Arthropod Pest Management in the Lower San Joaquin Valley

Project No.: 12-ENTO6-Haviland

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Objectives:

1) Evaluate miticides for their potential benefit in IPM programs for Pacific spider mite and determine ways to optimize their performance.
2) Develop information on the efficacy of registered and experimental insecticides against navel orangeworm at hull split in almonds.
3) Maintain two University-based research and demonstration orchards for almond pest management research in the San Joaquin Valley.

Interpretive Summary:

Pacific spider mite and navel orangeworm are the most significant arthropod pests of almonds in the lower San Joaquin Valley. Spider mite feeding leads to discoloration and eventual loss of leaves. Navel orangeworm feed directly on almond kernels and are associated with increased risk of kernel contamination by aflatoxins.

During 2012 we conducted three trials on spider mite management. In the first trial we evaluated the effectiveness of the surfactant Vintre as an alternative to 1% 415° Oil when used with five different miticides. In all cases spider mite densities in plots treated with Vintre were statistically equivalent to where 1% 415° Oil was used, suggesting that Vintre is a viable alternative to oil for miticide applications during the summer through hull split. In the second trial we evaluated whether or not the addition of potassium nitrate with five different miticides aided in the efficacy of those miticides. We did not determine any improvements in spider mite control where the potassium nitrate was included. In the third trial we evaluated two new miticides called Nealta and Magister. Spider mite densities in plots treated with both of these products were similar to the mite densities found in plots treated with commercial standard miticides. In the same trial we evaluated four different pyrethroids that are typically used against navel orangeworm for their effects on spider mites. Spider mite densities in plots treated with pyrethroids Brigade and Danitol were similar to densities in the untreated check, whereas mite densities in plots treated with pyrethroids Asana and Warrior II were approximately two to three times higher than in the untreated check.

Navel orangeworm management was evaluated in two field trials located in Shafter, CA (Kern County) and at the UC West Side Research and Extension Center in Five Points, CA (Fresno County). Each trial evaluated 21 different insecticides or combinations of insecticides against

navel orangeworm. At the Shafter location there were no significant differences among treatments due to overall low navel orangeworm pressure. At UC West Side Research and Extension Center the untreated checks had 17.6% damage. In this trial the four treatments that contained tank mixes or premixes of a pyrethroid and a diamide reduced damage by 48 to 69%, the six treatments that contained only a diamide reduced damage by 36 to 65%, the eight treatments containing only a pyrethroid had more variable results ranging from 17 to 64% reductions in damage, while the three treatments containing other larvicides reduced damage by 46 to 64%.

Funding through the Almond Board of California also provides partial support for the two experimental research orchards in Kern County (7 acres) and Fresno County (5 acres). During the last three years these two orchards have hosted a total of 30 field experiments related to the management of insect pests and weeds in almonds, including the experiments described in this report.

Materials and Methods:

Objective 1: Spider Mite Management. During 2012 we conducted three spider mite trials in a 7.0 acre fourth-leaf orchard (20 x 22 spacing) that contained alternating rows of the varieties Nonpareil and Monterey. The first trial evaluated the surfactant Vintre as an alternative to 1% 415º Oil with miticides at hull split. There were a total of 12 treatments that included five miticides (Acramite, Envidor, Fujimite, Onager or Zeal) with either Vintre or with Oil, as well as a treatment of 1% 415º Oil alone and an untreated check. The second trial evaluated the effects of adding potassium nitrate (KNO_3) to miticide treatments. That trial had 11 treatments that included five miticides (Acramite, Envidor, Fujimite, Onager and Zeal) with or without the addition of 10 lb/ac of $KNO_{3,}$ as well as an untreated check. The third trial evaluated the effectiveness of two developmental miticides (Magister and Nealta) compared to six industry standard miticides (Acramite, Envidor, Fujimite, Onager, Vigilante and Zeal). We also included four pyrethroids into the trial (Asana, Brigade, Danitol, and Warrior II) to determine any secondary effects on spider mites of applying these products that are registered for use against navel orangeworm.

Due to significant overlap in several of the treatments among the three trials we decided to incorporate all three individual trials into one large trial. The result was one large trial that was organized into a randomized complete block design of 30 treatments plus an untreated check **Table 1**). Plot size was three trees long by one row wide. Treatments were applied on 16 or 17 July using a hand gun at 150 PSA in 200 gallons of water per acre.

Mite densities were evaluated in each plot prior to treatment on 15 Jul and then on 23 Jul (7 days after treatment, DAT), 30 Jul (14 DAT), 6 Aug (21 DAT), 13 Aug (28 DAT), and 28 Aug (35 DAT). On each sample date a total of 20 leaves were collected per plot. This included six to seven random leaves per tree from each of the three trees per plot. Leaves were transported to a laboratory where motile Pacific spider mites (larvae, nymphs, and adults) were counted. Data for each plot on each evaluation date were converted into a value of average spider mites per leaf.

Data from the one large trial were broken apart into the three smaller trials that were originally planned during the process of experimental design. Where appropriate, data from the same treatment were used multiple times. For example, data from the first treatment of Acramite

50WS were used in all three analyses. In the first trial the Acramite treatment served as a comparison for the Acramite + Vintre treatment, in the second trial the Acramite treatment served as a comparison for the Acramite + KNO3 treatment, and in the third trial Acramite served as a grower standard miticide against which to compare newer unregistered miticides. Each of the three trials were analyzed individually by ANOVA using transformed data (square root (x + 0.5)) with means separated by Fisher's Protected LSD (P = 0.05).

Because mite density was low throughout the trial we did one additional analysis of data across all evaluation dates for each trial. This was done by calculating the cumulative number of mite-days (1 mite for 1 day) found in each plot by taking the average mites per leaf for each sampling period and multiplying by 7 days, and then determining the sum of those calculations. Mite-days were analyzed by ANOVA using transformed data (square root (x + 0.05)) with means separated by Fisher's Protected LSD (P=0.05).

Objective 2: Navel Orangeworm Management. In 2012 we conducted two field trials for navel orangeworm. The West Side trial was located at the UC West Side Research and Extension Center in Five Points, CA (Fresno County) using trees that were planted in 2008 with a spacing of 22' x 15'. The second trial was located at the UC Research Farm in Shafter, CA (Kern County) using trees that were planted in 2009 with a spacing of 20' x 22'. At each location a total of 132 Nonpareil trees were organized into a randomized complete block design with six blocks of 21 treatments and an untreated check (**Table 2**).

Treatments were applied to individual trees with a hand gun in 200 gallons per acre (GPA) of water at 150 PSI. Applications at West Side were made on 19 and 20 July at the start of the second flight of navel orangeworm and the initiation of Nonpareil hull split. Applications at Shafter were made twice to each tree. The first application was made on 12 or 13 July during the second navel orangeworm flight at the initiation of hull split. The same treatments were applied a second time to the same trees on 16 or 17 Aug during the third navel orangeworm flight. The trials were harvested by hand on 23 or 24 Aug (West Side) and 19 Sept (Shafter) by collecting 300 to 400 nuts per tree. Samples were taken to the lab and allowed to dry for approximately three weeks. At that time they were placed into a walk-in refrigerator to stop development of navel orangeworm until the nuts could be processed. All nuts from each sample were cracked to determine the percentage nuts that were infested by navel orangeworm. Data were analyzed by ANOVA with means separated by Fisher's Protected LSD (P = 0.05). Data were also analyzed by mode of action. To do this, data from all treatments within a single mode of action were averaged for each block. The data were analyzed as a RCBD with 6 blocks of 5 treatments (diamides, other larvicides, pyrethroids, pyrethroids + diamides, and the untreated check) by ANOVA with means separated by Fisher's Protected LSD (P=0.05).

The density of Pacific spider mite was assessed on each tree approximately two weeks after insecticide applications at the West Side trial. On 01 Aug we collected twenty random leaves from each individual tree. Leaves were transported to a laboratory where motile Pacific spider mites (larvae, nymphs, and adults) were counted on each leaf. Average mites per leaf for each plot were analyzed by ANOVA using transformed data (square root (x + 0.5)) with means separated by LSD (P = 0.05).

Objective 3: Maintain Research Orchards. Funding provided by the Almond Board of California has allowed us to maintain two research orchards in the San Joaquin Valley. The first site is a 7-acre orchard in Shafter in Kern County on land that used to be part of the UC Shafter Research and Extension Center. The orchard is planted on a 20' x 22' spacing with alternating rows of Nonpareil and Monterey. These varieties were chosen due to their compatibility within an orchard and for the ability to conduct navel orangeworm trials in the Nonpareils (timed at the second flight when hull split occurs) and then again in the Montereys (timed at the third flight when Monterey hulls begin to split). Irrigation is set up using microsprinklers with the capability to turn water on and off on each individual row. The orchard has a total of 700 trees that were harvested for the first time in 2011.

The second orchard is 5 acres in size and located at the UC West Side Research and Extension Center in Five Points in Fresno County. The orchard is planted on a 22' x 15' spacing with a three-tree alternating pattern down each row of Nonpareil, Carmel, and NePlus Ultra. The orchard was designed and planted under the direction of Dr. Brent Holtz in 2008 to conduct research on almond diseases. It is now utilized for trials related to pest management.

Results and Discussion:

Objective 1: Spider Mite Management. The effects of miticide treatments on Pacific spider mite density are shown in **Table 1**. This table includes data from all treatments across the 3 experiments conducted during 2012. Overall mite density was low. Average mite density in the untreated check was less than 0.25 mites per leaf on all evaluation dates due to an abundant amount of six-spotted thrips and other predators. There were no significant differences in mite density in the precounts, 7 DAT, or 14 DAT. There were significant differences in mite density on evaluation dates 21, 28 and 35 DAT. These differences were easiest to evaluate by combining mite density across all treatments into one cumulative value of the total number of mites collected per plot (right column, **Table 1**). Evaluations of individual trials (described below) were done by calculating the total number of mite-days per leaf from the time each trial was sprayed until 35 DAT.

Evaluation of Vintre as an alternative to 415° Oil
Comparisons of the effectiveness of five miticides used with 415° Oil compared to the same miticides applied with Vintre did not result in any significant differences in mite-days for any of the five miticides (**Figure 1**). Numerically, accumulated mite-days were higher in plots treated with 415° Oil compared to Vintre for treatments including Envidor, Fujimite, and Onager, but were lower in plots treated with 415° Oil compared to Vintre for treatments including Acramite and Zeal. This is in comparison to the results of our trial last season in 2011 where accumulated mite-days were higher in plots treated with 415° Oil compared to Vintre for treatments including Onager, but were lower in plots treated with Vintre compared to 415° Oil in plots treated with Zeal or Envidor. Due to the lack of significant differences among miticide treatments made with either 415° Oil or Vintre, our conclusion at this time is that Vintre is an adequate alternative to oil as a surfactant with miticides at hull split.

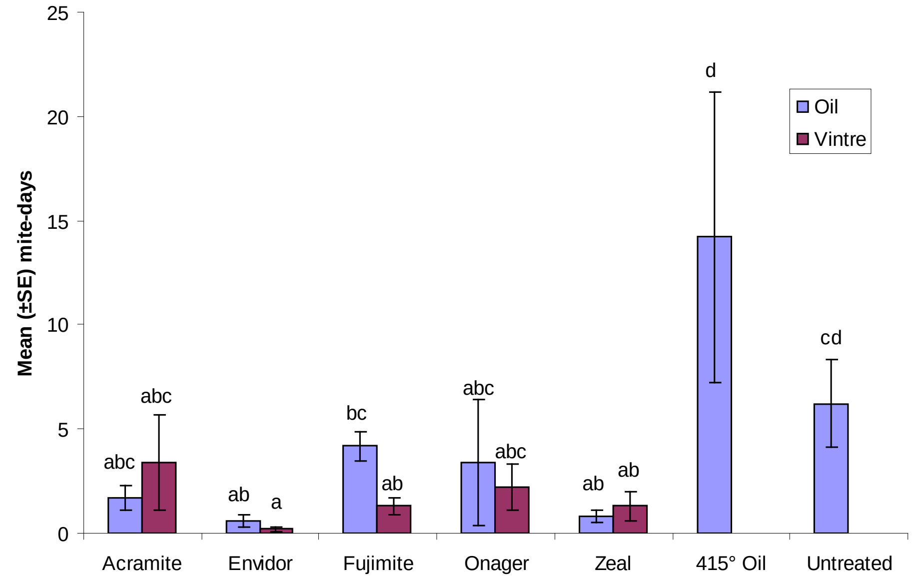

Figure 1. The effects of two surfactants (Vintre and 415° Oil) on mite densities of five standard miticides. The same letter are not significantly different ($P > 0.05$, Fisher's protected LSD) with square root (x + 0.5) transformation of the data. Untransformed data are shown.

Evaluation of Potassium Nitrate (KNO_3) as an additive to miticide treatments

Comparisons of the effectiveness of five miticides used with or without potassium nitrate (KNO_3) are shown in **Figure 2**. There were no significant differences in mite density for any miticide that was applied with or without KNO_3. These 2012 results were similar to those in 2011 where likewise there were no significant differences in the effectiveness of miticides with or without the addition of KNO_3 ($P = 0.1456$).

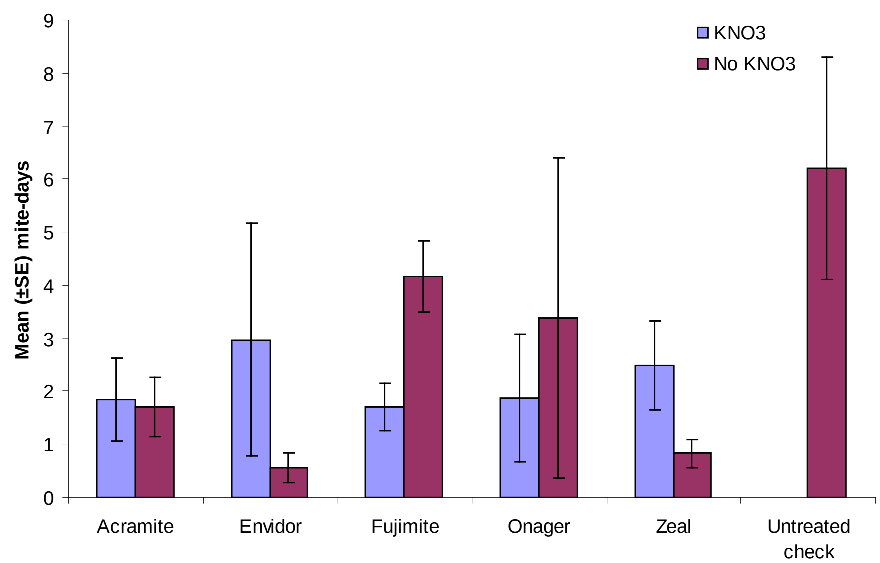

Figure 2. Effects of five standard miticides with and without potassium nitrate (KNO_3) on mite densities in almonds. There were no significant differences ($P > 0.05$, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.

Table 1. The effects of miticide treatments on the density of Pacific spider mite in almond, Shafter 2012.

Treatment[1]	Rate	Mean spider mites per leaf						Total mites[2]
		Pre-count	7 DAT	14 DAT	21 DAT	28 DAT	35 DAT	
Acramite 50WS	1 lb	0.03	0.06	0.00	0.04a	0.01a	0.20c-f	6.3 ± 2.5a-g
Acramite 50WS + KNO_3	1 lb + 10lb/ac	0.43	0.01	0.01	0.08ab	0.09abc	0.14b-f	6.5 ± 3.4a-g
Acramite 50WS + Vintre	1 lb + 1 qt/ac	1.00	0.00	0.00	0.35abc	0.01a	0.30e-f	12.3 ± 6.6b-g
Asana XL	9.6 fl oz	0.00	0.23	0.25	1.05de	0.05abc	0.20def	35.5 ± 14.4h
Athena	16 fl oz	0.15	0.05	0.08	0.03a	0.03a	0.05abc	4.5 ± 2.6a-e
Brigade WSB	1 lb	0.55	0.00	0.08	0.44bcd	0.16c	0.10a-d	15.8 ± 5.2d-h
Danitol 2.13EC	21.3 fl oz	0.48	0.11	0.18	0.33abc	0.15bc	0.09abc	16.3 ± 6.5e-h
Envidor 240SC	18 fl oz	0.13	0.03	0.00	0.01a	0.01a	0.04ab	1.8 ± 0.5ab
Envidor 240SC + KNO_3	18 fl oz + 10lb/ac	0.53	0.20	0.05	0.00a	0.01a	0.13b-f	7.8 ± 4.3a-g
Envidor 240SC + Vintre	18 fl oz + 1 qt/ac	0.15	0.00	0.00	0.03a	0.00a	0.01a	0.8 ± 0.5a
Fujimite 5EC	32 fl oz	0.00	0.21	0.63	0.10ab	0.05abc	0.13a-e	11.0 ± 1.5b-g
Fujimite 5EC + KNO_3	32 fl oz + 10lb/ac	0.03	0.04	0.13	0.03a	0.00a	0.00a-d	5.3 ± 1.3a-g
Fujimite 5EC + Vintre	32 fl oz + 1 qt/ac	1.20	0.00	0.03	0.06ab	0.09abc	0.01a	3.8 ± 1.0a-e
Magister 10EC	32 fl oz	0.05	0.21	0.00	0.08ab	0.05abc	0.08a-d	8.3 ± 3.6a-g
Magister + Onager	12 fl oz + 16 fl oz	1.78	0.20	0.05	0.04a	0.03a	0.09a-d	8.0 ± 3.2a-g
Magister + Onager	16 fl oz + 16 fl oz	0.63	0.00	0.10	0.08ab	0.04ab	0.03a	4.8 ± 1.5a-f
Magister + Onager	24 fl oz + 16 fl oz	0.23	0.06	001	0.10ab	0.04ab	0.03a	4.8 ± 2.1a-f
Nealta 20SC	13.7 fl oz	0.00	0.34	0.14	0.25abc	0.10abc	0.18b-f	20.0 ± 7.9gh
Nealta 20SC (+ Dyn.)	13.7 fl oz	0.01	0.01	0.00	0.06ab	0.05abc	0.05a	3.5 ± 1.2a-d
Onager 1EC	20 fl oz	0.08	0.29	0.01	0.00a	0.04ab	0.00a	6.8 ± 5.8a-f
Onager 1EC + KNO_3	20 fl oz + 10lb/ac	0.00	0.09	0.04	0.10a	0.06a	0.05ab	4.5 ± 2.5a-d
Onager 1EC + Vintre	20 fl oz + 1 qt/ac	0.23	0.04	0.15	0.09ab	0.00a	0.05abc	6.5 ± 3.3a-g
Vigilant 4SC	24 fl oz	0.23	0.00	0.04	0.09ab	0.05abc	0.19c-f	7.3 ± 1.9a-g
Vigilant + Brigade	24 fl oz + 1 lb	0.25	0.16	0.23	0.20ab	0.02a	0.05a	13.3 ± 5.4c-g
Vigilant + Athena	24 fl oz + 16 fl oz	0.55	0.00	0.01	0.00a	0.01a	0.05abc	1.5 ± 0.6a
Warrior II	2.56 fl oz	0.00	0.34	0.94	1.16e	0.35d	0.33f	62.3 ± 25.0i
Zeal 72WP	3 oz	0.00	0.00	0.10	0.01a	0.00a	0.01a	2.5 ± 0.7abc
Zeal 72WP + KNO_3	3 oz + 10lb/ac	0.00	0.09	0.04	0.10ab	0.06abc	0.05abc	6.8 ± 4.9a-g
Zeal 72WP + Vintre	3 oz + 1 qt/ac	0.43	0.00	0.16	0.00a	0.00a	0.03a	3.8 ± 1.9a-d
415° Oil	1%	0.00	0.70	0.23	0.56cde	0.16c	0.06a-d	34.3 ± 14.1h
Untreated Check	--	0.20	0.23	0.21	0.22abc	0.08abc	0.09a-d	16.4 ± 4.7fgh
	F =	1.32	1.05	1.50	3.02	2.91	2.28	4.14
	P =	0.1615	0.4053	0.0743	<.0001	<.0001	0.0015	<.0001

[1]All treatments included 415° Oil at 1% v/v with the following exceptions: 415° oil was not included as a surfactant for treatments that included Vintre, the 415° Oil treatment, the Untreated Check, or the Nealta 20SC (Dyne-Amic) treatment. In this latter treatment Nealta 20SC was applied with the surfactant Dyne-Amic at a rate of 4 fl oz/100 gal of water.
[2] Sum (± SEM) of the mites collected on 20 leaves per week for 5 weeks after application in each plot.
Means in a column followed by the same letter are not significantly different ($P > 0.05$, Fisher's protected LSD) with square root (x + 0.5) transformation of the data. Untransformed means are shown.

Evaluation of new miticides and pyrethroids for their effects on spider mite densities
During 2012 we evaluated two unregistered miticides (Nealta and Magister), seven registered miticides, and four pyrethroids for their effects on spider mite density (**Figure 3**). The most effective treatments (<2 mite-days) were Envidor, Zeal, Nealta + Dyne-Amic, Athena, Acramite and Vigilant. These top six miticides were statistically equivalent to the majority of the other treatments due to relatively low mite density in the trial. When only true miticides are considered (Acramite, Athena, Envidor, Fujimite, Magister, Nealta, Onager, Vigilant, and Zeal), all miticides resulted in accumulations of mite-days that were less than 4.2 compared to 6.2 in the untreated check. The only exception was Nealta + 415° Oil. For an unknown reason Nealta + 415° Oil had relatively high numbers of mite-days (7.6 mite-days) compared to the untreated check (6.2 mite-days) whereas Nealta applied with the non-ionic surfactant Dyne-Amic was one of the best treatments (1.1 mite-days). Follow-up studies on adjuvant use with Nealta should be pursued to determine if this pattern holds true across multiple trials in the field.

Plots treated with pyrethroids had mite densities that were equivalent or higher than the untreated check. Plots treated with the pyrethroids Asana and Warrior II had mite-day accumulations of 12.5 and 21.8 respectively, compared to 5.2 and 5.9 for Brigade and Danitol respectively. This suggests that some pyrethroids are more prone to flaring mites than others. These data are consistent with previous studies by Haviland and Rill that have shown that Asana is likely to flare mites, Brigade and Danitol tend to have mite densities comparable to the untreated check, and mite densities in plots treated with Warrior II tend to vary from one trial to another.

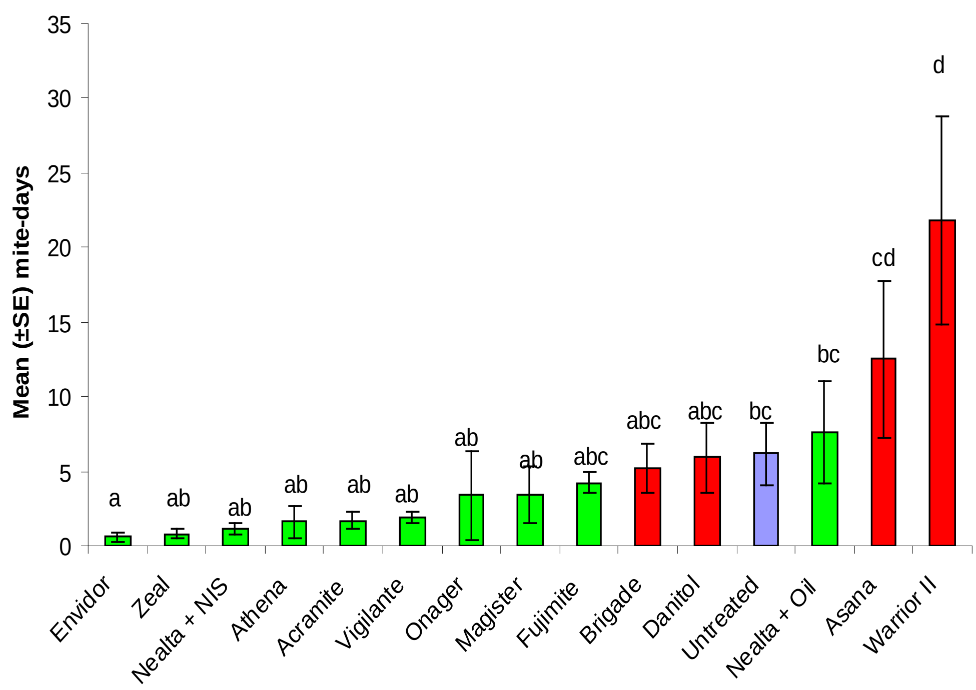

Figure 3. The effects of miticide treatments on the density of Pacific spider mite in almonds. Columns with the same letter are not significantly different (*P* > 0.05, Fisher's protected LSD) following square root (x + 0.5) transformation of the data. Untransformed means are shown. Green bars indicate miticides while red bars indicate pyrethroids.

Objective 2: Navel Orangeworm Management. The effects of insecticide treatments on navel orangeworm are shown in **Table 2**; navel orangeworm damage at the West Side trial, is also displayed graphically in **Figure 4**. In the West Side trial damage in the untreated check was 17.8% compared to 5.6 to 14.7% in treated plots. The four treatments of tank mixes of a diamide and a pyrethroid had 4.6 to 9.2% damage. This is a 48 to 69% reduction in damage compared to the untreated check. There were no significant differences among any of these four tank-mix treatments.

The trial included six insecticide treatments of products containing only the diamides chlorantraniliprole (Altacor), cyantraniliprole (Exirel), or flubendiamide (Belt, Tourismo). Plots where these products were used had 6.2 to 11.4% damage. This is the equivalent of 36 to 65% reductions in damage compared to the untreated check. These results were very similar to the results of other insecticides that work primarily as larvicides. Plots treated with Proclaim, Delegate or Intrepid had between 6.4 and 9.6% damage. This was the equivalent of a 46 to 64% reduction in damage compared to the untreated check.

Pyrethroid treatments resulted in more variable results in the trial. We tested 8 pyrethroids that resulted in 6.4 to 14.7% damage. This is the equivalent of 17 to 64% reductions in navel orangeworm damage compared to the untreated check. There were no significant differences in damage among the eight pyrethroid treatments, though five of these treatments had damage under 10% that was significantly lower than the untreated check (Brigade, Hero + Oil, Danitol, Brigade + Oil, and Athena + Oil) while three treatments had damage over 10% and were not significantly different than the untreated check (Warrior II, Athena, Baythroid).

Analysis of data by mode of action showed that all modes of action caused a significant reduction in damage by navel orangeworm compared to the untreated check (**Figure 5**). The lowest damage numerically was in plots treated with tank mixes of diamides and pyrethroids (7.2%). This is consistent with previous research that has shown that tank mixes of diamides and pyrethroids typically have reduced damage compared to when products with these modes of action are used individually. However, damage levels in the diamide + pyrethroid treatment (7.2%) were not significantly different from damage levels for diamides (8.6%), other larvicides (8.1%), or pyrethroids (9.7%).

Analysis of spider mite data (**Table 2**) at the West Side trial did not result in any significant differences in the density of Pacific spider mites two weeks after plots were treated for navel orangeworm.

In the trial at Shafter there were very low densities of navel orangeworm (**Table 2**). There were no significant differences among any of the treatments (0.13 to 3.0% damage) compared to the untreated check (0.9% damage).

Table 2. Effects of insecticide treatments on damage by navel orangeworm to kernels and density of Pacific spider mites on leaves, 2012.

			West Side			Shafter
Mode of Action	Treatment[1]	Rate per acre	Mean (± SE) NOW damage[2] (%)	Perc. Damage Reduction	Mean (±SE) mites/leaf 2 WAT [3]	Mean (± SE) NOW damage[2] (%)
Diamide + Pyrethroid	Voliam Xpress	9 fl oz	5.6 ± 1.0a	69	1.6 ± 1.2	0.13 ± 0.1
	Altacor WG 35PC + Bifenthrin 2E	3 oz + 6.4 fl oz	6.2 ± 1.9ab	65	0.2 ± 0.2	0.34 ± 0.2
	Tourismo + Brigade WSB	14 fl oz + 16 oz	8.0 ± 2.2ab	55	0.4 ± 0.3	0.19 ± 0.1
	Belt SC + Baythroid XL	4 fl oz + 2.8 fl oz	9.2 ± 2.9abc	48	0.9 ± 0.7	0.44 ± 0.2
Diamide	Belt SC	4 fl oz	6.2 ± 1.1ab	65	4.6 ± 4.6	0.62 ± 0.2
	Exirel 10SE	13.5 fl oz	6.3 ± 0.4ab	65	0.5 ± 0.4	0.18 ± 0.1
	Altacor WG 35PC	4 oz	8.2 ± 3.0abc	54	1.0 ± 0.6	0.51 ± 0.2
	Tourismo	14 fl oz	9.5 ± 1.9abc	47	3.0 ± 2.4	0.40 ± 0.3
	Altacor WG 35PC	3 oz	10.1 ± 1.9abc	43	0.1 ± 0.1	0.34 ± 0.2
	Exirel 10SE	20.5 fl oz	11.4 ± 3.7a-d	36	2.3 ± 1.6	0.13 ± 0.1
Pyrethroid	Brigade WSB	1.5 lb	6.4 ± 1.5ab	64	0.8 ± 0.4	0.45 ± 0.2
	Hero EW + 415° Oil	11.3 fl oz + 1% v/v	6.4 ± 2.7ab	64	0.9 ± 0.8	0.32 ± 0.1
	Danitol 2.4EC	21.3 fl oz	7.3 ± 3.1ab	59	0.3 ± 0.3	0.63 ± 0.2
	Brigade WSB + 415° Oil	1.5 lb + 1% v/v	9.2 ± 3.1abc	49	0.6 ± 0.3	0.90 ± 0.3
	Athena + 415° Oil	19.2 fl oz + 1% v/v	9.9 ± 3.8abc	44	0.1 ± 0.1	0.82 ± 0.3
	Warrior II	2.56 fl oz	11.6 ± 2.5a-d	35	0.1 ± 0.1	1.14 ± 0.4
	Athena	19.2 fl oz	12.1 ± 1.8bcd	32	0.1 ± 0.1	0.48 ± 0.2
	Baythroid XL	2.8 fl oz	14.7 ± 3.7cd	17	0.0 ± 0.0	0.78 ± 0.3
Other Larvicide	Proclaim	4.5 oz	6.4 ± 0.5ab	64	1.3 ± 0.8	0.30 ± 0.2
	Delegate WG	6.4 oz	8.1 ± 1.9ab	54	2.7 ± 1.4	1.06 ± 0.5
	Intrepid	16 fl oz	9.6 ± 2.4abc	46	0.9 ± 0.4	0.67 ± 0.3
Untreated	UTC	--	17.8 ± 2.2d	0	0.9 ± 0.5	0.49 ± 0.2
		F =	1.73	--	1.03	
		P =	0.0372	--	0.4328	

[1]Dyne-Amic was used as a surfactant at 4 fl oz per 100 gallons for all treatments except where 1% 415° Oil was used.
[2]Means in a column followed by the same letter are not significantly different ($P > 0.05$).
[3]Means in a column followed by the same letter are not significantly different ($P > 0.05$, Fisher's protected LSD) after sqrt (x) transformation of the data. Untransformed means are shown.

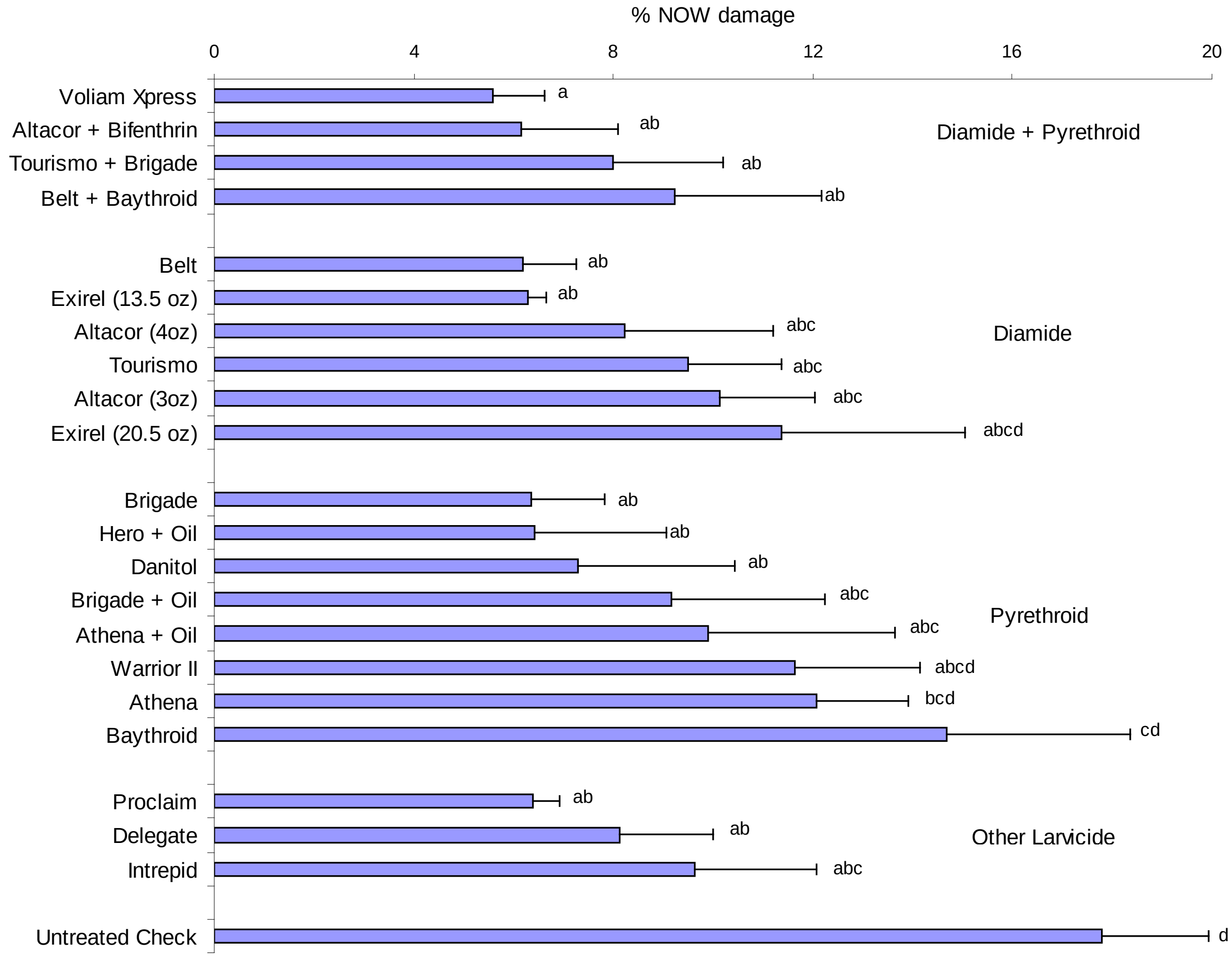

Figure 4. Effects of insecticide treatments on the percentage of kernels infested by navel orangeworm.

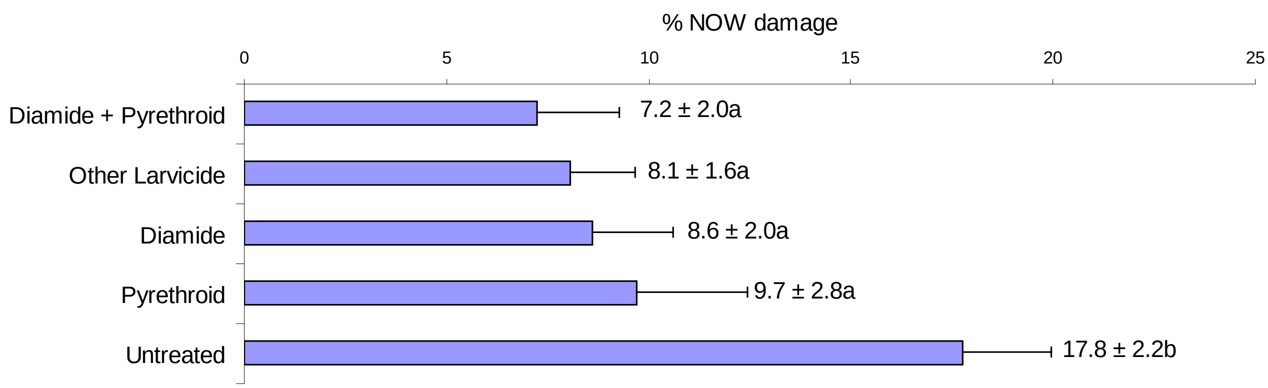

Figure 5. Effects of insecticide treatments from the same mode of action on the percentage of kernels infested by navel orangeworm.

Objective 3: Maintain Research Orchards. During 2012 there were a total of eleven research trials completed within the two research orchards that are maintained in part by funding from the Almond Board of California. The trials are as follows: 1-3) three miticide trials by David Haviland in Shafter, 4-5) two navel orangeworm trials by David Haviland (one at West Side and one in Shafter), 6) a miticide trial by Syngenta at West Side, 7-8) two miticide trial by Nichino (one at West Side and one in Shafter), 9) an ant bait trial at Shafter by David Haviland, and 10-11) two field trials on overwintering survival of navel orangeworm in mummies by Frank Zalom.

Over the past three years (2010-2012), these research orchards have now been used for a total of 30 trials. Results from each individual project are being reported independently by the researchers that are responsible for them. Results of the three mite trials and two navel orangeworm trials by David Haviland are available within this report that is being submitted to the Almond Board of California for the 2011-2012 research cycle. The ant bait trial is considered preliminary and results are being used to determine treatments in a larger ant bait trial being conducted on a commercial farm in Kern County during 2013. Trials by Syngenta and Nichino were considered internal preliminary trials for those companies and are not available publicly. However, the results were used by these companies and David Haviland to determine treatments and rates for products from those trials that are being tested in UC miticide trials by David Haviland during the summer of 2013. Results of the overwintering trial will be made available at a future date by Dr. Frank Zalom.