Another Look at Pheromonal or Related Attractants for Leaffooted Bugs (*Leptoglossus* spp.) Infesting California Nut Crops

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INTRODUCTION

Epicarp lesion, nut abortion, kernel necrosis and stigmatomycosis (pistachio), associated with the feeding of a suite of true bug species, are major sources of yield losses in California nut crops. Among these species, leaffooted bugs (LFB, *Leptoglossus* spp.) are some of the most damaging pests. In California, LFB overwinter primarily as adults, then move to feeding sites and start to oviposit in the spring. There are typically three generations per year, although a partial or complete fourth generation is possible in some regions. Damage is unpredictable because bug populations from surrounding crops or native vegetation can immigrate into nut crops within a few days. In the congeneric species *L. australis*, there is evidence that males move into a crop first and begin producing an aggregation pheromone that accelerates the rapid buildup of bugs in the crop (Yasuda and Tsurumachi 1994). Because of these rapid buildups, and because symptoms of bug damage may only appear some time after the bugs have moved through the crop, continuous monitoring of bug populations is a key factor in timing treatments. Current bug monitoring methods rely primarily on beat tray or sweep-net sampling. Trapping systems based on pheromonal or related attractants would be of great value for monitoring purposes. Thus, our overall goal is to reexamine the pheromone-mediated behavior of leaffooted bugs, with the goal of identifying any insect-produced compounds that could be exploited in IPM programs.

LFB could use at least four different types of pheromones. First, both sexes produce alarm pheromones and defensive secretions, which are not species specific and so are unlikely to be involved in sexual interactions. Second, male LFB have a pair of glands whose contents are species-specific. These compounds are aphrodisiacs, rendering females receptive to mating, but they do not attract adult bugs into traps. Third, fragmentary evidence suggests that male, summer-form LFB may produce aggregation pheromones that attract both sexes into orchards. Finally, LFB form overwintering aggregations in sheltered spots, and it is likely that pheromonal signals assist in the formation and maintenance of these overwintering aggregations. These signals are likely to be different from the signals used to attract bugs into a crop for feeding and mating. The possible source and structures of these pheromone compounds are not known.

Our project objectives are to identify and verify the function of each type of pheromone, with the goal of developing practical applications of one or more of these pheromones for LFB management.

RESULTS

Because we initially had difficulty in establishing colonies of LFB to work with, we did not request additional funding for our second year of work. Thus, this report covers work for the

period March 2016-November-2017. In addition, a new hire at Kearney Agricultural Research and Extension Center (KARE), Dr. Houston Wilson, has joined the team to carry out field trials of traps and test lures.

Summer-form colonies of *Leptoglossus zonatus* (LZ) were established in late summer of 2016, and they transitioned into the nonreproductive, overwintering form. The colonies were refreshed with field-collected insects through 2017. We were not able to collect our second target, *L. clypealis* (LC), until recently because, for unknown reasons, this species has become less common in Central California. We finally located an overwintering site near UCR in October 2017, and collected several hundred adults. Through the winter, we will try and revert them to the reproductive summer-form so that we can establish a colony. Specimens have also been sent to Daane to start a colony at KARE.

Other work conducted at UC Riverside to date includes:

1. Extraction and identification of the alarm and defensive compounds produced by immature and adult LZ.
2. Collection and analysis of odors released by sexually immature and sexually mature LZ adults, from both summer- and winter-form individuals. The analyses showed that sexually mature summer-form males specifically produce several compounds, which are not produced by adults of any other type or sex. These compounds are strong candidates for attractant pheromones used to attract large numbers of conspecifics into nut orchards. All of these compounds have been identified, and the key compound has been synthesized in small amounts for testing. We are currently assessing whether the synthesis can be improved, or whether we can instead isolate the key compound from a commercially available plant oil.
3. Analysis of cuticular hydrocarbons from summer- and winter-form LZ adults of both sexes to assess whether these compounds might be involved in forming or holding overwintering aggregations together. We have found clear differences between the sexes, and between summer- and winter-forms, so it is likely that these compounds are indeed overwintering signals.

Work conducted by Daane and Wilson to date includes:

1. Providing LZ starter colonies to the UCR team.
2. Field trials attempting to demonstrate attraction of adults to caged summer-form males and females. This experiment was not successful due to the difficulty in keeping bugs alive in cages.
3. Testing of different trap types, which showed that cross-vane panel traps are far superior to other types of traps for catching LFB, even with no attractant lure.
4. A quick-and-dirty field trial of the impure synthetic reconstruction of the sex-specific compounds produced by summer-form male LZ, showing some evidence of attraction to the synthetic lure.

CONCLUSION AND APPLICATION

This project is now on a firm footing with colonies of the two target species at both UCR and KARE, and we are making good progress. Specifically, we have strong leads for a male-produced aggregation pheromone for LZ, as well as leads for compounds involved in overwintering aggregation formation. For the coming year, we anticipate further field tests of the synthetic pheromone candidates and doing the analyses described above on our newly established colonies of LC.