CONSEQUENCES OF NATURAL ENEMY DISRUPTION WITH APPLICATIONS OF "HARD" INSECTICIDES PRIOR TO THE BOLLWORM FLIGHT IN CONVENTIONAL AND B.T. COTTON.

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Abstract

Natural enemies were monitored throughout the season after insecticidal applications (acephate) vs. no applications to cotton just prior to the bollworm flight in mid-July. Large one-half acre replicated plots were utilized under two management scenarios: conventional cotton with a pyrethroid (Karate®) for bollworm control and B.t. cotton with supplemental control using a spinosyn (Tracer®). These early applications controlled plant bugs and disrupted natural enemies causing season-long reductions in geocorids and ants, the most abundant predacious arthropod groups. By late July, there was an average ca. 3.0 large bollworms per foot of row following three applications of Karate® to previously treated (disrupted) conventional plots compared with ca. 1.5 per foot following two applications to previously untreated (non-disrupted) plots. On the same date in B.t. cotton, there were 6X more bollworms (0.75/ft.) in disrupted plots after two applications of Tracer® than in non-disrupted plots after only one application. Obviously, use of "hard" insecticides just prior to the bollworm flight should be avoided in both conventional and B.t. cottons because their use destroys predacious arthropods, which can result in more crop damage even with more intensive spraying for bollworm control.

Introduction

The value of natural enemies of cotton insect pests has increased dramatically with the decreasing use of broad spectrum insecticides on the crop. Recent advances in cotton insect management that have contributed to this decrease include: 1. the success of the Boll Weevil Eradication Program, 2. the expanding use of transgenic B.t. cotton, and 3. availability of data showing that high retention of initial fruiting structures is unnecessary (Mann et al. 1997, Ihrig et al. 1996, Herbert 1999). All of the above advances result in diminished use of hard pesticides, particularly in early season, which can allow predacious arthropods to build up and help control major pests throughout the season.

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Examples of studies evaluating the impact of beneficials on the cotton bollworm and/or tobacco budworm include: Lopez et al. 1976, Hutchinson and Pitre 1983, Ruberson and Greenstone 1998 and Turnipseed and Sullivan 1998. Results from small plot studies in North Carolina (Lambert et al. 1997) indicated that insecticidal disruption did not negatively impact bollworm control in B.t. cotton. However in South Carolina, data from insecticidally-disrupted and non-disrupted large (5-acre) field plots demonstrated that destruction of beneficials compromised the effectiveness of B.t. cotton (Turnipseed and Sullivan 1997).

The current study was designed to further evaluate the impact of insecticidal disruption of natural enemies (predacious arthropods, parasitoids and entomopathogens) in both conventional and B.t. cotton utilizing large (½ acre) replicated plots. A pyrethroid (Karate®) was used to control bollworm in conventional cotton and a spinosyn (Tracer®) was used for supplemental control in B.t. cotton. Although most phytophagous insects and natural enemies were monitored, only data on plant bugs, geocorids, ants and cotton bollworm are presented in this paper.

Materials and Methods

Plots one-half acre in size were planted May 20, 1998 at the Edisto Research and Education Center near Blackville, SC in a randomized block design with 5 replications of each of the 5 treatments described below:

1. Conventional (Cv) 'DPL5415'; beneficials disrupted with acephate (Ac) prior to the bollworm flight into cotton (at 0.5 lbs. a.i./acre on 6/25 and 7/6); a pyrethroid (Py) used for bollworm control (Karate® at 0.025 a.i./acre on 7/10, 7/13, 7/23 and 7/31).
2. Conventional 'DPL5415'; no disruption of beneficials; a pyrethroid (Karate®) used for bollworm control at 0.025 a.i./acre on 7/10, 7/23 and 7/31.
3. B.t. 'NuCotn 33b'; beneficials disrupted with acephate (0.5 lbs. a.i./acre on 6/25 and 7/6) a spinosyn used for supplemental control of bollworm (Tracer® at 0.09 a.i./acre on 7/10, 7/23 and 7/31).
4. B.t. 'NuCotn 33b'; no disruption of beneficials; a spinosyn used for supplemental control of bollworms (Tracer® at 0.09 a.i./acre on 7/23 and 7/31).
5. B.t. 'NuCotn 33b'; untreated.

Aldicarb was applied in-furrow to all cotton at a rate of 5 lbs. 15G per acre for early season insect control and nematode suppression. Weed control, fertilization and other agronomic practices were applied according to South Carolina Extension recommendations. Insecticides were applied to plots using a high clearance sprayer that delivered 7 gal/acre at 52 p.s.i. with 8 X cone nozzles. Plots were

126.7 ft. wide (40 rows) by 165 ft. long separated by 30 ft. alleys.

The upper third of 20 cotton plants per plot was examined weekly for eggs and small and large larvae of bollworm. Treatment decisions were made following South Carolina Extension recommendations for conventional and B.t. cotton. Populations of plant bugs, bollworms, most other phytophagous insects and predacious arthropods were assessed periodically by taking four samples toward the center of each plot using a 3 ft. long beat cloth. Samples were taken on the middle 10 rows at least 40 ft. in from alleys.

Results and Discussion

The numbers of the two most abundant predator groups, geocorids (primarily *Geocoris punctipes*) and ants (primarily *Solenopsis invicta*) were substantially lower on July 9 (Table 1) in treatments 1 and 3 that received acephate applications on June 25 and July 6 to disrupt beneficials. Although not shown, populations of spiders, hooded beetles (*Notoxus spp*.) and minute pirate bugs were also severely disrupted.

By July 30 (Table 2), a pyrethroid (Karate®) had been applied three times for bollworm control in disrupted and twice in non-disrupted conventional cotton plots. Disrupted B.t. plots had received two applications of a spinosyn (Tracer®) compared with only one application on non-disrupted plots . Plant bug numbers were lowest in disrupted plots of both genotypes (treatments 1 and 3) and in non-disrupted conventional plots with pyrethroid for bollworm control (treatment 2). Numbers of the two predator groups followed a similar pattern, with lower counts in treatments 1-3 and no difference between the spinosyn alone and untreated B.t. Bollworm counts were exceptionally high after three pyrethroid applications in disrupted conventional plots (ca. 3 larvae/ft. of row). Also, their numbers were ca. 2 X higher (37 larvae/12 ft.) after three pyrethroid applications in disrupted conventional plots than in non-disrupted ones with only two applications(19 larvae/12 ft.). In B.t. plots bollworm numbers were much lower, but there were ca. 6 X more larvae in disrupted plots with two spinosyn applications (9.0 larvae/12 ft.) than in non-disrupted ones with one application (1.4 larvae/12 ft.). Bollworm numbers were intermediate in untreated B.t. plots (4.2 larvae/12 ft.). The exceptionally high bollworm numbers in conventional/pyrethroid plots was probably due to increasing tolerance of bollworms to pyrethroid and to long spray intervals. Data on numbers of plant bugs, geocorids, ants and bollworms (Table 3) on August 10 indicated that acephate or pyrethroid applications caused significant reductions in plant bugs and geocorids. Ant numbers in non-disrupted conventional cotton (treatment 2) had rebounded after a third and final pyrethroid application on July 31, but remained extremely low 35 days after the 2nd acephate application (treatments 1 and 3). Numbers of plant bugs, geocorids and ants were similar in B.t. plots treated with spinosyn alone and in untreated B.t. plots. Bollworm numbers were significantly higher in disrupted vs. non-disrupted plots in both conventional (pyrethroid) and B.t. (spinosyn) scenarios. Also, bollworm was generally as abundant in B.t. as in conventional (Table 3) cotton, probably because larvae took longer to mature in the B.t. genotype.

The use of "hard" insecticides prior to the bollworm flight into cotton should be avoided because applications can cause season-long disruptions of important predacious arthropods. These disruptions in conventional and B.t. cotton resulted in increases in bollworm pressure and significantly higher larval numbers even with more intensive spraying. Several factors which have enhanced our opportunity to incorporate endemic natural enemies into effective IPM systems for cotton include: 1. the reduction in the need of insecticides for control of the boll weevil; 2. increasingly more studies across the cotton belt demonstrating that high retention of early first position squares is unnecessary; 3. the rapidly increasing use of B.t. genotypes that decrease the need for insecticides, particularly for tobacco budworm , that is often sprayed in early season for terminal and square loss in conventional cotton; and 4. increasing availability of new insecticides and different chemistries that control a range of lepidopterous pests with little adverse impact on natural enemies.

Studies are needed that integrate the above-mentioned factors into IPM systems that conserve and fully utilize natural enemies. We need assessments of the impact of different complexes in various production areas; and this should include information on efficient plot size, insecticidal disruption, etc.

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Table 1. Geocorid and ant numbers on July 9 from acephate-treated and untreated conventional and B.t. cotton plots.

	Mean no. in 12 ft. of row 3 days after 2nd acephate application [2]	
Treatment[1]	Geocorids[3]	Ants[4]
Cv- AcX2 - No Py	0.4b	1.4b
Cv- No Ac -No Py	4.8a	8.6ab
Bt- AcX2 - No Sp	0.4b	2.2ab
Bt- No Ac- No Sp	2.4ab	9.2a
Bt- untreated	3.6a	9.6a

[1] Treatment 1.= Conventional (Cv) 'DPL5415' with 2 acephate applications (AcX2) and no pyrethroid; 2.= as in 1. except no acephate applied; 3.= B.t. 'NuCotn33b' with 2 acephate applications and no spinosad, etc.
[2] Means followed by the same letter are not significantly different (Fisher's Protected LSD,p=0.05)
[3] >95% *Geocoris punctipes*.
[4] >95% *Solenopsis invicta*.

Table 2. Numbers of plant bugs, geocorids, ants and bollworms on July 30 from conventional and B.t. cotton plots treated with various insecticides.

	Mean no. in 12 ft. of row 3 days after 2nd acephate application [2]			
Treatment[1]	Pl.bugs	Geocorids[3]	Ants[4]	Bollworms
1. Cv- AcX2 -PyX3	0.0c	1.2c	4.0b	37.0a
2. Cv- No Ac -PyX2	0.2c	7.4b	4.2b	19.0ab
3. Bt- AcX2 - SpX2	0.2c	0.8c	1.0b	9.0b
4. Bt- No Ac- SpX1	4.6b	19.8a	7.2ab	1.4b
5. Bt- untreated	7.4a	17.0a	13.2a	4.2b

[1] Treatment 1.= Conventional with 2 acephate and 3 pyrethroid (PyX3)applications ; Treatment 2.= Conventional with 2 pyrethroid applications; etc.
[2] Means followed by the same letter are not significantly different (Fisher's Protected LSD,p=0.05)
[3] >95% *Geocoris punctipes*.
[4] >95% *Solenopsis invicta*.

Table 3. Numbers of plant bugs, geocorids, ants and bollworms on August 10 from conventional and B.t. cotton plots treated with various insecticides.

	Mean no. in 12 ft. of row [2]			
Treatment[1]	Pl.bugs	Geocorids[3]	Ants [4]	Bollworms
1. Cv- AcX2 -PyX4	0.2b	1.2c	0.4b	5.6ab
2. Cv- No Ac -PyX3	0.2b	8.6b	22.6b	1.4bc
3. Bt- AcX2 - SpX3	0.8b	4.6bc	1.0b	6.0a
4. Bt- No Ac- SpX2	4.0a	31.8a	15.4ab	0.8c
5. Bt- untreated	4.4a	27.4a	11.4ab	3.0abc

[1] Treatment 1.= Conventional with 2 acephate and 4 pyrethroid applications ; Treatment 2.= Conventional with 3 pyrethroid applications; etc.
[2] Means followed by the same letter are not significantly different (Fisher's Protected LSD,p=0.05)
[3] >95% *Geocoris punctipes*.
[4] >95% *Solenopsis invicta*.