MATING DISRUPTION OF THE NAVEL ORANGEWORM

Ring T Cardé

Department of Entomology, University of California, Riverside CA, 92521 USA

Objectives:

One objective of our work has been development of a pheromone lure that would useful in monitoring seasonal development and population density of the navel orangeworm moth, *Amyelois transitella*, referred to as "NOW." Although the complete, 4-component blend has been characterized (Cardé at al. 2010; Kuenen et al. 2010), we have yet to devise a lure that is as active after several days exposure in the field in its ability to lure males as caged virgin females. To understand why we are now conducting wind tunnel and field bioassays coupled with chemical analyses:

- We are evaluating several compounds that can be present in these lures for their possible antagonistic effects on the attractiveness of the pheromone blend;
- We are evaluating several formulation strategies that could minimize degradation of the pheromone in the field;
- In other studies, we are documenting the dispersal patterns of pheromone plumes in orchard canopies to aid in optimal placement of formulations for mating disruption.
- We also have verified the role of sound communication in courtship success and studied the biosynthesis of the pheromone.

Interpretive Summary:

We determined that upwind flight along the pheromone plume and landing on the odor source required the simultaneous presence of two components, (11*Z*,13*Z*)-hexadecadienal and (3*Z*,6*Z*,9*Z*,12*Z*,15*Z*)-tricosapentaene. Addition of either (11*Z*,13*Z*)-hexadecadien-1-ol or (11*Z*,13*E*)-hexadecadien-1-ol to these two components increased the proportion and rapidity of males contacting the source, and a mixture of all four components in their near natural ratio (**100:100:5:15** of Ald: ZZOH: ZEOH: C23) produced the highest levels of rapid source contact. In this wind-tunnel assay, a wide range of ratios of any of the three components added to (11*Z*,13*Z*)-hexadecadienal produced nearly equivalent levels of source finding, indicating that for this moth (unlike many others), having a ratio of components near that produced by the females is not crucial.

We also found that male NOW were somewhat sensitive to the dose of pheromone, with optimal attraction to 10 ng lures in the wind tunnel. This plateau of response might be indicative of male response being linked to an optimum concentration of pheromone (e.g., as in the oriental fruit moth, Baker and Cardé 1979).

Alternatively, the drop in attraction with increasing dose may be the result of small percentages of antagonistic impurities in the synthetic pheromone, which increase above the threshold required to affect the behavior of males as the overall pheromone dose is increased. These findings are fully described in our recent paper (Kanno et al. 2010) and reinforce the findings of Kuenen et al. (2010).

To characterize the blend attractiveness we use a large (3-m-long) wind tunnel and monitor the behavior of individual male NOW moths from take off until landing on a candidate lure, including time on the lure. Although it would seem that moving from these laboratory bioassays of optimal blend design already reported by Kanno et al. (2010) to field testing of lures based on this ratio and composition would be straightforward and rapidly accomplished, there are a number of issues to resolve.

For example, the main component, (*Z*,*Z*)-11,13-hexadecandienal, is unstable and can isomerize, particularly when exposed to light. Are its isomers antagonistic to attraction? This compound also can polymerize, of course rendering it unattractive. We have several sources of this component, all differing in purities, polymerization, and all potentially having antagonistic contaminants, even before field exposure. Each of the remaining 3 components also may contain antagonistic "additives."

One approach that we use is to add synthetic compounds likely or known to be contaminants or degradation products, such as the isomers of the main aldehyde component, to the optimal 4-component blend. Another approach is to vary, for example, the synthetic source of each component. (All have been supplied to us as "high purity samples" but they vary somewhat in their ability to lure males.) When testing these, we generally use a substitution paradigm to search for the best blend, holding the source of 3-components constant while we vary the source of the other component.

In field tests to date we have determined that plastic dispensers outperform "traditional" rubber septa and we have tested several antioxidants to stabilize the lures. Some of these field-exposed are now being analyzed for possible breakdown contaminants.

For example, in one replicated field test conducted by Brad Higbee, one lure formulation seemed comparable to a bait of 3-females for approximately 4 days. The female-baited traps caught 282 males compared to 248 males with a the synthetic lure, although it was clear that the these lures were somewhat more potent in the first two days of deployment. This finding suggests that devising a field lure suitable for field managers is feasible.

Other work is examining the pattern of odor plume dispersal in almond orchards by using visual tracers and a 3-D sonic anemometer sequentially positioned from near ground level to 2 meters above the canopy throughout the day and night. Visual plumes from point sources of titanium tetrachloride clearly show that at night plumes often have a vertical trajectory rather than the generally assumed horizontal or downward path. This finding implies that the optimal position for puffers used in mating disruption may be in the upper portion of the canopy.

References:

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