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: 2007-12

Research Project

Personnel:

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Objectives:

1) Determine efficacy of antifeedants and repellants, and two pyrethroids 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.

Methodologies:

A chemical control trial was initiated in a new caneberry planting at Kentland Farm, a research facility of the College of Agriculture and Life Sciences at Virginia Tech. A pyrethroid that was the most successful treatment in 2006 (deltamethrin (Battalion)), a compound of novel chemistry, metaflumizone (Alverde), an organically-approved botanical labeled for JB (azadirachtin (Aza-Direct)), and two purported biodynamic combinations, requested by growers (honey/milk, and lime/alum (or agricultural lime/aluminum potassium sulfate), the latter cited from Bader 2006) were applied to a varietal planting of primocane-bearing raspberries, and compared with an untreated control. In a block of two varieties of primocane-bearing blackberries (PrimJim and PrimJan), several organically approved materials were compared with two pyrethroids (bifenthrin (Capture) and deltamethrin (Battalion)) and an untreated control. These were capsaicin (Hot Pepper Wax), thyme oil (Proud), and potassium bicarbonate (Agricure).

On 19, 27 June, and 4, 9, 18, 26 July and 11, 24 August, deltamethrin (Battalion 0.2EC) (12 fl oz/ acre), azadirachtin (AzaDirect 1.2%) (2 pt/acre), metaflumizone (Alverde), honey/milk (1 gal milk, 12 fl oz honey and 9 gal water), and lime/alum 1 lb hydrated lime, 5 oz alum and 10 gal water) were applied to a 2-meter section of row, with eight replications. Plants were blocked on the following varieties of raspberries: Autumn Bliss, Dinkum, Fall Gold, Heritage, Prelude Caroline, Himbo Top and Anne (the first four were also used in 2006; the last four were newly included this year). On the same dates deltamethrin (Battalion 0.2EC) (12 fl oz/ acre), bifenthrin (Capture 2EC) (6.4 fl oz/acre), capsaicin (Hot Pepper Wax 0.00018%) (600 fl oz/ acre), thyme oil (Proud 3) (1 qt/25gal/acre), potassium bicarbonate (Agricure 85) (5 lbs/ acre) were applied to PrimJim and PrimJan varieties of blackberries using a randomized complete block design, blocking on variety. All treatments were applied using a CO_2-powered backpack sprayer.

After sprays were applied, a known number of Japanese beetles was contained on treated leaves with nylon netting. Mortality and leaf feeding were noted the next day. Starting on 26 June, the plants were carefully observed twice a week in an attempt to count all the beetles present in the marked off plots. The plots were observed twice a week until the number of beetles present dropped dramatically. The data were analyzed using analysis of variance followed by Fisher's HSD. Fruit were harvested every Tuesday and Friday between 14 August and 29 September (Fig. 1).

Results:
Objective 1:
Raspberry: Data from Japanese beetle counts in the chemical treatments in raspberry are presented in Table 1, for sample dates where there were significant treatment differences. On 26 June, there were significantly more beetles present on plots treated with the Aza-Direct and honey-milk treatments; this effect was also seen on 29 June for honey-milk treatment. On 2 July, beetle numbers in the control increased. Beetle numbers in the lime/alum treatment were significantly lower than the other chemical treatments. On 5 July, Battalion and Lime-Alum has significantly fewer beetles than other treatments. The next four dates shows that the Lime-Alum and Battalion treatments continued to control the numbers of beetles present. On 12 and 17 July, Aza-Direct controlled beetles, though not to the degree of Battalion and lime-alum. The last column in Table 1 shows seasonal means for each treatment. Only two treatments were significantly lower than the control, Battalion and lime-alum.

Blackberry: Japanese beetle count data from the blackberry trial are included in Table 2. On June 29th there were significantly fewer beetles on the plots treated with Agricure, Battalion and Capture than the control. This is the only date on which Agricure exerted an effect, and numbers in the control were low. On 5 July, there were lower numbers present in the Battalion treated plots only. Battalion and Capture provided significant beetle reductions on 12 July. The last column in Table 2 contains seasonal means.

Battalion and Capture provided significant control over the season. Control by Battalion was the most consistent.

Caged beetle data are still being analyzed, with calculation of leaf area loss in the treatments. The results will be reported at grower meetings and publications as noted below.

Objective 2:

Raspberry: Table 3 shows the varietal effects on the number of Japanese beetles present. Again only the dates with a significant differences in the numbers present were compared. On all of the dates shown here, there were always significantly fewer numbers of beetles present on the Dinkum, Heritage and Himbo Top varieties. The same pattern was seen with seasonal totals. When seasonal totals were considered, Prelude contained high populations. When we look at the totals for the year we see that there were significantly fewer beetles on the Caroline, Dinkum, Heritage and Himbo top varieties. Anne, Autumn Bliss and Fall Gold varieties had intermediate numbers of beetles present. As for the Prelude variety this data shows that it wouldn't be your best choice if you didn't want Japanese beetles.

Blackberry: There were significantly fewer Japanese beetles on the PrimJan varieties than on the PrimJan varieties (Table 4); this was consistent throughout the season, and was the same pattern seen in 2006.

Marketable berry evaluation: In this year's study, there were no significant differences in marketable fruit among the chemical control treatments. There were, however, varietal differences in marketable fruit. Autumn Bliss had the highest proportion of marketable fruit and Heritage had the lowest (Table 5). Also, even though Prelude had highest levels of Japanese beetles on the plant, a high proportion (83%) of the fruit was marketable. In blackberries, there was a significantly greater proportion of marketable fruit in PrimJim (71.5%) compared with PrimJan (45.1%), despite there being a greater number of Japanese beetles being found on PrimJim.

Table 1. Effects of three chemical treatments with an untreated control on numbers of Japanese beetles per 2 m of row in a raspberry planting at Kentland Farm (Montgomery County, 2007).

Trt	26 Jun	29 Jun	2 Jul	5 Jul	9 Jul	12 Jul	17 Jul	20 Jul	**Year Total**
Alverde	0.0b	1.0b	6.6a	16.3a	10.5ab	10.5ab	9.1b	11.6 a	**67.3a**
Battalion	0.1b	0.1b	6.4a	1.6b	4.3bc	2.5c	7.0b	2.5b	**25.0 b**
Lime-Alum	0.0b	0.1b	0.3b	0.4b	1.6c	0.4c	6.5b	1.3b	**11.8 b**
Aza-Direct	0.6a	2.1b	8.8a	16.9a	9.5ab	8.1b	9.6b	5.9ab	**62.8 a**
Honey-Milk	0.9a	5.4a	11.9a	21.6a	16.3a	13.8ab	12.9b	7.1a	**92.8 a**
Control	0.0b	1.8b	5.0ab	12.8a	14.3a	17.0a	23.8a	9.3 a	**86.9 a**

Means in a column followed by the same letter are not significantly different, $\alpha=0.05$ (Fisher's protected LSD test, following $((x+0.5)^{-0.5})$ transformation).

Table 2. Effects of five chemical treatments with an untreated control on numbers of Japanese beetles per 2 m of row in a blackberry planting at Kentland Farm (Montgomery County, 2007).

Treatment	**29 June**	**5 July**	**12 July**	**Year Total**
Agricure	**0.0c**	**7.3ab**	**7.0ab**	**44.8ab**
Battalion	**0.0c**	**2.3c**	**2.5b**	**15.3c**
Capture	**0.3bc**	**3.8bc**	**2.0b**	**28.0bc**
Hot Pepper Wax	**2.5ab**	**8.3ab**	**12.3a**	**54.5ab**
Proud	**3.8a**	**12.0a**	**8.5ab**	**46.8ab**
Control	**3.0ab**	**8.3ab**	**17.3a**	**59.0a**

Means in a column followed by the same letter are not significantly different, $\alpha=0.05$ (Fisher's protected LSD test, following $((x+0.5)^{-0.5})$ transformation).

Table 3. Differences among eight primocane-bearing raspberry cultivars in numbers of Japanese beetles per 2 m of row at Kentland Farm (Montgomery County, 2007).

Variety	5 Jul	9 Jul	17 Jul	20 Jul	Year Total
Anne	12.0ab	5.8b	10.3ab	4.2b	50.5bc
Autumn Bliss	5.7b	11.8a	13.5a	8.5b	56.3bc
Caroline	9.8ab	7.2b	4.2b	1.5b	40.2c
Dinkum	5.0b	6.7b	7.8b	2.7b	37.2c
Fall Gold	22.8a	13.2a	15.7a	4.0b	80.2b
Heritage	6.8b	4.3b	10.2b	2.3b	38.2c
Himbo Top	3.3b	4.8b	8.8b	5.5b	34.5c
Prelude	27.2a	21.3a	21.3a	21.5a	124.8a

Means in a column followed by the same letter are not significantly different, $\alpha=0.05$ (Fisher's protected LSD test, following $((x+0.5)^{-0.5})$ transformation).

Table 4. Differences among two primocane-bearing blackberry cultivars in numbers of Japanese beetles per 2 m of row at Kentland Farm (Montgomery County, 2007)

Variety	12 Jul	17 Jul	20 Jul	Year Total
PrimJim	3.4a	3.5a	2.0a	56.4a
PrimJan	1.8b	1.8b	1.2b	26.3b

Means in a column followed by the same letter are not significantly different, $\alpha=0.05$ (Fisher's protected LSD test, following $((x+0.5)^{-0.5})$ transformation).

Table 5. Differences among eight primocane-bearing raspberry cultivars in percent of the yield that was marketable from the year's total yield at Kentland Farm (Montgomery County, 2007).

Variety	**% Marketable Fruit**
Autumn Bliss	**87.2a**
Fall Gold	**83.6ab**
Himbo Top	**83.5ab**
Prelude	**82.9ab**
Dinkum	**81.8b**
Anne	**81.0bc**
Caroline	**76.81cd**
Heritage	**75.5d**

Conclusions: In the raspberry trial, only Battalion and lime alum provided significant reductions of Japanese beetle numbers when averaged over the season. Aza-Direct reduced numbers on two dates in July. Alverde reduced numbers on a single date, July 17. The honey-milk blend, a recipe suggested by two different growers, provided no control; in fact Japanese beetle numbers were significantly higher than in the untreated control on 29 June and 2 July. Numbers also appeared higher on these plants on 5 and 12 July, though these differences were not significant. The lime alum treatment, while effective at reducing Japanese beetle numbers, is unacceptable because of residues on the crop (Fig. 2).

In the blackberry trial, Battalion provided the most consistent control. Capture also provided significant control over the season. The only other significant effect was from Agricure, which reduced Japanese beetle numbers on the first date, when populations were still low.

Significant varietal effects on Japanese beetle populations were noted. Among the raspberries, Dinkum, Heritage and Himbo Top consistently had low Japanese beetle numbers. Prelude tended to have higher Japanese beetle populations, with Anne, Autumn Bliss, Caroline and Fall Gold intermediate. As in 2006, PrimJim was preferred over PrimJan among the blackberries.

As stated above, preharvest intervals (PHIs) need to examined in order to determine a fit with bramble production; intervals longer than 3 days are unlikely to be practical for growers. The following table contains PHI values for the products used in these trials.

Preharvest intervals (days) of materials employed:

Registered on brambles:
Capture – 3 days
Proud – 0 d
Agricure – 0 d
AzaDirect - 0 d

Not registered on brambles (PHI from other labeled crops):
Battalion – fruiting vegetables – 1d; cucurbits – 3 d; pome fruits - 21 d
Alverde – fruiting vegetables – 3 d

Plans for future research: Further work is planned under each of the above objectives. Additional data are needed for some of the pesticides employed in 2007. Some materials that showed no effect in 2006 provided some degree of control in 2007. Aza-Direct should be applied before the onset of adult beetle activity. Susceptibility of this wider range of cultivars will continue to be evaluated. Another issue relates to the higher numbers of beetles on some treated plants after longer intervals. The use of bags to study effects on know numbers of beetles appears promising and will continue in 2008. This will be especially helpful in studies on Japanese beetle in years following drought years, making research less reliant on suitable environmental conditions. The basis of varietal differences in attraction to Japanese beetle observed in this study should be determined.

Effect on marketable berries: In this year's study, there was no difference in marketable fruit, though the beetles may be found feeding on berries. Further data are needed on the effect of beetle feeding on treated versus untreated berries.

Impact Statements:

Control of Japanese beetle in primocane-bearing brambles: Of the materials tested here, two pyrethroids provided control of this key pest (Battalion and to a somewhat lesser degree, Capture). If brambles can be added to the Battalion label, these will be useful tools for producers. Two biodynamic preparations were shown to have no utility, in fact one sometimes elevated Japanese beetle numbers.

Varietal differences among brambles: Himbo Top, Dinkum and Heritage were less attractive to adult Japanese beetles. Prelude was preferred by adult beetles. This might aid planting decisions, although population differences in larger blocks will need to be evaluated. Among the blackberries, PrimJan was consistently less attractive than PrimJim; this could be another factor in cultivar choice as well, with the same caution as with raspberries. In general, there were fewer Japanese beetles in the blackberries than in the raspberries.

Contribution to student training: This project contributed to the training of two students, primarily an undergraduate with an interest in fruit production, Ms Laura Maxey, and a graduate student involved in the fruit IPM program, Ms Anna Wallingford.

Dissemination of information: In addition to this project report, information has been and will be shared through several venues. Results were shared with other fruit entomologists at an annual fruit workers' conference (Cumberland-Shenandoah Fruit Workers Conference, Winchester VA, an annual meeting of fruit specialists from VA, NC, SC, WV, PA, NJ, NY, and USDA) (the article to be submitted to the written proceedings is attached). Material from this project will be included in a presentation this winter at the Mid-Atlantic Fruit and Vegetable Conference, in Hershey PA, a planned bramble growers meeting in North Carolina, as well as other venues. Control and biological information has been updated in the NABGA-sponsored Virginia Tech Bramble IPM web sit (Pfeiffer et al. 2007a, available in both conventional desktop or PDA-ready formats (http://www.virginiafruit.ento.vt.edu/NABGAIPMSite/NABGAIPMHome.html)). Results will also be shared at meetings with small fruit producers, as well as reported in a a listserv for bramble-related issues maintained at Virginia Tech and supported by the North American Bramble Growers Association. Data will be used to update extension recommendations (Pfeiffer et al. 2007b).

References (* resulting from this study, ** modified based on this study):

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Fig. 1. Berry harvest in raspberry varietal planting following Japanese beetle treatments.

Fig. 2. Residues on raspberry plants following spray with lime/alum treatment.