INSECT PEST MANAGEMENT AS A COMPONENT OF A SUSTAINABLE COTTON PRODUCTION SYSTEM

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Abstract

This report summarizes the results of the 2nd year of a proposed 3-4 year research and demonstration project in biological pest control, soil conservation and production economics. The goal of this project is to develop a comprehensive, sustainable production system for cotton in post-eradication Georgia and the Southeast.

Sweep, pitfall traps, whole plant/shake samples, and *Heliothis*-egg predation experiments were used to monitor and compare the seasonal abundance of beneficial and pest insects in 12 fields located in the Coastal Plain, Piedmont, and Deep Sand regions of Georgia.

Some of this year's results support earlier data from last year. More ground dwelling beneficial insects were caught in pitfall traps in conservation than in conventional tilled cotton fields. Crimson Clover was the cover crop that harbored the highest populations of plant dwelling beneficial insects. Also pest insects were more abundant in this cover crop but this observation did not lead to more pest problems during the cotton season. It appears that there is no difference in abundance of plant dwelling beneficial insects between conservation and conventional tilled fields later in the season. The egg predation experiments revealed slightly higher predation rates in conservation fields. Parasitization rates of *Heliothis* eggs and captured larvae from conservation fields were also higher.

Introduction

Pesticide use in Georgia has already declined sharply since completion of the Boll Weevil Eradication Program, while grower interest in IPM principles, sustainable agriculture and biological control has never been greater. However, it is possible that we could still miss this opportunity and end up with another non-sustainable, pesticide-based approach to cotton pest management. We need monitoring guidelines and treatment thresholds which are founded on more complete biological and economic information, and we must continue monitoring the entire natural enemy and pest complex as the system continues evolving. Softer insecticides such as *Bacillus thuringiensis* (Bt) can effectively reduce populations of pests such as the budworm/bollworm complex while preserving their natural enemies, but timing is critical when such materials are used. We must also consider the effects of *Bt* cotton in our program. Finally, cover crops have often been utilized for their soil conservation benefits, but appropriate cover crops can also serve as powerful tools for enhancing populations of beneficial arthropods and relaying them into cropping systems, thereby improving biological control of crop pests and reducing overall pesticide use.

We propose to seize the opportunity at hand and develop an area-wide IPM program for the Southeast that is built on a foundation of long-term sustainability and overall crop health. Our primary emphasis will be to manage key pests such as the *Heliothis/Helicoverpa* complex by enhancing the effectiveness of their natural enemies and by adding diversity and stability to the cotton agro-ecosystem.

Project Objectives

Rather than 'dissecting' key pests out of the system for study by themselves, we propose to develop an IPM approach that deals with the natural enemy/pest complex as components of an overall system, with the following main objectives:

1) **Habitat Management**: Use of cover crops such as vetch, winter grains and crimson clover combined with conservation tillage to improve soil quality and fertility, provide alternate habitats, and increase stability in the cotton agroecosystem. This will also help decrease the amount of soil erosion, run-off, and nutrient leaching.
2) **Crop Attributes**: Use of improved varieties and agronomic practices (planting dates, fertilization practices, etc.) combined with management of the surrounding habitat to help attract natural enemies.
3) **Treatment Thresholds**: Develop more precise treatment guidelines that include not only the pest numbers but also consider natural enemy densities. This component also focuses on pest and natural enemy biology, and on timing of treatments.
4) **Therapeutics**: Use of 'soft' materials that target the key pest while causing minimum disruption of the agroecosystem. Also considers indirect sublethal effects such as reduced fecundity, behavioral disruptions, etc.
5) **Economics**: Help make cotton more sustainable by reducing energy, equipment, pesticide, fertilizer and labor input costs, and by maximizing yields and net returns.

Materials and Methods

Twelve fields in four counties in the Piedmont, Coastal Plain, and Deep Sand regions were monitored during the

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1997 season. Seven of the fields were conservation-tilled with a winter cover crop, and five of the fields were conventional-tilled. The two Piedmont sites, located in Morgan county, included a 10 ha conservation-tilled field with a canola cover crop and a nearby 4 ha conventional-tilled field. The two Deep Sand sites, located in Decatur county, were an 11 ha conservation-tilled field with a rye cover crop and adjacent, a 7 ha conventional-tilled field. The remaining eight fields were all located in the Coastal Plain region. The Jenkins county site was a 10 ha field with a rye cover crop. In Spring two strips of buckwheat was planted; the site in nearby Burke county was a 12 ha conventional-tilled field. The other six fields were all located in Coffee county. Four of the sites were conservation-tilled fields with cover crops, including a 3 ha field with Crimson clover, a 15 ha field with a wheat/rye mixture, a 6 ha field with a mixture of Crimson clover and rye and a 10 ha field with rye. Two sites were conventional-tilled fields of 10 and 15 ha.

Insect Sampling Methods

Pitfall Traps
Eight traps per field were monitored weekly from April 7 through September 25. Construction of the traps is described in Haney et al. (1996), and each trap site was marked by a 2 m stake tied with red flagging ribbon. Insects that were monitored are listed in table 1 (pitfall traps). The contents of each trap were collected in separate cups and were inspected in the laboratory. The cups were also checked for cracks or damage before being refilled with rock salt and fresh water.

Sweep Samples
Sweep samples were taken weekly between April 7 and May 28 in the seven conservation-tilled fields. There was no reason to sweep in the conventional tilled fields as these fields had no ground cover. 25 sweeps were taken with a 36 cm (15 inch) net at 16 randomly selected locations, for a total of 400 sweeps per field. The sweep samples were collected in marked paper bags, stored in cool boxes and the insects were identified and counted in the laboratory. The identified beneficial and pest insects are listed in table 1 (whole plant samples).

Whole Plant / Shake Samples
Whole plant/shake samples were taken from July 9 through August 27. Each field was divided into four approximately equal sections. Plant samples were then taken from 8 plants per section, for a total of 32 plant samples per field. The plants were carefully examined for beneficial and pest insects. Worms were collected in marked diet cups and taken back to the laboratory to check for parasitization. Four shake samples per field section were obtained with a 'beat-sheet' of 1x1 m. 1 m rows of cotton plants on both sides of a 'beat-sheet' were vigorously shaken and the dislodged insects were identified and counted on the sheet. Worms were collected in marked diet cups and taken back to the laboratory to check for parasitization. The identified beneficial and pest insects are listed in table 1 (whole plant samples).

Heliothis Egg Predation Experiment
Heliothis egg predation experiments were conducted simultaneously in 3 conservation fields and in a nearby conventional field between June 25 and August 29. In 4 randomly chosen rows of 25 m in the field, 20 sterile *Heliothis* eggs were distributed over 20 plants, that were located approximately 2 m apart. The eggs were attached to the upper surface of a leaf in the top of the plant. The eggs were placed on the leaves with a camel hair brush and glued with a solution of 30% Plantgard® and 70% water (Nordlund et al., 1974). To help facilitate location and evaluation, leaves with eggs were numbered with a waterproof laundry marker, and each sub-plot was marked with red flagging ribbon. Plots were evaluated after 24 hours and the remaining eggs were removed and taken back to the laboratory to check for egg parasitization.

Results and Discussion

Pitfall Traps
In the period before cotton planting higher numbers of ground dwelling beneficial insects were collected in conservation fields than in the conventional fields ($p<0.05$) in the Coastal Plain Region (Fig. 1). In the Piedmont and Deep Sand regions significant differences were not observed and this is probably caused by the poor ground coverage of resp. canola and rye at that time. After planting significant differences in number of beneficial insects between conservation and conventional tilled fields was observed in all regions (Fig. 2).

Sweep Samples
One of the benefits of a cover crop is that it encourages beneficial insect populations to build up early in the season. These beneficial insects are expected to relay into the cotton crop as the season progresses. Significantly more beneficial insects were collected from fields with cover crops wheat/rye, Crimson clover, and a mixture of Crimson clover and rye ($p<0.05$, Duncan Multiple Comparison Test, SAS, Fig. 3). However, also significantly more pest insects were collected. Higher numbers of pest insects in the cover crops are necessary to maintain high population levels of beneficial insects. Additional insect problems in the cotton season resulting from higher pest levels in the cover crops were not observed.

Whole Plant / Shake Samples
Unlike expectations that more beneficial insects may be found in cotton fields with cover crops, no differences were observed between conservation and conventional tilled fields (Fig. 4). Also, last year did we observe no differences except in fire ant populations (Lewis et al., 1997). A higher number of beneficial insects may be present earlier in the

season on cotton plants in conservation fields due to the presence of cover crops, but beneficial insects eventually will also invade conventional fields. Therefore the difference in number of beneficial insects between conservation and conventional fields may likely decrease rapidly. Whole plant / shake sampling started when the cotton had reached the 6-8th leaf stage so we may have missed the early season difference. Surprising, however, were the higher parasitization rates in collected eggs and worms from conservation fields in Coffee county (Fig. 5).

Heliothis Egg Predation/Parasitization Experiments

Lewis et al. (1997) found that early season predation of *Heliothis* eggs surpassed 85% in the conservation fields versus only <25% in the conservation field. For this year predation contrasts between conservation and conventional fields were less clear. Egg predation in the conventional field was generally lower than in the three conservation fields, but this was statistically not significant (Fig. 6). The first replication indicated a similar trend as observed by Lewis et al. (1997), but later replications were not as striking. These results suggest that differences in predation rates can only be observed very early in the season. The parasitization rate of the retrieved eggs was generally lower in the conventional field but also this was statistically not significant (Fig.7).

Summary

Our 2nd year results support data from similar studies we conducted in previous years (Haney et al., 1996; Lewis et al., 1996; and Haney and Lewis; 1997; Lewis et al., 1997). We found that in nearly every case seasonal densities of major ground dwelling predators in the conservation-tilled cover crop fields were significantly higher than densities in the conventional fields. Although no differences were observed in numbers of plant dwelling beneficial insects, slightly higher *Heliothis*-egg predation and parasitization rates were obtained in conservation fields. This was especially true for the conservation field with Crimson Clover as cover crop. In this field we also obtained the highest parasitization rate of captured larvae.

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Table 1. List of Monitored Insects

Beneficial Insects	
Pitfall Trap Sampling	Spiders
	Centipedes
	Staphylinidae (6 spp.)
	Ciccindellidae (2 spp.)
	Carabidae (17 spp.)
	Earwigs (Dermapterae)
	Ants
Whole Plant Sampling	Parasitoids (Hymenopterae, 10 spp.)
	Coccinellidae
	Hoverflies (Syrphidae)
	Big eyed bugs (*Geocoris* spp, 2 spp.)
	Lacewings (Chrysopidae, Hemerobiidae)
	Damsel bugs (Nabidae)
	Assasin bugs (Reduviidae)
	Minute Pirate bugs (Anthocoridae)
	Ant-like flower beetles (Anthicidae)
	Predacious stinkbugs (Asopinae)
	Ants
Pest Insects	
Whole Plant Sampling	Tabacco Budworm (*Heliothis virescens*)
	Corn Earworm (*Helicoverpa zea*)
	Beet Armyworm (*Spodoptera exigua*)
	Cabbage Looper (*Trichoplusia ni*)
	Thrips
	Aphids
	Tarnished Plant Bugs (*Lygus lineolaris*)
	Stinkbugs (Pentatomidae)

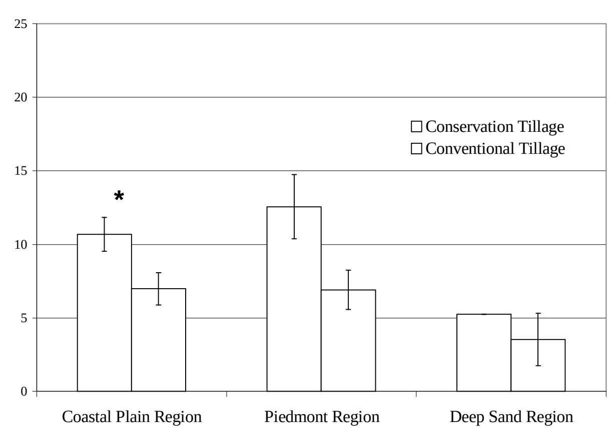

Figure 1. Mean Number of Ground Dwelling Beneficial Insects per Pitfall Trap in 3 Regions of Georgia before start of Cotton Season.

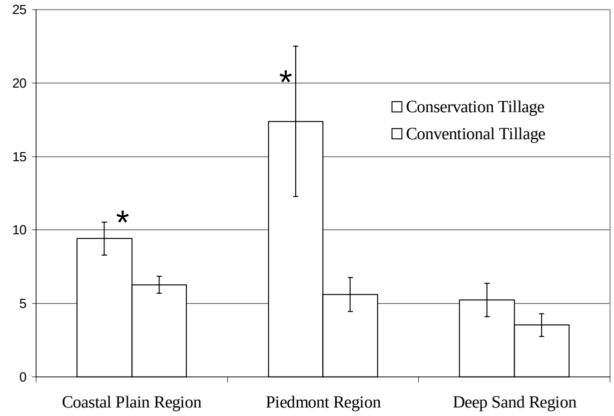

Figure 2. Mean number of ground dwelling beneficial insects per pitfall trap in 3 regions of Georgia during cotton season.

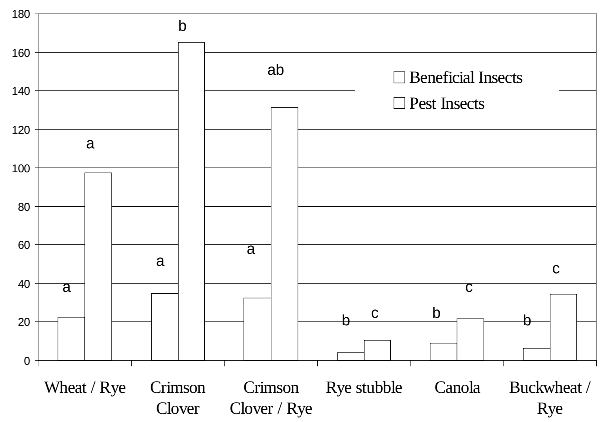

Figure 3. Mean number of insects per sweep in different cover crops.

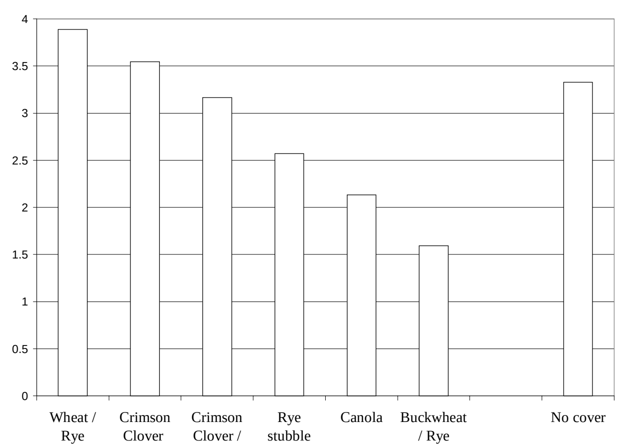

Figure 4. Mean number of plant dwelling beneficial insects per whole plant sample in cotton.

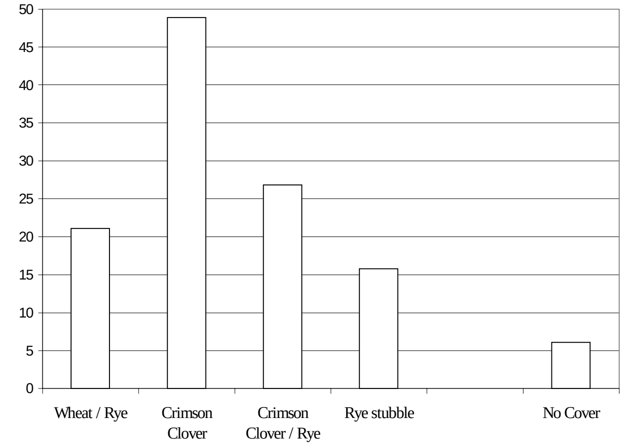

Figure 5. Percent Parsitization of Lepidopteran pests* in Coffee Co. *Larvae and eggs of *Heliothis virescens, Helocoverpa sea, Spodoptera sxigua, Trichoplusia ni*

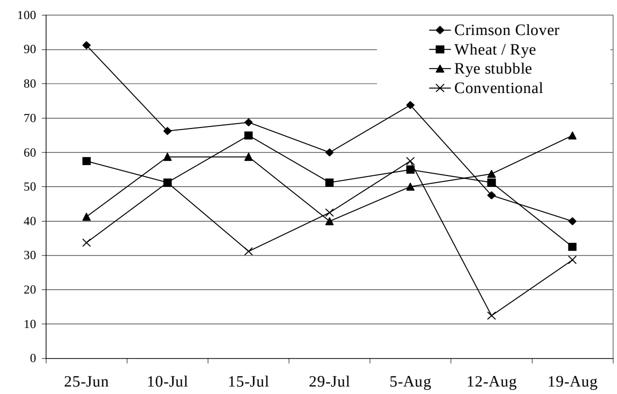

Figure 6. Percent predation of *Heliothis* eggs in cotton fields with differenct cover crops.

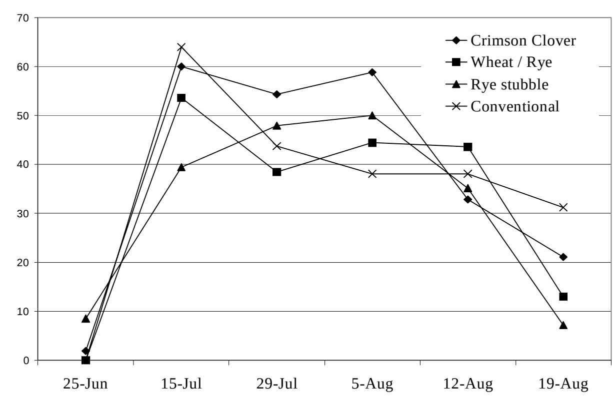

Figure 7. Percent parasitization of *Heliothis* eggs in cotton fields with different cotton crops.