BENEFICIAL ARTHROPODS IN CONSERVATION TILLAGE COTTON - A THREE-YEAR STUDY

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Abstract

Although cotton is a major crop in the southeastern Coastal Plain, only a relatively small percentage of it is planted using some form of conservation tillage. Because of the potential for insect pests to build up in crop residues, manipulation of cultural practices may be utilized to better manage species of pests and reduce dependence on traditional pest control methods, especially the use of broad-spectrum pesticides. This will increase grower profits, making conservation tillage more acceptable and in turn creating a cleaner environment and increasing the sustainability of our agricultural systems. The effect of conservation tillage on natural enemies of major insect pests of cotton was determined from 1997 through 1999 in Florence, SC. Treatments included rye/disk, rye/no-till, monocrop/disk, monocrop/no-till, corn/disk, and corn/no-till. The last two were rotated with corn during 1997 and 1999 and with cotton during 1998. Insect pests detected included thrips, tobacco budworms, cotton bollworms, soybean loopers, beet armyworms, fall armyworms, and cotton aphids. The most abundant predator was the red imported fire ant. The ants were more abundant in the rye/no-till treatment where no aldicarb was applied than in each of the other treatments. Other major predators included bigeyed bugs and lady beetles. More bigeyed bugs were observed in the disked treatments. More lady beetles occurred in the monocrop/disk treatments. In addition, hooded beetles, lacewings, spiders, and pirate bugs were detected. Conservation tillage can have an effect on population density of predaceous arthropods.

Introduction

Potential insect problems in conservation tillage due to the presence of crop residues, along with strategies for integrated pest management have been investigated throughout the southern United States. In Georgia and Louisiana, lower thrips populations were associated with conservation tillage plots than with conventional-tillage plots (All et al. 1992, Leonard 1995). Cotton aphid densities were higher in conservation tillage plots than in conventional-tillage plots (Leonard 1995). Ruberson and Phatak (1997) reported that cotton aphid populations were similar among treatments during July, but increased significantly in the conventionally-tilled plots in August. In their study, natural enemy populations were similar among treatments except for the red imported fire ant, which was more abundant in conservation tillage plots than in conventional-tilled plots. In South Carolina bigeyed bugs, lady beetles, and imported fire ants were the most abundant predators (McCutcheon et al. 1995). As in the previously described study, densities of red imported fire ants were highest in row-tilled plots that had a clover cover than in conventional-tilled plots.

In South Carolina, predaceous arthropods can have a significant impact in regulating insect pests during early season. There are several species of predators that are abundant in cotton and prey on insect pests. These include the bigeyed bug, *Geocoris* spp. (Heteroptera: Lygaeidae); damsel bug, *Nabis* spp. (Heteroptera: Nabidae); green lacewing, *Chrysopa* spp. (Neuroptera: Chrysopidae); hooded beetle, *Notoxus* spp. (Coleoptera: Anthicidae); lady beetle (Coleoptera: Coccinellidae); ants (Formicidae); and spiders (Araneae) (Greene 1995, Massey and Young, 1974). The efficacy of predaceous arthropods has been studied (Lopez et al. 1976). Predation studies have been conducted with the bigeyed bugs and other predators using various densities of prey (Hutchison and Pitre 1983). The purpose of the work reported herein was to evaluate the effects of surface tillage on the population dynamics of beneficial arthropods in cotton.

Materials and Methods

Natural enemies of major insect pests were monitored in cotton with various tillage systems at the Pee Dee Research and Education Center, Florence, S. C. Treatments included monocrop/disk, monocrop/no-till, rye/disk, rye/no-till, corn/disk, and corn no-till. The corn/disk and corn/no-till treatments were rotated with corn during 1997 and 1999 and with cotton during 1998. Each treatment was split with aldicarb and no-aldicarb. Treatments were replicated three times. Samples of arthropods were taken in a 50-ft section of row which was left untreated by insecticides other than aldicarb.

Weekly sampling of arthropods began in mid June and continued through mid August of each of the three years. Ten m of row were sampled in plots left untreated with Karate in 1997, and 3 m of row were sampled in untreated plots in 1998 and 1999. Sampling of predators was conducted using a 14-liter plastic dishpan (37.1 x 33.0 x 15.6 cm). The plants were bent and shaken over the dishpan to dislodge arthropods. Predators were counted by species or taxa. Eggs of tobacco budworms and cotton bollworms were collected from 10 plants per plot. The eggs were placed in individual gelatin capsules and held for emergence of parasitoids or hatching. Lepidopterous larvae were counted by species and placed in individual 30-ml cups on an artificial diet. Both eggs and larvae were held in a rearing room at 26° C, 50-60%

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RH, and a photoperiod of 14:10 (L:D) h until emergence of parasitoid, pupation, or death by other causes. Adult parasitoids were identified by this author.

Results and Discussion

1997

Natural enemies of major cotton insect pests occurred for the duration of this study. During mid June 1997, thrips were present when predators included imported fire ants, spiders, and pirate bugs. The ants were most abundant, and as their populations increased on 1 July, there were significantly higher numbers in the rye/no-till treatment than in the rye/disk and the monocrop/disk treatments (Table 1). That trend continued throughout the growing season. Ruberson and Phatak (1997) also reported higher red imported fire ant populations in conservation tillage plots than in conventional-tilled plots. Spiders were next in abundance, and there were differences among treatments on 29 June with higher numbers in the monocrop/disk when aldicarb was applied (Table 2). Spider populations peaked on 14 July at 14 per 10 m row with no differences in population density among treatments.

Other predaceous arthropods detected included bigeyed bugs, lady beetles, hooded beetles, and pirate bugs. These predators became more abundant in July as the cotton bollworm eggs, small larvae, and aphids became available as prey. Bigeyed bugs appeared to have lower population density in the rye/no-till treatment than in two of the disked treatments on 8 July (Table 3). The bigeyed bug is one of the most abundant predators in cotton production in South Carolina (Greene 1995). It is important to determine the reason for this difference in population density. Interestingly, population trends of bigeyed bugs were inversely related to those of the imported fire ant. Although differences among densities of eggs on 15 July were not significant for treatments or the interaction, fewer eggs were observed in the disked plots than in the no-till plots (J. A. DuRant, pers. communication). Bigeyed bugs appear to have had more of an impact on bollworm egg populations in the disked plots. Population density of lady beetles was similar on 8 July in all treatments. On 21 July, there was some indication that lady beetle populations were higher in rye/no-till plots where aldicarb was not applied than in monocrop/no-till where aldicarb was applied. Observations were that lady beetle population density was somewhat dependent upon population density of cotton bollworm eggs and cotton aphids. Hooded beetles were more abundant in the monocrop/disk (no aldicarb) than in the rye no-till (aldicarb) on 8 July. On 14 July, hooded beetles were more abundant in the rye/disk (no aldicarb) than in the rye/no-till (aldicarb). These predators were often more abundant in the disked treatments. Pirate bugs were detected on 8 and 21 July with highly variable numbers among treatmnets and no clear trend in population density (Table 4).

Insect parasitism was detected from collections of lepidopterous larvae during mid August. Parasitic wasps included *Copidosoma truncatellum* which attacked the soybean looper, *Meteorus autographae* which attacked fall armyworm, and *Cotesia marginiventris* which attacked the cotton bollworm. Incidence of parasitism was 11.1%.

1998

During May, tobacco thrips densities were significantly reduced by no-till (J. DuRant, personal communication). Lower thrips populations are more often associated with conservation-tillage plots than with conventional-tillage plots (Khalilian et al. 1991, All et al., 1992). Predaceous arthropods were again present for the duration of the study. Fire ants were the most abundant predators with higher numbers in rye/no-till than in each of the other treatments on 13 July (Table 5). On 27 July, imported fire ants were more abundant in rye/no-till (aldicarb) than in monocrop/disked (both aldicarb and no aldicarb). When populations of ants peaked in all treatments on 17 August 1998, there were no significant differences in numbers detected among the six treatments. General observations indicated that aphids were abundant in plots with high density ant populations. Because imported fire ants "farm" aphids, this interaction is expected. Fire ants also appear to run other predaceous arthropods away from the aphids. For example, as in 1997, there was an inverse relationship between the abundance of the fire ant and the bigeyed bug, another major predator of cotton insect pests. On 27 July, there were significantly more ants (40 per 3 m of row) in the rye/no-till plots treated with aldicarb than in the monocrop/disk plots (both treated with aldicarb and untreated). Conversely, there were significantly more bigeyed bugs (6 per m or row) in the monocrop/disk plots (no aldicarb) than in the rye/no-till plots (Table 6). Other predaceous arthropods detected included lacewings, lady beetles, spiders, and hooded beetles. Lacewing populations peaked during mid August with highest numbers in rye/no-till plots. Lady beetles peaked in population on 3 August at 10 per 3 m of row. No significant differences in lady beetle populations were detected among treatments. Higher numbers were observed in the monocrop/disk treatments of both the aldicarb and no aldicarb treated plots. Again, this is of interest because fire ant populations were significantly lower in the monocrop/disk plots. There were no differences among treatments for spiders and hooded beetles.

Insect parasitism was important in helping regulate cotton bollworm egg populations. Peak cotton bollworm egg populations were detected 20 July at 106 per 100 plants. On 27 July, incidence of egg parasitism by *Trichogramma* spp. was between 16 and 47%. A total of 1,193 eggs was collected and reared individually during the third week of

July. No trends were detected in the incidence of parasitism among treatments.

The most abundant parasitoid of lepidopterous larvae was the braconid wasp, *Cotesia marginiventris*. It was reared from the cotton bollworm, beet armyworm, and fall armyworm. The braconid wasp, *Meteorus autographae* was reared from fall armyworm. The encyrtid wasp, *Copidosoma truncatellum* was reared from the soybean looper. None of the larval parasitoids had a significant impact on regulating the population density of lepidopterous larvae.

1999

Red imported fire ants were again the most abundant predators throughout the study. Higher numbers occurred in the no till plots than in the disked plots (Table 7). Other predaceous arthropods detected in order of abundance included hooded beetles, spiders, lady beetles, bigeyed bugs, and pirate bugs. Populations of bigeyed bugs again indicated that there is an inverse relationship between the bugs and the imported fire ants. There were significantly more bigeyed bugs in the rye/disk treatment than in the rye/no-till treatment (Table 8). The bigeyed bug is known to be a very effective predator. It is interesting to note that conditions which favor an increase in densities of ants (rye/no-till) may result in decreased densities of bigeyed bugs. No differences were detected among treatments of populations of the other predaceous arthrpods. Lacewing populations were very sparse except on 22 July. Nabid populations were very sparse.

Incidence of parasitism by the egg parasitoid, *Trichogramma* sp. reached 18.6% on 29 July over all treatments. Population of *Helicoverpa zea* were low throughout the growing season. Of 149 eggs collected during the season, 17.4% were parasitized.

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Table 1. Effects of doublecropping, surface tillage, and soil insecticide on densities of predaceous arthropods in cotton in SC on 1 July 1997.

	Ants per 10 m row	
Cropping/Surface Tillage	**Aldicarb**	**No Aldicarb**
Rye/disk	54.3 b	55.3 b
Rye/no-till	133.3 a	145.7 a
Monocrop/disk	48.3 b	50.3 b
Monocrop/no-till	113.3 ab	97.3 ab

Means within a column (or row) followed by the same letter are not significantly different (P=0.05, Fisher's protected LSD test).

Table 2. Effects of doublecropping, surface tillage, and soil insecticide on densities of predaceous arthropods in cotton in SC on 29 July 1997.

Cropping/Surface Tillage	Spiders per 10 m row	
	Aldicarb	No Aldicarb
Rye/disk	6.7 b	10.0 b
Rye/no-till	5.0 cd	4.7 cd
Monocrop/disk	13.0 a	6.7 bcd
Monocrop/no-till	8.3 bc	2.7 d

Means within a column (or row) followed by the same letter are not significantly different (P=0.05, Fisher's protected LSD test).

Table 3. Effects of doublecropping, surface tillage, and soil insecticide on densities of predaceous arthropods in cotton in SC on 8 July 1997.

Cropping/Surface Tillage	Bigeyed Bugs per 10 m row	
	Aldicarb	No Aldicarb
Rye/disk	7.3 ab	5.7 abc
Rye/no-till	1.3 c	1.7 c
Monocrop/disk	3.7 abc	7.7 a
Monocrop/no-till	2.3 bc	3.0 abc

Means within a column (or row) followed by the same letter are not significantly different (P=0.05, Fisher's protected LSD test).

Table 4. Effects of doublecropping, surface tillage, and soil insecticide on densities of predaceous arthropods in cotton in SC on 21 July 1997.

Cropping/Surface Tillage	Pirate Bugs per 10 m row	
	Aldicarb	No Aldicarb
Rye/disk	1.3 b	4.3 ab
Rye/no-till	5.0 a	4.3 ab
Monocrop/disk	1.0 b	3.3 ab
Monocrop/no-till	1.7 ab	3.3 ab

Means within a column (or row) followed by the same letter are not significantly different (P=0.05, Fisher's protected LSD test).

Table 5. Effects of doublecropping, rotation, surface tillage, and soil insecticide on densities of predaceous arthropods in cotton in SC on 13 July 1998.

Cropping/Surface Tillage	Ants per 3 m row	
	Aldicarb	No Aldicarb
Rye/disk	8.0 b	6.7 b
Rye/no-till	41.3 a	9.6 b
Monocrop/disk	0.3 b	0.0 b
Monocrop/no-till	3.7 b	5.3 b
Corn/disk	7.7 b	5.7 b
Corn/no-till	9.0 b	18.7 b

Means within a column (or row) followed by the same letter are not significantly different (P=0.05, Fisher's protected LSD test).

Table 6. Effects of doublecropping, surface tillage, and soil insecticide on densities of predaceous arthropods in cotton in SC on 27 July 1998.

Cropping/Surface Tillage	Bigeyed Bugs per 3 m row	
	Aldicarb	No Aldicarb
Rye/disk	3.0 bcb	3.0 bc
Rye/no-till	0.7 c	0.0 c
Monocrop/disk	1.7 bc	6.0 a
Monocrop/no-till	0.3 c	1.7 bc
Corn/disk	1.3 c	4.7 ab
Corn/no-till	1.0 c	0.3 c

Means within a column (or row) followed by the same letter are not significantly different (P=0.05, Fisher's protected LSD test).

Table 7. Effects of doublecropping, surface tillage, and soil insecticide on densities of predaceous arthropods in cotton in SC on 9 July 1999.

Cropping/Surface Tillage	Ants per 3 m row	
	Aldicarb	No Aldicarb
Rye/disk	7.7 ab	4.7 b
Rye/no-till	34.0 a	11.3 b
Monocrop/disk	0.7 b	1.0 b
Monocrop/no-till	13.3 ab	25.3 a

Means within a column (or row) followed by the same letter are not significantly different (P=0.05, Fisher's protected LSD test).

Table 8. Effects of doublecropping, surface tillage, and soil insecticide on densities of predaceous arthropods in cotton in SC on 15 July and 6 August 1999.

Cropping/Surface Tillage	Bigeyed Bugs per 3 m row
Rye/disk	13.3 a
Rye/no-till	3.3 b
Monocrop/disk	8.0 ab
Monocrop/no-till	3.7 ab

Means within a column (or row) followed by the same letter are not significantly different (P=0.05, Fisher's protected LSD test).