Efficacy Trials of Registered and Developmental Insecticides for Navel Orangeworm

Project No.: 08-ENTO8-Haviland/Holtz

Project Leaders:

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

Brent Holtz
Pomology Farm Advisor
UCCE - Madera County
328 Madera Avenue
Madera, CA 93637
(559) 675-7879 ext. 205
e-mail: baholtz@ucdavis.edu

Project Cooperators and Personnel:

Tome Martin-Duvall, UCCE - Madera County
Stephanie Rill, UCCE - Kern County
Brad Higbee, Paramount Farming Company
James Bettiga and Kevin Olsen, S&J Ranch

Objectives:

1. Develop efficacy data for newly-registered and experimental insecticides against Navel Orangeworm (NOW) in almonds

Interpretive Summary:

Navel orangeworm management in almonds requires a combination of cultural and chemical controls. In most cases this consists of mummy removal and orchard sanitation in the winter combined with in-season insecticide applications. The purpose of this project was to evaluate insecticides that have recently been registered, or that have the potential for becoming registered in almonds, for their effects against navel orangeworm when applied at hull split. Data were collected from two research sites in

Madera and Kern Counties that evaluated twenty-one different insecticide treatments and compared the results to two different untreated checks. Data showed a wide range of activity of different treatments against navel orangeworm. The most notable result was the pattern seen of good efficacy of products representing a new mode of action called anthranilic diamides. This included four insecticides using the active ingredients flubendiamide and chlorantraniliprole (Altacor, Belt, Tourismo, and Voliam Xpress). Products with this mode of action affect the ryanodine receptors of worm pests and result in cessation of feeding. These products are considered reduced-risk, are thought to have little impact on natural enemies, and can provide a new tool in resistance management programs for all worm pests in almonds.

Introduction:

Effective navel orangeworm management in almonds requires a combination of cultural practices, such as winter orchard sanitation and early harvest, and properly-timed insecticide treatments. When utilized properly, programs based on these tactics have provided relatively effective navel orangeworm control during the 1990s and early 2000s.

Over the past few years there have been several changes that have affected navel orangeworm control programs. Two of the most significant changes have been the inability to use Guthion due to regulatory actions, and the increased concerns over aflatoxins. Guthion was previously used as a one-spray program at hull split. Now, the loss of Guthion and need for long residual in an insecticide has caused increased consideration and use of two-spray programs. In areas where peach twig borer are a problem, these two-spray programs often consist of a May spray and a hull split spray. In southern almond regions of the state where peach twig borer is less of a concern, two-spray programs often consist of the application of an insecticide at the initiation of hull split followed by the application of a second insecticide about two weeks later.

This project was initiated due to increased concerns over navel orangeworm management. The primary objective is to screen new insecticides for their effectivieness against navel orangeworm with the ultimate goal of determining which products have the best fit for almonds, and how to best position them within an integrated pest management program. One group of products under evaluation includes newer generation pyrethroids such as Brigade, Battalion, Baythroid, Danitol, Renounce and Warrior. It is generally considered true that many of these new generation pyrethroids have higher activity against worms and longer residual in the field compared to their predecessors. Some also have the added benefit of activity against spider mites, which might allow their use in locations with histories of spider mite outbreaks.

The other group of new insecticides includes mostly reduced-risk products that are categorized as anthranilic diamides (Altacor, Belt, Tourismo, and Voliam Xpress), metaflumizone (Alverde), a neonicotinoid (Assail), a spinosyn (Delegate), benzyoylureas (Dimilin, Rimon) and an emamectin benzoate (Proclaim). Each of these new products provides new active ingredients for almonds as well as several new modes of action.

Currently there is a large gap in our understanding of the efficacy of these products. Many of these products have undergone substantial testing and have been proven effective against codling moth in apples, pears and walnuts; however, to date there is very little information on how they perform on navel orangeworm on almonds. Considering the economic scale of the significance of navel orangeworm as a pest of almonds in California, including both the effects on percentage offgrades and aflatoxins, it is essential that we learn more about how each of these new insecticides works and might contribute to improved control in the field.

Materials and Methods:

During 2008 we conducted two navel orangeworm insecticide field trials. The first trial was located in Madera County. A total of 138 trees in a mature almond orchard were organized into a randomized complete block design with six blocks of 21 treatments and two sets of untreated checks. Treatments were applied at approximately 30% hull split on 24 July with a handgun sprayer delivering 150 gallons of spray solution per acre at 200 PSI. Most insecticides were also sprayed with the inclusion of a surfactant or oil (**Table 1**). Samples of 200 random nuts per tree were collected on either 14 August (trees sprayed with unregistered pesticides) or 21 August (trees with registered insecticides). On 22 August all samples were oven dried to kill the existing NOW larvae. Nuts were processed to evaluate the percentage of nuts infested by navel orangeworm. Data were analyzed by ANOVA with means separated by Fisher's Protected LSD (α=0.05).

The second trial was conducted near Shafter, Kern Co., CA. A total of 138 mature Nonpareil trees (21' x 24' spacing) were each assigned to one of 21 treatment or two sets of untreated checks in a completely randomized design with six replications. Treatments were applied to individual trees with a hand gun at 200 GPA at 150 PSI on either 16 or 17 July. This corresponded with the second flight on navel orangeworm and the initiation of Nonpareil hull split. Trees were shaken mechanically on 9 September. On 10 September we collected approximately 500 nuts off of the ground from each individual tree and placed them into a paper sack. Within the next few days samples were processed through a small mechanical huller to crack away the hulls and shells. The slurries of nuts, shells and hulls that exited the mini-huller were then placed in the freezer to stop development of any insects and stored until the nuts could be separated from the hulls and shells and evaluated for damage by navel orangeworm. Data on the percentage of the nuts that were damaged by navel orangeworm were analyzed by ANOVA with means separated by Fisher's Protected LSD (α=0.05).

Results and Discussion:

The Madera County research site had very high navel orangeworm pressure (**Table 1**). Infestation levels across all treatments ranged from 29.3 to 58.8%; the two untreated checks averaged 27.2 and 57.8% damage. Out of the 21 treatments, sixteen had navel orangeworm damage at a level significantly lower than that the untreated check with the highest damage, while six treatments had damage significantly lower than both untreated checks. These top six included both rates of Voliam Xpress, Belt, the WP formulation of Assail, the grower standard Intrepid, and Tourismo.

The grower standard Intrepid had 31.8% damage, and was statistically equivalent to the top sixteen treatments. New pesticides in the chemical class anthranilic diamides (Voliam Xpress, Belt, Tourismo, and Altacor) did well in the trial. All six treatments utilizing this mode of action had damage significantly equivalent to that of the grower standard Intrepid, and represented four of the six top treatments in the trial. Pyrethroids had mixed results. Brigade was equivalent to the untreated checks, Danitol had 34.0% damage, and the two rates of Voliam Xpress (a mixture of an anthranilic diamide and a pyrethroid) were the first and sixth best treatments. It is likely however that the timing of this trial was not optimal for the use of pyrethroids. Applications were made late in the hull split process such that products that target small worms would have likely been more effective and the potential effects of products that have adulticidal activity would have likely been compromised. The neonicotinoid Assail also did well in the trial with 30.2 and 37.2% damage for the two formulations.

Damage in trees treated with other modes of action had variable results and generally fell out towards the middle of the trial in effectiveness. Generally speaking, trees treated with these products had damage that was both statistically equivalent to the best treatments, but also statistically equivalent to one or more of the untreated checks. The organophosphates Imidan, Lorsban 4E, and the low volatile organic compound version of Lorsban (Lorsban Advanced) had 34.2, 45.8, and 38.3% damage, respectively. The spinosyn Delegate had 51.3% damage. The metaflumizone product Alverde and the emamectin benzoate product Proclaim had 41.7 and 40.0% damage, respectively. The benzyoylureas Rimon and Dimilin had 54.0 and 36.5% damage, respectively.

In the Kern County trial we evaluated an average of 405 nuts per tree, or 2429 nuts (range of 2,009 to 2,911) per treatment. Average percentage infestation by navel orangeworm ranged from 1.0% to 4.0% with the untreated checks having 1.54 and 2.18% damage. Statistical analysis showed that there were no significant differences between insecticide treatments compared to the untreated checks, nor between the best and worst treatments (P = 0.3043).

Table 1. The effects of hull split insecticide treatments for navel orangeworm on the percentage of infested nuts at harvest, 2008

Treatment	Rate[a] (Madera site, Kern Site)	Surfactant[b] (Madera site, Kern Site)	Percentage Infested Nuts	
			Madera Co. Trial	Kern Co. Trial
Voliam Xpress 1.25ZC	8 fl oz	D, D	29.3 a	2.1 a
Belt 480SC	4 fl oz	R, D	30.0 a	1.6 a
Assail 70WP	2.6 oz	Si, Sy	30.2 a	2.0 a
Intrepid 2F	16 fl oz	I, I	31.8 a	2.4 a
Tourismo SC	13.7 fl oz	I, D	31.8 a	1.0 a
Voliam Xpress 1.25ZC	9 fl oz	D, D	33.7 ab	2.5 a
Danitol 2.4EC	21.3 fl oz	R, I	34.0 abc	1.7 a
Imidan 70W	5.33lb, 5.0lb	-, I	34.2 abc	4.0 a
Altacor	3 oz	I, I	34.3 abc	1.4 a
Dimilin	16 fl oz	Sy, D	36.5 abc	2.5 a
Alverde 2SC	12.56 fl oz	I, I	36.7 abc	1.1 a
Assail 30SG	6 oz	Si, Sy	37.2 abc	2.0 a
Lorsban Advanced	4 pts	-, I	38.3 abcd	2.3 a
Altacor	4 oz	I, I	38.5 abcd	1.4 a
Proclaim	4 oz	D, D	40.0 abcd	1.5 a
Alverde 2SC	16 fl oz	I, I	41.7 abcde	1.7 a
Lorsban 4E	4 pts	-, I	45.8 bcdef	1.6 a
Brigade WSB	1 lb, 2 lb	O, I	46.8 bcdef	1.2 a
UTC 2	-	-, -	47.2 cdef	2.2 a
Delegate 25WG	6.4 oz	I, I	51.3 def	1.7 a
Rimon	12 fl oz	Sy, D	54.0 ef	3.2 a
UTC 1	-	-, -	57.8 f	1.5 a
DiPel 6.4WP	16 oz	R, I	58.8 f	2.1 a
			P<0.0001	P=0.3043

Means in a column followed by the same letter are not significantly different (P>0.05, Fisher's protected LSD).

[a] One rate indicates that the same rate was used at each location. Two rates indicate that the first rate was used at the Madera County trial site and the second rate was used at the Kern County trial site.

[b] D = Dyne-Amic at 48 fl oz, R = R-11 at 48 fl oz, S = Silwet at 24 fl oz, I = Induce at 24 fl oz, Sy = Sylgard at 24 fl oz, O = 415 Oil at 1.5 gal.