Leaffooted bugs (*Leptoglossus* spp.) and Stink bugs on Almonds

Andrea Joyce[1], Bradley Higbee[2], David R. Haviland[3], David Doll[4]

(1) University of California, Merced, Sierra Nevada Research Institute (2) Entomology Research, Paramount Farming Co, Shafter, CA (3) University of California, Cooperative Extension Bakersfield, CA (4) University of California, Cooperative Extension Merced

OBJECTIVES

Objectives:

1. *Determine the species composition of leaffooted bugs and stink bugs on almonds and alternate host plants*
2. *Conduct a field-cage study to assess feeding damage by leaffooted bugs on almonds*

INTRODUCTION

Leaffooted plant bugs (LFPBs) feed on developing almonds, which results in nut drop and damage to developing kernels. LFPBs are difficult to detect in the field prior to observing symptoms of feeding (gummosis) or nut drop (3,4,5). Currently, there is no trap or lure for monitoring LFPBs. **A long-term goal for leaffooted bug management is to develop an early detection monitoring system.**

Our first goal is to determine which species of LFPBs are abundant, and whether there may be cryptic species or host plant associated strains. Species identification is important, as attractants such as pheromones can be species specific (1,6,11).

In addition, the almond age and the variety may affect when the gummosis response appears. Our second goal was to conduct a field-cage study to assess feeding damage by LFPBs on almonds

OBJECTIVE 1

• Determine the species composition of Leaffooted plant bugs on almonds and alternate host plants

L. clypealis *L. zonatus*

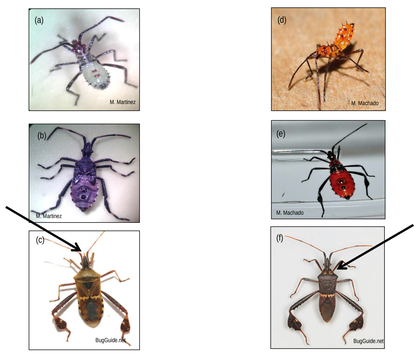
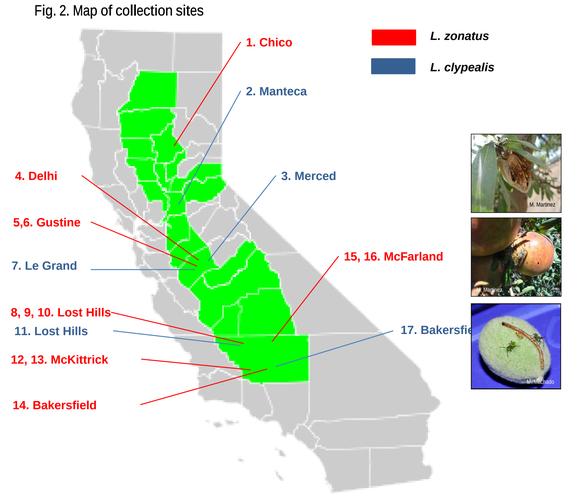


Fig. 1. Leaffooted plant bugs found in this study. The two species can be distinguished at each instar/stage.
1a. *Leptoglossus clypealis* nymph 1st instar. 1b. *Leptoglossus clypealis* in roughly 3rd instar stage. 1c. *Leptoglossus clypealis* adult has a distinctive spine-like tylus on the distal end of head. 1d. *Leptoglossus zonatus* nymph. 1e. *Leptoglossus zonatus* in roughly 2nd instar. 1f. *Leptoglossus zonatus* adult has 2 distinct spots on its anterior pronotum.

COLLECTION SITES

Leaffooted plant bugs have been collected from almonds, pistachios and pomegranates throughout the central valley.

Fig. 2. Map of collection sites



L. zonatus		*L. clypealis*	
Site Collected	**Host Plant**	**Site Collected**	**Host Plant**
1. Chico	Pomegranate	2. Manteca	Almond
4. Delhi	Almond	3. Merced	Unknown
5. Gustine	Pomegranate	7. Le Grand	Pistachio
6. Gustine	Almond	11. Lost Hills	Pistachio
8. Lost Hills	Pomegranate	17.Bakersfield	Pistachio
9. Lost Hills	Pistachio		
10. Lost Hills	Pomegranate		
12. McKittrick	Almond		
13. McKittrick	Pistachio		
14. Bakersfield	Pomegranate		
15. McFarland	Pomegranate		
16. McFarland	Pistachio		

The California map (Fig.2) shows northern, central and southern collection sites for both *L. clypealis* and *L. zonatus.*

Table 1. Collection sites and host plants for both species.

Results – Leaffooted bug Species Abundance

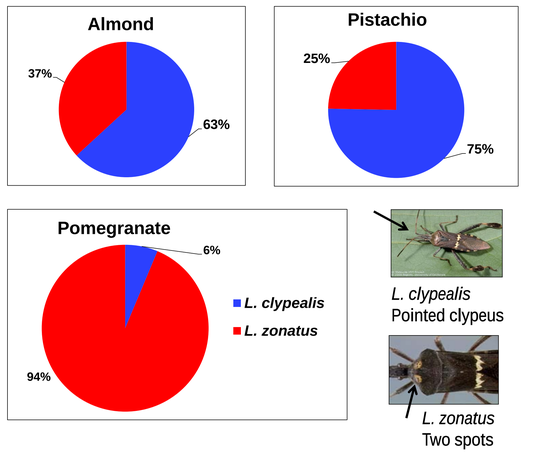


Fig. 3. For each crop plant, the percent of *L. zonatus* (red) or *L. clypealis* (blue) collected on each of the host plants.

Results - *L. clypealis*

DNA was extracted from a total of 47 *Leptoglossus clypealis* male adults. Two primer combination were used to obtain 360 AFLP markers. This number of individuals and markers were found to be sufficient in order to adequately represent population genetic structure (8).

Most individuals belonged to one genetic cluster (Fig.4).
No cryptic species of *L. clypealis* were found.

L. clypealis on almonds and pistachios are interbreeding

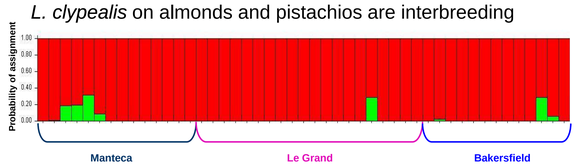


Fig. 4. Structure-generated bar graph for *L. clypealis* with 47 individuals, K=2. *This suggests that these insects on almonds and pistachios are interbreeding and moving between almonds and pistachios.*

Results - *L. zonatus*

For *Leptoglossus zonatus*, a total of 150 male adults were collected on almond, pomegranate and pistachio host plants. DNA was extracted, and a total of 327 AFLP markers were obtained using two primer combinations.

There were two genetically distinct clusters (Fig.5).

Genetically distinct populations were collected from Lost Hills in 2013 and 2014 (green and red bars)(Fig.5).
(Lost Hills is south of Kettleman City)

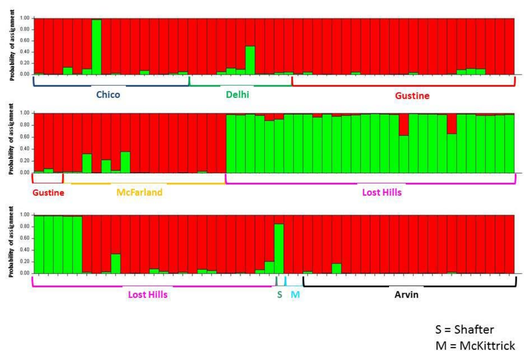


Fig. 5. Structure analysis of *L. zonatus* collected from various locations throughout California (see Table 1 for map).

OBJECTIVE 2-FIELD CAGE STUDY

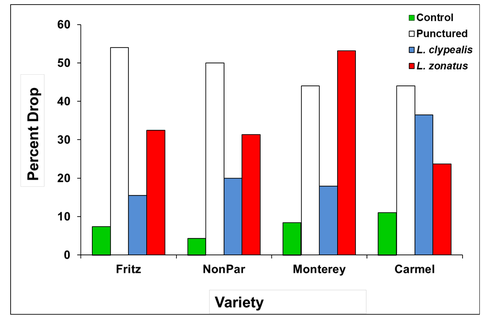


Fig. 6. The percent almond drop in each treatment over the course of the field-cage study (March-Sept 2014). Controls (green bars) were branches enclosed in a mesh sleeve cage. Almond drop in controls was ~5-10%. The mechanically punctured almonds (white bars) had nearly 50% of almonds drop. *L. clypealis* adults were caged on a separate group of branches (blue bars), and almond drop was about twice as high as the controls. The fourth group (red bars) are caged branches with *L. zonatus*. Almond drop in *L. zonatus* cages was higher than in *L. clypealis* cages, for three of four varieties.

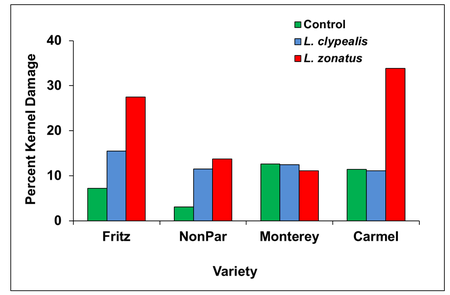


Fig. 7. Kernel damage totals at end of field-cage study

ACKNOWLEDGEMENTS

We would like to thank the following people for assistance with this project: Mel Machado, Blue Diamond; Steve Boone, Wilbur-Ellis; Matt Thompson, Mid-Valley Agricultural Services; Roger Duncan, UC Cooperative Extension Stanislaus County; Chris Morgner; Dan Clendenin, Clendenin Orchards Merced; Brad Robson, Buchanan Hollow Nut Co., Le Grand; Arnold Farms, Winton; Joe Connell, UC Cooperative Extension, Butte County; Lab Technicians at UC Merced, Ashley Valley and Maria Martinez; Undergraduate Student Assistants at UC Merced Etienne Melese, Amanda Khoo, Rebecca Quinte; Summer Research Assistants Kylie McMillan and Lindsay Robson; Juan Holguin, Monarch Bio Systems.

REFERENCES

1. Aldrich, J.R., Blum, M.S., and H.M. Fales. 1979. Species-specific natural products of adult male leaf-footed bugs (Hemoptera: Heteroptera). Journal of Chemical Ecology 5:53-60.
2. Brailovsky, H. and E. Barrera. 2004. Six new species of *Leptoglossus* Guérin (Hemiptera: Heteroptera: Coreidae: Coreinae: Anisoscelini). Journal of the New York Entomological Society 112: 56-74.
3. Daane, K. 2007. Predicting leaffooted bug outbreaks to improve control. Almond Board Report, pg.1-13.
4. Daane, K. M., Yokota, G.Y., Bentley, W.J., and D.R. Haviland. 2008. Winter/Spring Sampling for Leaffooted bug in nut crops. Reference handout 2008-LFB-1, March pg. 1-4.
5. Haviland, D. 2007. In season management of leaffooted bugs in almonds. Almond Board Conference Proceedings 2007. Project Report, 07-Ent04-Haviland. Pg. 1-4.
6.Landolt, P. and T. Phillips. 1997. Host plant influences on sex pheromone behavior of phytophagous insects. Ann Rev Entomol 42: 371-391.
7. McPherson, J.E., Packauskas, R.J., Taylor, S.J., and M.F. O'Brien. 1990. Eastern range extension of *Leptoglossus occidentalis* with a key to *Leptoglossus* species of America north of Mexico (Heteroptera: Coreidae). Great Lakes Entomologist 23: 99-104.
8. Medina RF, Barbosa P, Christman M, Battisti A. 2006. Number of individuals and molecular markers to use in genetic differentiation studies. Mol Ecol Notes 6: 1010–1013.
9.Michailides, T.J. 1989. The achilles heel of pistachio fruit. California Agriculture 43:10-11.
10.Vos P, Hogers R, Bleeker M, ReijansM, van de Lee T, others. 1995. AFLP: a new technique for DNA fingerprinting. Nucleic Acids Research 23: 4407–4414.
11.Wang,Q and J.G.Millar. 2000. Mating behavior and evidence for male-produced sex pheromone in *Leptoglossus clypealis* (Heteroptera: Coreidae). Annals Entomol. Soc. Amer. 93: 972-976.