Synopses of Projects Addressing Ecologically-Based Management of Insects in Cotton

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Justification and Problem Statement

Lygus bugs play a pivotal role in cotton pest management in California. They cause direct damage to bolls, and their control with broad spectrum pesticides disrupts natural enemies and induces outbreaks of secondary pests. Cotton pests and their natural enemies move within cotton fields and migrate between the field and adjacent areas. Quantitative knowledge of the movement of *Lygus* bugs in the field is lacking. Understanding of the dispersal and host finding behavior of these pests and their natural enemies would facilitate development of improved management plans. Knowledge of *Lygus* movement is also important for the selection and conservation of associated biocontrol agents. Previous mark-recapture studies measured the movement of *Lygus* bugs within fields of cotton, alfalfa and beans, and between fields of alfalfa and cotton (Bancroft 2005). Most *Lygus* were predicted to have a lifetime within-field dispersal range of less than 1000, but they may fly much farther when host-plants are not available or become unsuitable. Simulation models of dispersal have also been constructed to quantify the effect of plant condition and weather on observed dispersal patterns. We continue to conduct experiments to provide a link between pest management practices and the migratory behaviors of *Lygus*.

Movement patterns of *Lygus* within a multi-crop landscape. This was the 2nd season of a cooperative effort with several growers, Dale Deshane (PCA) and Peter Goodell (UC Kearney). The work was supported by a grant from Cotton Incorporated. *Lygus* populations were monitored at 2 multi-field sites in Kern county (Fig. 1). Each of the 77 cotton, alfalfa, and potato fields within the two sites was sampled twice weekly, except when agronomic activities interfered. Two 50-sweep samples were collected from each cotton field and two 25-sweep samples were collected from each field of alfalfa or potato. Samples were frozen and *Lygus* and natural enemies are currently being counted. A database is being used to record the data. A time series of *Lygus* from 2006 is shown in Fig. 2. Variability among fields (for a given week and crop) was generally less than variability through time, suggesting sampling was conducted at an appropriate scale to assess fluctuations in landscape population dynamics as a result of environmental conditions. Cotton plant mapping data were collected from 36 of the fields sampled for *Lygus*.

During 2006, 69 of the 77 fields were sprayed with pesticides. A total of 46,975 arthropods were identified and recorded in the database. Of those, 5370 were *Lygus*. The overall time series for *Lygus* in alfalfa (Fig. 2) shows distinct generational peaks. The multi-field site with a greater number of potato fields tended to have larger *Lygus* population levels than were observed in the other site. These data will be analyzed in an effort to understand causes of local *Lygus* population fluctuations, and will be used to test a simulation model to forecast *Lygus* populations.

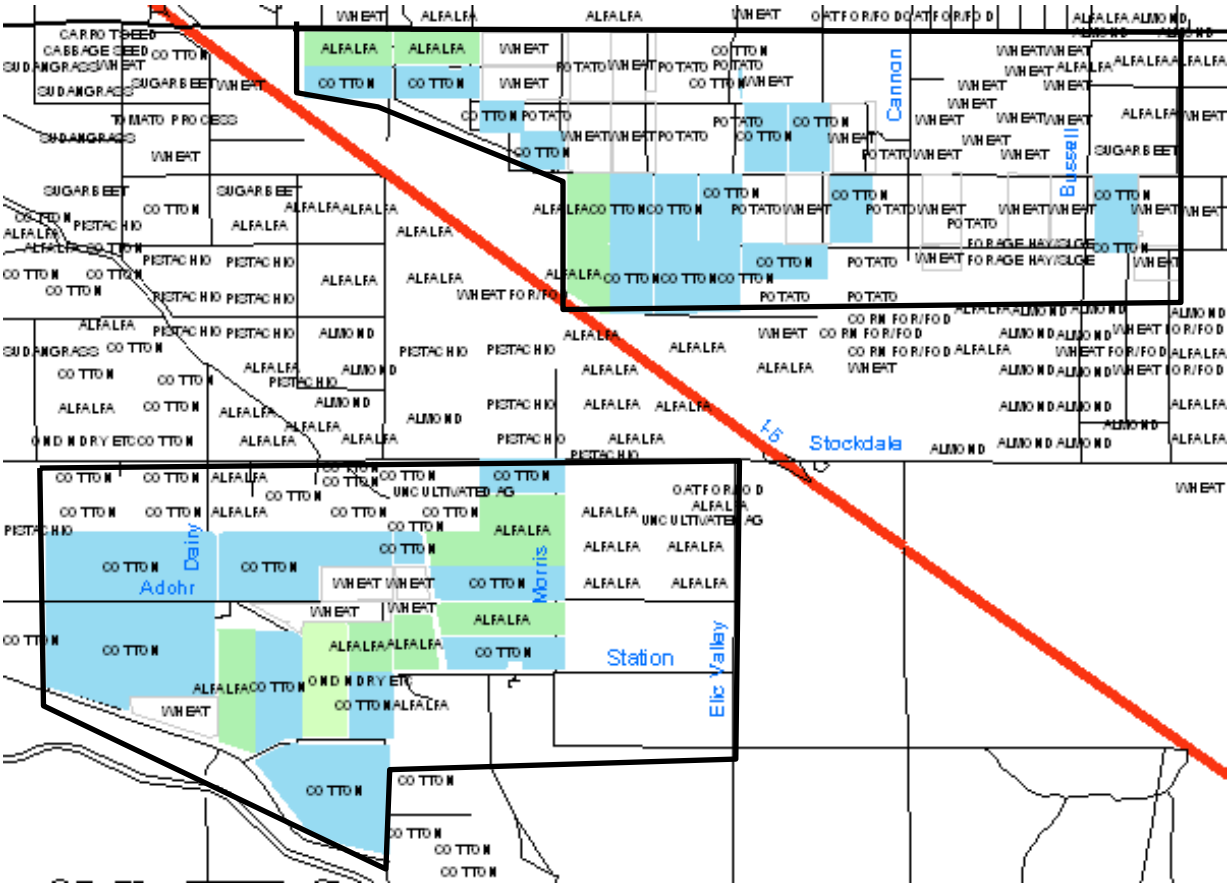

Fig. 1. Locations of two multi-field *Lygus* sampling sites, San Joaquin Valley, California.

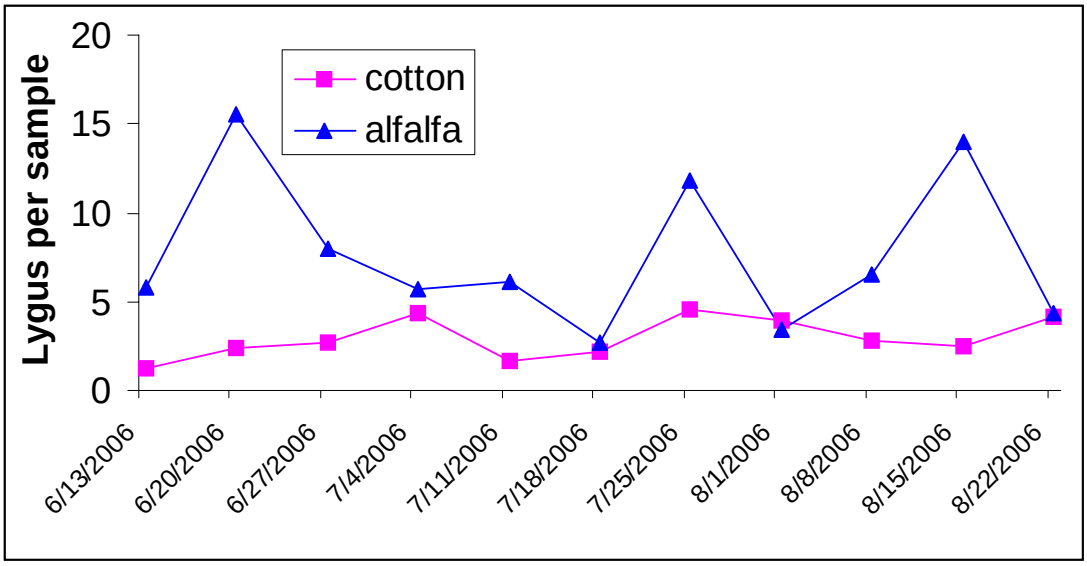

Fig. 2. Time-series of *Lygus* seasonal abundance averaged across all fields.

Patterns of *Lygus* emigration from alfalfa. A study area was established on the southwestern corner of SREC field 44. Within this area pairs of alfalfa and cotton plots, each plot roughly 60 x 150', were arranged in a checker-board pattern (Fig. 3). At two-week intervals, half of the alfalfa plots (either plots 1, 4, 5, and 8, or plots 9, 12, 13, and 16) were mowed, with cuttings alternating between the two ends of the study area. Therefore, each set of plots was cut monthly. Three days before each cutting, eight interception traps (see. Fig. 4) were established on the borders the alfalfa plots so that cardinal directions were equally represented. Immediately before cutting, *Lygus* and associated predators captured in the interception traps were tallied and relative population levels of *Lygus* and predators were estimated in each alfalfa plot by two 25-sweep samples. On each day for three days after cutting, insects captured in the interception traps were recorded, and corresponding population levels within each companion cotton plot were estimated by two 25-sweep samples.

Captures of *Lygus* in the interception traps, before and after the alfalfa was cut, indicates emigration of *Lygus* from the mowed fields. Captures by the traps decreased dropped quickly after the cutting, indicating that the emigration response of *Lygus* was short-lived (Fig. 5).

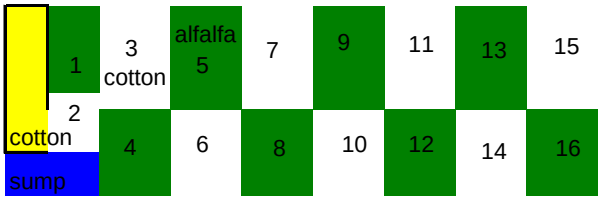

Fig. 3. Arrangement of alfalfa and companion cotton plots for study of *Lygus* emigration from alfalfa.

Fig. 4. A 1 x 2 m (h x w) interception trap used to study *Lygus* emigration from cut alfalfa.

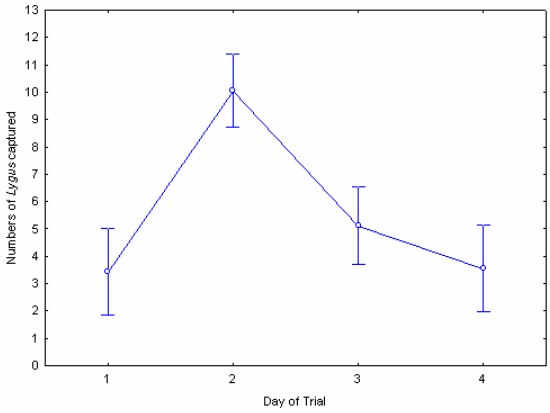

Fig. 5. Captures of *Lygus* by interception traps associated with mowed alfalfa plots. Captures for Day 1 of trial represent three days of capture before mowing; days 2-4 of trail represent daily captures following cutting of the alfalfa.

Sensitivity of *Lygus* bugs to high temperatures A laboratory study was conducted to determine the effects of high temperatures on survival and reproduction of *Lygus* bugs. The objective was to resolve enigmatic observations indicating reduced *Lygus* populations in the field under the high-temperature conditions associated with summer in the San Joaquin Valley. Groups of *Lygus* bugs were held from hatching until adulthood to determine the effects of temperature regime on development and survival (data not shown). After *Lygus* were adults, their reproductive rates were monitored in the same temperature regimes under which they had developed. Three temperature regimes were evaluated, each corresponding to an average daily temperature profile in the San Joaquin Valley for either May, July, or September. For each profile, a broken stick regression was used to mimic daily temperature fluctuations (Fig. 6). Results indicate that *Lygus* nymphs can survive and continue to develop under at least short periods of exposure to temperatures above 35°C. Combined analyses of reproduction, development and mortality data were used to calculate the population doubling-time. As expected doubling-time decreased as temperature increased, but these decreases became incrementally smaller at the higher temperature (Fig. 7). These results begin to explain reduced abundance in the field under summer conditions.

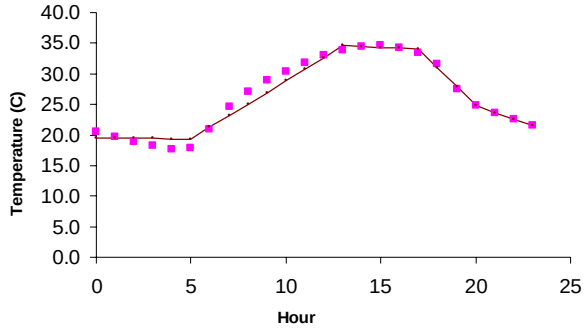

Fig. 6. Simulated (line) and actual (squares) average daily temperatures for July in the southern San Joaquin Valley.

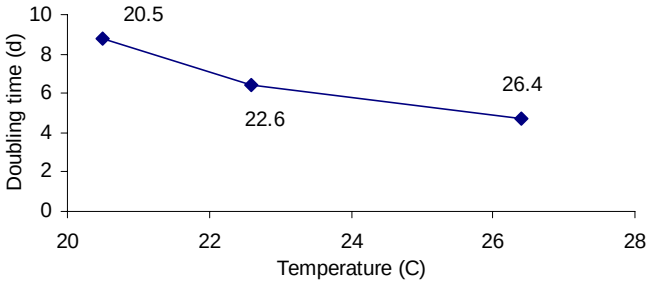

Fig. 7. Influence of temperature regime on population doubling time of *Lygus* bugs. Data labels are average daily temperatures.

Influence of cotton variety on pest prevalence and foliar injury. Efforts to define differences in attractiveness, susceptibility, or resistance to cotton insect pests for 22 varieties are continuing in 2007, but these data are not yet available. In 2006, we examined 27 cotton varieties for prevalence of aphid, whitefly, and foliar injury from chewing insects. In association with these observations we measured selected physical traits, nutrient composition, and defensive chemical components of the cotton varieties. A best subset regression was performed on plant characteristics against the three pest categories (aphids, whiteflies, and leaf injury). Increased aphid abundance was correlated with decreases in leaf redness, leaf hairiness, gossypol content, and foliar potassium. Increased whitefly abundance was correlated with decreases in foliar nitrogen, gossypol, and leaf bluing, and increases in leaf potassium. Greater leaf injury from chewing insects was correlated with decreasing phosphorus and leaf hairiness. These results identify characteristics for further study.

Additional materials are available from Jay Bancroft at 746-8003 or jay.bancroft@ars.usda.gov.

References

Bancroft, J.S. (2005). Dispersal and abundance of *Lygus hesperus* in field crops. Environmental Entomology 34(6): 1517-1523.

Acknowledgement Assistance critical to the research was provided by the SREC farm crew and student interns Jessen Bredesen, Hector Felix, Maribel Martinez, and Cameron Snell.