IMPACT OF BENEFICIAL ARTHROPOD CONSERVATION IN B. T. AND CONVENTIONAL COTTON

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Abstract

Predaceous arthropods and bollworms (*Helicoverpa zea* [Boddie]) were monitored throughout the season in large plots of conventional and B. t. cotton with and without applications of a broad-spectrum insecticide in early season to disrupt beneficials. Cyhalothrin was applied as needed for bollworm control in disrupted and non-disrupted conventional plots and spinosyn was utilized in a similar way in B.t. plots. Spinosyn was also applied for bollworm control in previously untreated conventional plots. Early-season applications of acephate to conventional or B.t. cotton prior to the bollworm flight caused reductions in predators (geocorids, ants and spiders) that lasted throughout the season. These applications resulted in higher numbers of bollworms later in the season that required more insecticide for control compared to plots that were untreated in early season. Application of broad-spectrum insecticides to cotton in early season should be avoided unless absolutely necessary for control of crop-damaging pests that exceed well-defined treatment thresholds.

Introduction

Due to recent advancements in cotton insect pest management the use of broad-spectrum insecticides during early season has been substantially reduced. These advancements include: 1. eradication of the boll weevil (*Anthonomous grandis grandis* Boheman), 2. widespread use of B. t. cotton (Turnipseed and Sullivan 1998, 1999), and 3. data showing that lack of early season square retention does not significantly reduce yield (Ihrig et al. 1996, Mann et al. 1997, Herbert and Abaye 1999). Without early-season insecticide applications, beneficial arthropod complexes reach their full potential and assist in control of the bollworm (*Helicoverpa zea* [Boddie]) (Turnipseed and Sullivan 1998, 1999). Thus, South Carolina provides a unique situation in which the impact of beneficial arthropod complexes can be assessed.

Numerous researchers have evaluated the impact of predaceous arthropods on the cotton bollworm/tobacco budworm complex in cotton (e.g., Lopez et al. 1976, Hutchinson and Pitre 1983, Ruberson and Greenstone 1998, Turnipseed and Sullivan 1998). In North Carolina Lambert et al. (1997) found that insecticidal disruption of beneficial arthropods in small plots did not impact bollworm control in B. t. cotton. However, in South Carolina, data from insecticidally-disrupted and non-disrupted large (5 acre) plots demonstrated that disruption of predaceous arthropod complexes reduced the effectiveness of B. t. cotton (Turnipseed and Sullivan 1997). Data collected from smaller (1/2 acre plots indicated that insecticidal disruption negatively impacted bollworm control in B. t. and conventional cotton (Turnipseed and Sullivan 1999).

The purpose of this study was to determine the importance of beneficial arthropod complexes under different insecticidal regimes in conventional and B. t. cottons

Materials and Methods

Studies were conducted in both irrigated and dry land cotton. In the irrigated field, `DP5415RR´and `DP458B/RR´were planted side by side on 5 May 1999 on the Bamberg Farm near Denmark, SC. On 15 June, plots one-third acre (36 rows by 115 ft.) in size were established in both genotypes. Dry land plots were one-half acre in size (40 rows by 150ft.). The dry land field was planted to 'NuCotn 33B' and 'DP5415' on 14 May, 1999 at the Edisto Research and Education Center (EREC) near Blackville, SC. Plots in both areas were arranged in a randomized block design with 4 replicates at the Bamberg Farm and 5 replicates at EREC, for each of the 9 treatments described below:

1. Conventional cotton (Cv); beneficials disrupted with acephate (Ac) prior to the bollworm flight into cotton (at 0.5lbs. a.i./acre on 7/3 and 7/10); a pyrethroid (Py) used for later bollworm control (cyhalothrin at 0.033 a.i./acre).
2. Conventional cotton (Cv); no disruption of beneficials; a pyrethroid (Py) used for bollworm control (cyhalothrin at 0.033 a.i./acre).
3. Conventional cotton (Cv); no disruption of beneficials; spinosyn (Sp) used for bollworm control (Tracer® at 0.09 a.i./acre).
4. Conventional cotton (Cv); untreated.
5. B. t. cotton (B. t.); beneficials disrupted with acephate (Ac) prior to the bollworm flight into cotton (at 0.5lbs. a.i./acre on 7/3 and 7/10); spinosyn (Sp) used for bollworm control (Tracer® at 0.09 a.i./acre).
6. B. t. cotton (B. t.); no disruption of beneficials; a pyrethroid (Py) used for bollworm control (cyhalothrin at 0.033 a.i./acre).
7. B. t. cotton (B. t.); no disruption of beneficials; spinosyn (Sp) used for bollworm control (Tracer® at 0.09 a.i./acre).

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8. B. t. cotton (B. t.); no disruption of beneficials; thiodicarb (Th) used for bollworm control (Larvin® at 0.8 a.i./acre).
9. B. t. cotton (B. t.); no treatment.

Weed control, fertilization, and other agronomic practices were done 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 8X cone nozzles.

The upper third of 25 cotton plants was examined weekly for bollworm eggs and larvae, and treatment decisions were made following South Carolina Extension recommendations for conventional and B. t. cotton. Predaceous arthropods, plant bugs, bollworms and other phytophagous insects were sampled periodically within the middle 10 rows at least 20 ft. into the plots using a 3 ft. beat cloth (3 per plot during June, 4 per plot during July) as described by Shepard et al. (1974). Geocorids (primarily *Geocoris punctipes*), ants (*Solenopis invicta*) , and spiders which represent our most abundant and effective predaceous arthropods, are reported herein.

Data were analyzed using the JMP in software by the SAS Institute Inc. Means were separated with the Fisher's LSD test.

Results and Discussion

Populations of bollworms were low during 1999 and B.t. cotton without early season beneficial disruption required no supplemental applications. Therefore, treatments 6, 7, and 8 mentioned (above) were not used.

Two applications of acephate to either dry land (Table 1) or irrigated (Table 2) cotton plots caused substantial reductions in populations of predaceous arthropods.

Dry Land Cotton

By 30 July (Table 3), acephate-treated conventional cotton plots required two applications of pyrethroid for bollworm control vs. one where there were no early-season applications. In B. t. cotton, only plots treated with acephate required control (one application of spinosyn). Numbers of predaceous arthropods were still very low in acephate-treated plots of both genotypes. Numbers of geocorids (0.2 and 08) were significantly lower compared with all other treatments. Numbers of ants and spiders varied among treatments, but were lowest in acephate- and pyrethroid-treated plots. Bollworm numbers were significantly higher in untreated conventional compared with all other plots. There were no significant differences between B. t. untreated and all other treated plots

By 4 August (Table 4), acephate-treated conventional cotton plots had required three applications of pyrethroid for bollworm control vs. only one where there were no early applications. In B. t. cotton, only plots treated with acephate required control (2 applications of spinosyn). Numbers of predaceous arthropods were still very low in acephate-treated conventional and B.t. plots, having significantly lower numbers of geocorids compared with all other treatments. Numbers of ants and spiders varied among treatments, but were lowest in acephate- and pyrethroid-treated plots. Bollworm numbers were still highest in untreated conventional compared with all other plots. There were no significant differences in bollworm numbers in all treated conventional cotton plots. However, in B. t. cotton, bollworm numbers were significantly lower in plots untreated with any insecticide compared to acephate-treated plots that had received two applications of spinosyn. Results from dry land cotton plots were similar to those obtained by Turnipseed and Sullivan (1999).

Irrigated Cotton

By 30 July (Table 5), two applications had been applied to all conventional plots except the untreated check. In B. t. cotton, acephate treated plots had received one application of spinosyn for bollworm control. Numbers of geocorids, ants, and spiders were lowest in acephate-treated B. t. and conventional cotton plots. Differences in predaceous arthropods in other plots varied considerably. Among the three predaceous arthropods, numbers were generally higher in untreated conventional, untreated B.t. and spinosyn-treated plots. Bollworm numbers were highest in untreated and acephate-pyrethroid treated conventional cotton plots when compared with all other treatments among which there were no differences. The fact that there was an average of 12.3 bollworms per 12 row feet in acephate-treated conventional cotton, indicates that a third application of pyrethroid should have been made prior to 30 July.

By 13 August (Table 6), acephate-treated and acephate-untreated conventional cotton plots had received four applications of either pyrethroid (treatments 1 and 2) or spinosyn (treatment 3). B. t. cotton plots treated with acephate had received two applications of spinosyn and untreated B. t. plots required no supplemental treatment. At this date (13 August), 34 days after the last acephate application, geocorid numbers were more than 10 times higher in untreated conventional, spinosyn-treated conventional and untreated B.t. compared with other treatments (1., 2. and 5.) that had received broad-spectrum insecticides (acephate or pyrethroid). Numbers of ants in the plots followed a similar pattern. Spider numbers were variable but lowest in plots treated four times with cyhalothrin. Bollworm numbers were low and had "cycled-out" of conventional plots.

Summary

Our data show that application of broad-spectrum insecticides during the early season can reduce numbers of predaceous arthropods to the point that additional applications will likely be needed for bollworm control compared to plots where such an insecticide has not been applied. Careful consideration should be given before any "hard" insecticide is applied in early season. If such applications are necessary, growers should be prepared to both closely monitor bollworm/budworm numbers and to use more applications for their control.

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Table 1. Geocorid, Ant, and Spider numbers on 15 July from dry land acephate-treated and untreated conventional and B. t. cotton plots.

	Mean no. in 9 ft. of row5 days after 2nd acephate application[2]		
Treatment[1]	Geocorids	Ants	Spiders
1. Cv - AcX2	0.0a	0.0a	3.8a
2. Cv - untreated	8.6b	4.0ab	6.6ab
3. Bt - AcX2	0.0a	0.0a	2.0a
4. Bt - untreated	7.6b	8.4b	9.4b

[1]Treatment = 1. Conventional (Cv) 'DP5415' with 2 acephate applications (AcX2); 2. conventional untreated; 3. B.t. 'NuCotn33b' with 2 acephate applications; etc.
[2]Means followed by the same letter are not significantly different (Fisher's LSD, p=0.05).

Table 2. Geocorid, Ant, and Spider numbers on 15 July from irrigated, acephate-treated and untreated conventional and B. t. cotton plots.

	Mean no. in 9 ft. of row3 days after 2nd acephate application[2]		
Treatment[1]	Geocorids	Ants	Spiders
1. Cv - AcX2	0.0a	3.3a	3.0a
2. Cv - untreated	6.5b	22.5b	7.5a
3. Bt - AcX2	0.3a	3.0a	4.8a
4. Bt - untreated	3.8ab	9.3ab	6.8a

[1]Treatment = 1. Conventional (Cv) 'DP5415RR' with 2 acephate applications (AcX2); 2. conventional untreated; 3. B.t. 'DP458B/RR' with 2 acephate applications; etc.
[2]Means followed by the same letter are not significantly different (Fisher's LSD, p=0.05).

Table 3. Geocorid, Ant, Spider and Bollworm numbers on 30 July from dry land conventional and B. t. cotton plots treated with various insecticides.

	Mean no. in 12 ft. of row[2]			
Treatment[1]	Geocorids	Ants	Spiders	Bollworms
1. Cv - AcX2 - PyX2	0.2a	3.8a	2.0a	2.4a
2. Cv - no Ac - PyX1	12.0b	5.2a	3.8ab	0.8a
3. Cv - no Ac - SpX1	18.4c	39.4b	6.4b	1.8a
4. Cv - untreated	21.4c	23.2ab	10.0bc	5.2b
5. Bt - AcX2 - SpX1	0.8a	0.4a	4.0a	1.8a
6. Bt - untreated	18.0bc	19.2ab	11.4c	0.4a

[1]Treatment = 1. Conventional with 2 acephate applications and 2 pyrethroid (cyhalothrin) applications (PyX2) ; 2. Conventional with 1 pyrethroid application (PyX1); etc.
[2]Means followed by the same letter are not significantly different (Fisher's LSD, p=0.05).

Table 4. Geocorid, Ant, Spider, and Bollworm numbers on 4 August from dry land conventional and B. t. cotton plots treated with various insecticides.

	Mean no. in 12 ft. of row[2]			
Treatment[1]	**Geocorids**	**Ants**	**Spiders**	**Bollworms**
1. Cv - AcX2 - PyX3	0.0a	0.0a	2.0a	0.4ab
2. Cv - no Ac - PyX1	19.2b	6.6ab	3.6a	1.0ab
3. Cv - no Ac - SpX2	35.8c	19.8b	11.0b	1.4ab
4. Cv - untreated	36.2c	38.6c	11.0b	5.8c
5. Bt - AcX2 - SpX2	0.8a	0.6a	4.0a	2.4b
6. Bt - untreated	26.4bc	15.6b	12.0b	0.0a

[1]Treatment = 1. Conventional (Cv) with 2 acephate applications and 3 pyrethroid applications, 2. conventional with 2 pyrethroid applications; etc.
[2]Means followed by the same letter are not significantly different (Fisher's LSD, p=0.05).

Table 5. Geocorid, Ant, Spider, and Bollworm numbers on 30 July from irrigated conventional and B. t. cotton plots treated with various insecticides.

	Mean no. in 12 ft. of row[2]			
Treatment[1]	**Geocoris**	**Ants**	**Spiders**	**Bollworms**
1. Cv - AcX2 - PyX2	0.3a	0.0a	2.0a	12.3b
2. Cv - no Ac - PyX2	5.3ab	12.8a	3.8ab	2.8a
3. Cv - no Ac - SpX2	7.0b	65.5b	6.3ab	1.8a
4. Cv - untreated	5.0ab	9.8a	6.5ab	13.5b
5. Bt - AcX2 - SpX1	0.0a	7.5a	3.5ab	1.5a
6. Bt - untreated	7.8b	24.8a	6.8b	1.0a

[1]Treatment = 1. Conventional with 2 acephate applications and 2 pyrethroid applications (PyX2); 2. Conventional with 2 pyrethriod (PyX2) applications; 3. Conventional with 2 spinosyn (SpX2) applications; etc.
[2]Means followed by the same letter are not significantly different (Fisher's LSD, p=0.05).

Table 6. Geocorid, Ant, Spider, and Bollworm numbers on 13 August from irrigated conventional and B.t. cotton plots treated with various insecticides.

	Mean no. in 12 ft. of row[2]			
Treatment[1]	**Geocorids**	**Ants**	**Spiders**	**Bollworms**
1. Cv - AcX2 - PyX4	0.3a	3.5a	1.8a	0.0a
2. Cv - no Ac - PyX4	1.5a	0.5a	0.5a	0.0a
3. Cv - no Ac - SpX4	11.3b	40.0bc	4.5ab	0.3ab
4. Cv - untreated	11.8b	61.0c	9.3b	1.3bc
5. Bt - AcX2 - SpX2	1.0a	4.0ab	9.0b	2.0c
6. Bt - untreated	10.5b	18.5ab	8.8b	1.5c

[1]Treatment = 1. Conventional with 2 acephate applications and 4 pyrethroid applications; 2. conventional with 4 spinosyn applications; etc.
[2]Means followed by the same letter are not significantly different (Fisher's LSD, p=0.05).