Use of a Hostplant Volatile Blend to Monitor Navel Orangeworm (NOW) Populations during IPM Treatments in Almond Orchards

Project No.: **14-ENT04-Beck**

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Objectives:

To determine if a recently developed blend of synthetic hostplant volatiles can effectively monitor male and female navel orangeworm populations in almond orchards under conventional (CONV) and mating disruption (MD) based IPM programs

Interpretive Summary:

Year one of the study demonstrated that host plant volatile-based (HPV) blend successfully attracted both male and female navel orangeworm (NOW) moths in both CONV and MD orchards, and overall attracted greater than 10x more moths than the control standard, almond meal. The HPV blend very clearly delineated four flights of NOW in the 2014 season between early April and late September. Unfortunately, the HPV blend was not available for the project in March due to product availability from the producer of one of the components. In response to the new demand for the product, the company has improved their synthesis and increased production to meet product demand for 2015.

Materials and Methods:

Using well established protocols by Wonderful Orchards (formerly Paramount Farming) personnel and large plots of almond orchards undergoing MD treatments (Higbee and Burks, 2008), the HPV blend, placed in 8 mL Nalgene bottles with a 3.0 mm hole drilled in the cap (Beck et al., 2012) was placed in pre-established locations – edges paired with interior areas in the Lost Hills Areawide NOW MD project, at a density of one trap per 50 acres. The number of moths captured by the blend was compared to those of almond meal-baited traps. A total of 2,500 acres of almonds containing both CONV and MD managed areas were monitored for 30 weeks with 60 vials every two weeks used (vials + chemicals are ca. $5 per vial). Ranch personnel placed and monitored delta traps throughout the experiment. ARS personnel prepared the vials (Beck and Higbee, 2013) and shipped to Wonderful Orchards for placement into traps in the field.

Results and Discussion:

This report summarizes the results obtained from year one of this study, which seeks to determine if a recently developed HPV blend reliably attracts male and female navel orangeworm adult moths in MD treated orchards. Trapping studies performed during the 2011-2013 growing seasons demonstrated that the HPV blend was more effective than the current monitoring standard, almond meal, for capturing NOW adult moths in CONV almond orchards (Beck et al., 2012; Beck and Higbee, 2013). Moreover, unlike almond meal, the host plant volatile blend captured male NOW. **Figure 1** illustrates the comparison of trap capture abilities of the HPV blend almond meal in both CONV and MD almond orchards for the 2014 growing season (Kern country orchards). The HPV blend clearly delineated the 1st, 2nd, 3rd, and 4th flights of NOW in CONV orchards (solid green line). In MD orchards (dashed light green line) the HPV blend did identify and record moth captures for each flight; however, 2nd flight peak was very small and not as clearly delineated when compared to the trap data for the HPV blend in CONV orchards. For all treatments and trap check periods, the HPV blend clearly outperformed almond meal.

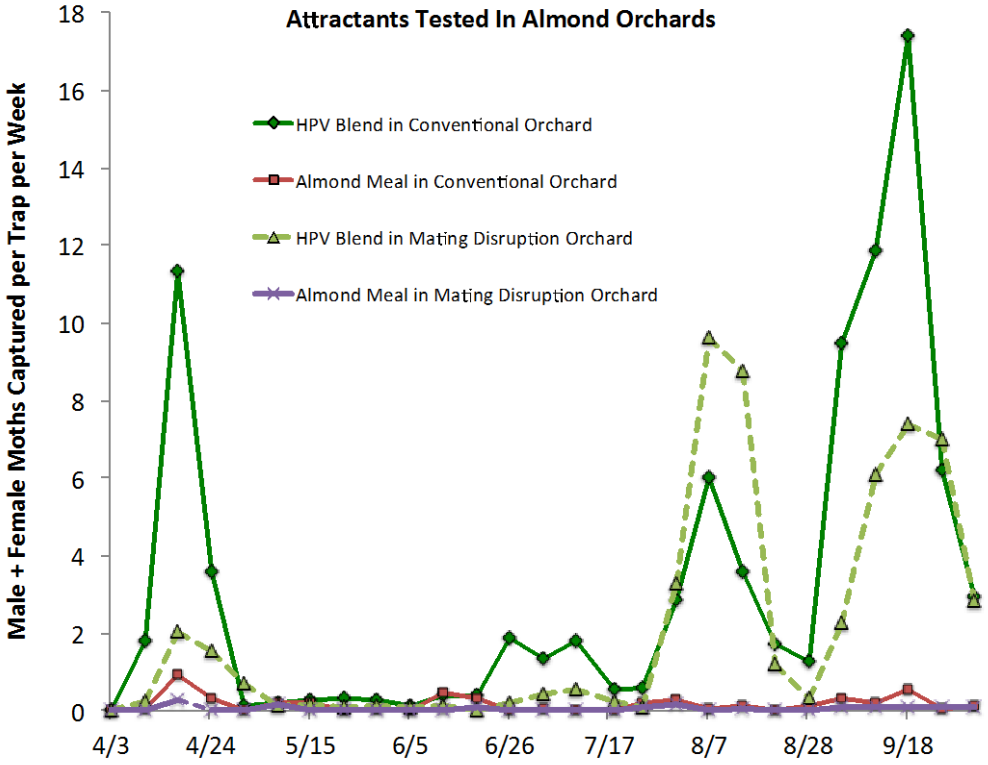

Figure 1. Trap capture data from the 2014 almond orchard growing season of navel orangeworm moths attracted to and trapped by the HPV blend. Trap captures are compared to almond meal. The HPV blend was evaluated simultaneously in CONV and MD almond orchards.

In MD orchards, the HPV blend on average attracted more female NOW adult moths in an approximate 2:1 F:M ratio. **Figure 2** illustrates this with the blue and pink columns representing male and female moth capture numbers for each week, respectively. Overlaid on these data are the corresponding weekly combined moth captures. The data suggest that during lulls in moth population the F:M ratio fluctuates to give a more 1:1 F:M ratio (e.g., 5/22 to 6/12 in **Figure 2**). Beginning on 6/19 and lasting until 7/10 an unexplained increase in the number of male vs. female moths were captured by the HPV blend, but the higher female to male ratio returns at the 7/17 date.

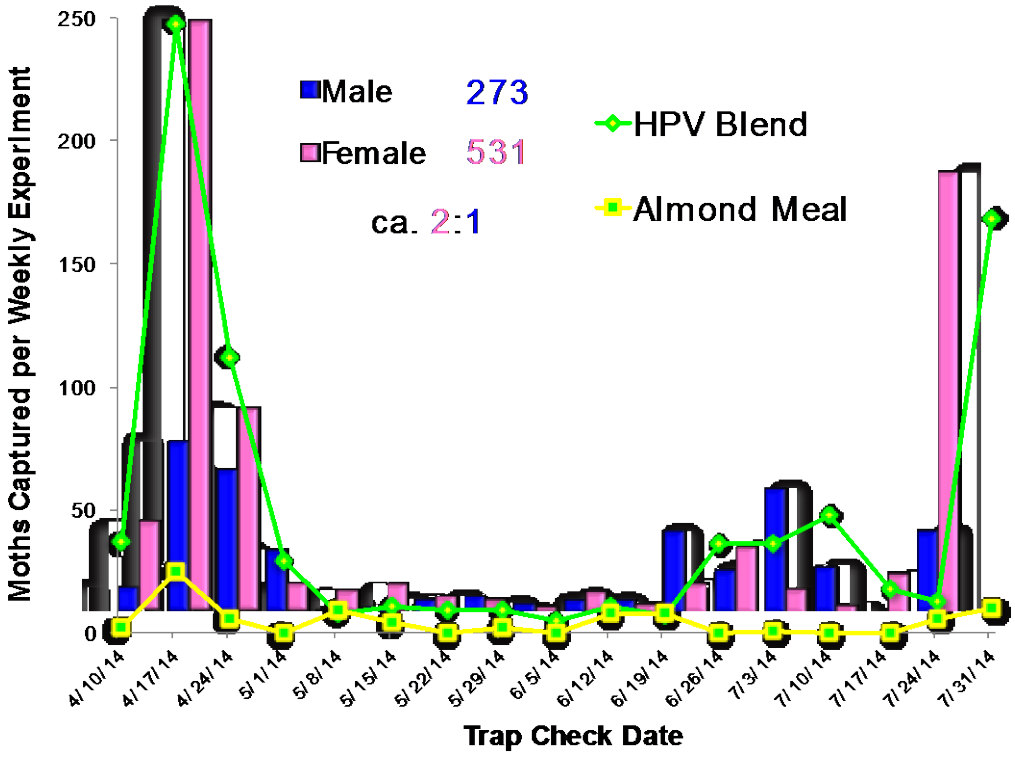

Figure 2. Overlay of trap capture data from the 2014 almond orchard growing season of navel orangeworm moths attracted to and trapped by the HPV blend (green line, open diamonds) in MD orchards. Pink and Blue columns represent the breakdown of the number of females and males trapped by the HPV blend, respectively. Trap captures are compared to almond meal. Average female to male (F:M) ratio was ca. 2:1.

In an attempt to understand the increase in male moths captured by the HPV blend, the data for males captured by the pheromone blend were overlated onto the male and female capture numbers (blue and pink columns, **Figure 3**). These data did not readily explain the increase in male to female ratios, though the data did suggest that relatively large increases in male captures by the pheromone blend in general corresponds with an increase in the female to male ratio trapped by the HPV blend (**Figure 3**). Additionally, the trap dynamics for the HPV blend were synchronous with that represented by pheromone traps.

Data that delineates moth captures from the orchard edge versus interior is available, but has not yet been analyzed statistically. In general, the HPV blend performed similar in the orchard interior during both treatments. More data are forthcoming regarding edge versus interior moth capture comparisons. Analysis of data of subsequent years will help define the aforementioned phenomena.

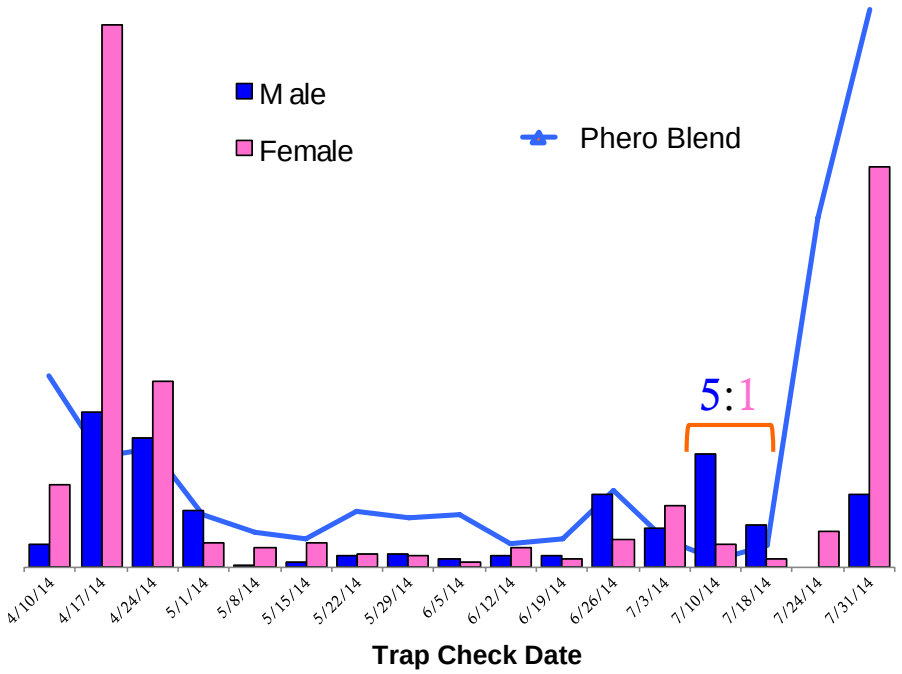

Figure 3. Trap capture data from the 2014 almond orchard growing season of male navel orangeworm moths attracted to and trapped by the synthetic pheromone blend (blue line, triangles) in a MD orchard. Pink and Blue columns represent the breakdown of the number of females and males trapped by the HPV blend, respectively. A notable, but unexplained phenomenon was the change in female to male capture ratio during the 6/26, 7/10, and 7/18 by the HPV blend. Of particular interest was the shift from the average 2:1 F:M ratio noted in **Figure 2** to the 1:5 F:M ratio observed for the 7/10 and 7/18 trap check dates.

Preliminary comparisons of trap capture data to kernel damage:
There is some association between NOW damage and HPV trap counts. Further analysis is underway with the addition of the 2015 data scheduled for the end of the 2015 growing season.

Research Effort Recent Publications:

San Román I, Bartolomé L, Gee WS, Alonso RM, Beck JJ. 2015. Comparison of *ex situ* volatile emissions from intact and mechanically damaged walnuts. *Food Res Inter* **72**:198-207.

Beck JJ, Baig N, Cook D, Mahoney NE, Marsico TD. 2014. Semiochemicals from *ex situ* abiotically stressed cactus tissue: a contributing role of fungal spores? *J Agric Food Chem* **62**:12273-12276.

Beck JJ, Light DM, Gee WS. 2014. Electrophysiological responses of male and female *Amyelois transitella* antennae to pistachio and almond host plant volatiles. *Entomol Exp Appl* **153**:217-230.

Beck JJ, Mahoney NE, Higbee BS, Gee WS, Baig N, Griffith CM. 2014. Chapter 14, Semiochemicals to monitor insect pests – future opportunities for an effective host plant volatile blend to attract navel orangeworm in pistachio orchards. In *Biopesticides: State of the Art and Future Opportunities*, ACS Symposium Series. Gross, A.D.; Seiber, J.N.; Coats, J.R.; Duke, S.O. (eds). American Chemical Society, Washington, D.C. Vol 1172, pp. 191-210.

Beck JJ, Mahoney NE, Cook D, Gee WS, Baig N, Higbee BS. 2014. Comparison of the volatile emission profiles of ground almond and pistachio mummies: part 1 – addressing a gap in knowledge of current attractants for navel orangeworm. *Phytochem Lett* **9**:102-106.

Beck JJ, Mahoney NE, Cook D, Higbee BS, Light DM, Gee WS, Baig N. 2014. Comparison of the volatile emission profiles of ground almond and pistachio mummies: part 2 – critical changes in emission profiles as a result of increasing the water activity. *Phytochem Lett* **8**:220-225.

Mahoney NE, Gee WS, Higbee BS, Beck JJ. 2014. Ex situ volatile survey of ground almond and pistachio hulls for emission of spiroketals: analysis of hull fatty acid composition, water content, and water activity. *Phytochem Lett* **7**: 225-230.

Beck JJ. 2013. Conophthorin from almond host plant and fungal spores and its ecological relation to navel orangeworm: a natural products chemist's perspective. *J Mex Chem Soc* **57**:69-72.

References Cited:

Higbee BS, Burks CS. 2008. Effects of mating disruption treatments on navel orangeworm (Lepidoptera: Pyralidae) sexual communication and damage in almonds and pistachios. *J Econ Entomol* **101**:1633-1642.

Beck JJ, Higbee BS, Light DM, Gee WS, Merrill GB, Hayashi JM. 2012. Hull split and damaged almond volatiles attract male and female navel orangeworm. *J Agric Food Chem* **6:**8090-8096.

Beck JJ, Higbee BS. 2013. Volatile natural products for monitoring the California tree nut insect pest *Amyelois transitella*. In *Pest Management with Natural Products*, ACS Symposium Series. Beck JJ, Coats JR, Duke SO, Koivunen ME. (eds). American Chemical Society, Washington, DC. Vol 1141, pp. 59-72.