Leaffooted plant bugs (*Leptoglossus* spp.) and Stinkbugs on Almonds

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OBJECTIVES

- *Establish a colony of Leaffooted plant bugs for field and lab work*
- *Determine species composition of leaffooted bugs (*Leptoglossus *spp.) and stinkbugs on almonds and alternate host plants*
- *Conduct a field cage study to compare natural levels of almond drop with the almond damage and nut drop caused by two separate species of leaffooted plant bugs*

INTRODUCTION

Leaffooted bugs (*Leptoglossus* species) are large, seed-feeding insects that move from native host plants to nut crops, such as almonds, pistachios, and pomegranates. Their long mouthparts pierce through almonds, feeding on developing kernels. In the early stages of almond development this feeding causes the nuts to discontinue growth and drop from the tree, whereas bug feeding later in the season can impact the kernel (Fig. 1), with strikes or lines on the almond kernel.

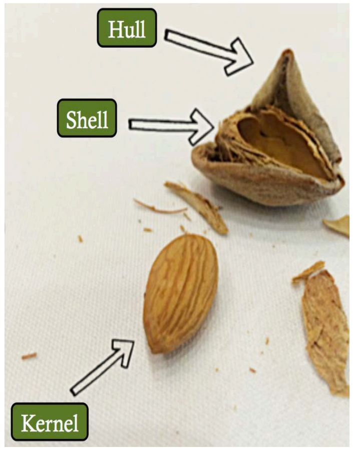

Fig. 1 Almond Hull, Shell, and Kernel

When substantial almond drop is observed, insecticide applications are often applied for insect control. However, by the time the damage is observed, the insects may have already dispersed. Management of these insects may be more effective through monitoring with traps such as pheromone traps to detect insects **before** damage occurs. *L. zonatus* has an aggregation behavior which might be exploited to trap insects for monitoring or early detection. During the last two years, we determined there are two species of leaffooted bugs infesting almond orchards (Fig. 2a,2b). *L. zonatus* is about twice as large as *L. clypealis.* This poster will focus on a field-cage study which compares feeding damage to almonds by two species of leaffooted bugs, *L. clypealis* and *L. zonatus.*

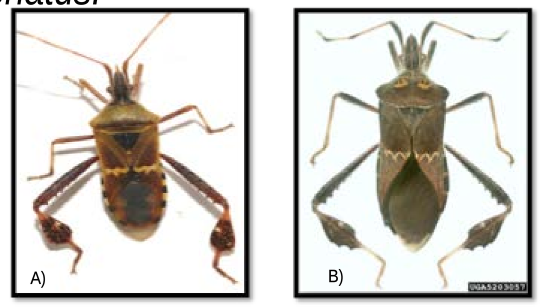

Fig. 2 a) *L. clypealis* 2b) *L. zonatus*

The field-cage study to assess feeding damage had four experimental treatments on four almond varieties to determine nut drop and final damage to almonds, when either bug species (*L. clypealis* or *L. zonatus*) was feeding at different stages of almond development throughout the growing season.

METHODS (Objective 1)

Leaffooted plant bugs (LFPBs) were collected on three hosts; almonds, pistachios, and pomegranates in the central valley, as well as sent in from collaborators at additional field sites. Two species were identified as *L. clypealis* and *L. zonatus* (Fig. 2a,b). Back in the laboratory, the adults, nymphs, and eggs of both species were placed in large-scale bug confinements to expand lab colonies (Fig. 3).

Fig. 3 Bug Colonies

These colonies have been maintained in the laboratory successfully. Adult LFPBs from the colony were used to conduct the field-cage study to assess damage throughout the growing season to different varieties of almonds.

METHODS

__Field-Cage Feeding Damage Study:__

Part 1: Determining Developing Almond Drop and Damage by two species of feeding Leaffooted bugs

Part 2: Final Assessment of Almond Damage at Harvest

PART ONE

Research sites:

The four almond varieties used in the study were Monterey and Carmel, and Fritz and Nonpareil. Monterey and Carmel varieties were in Merced, Merced County, California (37º18'10.63"N 120º;23'18.14"W) . The Fritz and Nonpareil varieties were in Winton, Merced County, California (37º22'45.73" N 120; 37'39.82"W) (Fig. 4).

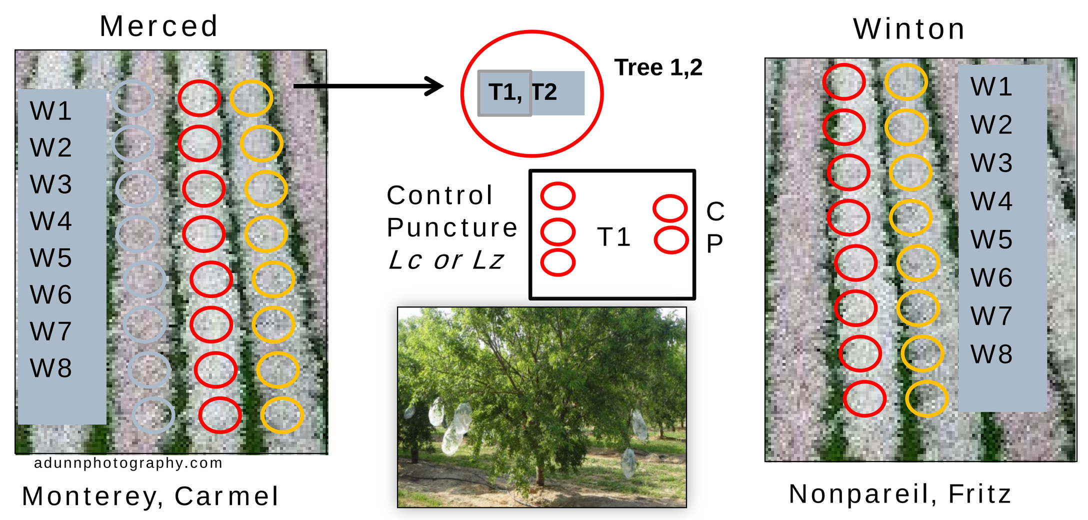

Fig. 4 Research Sites in Merced and Winton used for field-cage Study

Field Cage Set Up:

For 8 weeks, starting at the end of March, field cages were set up weekly on two trees of each variety. A paint strainer was used as a sleeve cage. Each cage was placed around approximately 20 almonds, closed securely with a binder clip, and given a specific identification number for data collection purposes (Fig. 5) .

Fig. 5 Field Cage

Each tree had five sleeve cages; 3 on the North side, and 2 on the South side (Fig. 6). The North side contained one control cage, one cage with punctured almonds, and a bug feeding cage. On the South side, one additional control and one additional punctured almond cage were added.

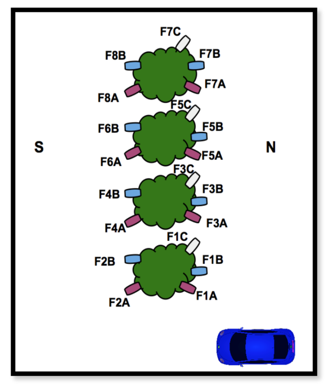

Fig. 6 Cage Set Up

__4 Experimental Treatments on 4 Varieties__

For the **Control** cages, we enclosed a group of almonds to observe the natural nut drop rate of almonds. In the "**Punctured-Mechanical Damage**" cages, we sought to mimic Leaffooted Plant Bug feeding by puncturing the almonds twice on both sides of the nut, down into the core of the developing embryo of the almond with an insect pin (Fig. 7). This helped us determine when the almond shell hardened and became less susceptible to bug feeding damage.

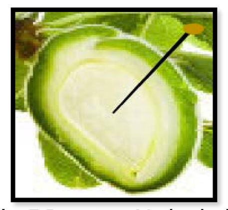

Fig. 7 Puncture Method with Insect Pin

In the **Bug fed cages,** we housed five adult leaffooted plant bugs (typically 3 females/2 males of either *L. zonatus* or *L. clypealis*) that were taken from our lab colony, and placed on the caged branches for one week, then removed (Fig. 8). New bugs were used for each bug-feeding cage.

Fig. 8 *L. zonatus* feeding on almond

Almond Size, Hull Width, & Gummosis Response

Before leaving the field site each week, 10-15 almonds of each variety were collected and brought back to the lab to determine the size of the almonds that week. Each almond was cut in half longitudinally and then measured for almond length, width, and hull width. Hull width Might influence the susceptibility of the varieties to bug feeding.

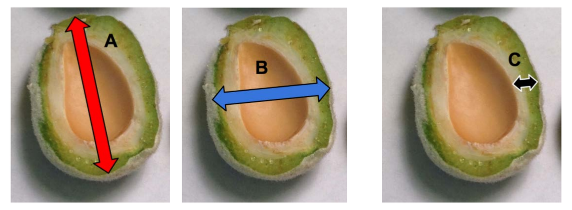

Fig. 9 A) length of the almond, B) Width of the almond, C) Width of the hull

Each week we noted whether punctured almonds or bug fed almonds exhibited the gummosis-sap response, how many almonds had dropped and we removed leaffooted bugs that had been feeding on the caged branch for 7 days (Fig. 10).

Fig. 10 Gummosis-Sap Response

Final Damage at Harvest

__Final Assessment of Almonds Remaining on Trees at Harvest__

Just before harvest, we collected a subset of the remaining caged almonds. After recording the final number of almonds on each branch, we collected four of the remaining nuts from the control and punctured branches to bring to the lab for assessment. For the cages where bugs had been feeding, all remaining almonds were collected for final damage assessment. Each individual almond was then assessed into four categories: strike on the hull, nut damage, strike on the nut, or shriveled kernel (Fig. 11). Finally all of the almond kernels and inner and outer hulls were photographed for future reference.

Strike on the Hull: a blemish in the lining, such a black or brown dot or bruise.	
Nut Damage: apparent indentations from nut strikes, is shriveled, slimy or may be deemed "unsellable."	
Strike on the Nut: blemishes or bruises on the nut, usually accompanied by a strike on the hull.	
Almond Shriveled: very obvious discoloration and shrunken/hardened kernel	

Fig. 11 Determining Almond Damage by Category

RESULTS-Part 1 Almond Drop

One focus for this study was to determine how the age of a developing almond relates to vulnerability to bug feeding, resulting in nut drop

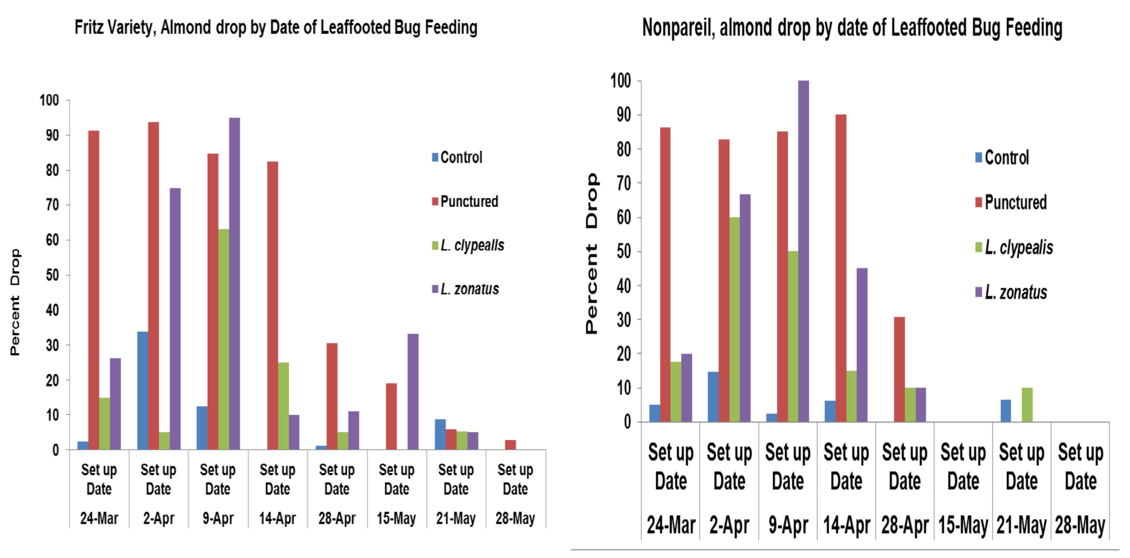

Fig. 12 A) Fritz Weekly Almond Drop B) Nonpareil Weekly Almond Drop

We determined the different almond stages most susceptible to natural nut drop and bug feeding resulting in nut drop. We found that **late March to mid-April** had the highest rate of almond drop from bug feeding, for Fritz and Nonpareil (Fig. 12). **More almonds dropped from *L. zonatus*** feeding (purple) than *L. cylpealis* (green).

RESULTS Part 2-Final Damage

Hull width: the hull width of nonpareil was thicker than Fritz on both April 14 and May 15. At both dates, Fritz suffered more almond drop (Fig. 12 and 13).

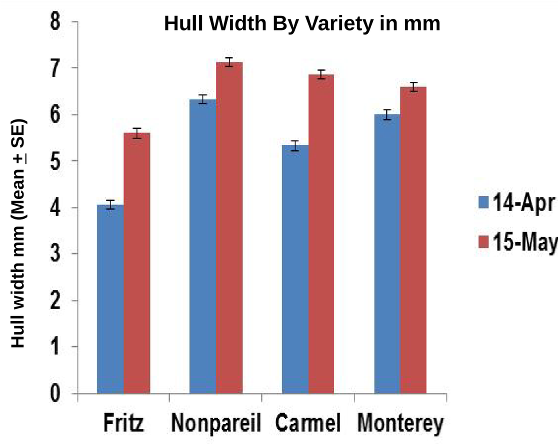

Fig. 13 Hull Width in mm of Almond Varieties

__Overall Almond Drop by Variety__

After conducting the 2014 Field-cage damage study we were able to determine which varieties exhibited the highest responses of nut drop and/or damage in the treatments. It is important to determine which varieties have higher levels of natural nut drop so that it is not mistaken for leaffooted bug feeding damage. As expected, each variety expressed about a 10% drop from the control branch (blue bars) and a 50% drop from the punctured treatment (red bars) (Fig. 14).

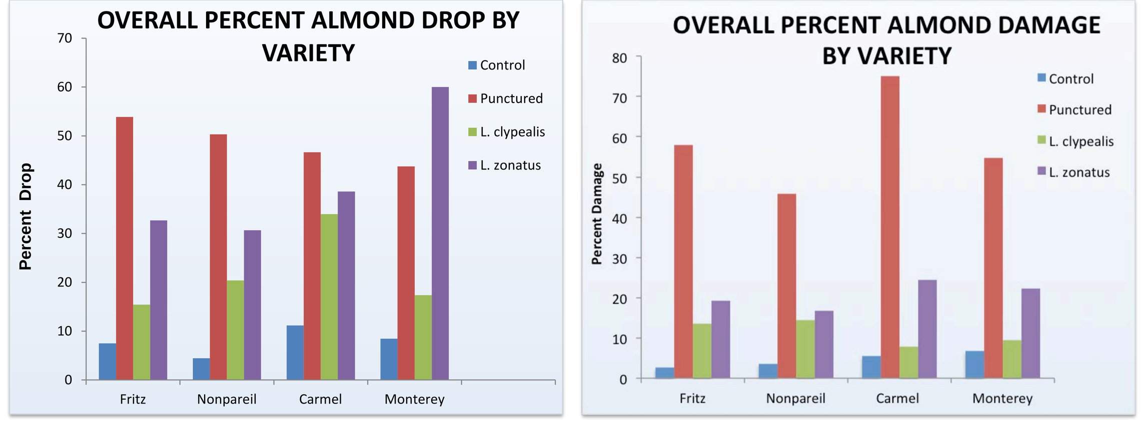

Fig. 14 A) Final Almond Drop in Percent B) Final Almond Damage in Percent

The overall percent almond drop and overall damage was greater when *L. zonatus* fed (purple bars) than when *L. clypealis* fed (green bars) (Fig. 14a,b). *L. zonatus* even had a higher impact on the Carmel and Monterey varieties.

Based on the 2014 field-cage bug feeding study, we conclude that all varieties of almonds are susceptible to drop and damage during the early developmental stages of the nut. Management would be improved through development of traps such as pheromone traps/lures for early detection monitoring before the insect damage occurs.

Understanding the timing of almond vulnerability to these two LFPB species contributes to developing an IPM system for these insects.

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