Monitoring the Adult Navel Orangeworm (NOW) Moths with Pheromone and Hostplant Volatiles

Project No.: **15-ENTO9-Cardé**

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Objectives:

1. One long-standing aim has been development of a **long-lasting pheromone lure**. This objective has been largely achieved with the new Suterra membrane formulation. There remains, however, one outstanding issue: for reasons unknown, the 4-component synthetic lure is still not quite as attractive as female extract. Our recent (unpublished) work has shown that the 3 geometrical isomers of the aldehyde component, the 2 geometrical isomers of the 2 alcohol components, and 5 other likely contaminants/breakdown products have no antagonistic properties. There is one remaining lead to pursue in 2014-2015.
2. We will use a newly devised laboratory assay based on a port-entry trapping system to help in refining the most active blend for a **female lure** based on **host-plant volatiles**. This assay is run year round (notably when moths are not available for testing in the field) and its value is to speed up defining the most useful as well as new blends for field testing. We also will evaluate egg traps in this assay, and see if conventional wind-tunnel and Y-choice assays are useful diagnostic methods.

Interpretive Summary:

Our work over the past year has been centered on improving monitoring systems for navel orangeworm (NOW) males (pheromone-based lures) and for both sexes (lures based on almond and pistachio volatiles, collectively termed HPVs or host-plant volatiles). We tested 1000s of males individually in wind-tunnel trials but so far we have been unable to improve upon the currently available lures.

Materials and Methods:

Insects. We rear a large, continuous colony of NOW at Riverside.

Objective 1. The 4-component pheromone is comprised of (*Z*11,*Z*13)-hexadecadienal, (*Z*11,*Z*13)-hexadecadien-1-ol, (*Z*11,*E*13)-hexadecadien-1-ol, and (*Z*3,*Z*6,*Z*9,*Z*12,*Z*15)-tricosapentaene (Kanno et al. 2010; Kuenen et. al. 2010). Surprisingly, varying the ratio of components is unimportant to lure attractiveness. Suterra plastic membrane dispensers have come close to the trap capture levels produced by 3 caged females on a weekly replacement schedule (Beck and Higbee 2013). However, female baits replaced weekly should be <u>less</u> attractive than a synthetic lure because females do not release pheromone at optimal levels over this long a time interval and not all females survive the full week. Moreover, synthetic lures were more efficacious in almond than in pistachio orchards, where their performance fell short of females. So we can conclude at this point the commercially viable lure available in 2014 could be improved. Because we have tested all logical candidate inhibitors (unpublished data: 3 isomers of the aldehyde, its acid, the 2 isomer of the 2 alcohol components, and 4 other compounds not previously known from the NOW pheromone gland), we assume that there remains a missing component. We have one new lead to follow and we will use our wind-tunnel assay and standard gas chromatogram-electroantennogram (GC-EAG) methods and as needed other chemical techniques (e.g., GC-mass spectrometry) for identification of possible new component(s).

Objective 2. Activity of NOW females has been monitored somewhat successfully with oviposition traps baited with almond meal. This suggests that host-plant volatiles mediate a **mated** female's in-flight location of suitable oviposition sites. Dr. John Beck has identified a suite of host-released volatiles (Beck et al. 2012; Beck and Higbee 2013) that in combination may mediate attraction and therefore might serve as effective bait for males and/or females. The field data demonstrate attraction of males and females, but the absolute numbers caught suggest that the blend as used to date is not as potent as the pear ester used to monitor codling moths (Knight and Light 2005).

Results and Discussion:

Objective 1. We have continued our evaluation of analogues of the aldehyde component of the 4-component pheromone blend. To date we have found no evidence of any of these compounds diminishing the attractiveness of the full pheromone blend. There remain two concerns. First, in our wind-tunnel assay, solvent extracts of the female's pheromone gland evoke somewhat higher levels of attraction compared to synthetic blends. Second, evidence from field trials suggests very different levels of attraction relative to the female-baited traps, dependent on whether the comparisons are conducted in almond or pistachio orchards (Higbee et al. 2014). Possibly the latter difference relates to different background odors in the two nut orchards (Webster and Cardé 2016). Wind-tunnel trials are continuing.

Objective 2. Our work with plant volatiles also used the same wind-tunnel assay system. We followed suggestions from John Beck as to which compounds had the highest probabilities of being active for male attraction, based on their presence as predominant constituents of the volatiles released by pistachio and almond foliage or developing nuts AND these compounds being active in electroantennogram assays (Beck and Higbee 2013; Beck et al. 2012). Among the compounds tested were methyl salicylate, 3-octen-2-one, (*Z*)-3-hexenal acetate, (*Z*)-3-hexenol, sabinene, octanal, nonanal, the pistachio blend, linolein and limonene. All of these were evaluated at a wide range of doses (0, 3 µg, 30 µg, or 300 µg of HPV dispensed in 20 µl of hexane on a rubber septum) to ensure that we would not miss any behavioral activity in our replicated trials. We did, to our surprise, not uncover any attractivity in any of the compounds tested either singly or in some combinations by class.

References Cited:

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