ALMOND INSECT AND MITE RESEARCH

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UCDAVIS ENTOMOLOGY

Objectives:

Purchase pheromone traps, navel orangeworm (NOW) bait traps, and lures for UC Cooperative Extension Farm Advisors for their ongoing monitoring and extension efforts.

Evaluate efficacy and May treatment timing for newly registered and candidate insecticides against peach twig borer.

Evaluate efficacy and May treatment timing for newly registered and candidate insecticides against navel orangeworm; conduct associated research on applications and NOW biology.

Determine direct and residual effects of4 pyrethroid insecticides on *Galendromus occidentalis*.

Monitoring supplies and regional trapping. 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 to update pest status for local growers and PCAĜ. The trapping supplies are standardized to insure consistency in data collected over years. For the 2011 season, supplies purchased and distributed included 220 traps of various kinds, 250 pheromone lures for peach twig borer (PTB), San Jose scale (SJS), and oriental fruit moth (OFM), and 8 lbs of NOW bait. Six Farm Advisors received these supplies.

Peach twig borer 'May sprays'. An experiment to determine efficacy of registered and candidate insecticides for control of the spring PTB larval hatch was conducted on third leaf almond trees at a site east of the Sutter Buttes and northwest of Yuba City. Treatments were applied to Nonpariel, Monterey and Wood Colony varieties. The treatments were blocked by variety with 2 replicates of each insecticide treatment for each variety (6 replicates in all). May sprays offer the potential to obtain some control of NOW which has flights that overlap somewhat with PTB flights. PTB biofix for the site was determined to be April 23, and the NOW biofix May 13 (Figure 1). We based the treatments on degree-days (DD), so most applications were applied at a timing of about 400 PTB DD. Intrepid and Altacor were applied at earlier (0 NOW DD) and later (91 NOW DD) treatment timings as well. All sprays were applied at a volume of 100 gal. PTB shoot strikes were evaluated June 22, 2011, at 870 DD following biofix. ANOV statistics revealed significant treatment differences (F=4.102; df=17, 113; p<0.0001; Table 1). Mean separation revealed that all treatments except for the treatments containing diflubezuron significantly reduced the number of PTB shoot strikes relative to the untreated check.

Table 1. Mean (± SE) peach twig borer shoot strikes per tree, Sutter Co., 2011.

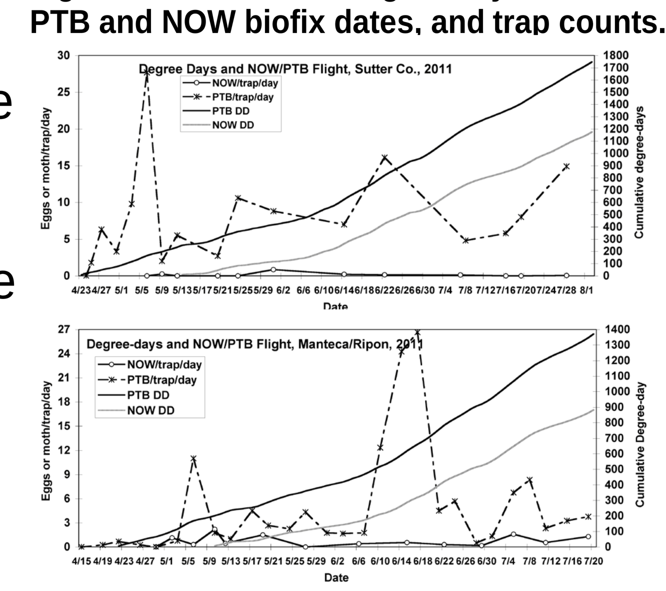
Treatment	Rate	Application date	PTB strikes/tree* Mean ± SD	
untreated	na	na	5.4 ± 4.8	A
Dipel[1]	1 lb	5/9 & 5/24/11	2.3 ± 2.9	CDE
Dimilin 2L	12 oz	5/24/11	3.5 ± 3.0	ABCD
diflubenzuron 2L (generic)	12 oz	5/24/11	5.2 ± 3.3	AB
Dimilin 2L + Lorsban	12 oz + 4 pt	5/24/11	3.8 ± 3.5	ABC
Lorsban	4 pt	5/24/11	2.0 ± 1.7	CDE
Intrepid 2F[3]	16 oz	5/13/11	2.5 ± 2.0	BCDE
Intrepid 2F[3]	16 oz	5/24/11	2.0 ± 1.5	CDE
Intrepid 2F[3]	16 oz	5/26/11	2.3 ± 1.8	CDE
Delegate WG[3]	4.5 oz	5/24/11	0.5 ± 0.5	E
Delegate WG[3]	7.0 oz	5/24/11	0.3 ± 0.5	E
Altacor[2]	4.0 oz	5/13/11	0.2 ± 0.4	E
Altacor[2]	4.0 oz	5/24/11	0.2 ± 0.4	E
Altacor[2]	4.0 oz	5/26/11	0.3 ± 0.5	E
Assail 70WP + Lamda-Cy EC	4.1 oz + 2.56 oz	5/24/11	0.8 ± 0.8	DE
Assail 70WP + Lamda-Cy EC	2.3 oz + 5.12 oz	5/24/11	0.5 ± 0.5	E
Belt SC[2]	4 oz	5/24/11	0.3 ± 0.8	E
cyazypyr 10SE[2]	16.9 oz	5/26/11	0.0 ± 0.0	E

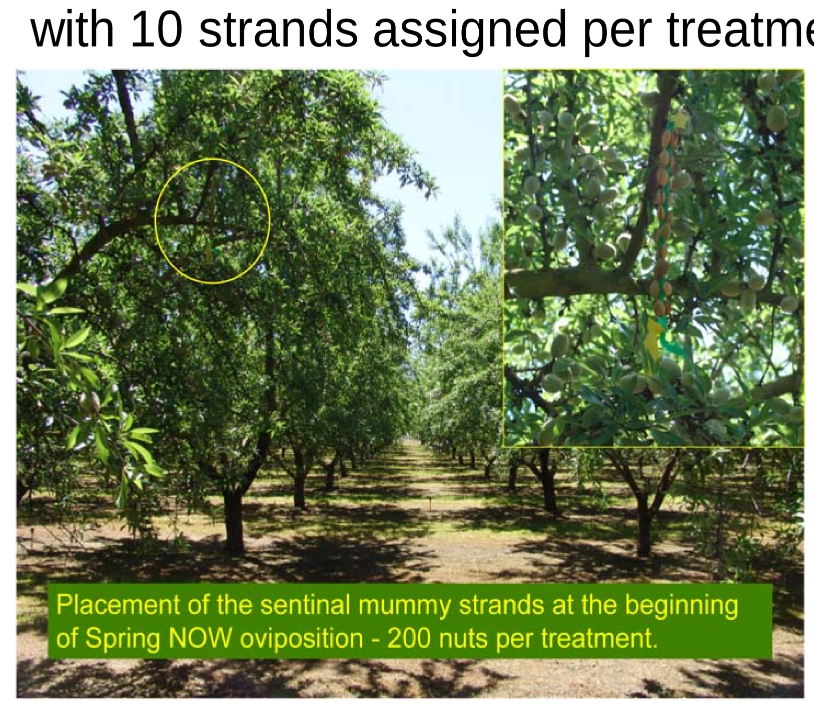
•Means followed by the same letter do not differ significantly at p=0.05 by Student's t-test.
[1] Mixed with LI-700 at 0.50% v/v
[2] Mixed with Dyne-Amic at 0.25% v/v
[3] Mixed with Induce at 0.25% v/v

Navel orangeworm, 'May sprays'. Many of the same products evaluated for PTB control may also provide NOW control during the 'May Spray' period. The current May spray timing recommendation for NOW is 100 DD after the first eggs are laid for 2 consecutive sampling periods on egg traps.

The site of our May NOW control study was a 20 acre almond orchard near Ripon. Biofix date for NOW was May 10. Treatments with most all products were made at 100 NOW degree-days (May 25). In addition, treatments with Altacor, Delegate and Intrepid were made at the biofix (May 10) and near the recommended 400 PTB DD treatment timing (May 27) (Figure 1). Mummies per tree in the Nonpariel trees averaged 21 on February 1. Mummies collected in Fall 2010 were glued to the outside of strands of vegetable mesh during April, 2011, and hung at mid-canopy on May 10 with 10 strands assigned per treatment. The mummies were removed on July 11 and hand-cracked for damage. ANOV statistics revealed significant treatment differences for NOW infestation (F=3.932, df=21, 222, p<0.0001). All products significantly reduced nut infestation except for the 2 numbered microbial agents and both diflubezuron treatments (Table 2). Of course, these results reflect optimal coverage, but they do illustrate that a number of products provide excellent control if the insecticide reaches its target.

Figure 1. Cumulative degree-days from PTB and NOW biofix dates, and trap counts.





Placement of the sentinal mummy strands at the beginning of Spring NOW oviposition - 200 nuts per treatment.

Table 2. Proportion of navel orangeworm infested mummies(total with larvae in meats and hulls), Ripon, 2011.

Treatment	Rate	Application date	Mean ± SD*	
Control (water)	na	na	13.8 ± 17.3	AB
Dipel[1]	1 lb	5/9 & 5/27	4.9 ± 9.3	CD
MBI-203[1]	2 gal	5/9 & 5/27	11.6 ± 7.7	AB
MBI-206[1]	2 gal	5/9 & 5/27	15.1 ± 17.6	AB
Dimilin 2L	12 oz	5/25	14.9 ± 11.2	A
diflubenzuron (generic)	12 oz	5/25	13.0 ± 11.8	AB
Lorsban	4 pt	5/25	0.0 ± 0.0	D
Intrepid 2F[3]	16 oz	5/10	1.7 ± 3.7	CD
Intrepid 2F[3]	16 oz	5/25	1.5 ± 3.2	CD
Intrepid 2F[3]	16 oz	5/27	2.0 ± 3.9	CD
Delegate 25WG[3]	7.0 oz	5/10	2.6 ± 4.2	CD
Delegate 25WG[3]	7.0 oz	5/25	3.2 ± 4.9	CD
Delegate 25WG[3]	7.0 oz	5/27	0.7 ± 2.3	D
Altacor 35WDG[3]	4.0 oz	5/10	1.7 ± 3.6	CD
Altacor 35WDG[3]	4.0 oz	5/25	1.9 ± 4.2	CD
Altacor 35WDG[3]	4.0 oz	5/27	0.0 ± 0.0	D
Assail 70WP + Lambda-Cy 11.4EC	4.1 oz + 2.56 oz	5/25	4.4 ± 6.1	CD
Assail 70WP + Lambda-Cy 11.4EC	2.3 oz + 5.12 oz	5/25	3.5 ± 8.3	CD
Belt 4SC[2]	4 oz	5/27	3.3 ± 4.6	CD
Dimilin 2L + Lorsban EW	12 oz + 4 pt	5/25	3.7 ± 5.6	CD
Dimilin 2L + Altacor 35WDG	12 oz + 3 oz	5/25	1.6 ± 3.0	CD
HGW86	16.9 oz	5/27	7.0 ± 9.0	BC

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Predator mite and spider mite research. In a previous study, we determined that the pyrethroid insecticides esfenvalerate (Asana) and permethrin (Ambush or Pounce) residues were surprisingly long-lived on almond bark and affected the survival of the predator mite *Galendromus ocidentalis*. The reason for doing this study was that some of the more recently registered pyrethroid insecticides represent somewhat different chemistry than did efenvalerate and permethrin.

Laboratory study. For the laboratory study, we exposed the female predators by treating them on leaf surfaces with the same concentration of each product that would be used in the field (contact assay) or by transferring females to previously treated and air dried leaves (residual assay), then determined female adult survival, number of eggs laid and percent eggs from which live offspring emerged.Table 3 shows female *G. occidentalis* survivorship for the laboratory study. All of the pyrethroids applied by direct contact to *G. occidentalis* caused a significant decline in survivorship (F=3.26, df=4,30, P=0.0246) with possible exception of λ-cyhalothrin (Warrior or Lambda-Cy). Fewer survived the permethrin treatment than the other treatments. Most of the mortality occurred on the first day following treatment. Table 4 shows number of surviving females during the 3 day period. The greatest effect on fecundity from exposure to all pyrethroids except bifenthrin (Brigade) occurred on the first day after exposure, with egg-laying by surviving females recovering on days 2 and 3. The bifenthrin treated females on average laid only 0.11 eggs on each of the 3 days with no apparent recovery during this period.

Table 3. Mean (± SD) surviving *Galendromus occidentalis* females on each of the 3 days following treatment

Treatment	Mean ± SD surviving females Day 1	Day 2	Day 3
Control	2.86 ± 0.38	2.71 ± 0.76	2.71 ± 0.76
Permethrin	0.57 ± 0.79	0.43 ± 0.53	0.43 ± 0.53
Esfenvalerate	1.29 ± 0.79	1.14 ± 0.95	1.29 ± 0.95
λ-cyhalothrin	1.71 ± 1.25	1.43 ± 1.13	1.43 ± 1.13
Bifenthrin	1.29 ± 0.76	1.43 ± 0.76	1.29 ± 0.76

Table 4. Mean eggs (± SD) laid per surviving *Galendromus occidentalis* female on each of the 3 days of the laboratory study.

Treatment	Mean ± SD eggs laid per female Day 1	Day 2	Day 3
Control	1.05 ± 0.60	0.68 ± 0.86	0.70 ± 0.76
Permethrin	0.00 ± 0.00	0.33 ± 0.58	0.67 ± 0.58
Esfenvalerate	0.10 ± 0.32	0.56 ± 0.73	0.89 ± 0.33
λ-cyhalothrin	0.17 ± 0.39	0.50 ± 0.53	0.40 ± 0.70
Bifenthrin	0.11 ± 0.33	0.11 ± 0.33	0.11 ± 0.33

Field study. The field study was conducted at Nickel's Estate in Colusa County. Nonpareil and Butte variety almond trees were treated at hullsplit (August 5) by handgun sprayer to runoff with the pyrethroids bifenthrin (Brigade) at 94.64 ppm or lambda-cyhalothrin (Warrior) at 44.53 ppm with 4 additional trees of each variety remaining untreated as controls. There were 4 single tree replicates of each treatment with one tree left untreated between each treated tree as a buffer. Treatments and varieties were assigned in a completely randomized design. Twigs were sampled from the trees the day following application, before leaf fall on November November 25 to coincide with the timing of natural predator movement off of the foliage and onto the bark where they would normally overwinter, and after bloom on February 16. Twigs were placed into washed glass jars, and frozen at -20ûC within 4 hours of collection. Half of the twigs collected were randomly selected and sent to Environmental Micro Analysis Inc. (Woodland, CA) for analysis of surface residues of both products, and half were used for laboratory bioassays to determine the effect of remaining residue on *G. occidentalis* females which would normally be overwintering on bark.

G. occidentalis survivorship on twigs collected from pyrethroid treated trees was reduced relative to the untreated control on both the November 25 and February 16 sampling dates (Table 5). Survivorship was not significantly reduced (P>0.05) on twigs from the bifenthrin treated trees collected on the day following treatment, but it was significantly lower on twigs from the λ-cyhalothrin treated trees. Lambda-cyhalothrin significantly (P<0.05) reduced fecundity of females exposed to twig residues on both the day following application and the November 25 sample dates, while bifenthrin reduced fecundity on only the date following treatment.

Mean (± SD) residues recovered (ng/cm^2) for bifenthrin on each of the 3 sampling dates (August 6, November 24, and February 16) were: 109.58±34.59, 46.38±16.16, and 16.99±10.34, respectively, while mean (± SD) residues recovered for λ-cyhalothrin were: 51.22±16.47, 7.24±4.33, and 8.49±3.18 respectively. This correlates with observed survival in the twig bioassays except for bifenthrin on the day following application. There was no residue found on control twigs

Table 5. Adjusted mean ± SD fecundity and survival for *Galendromus occidentalis* females placed on twigs collected from treated or untreated almond trees on all three sample dates.

Treatment		August 6 Mean ± SE	August 6 P	November 25 Mean ± SE	November 25 P	February 16 Mean ± SE	February 16 P
Control	Fecundity	2.32 ± 0.18	-	1.52 ± 0.38	-	2.34 ± 0.12	-
	Survival	0.71 ± 0.04	-	0.76 ± 0.04	-	0.63 ± 0.03	-
λ-cyhalothrin	Fecundity	1.66 ± 0.17	0.0373*	3.22 ± 0.56	0.0452*	2.19 ± 0.12	0.66
	Survival	0.19 ± 0.03	<0.0001*	0.39 ± 0.04	<0.0001*	0.49 ± 0.03	0.0117*
Bifenthrin	Fecundity	0.41 ± 0.04	<0.0001*	1.86 ± 0.42	0.830	2.32 ± 0.12	0.99
	Survival	2.18 ± 0.18	0.860	0.54 ± 0.04	0.003*	0.49 ± 0.03	0.0117*

*Means followed by the same letter do not differ significantly at p=0.05 by Student's t-test.