EVALUATION OF INSECTICIDES ON COTTON FLEAHOPPER AND BENEFICIAL ARTHROPOD POPULATIONS

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Abstract

An experiment was initiated in 2009 concurrently with a cotton fleahopper insecticide efficacy trial to determine which products were the most and least detrimental to arthropod natural enemies. Insecticides evaluated included Bidrin 8E, Bidrin XP, Centric 40WG, Discipline 2EC, Intruder 70WP, Orthene 97S, and Trimax Pro. The initial application was made during the second week of squaring and a second application was made 8 d later. With the exception of Trimax Pro at 6 DAT-1 (6 d after first treatment), all tested products reduced and maintained cotton fleahopper populations below the recommended action threshold of 15 fleahoppers per 100 terminals throughout the study period. Ladybird beetles and spiders were the most prevalent predators encountered in the study, accounting for 76 to 99% of the total abundance of beneficial arthropods on each sample date. Based solely on the numbers of total predators, none of the insecticides appeared to have an adverse effect on natural enemy populations. In fact, on the final assessment date (12 DAT-2, 12 d after second treatment), plots treated with Bidrin XP or Discipline 2E contained significantly more beneficial arthropods than the other treated or non-treated plots. Coincidentally, the greatest numbers of aphids were also observed in plots treated with these products, although only Discipline was significantly different. Numerically, Intruder 70WP had the fewest numbers of predators as well as aphids. Given the apparent relationship between aphid densities and predator abundance, additional studies are needed to fully understand the mechanisms by which these insecticides impact natural enemy populations.

Introduction

Producers rely almost exclusively on insecticides to manage cotton fleahoppers, *Pseudatomoscelis seriatus* (Reuter), typically making one or more insecticide applications during the initial three or four weeks of squaring. Traditionally, acephate and dicrotophos have been the compounds of choice because of their relative effectiveness and low cost. However, increasing concerns over human safety and the disruptive nature of these two insecticides on natural enemy populations has motivated research and extension entomologists to identify alternative products.

During the past several years, a number of highly effective insecticides have been identified and are now recommended for use against the cotton fleahopper. Several of the preferred products belong to the class of insecticides known as neonicotinoids, which as a group are documented to be safer than traditional insecticides. However, few studies have examined the impact of neonicotinoids or other recommended fleahopper products on beneficial arthropod populations. Because natural enemies help maintain cotton fleahopper populations below economically damaging levels and/or prevent outbreaks of secondary pests, conservation of key predators is fundamentally important. The main objective of our study was to determine which insecticides commonly used to manage cotton fleahoppers were the least and most detrimental to arthropod natural enemies. Presented herein are preliminary results from the first year of the study.

Materials and Methods

The study was conducted in a commercial field (Wharton Co., TX) planted with Phytogen 440WRF on 39-inch rows. The experiment was a randomized complete block design with eight treatments (Table 1) and four replications (blocks). Treatments in each replication were arranged down the rows instead of across the field to reduce the width of the test site area and to make it easier to treat and harvest plots. Each plot measured 12 rows by 50 ft, but treatments were only applied to the center 8 rows of each plot. Applications were made with a Spider-Trac ground sprayer at 4.25 mph. Insecticides were applied through 4X hollow-cone nozzles (2 nozzles per row) at 40 psi in a total volume of 5.1 GPA. All treatments were applied when cotton fleahopper populations met or exceeded the recommended action threshold for the area (15 fleahoppers per 100 terminals) (Parker et al. 2008). This resulted in two applications, 20 and 28 May, which corresponded to the 2nd and 3rd week of squaring, respectively. The producer treated the entire field with a plant growth regulator (PGR) on 5 June (8 DAT-2). Unfortunately, the spray tank also contained acephate which was leftover from an application preceding the use of the PGR.

Table 1. Description of insecticide treatments with corresponding rates of application.

Treatment	Class	Product per acre
Bidrin 8E (dicrotophos)	Organophosphate	3.2 fl-oz
Bidrin XP (dicrotophos + bifenthrin)	Organophosphate + Pyrethroid	1.6 and 2.6 fl-oz, respectively
Centric 40WG (thiamethoxam)	Neonicotinoid	1.25 oz
Discipline 2EC (bifenthrin)	Pyrethroid	5.2 fl-oz
Intruder 70WP (acetamiprid)	Neonicotinoid	1.0 oz
Orthene 97S (acephate)	Organophosphate	8 oz
Trimax Pro 4.44 (imidacloprid)	Neonicotinoid	1.25 fl-oz
Non-treated control		

Cotton fleahopper population levels were assessed by counting the number of adults and nymphs on the terminal portion of 20 plants in the center two rows of each plot. Counts were made on 19 May (pretreatment), 23 May (3 DAT-1), 26 May (6 DAT-1), 30 May (2 DAT-2), 2 June (5 DAT-2), and 8 June (11 DAT-2).

Beneficial arthropod population levels were assessed using a hand-held pneumatic sampler known as the Keep-It-Simple-Sampler (KISS) (Beerwinkle et al. 1997). Plots were sampled on 20 May (pretreat), 26 May (6 DAT-1), 2 June (5 DAT-2), and 9 June (12 DAT-2). On each sampling date, one treated row in each plot was selected (excluding the center two rows) and the entire length of row (50 ft) within the plot was sampled with a KISS. Rows were systematically selected on each date to avoid sampling adjacent rows on consecutive dates and to prevent sampling a row more than once during the study. Captured contents from each plot were transferred into separate sealable plastic bags and were placed in a cooler equipped with ice packs. Upon return to a laboratory, bags were placed in a freezer overnight to kill or at least debilitate captured arthropods. The numbers of spiders, ladybird beetles, lacewings, minute pirate bugs, big-eyed bugs, damsel bugs, and syrphid flies collected from each plot were recorded. With the exception of spiders, adults and immatures were counted separately.

Because elimination of natural enemies commonly results in outbreaks of aphids or other secondary pests, aphid population levels were estimated on 9 June (12 DAT-2) to obtain supporting information. Aphid densities were determined by removing the 4th fully expanded leaf below the terminal of 10 plants from the center two rows of each plot. Leaves from each plot were placed in sealable plastic bags and were stored in a freezer. The average numbers of aphids per leaf in each plot were calculated and used as model inputs in subsequent analyses.

Data for cotton fleahoppers were subjected to analysis of variance and means were separated by LSD (P=0.05) using ARM software (Gylling Data Management 2000). Numbers of total beneficial arthropods, spiders, ladybird beetles, and aphids on each sample date were analyzed using mixed-model analysis of variance (PROC MIXED, SAS Institute 2006). Data for the other insect species were not analyzed because their presence in terms of number and frequency of occurrence were too low to make meaningful comparisons. Differences among treatments were identified using the "ADJUST=TUKEY" option of the LSMEANS statement (P=0.05). However, arithmetic means and standard errors are reported.

Results and Discussion

Pretreatment counts of cotton fleahoppers were mostly comprised of adults (≈70%) and were similar among treatments (Table 2). With the exception of Trimax Pro at 6 DAT-1, all products reduced and maintained cotton fleahopper populations below the recommended threshold level throughout the study period (Table 2). In comparison, fleahopper populations in the non-treated plots remained above the action threshold level until the final assessment date (Table 2). Following the producer's application of a PGR which also contained residues of acephate, only one cotton fleahopper was found in a non-treated plot. Nevertheless, results from prior sample dates indicated all tested products provided adequate cotton fleahopper control.

Table 2. Performance and comparison of insecticides commonly used or recommended for cotton fleahopper control in cotton, Wharton Co., TX, 2009.

Treatment	Mean number of cotton fleahoppers (adults + nymphs) per 100 terminals						
	Pretreat (19 May)	3 DAT-1 (23 May)	6 DAT-1 (26 May)	2 DAT-2 (30 May)	5 DAT-2 (2 June)	11 DAT-2 (8 June)	Post-treat avg.
Bidrin 8E	11.3 a	2.5 b	2.5 c	0.0 b	2.5 b	0.0 a	1.5 b
Bidrin XP	18.8 a	0.0 b	10.0 bc	0.0 b	0.0 b	0.0 a	2.0 b
Centric 40WG	13.8 a	0.0 b	2.5 c	1.3 b	0.0 b	0.0 a	0.8 b
Discipline 2EC	11.3 a	0.0 b	0.0 c	0.0 b	0.0 b	0.0 a	0.0 b
Intruder 70WP	11.3 a	0.0 b	3.8 c	0.0 b	2.5 b	0.0 a	1.3 b
Orthene 97S	13.8 a	0.0 b	5.0 bc	1.3 b	0.0 b	0.0 a	1.3 b
Trimax Pro 4.44	17.5 a	3.8 b	16.3 b	1.3 b	1.3 b	0.0 a	4.5 b
Non-treated	12.5 a	13.8 a	32.5 a	18.8 a	51.3 a	1.3 a	23.5 a

Within a column, means followed by the same letter are not significantly different (LSD, *P*=0.05).

Spiders and ladybird beetles were the most prevalent predators encountered during the study, accounting for 76 to 99% of the total abundance of beneficial arthropods observed on each sample date (Fig. 1). In comparison, combined counts of adults and immatures of lacewings, minute pirate bugs, big-eyed bugs, damsel bugs, and syrphid flies comprised ≤ 24% of the total abundance of predators on any given sample date. Post-treatment observations revealed a substantial shift in the composition of predators across all treatments. In general, ladybird beetles became more prominent as the study progressed, while the opposite trend was observed for spiders (Fig. 1). Further examination of the data revealed that reproduction was largely responsible for the substantial increase in beetle densities as well as shift in predator composition (Fig. 2).

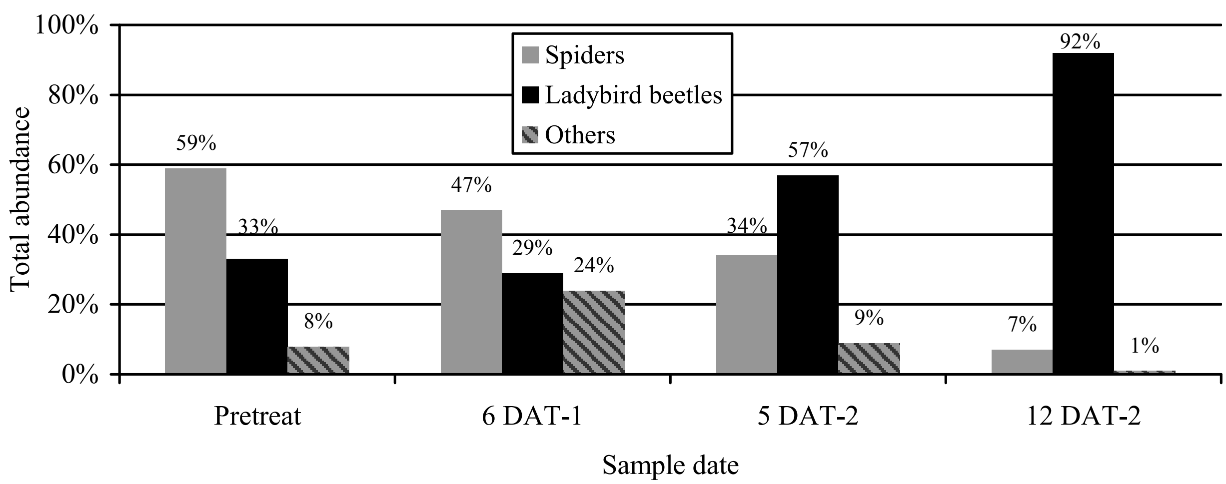

Figure 1. Overall (across all treatments) composition of predators prior to and following cotton fleahopper insecticide treatments in a commercial cotton field, Wharton Co., TX, 2009. "Others" include lacewings, minute pirate bugs, big-eyed bugs, damsel bugs, and syrphid flies.

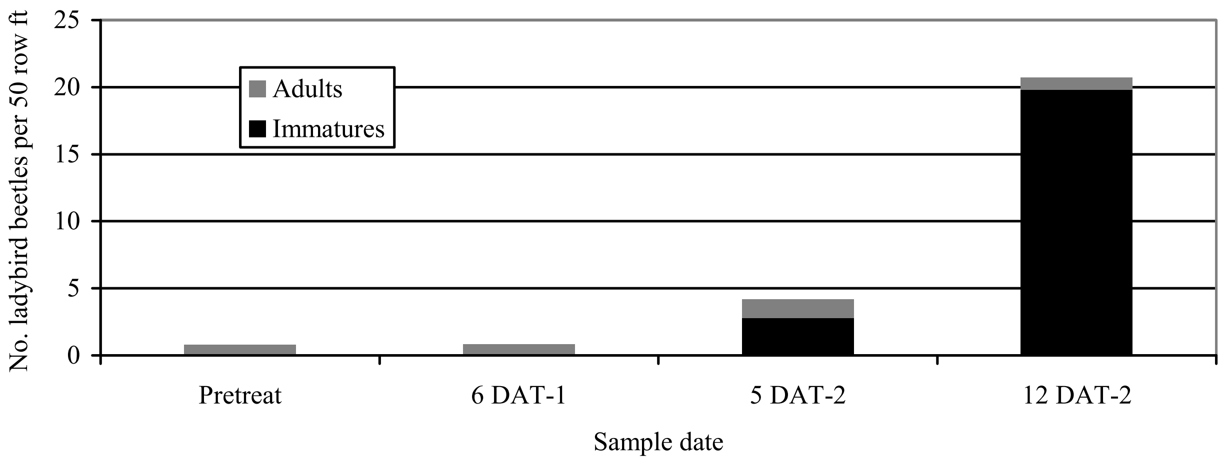

Figure 2. Overall (across all treatments) mean number of ladybird beetles per 50 row ft sampled with a Keep-It-Simple-Sampler in a commercial cotton field, Wharton Co., TX, 2009.

Pretreatment counts of total predators were similar among treatments, but significant differences were detected among treatments on the last two assessment dates (Table 3). At 5 DAT-2, Orthene had significantly more predators than the other treatments. However, on the final assessment date (12 DAT-2), plots treated with Bidrin XP or Discipline 2E possessed significantly more beneficial arthropods than the other treated or non-treated plots (Table 3). Coincidentally, the greatest numbers of aphids were also observed in plots treated with these products (Table 4), although only Discipline 2E separated out statistically from the other treatments. Numerically, Intruder 70WP had the fewest numbers of total predators as well as aphids (Tables 3 and 4). Given the apparent relationship between aphid densities and the abundance of beneficial arthropods, particularly ladybird beetles, it is difficult to determine how these products directly impacted natural enemies. Based solely on the numbers of total predators, none of the insecticides appeared to have an adverse effect on natural enemy populations. However, additional studies are needed to determine the mechanism(s) by which these insecticides impact key predators. In particular, the direct and indirect impacts of insecticides on aphid populations as well as on natural enemy composition and abundance require further investigation.

Table 3. Impact of cotton fleahopper insecticides on the total abundance of arthropod predators in a commercial cotton field, Wharton Co., TX, 2009

Treatment	Mean ± SE number of total predators per 50 row ft (KISS)*			
	Pretreat (19 May)	6 DAT-1 (26 May)	5 DAT-2 (2 June)	12 DAT-2 (9 June)
Bidrin 8E	2.8 ± 0.5 a	3.8 ± 1.1 a	9.0 ± 1.7 a	15.3 ± 5.5 a
Bidrin XP	2.5 ± 1.0 a	2.5 ± 1.0 a	5.0 ± 1.1 a	49.0 ± 13.3 b
Centric 40WG	2.3 ± 0.5 a	3.0 ± 0.7 a	7.0 ± 1.3 a	10.3 ± 1.7 a
Discipline 2EC	2.3 ± 0.5 a	1.8 ± 0.5 a	5.5 ± 0.9 a	67.0 ± 11.3 b
Intruder 70WP	1.5 ± 0.3 a	2.3 ± 0.8 a	6.3 ± 0.6 a	5.5 ± 1.6 a
Orthene 97S	2.5 ± 0.6 a	2.0 ± 0.9 a	14.5 ± 1.3 b	15.3 ± 2.7 a
Trimax Pro 4.44	2.8 ± 0.3 a	3.8 ± 1.2 a	5.0 ± 1.3 a	14.8 ± 2.3 a
Non-treated	2.3 ± 0.3 a	2.3 ± 0.3 a	7.0 ± 1.3 a	15.0 ± 4.7 a

Within a column, means followed by the same letter are not significantly different (Tukey-Kramer test, P=0.05).
* Predators included immature and adult stages of spiders, ladybird beetles, minute pirate bugs, big-eyed bugs, damsel bugs, lacewings, and syrphid flies.

Table 4. Comparison of ladybird beetle and aphid abundance in plots treated with various cotton fleahopper insecticides, Wharton Co., 2009.

Treatment	Mean ± SE number of ladybird beetles per 50 row ft (KISS)				Mean ± SE aphids per leaf *
	Pretreat (19 May)	6 DAT-1 (26 May)	5 DAT-2 (2 June)	12 DAT-2 (9 June)	12 DAT-2 (9 June)
Bidrin 8E	1.3 ± 0.3 a	1.3 ± 0.5 a	6.3 ± 2.3 ab	13.3 ± 5.1 a	2.8 ± 0.8 a
Bidrin XP	1.0 ± 0.4 a	1.0 ± 0.4 a	3.8 ± 1.3 a	45.5 ± 13.0 b	7.9 ± 1.9 a
Centric 40WG	0.8 ± 0.3 a	0.5 ± 0.3 a	4.0 ± 1.2 a	8.3 ± 2.3 a	3.1 ± 9.0 a
Discipline 2EC	0.3 ± 0.3 a	0.8 ± 0.5 a	3.3 ± 1.1 a	59.0 ± 9.5 b	29.8 ± 12.9 b
Intruder 70WP	0.3 ± 0.3 a	0.5 ± 0.3 a	1.5 ± 0.6 a	3.8 ± 1.0 a	1.0 ± 0.6 a
Orthene 97S	1.0 ± 0.4 a	0.8 ± 0.5 a	11.0 ± 1.2 b	12.3 ± 2.1 a	5.5 ± 0.6 a
Trimax Pro 4.44	0.8 ± 0.3 a	1.3 ± 0.8 a	1.5 ± 0.9 a	13.0 ± 2.2 a	5.1 ± 1.3 a
Non-treated	1.0 ± 0.4 a	0.3 ± 0.3 a	2.8 ± 0.5 a	10.3 ± 3.0 a	5.0 ± 2.8 a

Within a column, means followed by the same letter are not significantly different (Tukey-Kramer test, *P*=0.05).
* Average number of aphids on the 4th fully expanded leaf below the terminal of 10 plants from each plot.

Summary

All of the tested products provided adequate cotton fleahopper control. Based solely on the numbers of total predators found in the treated and untreated plots, none of the insecticides appeared to have a detrimental impact on beneficial arthropod populations. However, given the apparent relationship between aphid densities and natural enemy abundance, additional studies are needed to fully understand the mechanisms by which these insecticides impact beneficial arthropod populations.

Acknowledgements

The authors would like to thank Rudy Alaniz, Jordan Dickerson, Derrick Hall, Clinton Livingston, and Chris Parker for their technical assistance. Special appreciation is extended to Michael Watz for providing the cotton field and to B. B. Krenek, Crop Consultant, for assistance in locating the test site. Several chemical companies are thanked for providing insecticides and funding. Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

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