Predicting Leaffooted Bug Outbreaks to Improve Control

Project No.: **07-ENTO3-Daane**

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Objectives:

1. Investigate development of sampling protocols for winter and spring populations of leaffooted bug.
2. Determine overwintering cues that result in leaffooted bug aggregation – and to determine if these aggregations can be manipulated for monitoring or control.
3. Determine the potential number of leaffooted bug generations per year, and when the adult population begins its overwintering period.

Interpretive Summary:

In spring 2006, many California almond and pistachio orchards had significant crop loss from adult leaffooted bugs (*Leptoglossus* species). The occurrence of leaffooted bug populations covered a wide geographic range, including nut producing regions from the northern, western, and southern Central Valley. However, leaffooted bug densities and damage varied considerably, with some growers reporting significant bug densities and more than 50% crop loss, while nearby growers reported few leaffooted bugs and little crop damage. Regardless, spring 2006 was the worst leaffooted bug year over the past 20 years. Here, we investigated sampling methods, overwintering habits (particularly aggregations), and the potential number of leaffooted bug generations per year.

***Sampling protocols for winter and spring populations*.** Different types of pest sampling methods are useful to predict pest densities. The most common is a direct count of individuals on the plant leaves or branches, caught in pheromone or sticky traps, or collected via sweep nets or beating trays. These methods are not very effective for spring-time leaffooted bug populations, which move into the orchard as adults and are difficult to sample.

In 2007, we selected almond and pistachio orchards that had histories of leaffooted bug damage and sampled in and around those orchards for overwintering leaffooted bug populations. From our winter/spring sampling, we predicted (in February) that the 2007 leaffooted bug adult population would be considerable lower than the 2006 season's – a result of the cold winter temperatures. The prediction appeared to hold true throughout the spring and early summer – the critical period for leaffooted bug damage. The results suggest that through a relatively small group effort, regional "hot-spots" can be sampled from December to February and get a reasonable prediction of the leaffooted bug population size for the spring. We believe that we can establish annual winter monitoring programs that will help to forecast spring bug abundance, thereby giving managers a warning about bad years.

Results from two "hot spots" are as follows: In October/November 2006, leaffooted bugs were observed leaving a pomegranate field (Tulare County) and an almond field (Fresno County) and aggregating on eucalyptus and citrus trees in adjacent fields. There were several aggregates of 15-40 adults tightly clustered on the terminals branches, often exposed. After the hard freeze in January the leaffooted bugs in the citrus were dead and falling to the ground. No alive leaffooted bugs were observed in that citrus field after the freeze. Several leaffooted bugs under the bark of the palm tree were more protected and had survived. We suspect that the bugs must form the aggregation in a protected area by November / December as after temperatures drop there was little movement to more protected places. In other words, if the aggregation formed in October was in an exposed location, the bugs would rarely move unless the temperature were warm enough.

Throughout the winter we observed leaffooted bug adults dying, dropping directly from the aggregation to the ground. We estimate about 90% of the individuals in the more exposed aggregations (e.g., on a citrus branch) died. Individuals in protected locations (e.g., in palm trees) survived – at least 50% of the population. In March, the aggregations began to break out and adults started to move back into almonds.

In summary, the winter sampling program provided information on the leaffooted bug population size. It showed high mortality of exposed leaffooted bugs, and reinforced the importance of nearby protected shelters for overwintering survival. The value of such a sampling routine will be the annual addition of survey counts at each site. These surveys can be compared with insecticide sprays and harvest damage reports. The goal is to develop inexpensive, collaborative, regional surveys for leaffooted bug that could be used to predict potential "bad years" by showing high overwintering populations.

Winter aggregations. We artificially created small aggregations of leaffooted bug adults (photo 1) in the field to determine if aggregations of the resident population could be manipulated. The wooden leaffooted bug overwintering chambers (photo 2) were placed in a citrus orchard that was adjacent to a heavily infested pomegranate orchard, and an almond orchard that where leaffooted bugs have consistently come into the orchard from overwintering sites nearby. The goal was to create a protected location where the bait (other leaffooted bugs) would attract resident leaffooted bugs to form overwintering aggregations. The baits tested was one of the three groups of caged leaffooted bugs. The number of resident leaffooted bug adults that approach and aggregate in the cages were recorded.

Photo 1. Screened cage with artificial aggregation of adult leaffooted bugs, provided with food (peanuts) and water. The aggregations were either: females only, males only, or both sexes

Photo 2. Wooden shelter, which housed the artificial leaffooted bug aggregations, were placed in orchards to help determine if adult leaffooted bug dispersion and aggregations could be manipulated

Result found few resident leaffooted bugs were attracted to the artificial aggregations. No true aggregations of resident bugs were formed and, therefore, we can make no comments on the attractiveness of the four treatments (virgin females, males, female and male aggregations and a shelter with food only). The obvious conclusion is that our artificial shelters were not attractive, even with caged aggregations of leaffooted bugs and food. It is as likely that the shelter were placed into the field too late (October/November). We observed, while establishing the plots, that much of the dispersing leaffooted bug population moved in October.

In the second study, we used large (10 × 12 foot) cages to manipulate leaffooted bug aggregations. In each of the four corners of the cage a potted tree was placed as a “substrate” for the leaffooted bugs to form an aggregation upon. We then added to one of the cages an artificial aggregation of caged leaffooted bug adults. Results were similar to the field trial as the freely released leaffooted bugs did move towards the aggregation cage in any of the trials. Aggregation cues might be a combination of changing climate, from summer to fall, as well as an insect cue, such as an aggregation pheromone, sound, or vibration cue (or a combination of many cues). Support for this observation is the aggregations that formed in the small cages used to conduct the study of leaffooted bug generations.

Leaffooted bug seasonal development. We utilized small cages to collect information on leaffooted bug development. At the Kearney Agricultural Center, adult leaffooted bugs were collected during the winter. This cohort was placed into small tree cages placed outside and held at ambient temperatures. The leaffooted bugs were fed peanuts and provided with an Italian cypress as food and structural support. During each egg-laying period, additional cages were established for each consecutive generation produced. We then determined the longevity of the adults, their egg-laying period, and the number and length of each successive generation.

There were three generations per year, and a partial fourth genearation (the nymphs never made it to the adult stage before winter). Adults producted, on average >150 eggs each; we suspect egg production would be higher given better food supply. The overwintered adults began depositing eggs in late March April, and continued to deposit eggs through May, possibly longer. Nymphs reared from these egg masses passed through five nymphal stages, with the first nymph developing to the adult stage in late June. Altogether, we collected more than 300 adult leaffooted bugs in the cages, which formed the adults for the first summer generation. These adults were placed into new cages, provisioned as before, and began depositing egg masses in early July 2006. Egg deposition continued until late September, with first instar nymphs hatching from these egg masses from mid July to mid October. Therefore, adults of the first summer generation (from eggs deposited by overwintered adults from April to May) were active from July through October, depositing eggs over a 4 month period. The resulting nymphs formed the second summer generation. Adults from this second summer generation were first observed in mid August and survived, typically, until late October, although a smaller proportion of this second generation survived into winter as well. Eggs deposited from the second generation were first observed reaching the adult stage in mid October, but deposited no egg during the fall. Adults fro the second and third generation overwintered, with little mortality. Currently (October), the overwintering population consists of adults and nymphs from the second and third generations.

Clearly, adult leaffooted bugs are long-lived and deposit eggs throughout most of their lifetime, often depositing eggs over a 3 months period. This results in considerable overlap of generations, with adults from one generation living beyond the period when their offspring became adults and produced eggs of the next generation.

The overlap of leaffooted bug stages makes insecticides applications based on short residual insecticides very difficult because there are always adults that can migrate into the orchard. Typically, control is based on April or May applications of chlorpyrifos (e.g., Lorsban), pyrethroids, or permethrin to kill overwintering adults that have migrated into the orchard. The biggest concern with these products is the potential to flare spider mites later in the season. In general, control in June is not needed because populations of overwintering adults have declined and most nymphs are too small to penetrate into the kernel. By July, however, large nymphs and new adults may be of sufficient size to cause kernel damage, although most of their attempts to reach the kernel fail because of the hardened shell.

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