distances into the strawberry plots (edge and interior) using an agricultural backpack 2-cycle aspirator (John W. Hock Co., Gainesville, FL). Strawberry fruit damage from TPB was evaluated for both sites from randomly selected, 0.5m linear row sections, at two distances (edge and interior) multiple times throughout the fruiting period. Fruit was characterized as either healthy, tarnish plant bug damaged (unmarketable), minor TPB damaged (marketable), and "other" damaged (unmarketable).

Results and Discussion

Evaluating winter canola varieties

Tarnished plant bug densities were assessed on three occasions between 6 May and 27 May (Figure 2). No differences among varieties were apparent for any of the individual sampling dates, or when sampling dates data were combined (Figure 3). Adult tarnished plant bugs were recorded on all three of the sample dates and no significant differences were found among cultivars. These results are consistent with previous winter canola variety assessments (10 varieties in 2009) that indicated that TPB will readily colonize winter canola in early spring prior to flowering of perennial strawberries. Additionally, these results are consistent with previous assessments that found no





Figures 2 and 3. TPB adults vacuum sampled from different canola variety treatments on different dates between 6 May and 27 May 2010 in Geneva, NY.

significant preference of variety by colonizing adult tarnished plant bug. These results suggest that varietal selection, with regards to suitability as a trap crop for TPB adults, should not adversely impact the effectiveness of winter canola attracting TPB adults in a perennial strawberry trap cropping system.

Immature tarnished plant bugs were not present in the first two samples but were recorded on the third sampling date (Figure 4). Of the six treatments in the trial, the only significant difference with regards to density of immature tarnished plant bug was recorded between the cultivar Sitro and the treatment containing the five cultivars as a blend. These results suggest that there may be variation in how well different cultivars, or combinations of cultivars, support developing TPB. This could be advantageous in a trap crop system if reduced numbers are the result of mortality as opposed to migration. These results also support previous findings that clearly indicate the ability of tarnished plant bug to reproduce and flourish in winter canola.

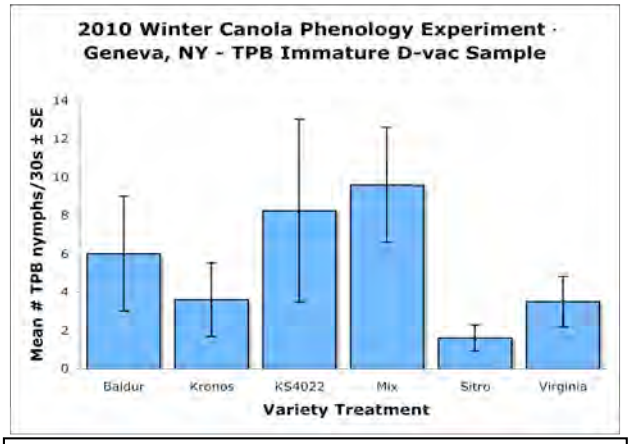


Figure 4. TPB Immatures vacuum sampled from different canola variety treatment on 27 May 2010 in Geneva, NY.

Phenology of the variety trial was measured between 29 April and 3 June (Figure 5). No stark phenological differences were found among cultivars that could impact the level of effectiveness as a trap crop with perennial strawberries. All cultivars had achieved a mean stage of development of flower initiation by the first assessment on 29 April. All cultivars had achieved a mean stage of open flowers

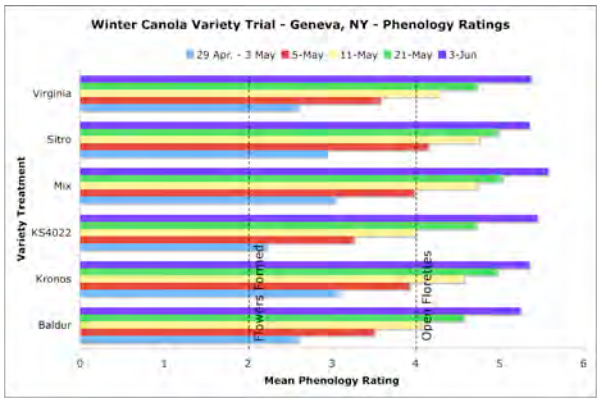


Figure 5. Phenology during 2010 of 5 winter canola varieties and a mixed entry planted at Geneva Experiment Station in mid-September 2009. Phenology rating of 1 = rosette stage and rating of 6 is only maturing seed pods.

between 5 May and 11 May. Open florettes were present for all cultivars through 3 June. These results indicate that cultivar selection should not adversely impact the effectiveness of winter canola as a trap crop in strawberries, as all cultivars that have been evaluated to date have flowered prior to flowering of strawberry, and retained a floral display throughout strawberry flowering.

Influence of winter canola on TPB abundance and damage in strawberry under field conditions

Tarnished plant bug adults were predominantly concentrated in the winter canola border throughout the season (Figure 6, Geneva and Ithaca sites combined). That effect was stronger for the Geneva site than the Ithaca site. Within strawberry plots the trend was towards higher numbers of TPB adults in plots bordered by canola, and higher on the edge than the interior. Immature tarnished plant bugs were not found during the early season. In Geneva, middle season samples indicated that immature tarnished plant bugs were more abundant in the canola associated strawberry plots than the control strawberry plots (Figure 7). In late season samples from Geneva, the density of immatures was found to be greater in the winter canola border than the strawberry plots. In Ithaca, middle and late season densities of immature tarnished plant bugs were relatively similar between plots with and without canola, and those densities were higher than those found in the winter canola border (Figure 8). Considering the results pertaining

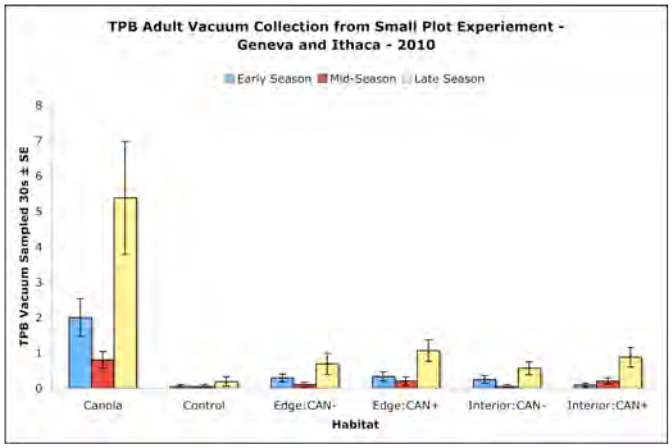
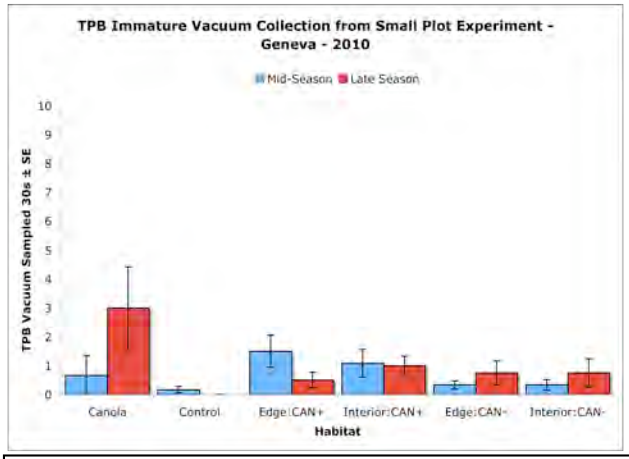
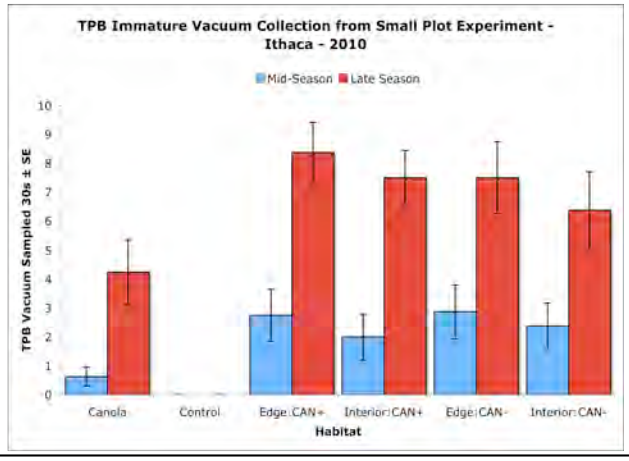


Figure 6. Number of TPB adults collected during fruiting season for border zones and interior and edge sections of strawberry with (CAN+) and without (CAN-) winter canola trap crop.





Figures 7 and 8. Number of TPB immatures collected during fruiting season for border zones and interior and edge sections of strawberry with (CAN+) and without (CAN-) winter canola trap crop.

to TPB adults (Figure 6), these results suggest that TPB immatures are possibly migrating from the winter canola border into the strawberries. Or, the survivorship of immature TPB on strawberries is higher than survivorship on winter canola. A third possibility is a difference in sampling efficiency between the two habitats (winter canola and strawberry) of capturing a representative sample of TPB immatures with our vacuum sampling method.

Harvest data from both sites indicated slightly higher levels of damage on the edge of plots in comparison to the interior of plots, but there was no difference between winter canola and non-canola plots (Figure 9).

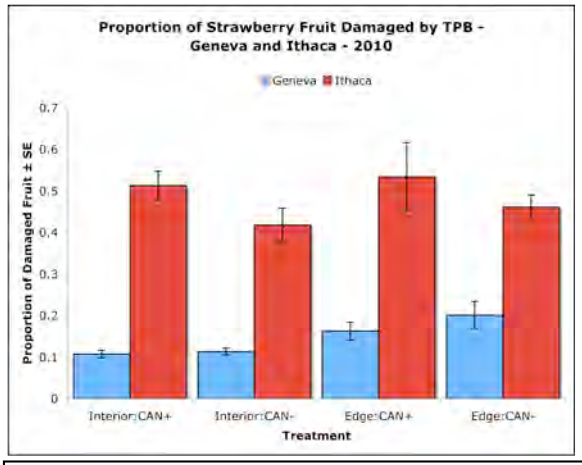


Figure 9. Number of TPB-damaged fruit in interior and edge sections of strawberry with (CAN+) and without (CAN-) winter canola

Conclusion

Results from the 2010 field season indicate significant potential for the winter canola trap crop technique but also some constraints that need to be addressed. Winter canola formed flowering structures in the spring well before June-bearing strawberry and was colonized by overwintered TPB. At the same time, strawberry, which was still in vegetative state, was not colonized. Hence, winter canola helped concentrate TPB early in the season. However, our initial results also suggest that TPB may eventually move from the canola to the edge of the strawberry plot since we observed relatively high levels of immature TPB (figure 7 and 8), and equally high levels of fruit damage in winter canola associated strawberry plots (Figure 9). The reason for this movement may, in part, be due to the canola progressing from flowering to seed maturation and being less attractive to nymphs and adults. In 2011we will test several methods to intervene. In particular, we will modify the experimental design (Figure 1) to include a winter canola border for all plots. We intend to test insecticide treatment of canola targeting early colonizing adults, separating the canola from strawberry with a bare ground buffer, or partial clipping of the canola to prolong flowering thereby maintaining a higher level of attractiveness to TPB.

Acknowledgments

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