Rosy Apple Aphid Insecticide Efficacy Trial
2012

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Objectives:
To evaluate the efficacy of a new systemic insecticide from Bayer CropScience, flupyradifurone (Sivanto 200SL; numbered compound name, BYI02960), applied at multiple rates and compared with the neonicotinoid insecticide Admire Pro for control of rosy apple aphid (*Dysaphis plantaginea*) in apple. Green apple aphid, *Aphis pomi*, was present in the orchard, and so insecticide efficacy against this aphid was also evaluated. Sivanto is in a new class of insecticides, Butenolide. It has fast uptake by plants and translaminar movement. Bayer CropScience anticipates registration of Sivanto in 2014.

Methods:
Experimental Design
The study was conducted in a 2-acre apple orchard planted in 2006 at the Utah State University research farm in Kaysville, UT (Davis County). Plot design was a randomized complete block with four replicates per treatment. Plots were a single row wide by 3 trees in length (12 ft X 20 ft tree and row spacing, respectively = 20 ft wide X 36 ft long or 0.02 acre per plot). All blocks were placed in the eastern third of the orchard with the apple cultivar 'Fuji' (see plot map). Treatments were applied a single time on May 11 with an orchard air blast sprayer at 140 psi and 100 gpa. This spray pressure and rate provided complete coverage of the trees. Treatments were applied to both sides of each row in a plot. Apple phenology was late petal fall at the time of treatment application.

Treatments
1. Untreated control (no spray)
2. Sivanto at 3.5 oz/acre + 0.25% v/v horticulture oil
3. Sivanto at 5.2 oz/acre + 0.25% v/v horticulture oil
4. Sivanto at 8.7 oz/acre + 0.25% v/v horticulture oil
5. Admire Pro at 2.8 oz/acre + 0.25% v/v horticulture oil

Aphid Sampling
Aphids were sampled 2-days pre-treatment on May 9; and 4-, 12-, 18-, and 26-days post-treatment on May 15, 23, and 29, and June 6, respectively. Two types of aphid counts were conducted on the center tree of each plot on each sample date: 1) the number of aphid-infested shoots per 50 shoots (infested with rosy apple aphid and/or green apple aphid) and 2) the number of aphids, predators, and aphid mummies (parasitized aphids) per shoot for 5 infested shoots per tree. On the pre-treatment sample date, for the center tree in each plot, five aphid-infested shoots were randomly selected and marked with flagging tape. If there was less than five infested shoots, than all that were present were flagged. More infested shoots up to five per tree were marked on subsequent sample dates. Rosy apple aphid, green apple aphid, aphid predators, and aphid mummies were identified and counted. Predator types

found included syrphid fly eggs and larvae; green lacewing eggs and larvae; ladybeetle eggs, larvae, and adults; western flower thrips adults; and minute pirate bug (Orius) nymphs and adults.

Crop Safety Assessment

On each sample date and through late July, leaves and fruits of treated trees were visually assessed for symptoms of phytotoxicity, including discoloration, russet, "burn", shriveling, or puckering.

Data Analyses

Because of low densities of predators, counts for all predator species were combined for comparison among treatments. To meet normality assumptions, data were square root-transformed before analysis. Actual means are reported in the table and figures. On each sample date, the number of infested shoots and numbers of aphids, predators, and aphid mummies per shoot were compared among treatments with analysis of variance (PROC MIXED, SAS version 9.2). When means were significantly different among treatments, they were separated with Tukey's test (α = 0.05).

Results:

Shoot Infestation by Aphids

Pre-treatment on May 9, the mean number of aphid-infested shoots ranged from approx. 3 to 6 per tree, and were not different among plots (Table 1 and Fig. 1). Infested shoot counts included those with rosy and/or green apple aphid. In untreated plots, shoot infestation increased to highest levels on May 23 and 29, and only declined slightly be the end of the trial on June 6. On May 15, 23, and 29 (4-, 12- and 18-days post-treatment, respectively), shoot infestation was significantly different among treatments. On 4-days post-treatment, shoot infestation was lowest in the highest rate of Sivanto (8.7 oz per acre) and in Admire Pro plots. On 12-days post-treatment, there were no differences among insecticide treatments, and all were less than the untreated control. By 18-days post-treatment, only Admire Pro had significantly fewer aphid-infested shoots than the untreated control; however, the differences among insecticide treatments were slight. The number of aphid infested shoots gradually increased in all insecticide treatments during the course of the study and by 26-days post-treatment there were no differences among treatments, and all insecticides were similar to the untreated control. The increase in shoot infestation during the study was primarily due to increasing green apple aphid densities as rosy apple aphid densities declined over time (see Figs. 2 and 3).

Rosy Apple Aphid

Densities of rosy apple aphids on shoots were variable among treatments on the pre-treatment sampling date, but they did not differ significantly (Fig. 2). Rosy apple aphid densities declined quickly by 4-days post-treatment in the two higher rates of Sivanto and Admire Pro, while densities did not decline in the lowest rate of Sivanto and the untreated control on 4-days post-treatment (Table 1 and Fig. 2). From 4- to 18-days post-treatment, the two higher rates of Sivanto and Admire Pro significantly reduced densities of rosy apple aphids as compared to the untreated control (Fig. 2). The lowest rate of Sivanto was the slowest insecticide treatment to reduce rosy apple aphid densities after application. By 26-days post-treatment (June 6), densities of rosy apple aphid had declined to zero or near zero in all treatments (Table 1).

Green Apple Aphid
In contrast to rosy apple aphid population dynamics, green apple aphids were very low at pre-treatment and increased throughout the trial period in all treatments (Table 1 and Fig. 3). There were no differences among treatments on any date. This result is in sharp contrast to the 2011 trial where all rates of Sivanto and Admire Pro significantly reduced green apple aphid densities as compared to the untreated control.

Predators
Densities of aphid predators were low throughout the trial, and did not exceed 0.8 per shoot, except in the highest rate of Sivanto on 26-days post-treatment when they reached a mean of 1.2 total predators per shoot (Table 1 and Fig. 4). This high predator count for the Sivanto treatment was primarily caused by a large cluster of lady beetle eggs (19 eggs) on one shoot. Thrips and syrphid flies were the most abundant predators observed. Although numbers of all predators combined was lower in most insecticide-treated plots during the latter half of the trial, there were no significant differences among treatments due to the low densities (Fig. 4).

Aphid Mummies
Parasitized rosy apple aphids were observed primarily in the latter half of the trial period (Table 1 and Fig. 5). There were significantly more aphid mummies in the untreated control plots on 18-days post-treatment, and a general trend for more mummies in the untreated control also on 12- and 26-days post-treatment (Fig. 5). The higher number of parasitized rosy apple aphids in the untreated control corresponded to where there were higher densities of aphids to available to parasitize.

Crop Safety
There were no symptoms of phytoxicity observed in any treatment plot during or after the trial.

Conclusions:
The two higher rates of Sivanto and Admire Pro performed well in reducing the number of aphid-infested shoots and rosy apple aphid densities on shoots. There was no difference in performance of the two higher rates of Sivanto, 5.2 and 8.7 oz per acre, in reducing rosy apple aphid infestations more quickly and for longer duration. In sharp contrast to results in 2011, none of the insecticide treatments were effective in reducing green apple aphid. The 2012 trial was initiated one month earlier than in 2011 due to the warm spring and more advanced growing season in 2012. Insecticides were applied during late petal fall in 2012 while they were applied at a slightly later tree phenology in 2011, fruit diameter ¼ to 1/3 inch. This slight difference should not have affected the performance of the insecticides. Furthermore, green and rosy apple aphid densities were three to four times higher in 2011 than in2012. Bayer Crop Science recommended application of Sivanto during bloom; however, we waited to begin the trial until rosy apple aphids were evident in order to select study trees that would have adequate populations.

Predator densities were relatively low during the trial and none of the insecticides significantly reduced their densities as compared to the untreated plots. Rosy apple aphids were parasitized at substantially higher rates in 2012 as compared to 2011. The presence of aphid mummies in 2011 was so low that they were only recorded as a side note on count sheets a couple of times. Parasitism was significantly reduced in all insecticide treatments as compared to the untreated control, but this was primarily caused by the higher densities of rosy apple aphids available in the untreated control plots.

In conclusion, the two highest rates of Sivanto and Admire Pro performed the best in suppressing rosy apple aphids for up to 26-days post-treatment. In contrast, Sivanto and Admire Pro did not suppress green apple aphid. Perhaps green apple aphid densities were too low for discernible differences among treatments.

Table 1. Effects of insecticide treatments on mean number of aphid-infested shoots per tree, and on the number of aphids (rosy apple aphid and green apple aphid), predators, and aphid mummies per shoot from 2-days pre-treatment through 26-days post-treatment in apple at Kaysville, UT in 2012.

Treatment	Rate per acre (oz)	2-days pre-treatment (May 9)					4-days post-treatment (May 15)				
		Infested shoots[1]	RAA[2]	GAA[3]	Pred[4]	Aphid mummies[5]	Infested shoots[1]	RAA[2]	GAA[3]	Pred[4]	Aphid mummies[5]
Untreated		4.8	27.8	0.5	0.3	0	11.3 a	30.3 a	1.2	0.1	0.2
Sivanto	3.5	3.3	4.1	3.7	0	0	3.5 ab	11.0 ab	1.3	0.1	0
Sivanto	5.2	5.8	7.4	4.1	0	0	4.3 ab	2.0 b	2.0	0.1	0
Sivanto	8.7	4.3	20.1	3.9	0.1	0	2.3 b	1.4 b	0.6	0.1	0
Admire Pro	2.8	4.3	15.7	1.2	0.1	0.2	2.8 b	1.4 b	0.9	0.0	0
P > F		*0.74*	*0.13*	*0.61*	*0.92*	*0.56*	***0.05***	***0.01***	*0.49*	*0.64*	*0.45*

Treatment	Rate per acre (oz)	12-days pre-treatment (May 23)					18-days post-treatment (May 29)				
		Infested shoots[1]	RAA[2]	GAA[3]	Pred[4]	Aphid mummies[5]	Infested shoots[1]	RAA[2]	GAA[3]	Pred[4]	Aphid mummies[5]
Untreated		24.3 a	14.3 a	5.3	0.7	2.9	24.5 a	8.0 a	3.5	0.5	4.4 a
Sivanto	3.5	13.3 b	4.3 ab	5.7	0.2	1.3	18.8 ab	0 b	6.8	0.2	0.7 ab
Sivanto	5.2	15.8 b	0.7 b	3.1	0.2	0.9	16.3 ab	0.1 b	2.4	0.1	0.1 b
Sivanto	8.7	14.5 b	0.7 b	1.8	0.2	0.2	17.0 ab	0 b	1.7	0.1	0 b
Admire Pro	2.8	16.3 b	0.2 b	3.4	0.2	0.1	15.5 b	0 b	3.6	0.1	0.1 b
P > F		***0.03***	***0.02***	*0.62*	*0.6*	*0.11*	***0.05***	***0.001***	*0.26*	*0.17*	***0.05***

Treatment	Rate per acre (oz)	26-days pre-treatment (June 6)				
		Infested shoots[1]	RAA[2]	GAA[3]	Pred[4]	Aphid mummies[5]
Untreated		23.5	0.4	10.0	0.1	2.6
Sivanto	3.5	21.8	0	13.8	0.2	0.6
Sivanto	5.2	23.8	0.8	12.3	0.1	0.9
Sivanto	8.7	21.5	0	6.7	1.2	0
Admire Pro	2.8	22.8	0	12.0	0.1	0.5
P > F		*0.98*	*0.56*	*0.75*	*0.44*	*0.13*

[1]Mean number of aphid-infested shoots per 50 shoots on a tree

[2]Mean number of rosy apple aphids per shoot

[3]Mean number of green apple aphids per shoot

[4]Mean number of aphid predators per shoot

[5]Mean number of aphid mummies (parasitized rosy apple aphids) per shoot

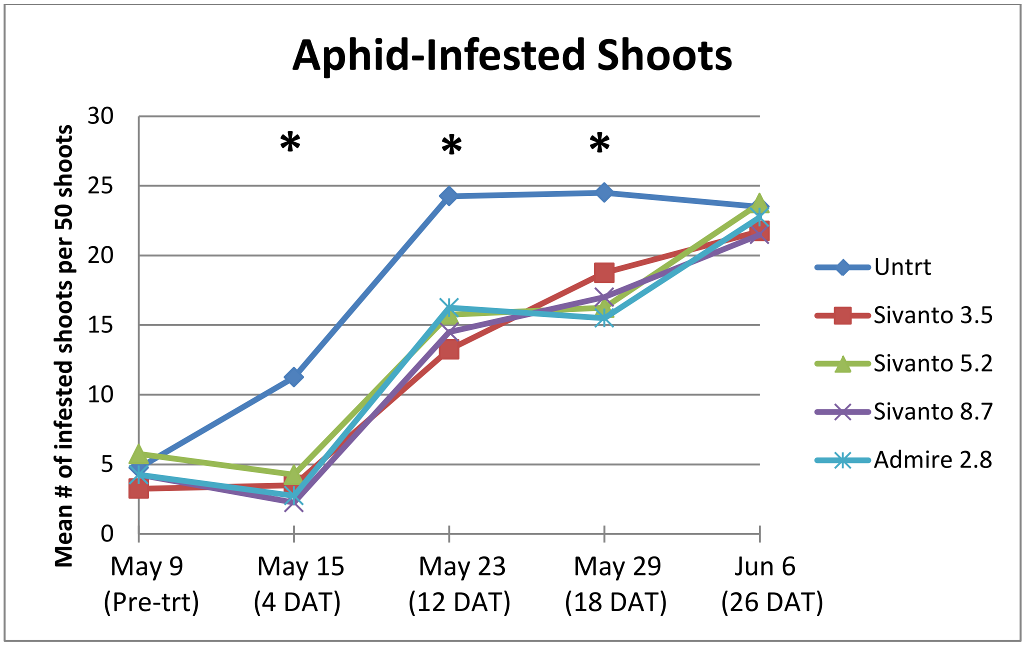

Figure 1. Effects of insecticide treatments on the mean number of aphid-infested shoots per 50 shoots from 2-days pre-treatment (May 9) through 26-days post-treatment (Jun 6). Insecticide treatments were applied on May 11. Asterisks indicate dates with significant differences among treatments.

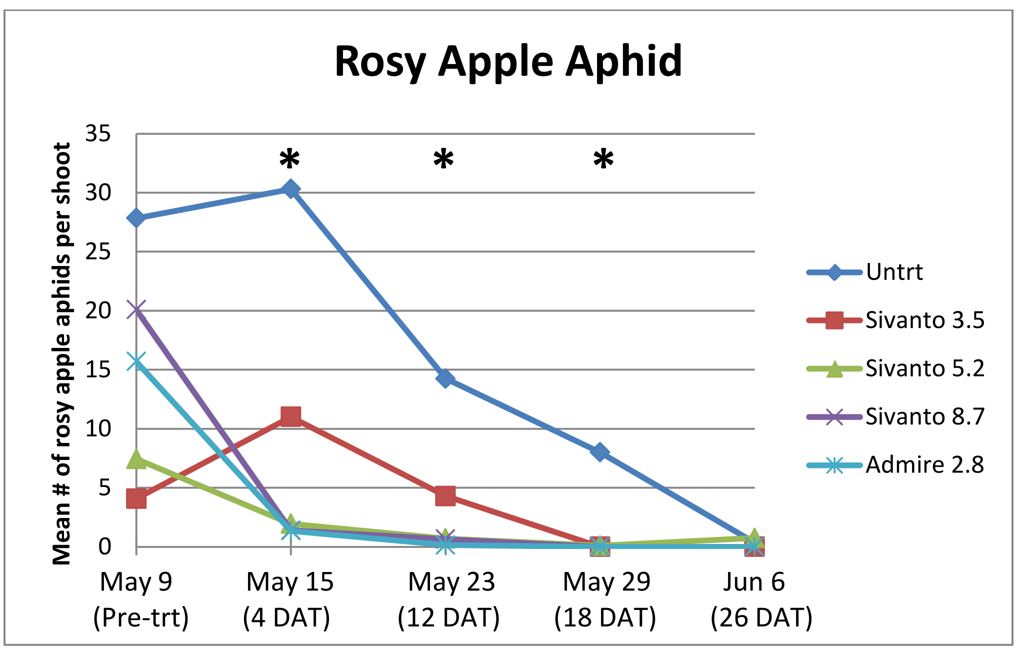

Figure 2. Effects of insecticide treatments on the mean number of rosy apple aphids per shoot. Asterisks indicate dates with significant differences among treatments.

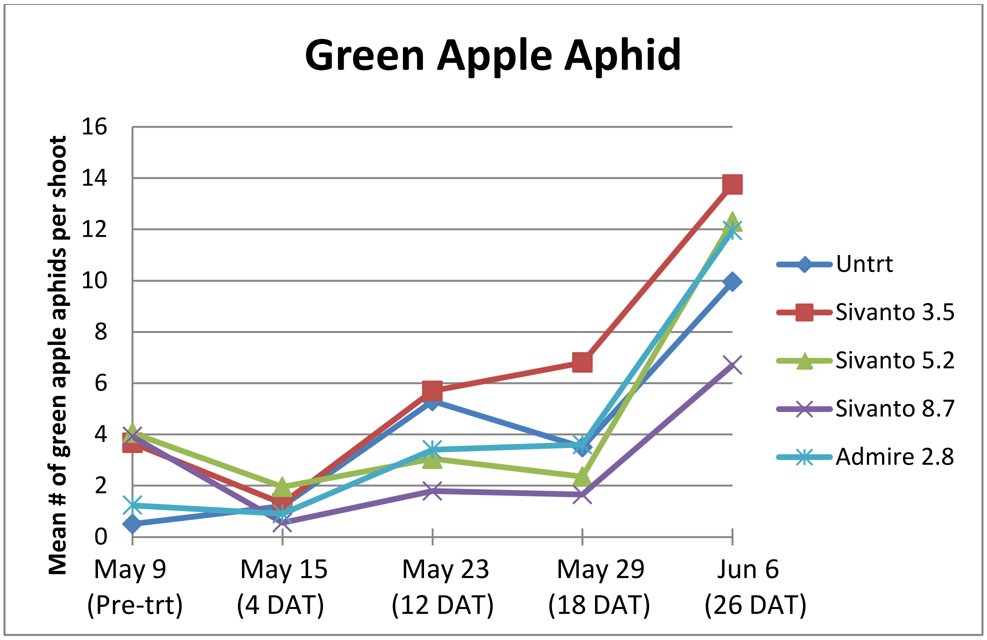

Figure 3. Effects of insecticide treatments on the mean number of green apple aphids per shoot. There were no significant differences among treatments.

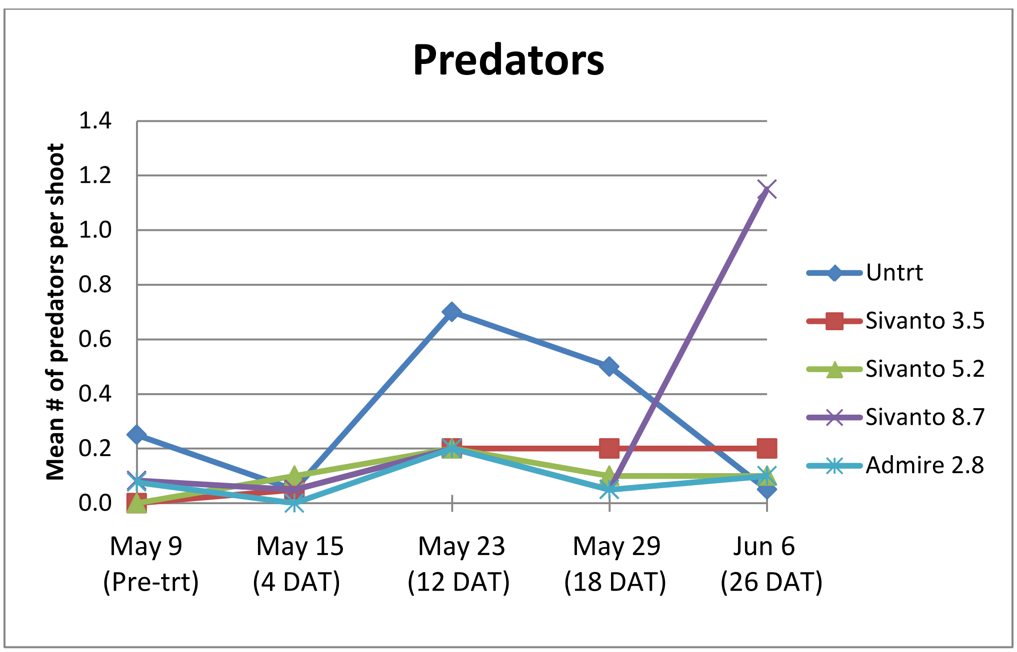

Figure 4. Effects of insecticide treatments on the mean number of predators (combined for all species) per shoot. There were no significant differences among treatments.

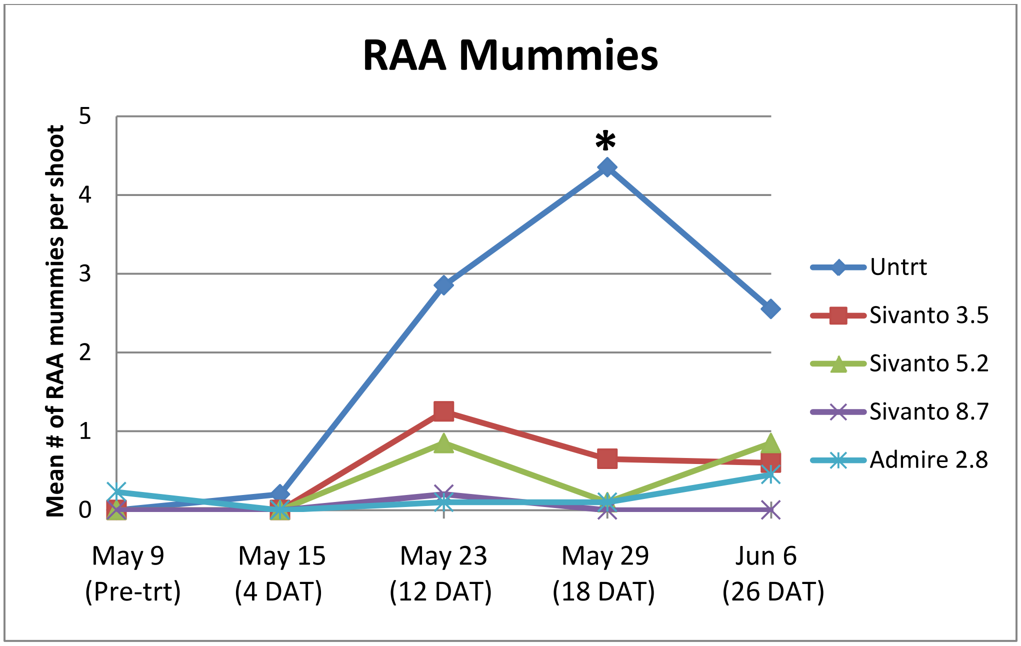

Figure 5. Effects of insecticide treatments on the mean number of aphid mummies (parasitized rosy apple aphids). The asterisk indicates one date with significant differences among treatments.