Pacific Spider Mite Control in the Lower San Joaquin Valley

Project No.: **08-ENTO6-Haviland**

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Objectives:

Provide overall improvements in IPM for spider mites in almonds by:

1) Refining miticide use patterns to accommodate opportunities presented by new miticides
   a) during the traditional abamectin timing in May,
   b) during the mid-season in June,
   c) and at hull split
2) Developing large scale research plots to evaluate and demonstrate predatory mite releases as an alternative to chemical controls

Materials and Methods:

Pacific spider mite is one of the most important arthropod pests of almonds in the lower San Joaquin Valley. Miticide treatments are used annually on the majority of almond acreage. Even with miticides, however, mite-induced defoliation of entire almond orchards can become a region-wide phenomenon, as occurred in the lower San Joaquin Valley in 2005.

Early-season control in the lower Valley for the past decade has been based on the use of abamectin (Agri-Mek). It is generally applied in April or May prior to when leaves harden off. It is not, however, as effective after about the first of June when weather turns hot and leaves harden off. Late season control has historically been achieved through contact miticides such as Omite. This product however has been under increased scrutiny due to suspected resistance in the orchards, and also due to human health and worker safety issues.

Recently there have been several new miticides registered in almonds. Each of these products has proven effective in one or more trials in almonds as well as other crops. The question that remains is how to determine the best fit for each product within the almond production system.

During 2008 we conducted three large scale miticide trials to evaluate the effectiveness of new miticides at three treatment timings: ‘preventative’ treatments in May, mid-season treatments at a treatment threshold in June and at hull split. Each trial evaluated miticides that had the greatest potential to be effective at each of those timings based on the results of the last two years of research related to this project.

‘Preventative’ application timing in May

We have now conducted two large scale miticide trials in May, one in 2007 and one in 2008. Each trial evaluated the effects of five miticide treatments that were each applied to six, 2.5 acre research plots (total trial size 80 acres). Miticides included in the trial were Agri-Mek and the four growth regulators Zeal, Onager, Envidor and Apollo. Applications were made at 200 gallons per acre of water with an air blast sprayer and included the addition of 1% 415 oil or Sylgard (with Apollo) when applied at a traditional mid-May timing. The trial also included two 2.5 acre untreated checks.

Plots in 2008 were sampled were evaluated on 12 sampling dates from 6 May to 27 August. On each date we evaluated two leaves from each of 15 trees in each plot for a total of 960 leaves from all treated plots per sampling date. Precounts were made on 6 May and averaged 0.01 mites per leaf. After treatments, mite densities continued to be low in all treated and untreated plots and never exceeded 0.08 mites per leaf on any evaluation date through the duration of the trial on August 27 August, including in the untreated checks.

Due to the very low mite densities in this orchard, including in the untreated check, we were unable to make comparisons regarding the relative efficacy of miticide treatments. Therefore, our conclusions thus far are that any one of the five miticides evaluated can be very effective if used in May, based on our 2007 trial. This information suggests that growers who use May treatments can improve their resistance management programs by rotating among these chemistries. However, the 2008 trial provides evidence that ‘preventative’ May treatments in hindsight can in some cases be considered unnecessary expenditures. For this reason we continue to evaluate the effectiveness of miticides during June and at hull split. The purpose of the June and hull split trials is to improve the predictability of management programs later in the season to the point that May treatments are only used when mites reach a treatment threshold, and are not used prophylactically as a form of insurance against the presence of mites later in the season.

June application timing

In 2008 we conducted a large scale miticide trial in June. An 80-acre field was divided into 32, 2.5 acre plots that were each assigned to one of 6 treatments plus two plots left as untreated checks (**Table 1**). Miticide treatments were applied on 6 June with commercial air-blast sprayers at 200 GPA with the addition of 1% 415 Oil or 16 fl oz of Sylgard. Predatory mites were released by placing one small bean plant infested with a minimum of 50 *Galendromus occidentalis* in the crotch of each tree on 11 June. This is the equivalent of a release rate of 5,000 mites per acre.

Mite densities were evaluated in each plot prior to treatment on 3 Jun and weekly or biweekly for twelve evaluation dates through 27 Aug (73DAT). Mite densities in the two control plots ranged from 0.3 to 0.9 mites per leaf in June and then spiked to 3.0 mites per leaf on 2 July. This was the equivalent of 50% and 97% leaves infested from the two untreated plots, respectively. At that time, beneficial insects moved in and reduced mite densities back to and below 0.3 mites per leaf for the remainder of the season. Similar results were seen for the six predatory mite release plots that had from 0.4 to 0.8 mites per leaf through 18 June, 0.6 to 2.1 mites per leaf from 24 June to 9 July, and then subsided to less than 0.3 for the remainder of the season.

Miticide treatments all produced significant reductions in mite densities such that the average mites per leaf for any given treatment never exceeded 0.2 mites per leaf for the remainder of the season. This represented either a statistical or numerical reduction compared to the predatory mite plots on every evaluation date at least 12 days after treatment. Since we only had two replications of untreated check plots, we were not able to use the untreated check for statistical purposes. However, in the predatory mite release plots we were only able to recover 4 predatory mites out of the 840 leaves collected and evaluated in those plots from 18 Jun to 30 Jul. As such, we consider the predatory mite plots to function as an untreated check for statistical purposes. Mite populations peaked in the predatory mite plots on 24 Jun and 9 Jul at 2.12 and 1.59 mites per leaf, respectively. This was the equivalent of 40 and 47.5% leaves infested, which are well above the established UC treatment threshold of 26% leaves infested in cases where no predators are present.

When compared anecdotally to the unreplicated untreated checks, as well as statistically to the predatory mite release plots, this trial demonstrated that Zeal, Envidor, Onager, Apollo and Fujimite can all be used effectively to control mites in June. This is consistent with observations in the field where these products, when used with adequate water and good coverage, provided excellent control, even when used in some high pressure situations.

Table 1. Effects of miticide treatments on the density of motile spider mites on almond leaves.

	Rate	Average spider mites per leaf (at indicated date and days after treatment)								
		6/3 Pre	6/11 5	6/18 12	6/24 18	7/2 26	7/9 33	7/14 38	7/24 48	7/30 54
Zeal[1]	3 fl oz	0.88a	0.53a	0.09a	0.01a	0.07a	0.07a	0.00a	0.00a	0.01a
Envidor[1]	25.6 fl oz	0.23a	0.02a	0.01a	0.00a	0.05a	0.00a	0.01a	0.00a	0.01a
Onager[1]	20 fl oz	0.42a	0.08a	0.03a	0.10a	0.13a	0.01a	0.01a	0.01a	0.01a
Apollo[2]	8 oz	1.02a	0.16a	0.01a	0.09a	0.22a	0.00a	0.01a	0.01a	0.00a
Fujimite	32 fl oz	0.59a	0.11a	0.05a	0.10a	0.17a	0.10a	0.03a	0.01a	0.03a
Pred. mites[3]	--	0.79a	0.39a	0.41b	2.12a	0.59a	1.59b	0.26b	0.04a	0.17a
UTC[4]	--	0.27	0.33	0.85	0.92	2.98	0.32	0.08	0.05	0.05
	F =	1.02	1.63	6.14	2.17	1.26	3.32	3.25	0.84	2.21
	P =	0.434	0.197	0.001	0.098	0.318	0.024	0.026	0.539	0.094

[1] 415 oil used as a surfactant at 1% v/v
[2] Sylgard used as a surfactant at 4 fl oz/100 gallons
[3] Release rate of 5,000 Galendromus occidentalis per acre on 11 June.
[4] Average of 2 untreated check plots; not included in the statistical analysis.
Means in a column followed by the same letter are not significantly different ($P > 0.5$, Fisher's protected LSD) after
square root (x + 0.5) transformation of the data. Untransformed means are shown.

<u>Hull split trial</u>

The 2008 hull split miticide trial was conducted near McFarland, Kern Co. CA, to evaluate the effects of miticides on heavily infested mature almond trees at hull split (**Table 2**). Approximately 22 acres of trees were divided into 36, 1.9 acre plots that each contained 4 rows by approximately 10 trees long. Each plot was assigned to one of eight treatments in a completely randomized design with 4 blocks. Plots were sprayed on 9 Jul 2008 using commercial air-blast sprayers at 200 gpa. All treatments were combined with 1% 415 Oil. Mite densities were evaluated weekly through 65 days after treatment. On each evaluation date, two leaves were randomly collected from each of 15 trees in the center two rows of each. Mites per leaf were counted in a laboratory and data were analyzed by ANOVA using transformed data (squareroot (x + 0.05)) with means separated by LSD ($P = 0.05$).

Precounts in the trial were very high, with treatment averages ranging from 1.7 to 7.4 mites per leaf. Numbers of beneficials were also very high, though not quantified. As a result, mite densities that usually spike after hull split remained relatively constant from 1.24 to 2.19 mites per leaf on each of the 8 evaluation dates.

All treatments, including 2% oil, reduced spider mite densities to less than 0.1 mites per leaf through 16 DAT compared to 1.41 to 2.19 for the untreated check. By 23 and 29 DAT we began to see the mite density increase in the Kanemite plots and to a lesser degree the Oil plots. By 36 DAT plots treated with Zeal, Acramite and Brigade began to see increases in mite density. Longest residual in the trial was provided by plots treated with Envidor and Fujimite, which consistently had the numerically lowest mite densities through 48 DAT.

Data from this trial are consistent with results of previous trials at hull split in 2006 and 2007. For three straight years all miticides tested have provided excellent mite control for approximately two weeks, with residual effects ranging from three to six weeks depending on the project and the year. Shortest residual over the three years was consistently found in plots treated with Kanemite or Oil, followed by plots treated with Acramite and Zeal. The longest residual effect for all three years was provided by Fujimite and Envidor. We also determined that Brigade, as a pyrethroid, significantly reduced spider mite densities. Additionally, despite the large numbers of mites and mite predators, we did not document any flaring of spider mites through 65 days after treatment in plots treated with this pyrethroid.

Table 2. Effects of miticide treatments at hull split on the density of motile spider mites on heavily infested almond leaves, 2008.

		Average spider mites per leaf (at indicated date and days after treatment)								
	Rate	Pre	7/11 2	7/17 9	7/24 16	7/31 23	8/6 29	8/13 36	8/18 41	8/25 48
Zeal[1]	3oz	4.4a	0.03a	0.83a	0.00a	0.58a	0.10a	0.90a	1.40a	3.72a
Envidor[1]	25.6fl oz	2.4a	0.06a	0.01a	0.00a	0.02a	0.02a	0.02a	0.10a	0.29a
Kanemite[1]	31fl oz	5.0a	0.02a	0.01a	0.03a	0.99a	1.05bc	2.15a	1.21a	1.76a
Acramite[1]	16oz	3.3a	0.02a	0.05a	0.00a	0.20a	0.35ab	1.03a	1.05a	2.68a
Brigade[1]	16oz	2.5a	0.00a	0.00a	0.00a	0.01a	0.04a	0.18a	2.37a	1.54a
Fujimite[1]	2pt	6.3a	0.00a	0.03a	0.00a	0.04a	0.18ab	0.50a	0.28a	0.40a
415 Oil	2%	1.7a	0.13a	0.10a	0.00a	0.28a	0.49ab	0.48a	1.23a	2.30a
Untreated	--	7.4a	2.19b	1.41b	2.05b	2.15a	1.58c	1.98a	2.61a	1.24a
F		0.37	2.86	3.79	3.67	1.97	2.85	1.58	2.29	0.91
P		0.927	0.022	0.005	0.006	0.095	0.023	0.184	0.056	0.522

[1] 415 oil used as a surfactant at 1% v/v
Means in a column followed by the same letter are not significantly different ($P > 0.5$, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.