

PULLING IT ALL TOGETHER: MANAGING LYGUS IN THE LANDSCAPE

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This summit has successfully drawn knowledgeable individuals from diverse crops such as alfalfa seed, cotton, strawberry, cool season crops, dry beans, and apples that are produced in widely separated western landscapes from Washington to Arizona. We have listen to experts describe lygus ecology in their cropping and ecological settings. We have heard extensively on the management of lygus using a wide variety of approaches. What draws all this diverse information together?

The theme that lygus cannot be managed in isolation from its surroundings is the common thread through this entire conference.

We have learned that lygus is well adapted to the western landscape. It thrives on native plants, on cultivated crops and introduced weeds. We know it builds through the year, moving from plants that become unsuitable to those that can provide habitat for the next generation. This movement into a farmer's field usually is not a result of his or her current management practices in that field. It is a threat external to the management of the recipient crop.

We have learned that there is no "*silver bullet*" solution to lygus. No single insecticide, cultural technique, or biological approach will provide an economic and environmental satisfactory solution.

However, today we have heard numerous speakers tell us that lygus is manageable. That one tactic or another strategy can reduce the population or prevent movement. That's the good news. The bad news is that no single farm or farmer can succeed without considering context of the large region surrounding his or her fields. Professor Vern Stern, the eminent entomologist from UC Riverside, recognized this fact in 1967 when he wrote:

"The grower, faced with rising production costs at all levels must decide if he will rely completely on insecticides to fight *Lygus* and accept the financial burden or if he will look for another method of control....."

"In attacking the *Lygus* problem, chemicals are used when absolutely necessary; but first a major change must be made in farm practices to keep *Lygus* out of cotton"

Dr. Stern and his students made invaluable contributions to our understanding of lygus in a regional context (Stern, 1969). They realized that managing lygus on a large scale

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required understanding of the crops that acted as sources and which ones became sinks for lygus. Managing these sources to prevent susceptible crops from becoming sinks required management of the habitat from which lygus originated or providing alternative, preferred habitats into which they can move. Some of their ideas included:

- habitat diversification through the interplanting of alfalfa strips in a cotton field
- habitat preservation in alfalfa hay by retaining uncut strips or staggering the harvest of large alfalfa fields
- prevention of lygus movement from safflower by timing insecticides based on insect phenology.

Interest in regional approaches is increasing in the management of plant bugs in general and lygus in particular. For example, as boll weevil is eradicated in the South and the Heliothine complex is controlled with transgenic cotton, plant bugs are becoming the key pest in their cotton systems. Area-wide management, so successful in taming boll weevil, is seriously being considered as a viable management approach for lygus. Key to this approach is the destruction of host plants that provide important habitat for lygus population development.

Nordlund (in press) suggests that the tarnished plant bug (*Lygus lineolaris*) is a likely candidate for an area-wide program to suppress lygus populations in the South. Area-wide management moves the decision-making authority for the management of lygus from the individual farmer to a group authority, usually governmental or quasi-governmental (Knipling, 1978). Area-wide management is a coordinated and offensive strategy designed to reduce the pest population to easily managed numbers. Within the San Joaquin Valley, the Pink Bollworm Eradication Project and Whitefly Management Zones are examples akin to this concept.

California, and especially the Central Valley, has a wide diversity of cultivated and wild plants. These provide lygus with multiple habitats, some being preferred over others. In non-host crops such as garlic and onions, annual weeds provide suitable hosts, allowing the field to act as a source for lygus. Thus, implementing a regulatory area-wide management for lygus may not be feasible.

However, informal and community-based programs do show promise. For example, within the Tulare Lake bottom area of Kings County, farms will work together to time insecticide treatments on safflower (Sevacharian et al, 1977), coordinating both timing and insecticide choice. This approach provides some uniformity in seeking to minimize the need for duplicate treatments in a field.

Examples from the San Joaquin Valley

In northwestern Fresno County, almond growers were unwittingly driving lygus into cotton fields through poor timing of their mowing of the orchard floor. Consultants and extension advisors facilitated meetings between cotton and almond growers to develop a strategy that limited the population development of lygus while not being onerous. By mowing alternate orchard middles more frequently in those orchards that bordered cotton, lygus hosts were limited in their growth and lygus population buildup was minimized.

The use of interplanting crops to draw lygus away from the primary crop has been proposed (Stern et al, 1969). While this approach was used on large farms in the 1960's, it was abandoned shortly thereafter, primarily due to the incompatibility between cotton and alfalfa production. Other examples of trap cropping, utilize the primary crop as the trap. For example, Pima cotton (*Gossypium barbadense*) is considered more attractive to lygus than Acala cotton varieties (*G. hirsutum*). Large strips of Pima were interplanted within Acala fields to draw and concentrate lygus. The same idea is employed when strips within a cotton field were maintained in a more vigorous state of growth. These strips were considered more attractive to lygus and would concentrate the population. In both approaches, insecticides are focused on the trap area while the larger area of the field is left undisturbed. While only limited demonstration trials have been conducted to evaluate the performance of these approaches, practical experience indicates the results are of limited use.

California blackeye beans (*Vigna sinensis*) have been demonstrated (Goodell and Eckert, 1998) to be more attractive to lygus than cotton (Figure 1). The advantage of blackeye beans is their compatibility with cotton production. Beans can be sown with the same planters and at the same time as cotton. It is managed similarly and is not overly stressed when its irrigation schedule is dictated by cotton. The beans, planted on the edge of a cotton field, act as a buffer slowing the movement of lygus generally into the cotton field. Such a buffer strip could provide a killing zone in which lygus would be drawn and treated with insecticides. This approach would concentrate the lygus, reduce the overall amount of insecticides applied and preserve natural enemies on the majority of the cotton field. This concept was demonstrated on fields in the West Side of Fresno County with some success. The key problem was lygus movement into the field from many directions. If the buffer strip was encountered, lygus settled. However, lygus will not search for the buffer strips and there are practical limitations to the amount of acreage that can be committed to non-productive areas. There is a breakeven point between loss of yield (and profit) due to lygus damage and management and loss of yield due to reduction in cotton acreage to accommodate buffer or trap crops.

In many areas of the Valley, alfalfa forage plays a key role in providing stable, preferred habitat for lygus. Modified harvesting patterns has been suggested for over 30 years as a strategy for maintaining habitat and reducing the movement of lygus from alfalfa to more susceptible crops, especially cotton. This technique was articulated by Van den Bosch and Stern (1969) and Stern et al (1967) but has not been accepted due to pragmatic management issues. Demonstration trials in 1998 and 1999 (Goodell et al, 2000) have rekindled an interest in maintaining alfalfa as alternative habitat. There are two viable approaches; first leaving smaller, uncut strips in the field (Summers 1976) and second modifying the approach of Stern to ensure that vigorously growing alfalfa is available to absorb lygus displaced from harvested areas.

Following up on the observations of Summers (1976) that smaller uncut alfalfa strips will retain lygus, on-farm demonstrations were initiated in 1998. These three demonstration fields were bordering cotton fields. Two, three and eight strips were left uncut in three

fields representing 5%, 7%, and 18% of the total area. All three alfalfa fields retained lygus equally well. In contrasting the neighboring cotton to alfalfa strips, there was a 30-fold population difference in lygus density (Figure 2). In another demonstration, hand moved sprinkler lines were not removed prior to hay cutting, providing a four-foot wide strip of uncut alfalfa. This approach provided labor savings for the grower, while providing habitat throughout the field for lygus.

While there are still questions concerning the minimal amount of uncut alfalfa that is required to hold sufficient lygus, general guidelines suggest leaving end strips and several strips through the field. It is not well understood how far lygus will travel to a strip or how much of the population remains in the field. Further studies utilizing mark and recapture methods (Hagler, 1992) are planned.

The forage hay industry has expressed concern about the impact of quality when 28-day and 56-day (uncut strip from previous harvest) hay are mixed. Summers (1976) find no difference in quality but changes in variety since 1976 and current market pressures require that this concern be further examined. Experiments are underway to evaluate mixtures of old and new hay using both qualitative and quantitative measures.

The concept of splitting hay fields and staggering harvests is a valid but an unacceptable approach for farmers. However, in many locations alfalfa is produced on sufficient acreage that existing harvest schedules may provide adequate habitat. For example, in the San Joaquin Valley, hay is cut on a 28-day cycle. In any given area, it could be estimated that 25% of the fields are harvested and curing, 25% are getting the first irrigation since cutting, 25% are vigorously growing and 25% are being prepared for harvest. Thus, about 75% of the acreage in an area might be receptive to attracting and holding lygus. In 1998 and 1999, large-scale, on-farm trials demonstrated that alfalfa could provide adequate habitat and be managed to avoid lygus movement into cotton (Goodell et al, 2000). Cotton in close proximity to alfalfa resulted in lower lygus populations in those fields than in situations in which there was no alfalfa nearby (Figure 3).

Regional management issues come into focus when questions about the relationships between crops need to be addressed. What proportion of an area is required for alfalfa to be effective sink for lygus rather than a source? What are the spatial relations between alfalfa and cotton? How close to each other do they have to be? How close do alfalfa fields have to be from each other? These questions require spatial analytical techniques such as those offered by geographical information systems (GIS) and ecological landscape integration tools (Berry et al, 1998). Efforts are currently underway to investigate the usefulness of these landscape analysis approaches.

Piecing it together

The development of regional management strategies will not be easy. Successful programs have generally been imposed and involved some governmental or quasi-governmental organization to conduct the program. While lygus is a key pest in some crops in most years, it does not represent the threat that exotic pest introductions often do. Thus, the driving need to organize and work together is not compelling.

Since lygus does not threaten everyone in every year, what is the motivation to work together? Several factors actually encourage the development of community-based programs:

1. farm economics are driving the search for ways to reduce cost; i.e. avoiding insecticide costs
2. many of the cultural control techniques can be implemented and become almost transparent in the production practices
3. multiple tactics will lead to a general decrease in population density while no tactic will solve the entire problem
4. the entire area may not have to be committed; suppression and management of the population is the goal, not eradication

Many of the approaches we have heard today fit into this community-based, regional management approach. Maintaining alfalfa habitat could provide pyrethroid-free refugia while providing release sites for parasitoid releases. Safflower could be another potential release site for natural enemies of lygus, thereby slowing the area-wide buildup of the population. Introduction of lygus resistant crops could not only reduce insecticide pressure on lygus populations, but could reduce the population development in an area. Introduction of specific genes into cover crop plants could provide population reduction while avoid issues associated with GMOs (genetic modified organisms) and human food supplies.

A successful management program will result in the overall reduction in lygus population. This in turn should result in reduced movement into susceptible crops, fewer broad-spectrum insecticides required for lygus management, less secondary disruptions and improved stability in field and fruit crops. Such a program will have two pillars supporting it. The first is having adequate knowledge of lygus biology at the ecological landscape level and second is the willingness of the community to implement such a program.

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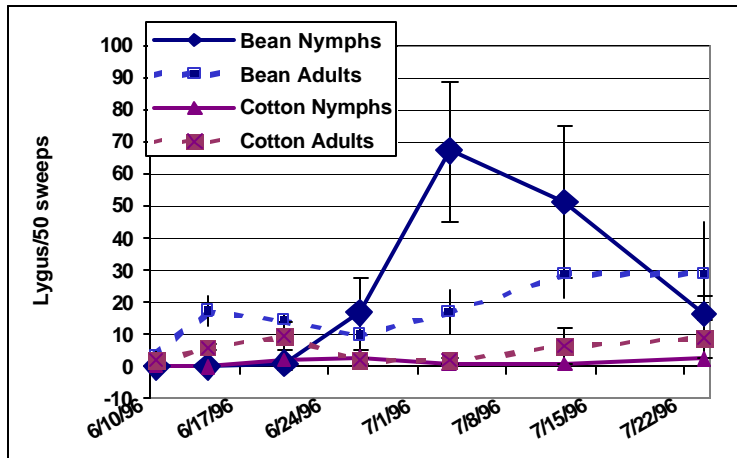


Figure 1. Lygus densities in adjacent, replicated small plots from blackeye beans and cotton. Kearney Research and Extension Center, 1996.

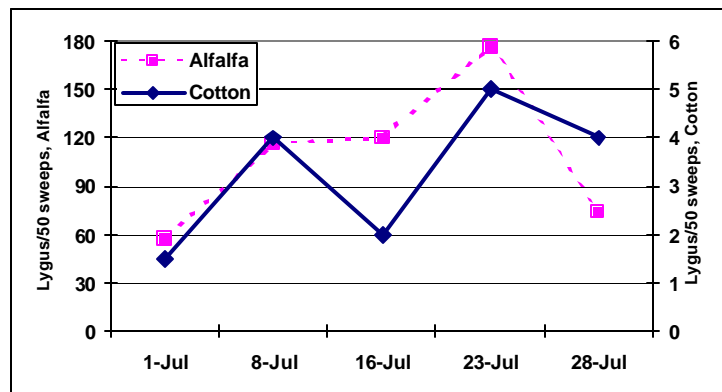


Figure 2. Lygus densities from adjacent alfalfa and cotton fields, Tulare Co. 1999. Note the difference in scale between cotton and alfalfa axes.

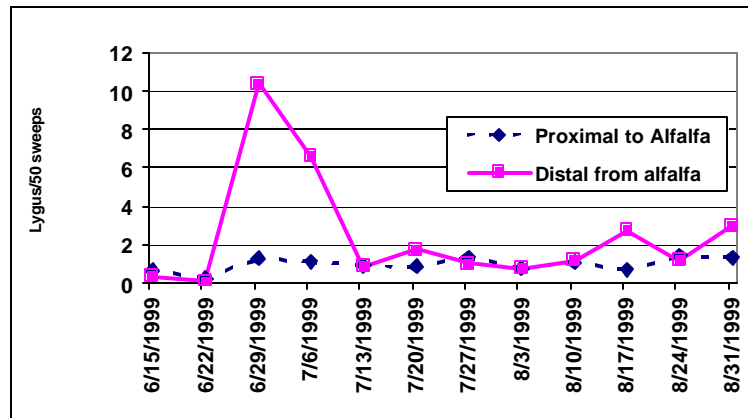


Figure 3. Lygus densities from cotton near alfalfa or distant from alfalfa, Fresno County 1998.