Ohio Apple Mite Management Trial, 2004
Final report 12/31/04

Celeste Welty, Associate Professor of Entomology, The Ohio State University
Extension Entomology Building, 1991 Kenny Rd, Columbus OH 43210-1000
(phone 614-292-2803; fax 614-292-9783; e-mail welty.1@osu.edu)

Introduction & Objectives:

A field trial was conducted to evaluate chemical and biological management options for European red mite, which is an important foliar pest of apple. The three objectives were to evaluate the impact on predatory mites of two insecticide programs, organophosphate versus pyrethroid; to evaluate efficacy of the new acaricide Acramite with emphasis on how it is mixed with water before application; and to evaluate efficacy of the two insecticide programs on control of insect pests.

Methods:

The trial was conducted in a block of 20-year old Scarlet Spur Delicious apple trees at Ohio State University's Waterman Lab at Columbus, Ohio. Populations of predatory mites, *Zetzellia mali* (Acari: Stigmaeidae) and *Neoseiulus fallacis* (Acari: Phytoseiidae), are present in this block. The experimental design was randomized complete block with five treatments and four replicate blocks. Each plot contained five adjacent trees in one row. Insecticide and acaricide treatments were applied at timings and rates detailed in Table 1. Acramite and Savey treatments were applied when European red mite exceeded the action threshold of 2.5 motile mites per leaf in early summer (May until mid-June), 5 mites per leaf in mid-summer (mid-June until mid-July), or 7.5 mites per leaf in late summer (mid-July until mid-August). Insecticides and acaricides were applied at a dilute volume of 150 gallons per acre by a handgun sprayer operated at pressure of 100 psi, with a D6 ConeTip nozzle tip.

For fruit thinning, NAA, 10 ppm, was applied to all plots including untreated checks on 5/11/04. A standard fungicide program was used in all plots. Fungicides were applied by an AgTech 4002 airblast sprayer operated at pressure of 20 psi, with TeeJet 6510 and 6520 nozzle tips. Fungicides applied were Dithane at early tight cluster on 4/8/04, Dithane and Nova at early bloom on 4/19/04, and Captan and Nova at late bloom on 4/29/04. Fungicides applied in cover sprays were Dithane on 5/12/04, Captan and Topsin-M on 6/1/04, 6/17/04, 7/2/04, and 7/28/04, and Captan alone on 8/16/04.

Mite populations were sampled at 7- to 16-day intervals from late April until early August, with more frequent evaluations when density was approaching the threshold. A sample of 25 randomly selected leaves was taken from one tree at the center of each plot. Leaves were brushed with a mite-brushing machine, and mites were counted in subsamples to determine the average number of European red mite and predatory mites per leaf. Samples of predatory mites were preserved for species verification. Plots were scouted for nymphs of white apple leafhopper on 5/10/04, and for cumulative leafhopper damage on 5/31/04. Data was not taken for spotted tentiform leafminer because its population was negligible in 2004. Insect injury to fruit was evaluated on 100 fruit per plot on 10/20/04. Data were subjected to analysis of variance and mean comparisons by least significant difference (LSD) tests in the ANOVA procedure of the SAS statistics program. Cumulative mite-days were calculated using the treatment means and the number of days in the interval following each count.

Table 1. Rates and timing of insecticide and miticide applications in Delicious apples at OSU's Waterman Lab, Columbus, Ohio, 2004.

Treatment	Insecticide and miticide applications				
	Tight cluster (4/9)	Petal-fall (4/30)	Cover sprays for codling moth 1st generation (5/18, 6/4, 6/17)	Cover sprays for codling moth 2nd generation (7/12, 7/27, 8/16)	At mite threshold (6/18)
Untreated check	None	none	none	None	None
Standard organophosphate (OP) + Savey	None	Imidan 70WP, 4 lb/A	Imidan 70WP, 4 lb/A	Imidan 70WP, 3 lb/A	Savey 50WP, 3 oz/A
Pyrethroid + Savey	1% oil	Asana 4.8 fl oz/A	Asana 4.8 fl oz/A	Imidan 70WP, 3 lb/A	Savey 50WP, 3 oz/A
Standard OP + Acramite in city water	1% oil	Imidan 70WP, 4 lb/A	Imidan 70WP, 4 lb/A	Imidan 70WP, 3 lb/A	Acramite 1 lb/A + Choice 3 qt/100 gal + Silwet 3 oz/100 gal of city water
Standard OP + Acramite in well water	1% oil	Imidan 70WP, 4 lb/A	Imidan 70WP, 4 lb/A	Imidan 70WP, 3 lb/A	Acramite 1 lb/A + Choice 3 qt/100 gal + Silwet 3 oz/100 gal of well water

Results and discussion:

European red mite (ERM) reached peak density in untreated check plots on 7/6/04 for motile stages (Table 2) and on 6/28/04 for eggs (Table 3). Both Stigmaeid (Table 4) and Phytoseiid (Table 5) predatory mites were present throughout the season but reached maximum density in late July. Apple rust mite was abundant in all treatments and peaked in mid-June (Table 6).

There were no statistically significant differences among treatments in density of ERM motiles (Table 2). There were significantly fewer ERM eggs in the Acramite treatments than in the Savey or check treatments on 6/28/04 (Table 3). Application of Savey at threshold on 6/18/04 resulted in mite density that fell below threshold within 10 days and remained negligible for the remainder of the season (Table 2). Application of Acramite at threshold on 6/18/04 resulted in decreased mite density but the population did not go below threshold until late July (Table 2), when predatory mite activity was high (Tables 4 and 5). Although there were no significant differences between the two Acramite treatments, there were somewhat fewer ERM motiles and eggs in plots where Acramite was mixed with city water than with well water. Stigmaeid density differed significantly among treatments on 4/28/04, 6/7/04, and on 8/4/04 (Table 4), with more stigmaeids in treatments that had more ERM (Table 2). Phytoseiid density differed significantly among treatments only on 7/6/04 (Table 5), and phytoseiids were most abundant in treatments that had more ERM (Table 2). Savey used with Imidan as the insecticide resulted in higher density of stigmaeid predators than where Savey was used with Asana as the insecticide, but phytoseiid predators were about the same in both Savey treatments. No phytotoxicity was observed.

The cumulative effect of treatments on European red mite is shown by mite-day totals (Table 2). A theoretical mite population that remained below but close to threshold throughout the season would have resulted in 400 cumulative mite-days by 8/4/04. Treatments that were below the theoretical 400 cumulative mite-days were both Savey treatments; the Acramite in city water was slightly above this threshold. The untreated check and the Acramite in well water were well above this threshold.

White apple leafhopper was affected by treatments in the first cover spray. Although density of leafhopper nymphs was low on 5/10/04, there were significant differences in damage by the end of nymphal development in late May. Leafhopper damage was significantly lower where Asana was used than where Imidan was used (Table 7).

Insect injury at harvest showed significant treatment effects for internal Lepidoptera (Table 8) which was significantly lower in all insecticide treatments than in the untreated check, and significantly lower where Asana was used than in two of the three treatments where Imidan was used; in one Imidan treatment, damage was intermediate and not different than Asana. Other insects that caused damage but which showed no treatment differences were San José scale, plum curculio, and tarnished plant bug.

<u>Conclusions</u>:

Savey applied at threshold in mid-June provided excellent control of European red mite. Acramite applied at threshold in mid-June provided fair control of European red mite, and control was slightly better when Asana was mixed with city water than with well water. Both Savey and Acramite were tolerated well by predatory mites. Predatory mites were more abundant in plots where Imidan was used than where Asana was used. Asana had a harsher effect on stigmaeid predatory mites than on phytoseiid predatory mites.

Table 2. Number of motile European red mite per leaf (mean of four replicates) on Delicious apples on nine sampling dates in 2004, and cumulative mite-days, at OSU's Waterman Lab, Columbus, Ohio.

Treatment	4/28	5/14	5/27	6/7	6/14	6/28	7/6	7/20	8/4	Cum. Mite days
Untreated	0.42	0.26	1.6	2.2	12.1	16.4	18.1	0.5	0.00	605
Imidan, Savey	0.18	0.10	1.7	2.7	18.0	2.2	0.2	0.0	0.00	315
Oil, Asana, Savey	0.08	0.17	2.4	2.6	20.6	3.3	0.3	0.0	0.00	367
Oil, Imidan, Acramite, city water	0.20	0.08	2.2	3.6	15.9	10.0	3.1	0.5	0.04	407
Oil, Imidan, Acramite, well water	0.30	0.18	2.0	2.2	18.8	8.7	10.9	2.6	0.00	569
P (ANOVA)	*0.46*	*0.62*	*0.93*	*0.82*	*0.84*	*0.24*	*0.06*	*0.43*	*0.06*	–

Table 3. Number of European red mite eggs per leaf (mean of four replicates) on Delicious apples on nine sampling dates in 2004 at OSU's Waterman Lab, Columbus, Ohio.

Treatment	4/28	5/14	5/27	6/7	6/14	6/28	7/6	7/20	8/4
Untreated	0	3.7	4.9	11.2	30	116 ABC	63	2.0	0.08
Imidan, Savey	0	3.5	3.9	14.9	42	119 AB	34	1.0	0.00
Oil, Asana, Savey	0	2.8	6.1	19.0	48	159 A	67	1.7	0.02
Oil, Imidan, Acramite/city	0	3.9	5.9	17.9	43	50 C	33	1.9	0.04
Oil, Imidan, Acramite/well	0	3.0	6.1	11.8	48	53 BC	55	14.0	0.12
P (ANOVA)	–	*0.97*	*0.90*	*0.78*	*0.90*	*0.02 **	*0.67*	*0.41*	*0.68*

Table 4. Number of predatory stigmaeid mite motiles per leaf (mean of four replicates) on Delicious apples on nine sampling dates in 2004 at OSU's Waterman Lab, Columbus, Ohio.

Treatment	4/28	5/14	5/27	6/7	6/14	6/28	7/6	7/20	8/4
Untreated	0.02 B	0.04	0.04	0.16 A	0.14	0.44	1.00	1.32	1.01 A
Imidan, Savey	0.00 B	0.06	0.10	0.16 A	0.58	0.59	1.00	0.80	0.28 B
Oil, Asana, Savey	0.00 B	0.02	0.00	0.00 B	0.00	0.04	0.20	0.24	0.18 B
Oil, Imidan, Acramite /city	0.06 A	0.02	0.04	0.04 B	0.50	0.49	0.88	1.78	0.90 A
Oil, Imidan, Acramite /well	0.00 B	0.02	0.00	0.04 B	0.08	0.30	1.02	1.40	0.92 A
P (ANOVA)	*0.02 **	*0.64*	*0.27*	*0.02 **	*0.06*	*0.09*	*0.18*	*0.10*	*0.014*

Table 5. Number of predatory phytoseiid mite motiles per leaf (mean of four replicates) on Delicious apples on nine sampling dates in 2004 at OSU's Waterman Lab, Columbus, Ohio.

Treatment	4/28	5/14	5/27	6/7	6/14	6/28	7/6	7/20	8/4
Untreated	0.00	0.02	0.08	0.08	0.16	0.70	1.42 A	0.36	0.18
Imidan, Savey	0.00	0.00	0.02	0.08	0.33	0.73	0.64 B	0.20	0.10
Oil, Asana, Savey	0.00	0.00	0.04	0.04	0.34	1.04	1.01 AB	0.24	0.38
Oil, Imidan, Acramite /city	0.02	0.02	0.02	0.08	0.08	0.29	0.60 B	0.28	0.06
Oil, Imidan, Acramite /well	0.00	0.00	0.00	0.08	0.18	0.32	1.16 A	0.40	0.10
P (ANOVA)	*0.44*	*0.61*	*0.25*	*0.92*	*0.38*	*0.21*	*0.02 **	*0.70*	*0.15*

Table 6. Apple rust mite density rating[1] (mean of four replicates) on Delicious apple leaves on nine sampling dates in 2004 at OSU's Waterman Lab, Columbus, Ohio.

Treatment	4/28	5/14	5/27	6/7	6/14	6/28	7/6	7/20	8/4
Untreated	1.0	2.0	2.8	2.8	3.0	2.0	1.0	0.5	0
Imidan /Savey	1.5	1.8	2.8	3.0	3.0	2.0	1.2	0.2	0.2
Oil, Asana, Savey	1.0	1.8	2.5	2.5	3.0	2.0	1.0	0.2	0
Oil, Imidan, Acramite /city	0.8	1.5	2.2	3.0	3.0	2.0	1.2	0.2	0
Oil, Imidan, Acramite /well	0.8	1.5	2.2	2.5	3.0	2.0	1.8	0.2	0
P (ANOVA)	*0.14*	*0.53*	*0.22*	*0.30*	–	–	*0.14*	*0.93*	*0.44*

[1] Density rating scale: 0 = none; 1 = low (<5 per leaf); 2 = moderate (5 to 50 per leaf); 3 = high (>50 per leaf).

Table 7. White apple leafhopper density and damage rating (mean of four replicates) on Delicious apple leaves in 2004 at OSU's Waterman Lab, Columbus, Ohio.

Treatment	*Number of leafhopper nymphs per leaf on 10 May (10 days after petal-fall spray)*	*Damage rating[1, 2] on 31 May (13 days after first cover spray)*
Untreated	0.10	1.24 AB
Imidan, Savey	0.09	1.18 B
Oil, Asana, Savey	0.07	0.67 C
Oil, Imidan, Acramite in city water	0.06	1.23 AB
Oil, Imidan, Acramite in well water	0.06	1.49 A
P (ANOVA)[3]	*0.60*	*0.0003*

[1] Damage rating scale: 0 = none; 1 = light; 2 = moderate; 3 = heavy.
[2] Within each column, means followed by same letter are not significantly different (P>0.05); mean separations by LSD.
[3] Treatment effect from ANOVA.

Table 8. Insect injury evaluation of Delicious apple fruit at harvest, OSU's Waterman Lab, Columbus, Ohio, 20 October 2004, based on sample of 100 fruit per plot.

Treatment	Percentage of fruit (mean of 4 reps)[1]					
	Clean	Plum curculio	San José scale	Tarnished plant bug	Internal Lepidoptera[2]	Leafroller late
Untreated	36.3	4.2	46.8	1.4	18.2 A	1.0
Imidan, Savey	56.0	3.7	39.6	1.0	3.0 CD	0.0
Oil, Asana, Savey	48.3	5.7	46.5	0.7	1.0 D	0.0
Oil, Imidan, Acramite in city water	54.1	5.2	36.7	1.2	6.7 BC	0.0
Oil, Imidan, Acramite in well water	59.5	5.7	29.5	1.5	7.2 B	0.2
P (ANOVA)[3]	*0.59*	*0.84*	*0.78*	*0.38*	*0.0001*	*0.16*

[1] Within each column, means followed by same letter are not significantly different (P>0.05); mean separations by LSD. Values shown are actual percentages but ANOVA based on transformed values.
[2] Populations were codling moth and lesser appleworm; Oriental fruit moth was absent.
[3] Treatment effect from ANOVA.