2012 final report

Submittal Date: December 13, 2012

Contract: 11-C0087
Project Name: "Cotton Ecoinformatics"
Principal Investigator: Jay Rosenheim

Final report:

I. Goals

The goal of this project was to apply an 'ecoinformatics' approach to evaluating the impact of a key pest, the herbivore *Lygus hesperus*, on commercial cotton production in California. Ecoinformatics refers to gathering a data set by 'mining' two sources of pre-existing data: (1) data on pest densities, which are produced by private pest management consultants, who monitor commercial cotton fields each year to provide real-time pest management advice to their growers; and (2) data on cotton yield and quality, which are held by farmers. These data come from cotton gins, which process harvested cotton, separating the cotton into seed and fiber, and taking automated measurements of cotton fiber color, which determines fiber quality and selling price.

II. Objectives

The project had two objectives:

Objective 1. Expand the cotton ecoinformatics data set to include data on cotton lint quality.

Objective 2. Analyze the cotton ecoinformatics data set to assess the relationship between Lygus densities observed during June, July and early August, late-season pesticide use for Lygus suppression, and cotton lint quality.

III. Methodology

The methods involved were as follows.

First, we modified a customized software application ("Cottonformatics") to accommodate the entry of detailed data on cotton lint quality.

We then entered and quality-checked all of the data. The number of records available for analysis was modest (150 crops of upland cotton, *Gossypium hirsutum*, and 39 crops of Pima cotton, *Gossypium barbadense*). Given the difficulty of obtaining additional data, especially after most of California's cotton gins have gone out of business, we decided to analyze these data sets to see if there were clear trends in the data that warranted further exploration. Pima cotton is placed into one of six color grade classes, whereas upland cotton is graded separately for two quality variables, reflectance and brightness/yellowness, creating a larger number of grade class combinations. I calculated mean color grade (for Pima cotton) and mean reflectance and brightness/yellowness grades (for upland cotton) measured across all bales harvested in a particular crop. I also calculated the total proportional loss of crop value by averaging the price discounts associated with the observed color grades, using the spot market data reported by the USDA on 12 June, 2012.

We analyzed cotton lint quality and also used our data on historical average quality of lint grown in the focal cotton fields to develop a measure of how much observed cotton lint quality deviated from the 'norm' for each particular field. Data analysis involved traditional analysis of covariance.

IV. Deliverables

The full list of deliverables was as follows:

Deliverable 1.1: Semi-annual progress reports.

Deliverable 1.2: Quarterly invoices.

Deliverable 1.3: Informal update meetings as requested.

Deliverable 2.1: The cotton lint quality data set should be completed within the first six months of the project.

Deliverable 3.1: Contractor will conduct a formal statistical assessment of the relationship between Lygus densities observed in the field (June-August) and the resulting cotton lint quality.

Deliverable 4.1: Final report documenting goals, objectives, methodology, deliverables, conclusion, and discussion.

Work proceeded on schedule, and each of these deliverables was completed within the proposed time-line. We have written a manuscript reporting the results of the cotton lint quality analyses (it will be submitted with this final report).

Here are the key elements of the formal statistical assessment of the relationship between *Lygus* densities and cotton lint quality:

Our analyses revealed that *Lygus* densities generate a host of negative effects on cotton production, including (i) loss of yield; (ii) delays in crop maturity; (iii) a need for increased applications of a plant growth regulator (mepiquat chloride); and (iv) a need for increased applications of chemical defoliants at the end of the growing season. **Nevertheless, we find that *Lygus* are not associated with any detectable changes in cotton quality.**

Table 1. ANCOVA model of factors associated with the quality of harvested upland cotton (*Gossypium hirsutum*) lint: **reflectance**

Term	df	*F*	*P*
Farm	7	6.3	<0.0001
Year	5	2.7	0.025
June *L. hesperus* density	1	0.26	0.61
July *L. hesperus* density	1	0.01	0.92

Whole model R^2_{adj} = 0.22, N = 150, P < 0.0001

Table 2. ANCOVA model of factors associated with the quality of harvested upland cotton (*Gossypium hirsutum*) lint: **yellowness**

Term	df	*F*	*P*
Farm	7	1.3	0.25
Year	5	2.1	0.07
June *L. hesperus* density	1	1.0	0.32
July *L. hesperus* density	1	0.01	0.93

Whole model R^2_{adj} = 0.07, N = 150, P = 0.051

Table 3. ANCOVA model of factors associated with the quality of harvested Pima cotton (*Gossypium barbadense*) lint: **color grade**

Term	df	*F*	*P*
Farm	3	1.5	0.24
Year	5	4.4	0.004
June *L. hesperus* density	1	0.67	0.42
July *L. hesperus* density	1	0.06	0.81

Whole model R^2_{adj} = 0.50, N = 39, P = 0.014

V. Conclusion

As can be seen in Tables 1-3, there is not even the smallest hint in these data that *Lygus* has a negative effect on cotton lint quality (neither June nore July *Lygus* densities show any effect on lint quality). This was also true when lint quality was analyzed as a difference between historical norms for a given field and the quality observed in a given focal year.

Whereas "negative" results of this sort are often viewed as disappointing, in this case it is a very happy conclusion. This is a very important result, because most insecticide applications currently directed to control *Lygus* are made during the month of July. We have found that cotton has very strong abilities to compensate (fully) for *Lygus* herbivory during July. Thus, a key recommendation emerging from our analyses is that growers should largely desist from applying insecticides during July, unless their fields have exceptionally high *Lygus* densities (i.e., >10 bugs per standard sweep sample – 50 swings of a sweep net). Such high densities do occur occasionally, but are generally quite rare. We can now say that *Lygus* not only do not produce yield losses, but also produce no loss of fiber quality. This should reassure growers that they need not fear the typical, low- to intermediate-density populations of *Lygus* that are often seen in cotton fields during July.

VI. Discussion

Interactions of herbivorous insect pests with crop plants can generate a host of diverse adverse effects. This can include direct yield loss, as well as erosion of crop quality and non-yield costs associated with increased crop management costs. The complexity of these costs can make it quite difficult for researchers and extension specialists to generate clear, data-driven pest management plans for growers. In some cases, important costs stem from farmer decision-making, and thus are difficult, if not impossible, to study in a traditional experimental setting, which typically excludes the farmer.

This study has shown how an ecoinformatics approach, based on mining pre-existing data from farmers and private pest control specialists, can provide a basis for optimizing farmer pest management decisions. In particular, the results have identified periods of time during the middle of the growing season (July) when farmers can reduce their use of insecticides dramatically without incurring any loss of yield, quality, or associated production costs. This is the primary result of the study.

The final phase of work on this project, which will extend beyond the time period of this grant (and which was not part of the original proposed work) is to conduct effective outreach to the cotton grower community to bring these research results to the key stakeholders. I have already begun this process, including meeting with a large group of influential growers to discuss the new *Lygus* management recommendations. I will continue these meetings during the winter of 2013. In addition, I am currently preparing to write an extension-oriented manuscript for submission to *California Agriculture*, which is one of the most effective means by which agricultural research in California is delivered to the farming community.

VII. Appendix I

Here I append a draft of a scientific manuscript that is currently being readied for submission to a peer-reviewed journal in entomology of integrated pest management, which reports the lint quality results and places them in the context of the impacts of *Lygus* on cotton that go beyond simple loss of yield (pounds of lint harvested per acre).

(NOTE: Draft has been removed from final report, but will be cited on website when published)