Predicting Leaffooted Bug Outbreaks to Improve Control

Project No.: **08-ENTO3-Daane**

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Objectives:

1. Investigate the formation and population dynamics of Leaffooted Bug aggregations to determine if these aggregations can be manipulated for monitoring or control.
2. To document the species of secondary moth pests in almonds and produce a description brochure of the larvae and adults.

Interpretive Summary:

California almonds are attacked by a variety of Hemiptera, or true bugs. Our research has focused on the "big" bugs, which include the redshouldered stink bug (*Thyanta pallidovirens*), Uhler's stink bug (*Chlorochroa uhleri*), flat green stink bug (*Acrosternum hilare*), and the Leaffooted Bug (*Leptoglossus clypealis*). These big bugs can cause the same damage as their smaller relatives during the first half of the season; however, the big bug adults can continue to puncture the shell later into the season and will feed on more nuts – resulting in greater total nut loss.

In recent years, many California almond and pistachio growers had significant crop loss from adult Leaffooted Bugs. Most damage occurred early, from April to May, when the bugs' mouthparts piercing the small almond nuts resulted in the damaged nuts dropping from the tree. In previous years, we showed that the overwintering adult leaffooted bugs cause this damage and, therefore, are the most important stage to monitor and control. One problem is that these adult bugs are strong flyers and can quickly move

into the orchard, in large numbers, and cause damage before monitoring programs detect their presence. For this reason, in 2007 and 2008, we studied Leaffooted Bug overwintering biology and the cues that cause them to form winter aggregations and, more importantly, to disperse from the aggregations.

We searched for aggregations in regions near (<250 m) almond and pistachio orchards that reported Leaffooted Bug populations from 2005 to 2007. In winter 2007 - 2008, we found small aggregations in a citrus, Eucalyptus, Italian cypress, and palm trees. An extremely large population was found in an olive orchard that abutted a pomegranate field. We followed both winter temperatures (Fig. 1A) and the size of twenty individual aggregations in the olive orchard (Fig. 1B). The numbers of Leaffooted Bug adults in the olive aggregations remained relatively constant in December 2007, during which time the temperatures were relatively mild. Beginning in January there were periods of cold weather during which the numbers of bugs dropped, and we often found dead Leaffooted Bug adults below the aggregations when low temperatures dipped below freezing for three or more consecutive nights. Dispersion from the aggregations was not observed until after February 20, when temperatures increased sharply. Within 15 days (February 25 to March 7), all healthy Leaffooted Bug adults had left the overwintering aggregations to move to spring feeding sites.

These results show that in most years, there is considerable leaffooted bug mortality during the winter period – especially when temperatures drop below freezing for any length of time. We have used the results from our winter mortality surveys to correctly predict Leaffooted Bug damage in 2007 and 2008. A regional overwintering sampling program has been considered, but this season's sampling has shown that difficulty in finding appropriate overwintering aggregations for monitoring. A better program would use temperature data on Leaffooted Bug development thresholds (e.g., what low temperatures will kill the bugs) such that regional winter temperatures can be used to predict bug mortality. We will work on this program in 2009. Currently, suggestions for sampling Leaffooted Bugs were developed and 4-page brochure was provided by the almond industry.

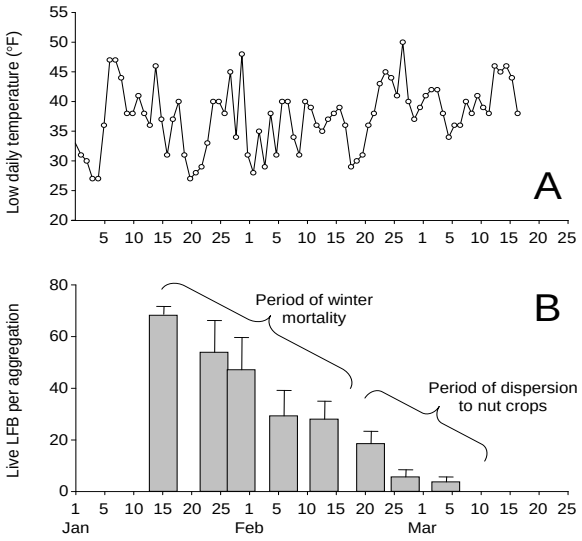

Fig. 1. Leaffooted Bug winter aggregations

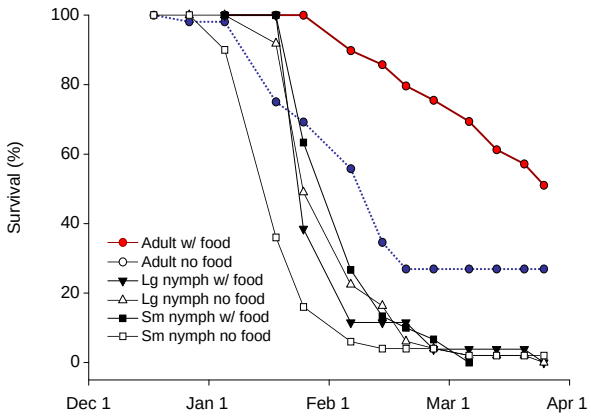

Fig. 2. Leaffooted Bug winter survival

Previously, we showed that leaffooted bugs have three complete generations each season. We have also sought to better understand Leaffooted Bug biology during the winter/spring generation. In 2007/08 we asked the questions: Do the overwintering Leaffooted Bugs need to feed? When do they mate? Can both adults and nymphs survive the winter? Results show that adults are the leaffooted bug stage that best survives the winter (Fig. 2). Adults both with and without food were able to survive until late March, when egg laying began. More adults that had food provisions survived, as was to be expected. Because most overwintering aggregations are not on sites where "nut" crops are available, we suspect that the most important element of the food was moisture – keeping the adults from desiccating. None of the medium sized or large nymphs survived the winter. The results suggest that the adults can survive outside the orchard, without food, and still be a problem. During the winter period, we never observed mating, which was first observed in March.

We also investigate cues that trigger formation of aggregations. While we have been unable to what signals are used to form how aggregations – in other words to call together the adults – we have shown that aggregations form from some kind of signal rather than simply the physical attributes of any location. This work may help develop programs that can manipulate aggregations for control, such as attract and kill, or monitoring (pheromone work should be done by Dr. Jocelyn Millar, UC Riverside).

Attached to the Leaffooted Bug proposal we also sought to describe the secondary moth pests in almond and pistachio fields. This is connected to studies of the key insect pest: the Navel Orangeworm (NOW). Currently, a large multi-agency project is targeting NOW for control, including the use of mating disruption, our role on a collaborative project on NOW (directed by Dr. Siegel, USDA-ARS) is to determine the impact of a NOW mating disruption program on population densities of insect pests and their natural enemies.

What is important to consider is that previous biological control work in the 1970s resulted in the importation of two NOW natural enemies: *Goniozus legneri* and *Copidosoma* (= *Pentalitomastix*) *plethorica*. In the past 40 years, while NOW has continued to be a significant pest, there has not been any more attempts to search for NOW natural enemies. We have begun studies to document the levels of NOW parasitism in different orchard systems, and these results will be compared to that earlier work (1970s and 1980s). These results will help determine how to proceed towards better NOW biological control.

One aspect of NOW parasitism is the other moth (or worm) pests in the orchard. The oriental fruit moth (*Grapholita molesta*) and peach twig borer (*Anarsia lineatella*) are the most common and geographically widespread; in some areas the fruittree leafroller (*Archips argyrospila*), obliquebanded leafroller (*Choristoneura rosaceana*), and the filbertworm (*Melissopus latiferreanus*) are also found. These pests can also reach damaging levels and may be confused with NOW. Moreover, these other moth pests might also be hosts for parasitoids that could be "shared" among the worms – resulting in higher overall levels of control. We are also documenting the kinds and densities of these moth pests, and cataloging which parasitoid species are found in the almond and pistachio orchards attacking them. This work will help select new NOW parasitoids.

Acknowledgements

We thank the Almond Board of California and California Pistachio Industry for funding. We thank Matt Middleton, Alex Morales, Dustin Pattigan, Murray Pryor, and Brandon Salazar for help with field collections and sorting laboratory samples.