Evaluation of Insecticides for Woolly Apple Aphid Control in Apple in Utah – 2004

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Objective:

To evaluate the efficacy of new insecticides for control of woolly apple aphid (*Eriosoma lanigerum*) as compared to a grower standard, Guthion. In addition, several formulations and rates of the new insecticides will be assessed.

Methods:

The study was conducted in a 2.1-acre 15-year-old apple orchard of mixed cultivars (‘Delicious’ strains: ‘Dixiered’, ‘Supreme’, and ‘Ultrastripe’; ‘Gala’; ‘Idared’; ‘Jonathan’; ‘Mutzu’; and ‘Prime Gold’) at the Utah State University Horticultural Research Farm in Kaysville, UT. Plot size was two rows wide by five trees long (40 ft x 60 ft; 0.06 acre per plot). Tree spacing was 12 ft x 20 ft and tree canopy height was 8 to 15 ft. Plot design was randomized complete block with four replicates of each treatment (0.24 acre per treatment; see plot map).

All insecticide treatments were applied with an air blast sprayer at a rate of 70-75 gpa of dilute spray. Sprayer pressure was 125 psi. A pH buffer, Tri-Fol, was added to all spray mixtures at 2 ml/gal to maintain a pH of 7.2. A delayed-dormant (one-quarter to one-half-inch green) treatment of Superior oil was applied to the entire orchard on March 30 for early-season control of arthropods. Fungicide treatments for control of powdery mildew were applied to the entire orchard on April 3 (Bayleton) and 24 (Flint), May 14 (Procure) and 31 (Rally), and June 14 (Bayleton) and 28 (Flint). Streptomycin was applied on April 28 for control of fireblight. To reduce fruit infestation by codling moth during the first generation, the insecticide Calypso was applied at 6 oz/acre on May 14 and 31. No codling moth treatments were applied during second generation. Acramite was applied for mite suppression on July 27.

All insecticide treatments targeting woolly apple aphid (WAA) were applied once on July 8 when aphid densities were in the early stage of increase and widespread in the orchard.

Treatments:

1. Untreated control
2. Grower standard, Guthion 50 WP at 2 lb product/acre
3. Bayer 150 OD at 4.4 oz product/acre
4. Bayer 150 OD at 6.6 oz product/acre
5. Bayer 150 OD at 8.8 oz product/acre
6. Bayer 100 OD at 6.6 oz product/acre
7. Bayer 100 OD at 13.1 oz product/acre
8. Bayer 240 SC at 4.1 oz product/acre + Methylated Seed Oil (MSO) at 1% V/V
9. Rimon 0.83 EC at 80 oz product/acre + 0.25% V/V Supreme oil

Aphid Sampling and Phytotoxicity Assessments

WAA population densities were quantified with two sampling methods: 1) the percentage of terminal shoots infested with WAA per tree for the two center trees per plot (two observations per plot and eight observations per treatment for each sample date; N=72 for all treatments on each date) and 2) the density of WAA per terminal shoot on two shoots per tree for the two center trees per plot (4 observations per plot and 16 observations per treatment for each sample date; N=144 for all treatments on each date). In addition to WAA densities, the number of parasitized WAA mummies and predaceous insects were determined in aphid samples from terminal shoots. WAA infestation samples were collected on 1 day before treatment, and on 1, 8, 13, 20, and 27 days after treatment (DAT).

Leaves and fruit on treated trees were inspected for symptoms of phytotoxicity (russetting, necrosis, or markings) on each aphid sampling date.

Aphid data were statistically compared among treatments and apple cultivars with analysis of variance within each sample date (Proc Glm, SAS Institute) and over time using repeated measures analysis (Proc Mixed, SAS Institute). Means were separated with Waller-Duncan *k*-ratio *t*-test when significantly different. Density data were square root transformed and proportion data were arcsine-square root transformed before analysis to meet data normality assumptions.

Results and Discussion:

Aphid Infestation and Population Densities

WAA infestation of shoots ranged from 22-36% at the beginning of the trial and did not differ among treatments (Table 1). After treatments were applied, none of the insecticides reduced shoot infestation throughout the trial period. Although Bayer 240 SC + MSO numerically lowered infestation levels below that of the untreated and other insecticides from 13-27 DAT, treatment differences were not significant. In general, aphid infestation levels initially increased slightly from before treatment to 1 DAT, and then gradually declined from 8 through 27 DAT.

WAA densities ranged from 102-222 per shoot before treatments were applied and did not differ among treatments (Table 2). Reductions in aphid densities in response to insecticides were delayed until 13 DAT. Mean densities of wingless WAA on shoots differed among treatments later in the trial period, from 13-27 DAT (Table 2 and Fig. 1). Bayer 240 SC + MSO was the only treatment to significantly lower densities below those in the untreated on 13, 20, and 27 DAT. On 27 DAT, the middle rate of Bayer 150 OD (6.6 oz/acre) also significantly lowered WAA densities below the untreated (Table 2 and Fig. 1).

Using repeated measures analysis to evaluate effects of treatments and apple cultivars on aphid population trends across time, differences were found only for cultivar effects and not for treatment effects. Percentage of infested shoots ($p<0.0001$) and aphid densities ($p=0.02$) were different among cultivars. WAA densities were greatest on 'Dixiered' and 'Idared' trees and least on 'Gala' and 'Ultrastripe' trees (Fig. 2).

Aphid Parasitism

Parasitism of WAA was very low from before treatment through 8 DAT (<0.5 parasitized aphid per shoot), however, densities of parasitized aphids increased on later sample dates and was influenced by insecticide treatments on 13, 20, and 27 DAT (p=0.02, 0.02, 0.05, respectively). The relative rank of highest parasitism for treatments varied. Parasitism was generally higher in the low rate of Bayer 150 OD (4.4 oz/acre) and in both rates of Bayer 100 OD (6.6 and 13.1 oz/acre) (Fig. 3). Parasitism was also elevated in the highest rate of Bayer 150 OD (8.8 oz/acre) on 27 DAT, but was lower on earlier dates. Densities of predaceous insects in aphid samples were too low (<0.3 predator per shoot) to detect any differences among insecticide treatments. Predators present included immature life stages of syrphid flies, lacewings, and minute pirate bugs.

Phytotoxicity

No symptoms of phytotoxicity (russetting, marking, or necrosis) to apple leaves or fruit were observed during the trial.

Conclusions:

Effects of insecticides on WAA densities were delayed until 13 DAT, but residual effects were detected through 27 DAT. Bayer 240 SC+MSO reduced aphid densities below untreated levels on 13, 20, and 27 DAT. No other insecticides consistently lowered aphid densities, including the grower standard, Guthion. The percentage of apple shoots infested with WAA were not significantly reduced by any insecticide treatment, although numerically shoot infestation was lowest in Bayer 240 SC+MSO on 13, 20, and 27 DAT. Parasitism of WAA was relatively low throughout the trial, but did differ among treatments on later sample dates. Parasitism was highest in the low rate of Bayer 150 OD and in the low and high rates of Bayer 100 OD. Parasitism was reduced by Bayer 240 SC+MSO as compared to untreated and some of the other insecticide treatments.

Table 1. Influence of insecticide treatments on the percentage of shoots infested with woolly apple aphid per apple tree.

Treatment	Rate	Mean percentage of shoots infested with WAA per tree					
		1 DBT+ July 7	1 DAT* July 9	8 DAT July 16	13 DAT July 21	20 DAT July 28	27 DAT Aug 4
Untreated		29.8	39.7	28.0	15.1	20.4	13.0
Guthion 50 WP	2 lb/acre	26.9	27.3	18.0	12.8	17.6	12.4
Bayer 150 OD	4.4 oz/acre	28.2	36.0	32.3	21.9	25.1	17.0
Bayer 150 OD	6.6 oz/acre	23.9	40.9	24.0	12.7	17.7	12.6
Bayer 150 OD	8.8 oz/acre	22.0	32.4	30.4	25.4	27.0	23.9
Bayer 100 OD	6.6 oz/acre	31.4	45.2	34.3	19.3	22.1	13.2
Bayer 100 OD	13.1 oz/acre	35.5	29.9	32.2	25.0	30.3	12.8
Bayer 240 SC + MSO	4.1 oz/acre + 1% V/V	26.0	31.3	15.9	2.6	7.2	4.5
Rimon 0.83 EC + Oil	80 oz/acre + 0.25% V/V	23.6	29.7	32.2	25.0	24.1	21.4
P>F		0.88	0.92	0.59	0.12	0.38	0.16

+DBT=days before treatment.
*DAT=days after treatment.
N=72 observations per date.
Proportion data were arcsine-square root transformed before analysis to meet normality assumptions.
Treatment means were separated with Waller-Duncan *k*-ratio *t*-test when significantly different in analysis of variance (Proc Glm; $p \leq 0.05$).

Table 2. Influence of insecticide treatments on the number of woolly apple aphids per shoot per apple tree.

Treatment	Rate	Mean number of WAA per shoot per tree					
		1 DBT+ July 7	1 DAT* July 9	8 DAT July 16	13 DAT July 21	20 DAT July 28	27 DAT Aug 4
Untreated		115.9	182.0	128.7	193.0 ab	189.3 a	146.6 ab
Guthion 50 WP	2 lb/acre	166.6	220.6	98.8	129.9 b	114.6 ab	69.3 bcd
Bayer 150 OD	4.4 oz/acre	221.5	158.2	138.3	107.8 b	113.2 ab	86.1 bcd
Bayer 150 OD	6.6 oz/acre	150.1	210.3	159.9	137.4 b	113.6 ab	25.0 cd
Bayer 150 OD	8.8 oz/acre	113.8	162.7	198.1	158.0 ab	143.2 ab	138.8 abc
Bayer 100 OD	6.6 oz/acre	192.3	284.4	195.2	101.9 b	153.9 a	83.6 bcd
Bayer 100 OD	13.1 oz/acre	152.9	278.4	202.8	224.8 a	228.6 a	190.8 a
Bayer 240 SC + MSO	4.1 oz/acre + 1% V/V	102.3	120.9	77.3	19.4 c	29.8 b	23.1 d
Rimon 0.83 EC + Oil	80 oz/acre + 0.25% V/V	122.9	202.6	128.4	145.4 ab	90.9 ab	44.4 bcd
P>F		0.26	0.14	0.12	.01	0.05	0.03

+DBT=days before treatment.
*DAT=days after treatment.
N=144 observations per date.
Data were square-root transformed (x+1) before analysis to meet normality assumptions.
Treatment means were separated with Waller-Duncan *k*-ratio *t*-test when significantly different in analysis of variance (Proc Glm; $p \leq 0.05$).

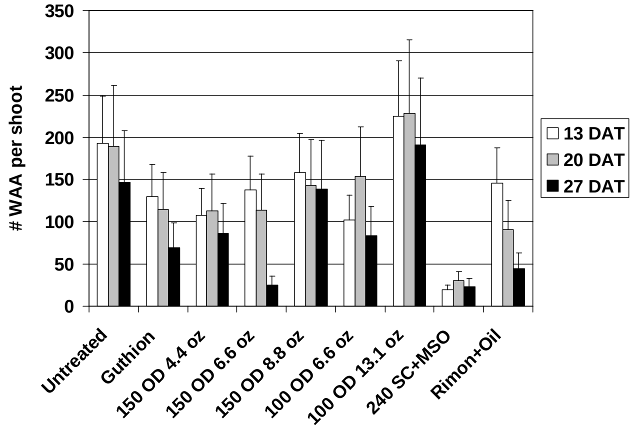

Figure 1. Influence of insecticide treatments on densities of woolly apple aphid per shoot (+SE) on 13, 20, and 27 days after treatment (DAT).

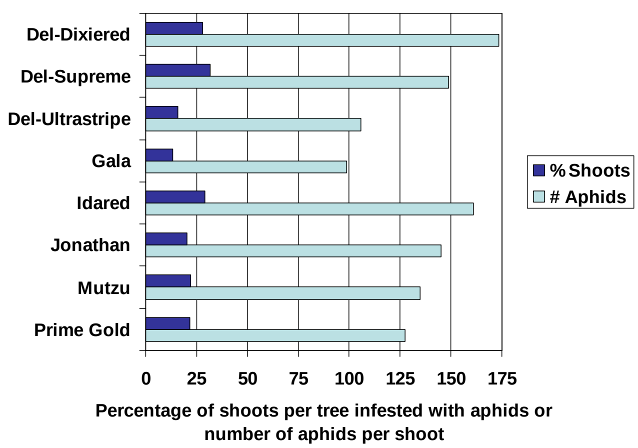

Figure 2. Influence of apple cultivar on shoot infestation and densities of woolly apple aphid.

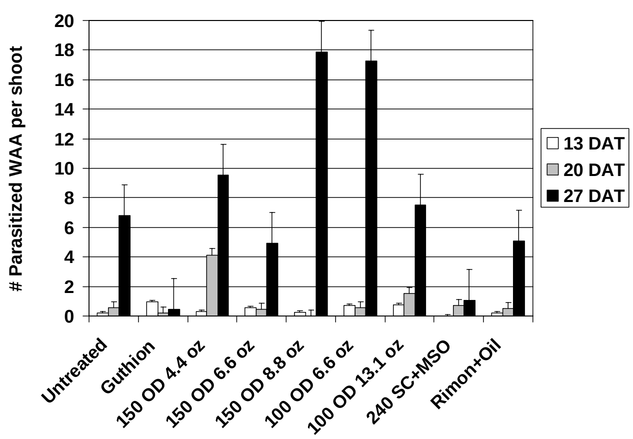

Figure 3. Densities of parasitized woolly apple aphids per shoot (+SE) as influenced by insecticide treatments on 13, 20, and 27 days after treatment (DAT).