SPATIAL RELATIONSHIPS OF PLANT BUGS IN LARGE SCALE COTTON OPERATIONS: DO EDGE AND ECOTONE MATTER?

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Abstract

The Cotton Fleahopper, and the Verde Plant bug (Hemiptera: Miridae) have become more problematic in recent years in the cotton growing region of South Texas. They feed on reproductive tissue: squares (cotton fleahopper) and young bolls (verde plant bug). Feeding during these stages can cause severe damage to the final cotton yield as well as introduce cotton boll rot. A pest management issue is that outbreaks vary from year to year and their densities vary from field to field. Edges and ecotones are often used in landscape ecology to aid in interpreting the functional heterogeneity of an organism. In the case of these cotton insects, how the surrounding landscape effects their population occurrence and movement from squaring through flowering. The goal of this study was to investigate the spatial relationships with these pest populations to get a better understanding on why some of these pests are present is some areas and not present in others. Our study found an edge effect for both verde plant bugs and cotton fleahoppers (more bugs were found nearer to the field edge) and ecotone modifies the strength of the edge effect. Edge effect was more predominant in the Cotton/Natural habitat ecotone than Cotton/Sorghum and Cotton/Cotton habitat ecotones. This information can prove to be useful in pest management as it may help managers focus on fields or areas of fields that may be of higher risk to colonization by these pests.

Objectives

- Investigate an edge effect on the population of cotton fleahopper and verde plant bug.
- Investigate the effect of ecotone on the populations of cotton fleahopper and verde plant bug and identify any interaction between ecotone and edge on populations of these pests.

Introduction

The cotton fleahopper feeds on cotton squares. The verde plant bug tends to feed on young bolls. These pests have one aspect in common, they both need an overwintering site after crops have been harvested and crop remnants have been tilled. The fleahopper tends to overwinter on woolly croton and selected other plants. The verde plant bug uses *Saueda* spp., a succulent type plant for overwintering. Both of these host plants occur throughout the mixture of grass and shrub land in natural habitat. Many agricultural fields are juxtaposed on this natural habitat matrix in our study area of interest.

Edges are defined as the distinct border between two different land cover types and can be hard or soft, curvilinear or straight, and natural or anthropogenic. In our case, the cover types are crops (cotton and sorghum) and are anthropogenic edges and natural habitat that borders the fields. An edge effect refers to the high population density and diversity of a species or species in the outer portion or edge of a patch of habitat, in this case fields. Ecotones are defined as the area occurring at the interface of two or more distinct landscape elements. In this study these would be the transition between different crops (cotton-cotton or cotton-sorghum) and natural habitat (cotton-natural habitat). An investigation of these effects can give us a better understanding of the spatial dynamics of these pests and perhaps provide useful information for pest management strategies including early detection and selective spatial application of insecticides.

Study Area

Our study area is a large commercial cotton and grain farming system in the coastal cotton growing region of South Texas. It is about a 30,000-acre system of cotton, sorghum, and unmanaged habitat. The unmanaged habitat is composed of mixed grass/shrub land and a bay/estuary zone that penetrates into the cropping system. There are many overwintering sites of our primary study insect pests, as well as beneficial organisms.

Methods

Since our research area provides a unique environment of large scale agricultural fields uniformly managed and juxtaposed along natural habitat areas, it provides a set up to investigate edge and ecotone effects.

Objective 1: Edge effects

- Fields were selected based on the diversity of the surrounding fields and natural habitat area surrounding them.
- A series of parallel transects 100 meters apart were constructed using ESRIs ArcMap GIS software then imported into a Trimble Juno 3b GPS unit running ArcPad. This allowed efficient collection of geo-reference data.
- Using the Juno 3b GPS system, insect samples were taken at specified localities at the edge 0m, 10m, 25m, 100m, 200m and 300m into the field.
- For Cotton Fleahopper; 40 plants were sampled using the beat bucket method and 20 plants were inspected for square damage.
- For Verde Plant Bug: 40 plants were sampled using the beat bucket method and 20 quarter sized green bolls were collected and inspected in the lab for internal damage.

Objective 2: Ecotone effects

- Ecotones of interest are cotton adjacent to cotton (CC), cotton adjacent to sorghum (CS) and cotton adjacent to natural habitat (CN).
- Two fields gave us all three transitions allowing us to proceed with transect sampling in each ecotone in a common cotton field.
- Ecotones were used as a covariate (CC,CN or CS) in analyzing the transects to investigate the ecotone effect and any interaction ecotone has on insect population density.

Results

Fleahopper

Is there an edge Effect?

When all cotton fleahopper densities were plotted against distance from edge, there was a significant negative relationship (**p <.0001**) however there was a weak **R^2** value of **0.18.** When densities were plotted against distance by the Cotton-Natural habitat ecotone, it strengthened the negative relationship with a much improved **R^2** of **0.5** (Fig. 1). This is similar to our analysis of distance with ecotone as a covariate.

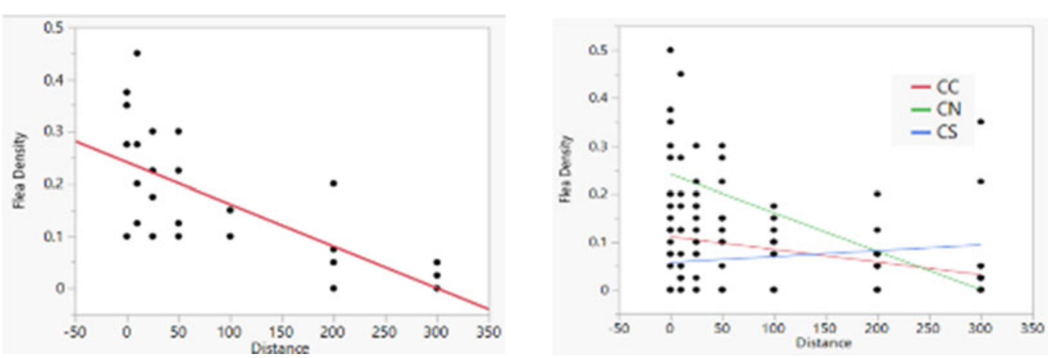

Figure 1. Linear regression of flea density vs distance. R^2: .5(left) and Linear regression of flea density vs distance with ecotone as a covariate. R^2.5 (Right).

<u>Is there an ecotone Effect?</u>

Cotton fleahpper densities were plotted against distance with ecotone as a covariate to test for an ecotone effect. There was a significant distance from the edge effect (**$p < .001$**) and a significant ecotone effect **($p < .001$)**. There also appears to be a significant interaction between ecotone and distance **($p < .001$)**, which indicates flea hopper densities on the edges are influenced by the ecotone. Overall the covariate regression model was significant with an **R^2** value of **0.4**. (Fig.2).

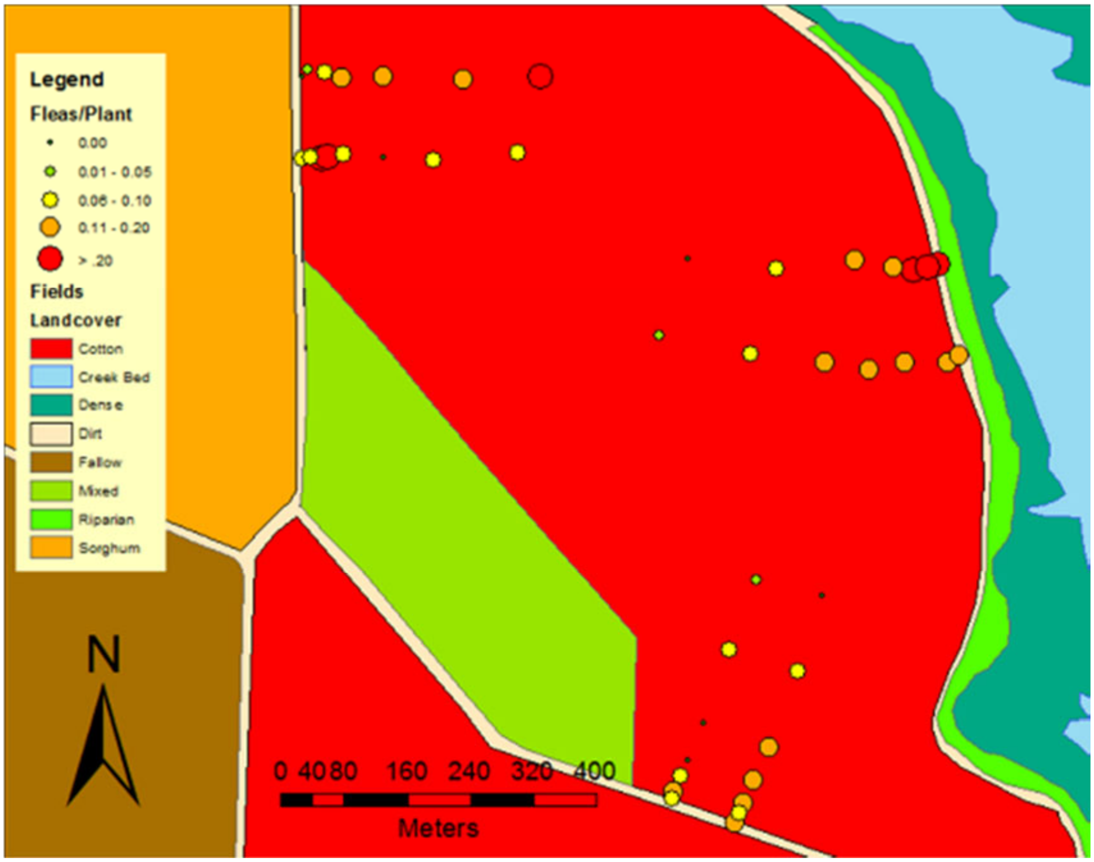

Figure 2. Cotton Fleahopper density showing the edge effect and ecotone effect driven by the cotton-natural habitat ecotone.

Verde Plant Bug

<u>Is there an Edge Effect?</u>

Verde plant bug densities were plotted against distance from edge. There was a significant negative linear relationship (**$p < .001$**) however there was a week **R^2** value of **0.11**. When the densities were plotted individually by 'ecotone' there were also significant linear relationships. For example, fig 3b shows the relationship between Verde density and distance for values in the cotton-natural habitat ecotone with an **R^2** of **0.5.** Similar results were found when analyzing an ecotone effect (Fig. 3).

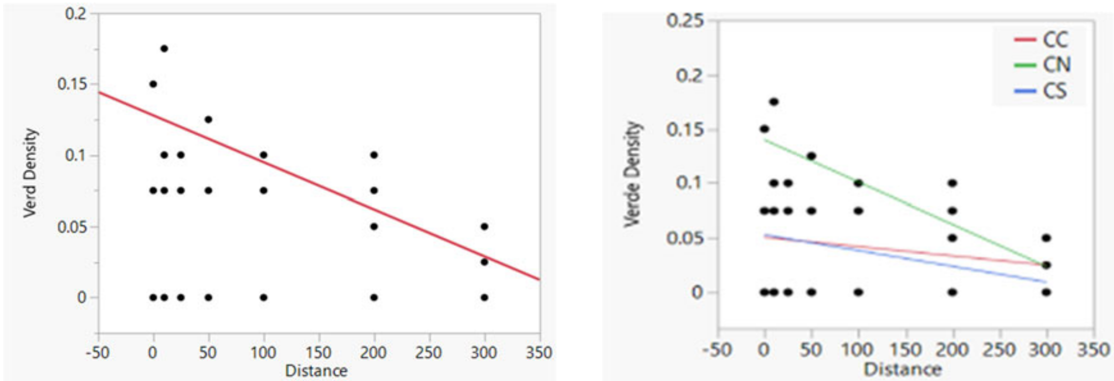

Figure 3. Linear regression of flea density vs distance. R^2: .5(left) and Linear regression of flea density vs distance with ecotone as a covariate. R^2.5 (Right).

Is there an Ecotone Effect?

Verde plant bug densities were plotted against distance from the edge with ecotone as a covariate to test for an ecotone effect. In our covariate analysis there was a significant edge effect with a (**$p < .0001$**) and a significant ecotone effect with a (**$p < .0001$**). There was also a significant interaction between ecotone and Distance (**p .0291**). This would suggest that much like fleahoppers, there appears to be more verde plant bugs on average at the edge of the cotton-natural habitat ecotone (Fig. 4).

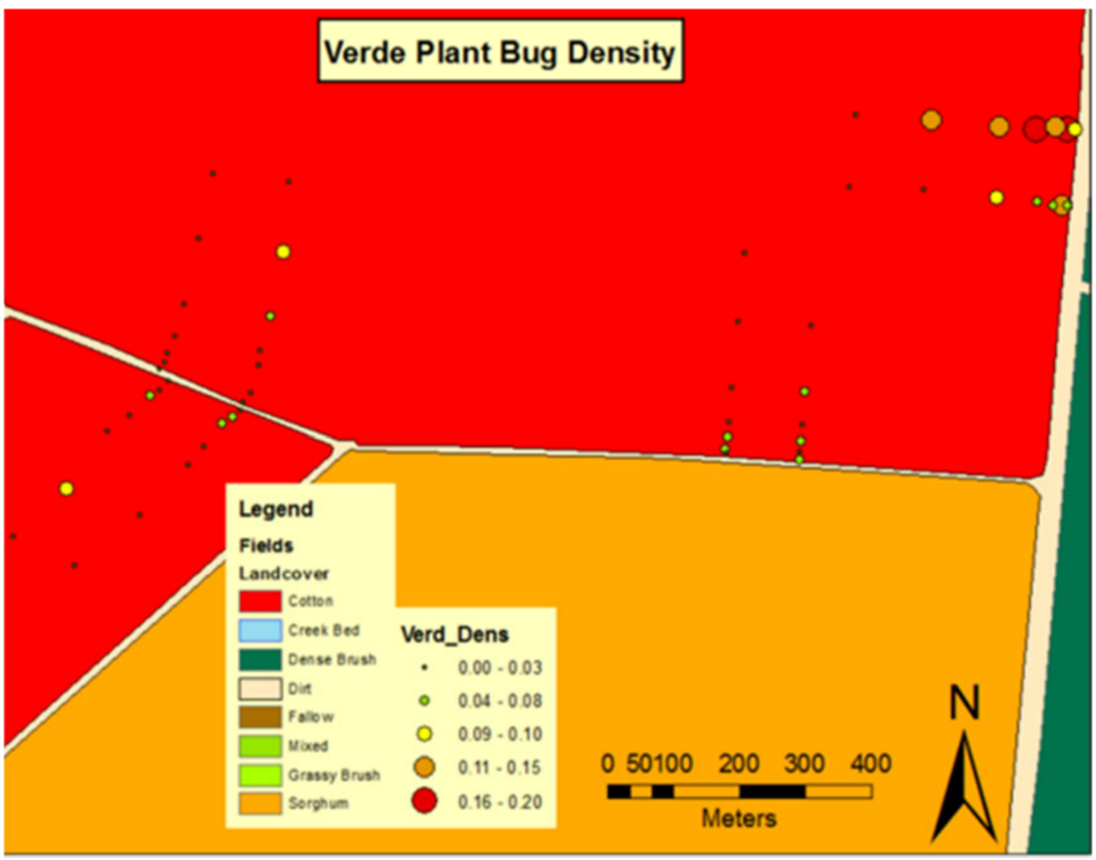

Figure 4. Verde plant bug density for the three distinct ecotones with the cotton-natural habitat ecotone influencing the interaction.

Discussion

Analysis of an edge effect for fleahopper indicates that overall there is a significant negative relationship with distance. However, when broken down by ecotone we also see a significant relationship with cotton fleahopper density at a much improved $\mathbf{R^2}$ of **0.5**. This would suggest that there is a weak edge effect overall but certain areas of the field have a strong edge effect while others may have a weaker or positive edge effect. The phenomena is similar with respect to Verde plant bug. When analyzed as a whole, there was a significant linear relationship but a weak $\mathbf{R^2}$. However when plotted separately by ecotone there was also a significant negative relationship with a much improved $\mathbf{R^2}$ value of **0.5**.

When analyzing the same data with ecotone as a covariate we see further evidence that ecotone has an effect on both the cotton fleahopper and verde plant bug densities. Our covariate analysis shows significant distance and ecotone effects. However, there is also a significant interaction between ecotone and distance. This supports that distance from the edge has a significant effect on cotton fleahopper and verde plant bug densities but only when you take into account the influence of ecotone. For example, the edge effect on the interface of cotton and natural habitat is statistically different from the edge effect at the interface of cotton and sorghum. These effects are driven by the cotton-natural habitat ecotone (fig 4) in which on average, there are more verde plant bugs and cotton fleahoppers at edge of the field along the cotton-natural habitat ecotone compared to the cotton-cotton and cotton-sorghum ecotone.

Our findings can be useful for mangers of large scale cotton systems as it appears pest densities are higher on average on sides of the field that abut natural habitat and tend to congregate at the edge of the fields between 0m – 100m. This may help save time and focus areas for detection and monitoring of insects, and possibly allow more focused and selective application of insecticides.

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