Effects of Selected Defoliants in Combination with Insecticides on the Sweetpotato Whitefly (Hemiptera: Aleyrodidae) and Its Parasitoids in Cotton[1]

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Abstract Cotton defoliation is an important management practice associated with high-yielding, high-quality cotton. The impacts of two commonly-used defoliants (tribufos and thidiazuron) individually and in combination with two commonly-used insecticides (lambda-cyhalothrin and azinphosmethyl) on the sweetpotato whitefly, *Bemisia tabaci* Gennadius biotype B (= silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring) and its parasitoids were determined in field studies in the Lower Rio Grande Valley of Texas. The two defoliants and their combinations with azinphosmethyl and lambda-cyhalothrin significantly affected the occurrence and survival of sweetpotato whiteflies and their parasitoids, *Encarsia* spp. and *Eretmocerus* spp., although the effects varied among the treatment combinations. Lambda-cyhalothrin alone had no significant effects on sweetpotato whitefly and its parasitoids. Combining defoliants and insecticides appears to be a potential management tool for whiteflies on cotton.

Key Words defoliants, whitefly, parasitoids, insecticide

Cotton is generally considered a source of sweetpotato whitefly, *Bemisia tabaci* Gennadius biotype B (= silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring), infestation in nearby vegetables and other field crops in south Texas (Legaspi et al. 1997; Liu, unpubl. data). During cotton defoliation season in the Rio Grande Valley of Texas, sweetpotato whitefly adults are seen leaving abscising or abscised leaves on which they have been feeding and developing and migrating to nearby field crops or weeds. After cotton defoliation, large numbers of whiteflies are found on all "green" broad-leaf plants, including summer and fall vegetables and many species of weeds. Further, whiteflies are seen flying and landing on vehicles, farm machinery, and individuals. It is not unusual to find that the leaves of some small plants in cotton fields or nearby vegetable fields are totally covered by whitefly adults at this time (Liu, pers. obs.). In addition, some older nymphs on abscising and abscised cotton leaves successfully complete their development to emerge as adults and migrate to alternative plant hosts.

Cotton also could presumably serve as a source of natural enemies of the whitefly. Some endoparasitoids (i.e., *Eretmocerus* spp. and *Encarsia* spp.) parasitizing whiteflies at the time of cotton defoliation and after leaves are on the ground have continued to mature, emerge, and subsequently disperse in search of hosts. However, some

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endoparasitoids within whitefly hosts at plant defoliation do not survive, dying before emergence.

The shift from conventional long-season cotton production to a short-season system will presumably alter the dynamics of the populations of whiteflies and other pest insects as well as their natural enemies, thus, impacting management strategies. Defoliation eliminates leaves, squares, and small bolls that provide feeding and oviposition sites for insect pests (Yuzbashian and Babaev 1980, Greenberg et al. 2000).

Chemical defoliants are commonly used as a harvest aid in cotton, causing leaf abscission, earlier boll opening, and shedding of young fruiting forms, thereby reducing boll rot and preventing deterioration in seed and fiber quality (Bhamburkar and Kathane 1984, Hernandez-Jasso and Solis 1991, Chu et al. 1992, Snipes and Baskin 1994). Tribufos and thidiazuron are the 2 most commonly used defoliants (Suttle 1985, Yang et al. 2003), and previous studies show that defoliants combined with insecticides had additive and synergistic effects on insect mortality (Greenberg et al. 2000).

Application of tribufos for defoliation of cotton has little effect on the eggs, second and older instars of sweetpotato whitefly (Liu et al. 2001). However, application of tribufos significantly reduced survival to 30% for first instars compared with a 70% survival in the nontreated control. Tribufos in combination with the 2 insecticides, lambda-cyhalothrin and azinphosmethyl, also decreased survival of first, second and third instars. Survival rate of fourth-instar nymphs and pupae was unaffected by any chemical treatments in that study. Although numbers of *B. tabaci* adults captured on yellow sticky cards varied greatly among treatments on different dates, the differences were generally not significant. However, numbers of parasitoids (i.e., *Eretmocerus* spp. and *Encarsia* spp.) captured on yellow sticky cards were significantly fewer in the plots treated with tribufos, tribufos + azinphosmethyl, and tribufos + lambda-cyhalothrin and in controls than those captured in the plots treated with lambda-cyhalothrin and azinphosmethyl without defoliants. Although defoliants are used in every season in south Texas, the role of these defoliants on *B. tabaci* and their natural enemies has not been fully understood. The objective of this study was to determine the effects of defoliants, tribufos and thidiazuron, either alone or in combination with the insecticides, lambda-cyhalothrin and azinphosmethyl, on survival of *B. tabaci* and their parasitoids.

Materials and Methods

Treatments. Two defoliants included in this study were tribufos (Def® 6; 70.5% S, S, S – tributylphosphorotrithioate; Bayer CropScience, Research Triangle, NC, USA) and thidiazuron (Dropp® 50 WP; 50% thidiazuron; Bayer CropScience). The two insecticides included were a pyrethroid, lambda-cyhalothrin (Karate® 2.08CS; Syngenta, Greensboro, NC, USA), and an organophosphate, azinphosmethyl (Guthion® 2L; Bayer CropScience).

The defoliants and insecticides were combined at different rates to create 7 treatment combinations plus a nontreated control. The combinations were: (1) tribufos (168 g a.i./ha) + thidiazuron (224 g a.i./ha) + azinphosmethyl (280 g a.i./ha); (2) tribufos (84 g a.i./ha) + thidiazuron (112 g a.i./ha); (3) thidiazuron (224 g a.i./ha) + azinphosmethyl (560 g a.i./ha); (4) tribufos (168 g a.i./ha) + azinphosmethyl (280 g a.i./ha); (5) tribufos (168 g a.i./ha) + lambda-cyhalothrin (33.6 g a.i./ha); (6) azinphosmethyl (560 g a.i./ha); (7) lambda-cyhalothrin (33.6 g/ha), and; (8) a nontreated control. Tribufos and thidiazuron alone were not used because local growers do not use them alone (Liu, pers. comm.).

Detailed information on the cotton field and experimental design has been described in Greenberg et al. (2002, 2004). Cotton was planted in the beginning of March (144 rows, 1.02 m wide and 110 m long). The 7 treatments were replicated 3 times in a randomized block design. There were 21 plots arranged in blocks of 7 plots each. Each plot consisted of 6 rows, all of which received the same chemical treatment with the outside 2 rows being considered buffer rows and were not sampled. Rows were numbered 1 - 6 from west to east. One treatment was applied at a time across each of the 3 blocks. The field was sprayed 24 July with a calibrated spider track sprayer. Chemicals were applied 6 rows at a time with 2 drops and 1 nozzle (8,001 EVS; TeeJet, Wheaton, IL, USA) over the top for each row.

Data. To test the effect of applied chemicals on emergence of adult *B. tabaci* and parasitoids, the third, fifth, and seventh leaves from the main terminal of each of 20 plants per plot were collected 2 and 33 days after treatment applications. The leaves from each plant terminal were placed in paper bags and held in the laboratory at ambient conditions for 3 - 4 wks. Numbers of whitefly and parasitoid adults that emerged within each bag were then recorded. Those numbers were analyzed using analysis of variance and, when appropriate, treatment means were separated using the least significant difference test (LSD) at $P = 0.05$ (SAS Institute 2000).

Results and Discussion

Whiteflies and their parasitoids exhibited some significant responses 2 days after application of treatments combining defoliants and insecticides. When compared with the nontreated control, most treatment combinations significantly reduced the numbers of whiteflies on the leaves removed from plants 2 days after application (Table 1). All treatment combinations significantly reduced the numbers of 3rd instars below the numbers observed in the control. However, treatment with lambda-cyhalothrin (33.6 g a.i./ha) did not significantly reduce numbers of either 4th instars or pupae, and the combination of one-half the recommended rates of tribufos (84 g a.i./ha) + thidiazuron (112 g a.i./ha) did not significantly reduce the numbers of 4th instars. The fewest numbers of late-instar and pupal-stage whiteflies were observed on leaves treated with either one-half recommended rates of tribufos + thidiazuron + azinphosmethyl (280 g a.i./ha) or the full rate of tribufos (168 g a.i./ha) in combination with the one-half recommended rate of lambda-cyhalothrin (16.8 g a.i./ha).

At 2 days after application, defoliants and their combinations with insecticides also significantly reduced the number of sweetpotato whitefly parasitized by beneficial insects in comparison with the untreated control (Table 2). Numbers of parasitized nymphs and numbers of parasitoid empty cases were significantly reduced below those observed in the control for all treatment combinations. Furthermore, only the application of lambda-cyhalothrin at 3.6 g a.i./ha did not significantly impact the number of parasitized pupae recovered from the treated leaves.

By 33 days after application, almost all leaves had abscised from the cotton plants, and few, if any, whiteflies and parasitized whiteflies were found on the leaves sampled on that date. Thus, there were no significant differences in numbers of whiteflies and parasitized whiteflies among the treatment combinations at this sampling interval (Tables 1, 2).

The numbers of *B. tabaci* adults that emerged from leaves collected 2 days after treatment showed that lambda-cyhalothrin alone and azinphosmethyl alone did significantly reduce whitefly emergence. Their combination with the 2 defoliants, in general, reduced adult emergence (Table 3).

Table 1. Numbers of large nymphs and pupae of sweetpotato whitefly on cotton leaves sampled 2 days after application of indicated treatments.

Treatments*	third instar	fourth instar	Pupae	Total
Untreated control	5.1a	5.1a	0.7a	10.9a
Tribufos + thidiazuron + azinphosmethyl, all 0.5X	0.7b	1.5b	0.3b	2.4c
Tribufos + thidiazuron, all 0.5X	1.6b	4.3ab	0.3b	6.2abc
Tribufos + azinphosmethyl, all 1.0X	0.9b	2.8b	0.3b	4.1bc
Tribufos 1.0X + azinphosmethyl 0.5X	0.7b	3.3b	0.6b	4.5bc
Tribufos 1.0X + lambda-cyhalothrin 0.5X	0.6b	2.1b	0.1b	2.7c
azinphosmethyl 1.0X	1.4b	1.8b	0.4b	3.6bc
lambda-cyhalothrin 1.0X	2.3b	4.3ab	1.5ab	8.1ab
F (df = 7, 112)	3.67	2.16	2.68	3.19
P	0.0013	0.0432	0.0132	0.0041

* Tribufos 1.0X = 168 g a.i./ha; Thidiazuron 1.0X = 224 g a.i./ha; Lambda-cyhalothrin 1.0X = 33.6 g a.i./ha; Azinphosmethyl 1.0X = 560 g a.i./ha.
** Means within a column and followed by the same letter do not differ significantly at $P = 0.05$ (LSD, SAS Institute 2000).

Table 2. Numbers of parasitized nymphs and pupae of sweetpotato whitefly on defoliant and insecticides treated cotton leaves 2 days after treatment.

Treatments*	Parasitized nymphs	Parasitized pupae	Parasitoid empty cases	Total
Untreated control	3.0a	1.3a	1.9a	6.1a
Tribufos + thidiazuron + azinphosmethyl, all 0.5X	0.5b	0.3bc	0.3b	1.0c
Tribufos + thidiazuron, all 0.5X	0.5b	0.5bc	0.3b	1.3bc
Tribufos + azinphosmethyl, all 1.0X	0.3b	0.2c	0.2b	0.7c
Tribufos 1.0X + azinphosmethyl 0.5X	1.0b	0.2c	0.3b	1.5bc
Tribufos 1.0X + lambda-cyhalothrin 0.5X	0.6b	0.1c	0.5b	1.2bc
Azinphosmethyl 1.0X	1.3b	0.4bc	0.5b	2.3bc
Lambda-cyhalothrin 1.0X	1.4b	0.9ab	0.8b	3.1b
F (df = 7, 112)	5.84	3.35	4.06	8.07
P	0.0001	0.0028	0.0005	0.0001

* Tribufos 1.0X = 168 g a.i./ha; Thidiazuron 1.0X = 224 g a.i./ha; Lambda-cyhalothrin 1.0X = 3.6 g a.i./ha; Azinphosmethyl 1.0X = 560 g a.i./ha.

** Means within a column and followed by the same letter do not differ significantly at $P = 0.05$ (LSD, SAS Institute 2000).

Table 3. Numbers of whitefly adults and parasitoid adults emerged from 20 cotton leaves sampled 2 days after treatments.

Treatments*	Whiteflies emerged	Parasitoids emerged
Non-treated control	8.0a	10.0
Tribufos + thidiazuron + azinphosmethyl, all 0.5X	0.3b	1.3
Tribufos + thidiazuron, all 0.5X	0.7b	5.3
Tribufos + azinphosmethyl, all 1.0X	3.3a	1.7
Tribufos 1.0X + Izinphosmethyl 0.5X	1.3b	1.3
Tribufos 1.0X + lambda-cyhalothrin 0.5X	1.0b	6.0
Azinphosmethyl 1.0X	3.0ab	3.3
Lambda-cyhalothrin 1.0X	4.0ab	7.0
F (df = 7, 112)	2.18	1.06
P	0.0930	0.4306

* Tribufos 1.0X = 168 g a.i./ha; thidiazuron 1.0X = 224 g a.i./ha; lambda-cyhalothrin 1.0X = 33.6 g a.i./ha; azinphosmethyl 1.0X = 560 g a.i./ha.

** Means within a column and followed by the same letter do not differ significantly at $P = 0.05$ (LSD, SAS Institute 2000).

Overall, the 2 defoliants - tribufos and thidiazuron - and their combinations with azinphosmethyl and lambda-cyhalothrin significantly affected the survival of sweetpotato whiteflies and their parasitoids, *Encarsia* spp. and *Eretmocerus* spp., on cotton grown in the Lower Rio Grande Valley in Texas. Although effects varied greatly among the treatment combinations, the combination of these defoliants with these insecticides appears to provide some control of whitefly populations and may help manage their migration to other crops in the landscape once the cotton crop is defoliated. However, these treatment combinations also have negative impacts on the parasitism rates of the sweetpotato whitefly.

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