Ambient Orchard Volatiles as Attractants for Navel Orangeworm (NOW) Monitoring

Project No.: **11-ENTO4-Beck**

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Objectives:

This project had three objectives:

- To collect and identify ambient volatile emissions (odors) of almond orchards over the course of a growing season.
- To develop a synthetic blend that mimics the primary orchard odor components for laboratory-based bioassays.
- To develop an agricultural adjuvant, or additive, that could be used to enhance existing navel orangeworm trapping and mating disruption.

Interpretive Summary:

The navel orangeworm (*Amyelois transitella,* NOW) is an insect pest of California tree nuts. Its feeding damage lowers nut kernel quality resulting in extensive monetary loss to growers, producers, and shippers. Moreover, NOW feeding damage directly contributes to aflatoxin contamination. Aflatoxins are mycotoxins produced by *Aspergillus flavus* and *Aspergillus parasiticus*, ubiquitous fungi in tree nut orchards, and represent a grave food safety problem due to their carcinogenic and teratogenic attributes[1,2].

There are numerous reports in the literature on both volatile and non-volatile composition of various parts of some almond cultivars[3-11]. Until recently, the volatile emission of almond[11] and pistachio orchards has not been studied over the course of an entire growing season. This aspect is particularly relevant to research concerning NOW and the identification of any associated and relevant semiochemicals.

The discovery of an efficacious attractant for NOW monitoring/trapping has remained elusive despite breakthroughs with the pheromone[12], the pheromone blend[13-15], long-chain fatty acids[16], use of almond meal, and caged virgin female NOW. The ability of an

insect to locate the desired host plant is in part dependent upon its ability to detect a specific volatile semiochemical (kairomone). As with the complex blend of NOW pheromone noted by Leal et al., a complex mixture of ubiquitous plant volatiles may be necessary to elicit an appropriate response from the insect to the host-plant[17,18]. Recent investigations of *in situ* ambient almond emission and corresponding NOW electroantennographic (EAG) bioassays suggested possible kairomonal-type behaviour from several of the collected volatiles[11,19].

To further explore the presence and role of these ambient volatiles from tree nut orchards, an optimized large-scale ambient orchard volatile collection system was implemented in the 2010 growing season and at varying phenological stages of almond growth. The results from the exploratory 2008 and subsequent 2009 study have been reported[11,20]. The third year of this project focused on the completion of data analysis of the 2010 volatile collections, their quantification, and associated EAG studies[20]. The fourth and final year of this project entailed evaluation of the blend via EAG and collaborative field trapping studies and comparison to almond meal, the current NOW monitoring standard[21].

Materials and Methods:

Field Trapping Studies[21]. A randomized block design was used in almond orchards located in Kern County. Standard delta traps with glue liners were baited with: Nalgene bottles containing 400 mg of the host plant volatile blend; traps baited with almond meal (ca. 18.6 g) in standard egg traps as a female attractant standard; and mesh cages containing three virgin females as a male attractant standard. Trap catches were collected weekly and fresh blend bottles placed in the traps. Each moth capture experiment comprised two one-week trapping intervals in 2011 and 2012.

Results and Discussion:

There were two changes in 2012 field trapping studies compared to those conducted in 2011: an increase in concentration of the blend (from 200 mg/2 mL to 400 mg/2 mL) and the testing of the neat blend contained within a membrane. These are preliminary analyses. A full report will be forthcoming after a second year of trappings has been completed and analyzed.

Table 1. May to October 2011 captures in almond and pistachio orchards of *A. transitella* moths in traps baited with host plant volatiles.

		Moths Captured		
Orchard	Treatment	NOW Total	Female	Male
Almond	Blend	155	59	96
	Meal	20	19	1
	Blank	2	1	1
Pistachio	Blend	32	20	12
	Meal	2	2	0
	Blank	0	0	0

For 2011 the total number of captures by the blend were greater than the almond meal for both female and male adult *A. transitella* moths (**Table 1**). The trapping results in pistachio were too intermittent for proper statistical analysis. Furthermore, though the total capture numbers are greater for the blend than for almond meal in pistachios, the vast majority of captures by the blend occurred in the September treatments, thus the blend demonstrated efficacy in the late season *A. transitella* flight.

Table 2. April to September 2012 captures in almond and pistachio orchards of *A. transitella* moths in traps baited with host plant volatiles.

		Moths Captured (2012)		
Orchard	**Treatment**	**NOW Total**	**Female**	**Male**
Almond	Blend	540	285	255
	Blend (membrane)	70	29	41
	Meal	40	33	7
	Blank	3	1	2
Pistachio	Blend	107	66	41
	Blend (membrane)	51	16	35
	Meal	29	25	4
	Blank	0	0	0

For 2012 the total number of captures by the blend was again greater than the almond meal for both female and male adults *A. transitella* moths and for both crops (**Table 2**). Further data analysis is required before any conclusive statements can be made regarding the 2011 and 2012 capture numbers. For instance, did the increase in active ingredient concentration affect capture numbers or were the capture increases due to greater *A. transitella* moth populations. The evaluation of the blend as a neat mixture in the membrane provided very interesting trends in terms of male vs. female captures as well as intercrop similarities.

The data for both the 2011 and 2012 trapping studies suggest that the blend shows promise as a host plant volatile blend for monitoring in almonds. Additionally, more work is needed on a blend dispersal method. The neat blend in the membrane suggests more knowledge is required regarding the individual component emissions from the membrane to determine if/how they differ from the blend in ethyl acetate. Work is ongoing to address the concerns noted above.

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