Southern Region Small Fruit Consortium – Final Report

Title: Antifeedants, Repellants, and Organic Controls for Plant-feeding Bugs, Japanese Beetle and Green June Beetle on Caneberries

Final Report

Grant Code: 2008-13

Research Project

Personnel:

Douglas G. Pfeiffer, Professor and Fruit Entomologist

Department of Entomology, Virginia Tech, Blacksburg, VA 24061

Tel.: 540-231-4183 Fax: 540-231-9131

dgpfeiff@vt.edu

Laura Maxey, Graduate Student

Department of Entomology, Virginia Tech, Blacksburg, VA 24061

Tel.: 540-231-4183 Fax: 540-231-9131

luaram@vt.edu

Objectives:

1) Determine efficacy of antifeedants and repellants, and sublethal doses of a pyrethroid, against a two complexes of blossom and berry feeders, (1) tarnished plant bug and stink bugs, and (2) Japanese beetle and green June beetle,
2) Determine relative susceptibility of several primocane-bearing brambles toward tarnished plant bug and Japanese beetle.
3) Develop illustrated guide to TPB injury to varying berry developmental stages.

Justification:

Japanese beetles in primocane-bearing brambles pose special problems because the flowering/fruiting phenology and pesticide preharvest intervals (Pfeiffer 2007). Control of berry-feeding pests is difficult in brambles because of preharvest intervals of many materials, coupled with losses of pesticide registrations. A key pest here is Japanese beetle, which feeds on ripe berries. A material frequently used for Japanese beetle is carbaryl, but this is not appropriate in this setting because of the 7 day PHI. Tarnished plant bug is also injurious to brambles since they will feed on both flowers and fruit, as do stink bugs. The purpose of this study was to evaluate several materials that might be usable in this system, where short PHIs and low human toxicity are required.

Treatments that were evaluated in 2008 are Battalion, azadirachtin, Trilogy, Neemix and rynaxypyr. Battalion's active ingredient is deltamethrin which is a pyrethroid. This pyrethroid is less heat-sensitive than other pyrethroids and offers a fast knock-down of target pests at lower rates than other pyrethroids. Battalion is not yet registered on caneberries and the PHI varies widely on several other horticultural crops (1 day on fruiting vegetables, 3 days on cucurbits, and 21 days on pome fruits).

Azadirachtin is a repellant, antifeedant, and insect growth regulator that allows harvest the same day as application (Gowan 2008). Azadirachtin is an extract of neem oil that acts through contact or ingestion (Caldwell et al. 2005). Azadirachtin prevents insects from molting by inhibiting production of the molting hormone, ecdysone. The volatile compounds from neem also repel insects from feeding and oviposition. However, 2006 and 2007 data do not indicate any control from this product against Japanese beetles on raspberries or blackberries, which could be an artifact of the formulation used. Therefore, two additional formulations of azadirachtin, Trilogy and Neemix, were evaluated.

Rynaxypyr is the first insecticide from a new class of chemistry, the anthranilic diamides (DuPont 2007). This pesticide is of interest because it has a new mode of action. Rynaxypyr binds to insect ryanodine receptors in muscle cells, causing a release of calcium ions from internal stores into the cytoplasm. This depletion of calcium from cells results in paralysis and death. Through this specific ion channel binding rynaxypyr controls pests that are resistant to other insecticides. Rynaxypyr has been shown to impose little impact toward non-target arthropods such as parasitoids, predators and pollinators. Evidence indicates that it has no effect on human cells. Other pesticides will be applied depending on their short pre-harvest intervals and control of Japanese beetle and other bramble pests.

All experiments were conducted to compare the effect of different varieties of raspberries and blackberries on the number of Japanese beetles present (Maxey et al. 2006, 2007). In 2006 Autumn Bliss, Dinkum, Fall Gold and Heritage raspberry varieties were evaluated. It was found that there were more beetles present on Autumn Bliss and Fall Gold than on Dinkum and Heritage. In 2007 the following raspberry varieties were evaluated: Anne, Autumn Bliss, Caroline, Dinkum, Fall Gold, Heritage, Himbo Top and Prelude. More beetles were present on Prelude than all other varieties observed. Also, there were significantly fewer beetles found on Caroline, Dinkum, Heritage and Himbo Top varieties. The 2008 experiments were conducted to see if modified experimental procedures would reveal additional differences this year.

Methodology

Research was conducted in a three-year-old planting of primocane-bearing raspberries and blackberries at Kentland Farm (College of Agriculture and Life Sciences), Montgomery County. This planting is on an elevated site above the New River in southwestern Virginia (37° 12.417'N, 80° 35.513'W, 2020 ft elev.) There are 11 cultivars of raspberries and two cultivars of blackberries planted in block design. Each cultivar of caneberry is replicated in four randomized replicates of six-eight plants each. The primocane bearing raspberry cultivars include: Anne, Autumn Bliss, Caroline, Dinkum, Fall Gold, Heritage, Himbo Top, Prelude, Autumn Britten, Josephine and Nova. The two cultivars of blackberries are Prim Jim and Prim Jan. This plot is bordered by an apple orchard, trees and pasture.

Objectives 1, 2:

On 25 June, 3, 10, 17, 24 and 31 July, deltamethrin (Battalion 0.2EC) (12 fl oz/ acre), rynaxypyr (Altacor WD) (4.5 oz/ acre), azadirachtin (Neemix 4.5) (16 fl oz/acre), azadirachtin (Trilogy) (64 fl oz/acre) and a control were applied to a 2-meter section of rows, with 8 replications. The raspberry varieties used included Fall Gold, Heritage, Dinkum, Autumn Bliss, Prelude, Caroline, Himbo Top and Anne. All treatments were applied using a CO_2-powered backpack sprayer. Due to a low number of Japanese beetles percent defoliation was only analyzed as a seasonal total instead of a weekly percent defoliation. In order to determine if either the treatments or the variety affected the percent defoliation, 35 leaves were randomly digitally photographed from a 1.2-meter section each varietal- treatment combination. These photographs were then analyzed using a computer program (ImageJ) which was downloaded from: http://rsbweb.nih.gov/ij/download.html. The total area of each leaf was measured. Then the area of the damage was measured. The damaged area was divided by the total area to obtain a percent damage. To determine if treatment or variety effects on yield, berries were picked within the sprayed or control 1.2-meter section of the row for each variety. All berries collected were divided into marketable and unmarketable yields. A berry was considered marketable if it did not contain damage whereas unmarketable berries contained damage. Yield data was collected twice a week from 22 August to 7 October. Both the percent defoliation data and the yield data were then analyzed using analysis of variance followed by Fisher's HSD.

Objective 3:

Stink bug specimens were collected for identification and are being photographed. Stink bugs were caged onto berries and the resulting feeding injury was photographed. This objective expanded into an effort to videotape feeding injury to raspberries by stink bugs. Cages were also erected containing thrips infested berries.

Objective 4 (new):

In August a high population of thrips was discovered feeding in our raspberry planting, especially on the internal surface of the receptacle, where high numbers of thrips were noted, a new observation.. An additional application of the trial insecticides was made on 22 August. Thrips were counted by examining the internal surface of the receptacle on 21 August (precount) and on 25 August.

Results

In 2008 Japanese beetle numbers were dramatically reduced due to a severe drought in 2007, during the beetles' larval developmental period. Japanese beetle larvae need sufficient moisture in order to develop (Fleming 1972). The drought prevented most Japanese beetle grubs from reaching the adult stage. There was therefore dramatically reduced pressure and stress imposed on the raspberry plants this year. It was even difficult to obtain sufficient beetles for some netting trials using Japanese beetle pheromone traps.

Objective 1:

Raspberry yield: Plots treated with Battalion and Neemix produced the greatest yield (Table 1). The control, Altacor and Trilogy plots produced lower yields in 2008 than the other treated plots. The previous years' data did not show significant differences between the yields of plots treated with different treatments.

Table 1. Effects of four chemical treatments and an untreated control on harvested grams per 1.2 meter of row in a raspberry planting at Kentland Farm (Montgomery County Virginia).

Treatment	Battalion	Neemix	Control	Altacor	Trilogy
Yield (g)	103.2 a	91.6 ab	80.2 bc	77.9 bc	69.7 c

Means in a column followed by the same letter are not significantly different, α=0.10 (ANOVA and Fisher's protected LSD test were performed on untransformed means).

Raspberry Percent Defoliation: Battalion and Altacor treated plots had less defoliation (Table 2). In 2007, plots treated with Battalion had the least number of Japanese beetles present (Maxey et al. 2007). Therefore, Battalion repels beetles and defers feeding. The control and the two azadirachtin formulations had the greatest defoliation in 2008. Therefore, the formulation of azadirachtin was probably not the cause for the lack of control in 2007 because all formulations of azadirachtin that were used in this system provided no reduction in defoliation.

Table 2. Effects of four chemical treatments and an untreated control on percent foliar damage per 1.2 m row in a raspberry planting at Kentland Farm (Montgomery County Virginia).

Treatment	Control	Trilogy	Neemix	Altacor	Battalion
% Defoliation	6.00 a	4.63 a	4.11 ab	2.59 bc	2.14 c

Means in a column followed by the same letter are not significantly different, α=0.05 ANOVA and Fishe protected LSD test were performed on arc sine transformed means.

Objective 2:

Autumn Bliss, Heritage, Caroline and Dinkum varieties produced the greatest yield in 2008 (Table 3). The varieties Prelude, Anne, Fall Gold and Himbo Top produced the least yield.

Table 3. Differences among eight primocane-bearing raspberry cultivars in harvested grams per 1.2 m of row at Kentland Farm (Montgomery County Virginia).

Treatment	Autumn Bliss	Heritage	Caroline	Dinkum	Himbo Top	Fall Gold	Anne	Prelude
Yield (g)	120.4 a	108.38 ab	105.3 ab	94.88 b	68.18 c	64.46 c	58.84 c	55.68 c

Means in a column followed by the same letter are not significantly different, α=0.05 (ANOVA and Fisher's protected LSD test were performed on untransformed means).

Raspberry Percent Defoliation: Prelude, Autumn Bliss, Fall Gold, Heritage and Anne varieties had the greatest defoliation (Table 4). Dinkum, Caroline and Himbo Top varieties had less defoliation which shows that these varieties are less preferred by the Japanese beetles.

Table 4. Differences among eight primocane-bearing raspberry cultivars on percent foliar damage per 1.2 m of row in a raspberry planting at Kentland Farm (Montgomery County Virginia).								
Variety	Prelude	Autumn Bliss	Fall Gold	Heritage	Anne	Himbo Top	Caroline	Dinkum
% Defoliation	5.60 a	5.14 ab	4.96 ab	3.74 abc	3.54 abc	3.26 bc	2.54 c	2.36 c

Means in a column followed by the same letter are not significantly different, α=0.10 ANOVA and Fisher's protected LSD test were performed on arc sine transformed means.

Objective 3:

Analysis of images and video method is continuing. It appears that stink bugs often feed by inserting the proboscis in the groove between drupelets (Fig. 1A). In some berries, cracks were seen to develop in these grooves on berries that had been caged with stink bugs (Fig. 1B). These drupelets sometimes collapsed (Fig. 1C). Fig. 1D shows a berry that had been caged with stink bugs next to a control berry. Additionally, single white drupelets were seen on berries with high thrips numbers (Fig. 2). This symptom had earlier been the source of confusion.

In the future, with greater pressure from Japanese beetles, the same treatments should be applied to the same varieties. The resulting data will further support or not support these findings. The beetles should be bagged onto the plants and the leaves should be analyzed with the same methods. The bagged experiments will show a better representation of the damage caused by the beetles. Also, bioassays should be conducted to see what happens when the beetles are directly exposed to the treatments.

Objective 4 (new):

Thrips were counted in receptacles of berries and compared with pre-treatment counts. Thrips populations had increased in the four days since the first count in the control treatment (19%), as well as Altacor (12%) and Trilogy (47%). However, Battalion produced an 83% reduction in thrips numbers, and Neemix reduced thrips numbers by 42%. Statistical analysis is continuing, as well as varietal differences.

Conclusions

Battalion, and Neemix treated plants had the highest yields of berries, although Neemix was not significantly different from the control. Trilogy and Altacor did not produce higher yields than the control. However, Trilogy, along with Battalion, reduced defoliation by Japanese beetle. It is noteworthy that the formulations of azadirachtin did not perform in the same manner towards Japanese beetle and thrips.

Neither the treatments applied nor the variety had an effect the percentage of the fruit that was marketable, the total weight of the yield that was marketable or the total weight of the yield that was unmarketable. The only significant differences found were in the total yield for each variety and for each applied treatment.

Dinkum, Caroline and Himbo Top appeared to be avoided by Japanese beetle. It remains to be seen if these differences would hold up in large plantings.

Analysis of stink bug feeding impact on berries is continuing. However, preliminary data indicate that stink bug feeding may cause splitting in the grooves between drupelets, sometimes accompanied by drupelet collapse. Thrips injury analysis is still limited, but thrips may be responsible for the symptom of individual white drupelets.

Impact Statement

This project has strengthened the case for the use of Battalion (deltamethrin) in caneberry production. The efficacy seen earlier against Japanese beetle was confirmed, and further data were collected showing efficacy against thrips. We made progress in determining feeding injury of stink bugs feeding on berries, as well as intriguing indications of thrips feeding symptoms. A successful method of quantifying percent defoliation was demonstrated. This will be helpful in further studies of foliar feeders in caneberries.

References

Caldwell, B., E. Rosen, E. Sideman, A. Shelton and C. Smart. 2005. Resource Guide for Organic Insect and Disease Management. New York State Agricultural Experiment Station, Geneva, NY, USA.

DuPont. 2007. Rynaxypyr insect control. Technical Bulletin. Retrieved March 16 2008: http://www2.dupont.com/Production_Agriculture/en_US/assets/downloads/pdfs/Rynaxypyr_Tech_Bulletin.pdf

Fleming, W. E. 1972. Biology of the Japanese beetle. U.S. Dept. Agric. Tech. Bull. 1449. 129 p.

Gowan. 2008. Aza-Direct label. CDMS web site. Retrieved March 16 2008: http://www.cdms.net/LDat/ld48H007.pdf

Maxey, L. M., C. A. Laub, Z. X. Shen, W. T. Mays, A. K. Wallingford and D. G. Pfeiffer. 2006. Insect control and varietal comparisons in primocane-bearing caneberries. Proc. 83rd Cumberland-Shenandoah Fruit Workers Conf.

Maxey, L. M., C. A. Laub, R. S. Mays and D. G. Pfeiffer. 2007. Japanese beetle control and varietal comparisons in primocane-bearing caneberries. Proc. 83rd Cumberland-Shenandoah Fruit Workers Conf.

Pfeiffer, D. G. 2007. Thrips in caneberry crops. The Bramble 22(2): 4-6.

Publications arising from this research:

While further publications are planned, to date two conference proceedings articles have been produced. The Cumberland-Shenandoah Fruit Workers Conference audience includes fruit research and extension personnel mainly from 6 mid-Atlantic states (but ranging from New England to Florida).

Maxey, L. M., C. A. Laub, Z. X. Shen, W. T. Mays, A. K. Wallingford and D. G. Pfeiffer. 2006. Insect control and varietal comparisons in primocane-bearing caneberries. Proc. 83rd Cumberland-Shenandoah Fruit Workers Conf.

Maxey, L. M., C. A. Laub, R. S. Mays and D. G. Pfeiffer. 2007. Japanese beetle control and varietal comparisons in primocane-bearing caneberries. Proc. 83rd Cumberland-Shenandoah Fruit Workers Conf.

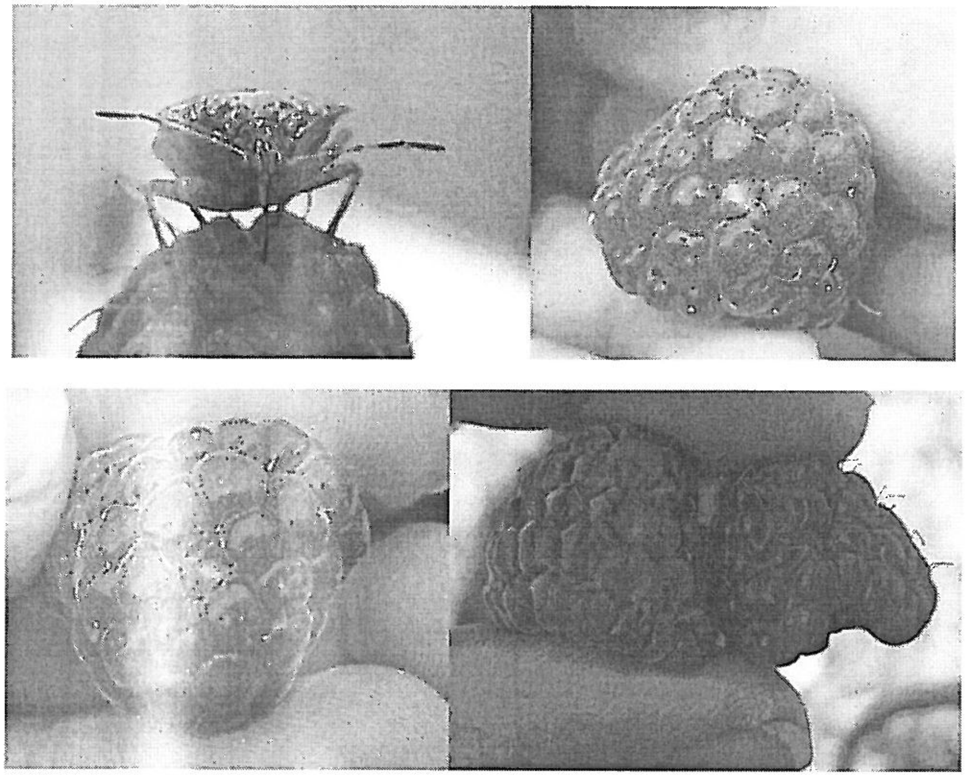

Fig. 1. A. Stink bug feeding on ripe raspberry. B. Splits evident at edge of drupelet of stink bug-injured berry. C. Splitting accompanied by drupelet collapse. D. Injured raspberry with control berry.

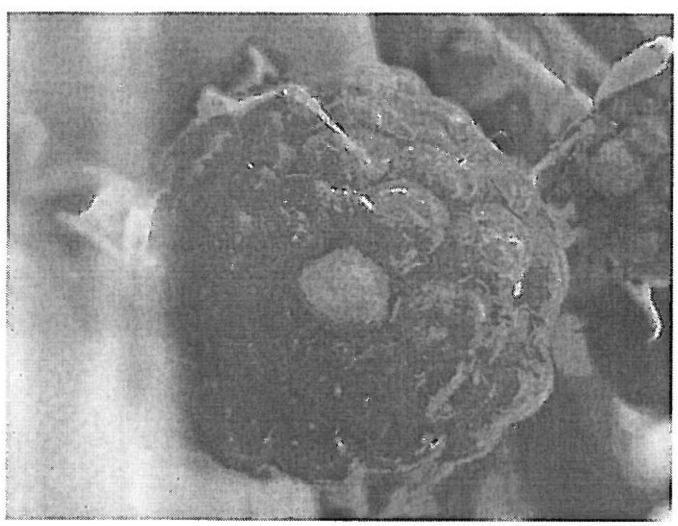

Fig. 2. Individual white drupelet on berry with high thrips numbers (note thrips on berry).