Control of Navel Orangeworm (NOW) in Almonds Using Insecticides and Assessing Spray Coverage

Project No.: **13-ENTO11-Siegel/Walse**

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Objectives:

1. Persistence of insecticides on nut surfaces:
   We will combine bioassay with analytical chemistry to establish both the duration of control and rate of degradation of insecticides on almonds. This is still in progress.

2. Relative photostability of insecticides:
   We will determine the relative stability of the most commonly used insecticides in almonds using our photolysis chamber. Initially, the stability of these insecticides will be evaluated on glass slides, and once we have perfected this technique, their stability on almonds collected at different times will be assessed. This research is conducted by Dr. Spencer Walse and his graduate student Philip Benedetti, and is still in progress.

3. Insecticide penetration into the upper canopy:
   In our previous studies we noted a substantial reduction in the number of droplets per square inch at distances greater than or equal to 12 feet. We have established that the use of two nozzles per vane provides superior coverage compared to a single vane and that engine powered insecticide sprayers provide superior coverage to PTO sprayers in almonds, up to 20 feet. This past winter AiroFan introduced a new multinozzle design for use in their sprayers. We are currently evaluating coverage in this system, in collaboration with Matt Strmiska, of Qualified Applicator Specialists (Fresno, CA). Matt Strmiska is also conducting additional studies on spray efficacy using spray rigs designed by other companies in addition to AiroFan, as well as engine driven and PTO models. These data will be available at the Almond Conference in Sacramento. This research will be continued with an emphasis on improving penetration into the canopy.

4. Importance of insecticide coverage of the suture/exposed nut:
   Field trials were conducted in Fresno County, in collaboration with Clay Beck and Joe Coelho (Valley Orchard Management, LLC) to specifically address this issue by collecting

commercially treated nuts. An egg paper containing 10 eggs was pinned into the suture or on the hull and survival assessed at 30 days.

Interpretive Summary:

Experiments are currently underway to meet the objectives listed above. Unfortunately, we have not yet concluded our photolysis chamber studies of photostability, and we are still conducting our studies on the duration of protection of Nonpareil almonds. We report data (June – early August 2014) on the adult activity, contact toxicity and insecticide coverage of Altacor, Bifenthrin, Belt, Intrepid, Intrepid Edge, and Proclaim. With the exception of Proclaim, all had substantial adult activity in our assays. Maximum mortality occurred by the third day following exposure, but many moths that were counted as alive at 24 hours were barely responsive to shaking or touch and probably would be killed in the field. Adult activity was greatest for Belt when the adjuvant DyneAmic was included at a concentration of 8 ounces per 100 gallons; DyneAmic was similar to Latron B-1956 for the other insecticides. There was no difference in contact toxicity for Belt between these two adjuvants. Eggs tucked in the suture of treated almonds were 1.8 - 5.9 times as likely to produce navel orangeworm as eggs pinned onto the hull. In collaboration with Dr. May Berenbaum and her graduate student, Mark Demkovich, research is underway to determine the detoxification of these insecticides by navel orangeworm. Field trials with Matt Strmiska are ongoing and the data will be reported at the Almond Conference.

Materials and Methods:

Adult mortality was assessed using mesh bags made from window screen, 3 adults of the same sex per bag. The bags were hung near the center of the tree in the canopy at a height of 5 - 6 feet. The moths were sprayed and retrieved 24 hours after they were hung. Adults were scored as living, in distress, or dead. The adults were kept at room temperature and scored at 24-hour intervals for 3 days. Differences among treatments were assessed using Chi Square analysis and multiple regression analysis.

Larval contact toxicity was assessed by hanging filter papers in the trees, exposing these papers to field applications, and removing the filter papers 24 hours later. The filter papers were placed on diet in petri dishes, one paper per petri dish. An egg paper containing 50 eggs was then placed on the filter paper so that the newly emerged larvae had to crawl over the treated filter paper. Survival/mortality was assessed 17 weeks after exposure. All filter papers were placed at 5-7 feet unless otherwise specified.

Spray coverage was assessed at Valley Orchard Management in Fresno County, in collaboration with Clay Beck and Joe Coelho, Valley Orchard Management LLC, and Todd Fukuda, Weinberger, Fukuda and Associates. Almonds were collected 3 and 14 days after spray. Egg papers containing 10 eggs were either pinned in the suture or on the hull and the nuts were then placed in buckets and incubated at 80°F for 4 weeks and survival evaluated.

Results and Discussion:

Adult mortality assessed at 72 hours following spray exposure 2014. Similar trials are currently being conducted in pistachios. A total of 2,223 adults were recovered. Application rate of 200 gallons per acre, 2 mph. L=, 3.2 ounces Latron B-1956 per 100 gallons, D = DyneAmic at 8 ounces per 100 gallons. All applications by ground unless marked by * for fixed wing aircraft.

Treatment	Distress + Mortality %	Total Adults
Control+D	39.2 A	176
Belt 4 oz/ac + L	43.8 A	185
Belt 4oz/ac + D	62.2 B	156
Control+L	17.5 A	126
Intrepid Edge 12 oz/ac + L	73.3 B	131
Delegate 3 oz/ac + L	100.0 C	108
Control	53.7 A	130
Intrepid Edge 12 oz/ac + L	97.4 B	114
Delegate 3 oz/ac + L	92.4 C	85
Altacor 4 oz/ac + L	88.1 C	84
Control	14.6 A	144
Altacor 4.5 oz/ac + Latron	56.4 B	156
Altacor 4.5 oz/ac + D	58.7 B	150
Control	21.1 A	166
Altacor 4.5 oz/ac + L	59.2 B	130
Altacor 4.5 oz/ac + D	49.4 B	158
Control	38.6 A	101
Proclaim 4.8 oz/ac + L	30.0 A	108
Control	16.7 A	54
Bifenthrin Aerial	70.4* B	54
Bifenthrin Aerial	87.5* C	48

Larval contact mortality. Mortality assessed at 17 days following exposure to filter paper exposed to insecticide. Similar trials are currently being conducted in pistachios. A total of 19,900 eggs were used. Application rate of 200 gallons per acre, 2 mph. L=, 3.2 ounces Latron B-1956 per 100 gallons, D = DyneAmic at 8 ounces per 100 gallons. All spray applications by ground.

Insecticide	**Mortality %**	**Eggs**
Control	36.7 A	1,950
Belt 4 oz/ac + L	74.8 B	2,000
Belt 4oz/ac + D	75.0 B	1,950
Control	48.2 A	1,500
Delegate 3.0 oz/ac + L	65.5 B	1,500
Intrepid Edge 12 oz/ac + L	77.2 C	1,500
Altacor 4.0 oz/ac+ L	89.7 D	1,500
Control	25.3 A	1,000
Altacor 4.0 oz/ac + L	48.8 B	1,000
Intrepid Edge 12.0 oz/ac + L	72.9 C	1,000
Intrepid 15.0 oz/ac + L	82.9 D	1,000
Delegate 3.0 oz/ac + L	49.1 B	1,000
Control	47.5 A	1,000
Altacor 4.5 oz/ac + L	71.3 B	1,000
Altacor 4.5 oz/ac + D	74.5 B	1,000

Spray coverage vs. larval mortality assessed at 3 days and 14 days after application. Mortality was scored 30 days after the eggs were pinned onto Nonpareil almonds. A total of 1,600 almonds were collected and infested with 16,000 eggs. Application rate of 150 gallons per acre, 2 mph.

Insecticide	Survival %	Ratio TUCK/PIN	Eggs
3 Days			
Belt 4.0 oz/ac TUCK	13.7		1,000
Belt 4.0 oz/ac PIN	3.4	4.03	1,000
Altacor 4.5 oz/ac TUCK	4.70		1,000
Altacor 4.5 oz/ac PIN	2.00	2.35	1,000
Intrepid 16 oz/ac TUCK	3.30		1,000
Intrepid 16 oz/ac PIN	1.80	1.83	1,000
Intrepid Edge 12 oz/ac TUCK	6.60		1,000
Intrepid Edge 12 oz/ac PIN	1.50	4.40	1,000
14 Days			
Belt 4.0 oz/ac TUCK	2.40		1,000
Belt 4.0 oz/ac PIN	1.0	2.4	1,000
Altacor 4.5 oz/ac TUCK	4.90		1,000
Altacor 4.5 oz/ac PIN	2.20	2.2	1,000
Intrepid 16 oz/ac TUCK	4.10		1,000
Intrepid 16 oz/ac PIN	0.70	5.9	1,000
Intrepid Edge 12 oz/ac TUCK	6.4		1,000
Intrepid Edge 12 oz/ac PIN	1.5	4.3	1,000