# Pacific Spider Mite Control in the Lower San Joaquin Valley

**Project No.:** **09-ENTO6-Haviland**

**Project Leader:** David Haviland
Entomology Farm Advisor
UCCE - Kern County
1031 S. Mount Vernon
Bakersfield, CA 93307
(661) 868-6215
E-mail: dhaviland@ucdavis.edu

**Project Cooperators and Personnel:**
Bradley Higbee, Paramount Farming Company
Stephanie Rill, UCCE - Kern County

**Objectives:**

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

1) Demonstrating the differences between a treatment program that is based on preventative May and hull split sprays to one that utilizes monitoring and treatment thresholds.
2) Continuing to screen new miticides and other insecticides for their effects on spider mites.

**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 along with a navel orangeworm spray. Historically, spring treatments in May have become the norm because this is the optimal timing for the use of miticides containing abamectin. 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. Hull split sprays may or may not also be used preventatively. Since mite densities can get high during harvest and hull split is usually the last opportunity to spray, a miticide is often included (despite whether or not mites are present) in order to ensure a mite-free harvest period from August through September or October.

Since these programs have been established several new miticides have been registered for almonds in California. Based on research conducted over the past several years, as well as grower experience, some of the most utilized have been Envidor, Fujimite, Onager, and Zeal, as well as Acramite and Oil. The first objective of this project is to determine if these new tools can allow for growers and pest control advisors to revert back to threshold-based treatment decision programs compared to

the relatively calendar-based, preventative programs that have become common among growers. The second objective of the project is to continue efforts to screen new miticides for their effects on Pacific spider mite, as well as evaluate the effects of insecticides that might be used for other pests for their secondary effects on mites.

Objective 1- Season-long approaches to management

Procedures

The first objective was accomplished in a large scale research area near Shafter, Kern County, 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 (10 fl oz/ac), 2) Envidor 2SC (25.6 fl oz/ac) at a treatment threshold, 3) Onager 11.8EC (20 fl oz/ac) at a treatment threshold, and 4) Zeal (3 oz/ac) at a treatment threshold. The abamectin treatment was applied on 28 April as a tank mix with a fungicide application for alternaria. Treatments two, three and four were applied 27 May once the presence/absence treatment threshold supported by the University of California was reached (http://www.ipm.ucdavis.edu/PMG/C003/almonds-mites.pdf). All treatments were made with the addition of 1% 415º oil. Each of the four blocks also contained a 2- to 3-acre untreated control plot. Control plots were kept untreated until the mite populations became sufficient to cause significant webbing and leaf stippling in the trees, and then were used as test plots to determine the effectiveness of 'rescue' treatments with Fujimite. Control plots were sprayed with Fujimite at a rate of 4 pt per acre on 9 Jun with the addition of 1% 415º oil.

All plots were evaluated weekly to biweekly from 4 May through 14 September. On each evaluation date we collected two random leaves per tree from ten trees per station from four stations per plot. This was a total of 80 leaves per plot (or 320 leaves per treatment on each evaluation date). The untreated check plots were sampled in a similar manner, but with only two sampling stations instead of four due to the smaller plot size. For evaluations in April and early May, random leaves were collected from short basal shoots that were low on the interior of the tree. For samples in June through September, samples were taken from the outer canopy of the tree. For all plots, leaves were analyzed for the number of motile spider mites (larvae, nymphs, and adults), spider mite eggs, and predators. Data for each plot were converted into the average number of motile spider mites or spider mite eggs per leaf, as well as for the percentage of leaves infested. Data on the average mites or eggs per leaf were analyzed by ANOVA with means separated by Fisher's protected LSD ($P>0.05$) after square root transformation of the data (sqrt(x+0.5). Data on the percentage of leaves infested were used when making threshold-based treatment decisions.

Results

During 2009 all season-long mite management programs that were evaluated required treatment. Preventative treatments were sprayed in late April, threshold-based treatments were made in late May, and rescue treatments of the untreated check were made in June (**Tables 1, 2**). Densities of spider mites and spider mite eggs following treatment with abamectin remained low for the remainder of the season and never exceeded 0.35 mites and 0.25 eggs per leaf.

In the plots evaluating threshold-based programs with Envidor, Onager or Zeal, average mite densities ranged from 0.39 to 2.08 mites per leaf on the 20 May and 26 May evaluation dates, respectively. This was the equivalent of 4 to 29% (average 13%) of the leaves infested in individual plots on 20 May and between 9 and 60% (average 27%) for individual plots on 26 May. Because these numbers exceeded the University of California presence/absence treatment thresholds, miticides were applied on 27 May. By 1 Jun mite densities in plots treated with Envidor, Onager or Zeal had significant reductions in mite densities compared to the untreated check. Mite densities remained low for the remainder of the season such that no retreatments were needed.

Mite densities in the untreated check increased through April and May and then increased exponentially in early June (**Tables 1, 2**). By 8 June mite densities increased to 15.53 mites per leaf with 12.91 eggs per leaf. At this time the untreated check had served its purpose in proving that mites were present in the field, and the untreated check was converted into an evaluation of rescue treatments with Fujimite on 9 June. Fujimite treatments were very effective at lowering mite densities to less than 0.4 mites per leaf and 0.2 eggs per leaf through 30 Jun. However, mite densities began to increase again on the 6 Jul and 13 Jul evaluations to mite densities of 1.87 and 1.32 mites per leaf and 0.70 and 0.90 eggs per leaf, respectively. At this time we contemplated a retreatment, especially considering that significant amounts of webbing were beginning to occur in the most heavily-infested individual trees. However, we decided to wait one more week because evaluations on 6 Jul revealed that percentage of leaves infested in individual plots ranged from 3 to 65% (average 34%), which is in the grey area regarding whether or not a treatment was needed. Also, during this evaluation, one out of every 27 leaves contained a predatory insect or mite. We therefore decided to wait one more week before making a retreatment decision. Data collected one week later on 13 Jul showed reductions in mite density (down to 1.32 mites per leaf) and in the percentage of leaves infested (down to 26%). We therefore decided to continue watching the field weekly and found consistent reductions in mite density until they were maintained at a low density for the remainder of the season without requiring an additional miticide application at hull split or during harvest, and without any defoliation occurring.

**Table 1**. The effects of miticide treatment programs on mite density.

| Treatment | Appli-cation date | 25-Apr | 4-May | 11-May | 20-May | 26-May | 1-Jun | 8-Jun | 22-Jun | 30-Jun |
|---|---|---|---|---|---|---|---|---|---|---|
| Abamectin | 25 Apr | 1.15 | 0.03a | 0.18a | 0.22a | 0.27a | 0.05a | 0.07a | 0.07a | 0.13a |
| Zeal | 27 May | - | 0.58ab | 0.86b | 0.39a | 1.41a | 0.04a | 0.08a | 0.03a | 0.12a |
| Onager | 27 May | - | 0.66ab | 0.78b | 0.73a | 2.08a | 0.28a | 0.02a | 0.09a | 0.09a |
| Envidor | 27 May | - | 0.38b | 0.88b | 0.68a | 0.80a | 0.01a | 0.00a | 0.00a | 0.00a |
| Untreated | 9 Jun | 0.61 | 1.92b | 1.14b | 0.58a | 3.31a | 2.53b | 15.53b | 0.33a | 0.38a |
| | *P* | | .0415 | .0159 | .6150 | .1092 | <.0001 | .0047 | .0566 | .1239 |

| | | 6-Jul | 13-Jul | 20-Jul | 27-Jul | 3-Aug | 10-Aug | 17-Aug | 27-Aug | 14-Sep |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.19 | 0.17 | 0.11 | 0.18ab | 0.33a | 0.16a | 0.16a | 0.35a | 0.07a |
| | | 0.21 | 0.16 | 0.05 | 0.13a | 0.26a | 0.05a | 0.08a | 0.24a | 0.11a |
| | | 0.47 | 0.40 | 0.01 | 0.00a | 0.01a | 0.02a | 0.03a | 0.07a | 0.16a |
| | | 0.04 | 0.01 | 0.01 | 0.02a | 0.01a | 0.06a | 0.23a | 0.17a | 0.14a |
| | | 1.87 | 1.32 | 0.64 | 0.23b | 0.13a | 0.25a | 0.20a | 0.43a | 0.16a |
| | *P* | .1565 | .2106 | .2215 | .0384 | .2307 | .1174 | .1329 | .4078 | .5154 |

**Table 2.** The effects of miticide treatment programs on the density of spider mite eggs.

| Treatment | Appli-cation date | 25-Apr | 4-May | 11-May | 20-May | 26-May | 1-Jun | 8-Jun | 22-Jun | 30-Jun |
|---|---|---|---|---|---|---|---|---|---|---|
| Abamectin | 25 Apr | 3.86 | 0.28a | 0.02a | 0.25a | 0.05a | 0.00a | 0.11a | 0.04a | 0.16a |
| Zeal | 27 May | - | 0.80a | 0.78c | 0.83a | 0.57a | 0.24a | 0.11a | 0.03a | 0.13a |
| Onager | 27 May | - | 0.84a | 0.39abc | 0.98a | 1.19a | 0.59a | 0.02a | 0.05a | 0.05a |
| Envidor | 27 May | - | 0.60a | 0.75bc | 2.22a | 0.95a | 0.04a | 0.02a | 0.01a | 0.02a |
| Untreated | 9 Jun | 2.76 | 0.83a | 0.29ab | 1.71a | 1.76a | 3.87b | 12.91b | 0.13a | 0.20a |
| | *P* | | .1487 | .0458 | .4271 | .2819 | .0177 | .0052 | .2678 | .2829 |

| | | 6-Jul | 13-Jul | 20-Jul | 27-Jul | 3-Aug | 10-Aug | 17-Aug | 27-Aug | 14-Sep |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.11a | 0.07a | 0.04a | 0.07a | 0.09a | 0.05a | 0.03a | 0.07a | 0.01a |
| | | 0.13a | 0.07a | 0.01a | 0.05a | 0.09a | 0.01a | 0.04a | 0.03a | 0.02a |
| | | 0.44a | 0.20a | 0.01a | 0.00a | 0.00a | 0.00a | 0.01a | 0.03a | 0.02a |
| | | 0.06a | 0.03a | 0.02a | 0.02a | 0.03a | 0.01a | 0.04a | 0.06a | 0.01a |
| | | 0.70a | 0.90a | 0.09a | 0.08a | 0.00a | 0.07a | 0.07a | 0.10a | 0.02a |
| | *P* | .3120 | .2651 | .2931 | .3064 | .5688 | .1338 | .6240 | .5373 | .5583 |

## Conclusions

This project documented that almond growers have multiple options available to them when it comes to season-long mite programs. The preventative abamectin program and the threshold-based programs with Envidor, Onager, or Zeal all had comparable results of season-long control of Pacific spider mites (**Figure 1**). This is consistent with data from the 2008 trials. Data also showed that Fujimite can provide excellent knock-down of spider mites in cases where mites have gotten out of control. However, the overall level of season-long control while letting things get out of hand and then trying to repair them was overall not as effective as either the preventative or threshold-based programs.

This project also showed that University of California thresholds can provide an excellent guideline for whether or not a treatment is needed. This was particularly true in July when the untreated trial plots (that got out of hand and were oversprayed with Fujimite) were again reaching treatment threshold levels. Despite widespread webbing of the trees, utilization of UC thresholds for when predators were present suggested that we avoid spraying despite mite densities approaching 2 per leaf with ~30% of the leaves infested (range from 3 to 65%), and considerable webbing beginning to occur. The result was that populations of beneficials became sufficiently established that mite populations were reduced, defoliation of trees did not occur, and mite populations never returned after hull split, thus allowing mites to be managed without a hull-split miticide spray in July.

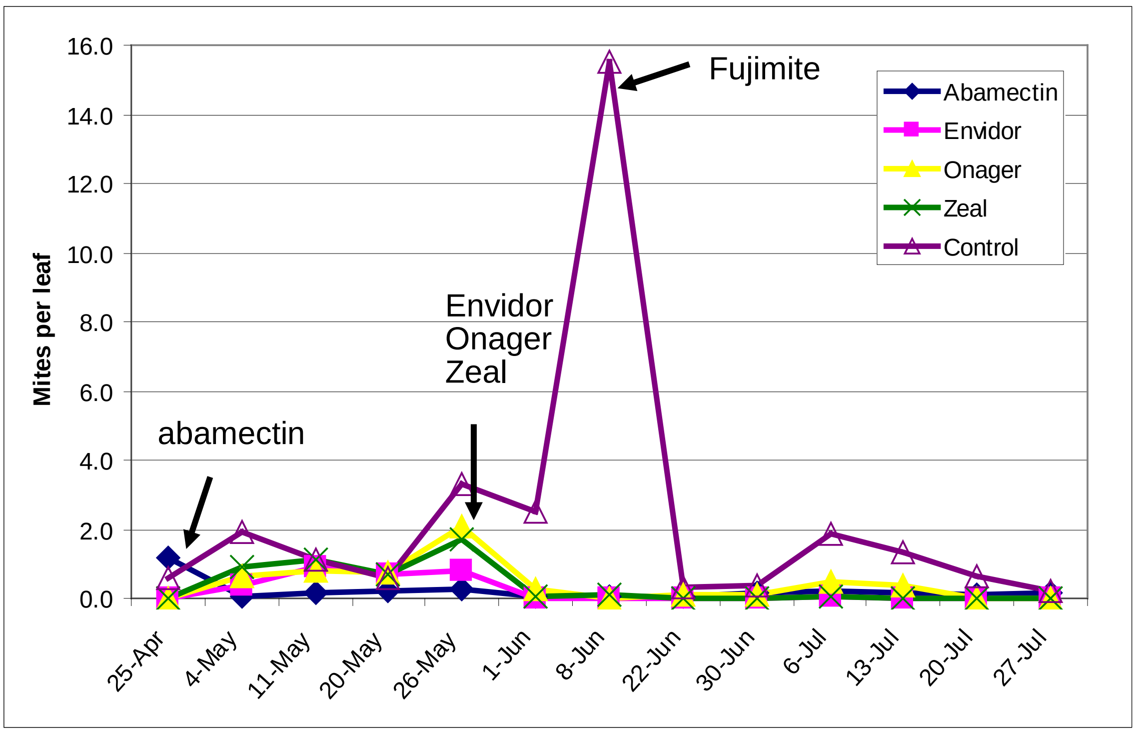


**Figure 1.** A comparison of treatment programs based on 1) a preventative abamectin treatment, 2) threshold-based treatments of Envidor, Onager or Zeal, or 3) knock-down ‘rescue’ treatments of Fujimite, on season-long control of Pacific spider mites in large scale plots of mature almonds. Arrows indicate time of application of each miticide.

Objective 2- Screening of new miticides

During 2009 we conducted a trial in Shafter, CA to evaluate the effects of miticides and insecticides on the density of Pacific spider mites in almonds. The trial location was an orchard of non-bearing, first-leaf almonds. Approximately 4.4 acres of trees were divided into 90 plots that each contained 5 trees in a 20 by 22 ft spacing. Plots were organized into a RCBD with 5 blocks of 17 treatments and an untreated check. Treatments were applied to individual trees with a hand gun at a water volume equivalent to 200 GPA on either 17 or 19 Jun, and were evaluated 3 days after treatment, and then weekly through eight weeks after treatment.

Spider mite pressure in this trial was moderate (**Table 3**). Pre-counts averaged 2.03 mites per leaf across the entire trial. Mite densities in the untreated check dropped substantially by 4 DAT (days after treatment), increased consistently through 7 WAT (weeks after treatment), and remained high at the 8 WAT final evaluation. All treatments resulted in significant reductions in mite density from the 2 WAT evaluations through 7 WAT, with the exception of 415º oil on the last of these evaluation dates.

Acramite and Proclaim reduced spider mite densities to <1 per leaf through 4 WAT for Acramite and 5 WAT for Proclaim. After that, mite densities in plots treated with either miticide increased substantially to densities between 3.5 and 8.4 per leaf on the 6, 7 and 8 WAT evaluation dates. Plots treated with EC formulations of abamectin (Agri-Mek 0.15EC and Zoro 0.15EC) had ≤0.12 mites per leaf through 5 WAT, regardless of rate. They remained low, never exceeding 0.57 mites per leaf, for the remainder of the trial. Evaluations of Zoro compared to Agri-Mek resulted in no significant differences in mite knockdown or in residual length of activity. Comparisons of the new, low volatile organic compound SC formulation of Agri-Mek compared to the EC formulation resulted in no significant differences through the duration of the trial.

Mite densities in plots with a combination of bifenazate and abamectin (Prevamite SC) had mite densities comparable to that of plots treated with abamectin. No synergistic benefits of putting the two active ingredients were observed. Comparisons of the high versus low rate of Mesa resulted in no significant differences on any evaluation date. Onager treatments kept mite densities <0.15 per leaf through 4 WAT, between 0.7 and 1.3 from 5 to 7 WAT, and then at 3.0 on the final evaluation date.

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

| Treatment[1] | Rate | Pre | Average spider mites per leaf | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 4 DAT | 1 WAT | 2 WAT | 3 WAT | 4 WAT | 5 WAT | 6 WAT | 7 WAT | 8 WAT |
| Acramite 4SC | 11 fl oz | 1.0a | 0.0a | 0.0a | 0.2a | 0.1a | 0.2ab | 1.4a | 7.8d | 5.7ef | 3.6a-e |
| Acramite 4SC | 15 fl oz | 1.2a | 0.1a | 0.1a | 0.0a | 0.0a | 0.2ab | 2.0a | 6.2d | 4.2def | 6.4cde |
| Prevamite SC | 11 fl oz | 3.7a | 0.0a | 0.0a | 0.0a | 0.0a | 0.0a | 0.1a | 0.4ab | 0.9a-d | 3.6a-d |
| Prevamite SC | 15 fl oz | 3.9a | 0.3a | 0.0a | 0.0a | 0.0a | 0.0ab | 0.1a | 0.0a | 0.1ab | 0.3a |
| Agri-Mek 0.15EC | 10 fl oz | 0.2a | 0.0a | 0.0a | 0.0a | 0.0a | 0.0a | 0.0a | 0.0a | 0.0a | 0.0a |
| Agri-Mek 0.15EC | 12 fl oz | 1.2a | 0.1a | 0.0a | 0.0a | 0.2ab | 0.0ab | 0.0a | 0.1ab | 0.2ab | 0.1a |
| Agri-Mek 0.15EC | 15 fl oz | 3.6a | 0.0a | 0.0a | 0.0a | 0.0a | 0.0a | 0.1a | 0.0a | 0.3abc | 0.6ab |
| Agri-Mek 0.15EC | 20 fl oz | 1.9a | 0.0a | 0.0a | 0.0a | 0.0a | 0.0ab | 0.0a | 0.1ab | 0.0a | 0.3a |
| Zoro 0.15EC | 10 fl oz | 2.7a | 0.4a | 0.0a | 0.0a | 0.1a | 0.0ab | 0.0a | 0.2ab | 0.3abc | 0.1a |
| Zoro 0.15EC | 20 fl oz | 2.1a | 0.0a | 0.0a | 0.0a | 0.0a | 0.1ab | 0.1a | 0.2ab | 0.4abc | 0.1a |
| Agri-Mek SC | 2.57 fl oz | 2.6a | 0.3a | 0.1a | 0.0a | 0.1a | 0.3ab | 0.1a | 0.9abc | 0.3abc | 0.6ab |
| Mesa EC | 25 fl oz | 1.2a | 0.0a | 0.0a | 0.0a | 0.0a | 0.2ab | 0.1a | 0.6ab | 2.3a-e | 0.9ab |
| Mesa EC | 30 fl oz | 0.5a | 0.3a | 0.0a | 0.0a | 0.0a | 0.0ab | 0.2a | 0.0a | 0.1ab | 0.2a |
| Onager 1E | 19.2 fl oz | 0.1a | 0.0a | 0.1a | 0.0a | 0.0a | 0.0ab | 1.3a | 1.0ab | 0.7abc | 3.0abc |
| Proclaim 5SG | 3.2 oz | 1.7a | 0.0a | 0.0a | 0.2a | 0.7b | 0.5ab | 0.5a | 3.6bcd | 3.5b-e | 8.4b-e |
| Proclaim 5SG | 4.8 oz | 5.5a | 0.3a | 0.5a | 0.0a | 0.1ab | 0.4ab | 0.5a | 4.4bcd | 7.3def | 4.3a-e |
| 415º oil | 1% v/v | 1.0a | 0.4a | 0.7a | 0.0a | 0.2ab | 1.0b | 0.9a | 5.4cd | 13.7fg | 12.1e |
| Untreated Check | -- | 2.4a | 0.1a | 0.5a | 1.7b | 2.6c | 4.9c | 9.5b | 14.7e | 17.1g | 10.1de |
| | *F* | 0.51 | 1.24 | 1.66 | 3.70 | 5.25 | 4.54 | 2.50 | 4.72 | 5.38 | 3.02 |
| | *P* | 0.938 | 0.261 | 0.072 | <.0001 | <.0001 | <.0001 | 0.0040 | <.0001 | <.0001 | 0.0006 |

[1] 415º 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.