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

Project No.: **15-ENT04-Beck**

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Objectives:

To determine if a recently developed blend of synthetic host plant 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 two of the study nicely corroborated year one results that the synthetic host plant volatile-based (HPV) blend successfully attracts both male and female navel orangeworm (NOW) moths in both CONV and MD orchards, and overall attracted greater than 50x more moths than the control standard, almond meal. The HPV blend very clearly delineated four flights of NOW in both the 2014 and 2015 seasons between early February and early October. Early flight NOW infestation and damage in almonds, varying varieties, was assessed in relation to trap capture numbers by the HPV blend. For the first two flights and in Nonpareil, total moth trap capture demonstrated a modest correlation to both % NOW damage and NOW infestation.

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 two 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, as well as evaluate potential correlations between moth trap captures by the HPV blend to NOW damage and infestation. 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 HPV blend captured male NOW adult moths. **Figure 1** illustrates the comparison of trap capture abilities of the HPV blend almond meal in both CONV and MD almond orchards for the 2015 growing season (Kern country orchards). The HPV blend clearly delineated the 1st, 2nd, and 3rd flights of NOW in CONV orchards (solid red line). In MD orchards (dashed red line) the HPV blend did identify and record moth captures for all five flights; however, 1st, 2nd, and 3rd flight peaks were 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.

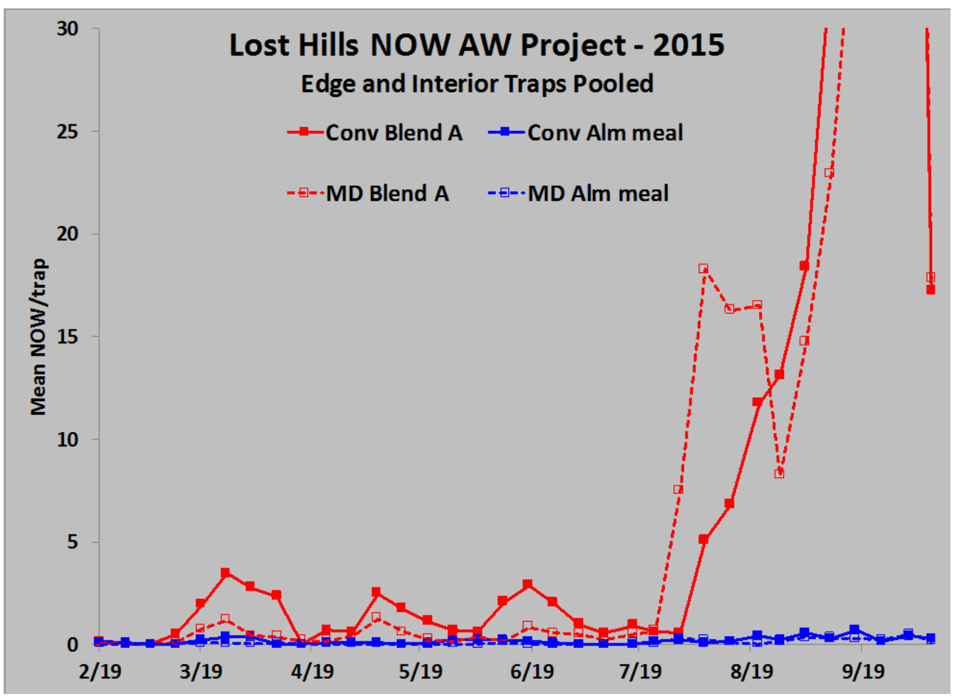

Figure 1. Trap capture data from the 2014 almond orchard growing season of navel orangeworm moths attracted to and trapped by the HPV blend. Trap captures are compared to almond meal. The HPV blend was evaluated simultaneously in CONV and MD almond orchards.

For the 2015 trap studies and for both MD and CONV orchards, the HPV blend on average attracted more male NOW adult moths in an approximate 1:1.5 F:M ratio. Specific female to male ratios have not been separately determined for the MD and CONV trap capture numbers.

In the second year the trap capture data were compared to corresponding NOW infestation and NOW damage of the tested almond orchards. Analysis of the data for the first two flights showed modest correlations of the trap capture data and both infestation and damage for Nonpareil almonds (**Figure 2**). However, this modest correlation did not translate to the pollenizer almond cultivars (**Figure 3**).

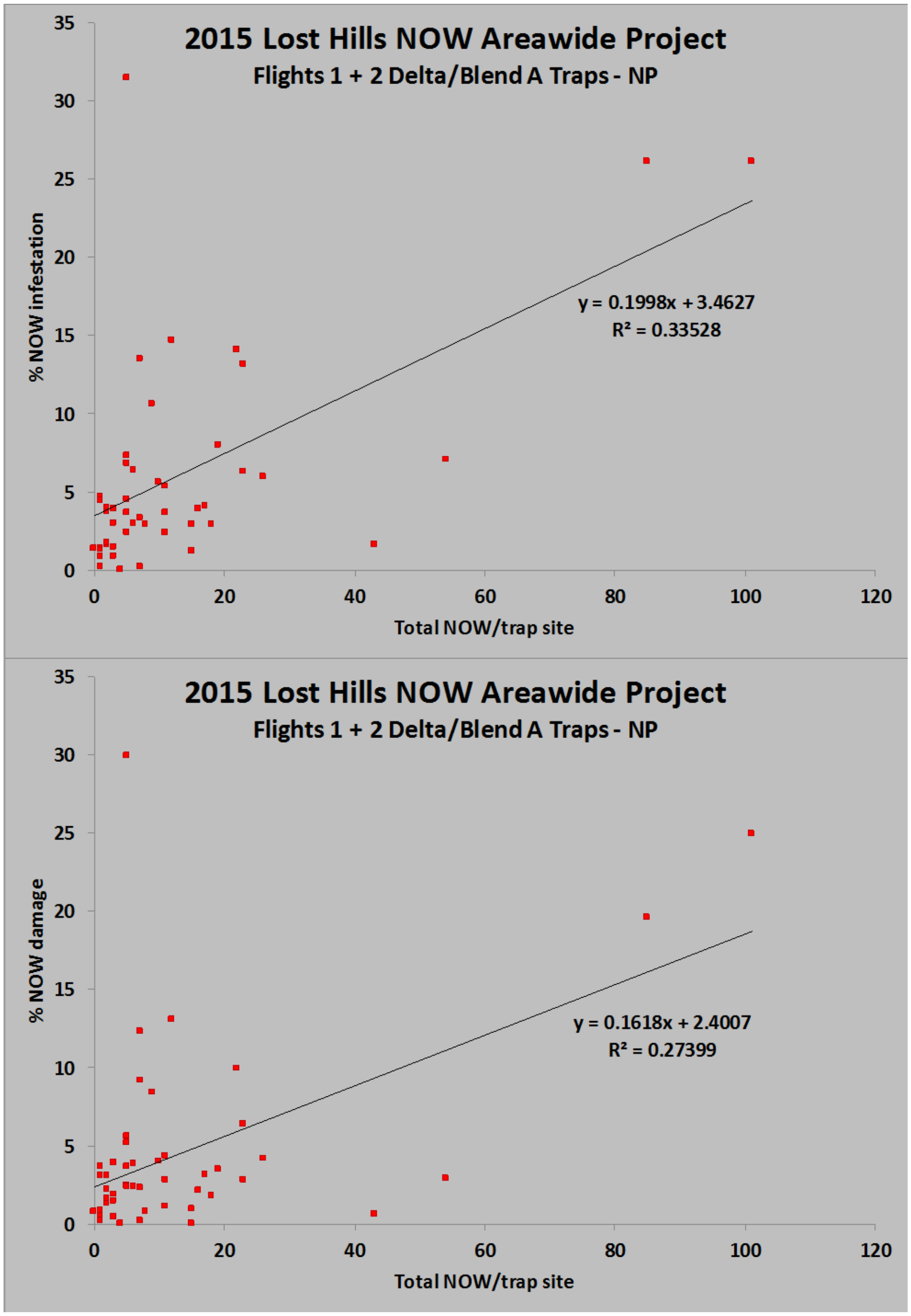

Figure 2. Trap capture data correlation to % NOW infestation (top) and % NOW damage (bottom) in Nonpareil trees.

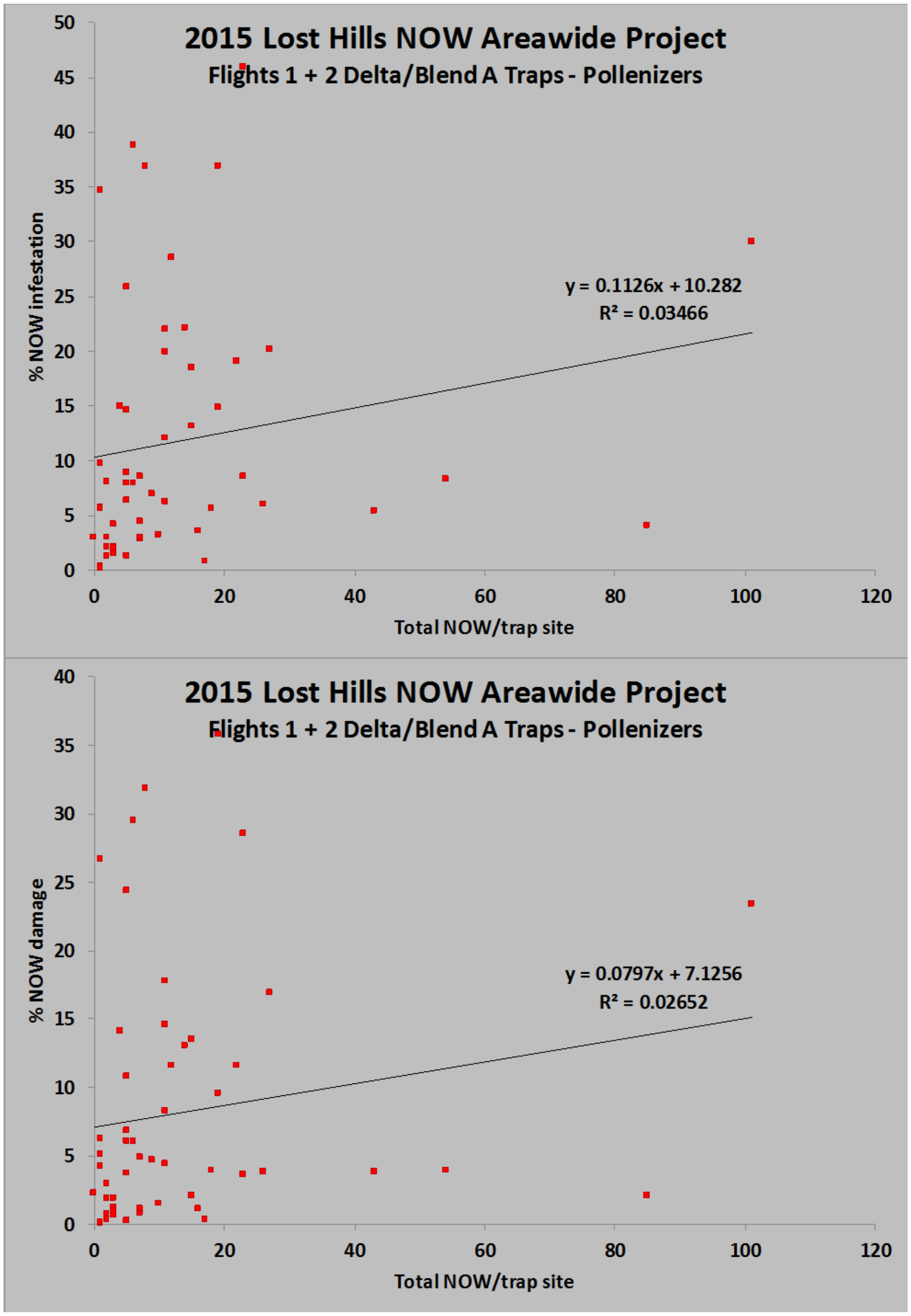

Figure 3. Trap capture data correlation to % NOW infestation (top) and % NOW damage (bottom) in almond pollenizer cultivars.

Given the results, thus far, the HPV blend-baited trap is likely to contribute to a predictive model that also uses other data to alert when corrective action is required to keep damage below a threshold. Data analyses are ongoing and more information will be forthcoming for further dissemination.

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.

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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.