Population Dynamics of Insect Pests and Beneficial Arthropods in a Crimson Clover/Cotton Ecosystem with Conservation Tillage Cotton

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Abstract

Populations of the tobacco budworm, *Heliothis virescens* (F.), the cotton bollworm, *Helicoverpa zea* (Boddie), and their natural enemies were monitored April 27-Sept. 8, 1993 and April 21-Sept. 1, 1994 in crimson clover *(Trifolium incarnatum* L.) and a subsequent conservation tillage cotton *(Gossypium hirsutum* L.) crop. Treatments included winter cover (crimson clover and fallow) and midrow weed control method (herbicide-glyphosate and V-blade cultivator). Thrips were counted weekly May 18-June 17, 1994. Predaceous arthropods (mostly the bigeyed bug, *Geocoris* spp.) and parasitoids (Hymenoptera: Braconidae) were very active against *H. zea* and *H. virescens* populations in crimson clover during May. Pest population densities remained low through June in cotton. The peak in tobacco budworm/cotton bollworm population densities occurred during July. Bigeyed bugs, lady beetles, and ants were the most abundant predators. Densities of ants were highest in plots that had a clover cover and were not cultivated, and tobacco budworm/cotton bollworm egg reductions were detected in noncultivated plots. Egg parasitism by *Trichogramma* spp. was important in helping to reduce bollworm populations during August. Thrips numbers were low and highly variable among treatments with no clear patterns.

Introduction

Increased interest in conservation tillage has caused concern about the potential of insect pests and the efficacy of their natural enemies in these systems. Conservation tillage has the potential to control soil erosion and to help growers use energy more efficiently. The effects of conservation tillage on specific arthropods in cotton are important because of the relationship of some arthropods with the soil and with various cover crops such as crimson clover *(Trifolium incarnatum* L.).

The major lepidopterous pests in cotton in South Carolina belong to the tobacco budworm (TBW), *Heliothis virescens* (F.)/cotton bollworm (CBW), *Helicoverpa zea* (Boddie), complex. These pests overwinter as diapausing pupae in earthen cells as deep as 6 inches. Overwintered moths emerge largely during May through exit tunnels made by the prepupae the previous year (Neunzig, 1969). Throughout the cotton growing season, prepupae drop to the soil before pupation and tunnel to the depth of about one inch. There can be up to four generations per year in South Carolina cotton. Roach (1981a) reported that although greater numbers of moths emerged from conservation-tillage plots, *Heliothis/Helicoverpa* populations in conservation-tillage and plow-tillage plots in cotton had similar densities (Roach 1981b).

The impact of predaceous arthropods on TBW in cotton during early season in South Carolina has been determined (Greene et al. 1995). Beneficial arthropods helped reduce numbers of TBW, providing adequate control in early season. Conservation-tillage systems may alter pest and beneficial insect populations (All and Musick, 1986). As much as possible, we should avoid practices that interfere with biological control and utilize procedures that favor the biological potential of natural enemies so that minimal insecticide applications will be necessary.

The purpose of this study was to document seasonal occurrence and population densities of thrips, tobacco budworm/cotton bollworm (TBW/CBW), and their natural enemies in conservation tillage systems.

Materials And Methods

Research was conducted at the Pee Dee Research and Education Center near Florence, South Carolina. Cotton ('DES 119') was planted with a four-row no-till planter in 38-inch rows. Plots were 8 rows wide and 50 feet long. Treatments included winter cover (crimson clover and fallow) and midrow weed control method (herbicide-glyphosate and V-blade cul-

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tivator). Treatments were arranged in a randomized complete block design with a split plot arrangement. Winter cover was the main plot, and the midrow weed control method was the subplot. Crop management and treatment applications are described by Bauer et al., 1994. Insecticide treatments targeting TBW/CBW were applied July 21 (Larvin) and July 27 (Scout@), and August 12 (Asana) in 1993; no insecticides were applied during 1994 against these insect pests.

Eggs and larvae of TBW/CBW and their natural enemies were monitored and sampled during two growing seasons, 1993 and 1994. Samples were collected one **or** two times per week April 27-Sept. 8, 1993 and from April 21 through Sept. 1, 1994. Thrips were counted weekly May 18-June 17, 1994.

Larvae were collected from crimson clover during April and May using a heavy sweep net (14.75-in. diameter). Eggs and larvae were collected and population density estimates were recorded from the visual examination of 100 cotton plants per treatment once or twice per week. Predaceous arthropod populations were estimated by using a 15-quart dishpan (14 X 13 x 6 in.). The plants (2 meters per plot) were bent gently over and shaken into the dishpan in order to count predators.

Each collected larva was placed in a 30-ml plastic cup containing artificial diet (Greene et al. 1976). Eggs were transported to the laboratory and placed individually in size 0 gelatin capsules. Larvae and eggs were held at 26 ± 2 °C, $60 \pm 5\%$ RH, and a 14:10 LD regimen and checked every 1 to 2 days for hatching, parasitoid emergence, pupation, and disease symptoms. Egg parasitoids were prepared and mounted on slides for identification. Adult parasitoids that emerged from pest larvae, along with their cocoons, were preserved in vials of 95% ethyl alcohol and identified by the senior author.

Results and Discussion

Insect pests

1993. Population density of TBW/CBW larvae was not determined in crimson clover. The peak population in TBW/CBW eggs occurred in cotton during late July 1993 with 84 eggs per 100 plants. Larval density reached only 2 per 100 plants. Percent composition of species is listed in Table 1.

1994. Thrips population densities during May and June 1994 are depicted in Figure 1. On May 23, population density peaked at less than 0.5 thrips per seedling. Insecticide applications are recommended when one or more thrips per plant are detected in the seedling stage. Through most of the sampling period, however, thrips numbers were highly variable among treatments with no clear patterns. Ruberson et al. (1995) reported that thrips populations were generally lower in reduced tillage (clover, strip-tilled) than in conventional tillage cotton. Economic threshold levels were not reached in either tillage system. The peak population density was less than 13 and 23 thrips per meter on July 29 and August 24 in conventional and reduced tillage, respectively. Thrips population densities are typically reduced in conservation tillage production systems relative to conventional ones (J. All, personal communication)

Egg numbers of TBW/CBW were low during June through the 6-leaf stage of cotton. Two peaks in egg densities are depicted in Figure 2. All plants were blooming at the time of occurrence of peak TBW/CBW population densities on July 25, and eggs were reduced in fallow, noncultivated (FH), conservation tillage plots. During August when bolls formed, egg densities were lower than during July.

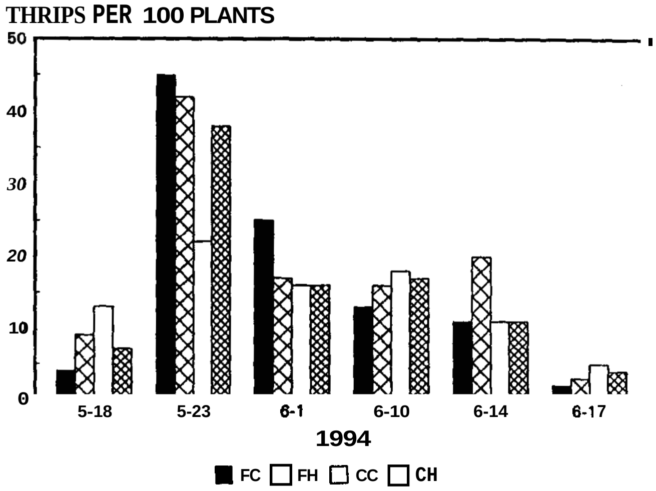

Figure 1. Population densities of thrips in fallow cultivated (FC), fallow herbicide (FH), clover cultivated (CC), and clover herbicide (CH) treated cotton. Florence, SC, 1994.

Table 1. Percent composition of two lepidopterous species in crimson clover during May and cotton during June, July, and August 1993. Florence. SC.

	n	*Heliothis virescens*	*Helieoverpa zea*
May	153	35.3	**64.7**
June	48	*19.2*	20.8
July	211	25.6	74.4
August	78	< 1.0%	99.6%

Predaceous Arthropods

1993. Beneficial arthropods were very active in crimson clover during the spring. During April, lacewings *(Chrysopa* spp.) were most prevalent, followed by lady beetles (Coccinellidae) and spiders (Araneida). The most prevalent predators during May 1993, were the bigeyed bugs (Geocoris spp.), followed by lady beetles, spiders, and nabids (Nabis spp.). Ants (Formicidae) were least prevalent.

During June, predators sampled with the dishpan reached a population density of 4.6 per m of row. Bigeyed bugs were most prevalent.

Predaceous arthropod populations peaked in midJuly

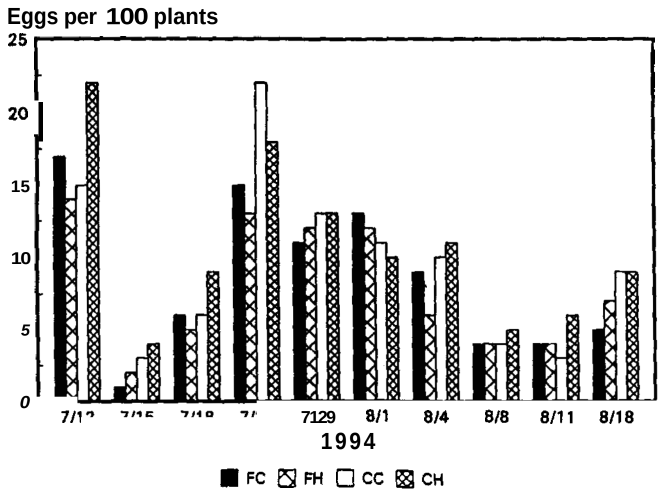

Figure 2. Population densities of tobacco budworm/cotton bollworm **eggs** in fallow cultivated (FC), fallow herbicide ((FH), clover cultivated (CC), and clover herbicide (CH) treated cotton. Florence, ***SC,*** **1994.**

reaching 9.2 per m of row. It appears that high numbers of bigeyed bugs helped to suppress the pest population but were not successful in maintaining egg densities below economic threshold levels. Insecticides were applied on July 21 and 27 and August 12.

1994. The most prevalent predators in crimson clover during April were lady beetles, followed by nabids and spiders. As in 1993, the bigeyed bug became the most prevalent predator from the maturing crimson clover during mid-May 1994.

During June when egg numbers of TBW/CBW were low,

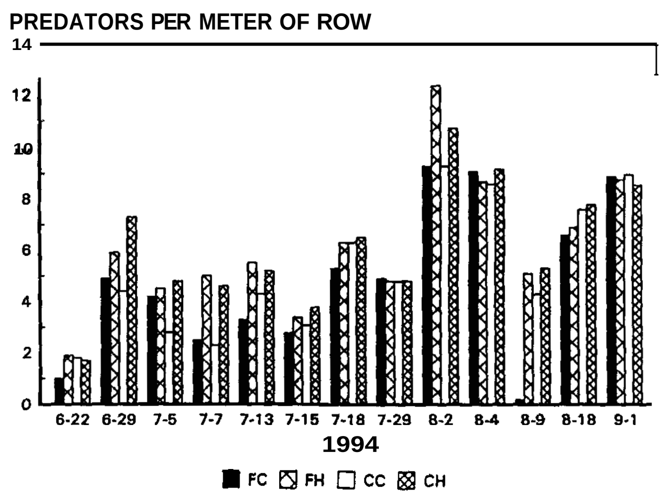

Figure 3. Population densities of predators in fallow cultivated (FC), fallow herbicide (FH), clover cultivated (CC), and clover herbicide (CH) treated cotton. Florence, SC, 1994.

predators sampled with the dishpan reached a population density of 7.5 per m of row. Ants were the most abundant predators.

Numbers of predators peaked at 13 per meter of row on August 2 (Figure 3), and pests did not reach economic thresholds. Ants were most abundant (Figure 4), followed by lady beetles and spiders (Figures 5 and 6, respectively). Bigeyed bugs, hooded beetles, and nabids were also present (Figures 7, 8, and 9, respectively). It appears that fire ants may have been reduced in cultivated plots during early July. The V-blade cultivator ran 1.5-2.0 inches under the soil surface with little disruption of surface residue. The cultivator

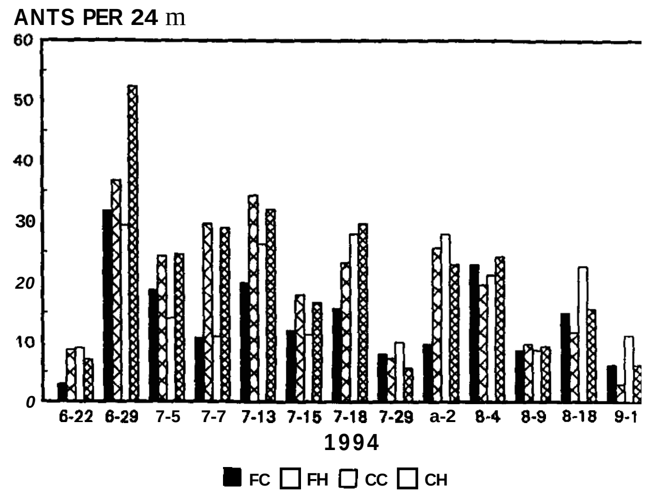

Figure 4, Population densities of ants in fallow cultivated (FC), fallow herbicide (FH), clover cultivated (CC), and clover herbicide (CH) treated cotton. Florence, SC, 1994.

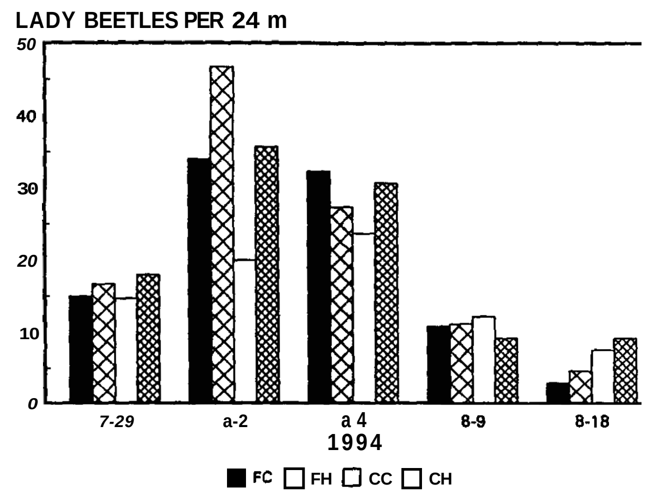

Figure 5. Population densities of lady beetles in fallow cultivated (FC), fallow herbicide (FH), clover cultivated (CC), and clover herbicide (CH) treated cotton. Florence, SC, 1994.

was utilized on June 13 and July 7 and 13. Ruberson et al. (1995) reported that there were more fire ants in a reduced tillage cotton field planted after clover as a cover compared with a conventional field of cotton.

Parasitoids

Parasitism of TBW/CBW larvae was high in crimson clover, reaching 66 and 33% during May of 1993 and 1994, respectively. Parasitoids included the braconid wasps *Cardiochiles* nigriceps Viereck, *Meteorus autographae* Muesebeck, and *Microplitis croceipes* (Cresson) both years. The braconid *Cotesia marginiventris* (Cresson) was detected only in 1993. Percentage of parasitism by various species is listed in Table 2. A eulophid wasp *Euplectrus* sp. occurred only in 1994. McCutcheon et al. (1981) reported that each of these beneficial wasps are active in agronomic crops later in the growing season. Crimson clover serves as an excellent host plant for beneficials to build up on.

Egg parasitism by *Trichogramma* spp. reached 30% by late July during both seasons, regardless of pyrethroid treatments applied 3 days prior to sampling during 1993. Egg parasitism

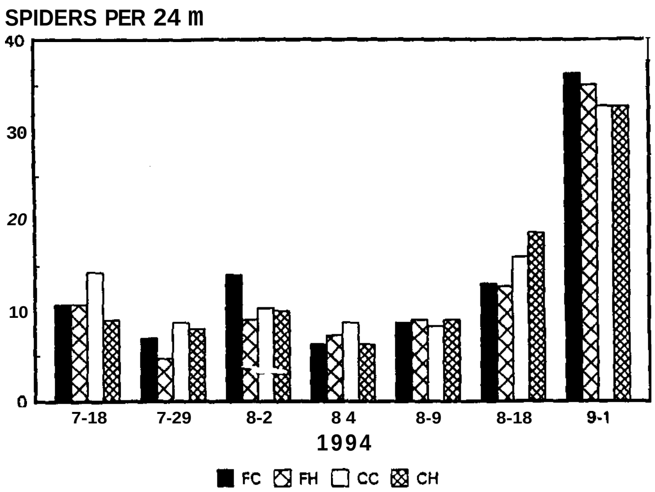

Figure 6. Population densities of spiders in fallow cultivated (FC), fallow herbicide (FH), clover cultivated (CC), and clover herbicide (CH) treated cotton. Florence, SC, 1994.

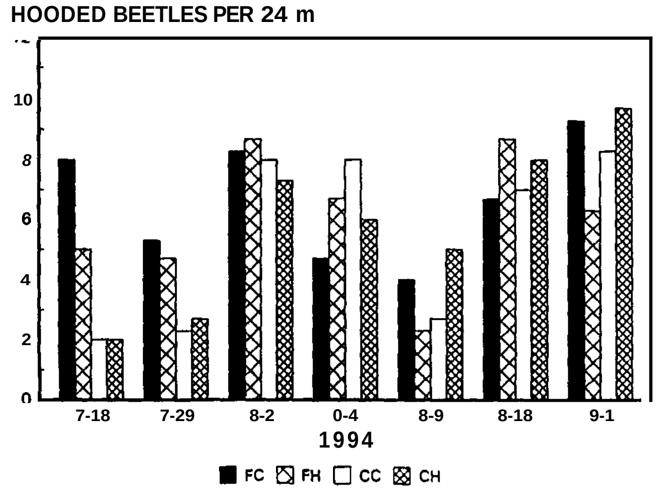

Figure 8. Population densities of hooded beetles in fallow cultivated (FC), fallow herbicide (FH), clover cultivated (CC), and clover herbicide (CH) treated cotton. Florence, SC, 1994.

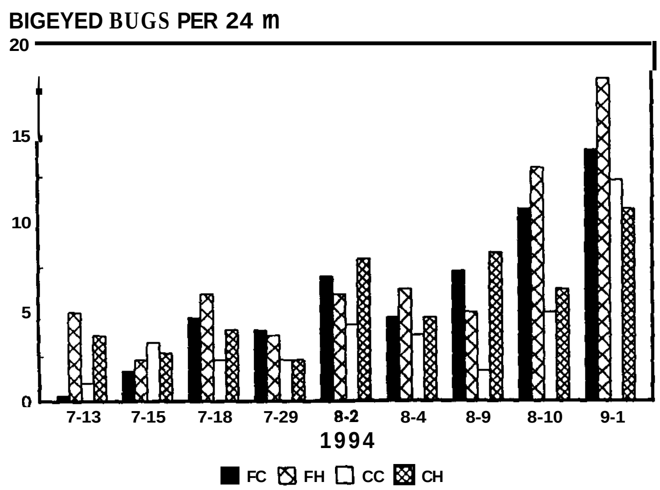

Figure 7. Population densities of bigeyed bugs in fallow cultivated (FC), fallow herbicide (FH), clover cultivated (CC), and clover herbicide (CH) treated cotton. Florence, SC, 1994.

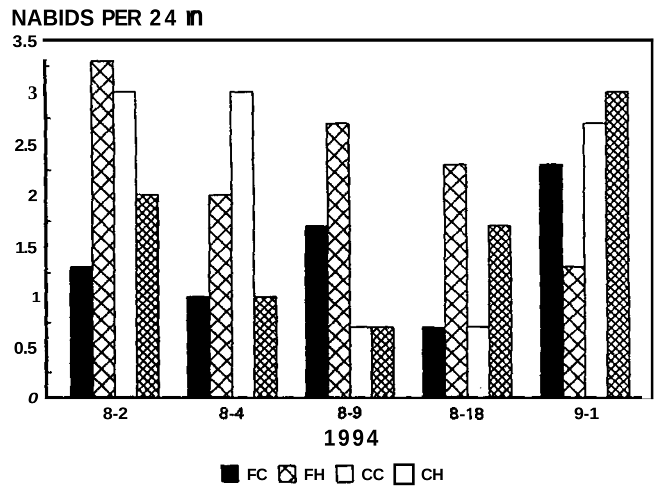

Figure 9. Population densities of nabids in fallow cultivated (FC), fallow herbicide (FH), clover cultivated (CC), and clover herbicide (CH) treated cotton. Florence, SC, 1994.

Table 2. Percent .parasitism by braconid wasps on budworm/bollworm larvae collected from crimson clover. 1993. Florence, SC.

	n	*Cotesia marginiventris*	*Cardiochiles nigriceps*	*Microplitis eroeeipes*	*Meteorus aufographae*
May 11	65	7.7	3.1	1.5	0.0
May 17	71	11.3	22.5	16.9	15.5
May 25	41	0.0	19.5	0.0	2.4
May 27	28	0.0	10.7	10.7	7.1
May 28	9	11.1	22.2	0.0	0.0

was high throughout August, reaching 42 and 70% in 1993 and 1994, respectively. *Tnchogramma* spp. remained active following an application of Asana on Aug. 12, 1993.

Parasitoids of TBW larvae collected from cotton included *Cardiochiles nigriceps* and *Cotesia marginiventns*. The latter was also reared from CBW. The tachinid fly, *Archytas marmoratus*, a larval-pupal parasitoid was reared from CBW.

Some differences in insect population densities were detected among treatments. Densities of ants were reduced in cultivated plots, and densities of TBW/CBW eggs were possibly reduced in non-cultivated plots as a result of this. These findings merit further investigation to determine the potential for pest insect suppression by beneficial arthropods in conservation tillage systems.

Acknowledgments and Disclaimer

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