Insect and Mite Research

Project No.: **07-ENTO7-Zalom**

Project Leader: Frank G. Zalom
Department of Entomology
University of California - Davis
One Shields Ave.
Davis, CA 95616
(530) 752-3687
fgzalom@ucdavis.edu

Project Cooperators: Franz Niederholzer, University of California
Cooperative Extension - Sutter/Yuba Counties
Walter Leal, Dept. of Entomology, University of California - Davis
Javier Saenz de Cabezon, Depto. de Agricultura y Alimentación,
Univ. de La Rioja
Kim Gallagher, Sterling Insectary, Delano, CA

Interpretive Summary:

A number of viable options for off-season control of peach twig borer and other insects and mites that had been traditionally controlled by the dormant season application of an organophosphate insecticide and dormant oil have been developed and evaluated through this project for several years. Options include alternative products and best management practices (BMPs) that mitigate the effects of the organophosphates. In this annual report, additional products were evaluated as dormant season, budswell or bloom treatments in comparison to the organophosphate insecticide diazinon and the pyrethroid insecticide esfenvalerate (Asana). In general, pyrethroids offer the least expensive alternative to the organophosphates, but there is increasing concern for their nontarget effects. However, several newly registered and as yet unregistered products including spinetoram (Delegate), methoxyfenazide (Intrepid), indoxacarb (Avaunt), and rynaxypyr (Altacor) evaluated in the current year provided peach twig borer control at a level similar to that afforded by the pyrethroids and organophosphates when properly timed. A BMP, earlier off-season treatment timing, was evaliuated for a second year in terms of efficacy against peach twig borer and impacts on return bloom. In the experiment, various combination of diazinon, esfenvalerate and dormant oil were applied at October, November, December or January timings. Results indicated that all treatment timings of diazinon or esfenvalerate provided significant control relative to untreated, but that the December and January treatments were generally better than the earlier timings. Oil alone did not control peach twig borer at any timing. Bloom was accelerated by as much as 8 days in trees with the December treatments containing oil relative to the other treatment timings and untreated controls, with the primary effect occurring in the first half of the bloom period. For a second year, Landguard, an enzyme product applied to the soil following the dormant season application of diazinon was shown to significantly

reduce the concentration of diazinon in runoff water. Abamectin (Agrimek), acequinocyl (Kanamite) bifenezate (Acramite), fenpyroximate (Fujimite), sprirodiclofen (Envidor) and horticultural mineral oil (Orchex) were all shown to reduce densities of two-spotted spider mites for at least 2 weeks following application relative to untreated. The residual effects of these products as well as etoxizole on the western orchard predator mite, *Galendromus occidentalis*, were evaluated for up to 37 days following application. Most of the products proved to be 'slightly harmful' to the predatory mites, according to IOBC standards, with the exception of etoxizole and fenpyroximate, which were determined to be harmful

Objectives:

1. Purchase pheromone traps, navel orangeworm bait traps, and lures for UC Cooperative Extension Farm Advisors for their ongoing monitoring and extension efforts. Assist in evaluating NOW pheromone blends and formulations and in ten lined June beetle monitoring as necessary in collaboration with other UC researchers.
2. Peach twig borer - evaluate efficacy and treatment timing for registered and candidate insecticides.
3. Dormant spray best management practices (BMPs) – establish efficacy and possible phytotoxicity (from oils) resulting from earlier dormant spray timing, and from use of other mitigation practices.
4. Spider mites – evaluate efficacy of registered and candidate miticides, and determine their specific activity. Continue to evaluate direct and residual effects of pesticides against predatory mites.

Materials and Methods:

Objective 1 - Monitoring and collaboration.

Each year through this project, trapping supplies are purchased for use by UC Cooperative Extension Farm Advisors to help them monitor the phenological activity of almond insect pests in their counties. The Advisors use the data gathered from these traps to update pest status for local growers and PCA's. Continuing to coordinate regional insect trapping and collaborating with new monitoring research allows for consistency and improvements in this important component of almond IPM. As in the previous year, I have continued to assist in Dr. Walter Leal's field work to evaluate NOW pheromone blends and formulations, and for monitoring ten lined June beetle populations. This required a number of visits to the field by myself and members of my lab to monitor traps and make collections. The ten lined June beetle collections must take place in the evening when the adults emerge from the soil and are active.

Objective 2 - Peach twig borer studies.

An experiment to determine efficacy of registered and candidate insecticides for control of PTB was conducted in collaboration with Sutter County CE Farm Advisor, Franz Neiderholzer. The site of this study was a commercial third leaf almond orchard located east of the Sutter Buttes and northwest of Yuba City, Sutter Co., California. The orchard was a standard planting for the area, and all treatments were applied to Nonpareil variety trees grafted onto Lovell peach rootstock.

The experiment consisted of 25 treatments and an untreated check (Table 1). Dormant treatments were applied on January 18, 2007. Delayed dormant/budswell sprays were applied on February 1.

Full bloom sprays were applied on February 28. Each treatment replicate was a single tree, and all treatments were replicated 8 times with four randomized complete blocks of each treatment placed into each of the 2 treatment rows. Tree spacing was 22 feet across rows, and 18 feet in the row. Treatments were applied using an Echo Duster-Mister Air Assist Sprayer to runoff at the equivalent volume of approximately 80 gal/acre. All of the dormant and delayed dormant sprays which included horticultural mineral oil included Gavicide Super 90 Horticultural Oil at 4% vol/vol. Treatments not containing oil or containing a different adjuvant are so indicated on the Table 1. We used the number of flags per tree counted in a 5 minute timed search as an indicator of the number of peach twig borer larvae present on a given tree. Shoot strikes in this experiment were counted on April 4.

Objective 3 - Dormant spray best management practices (BMPs).

Earlier dormant spray timing has been one of the most effective methods for reducing insecticide runoff from orchards in our BMP studies. However, there is concern about both the efficacy of the approach against target pests such as PTB, and also possible phytotoxicity from the oils included in the dormant sprays. This is the second year of a study to address the efficacy and phytotoxicity of different dormant season timings, and was conducted in collaboration with Sutter County CE Farm Advisor, Franz Neiderholzer.

Table 1. Treatments and treatment dates for the treatment timing experiment, 2007.

Number	Treatment	Treatment date
1	Oil alone	October 18, 2006
2	Asana + oil	October 18, 2006
3	Diazinon 50WP + oil	October 18, 2006
4	Asana	October 18, 2006
5	Diazinon EC	October 18, 2006
6	Oil alone	November 24, 2006
7	Asana + oil	November 24, 2006
8	Diazinon 50WP + oil	November 24, 2006
9	Diazinon EC	November 24, 2006
10	Asana + oil	December 30, 2006
11	Diazinon 50 WP + oil	December 30, 2006
12	Oil alone	December 30, 2006
13	Diazinon EC	December 30, 2006
14	Diazinon 50WP	December 30, 2006
15	Asana + oil	January 25, 2007
16	Diazinon 50 WP + oil	January 25, 2007
17	Untreated	---

The site of this study was a commercial third leaf almond orchard located east of the Sutter Buttes and northwest of Yuba City, Sutter Co., California. The orchard was a 22’ x 18’ planting, and all treatments were applied to Nonpareil variety trees grafted onto Lovell peach rootstock. Treatments were applied at 4 different timings, October 18, November 24, December 30, 2006, or January 25, 2007. Treatments and treatment dates for each are shown on Table 1. Rates for products applied were esfenvalerate (Asana) at 9.6 oz per acre, Diazinon EC at 0.5 gal per acre, Diazinon 50WP at 4 lb. per acre and horticultural mineral oil (Gavicide Super 90) at 4 gal per acre. All applications were made at a volume of 100 gal per acre to individual nonpareil trees using an air assist sprayer and replicated 8 times. Return bloom and bloom progression on each tree was determined by counting the number of opened flowers per tree from February 16 through March 8 when 100 percent bloom was recorded. PTB shoot strikes were evaluated on April 4.

In 2006, we reported results of experiments using Landguard, an enzyme product from Orica Inc that is intended to increase the rapidity of organophosphate breakdown. When Landguard was applied to the soil surface after a dormant diazinon application, the resulting concentration of diazinon in the runoff was significantly reduced. We repeated the experiment in 2007 in a 10 year old almond orchard adjacent to Gilsizer Slough in Sutter County which had an orchard floor maintained without tillage and using herbicides for weed control.

Diazinon AG500 was applied on February 15, 2007, at a rate of 4 pts/acre in 100 gal of water to 8 replicate plots, and 4 plots remained untreated. Landguard was applied to the soil surface of 4 of the diazinon-treated plots at a rate of 1000 g per 1500 L of volume immediately following the diazinon application. Each treatment plot consisted of a central 20 ft by 110 ft runoff monitoring strip within the row between two adjacent tree row berms. The treatments were alternated, with at least two untreated tree row middle separating the experimental plots. Measurement of water volume and water collections for diazinon concentration was achieved by an autosampler unit deployed at the downslope end of each experimental orchard row. At the low end of sample areas, earthen dams were built diagonally across the area between the berms. Each dam is intended to isolate runoff from the defined area and directs the runoff water to one side where a 3 gal plastic bucket is buried in the soil. To prevent the buckets from floating when the soil becomes saturated, they are anchored to 3 steel bars pounded into the ground around them. The bucket's rim is surrounded by fine plastic mesh to prevent debris from entering, and a lid is attached to the top of the mesh to prevent rainfall from directly entering the bucket. The bucket fills with runoff water until a float switch inside of the bucket turns on an electric sump pump powered by a 12-volt car battery. The runoff water is then pumped out of the bucket, through a flow meter, to a T fitting that diverts 99% of the water into the row downslope of the dam, and 1% to a Nalgene® tub which is used for the composite sample to determine diazinon concetration. Samples of the water from the Nalgene® tubs were collected in two 1000 ml glass acid-washed jars with Teflon lids, and submitted to the EMA Laboratory in Woodland, CA, for chemical analysis. The sample results were averaged before calculating concentration (ppm) and total load.

Objective 4 - Spider mites.

This experiment was conducted mature almond orchard located near Lake Boulevard east of Waterford, Stanislaus County, California. The treatments were applied on August 14, 2007, and leaves were collected for pretreatment mite counts immediately before the application. Twospotted spider mite (*Tetranychus urticae*) densities averaged 6.8 per leaf at the time of application. The action threshold for webspinning spider mites on almonds is about 4.0 motile mites per leaf. No predator mites were found in the pretreatment samples. Mite densities were generally low throughout the northern San Joaquin Valley and Sacramento Valley's this season and it was difficult to find an optimal location for this trial. Therefore the trial was initiated later than we had planned. Treatments were applied to runoff using a gas-powered hand gun sprayer at the equivalent volume of 400 gal/acre. Each treatment replicate was a single tree, and each treatment was replicated 4 times in a completely randomized design. Products tested included horticultural mineral oil (Orchex), acequinocyl (Kanemite), bifenezate (Acramite), spirodiclofen (Envidor), fenpyroximate (Fujimite), and abamectin (Agri-mek). Treatments and application rates are provided on Table 5.

Mite sampling consisted of removing 10 leaves per tree randomly from around the circumference of each tree, placing the leaves from each tree into a labeled plastic bag, and returning the leaves to the Zalom lab for counting. Using a mite brushing machine, the total number of twospotted spider mite motiles was determined. A pretreatment count was made on August 14, with post-treatment counts taken one, two, three, and four weeks later.

A study was conducted to describe the direct and side effects of leaf surface residues of selected acaricides to *G. occidentalis* by assessing adult female mortality, fecundity and fertility at 3, 6, 10, 14, 17, 24, 30 and 37 days following their application. A colony of *G. occidentalis,* originally obtained from Sterling Insectary (McFarland, CA), was maintained on twospotted spider mites in growth chambers at 24±1ºC, 75-85% RH and 16:8 photoperiod. Plants were treated in the field with either acequinocyl at 181.5 ppm, bifenezate at 200.7 ppm, spiromesefen 142.6 ppm, fenpyroximate 62.5 ppm, abamectin at 93.0 ppm or water only. Leaves excised at the specified intervals were returned to the lab where they were set up in bioassay units consisting of five 20 mm leaf disks cut with a cork borer from one of the treatments placed on wet filter paper inside a 90 mm diameter Petri dish. Three random age adult predator mite females were transferred onto each leaf disk using a fine camel hair brush. A surplus of twospotted mites and eggs were transferred to each leaf disk daily as food for the predators. Mortality and fecundity (number of eggs laid) were recorded per leaf disc, after three days. Fertility (number of young produced) was determined 6 days after being placed on a disk. There were five replicates of a bioassay unit for each acaricide treatment and control. Mean mortality, and fertility after three days exposure were analyzed by non-parametric Kruskal-Wallis test followed by a Mann Whitney *U* test on all pairs of groups in order to determine differences between treatments. Fecundity was analyzed by ANOVA with means separated by LSD ($p < 0.05$) (SPSS 2003). Total effects of pesticides (E) values were calculated to measure the persistence of pesticides.

Results and Discussion:

<u>Objective 1 - Monitoring and collaboration</u>

For the 2007 season, supplies were purchased and distributed to 7 individuals in Cooperative Extension, and the total request included 744 wing traps and trap liners, 348 San Jose scale (SJS) traps, 50 navel orangeworm (NOW) egg traps, 825 'regular' pheromone lures for peach twig borer (PTB), SJS, oriental fruit moth, and obliquebanded leafroller, 120 'long-life' PTB pheromone lures, and 11 lbs of NOW bait.

<u>Objective 2 - Peach twig borer studies.</u>

ANOVA revealed significant differences between treatments (ANOVA statistics, $F = 22.16$, df = 25,190; $p < 0.0001$). Means were separated by Fisher's Protected LSD following SQRT (x + 0.5) transformation. The analysis revealed that all treatments except for Ecotrol EC significantly reduced the number of peach twig borer shoot strikes relative to the untreated check (Table 2). All treatments except for BAS 320 WU I, BAS 320 00 I, and the 2 Assail treatments provided statistically similar control as the diazinon plus oil and Asana plus oil standard

Table 2. Mean (± SD) peach twig borer shoot strikes per tree, 2007.

Treatment	Rate (formulated)	Timing[1] D	BS	Bl	Mean (± SD) shoot strikes per tree[2]
Untreated	NA	X			13.44 ± 8.16 A
Diazinon + Oil	4 pts + 4 gal. oil	X			0.25 ± 0.71 EFG
Asana + Oil	9.6 oz + 4 gal. oil	X			0.75 ± 0.89 EFG
Brigade + Oil	0.5 lb + 4 gal. oil	X			0.00 ± 0.00 G
Brigade + Oil	0.5 lb + 2 gal. oil	X			0.00 ± 0.00 G
BAS 320 WU I	0.21 lb ai			X	4.25 ± 3.62 B
BAS 320 00 I	0.25 lb ai			X	3.50 ± 2.27 BC
Baythroid + Oil	2.0 oz + 4 gal. oil	X			0.13 ± 0.35 FG
Baythroid + Oil	2.8 oz + 4 gal. oil	X			0.63 ± 1.06 EFG
rynaxypyr	4.0 oz	X			0.00 ± 0.00 G
rynaxypyr + Oil	3.0 oz + 4 gal oil	X			0.13 ± 0.35 FG
rynaxypyr + Oil	4.0 oz + 4 gal oil	X			0.13 ± 0.35 FG
rynaxypyr	3.0 oz			X	0.25 ± 0.71 EFG
rynaxypyr	4.0 oz			X	0.38 ± 0.74 EFG
Avaunt + Oil	6 oz + 4 gal oil	X			1.75 ± 1.75 CDE
Avaunt	6 oz			X	0.25 ± 0.46 EFG
Warrior + Oil	3.0 oz + 4 gal. oil	X			1.88 ± 2.80 DEF
zetacypermethrin + Oil	0.025 lb ai + 4 gal. oil	X			0.25 ± 0.71 EFG
zetacypermethrin + Oil	0.025 lb ai + 2 gal. oil	X			0.38 ± 0.74 EFG
Assail + Oil	5 oz + 4 gal. oil		X		4.38 ± 2.26 B
Assail + Oil	8 oz. + 4 gal. oil		X		3.00 ± 2.78 BCD
Delegate + Oil	1.6 oz + 4 gal oil	X			0.00 ± 0.00 G
Delegate + Oil	2.4 oz + 4 gal. oil	X			0.38 ± 0.74 EFG
Delegate 25 + Oil	3.2 oz + 4 gal. oil	X			0.25 ± 0.71 EFG
Intrepid + Latron	10 oz. + 0.125% v/v		X		0.88 ± 1.36 EFG
Ecotrol EC	3 pts.		X		15.50 ± 9.83 A

ANOVA statistics: F=22.16, df=25,190; $P<0.0001$.

[1] Treatment timings; Dormant, 18 January; Delayed Dormant/Budswell, 1 February; Full Bloom, 28 February.

[2] Means followed by the same letter do not differ significantly at (P=0.05) from one another by Fisher's Protected LSD, following SQRT (x + 0.5) transformation.

dormant sprays. This was the first year that we tested the two BAS products and Assail.peach twig borer, and it is possible that a different application timing of these products could have resulted in different results.

From our previous experience, the mean number of peach twig borer shoot strikes found in the untreated checks (13.44 strikes per tree) would be considered in excess of a treatable level for mature almond trees and for fresh or canned soft fruit to avoid direct damage to nut meats and fruit later in the season.

Objective 3 - Dormant spray best management practices (BMPs)

Although PTB shoot strikes were significantly reduced in all of the esfenvalerat and diazinon treatments on all treatment dates when compared to untreated controls (*F*=17.52, df=16,135, *P*<0.0001), treatment efficacy was better on both of the later treatment dates than on the October or November treatment dates. Table 3 presents the results for the Asana and oil treatments, but similar results were observed for the diazinon treatments. There was no significant PTB control afforded by the oil alone.

Table 3. Mean (± SE) peach twig borer shoot strikes per tree, 2007.

			# strikes / tree			
Treatment	Rate (form. / ac.)	Application Date	Mean	±	SEM	
Oil	4 gal.	10/18/06	12.25	±	1.91	a
Asana + oil	9.6 oz. + 4 gal.	10/18/06	4.38	±	1.28	b
Diazinon EC + oil	0.5 gal. + 4 gal.	10/18/06	4.25	±	1.36	b
Asana	9.6 oz.	10/18/06	5.25	±	1.98	b
Diazinon EC	0.5 gal.	10/18/06	3.75	±	1.37	bc
Oil	4 gal.	11/24/06	15.75	±	1.74	a
Asana + oil	9.6 oz. + 4 gal.	11/24/06	3.63	±	1.21	bc
Diazinon EC + oil	0.5 gal. + 4 gal.	11/24/06	5.88	±	2.40	b
Diazinon EC	0.5 gal.	11/24/06	4.38	±	1.12	b
Asana + oil	9.6 oz. + 4 gal.	12/30/06	0.13	±	0.13	d
Diazinon EC + oil	0.5 gal. + 4 gal.	12/30/06	0.13	±	0.13	d
Oil	4 gal.	12/30/06	16.63	±	1.40	a
Diazinon EC	0.5 gal.	12/30/06	0.13	±	0.13	d
Diazinon WP	4 lbs.	12/30/06	1.38	±	0.60	cd
Asana + oil	9.6 oz. + 4 gal.	1/25/07	0.00	±	0.00	d
Diazinon EC +oil	0.5 gal. + 4 gal.	1/25/07	0.63	±	0.42	d
Untreated	na	Na	12.25	±	1.77	a

ANOV statistics – *F*=17.52, df=16,135, *p*<0.0001
[1] Means followed by the same letter do not differ significantly at (*P*=0.05) from one another by Fisher's Protected LSD, following SQRT (x + 0.5) transformation.

Results of the return bloom and bloom progression were similar to what we reported in 2006 (Figures 1 – 4). Bloom was accelerated by as much as 8 days in the December treatments (Figure 3) containing oil relative to the other treatment timings and untreated controls, with the primary effect occurring in the first half of the bloom period.

Figure 1. Nonpareil bloom date as affected by the October treatment timing, 2006-07.

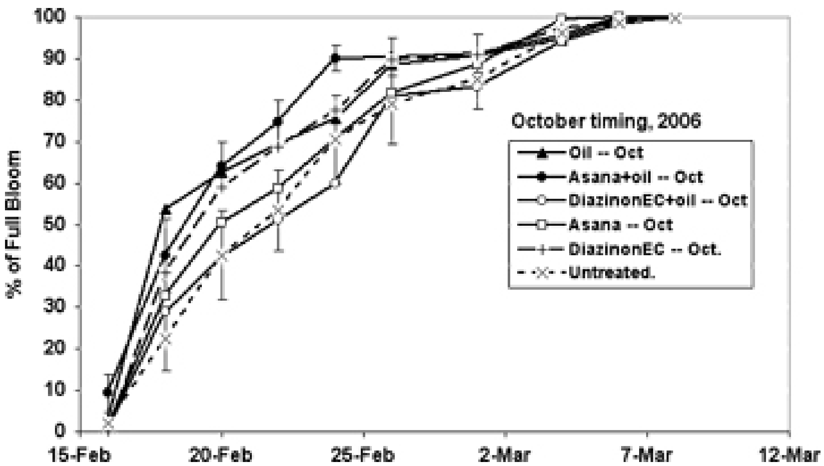


Figure 2. Nonpareil bloom date as affected by the November treatment timing, 2006-07.

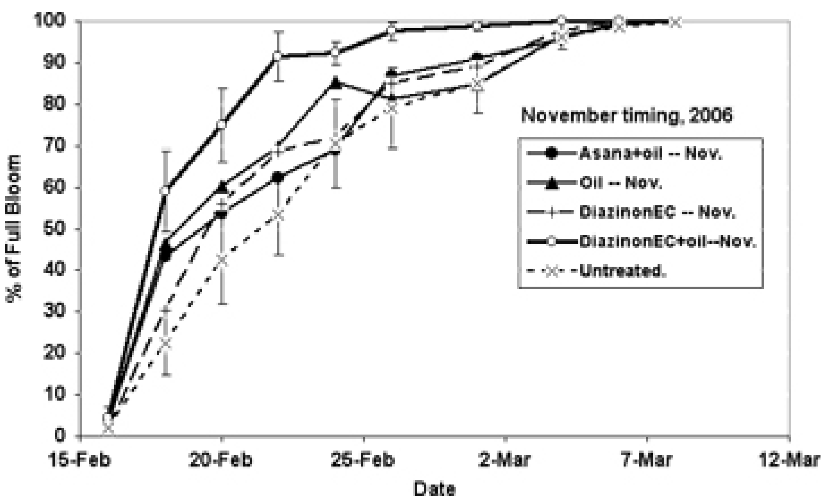


Figure 3. Nonpareil bloom date as affected by the December treatment timing, 2006-07.

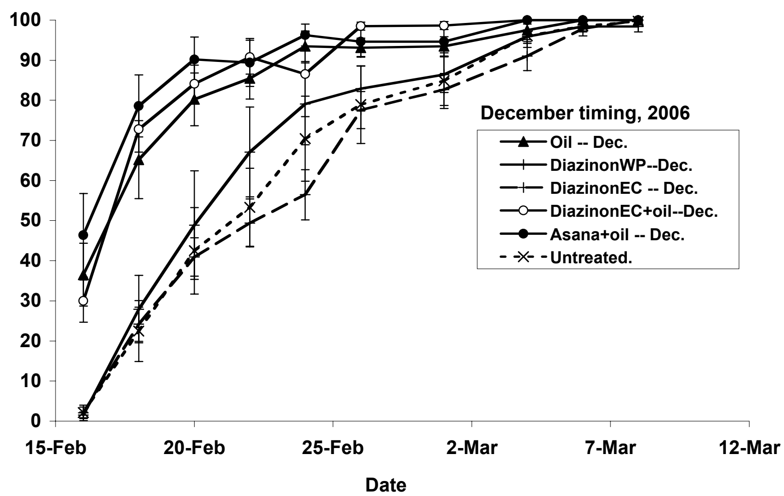
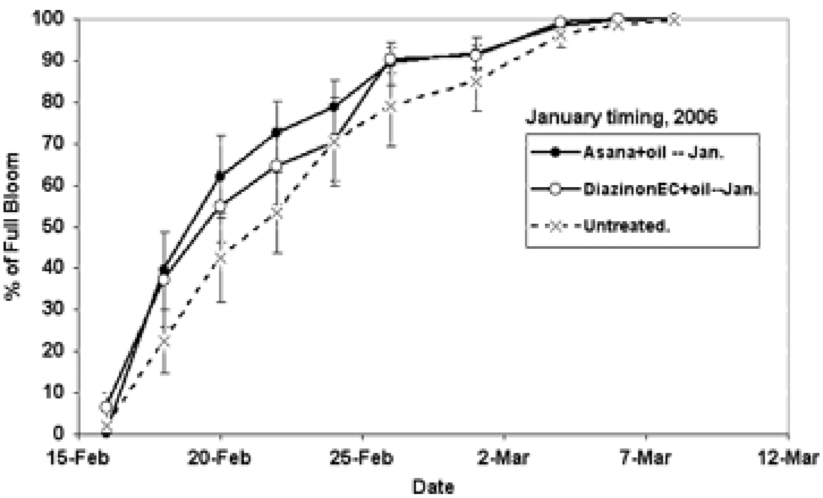


Figure 4. Nonpareil bloom date as affected by the January treatment timing, 2006-07.



As in 2006, the application of Landguard to the orchard floor following the diazinon application significantly (F=114.721, df=2,11, P<0.0001) reduced the subsequent diazinon concentration in runoff water with a mean $\pm$ SE of 119.03 $\pm$ 9.36 µg/L in the diazinon only plots to 16.87 $\pm$ 4.34 µg/L in the plots treated with Landguard following the diazinon application (Table 4). The reduction was even greater in 2007 than in the previous year. This may have been due to the timing of the diazinon application relative to the runoff event. In 2007, the event occurred 5 days following application, while in 2006 it occurred almost 4 weeks after application which would have allowed the diazinon remaining on the soil surface to degrade prior to the runoff event thus reducing its concentration in the runoff water.

Table 4. Concentration and total load of diazinon in runoff following a dormant season application with and without a subsequent application of Landguard, 2007.

	Concentration ppb (µg/L)				Total Load µg/acre			
Treatment	Mean	±	SEM		Mean	±	SEM	
Control	1.46	±	0.56	b	232758	±	89522	b
Diazinon 4E	119.03	±	9.36	a	19007891	±	1494429	a
Diazinon 4E + Landguard	16.87	±	4.34	b	2693882	±	693835	b

Means followed by the same letter are not significantly different by Fisher's LSD at $P < 0.05$

Objective 4 - Spider mites.

Significant (P<0.05) differences were observed for all 4 weekly post treatment sampling dates (Table 5). The twospotted spider mite densities slightly exceeded the treatment threshold at the time of the application at a level of 6.8 spider mite motiles per leaf, but decreased somewhat in the control plots to reach 3.5 per leaf by 4 weeks after application. Significant differences were observed for all 4 weekly post treatment sampling dates. All products tested reduced spider mite densities except for the horticultural mineral oil applied at 1% v/v on weeks 3 and 4 following application, and Agri-mek plus oil and the 1% and 4% rates of Orchex horticultural mineral oil on the 4th week following application. The oil alone applied at 4% v/v reduced spider mite densities for 3 weeks following its application.

Temperature was relatively mild during most of the summer, which likely contributes to delay in spider mite densities in general throughout the Central Valley. The increase in this orchard was likely due to water stress to the trees in preparation for harvest.

Table 5. Mean (± SD) motile twospotted spider mites per leaf on almonds, 2007 (n=4).

		Mean ± SD twospotted mites per leaflet														
Treatment	Rate (Form/ac)	Aug.14 Pretreat			Aug. 21			Aug. 28			Sept. 4			Sept. 11		
Untreated	na	6.8	±	2.6	5.3	±	2.1	4.8	±	2.1	4.5	±	1.7	3.5	±	1.3
Envidor	18 oz	5.3	±	2.1	0.0	±	0.0*	0.3	±	0.5*	1.0	±	1.4*	1.0	±	0.8*
Envidor + LI7000	18 oz + 0.25%	7.8	±	2.1	0.0	±	0.0*	0.0	±	0.0*	0.5	±	0.6*	0.8	±	1.0*
Acramite	1 lb	5.8	±	2.2	0.5	±	0.6*	0.8	±	1.0*	0.8	±	1.0*	1.5	±	1.3*
Fujimite + oil	32 oz + 1%	6.5	±	3.1	0.3	±	0.5*	0.5	±	1.0*	0.8	±	1.0*	1.0	±	0.8*
Kanemite	31 oz	5.8	±	2.9	0.0	±	0.0*	0.5	±	1.0*	0.8	±	0.5*	1.3	±	1.3*
Agri-mek + oil	15.6 oz + 1%	3.8	±	1.0	1.0	±	0.8*	0.8	±	0.5*	1.3	±	1.5*	1.8	±	1.3
Orchex	1% v/v	7.3	±	4.3	3.0	±	0.8*	3.3	±	1.0*	5.0	±	2.2	3.3	±	1.3
Orchex	4% v/v	8.5	±	2.9	0.8	±	1.0*	1.3	±	1.0*	2.5	±	1.3*	2.3	±	1.9

*Means significantly different from untreated control at P<0.05 by Student's t-test.

ANOV statistics for each sampling date:

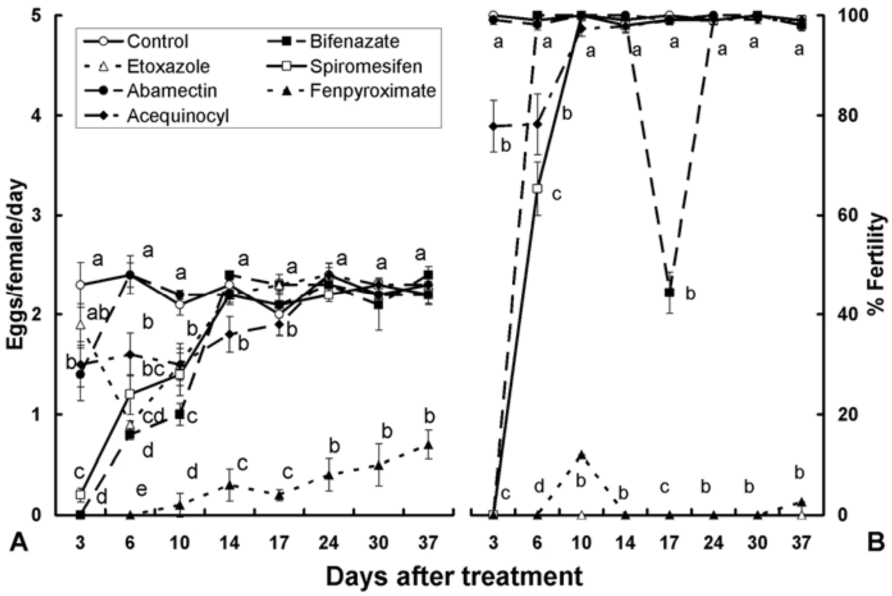
Date	*F*=	df=	*P*=
Pretreatment	8,35	1.1	0.3924
8/21/07	8,35	16.3	<0.0001
8/28/07	8,35	9.7	<0.0001
9/4/07	8,35	6.7	<0.0001
9/11/07	8,35	2.6	0.0312

Our detailed study intended to determine direct and sublethal effects of some of the newer acaricides on *G. occidentalis* provided stunning results. Adult female *G. occidentalis* mortality recorded 72 h after exposure to acaricide leaf residues collected at each post treatment interval was greatest for fenpyroximate, resulting in 100 percent mortality up to 10 days after treatment ($H = 34.0$; df = 6; $p < 0.001$). Etoxazole, abamectin and acequinocyl significantly ($H = 29.2$; df = 6; $p < 0.001$) increased mortality at 3 days after treatment. No mortality was observed for bifenezate or spiromesefen residues following the application, or for any of the acaricides at 14 days after treatment.

Exposure to fenpyroximate residues significantly ($F = 30.2$; df = 6,28; $p < 0.001$) reduced fecundity of *G. occidentalis* for 37 days after treatment of the strawberry plants (Figure 5A) for 14 days following acequinocyl treatment ($F = 43.3$; df = 6,28; $p < 0.001$), and for 10 days following treatment with bifenazate, etoxazole and spiromesifen ($F = 22.4$; df = 6,28; $p < 0.001$). Abamectin significantly ($F = 30.3$; df = 6,28; $p < 0.001$) decreased fecundity on only the first observation date (3 days) following treatment. *G. occidentalis* female fertility was significantly decreased ($H = 25.1$; df = 6; $p < 0.001$) following exposure to leaflets treated 37 days earlier with either etoxazole or fenpyroximate (Figure 5B). A few eggs laid by females exposed on the 10th and 37th days after treatment with fenpyroximate hatched, but none hatched when exposed on the other dates. Spiromesifen and acequinocyl significantly ($H = 32.2$; df = 6; $p < 0.001$) reduced *G. occidentalis* fertility for 6 days after treatment, and bifenazate ($H = 33.6$; df = 6; $p < 0.001$) for 3 days after treatment. Abamectin had no effect on *G. occidentalis* fertility.

Total effects of acaricides (*E*) and IOBC persistence categories are presented on Table 5. Total effects of etoxazole and fenpyroximate residues remained at 100 for all 37 days following application and would be considered harmful by IOBC standards. Bifenazate, acequinocyl and spiromesifen total effects on *G. occidentalis* exceeded 30 for 10 days following treatment. Total effects of abamectin on *G. occidentalis* exceeded 30 for only 3 days, and would be considered short lived for this species.

Figure 5. (A) Mean ± SD *G. occidentalis* fecundity (eggs/female/day) and (B) fertility recorded 72 h after exposure to treated leaves removed from the field on the indicated days after treatment. (B) Mean ± SD *G. occidentalis* fertility after 72 h exposure to treated strawberry leaflets using the labeled concentration of formulated products.



For (A) within each time interval, the means followed by the same letter do not differ significantly at p=0.05 by ANOVA and LSD.
For (B) within each time interval, means followed by the same letter do not differ significantly at p=0.05 by the Kruskal-Wallis test and by the Mann Whitney *U* test.

Table 5. Total effects (E) of acaricide residues on *G. occidentalis* recorded 72 h after exposure to leaves returned from the field on the indicated days after treatment using the labeled dose of formulated products.

	Days after treatment								
Treatment	3	6	10	14	17	24	30	37	IOBC[a]
Bifenazate	100	67	52	0	0	0	0	0	B
Etoxazole	100	100	100	100	100	100	100	100	D
Spiromesifen	100	67	33	0	0	0	0	0	B
Abamectin	60	0	0	0	0	0	0	0	A
Fenpyroximate	100	100	100	100	100	100	100	100	D
Acequinocyl	100	48	30	23	6	0	0	0	B

IOBC categories: A = short lived (<5 d), B = slightly persistent (5-15 d), C = moderately persistent (16-30 d), D = persistent (>30 d).
E (%) = 100% - (100% - M) x R

Recent Publications:

Saenz de Cabazon Irigaray, F. J., F. G. Zalom, and P. B. Thompson. 2007. Residual toxicity of acaricides to *Galendromus occidentalis* and *Phytoseiulus persimilis* reproductive potential. Biological Control. 40:153-159.

Saenz de Cabazon Irigaray, F. J. and F. G. Zalom. 2007. Selectivity of acaricide exposure on *Galendromus occidentalis* reproductive potential. Biocontrol Science and Technology. 17(5): 541-546.