REPORT TO OHIO FRUIT GROWERS SOCIETY, 31 DECEMBER 2001

Integrating mite control by predators with insect control by pyrethroids in apple orchards

Celeste Welty, Associate Professor of Entomology, The Ohio State University

Background: This project was done to evaluate several ways of allowing survival of the predatory mite *Zetzellia mali* (Acari: Stigmaeidae) for biological control of European red mite. *Z. mali* has been known worldwide as a minor player in biocontrol but the *Z. mali* population in our research orchard has provided biological control of European red mite in the past 5 years and has shown tolerance to pyrethroids. If the organo-phosphate registrations are lost or severely restricted as the Food Quality Protection Act is implemented, growers are concerned that the new insecticides being suggested as replacements are prohibitively expensive. If pyrethroids along with other non-organophosphate insecticides could be used for insect control while *Z. mali* is providing mite control, we would have an integrated management program that would be an ecologically sound and economical alternative to an organophosphate-based system.

Objectives: 1) evaluate insect control with very low rates of Asana or moderate rates of Danitol and their effect on mites; 2) assess susceptibility of predatory mites to orchard pesticides using laboratory bioassays; 3) evaluate banding and branch transfer as methods of distributing *Z. mali* into orchards where it does not occur naturally.

Methods, insecticide field trial: A field trial was conducted in Delicious apples at OSU's Waterman Laboratory in Columbus. Plot size was four to five adjacent trees; all data were taken from one central tree per plot. The experimental design was randomized complete block with five replicates of five treatments: an *untreated check* that received no insecticides; *standard organophosphate* where superior oil (1%) was applied at tight cluster on 11 April, and Imidan 70WP (3 lb/A) at petalfall on 1 May and in 2 cover sprays (2.1 lb/A) for first brood codling moth (17 and 31 May) and 2 cover sprays for second brood codling moth (27 July, 10 August); *Asana*, where superior oil (1%) was applied at tight cluster, and Asana XL 0.66EC (1 oz/100 gal) applied at pink (18 April), petalfall, and 4 times during codling moth egg hatch periods; *Danitol plus organophosphate* where Danitol 2.4EC was applied at pink (10.7 oz/A) and petalfall (16 oz/A) and for the first spray against second brood codling moth, Imidan applied for codling moth first brood and the second spray against second brood; and *Danitol plus non-organophosphates*, where Danitol (10.7 oz/A) was applied at pink, Avaunt 30WDG (6 oz/A) was applied at petalfall and for first brood codling moth, and Intrepid 2F (16 oz/A) was applied for second brood codling moth. Note that the rate of Asana (1 fl oz/100 gal) was half of the minimum rate on the label; this is intermediate between the two Asana rates tested in 2000. In the Danitol plus non-OP treatment, European red mite exceeded the threshold in early July; we decided to use Danitol on 12 July to document the effect on the predatory mite population which was building to high levels in that treatment at that time. All plots except the checks were treated with Esteem 35WP (4 oz/A) for control of San José scale crawlers on 11 June. Treatment sprays were applied by hand-gun sprayer. All plots including the checks were treated by an airblast sprayer with fungicides: Captan plus Nova at tight cluster, pink, bloom, petalfall, and first cover, and Captan plus Topsin-M in the second to eighth cover sprays. For fruit thinning, NAA was applied in all plots on 7 May. Mite populations were evaluated every 9-20 days from late April through early September on 25 randomly selected leaves per tree. Samples of predatory mites were preserved for species verification. Plots were scouted for rosy apple aphid at early pink; for spotted tentiform leafminer at petalfall; and for white apple leafhopper at petalfall, one week after petalfall, and 4 weeks after petalfall. At harvest on 25 September, insect damage was evaluated on 100 fruit per tree. Data were subjected to analysis of variance and mean comparisons by least significant difference (LSD) tests in the ANOVA procedure of the SAS mainframe statistics program.

Methods, bioassays: Bioassays were conducted in the lab to determine the susceptibility of *Z. mali* to common pesticides, as a continuation of a study started in 2000. Adult *Z. mali* were field collected. A slide-dip bioassay method was used with each replicate containing 10 live mites placed on their backs on sticky tape on a glass slide. Slides were dipped for 5 seconds in pesticide solution then held in a moist box. Mortality was evaluated after 24 hours. Four replicate tests were done for each of 5 insecticides, 5 miticides, 14 fungicides, and 10 plant growth regulators. Distilled water was used as a control treatment; 4 replicates of controls were done on each of the 18 dates when bioassays were done. Most pesticides were tested at one typical rate but a few were tested at two or three rates. Any replicates with control mortality greater than 20% were discarded. Mortality from chemical treatments was adjusted for control mortality using Abbott's formula.

Methods, predator transfer trial: A banding experiment was set up in October 2000 with 96 trees in a Melrose apple block known to have *Z. mali* at OSU's Waterman Laboratory in Columbus. There were 8 replicates of experimental treatments. In each replicate there were three main-plot treatments for band location: 1) on trunk only, 2) on four scaffold branches only; 3) on both trunk and four scaffold branches. Within each of these main plots there were four subplot treatments for band material: 1) burlap only, 2) paper tree wrap only, 3) tree wrap lined with burlap, 4) no bands (check). Two replicates of these treatments were removed on 28 January 2001 and examined by microscope. Bands from three replicates were harvested on 27 March 2001 and placed in cold storage. On 26 April 2001, refrigerated bands were taken to a commercial block of young Fuji apples in Licking County where *Z. mali* was not already present, and bands were stapled to scaffold branches. The experimental design was randomized complete block with three replicate blocks of two treatments (bands and no bands) with 2 adjacent trees per plot. A third treatment was added on 31 July when 5 terminal branches from the Melrose source orchard were placed on each additional Fuji tree in each block. Leaves from these trees were sampled 5 times from mid-July until mid-September to evaluate whether *Z. mali* became established.

Results, insecticide field trial: There were significant differences among treatments in the number of European red mite (ERM) motiles in 5 of the first 7 sampling periods. In the untreated check, ERM never exceeded the early summer threshold (2.5 mites per leaf) or mid-summer threshold (5 mites per leaf) but it exceeded the late summer threshold (7.5 mites per leaf) on 23 July, then fell below threshold presumably due to predation by *Z. mali*. In the standard treatment, the mite threshold was not exceeded until late August. In the Danitol plus OP treatment, ERM was below threshold until late July. In the Asana treatment, the threshold was exceeded in late May but then fell below threshold until early August when it again exceeded threshold. In all four of these treatments, no action was taken to suppress mites once thresholds were exceeded other than to observe predatory mite activity.

In the Danitol plus non-OP treatment, ERM built up more quickly than in other treatments, with above-threshold populations for most of the summer; this was the treatment where we applied Danitol as a late summer miticide. After Danitol application, ERM density declined but still was above threshold throughout August.

One key difference between the Danitol treatments is that Danitol used at petalfall will suppress ERM, but Danitol used in just one application before bloom will not suppress ERM. Another miticide such as oil at delayed dormant should be applied if Danitol will be used only prebloom.

Stigmaeid mites were present in almost all treatments during all sampling periods. We set a new record high density in the standard treatment on 23 July, when there were over 3 stigmaeids per leaf at a time when there were 5 ERM motiles and 21 ERM eggs per leaf. In the Danitol plus non-OP treatment where Danitol was applied on 12 July after ERM exceeded threshold, the stigmaeids did not decline following the application, but they did not increase as rapidly as they did during the same period in the untreated and standard treatments. The only stigmaeid species found through late July was *Z. mali*. During August and September, the stigmaeid *Agistemus fleschneri* was detected although *Z. mali* was predominant.

Phytoseiid mites were not detected until 26 June and remained at low density through 7 August. They reached maximum density of 0.1 to 0.2 per leaf in the Asana treatment in late August and early September. The only phytoseiid species detected in this trial was *Neoseiulus fallacis*.

Scouting for foliar insect pests showed no rosy apple aphid detected at pink and no spotted tentiform leafminer at petalfall. White apple leafhopper was affected by treatments on all three dates when nymphs were counted and in rating of cumulative damage. There was significantly lower leafhopper damage in the two Danitol treatments than in the low-rate Asana treatment, the standard organophosphate treatment, and the untreated check.

At harvest, fruit in all insecticide treatments were significantly less damaged (67 to 82% clean fruit) than in the untreated check (37% clean fruit). There was a lot of damage by San José scale particularly in untreated check plots and in the Danitol plus non-OP treatment, despite application of Esteem during the crawler stage. Codling moth and plum curculio were other important causes of damage, including some damage due to a third generation of codling moth, which had not been targeted by insecticides. Codling moth was controlled equally by Imidan as by Avaunt and Intrepid, and equally by the below-label rate of Asana. Oviposition damage by plum curculio was controlled equally well in the Danitol plus organophosphate treatment where Danitol was used at pink and petalfall, as in the Danitol plus non-organophosphate treatment where Danitol was used at pink and Avaunt at petalfall. Damage by tarnished plant bug (TPB) was found on 0.2 to 1.2% of fruit, characterized by the classic deep indentation. There was also 2 -11% of fruit with injury that was similar but much shallower and usually with several injuries per fruit; the cause is not known but is likely to be a plant bug other than TPB.

The cost per acre for insecticide materials, excluding Esteem which was applied to all plots, was $124 for the standard OP program, $188 for the Danitol plus non-OP program, $102 for the Danitol plus OP program, and $13 for the below-label rate of Asana.

Results, bioassays: Toxicity of Asana to *Z. mali* in bioassays depended on rate; mortality varied from 31% at a low dilute rate, to 63% at a high dilute rate, to 97% at a high concentrate rate. Toxicity of Danitol did not vary as much among rates; mortality varied from 64-80% at a low dilute rate, to 81% at a medium dilute rate, to 86% at a medium concentrate rate. Miticides that had high toxicity to *Z. mali* were Pyramite, Omite, Vendex, and cyhexatin. The insecticide with highest toxicity to *Z. mali* was Thiodan. Two new miticides with pending registrations were tested: Mesa showed moderately high toxicity (40-64%), while Acramite showed low toxicity (6%). Most fungicides tested showed low toxicity to *Z. mali*, but sulfur and lime sulfur were highly toxic. All plant growth regulators tested showed low toxicity to *Z. mali*.

Results, predator transfer trial: Bands examined in January were found to contain a very small number of stigmaeid mites; there were never more than 3 stigmaeids per band. Tree wrap lined with burlap had the most stigmaeids, tree wrap alone had fewer mites, and burlap alone had no mites. Trunk bands had more mites than scaffold bands.

Mite sampling in Fuji trees in July showed there was no apparent success in establishing *Z. mali* after bands were transferred in April. In the treatment that received a branch transfer on 31 July, some stigmaeids were detected on 15 August, 29 August, and 17 September. ERM exceeded threshold on 17 July thus the block was treated with Savey on 20 July. ERM eggs and apple rust mite were also at high density through mid-August. Phytoseiid mites (*Neoseiulus fallacis*) were detected in all plots at low density in late July and at high density in August.

Conclusions: The field trial demonstrated that the local population of *Z. mali* predatory mite tolerates both Danitol and Asana. Insect control on harvested fruit after a standard organophosphate (Imidan) program was equal to a program of Danitol at pink and petalfall followed by Imidan, or a program of Danitol only at pink followed by the non-organophosphates Avaunt and Intrepid. Danitol used even in mid- to late summer did not disrupt the *Z. mali* population. Further work is needed with oil and Savey to determine how to work better mite control into the program. The approach of using *Z. mali* along with Danitol at pink and petalfall followed by other insecticides shows promise for an integrated management program.

Bioassays of *Z. mali* predatory mites with orchard chemicals showed a wide spectrum of susceptibility. Chemicals that are most harsh on *Z. mali* are the miticides Pyramite and Vendex, the insecticide Thiodan, and the fungicides sulfur and lime sulfur. Chemicals known to be harsh on *N. fallacis* but which are not harsh on *Z. mali* are Vydate, Carzol, and Lannate.

Transfer of terminal branches in late July from an orchard with high density of *Z. mali* to an orchard where *Z. mali* did not occur naturally was effective in establishing a small population. We do not have enough data to decide whether or not trunk bands are effective at concentrating *Z. mali* in source orchards for transfer to other orchards; in our trial, bands did not lead to establishment of *Z. mali* , but this might have been because we put the bands up too late in the fall in the source orchard.

Note: For a full report including data tables, please contact the author.