Pacific Spider Mite Control in the Lower San Joaquin Valley

Project No.: **10-ENTO6-Haviland**

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Objectives:

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

1) Evaluating and demonstrating the use of new miticides as part of a season-long management program
2) Comparing the effectiveness of preventive vs. threshold-based management programs for spider mites
3) Validate that University of California treatment thresholds for spider mites can be used effectively to time miticide treatments
4) Evaluating new miticides for their effects on spider mite control in almonds

Interpretive Summary:

Pacific spider mite is one of the most common pests of almonds in the lower San Joaquin Valley. Standard practice for most growers is to spray once for mites in the spring around May, and to spray a second time at hull split as a tank mix with an insecticide for navel orangeworm. Since abamectin works best while leaf tissue is still soft, usually defined as prior to June, abamectin treatments have typically been made in late April through May despite whether or not mites are present. As a result this program is generally considered a preventative approach to spider mite management. However, within the past few years new miticides that do not have the timing limitations of abamectin have become available such that threshold-based programs have greater potential to be successful. The primary purpose of this project was to compare a preventative approach to spider mite management with a threshold-based approach. In doing so the project was also used as a validation of the University of California presence-absence sampling method when used in the southern San Joaquin Valley.

During 2010 comparisons between preventative and threshold-based management programs showed that both can be highly effective at controlling mites throughout the season. This is similar to data from 2009 showing that in both years one application of Envidor, Onager or Zeal was sufficient to provide season-long control when applied at the University of California treatment threshold. These results suggest that almond growers have multiple options for controlling mites that can be adapted according to location and pest pressure. Preventative programs can be highly effective but often require two treatments to fields where one may have otherwise sufficed. On the other hand, threshold-based programs may save a spray but require more diligent monitoring and sufficient equipment to be able to spray as needed. Data from 2009 and 2010 also documented that the UC treatment thresholds that are based on presence-absence sampling (http://ucipm.ucdavis.edu/PMG/selectnewpest.almonds.html) accurately predicted when mite sprays were needed and can serve as a valuable resource to almond farmers.

Materials and Methods:

Preventative vs. Threshold-based programs trial

Comparisons of preventative versus threshold-based spider mite management programs were made in a commercial almond orchard near Shafter, Kern Co., CA. A total of 280 acres of mature almond trees were divided into sixteen, 17-acre plots that each contained approximately 1,500 trees. Each plot was assigned to one of four treatments in a randomized complete block design. Treatments were 1) preventative use of abamectin in May followed by Envidor at hullsplit, 2) Envidor at a treatment threshold, 3) Onager at a treatment threshold, and 4) Zeal at a treatment threshold. The abamectin treatment was applied in mid-May as a tank mix with an alternaria spray, whereas the threshold treatments were made on 21 Jul once the presence-absence treatment thresholds supported by the University of California were reached (http://www.ipm.ucdavis.edu/PMG/C003/almonds-mites.pdf). All treatments were made using commercial air-blast sprayers at 200 GPA with the addition of 1% v/v 415º Oil. Each of the four blocks also contained a 2- to 3-acre untreated control plot. Control plots were oversprayed with Envidor and oil on 11 Aug due to mite densities in excess of treatment thresholds.

Mite densities were evaluated in each plot on 28 Apr, 10 May, 17 May, 24 May, 1 Jun, 7 Jun, 14 Jun, 22 Jun, 28 Jun, 6 Jul, 12 Jul, 19 Jul, 26 Jul, 3 Aug, 9 Aug, 17 Aug, 23 Aug, 30 Aug, 8 Sept, 20 Sept, and 4 Oct. Evaluations were made by dividing each plot into four equal subplots. On each evaluation date, two leaves were randomly collected from each of ten trees in the center of each subplot with a total of 80 leaves per plot. Leaves were transported to a laboratory where the total number of Pacific spider mite motiles (larvae, nymphs, and adult) on each leaf was counted. Average mites per leaf from each plot were analyzed by ANOVA using transformed data (square root (x + 0.5)) with means separated by LSD (P = 0.05). Predatory mites and eggs were also counted but only 150 predatory mites were found out of 26000 leaves so data were not analyzed.

Miticide screening trial

During 2010 we conducted a trial in Shafter, CA to evaluate the effects of miticides on the density of Pacific spider mites in almonds. The trial was located in a 3.0 acre portion of a second-leaf orchard that contains alternating rows of the varieties Nonpareil and Monterey. Plot size was five consecutive Nonpareil trees on a 20’ ft by 22’ ft spacing. The plots were organized into a RCBD with 5 blocks of 5 treatments and an untreated check; rows of Monterey trees were not sprayed and were used as buffers between blocks. Treatments were applied to individual trees with a hand gun at a water volume equivalent to 100 gpa and 150 psi on 21 Jul. All treatments were combined with 1% 415º Oil.

Mite densities were evaluated in each plot prior to treatment on 21 Jul and then on 27 Jul (6 DAT), 30 Jul (9 DAT), 2 Aug (12 DAT), 6 Aug (16 DAT), 9 Aug (19 DAT), 13 Aug (23 DAT), and 16 Aug (26 DAT). On each sample date a total of 20 leaves were collected per plot. This included four random leaves per tree from each of the five trees per plot. Leaves were transported to a laboratory where the numbers of motile Pacific spider mites (larvae, nymphs, and adults) and spider mite eggs per leaf were counted. Average number of motiles and eggs per leaf were analyzed by ANOVA using transformed data (square root (x + 0.5)) with means separated by LSD ($P = 0.05$).

Results and Discussion:

Preventative vs. Threshold-based programs trial

The effects of miticide treatments on the density of spider mites and spider mite eggs are shown in **Figure 1** and in **Tables 1 and 2**. Overall in 2010 mite densities were low during May and June. As a result, there are no significant differences in mite densities in May or June between the preventative treatment (that was sprayed with abamectin in May) and plots of the threshold-based treatments that still remained untreated.

Mite densities began to increase from early through mid-July. By 12 July spider mite densities in the preventative treatment were 0.33 mites per leaf compared to 0.27 to 1.60 for the threshold-based and untreated plots that had not yet been treated. By 19 Jul the untreated check and threshold-based treatments averaged from 0.37 to 1.21 mites per leaf with averages within each individual plot ranging from 0.05 to 2.78 mites per leaf. Evaluations of the percentage of the leaves that were infested showed that several of the most-infested plots had infestation rates between 30 and 40%, which according to the UC treatment thresholds for spider mites when no beneficials are present is considered marginally treatable.

Threshold-based treatments of Envidor, Onager and Zeal were applied on 21 Jul based on the fact that a few plots had reached a treatment threshold, mite populations were slowly increasing, and hull split was approaching. Five days after application, mite densities on 26 July were 0.12 for plots of that received preventative abamectin treatments in May and ranged from 0.01 to 0.11 for plots treated with Envidor, Onager or Zeal at a treatment threshold, compared to 1.25 in the untreated check. By 9 Aug mite densities in all treated plots ranged from 0.09 to 0.32 mites per leaf compared to 3.16 in the untreated check.

Due to the rapid increases in mite density in the untreated check from 3 Aug to 9 Aug the untreated checks were oversprayed with Envidor on 11 Aug. The preventative program plots were also sprayed with Envidor to simulate the hull-split spray that typically accompanies a preventative program. On all evaluation dates from 17 Aug through 4 Oct mite densities in preventative plots, threshold-based plots and the oversprayed Check were all below 0.40 mites per leaf for the remainder of the season such that no additional sprays were needed.

Results from 2010 were similar to those from 2009. In both years spider mites were able to be managed with a single threshold-based application of Envidor, Onager or Zeal. Preventative programs were also effective. In 2009 a single application of abamectin in May was sufficient to control spider mites for the entire season while in 2010 the abamectin plus a hull split miticide application likewise provided excellent control. This suggests that both programs are viable options for spider mite control in almond orchards.

Data also suggest that University of California thresholds can be a valuable tool for deciding whether or not a miticide treatment is needed. Spider mite densities in almond orchards typically have a slow gradual increase in populations throughout spring and early summer. Then, at some point during the summer they begin to increase exponentially and can cause defoliation within a matter of a few weeks. During this project, in both years the presence-absence method for monitoring accurately predicted when treatments should be made. Comparisons with the untreated check in both years shows that the presence-absence sampling method accurately suggested that treatments be made right about the time that mite growth changed from linear to exponential. This work validates that UC thresholds that were developed primarily in the northern almond production areas of California can be used in the lower San Joaquin Valley.

Miticide screening trial

Mite populations in the trial were very high, with pre-counts averaging 20.5 mites per leaf across all treatments (**Table 3**). By 6 DAT all treatments reduced mite densities to 3.1 or less mites per leaf compared to 32.8 mites per leaf in the untreated check. By 9 DAT and 12 DAT all plots maintained significant reductions in mite density compared to the untreated check. By 16 DAT and 19 DAT the data for all treatments showed similar patterns as previous data with regards to which plots had numerically lower or higher mite densities. However, none of these were significantly different from the untreated check due to a reduction in mite densities in the untreated check as a result of significant defoliation in those plots, causing mite densities from the 12 DAT, 16 DAT and 19 DAT evaluations to go from 56.7 to 12.5 to 5.2 mites per leaf, respectively. On the 23 DAT and 26 DAT evaluations all mite densities were statistically equivalent.

Table 4 shows the effects of miticide treatments on egg density. With only one exception, all treatments provided significant reductions in egg density 6 DAT and 9 DAT. There were no significant differences in egg density from 12 DAT to the end of the trial.

One of the purposes of this trial was to evaluate the effects of standard rates of Acramite 50WS to a higher rate of the same product, as well as to compare the 50WS formulation to the 4SC formulation. Across all evaluations there were no significant differences among these treatments. However, numerically there were some interesting trends. With the exception of 6 DAT, mite densities (both motiles and eggs) were always numerically higher in plots treated with the 24oz rate of Acramite 50WS compared to the 16oz rate. Numerical comparisons between the two formulations showed that plots treated with Acramite 50WS had lower initial mite densities through 12DAT, suggesting that this older formulation might work slightly faster than the new 4SC formulation. However, during the last two evaluations the mite densities in plots treated with the new 4SC formulation were approximately half of the mite densities in the older 50WS formulation. This suggests that the new formulation may have the longer residual benefit that is needed by almond growers who use the product at hull split and need protection through the harvest period.

We also completed one additional evaluation of the data to look at cumulative mite counts in plots for all evaluations after treatments were made. This is a way to measure overall value to an almond farmer that wants rapid knockdown of a hull-split spray, but also needs residual control to last through harvest. The results of this evaluation are shown in the last column of **Table 1** (lower right corner). The lowest overall cumulative mite densities were found in plots treated with Onager, which was statistically equivalent to Acramite 4SC and the low rate of Acramite 50WS. Cumulative mite densities in plots treated with the high rate of Acramite 50WS and Fujimite were numerically lower, but statistically equivalent to the untreated check, though only because data for mite densities in the untreated check were underrepresented due to defoliation.

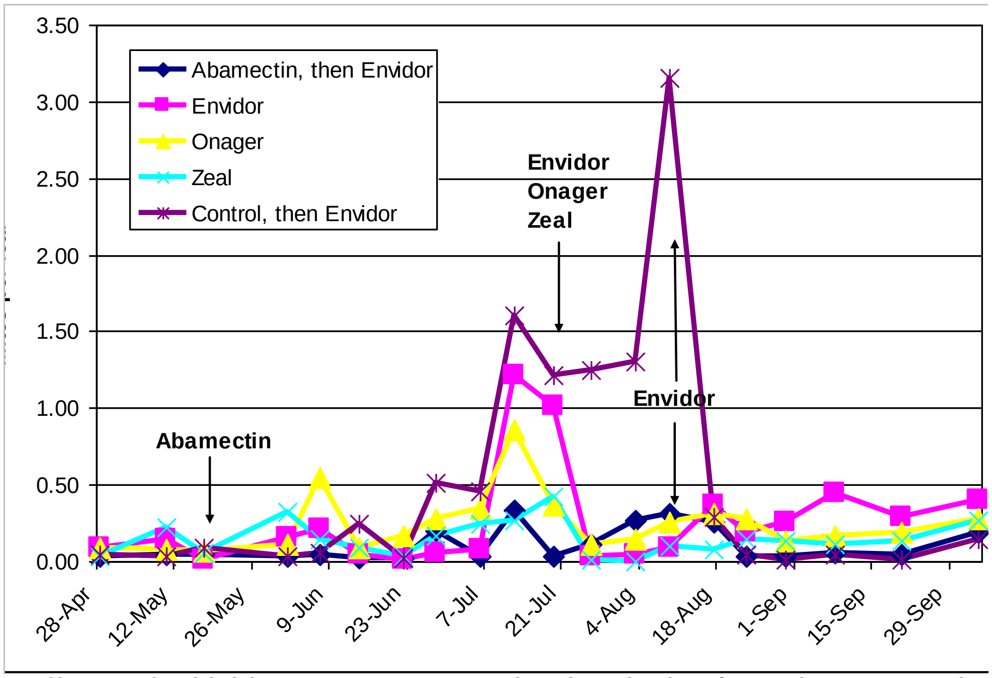

Figure 1. Effects of miticide treatments on mite density in almonds, 2010. The preventative program was sprayed in mid-May with abamectin followed by Envidor on 11 Aug. Threshold-based programs were sprayed with either Envidor, Onager or Zeal on 21 Jul. The control plot was oversprayed in 11 Aug with Envidor. All treatments included 1% 415° oil.

Table 1. Effects of miticide treatments on the density of spider mite motiles on almond leaves.

Treatment[1]	Rate	Average spider mites per leaf										
		28Apr	10May	17May	1Jun	7Jun	14Jun	22Jun	28Jun	6Jul	12Jul	19Jul
Epi-Mek 0.15EC		0.04a	0.05a	0.05a	0.03a	0.04a	0.02a	0.03a	0.20a	0.03a	0.33a	0.03a
Envidor 2SC	20 fl oz	0.09a	0.15a	0.01a	0.16a	0.21a	0.04a	0.01a	0.06a	0.08a	1.22a	1.02a
Onager 11.8EC	25.6 fl oz	0.09a	0.08a	0.07a	0.11a	0.54a	0.08a	0.16a	0.28a	0.35a	0.86a	0.37a
Zeal 72WDG	3 fl oz	0.03a	0.22a	0.06a	0.33a	0.14a	0.09a	0.04a	0.16a	0.25a	0.27a	0.43a
Control	--	0.05a	0.44a	0.09a	0.04a	0.06a	0.24a	0.02a	0.51a	0.46a	1.60a	1.21a
	F =	1.14	0.98	0.57	1.37	1.14	0.78a	1.93a	0.69	1.87	1.69	2.75
	P =	0.3847	0.4549	0.6865	0.3010	0.3846	0.5601	0.1703	0.6099	0.1807	0.2159	0.0780

Treatment[1]	Rate	26Jul	3Aug	9Aug	17Aug	23Aug	30Aug	8Sept	20Sept	4Oct	Cumulative
Epi-Mek 0.15EC		0.12a	0.27a	0.32a	0.26a	0.03a	0.03a	0.06a	0.04a	0.19a	2.13a
Envidor 2SC	20 fl oz	0.03a	0.04a	0.09a	0.37a	0.19a	0.26a	0.44b	0.29b	0.40a	5.11ab
Onager 11.8EC	25.6 fl oz	0.11a	0.14a	0.26a	0.31a	0.28a	0.14a	0.17a	0.19ab	0.28a	4.63a
Zeal 72WDG	3 fl oz	0.01a	0.00a	0.10a	0.08a	0.14a	0.13a	0.11a	0.14ab	0.27a	2.88a
Control	--	1.25a	1.31b	3.16b	0.29a	0.05a	0.01a	0.05a	0.01a	0.15a	10.33b
	F =	2.95	5.86	8.37	2.05	2.17	2.80	8.66	3.61	2.96	4.92
	P =	0.0653	0.0075	0.0018	0.1508	0.1347	0.0747	0.0016	0.0374	0.0649	0.0139

[1] 415 oil used as a surfactant at 1% v/v

Means in a column followed by the same letter are not significantly different ($P > 0.05$, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.

Table 2. Effects of miticide treatments on the density of spider mite eggs on almond leaves.

Treatment[1]	Rate	Average spider mites per leaf										
		28Apr	10May	17May	1Jun	7Jun	14Jun	22Jun	28Jun	6Jul	12Jul	19Jul
Epi-Mek 0.15EC		0.12a	0.14a	0.03a	0.02a	0.08a	0.02a	0.00a	0.49a	0.18a	0.41a	0.03a
Envidor 2SC	20 fl oz	0.17a	0.35a	0.02a	0.42a	0.05a	0.17a	0.05a	0.24a	0.21a	0.52a	0.51a
Onager 11.8EC	25.6 fl oz	0.11a	0.21a	0.05a	0.14a	0.56a	0.06a	0.28a	0.56a	0.54a	1.22a	0.53a
Zeal 72WDG	3 fl oz	0.25a	0.19a	0.01a	0.28a	0.29a	0.05a	0.30a	0.19a	0.07a	1.21a	1.14a
Control	--	0.18a	0.09a	0.16a	0.08a	0.06a	0.15a	0.14a	0.04a	0.24a	1.83a	1.16a
	F =	0.45	0.80	3.13	2.03	2.12	0.53a	1.59a	0.38	1.10	2.33	1.48
	P =	0.7716	0.5498	0.0560	0.1542	0.1405	0.7194	0.2395	0.8187	0.4004	0.1147	0.2692

Treatment	Rate	26Jul	3Aug	9Aug	17Aug	23Aug	30Aug	8Sept	20Sept	4Oct	Cumulative
Epi-Mek 0.15EC		0.08a	0.25ab	0.59a	0.78a	0.12a	0.01a	0.02a	0.00a	0.03a	3.37a
Envidor 2SC	20 fl oz	0.15a	0.00a	0.22a	0.17a	0.08a	0.11a	0.15a	0.03c	0.03a	5.59ab
Onager 11.8EC	25.6 fl oz	0.44a	0.55ab	0.42a	0.49a	0.20a	0.28a	0.10a	0.04bc	0.00a	6.46ab
Zeal 72WDG	3 fl oz	0.13a	0.03a	0.23a	0.77a	0.30a	0.23a	0.16a	0.07ab	0.03a	3.40a
Control	--	1.29a	0.93b	3.05b	0.40a	0.13a	0.01a	0.00a	0.00a	0.00a	9.65b
	F =	1.73	3.41	6.47	1.78	2.05	1.64	2.01	4.57	1.51	4.18
	P =	0.2073	0.0440	0.0052	0.1978	0.1513	0.2281	0.1566	0.0179	0.2614	0.0239

[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* > 0.05, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.

Table 3. Effects of miticide treatments on the density of motile spider mites on almond leaves.

Treatment/Forumlation[1]	Rate Form. Prod/acre	Average spider mites per leaf								
		Pre-counts	6DAT	9DAT	12DAT	16DAT	19 DAT	23DAT	26DAT	Cumulative mites
Acramite 50WS	16 oz	15.6a	0.3a	0.6a	3.2a	4.6a	4.4a	33.1a	89.4a	135abc
Acramite 50WS	24 oz	23.2a	0.3a	2.4a	10.2a	6.1a	10.0a	61.1a	116.0a	206cd
Acramite 4SC	24 fl oz	16.9a	3.0a	5.2a	7.2a	3.1a	7.4a	24.2a	48.0a	98ab
Onager 1EC	24 fl oz	7.3a	3.1a	4.7a	7.5a	7.0a	3.3a	19.4a	30.4a	75a
Fujimite 5EC	48 fl oz	28.3a	2.4a	19.3a	13a	17.9a	14.9a	24.0a	92.6a	184bcd
UTC	--	31.7a	32.8b	63.6b	56.7b	12.5a[2]	5.2a[2]	19.1a[2]	54.6a[2]	244d[2]
	F=	0.73	12.62	5.65	6.67	1.22	1.48	0.96	2.60	4.43
	P=	0.6081	<.0001	0.0021	0.0008	0.3372	0.2394	0.4649	0.0572	0.0092

[1] 415º oil used as a surfactant at 1% v/v
[2] Significant amounts of defoliation were present in the untreated check during the 16DAT through 26DAT evaluations due to heavy defoliation.
Means in a column followed by the same letter are not significantly different (*P* > 0.05, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.

Table 4. Effects of miticide treatments on the density of spider mite eggs on almond leaves.

		Average spider mite eggs per leaf							
Treatment/Forumlation[1]	Rate Form. Prod/acre	Pre-counts	6DAT	9DAT	12DAT	16DAT	19 DAT	23DAT	26DAT
Acramite 50WS	16 oz	29.5a	0.4a	1.1a	10.2a	8.9a	5.3a	19.6a	102.8a
Acramite 50WS	24 oz	27.4a	0.4a	5.0a	13.5a	11.9a	19.0a	57.5a	148.7a
Acramite 4SC	24 fl oz	36.8a	1.8ab	9.0a	20.4a	7.1a	14.7a	14.0a	36.7a
Onager 1EC	24 fl oz	11.0a	11.2b	5.2a	14.3a	8.0a	5.0a	14.2a	29.5a
Fujimite 5EC	48 fl oz	52.3a	3.1ab	28.1ab	16.5a	16.6a	15.3a	4.2a	53.4a
UTC	--	61.6a	39.1c	63.8b	37.6a	6.3a[2]	4.2a[2]	4.0a[2]	24.1a[2]
	F=	0.91	9.44	3.29	1.22	0.10	1.70	2.27	2.11
	P=	0.4954	<.0001	0.0251	0.3341	0.9901	0.1810	0.0872	0.1063

[1] 415º oil used as a surfactant at 1% v/v

[2] Significant amounts of defoliation were present in the untreated check during the 16DAT through 26DAT evaluations due to heavy defoliation.

Means in a column followed by the same letter are not significantly different (*P* > 0.05, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.