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MANAGING LYGUS HESPERUS IN AN ECOLOGICAL CONTEXT IN THE SAN JOAQUIN VALLEY OF CALIFORNIA

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Abstract

Lygus hesperus is a key pest on cotton in the San Joaquin Valley of California. Successful management of this pest will require an increased understanding of the insect in the ecosystem and its movement from other crops and plants into cotton. We have attempted to characterize cropping landscapes in Kern County for their propensity for *Lygus* severity in cotton. Using geographically based approaches from 2000, we examine 840,000 acres at the township level for crop diversity and the distribution and abundance of key crops. Using these data, we evaluated a conceptual approach to characterizing the landscapes for *Lygus* and cotton.

Introduction

The western tarnished plant bug (*Lygus hesperus)* is a key pest on numerous crops and present on a wide variety of weeds and other plants. The population survives at low numbers during the winter as sexually immature adults (Beards and Strong, 1966) and the population builds during the spring and summer. As one crop or host becomes unsuitable, western tarnished plant bug or Lygus moves into neighboring fields. Thus, the landscape is made up of a mosaic of crops acting as sources or sinks for Lygus through time (Stern, 1969). Within the landscape, alfalfa grown for forage has been noted as an important preferred host for Lygus and its management cited as central to Lygus management (Stern, 1969; Stern et al, 1967; Goodell et al, 2000; Summers et al, 2004).

Lygus is a key pest in cotton and invades the field from the outside. The intensity of the infestation is mostly out of the control of the grower since the severity is dependent on the crops and hosts surrounding a particular field. However, Pest Control Advisers (PCAs) have reported that the severity of the problem varies between geographical locations. In particular, landscapes that contain alfalfa forage are reported to have less mid-season Lygus infestations.

The goal of this study was to determine which factors might be important in characterizing a landscape for its propensity to develop Lygus outbreaks in cotton. Specific factors that were examined included crop diversity, relative abundance of alfalfa and cotton and proximity of alfalfa fields to each other.

Methods and Materials

The location for this study was Kern County at the southern end of the San Joaquin Valley. The data set was developed from information provided by the Kern County Agricultural Commissioner's Office for the year 2000. It was collected as part of the pesticide permit issuance procedure. The permit issuance process is geographical information system (GIS) based and requires the identity of the crop on the location which the permit is being issued. We developed a land use map based on individual fields and consolidated across townships.

The spatial relationships were analyzed using ArcView™ 8.3. The relationships were presented as individual fields (1,048) or aggregated at the township level (6 x 6 miles). For this study, the township level was deemed an appropriate scale based on the motility and trophic characteristics (Tscharntke and Brandl, 2004) of Lygus. Procedures within ArcView (e.g. clipping, selecting) or existing scripts or extensions (identify features within a distance) were utilized.

After the crop area of Kern County was mapped, the data were summarized to develop indices of crop diversity and prominence. Each crop was subjectively ranked for its suitability as a Lygus host, 1 being poor, 4 being excellent. Since alfalfa is considered important in regional management of Lygus, the abundance of alfalfa was summarized. We defined abundance in terms of the ratio of cotton to alfalfa acres and classified the townships into four categories more alfalfa than cotton, equal alfalfa to cotton, more cotton than alfalfa (2-3x) and much more cotton than alfalfa (>3x cotton).

In the San Joaquin Valley, alfalfa is cut for forage every 28 days. The adult insects are forced to leave the field and move into adjacent alfalfa fields, if in close proximity. Otherwise, Lygus would be required to move into other crops. We evaluated the proximity of alfalfa fields to each other by calculating the average distance between fields within a specific township.

Results

Crop Diversity

The data base represented an area of 840,000 acres of crop land located within the San Joaquin Valley portion of Kern County. Within the possible 127 townships, only 51 townships had crops. There were 110 different crops reported in Kern County during 2000. Within a township, there were between three to 44 crops present with an average of 20 crops per township. The most common crop (on an acreage basis) was cotton (20%), almonds (13%) and alfalfa (9%) and 20 crops represented 90% of the acreage (figure 1).

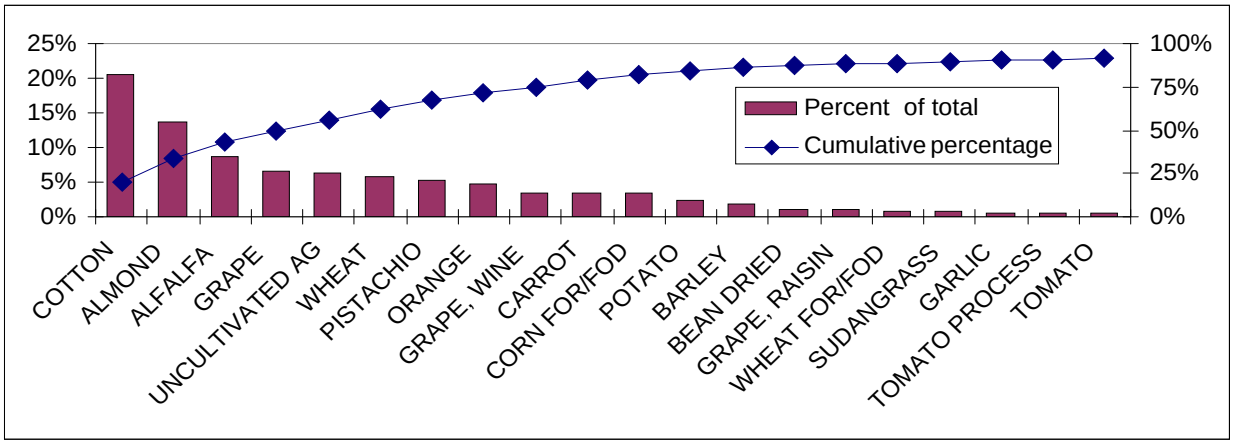

Figure 1. Crop diversity in Kern County, CA in 2000. Proportion is based on total reported acres.

When the crop suitability as a Lygus host were displayed as a map (figure 2), good to excellent hosts are embedded everywhere in the landscape. If sources of Lygus are easily found throughout the landscape, Lygus pressure would be expected to be fairly uniform through an area. However, Lygus severity in cotton is reported to vary between locations. Thus some crops might be acting as act as a sink, accepting Lygus without risk to yield while others are acting as source to cotton. Within the landscape, it would be ideal to have crops that are continually available, and could receive Lygus without consequence. Alfalfa forage is such a crop.

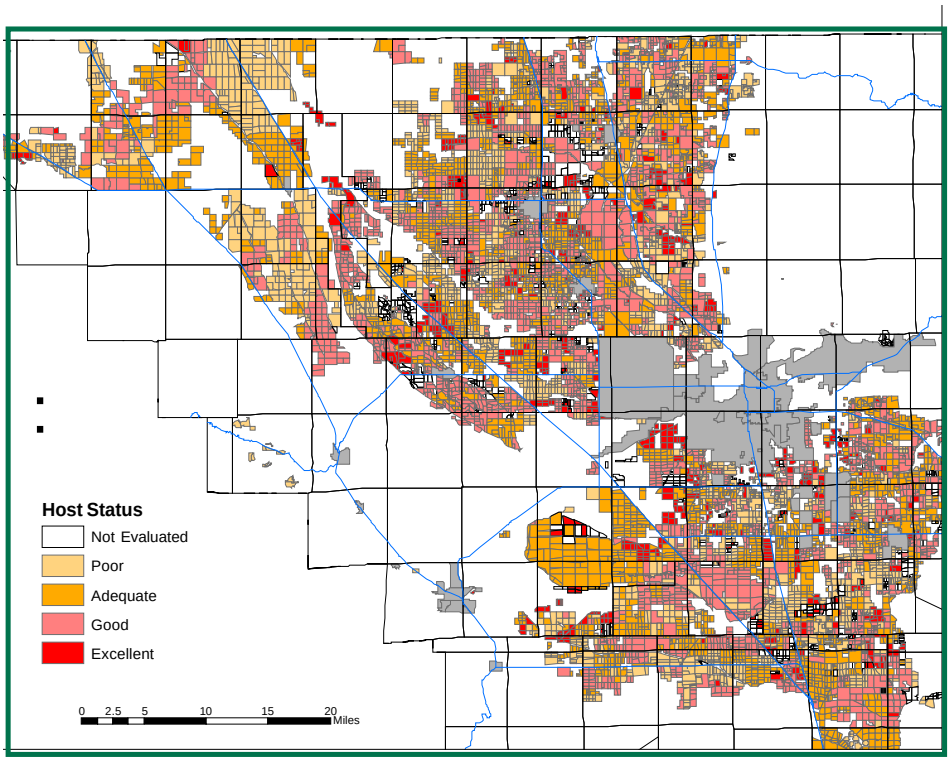

Figure 2. Distribution of Lygus hosts in Kern County, CA 2000.

Abundance: Cotton and Alfalfa Ratio

Within the 51 townships, 45 contained cotton and 34 contained alfalfa and cotton. There were 11,279 acres of cotton and 6,935 acres of alfalfa in the San Joaquin Valley of Kern County in 2000. (Figure 3).

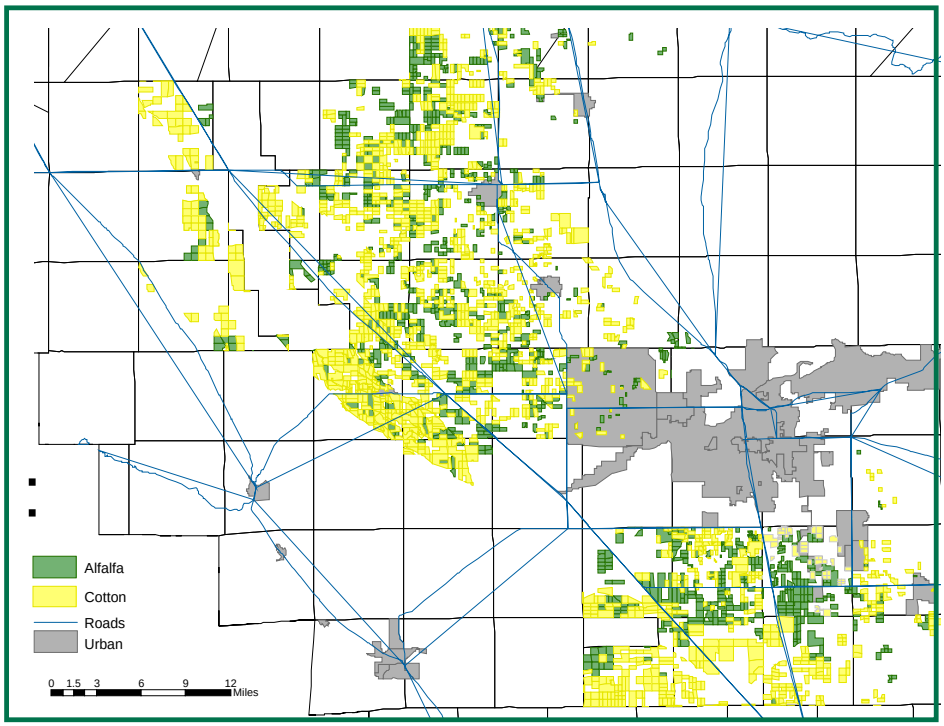

Figure 3. Alfalfa and cotton distribution in Kern County, 2000.

There were six townships that contained more alfalfa than cotton and 25 townships in which there was more cotton than alfalfa (Figure 4) and one township in which the abundance was nearly equal.

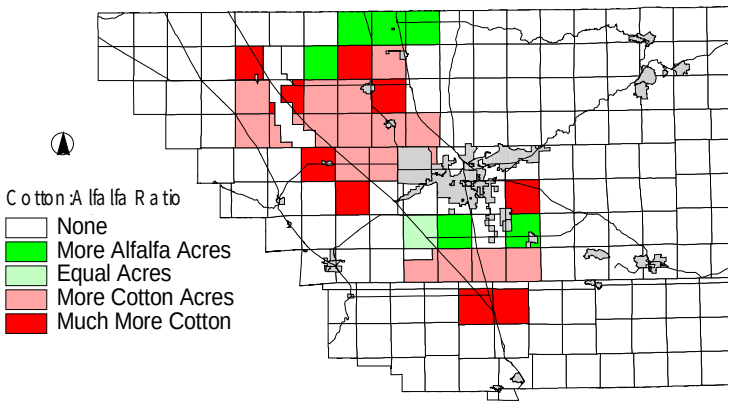

Figure 4. Relative abundance of alfalfa and cotton in Kern County townships, 2000.

Alfalfa Proximity

Alfalfa forage is cut every 28 days. While the immature Lygus are essentially removed from the system, the mobile adults will leave the field to seek shade and moisture. Adults will move into bordering cotton (at least temporarily) if no alfalfa is available.

Thus another important characteristic of the landscape should be the proximity of alfalfa to other alfalfa fields. If fields are in close proximity or small strips are left uncut, alfalfa will continue to act as a sink rather than a source.

There were 34 townships that contained at least two alfalfa fields. In 17 townships, alfalfa fields averaged more than ¾ mile from each other. In 10 townships, the distance between fields was between ½ to ¾ mile and in four and three townships the distances were ¼ to ½ mile and less then ¼ mile, respective (figure 5).

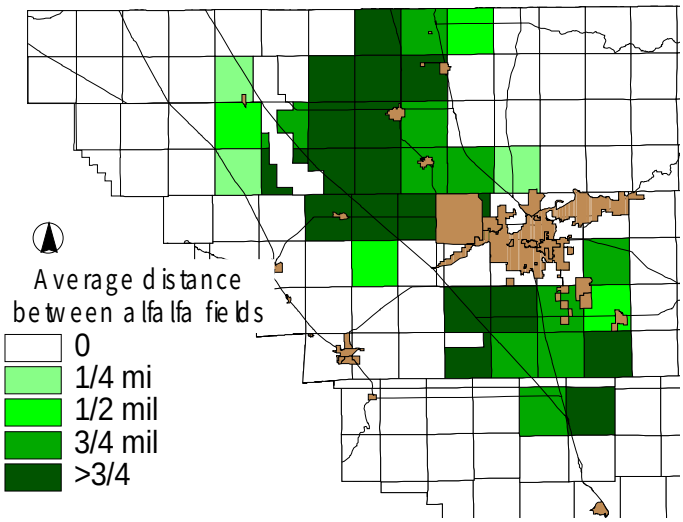

Figure 5. Average distance between alfalfa fields at the township scale in Kern County, Ca in 2000

Discussion

Alfalfa forage is a preferred host for Lygus. It is a unique crop because it is grown for its vegetative rather then its reproductive structures. Thus, alfalfa is in a continual vegetative state and is not allowed to senesce. Unlike other crops that Lygus utilize that eventually become unsuitable as a host prior to harvest, alfalfa remains attractive year round. It would seem appropriate that alfalfa abundance in township would be an important characteristic of the landscape.

The abundance and proximity of alfalfa were the key landscape components we used to characterize the Lygus threat to cotton. Looking at these components on two axes, we conceptualized landscapes (figure 6) as ranging from abundant alfalfa in close proximity (upper right) to low abundance and distal (lower left). The 32 townships were ranked by their abundance relative to cotton and the average distance between alfalfa fields and cross tabulated.

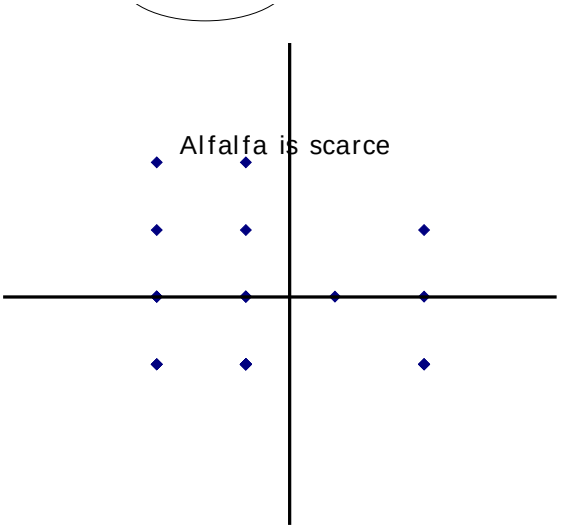

Figure 6. A conceptual illustration of the 32 townships arranged by abundance relative to cotton and distance between alfalfa fields.

We reasoned that a township with an abundance of alfalfa fields should preserve preferred habitat during the summer with minimum distance between habitats. When many alfalfa fields are present, cutting cycles are staggered through time and space and this type of arrangement should lead to fewer Lygus problems in cotton. Cotton in these townships (colored green and yellow) could be predicted to be less problematic to Lygus infestations (figure 7).

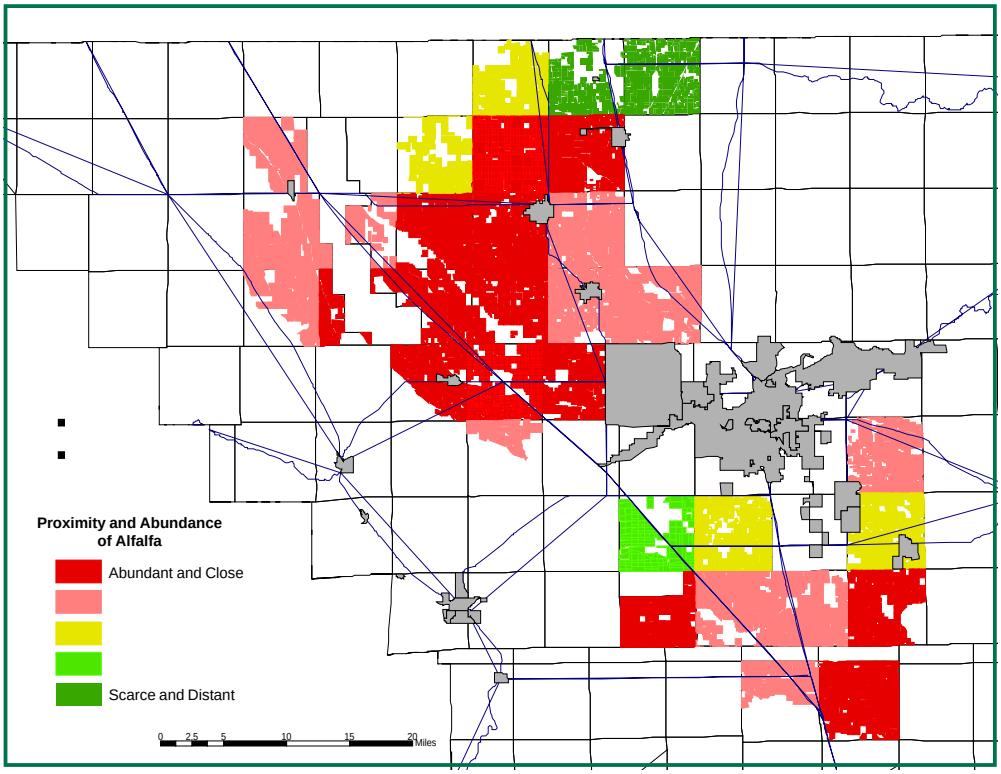

Figure 7. Thirty-two townships in Kern County color coded by alfalfa abundance relative to cotton and average distance between alfalfa fields. Townships are color coded as in Figure 6.

For example, in figure 8 can be found spatial arrangements of cotton and alfalfa in townships which occurred in the upper right (A) and lower left (B) of figure 5. These fall into expectations of areas that would be prone or exempt from Lygus infestations, respective. Township A has cotton and alfalfa in nearly the same ratio and well distributed with alfalfa fields in close proximity to each other. Township B has much more cotton than alfalfa and the alfalfa is distal to cotton and other alfalfa.

Figure 8. Examples of townships that have spatial arrangement of alfalfa and cotton that would limit Lygus problems (A) in cotton or be prone to Lygus infestation (B) in cotton.

However, the characterization of landscapes using just these two factors can be misleading. One of the highest ranked townships (upper right quadrant in figure 6) actually had very poor spatially arrangement for cotton and alfalfa (figure 9). This township contained more alfalfa than cotton with the alfalfa fields in close proximity. However, the distance between alfalfa and cotton is so great as to render this advantage useless.

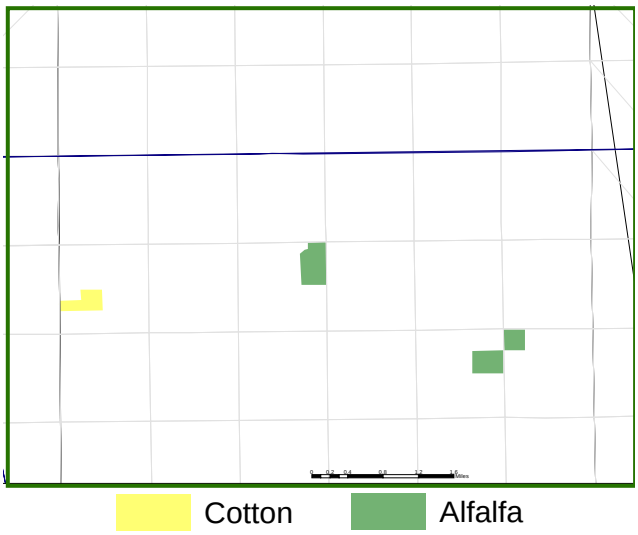

Figure 9. An example of a township that ranked high for alfalfa abundance and proximity but would not be predicted to have an influence on Lygus movement into cotton.

Characterizing a landscape for the propensity of cotton to have Lygus problems requires more than just the abundance alfalfa and cotton and the distance between alfalfa fields. Characterization should also include a host diversity index to quantify source relationships spatially and through time. The distance between alfalfa and cotton should be brought into consideration to understand how many alfalfa sinks need to between the source and cotton. Even though alfalfa can act as a sponge to absorb Lygus, if major sources are releasing Lygus at greater densities than the fields can absorb, then movement into cotton is inevitable. Thus a ratio between available sink capacity (alfalfa) and source potential (safflower, seed alfalfa, sugar beets, tomatoes or weedy fields) is critical to characterize the potential threat in a landscape. The latter (weedy fields) is difficult to ascertain from this data base since the fields are classified only as fallow or uncultivated agricultural land.

Further analysis using landscape approaches is required. An understanding of alfalfa patchiness, clustering of sources, crop assemblages and distribution of alfalfa could provide valuable factors in characterizing a landscape. Finally, to test the predictions from such models, insecticide use for Lygus in cotton would be a useful measure of the predictability of the approach. Such data are available at the section level although not directly attributable to target species. However, targets can be surmised based on product and timing.

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