Pacific Spider Mite Control in the Lower San Joaquin Valley

Project No.: 06-Ento4-Haviland

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Introduction:

Pacific spider mite is one of the most important arthropod pests of almonds in the lower San Joaquin Valley. In average years most acreage is sprayed for this pest one to two times, with additional applications being made in years, such as 2005, when pest pressure is particularly high. Applications early in the season (April or May) are almost exclusively Agri-Mek, whereas a applications later in the season have primarily been Omite, with lesser uses from other miticides like Vendex, Nexter, Acramite, or Oil. However, there have recently been several new miticides that have received, or are about to receive, registrations for almonds, including Onager, Zeal, Kanemite, Fujimite, Desperado, Ecotrol, and Envidor (likely registered for 2007). Each of these products has the potential to improve the ability to manage spider mites. The goal of this research project is to conduct miticide trials during the 2006 and 2007 growing seasons to help determine the best fit for each of these new products into an IPM program.

Objective:

1) Evaluate the effects of miticide applications on Pacific Spider mite control
- **a) during the spring (April/May timing)**
- **b) during the summer (hull split timing)**

Materials, Methods and Results:

Trial 1. Screening field trial, 1st year almonds, single tree treatments in August

This experiment was conducted during the late summer during 2005 in a 1-yr-old commercial block of almonds located in western Kern County, CA. Due to the sporadic nature of the density of spider mites, we did a visual survey of trees in an area of approximately 2 acres and chose the 85 most infested trees. These trees were randomly assigned to one of 5 repetitions each of 14 treatments, an Oil alone treatment, a Water Check, and an Untreated Check. Miticides were applied on 12 Aug with a CO_2 powered backpack sprayer. Applications were made at 30 psi using an 8002 fan jet nozzle. The spray solution was prepared by mixing the miticides to a 200 gpa dilution and then spraying each individual tree with 500 ml of that solution. At the time of application it was over 100°F, the leaves were very hardened off and dusty, and there was a large amount of webbing covering many of the leaves.

Mite populations were evaluated one day prior to treatment on 11 Aug and then again 3 DAT (15 Aug), 7 DAT (19 Aug), 14 DAT (26 Aug), and 21 DAT (2 Sept). On each evaluation date 10 random leaves were collected from each tree and evaluated for the total number of Pacific spider mite eggs and motiles (juveniles + adults). Average motiles and eggs per leaf were calculated for each experimental plot. These data were transformed using a standard sqrt transformation and analyzed by ANOVA with means separated by Fisher's Protected LSD at $\alpha \leq 0.05$. Data are presented as the mean of the average mites per leaf with means separation reported from analyses using transformed data.

This trial was a good side-by-side comparison of how miticides perform when there is heavy mite pressure with hardened off, webbed over leaves under temperature conditions over 100°F. Even under these sub-optimal conditions, several newer miticides, including Kanemite, Zeal, Envidor + Oil, both rates of Onager, Fujimite, and Acramite did well. The least effective of the miticides were the two abamectin products (Agri-Mek and A-8612), which are best known for their effectiveness prior to when leaves harden off.

Table 1 shows the effects of miticide treatments on the number of motile spider mites per leaf. There were no significant differences in pre-counts which ranged from 29.5 to 96.2 mites per leaf. By 3 DAT Kanemite, Zeal, Fujimite, Envidor + Oil, and Acramite had mite densities significantly lower than the Untreated Check. Mite densities in plots of all other treatments were numerically, but not significantly, lower than the Untreated Check.

By 7 DAT, all treatments (except for water alone) resulted in significant reductions in mite density. The lowest densities of mites were in plots treated with Zeal, Envidor + Oil, Onager 16oz, Kanemite, Acramite, and Onager 24oz. These treatments were statistically inseparable from the seven next best products. Agri-Mek + Oil and Spray Oil alone had egg densities significantly higher than the best six treatments but that were still significantly lower than the Untreated Check.

By 14 DAT the lowest mite densities (under 1 mite per leaf) were achieved by Envidor + Oil, Kanemite, Omite, the high rate of Onager, and Zeal. These were statistically comparable to all other treatments except for the two abamectin treatments (Agri-Mek + Oil and A-8612) which were both statistically comparable to the Untreated Check. By 21 DAT the density of spider mites in all treated plots (0.2 to 7.3 mites per leaf) was numerically, but not statistically, decreased compared to the Untreated Check (7.4

Spider mite eggs:

Table 2 shows the effects of miticide treatments on the number of spider mite eggs per treatment. There were no significant differences in pre-counts or in data 3 DAT. By 7 DAT there were some significant differences in mite egg densities. Lowest densities were in plots treated with Kanemite. The number of eggs in Kanemite plots was statistically lower than that of Omite, Onager 16, Onager 24, Water, and the Untreated Check; but was statistically equivalent to all other treatments. Despite the fact that all treatments produced numerical reductions in the number of mite eggs compared to the control, statistically significant reductions were achieved by Agri-Mek + Oil, Desperado, Envidor + Oil, Fujimite, Kanemite, Zeal, and Oil alone.

By 14, 21, and 28 DAT the numbers of mites per leaf dropped and there were no longer any significant differences in the densities of spider mite eggs.

Table 1. Effects of miticide treatments (to single trees) on the number of spider mites per leaf.

		Average motile (juvenile + adult) mites per leaf				
Treatment/formulation	Rate per acre	Pre	3 DAT	7 DAT	14 DAT	21 DAT
Acramite 50 WS	1 lb	80.1 a	9.9 abc	3.3 a	4.3 abcd	0.6 a
Acramite 50 WS + 1% oil	1 lb	93.8 a	22.0 abcd	3.4 ab	3.6 abcd	0.1 a
Agri-Mek 0.15EC + 1% oil	10 fl oz	28.2 a	24.8 bcd	24.2 cd	9.9 ef	4.9 a
A-8612 0.15EC + 1% oil	10 fl oz	29.5 a	26.1 abcd	10.3 abc	6.4 def	5.7 a
Desperado 54AS	1 gal	71.4 a	16.5 abcd	5.6 abc	4.6 abcde	1.7 a
Envidor 240SC	18 fl oz	66.8 a	34.3 d	5.3 abc	2.7 abcde	3.4 a
Envidor 240SC + 1% oil	18 fl oz	60.2 a	7.6 abc	0.9 a	0.6 abcd	0.5 a
Fujimite 5EC	2 pt	43.6 a	5.8 ab	7.1 abc	2.4 abcd	1.4 a
Kanemite 15SC	31 fl oz	36.7 a	3.6 a	2.9 a	0.2 ab	0.5 a
Omite 30WS	8 lb	89.8 a	21.6 abcd	11.8 abcd	0.5 abc	1.2 a
Onager 11.8EC	16 fl oz	82.4 a	37.7 d	1.9 a	2.2 abcd	0.1 a
Onager 11.8EC	24 fl oz	32.1 a	25.2 abcd	3.6 a	0.1 a	0.3 a
Vendex 50WP	2.5 lb	76.4 a	23.4 cd	8.4 abcd	1.4 abcd	0.3 a
Zeal 72WDG	3 oz	60.8 a	3.9 abc	0.8 a	0.2 ab	0.2 a
Spray Oil (415F)	2%	51.3 a	16.6 abcd	19.5 bcd	5.1 abcde	7.3 a
Water Check		65.7 a	37.8 d	25.5 e	2.6 abcd	3.9 a
Untreated Check		96.2 a	39.0 d	60.9 e	16.3 f	7.4 a

Means in a given column followed by the same letter are not significantly different (Fisher's protected LSD). Data are reported as original numbers with means separation from a sqrt(value + 0.5) transformation.

Table 2. Effects of miticide treatments (to single trees) on the number of spider mite eggs per leaf.

		Average eggs per leaf				
Treatment/formulation	Rate per acre	Pre	3 DAT	7 DAT	14 DAT	21 DAT
Acramite 50 WS	1 lb	31.7a	6.0a	1.5a	4.3a	1.3a
Acramite 50 WS + 1% oil	1 lb	48.4a	8.0a	2.4abcd	2.4a	0.1a
Agri-Mek 0.15EC + 1% oil	10 fl oz	18.1a	3.8a	8.4abcd	7.6a	1.2a
A-8612 0.15EC + 1% oil	10 fl oz	10.9a	6.9a	3.9abcd	6.7a	5.2a
Desperado	1 gal	27.0a	3.3a	1.5ab	7.7a	0.5a

Envidor 240SC	18 fl oz	17.1a	5.9a	2.4abcd	2.7a	2.8a
Envidor 240SC + 1% oil	18 fl oz	17.2a	1.7a	0.4a	0.6a	1.4a
Fujimite 5EC	2 pt	36.6a	2.7a	5.6abcd	0.8a	1.1a
Kanemite 15SC	31 fl oz	15.4a	0.4a	0.2a	0.3a	2.0a
Omite 30WS	8 lb	24.5a	10.6a	4.8abcd	0.1a	2.3a
Onager 11.8EC	16 fl oz	57.6a	12.7a	0.5a	1.6a	0.0a
Onager 11.8EC	24 fl oz	16.0a	9.4a	1.8ab	0.2a	0.3a
Vendex 50WP	2.5 lb	47.2a	4.3a	4.2abcd	1.2a	0.1a
Zeal 72WDG	3 oz	27.0a	4.2a	1.4ab	0.2a	0.2a
Spray Oil (415F)	2%	15.7a	3.0a	12.2de	2.6a	0.8a
Water Check		35.2a	13.2a	12.3cde	1.7a	1.6a
Untreated Check		27.1a	14.6a	26.8e	5.4a	7.6a

Means in a given column followed by the same letter are not significantly different (Fisher's protected LSD). Data are reported as original numbers with means separation from a sqrt(value + 0.5) transformation.

Trial 2. Large scale miticide trial, non-bearing almonds, July timing

This trial was conducted near Blackwell's Corner, Kern Co. CA. to evaluate the effects of miticides on mite density in two-year old, non-bearing almond trees. Approximately 110 ac of trees were divided into 50, 2.1 ac plots that each contained 6 rows by approximately 30 trees at a 21 by 24 ft spacing. Each plot was assigned to one of nine treatments or an untreated check in a RCBD with 5 blocks. Plots were sprayed at night on 14 July using commercial air-blast sprayers at 200 GPA. All treatments were done with the addition of either 1% 415 Oil, which is noted in the tables, or with 16 fl oz of the non-ionic surfactant Exit™ (Miller Chemical and Fertilizer Corp., Hanover, PA). Due to a large amount of mite-induced damage in the untreated check, these five plots were oversprayed with a miticide on 8 August (25 DAT).

Mite densities were evaluated in each plot prior to treatment on 13 July and then 3, 6, 13, 20, 27, and 33 DAT on 17, 20, and 27 July and 3, 10, and 16 August. On each evaluation date two random leaves were collected from each of 20 trees in the center two rows of each plot. Leaves were transported to a laboratory where the total number of Pacific spider mite motiles (larvae, nymphs, and adult) and eggs were counted. Numbers of predatory mites and predatory mite eggs were also recorded, but are not reported since only 4 were found during all evaluation dates. Average numbers of Pacific spider mite motiles and Pacific spider mite eggs per leaf were calculated per plot and data were analyzed by ANOVA using transformed data (squareroot (x+0.05)) with means separated by Fisher's Protected LSD at P>0.05.

Table 3 shows the effects of miticides on the density spider mites per leaf. There were no significant differences in precounts which ranged from 0.4 to 4.8 mites per leaf. On evaluation dates 3, 6, 13, and 20 DAT all treatments resulted in significant reductions in mite density compared to the untreated check, yet there were no significant differences among treatments. All treatments on these evaluation dates resulted in mite densities less than or equal to 0.3, 0.3, 1.8, and 2.7 mites per leaf compared to 1.9, 3.6, 27.5, and 55.9 mites per leaf respectively in the untreated check. By 21 DAT Envidor, Fujimite and Omite maintained mite densities below 2 per leaf at a level significantly lower than

Acramite or the untreated check; other miticides were also lower than the untreated check but were inseparable from any other treatments. By 33 DAT, mite densities in plots treated with Fujimite and Omite were the only ones with mite densities at or below those when the trial began (2.3 mites per leaf average in the precounts).

Table 4 shows the effects of miticide treatments on spider mite eggs. All treatments caused significant reductions in spider mite eggs through 27 DAT. These reductions, and the relationships among treatments very closely paralleled the results previously described for motile forms of spider mites. As with data on motile forms of mites, Fujimite and Omite consistently had the lowest mite densities.

Table 3. Effects of large scale miticide treatments on the number of spider mites per leaf.

			Spider mites per leaf					
Treatment	Rate	Precounts	3 DAT	6 DAT	13 DAT	20 DAT	27 DAT	33 DAT
Acramite 50WS + Oil	1 lb	3.7a	0.1a	0.1a	0.9a	2.4a	11.1b	20.6c
Ecotrol 10EC	96 fl oz	4.3[a]	0.1a	0.0a	0.0a	0.4a	3.4ab	6.8ab
Envidor 2SC+ Oil	18 fl oz	3.1a	0.2a	0.2a	0.2a	0.4a	0.7a	3.5ab
Fujimite 5EC + Oil	32 fl oz	1.4a	0.1a	0.0a	0.0a	0.2a	1.0a	1.4a
Kanemite 15SC	31 fl oz	0.9a	0.3a	0.1a	1.8a	2.2a	9.8ab	13.8bc
Omite 6E	64 fl oz	1.7a	0.0a	0.0a	0.1a	0.1a	1.5a	1.4a
Onager 1EC	20 fl oz	0.9a	0.1a	0.2a	1.8a	2.7a	14.7ab	14bc
Vendex 50WP	2.5 lb	1.7a	0.1a	0.0a	0.2a	0.2a	3.8ab	3ab
Zeal 72WDG	3 oz	0.4a	0.2a	0.3a	0.5a	0.5a	3.7ab	6.5ab
Untreated Check		4.8a	1.9b	3.6b	27.5b	55.9b	*76.6c	*12.4bc

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.

*Due to mite-induced damage, untreated check plots were oversprayed with a miticide on 9 August (25 DAT). Data for the untreated check 27 DAT were collected on 9 August (25 DAT) prior to the spraying, and data shown 33 DAT represent mite densities 8 days after retreatment.

Table 4. Effects of large scale miticide treatments on the number of spider mite eggs per leaf.

				Spider mite eggs per leaf				
Treatment	Rate	Precounts	3 DAT	6 DAT	13 DAT	20 DAT	27 DAT	33 DAT
Acramite 50WS + Oil	1 lb	2.1a	0.1a	0.2a	1.0a	4.1b	6.2a	7.8d
Ecotrol 10EC	96 fl oz	1.9a	0.0a	0.0a	0.2[a]	0.5ab	4.2a	3.2abcd
Envidor 2SC + Oil	18 fl oz	3.2a	0.1a	0.0a	0.3a	0.5ab	0.7a	2.1abc
Fujimite 5EC + Oil	32 fl oz	2.0a	0.0a	0.0a	0.0a	0.1a	1a	0.1a
Kanemite 15SC	31 fl oz	0.3a	0.3a	0.0a	2.0a	2.3ab	5.8a	3.9bcd
Omite 6E	64 fl oz	1.8a	0.1a	0.0a	0.0a	0.2a	1.5a	0.4abc
Onager 1EC	20 fl oz	1.0a	0.2a	0.0a	1.8a	3.5ab	7.6a	5.2cd
Vendex 50WP	2.5 lb	0.8a	0.2a	0.0a	0.2a	1ab	4.4a	1.3abc
Zeal 72WDG	3 oz	1.2a	0.4a	0.1a	0.2a	1ab	2.1a	2.9abc
Untreated Check		3.4a	1.4b	2.2b	27.0b	36.5c	*48.1b	*2.9abc

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.

*Due to mite-induced damage, untreated check plots were oversprayed with a miticide on 9 August (25 DAT). Data for the untreated check 27 DAT were collected on 9 August (25 DAT) prior to the spraying, and data shown 33 DAT represent mite densities 8 days after retreatment.

Discussion

Thus far during year one of this grant we have focused our trials on the traditional hull-split timing in almonds in an effort to identify potential Omite replacement products. The newer contact miticides Acramite, Kanemite and Fujimite can all provide excellent knock-down of mites. Residual effects of Acramite and Kanemite lasted for about three weeks, and were comparable to that of Vendex. Fujimite, however, suppressed mites for five to six weeks for a period comparable to that of plots treated with Omite. The mite growth regulators Zeal, Onager, and Envidor also had excellent knock-down of mites, with residual effects of Onager lasting about three weeks and the residual of Zeal and Envidor lasting about 5 weeks. The organic product Ecotrol also performed very well in the large scale trial we performed, with residual effects lasting approximately three weeks.