COMPARISON OF NEONICOTINOID WITH PYRETHROID INSECTICIDES FOR CONTROL WHITEFLY IN COTTON

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Abstract

Studies were conducted in Imperial Valley, CA to evaluate neonicotinoid insecticides and pyrethroid insecticides for control of silverleaf whitefly in cotton. Neonicotinoid insecticidal compounds, acetamiprid (Assail®), imidacloprid (Provado®), and thiamethoxam (Actara®) were compared to the standard whitefly insecticide fenpropathrin (Danitol®) in a tank mixture with an organophosphate, acephate (Orthene®) and compared to a cyclodiene compound endosulfan (Thiodan® or Phaser®) for control efficacy of whitefly adults, eggs and nymphs. The neonicotinoid insecticide, Assail®,and Danitol® plus Orthene® treatments provided the highest levels of control for silverleaf whitefly.

Introduction

The silverleaf whitefly, *Bemisia argentifolii* Bellows and Perring, (Bellows et al. 1994) caused severe economic losses to cotton and other crops in the United States in 1991 with conservative estimates of direct dollar losses exceeding $200 million and the direct dollar loss to cotton producers in the Lower Rio Grande Valley of Texas was more than $80 million (Henneberry 1993). Direct dollar losses to cotton in Arizona in 1992 exceeded $100 million (Henneberry 1993). Whitefly-induced economic losses to cotton occur as a result of reduced cotton yield (Mound 1965) and contamination of lint with honeydew and sooty molds (Davidson et al. 1994). The whitefly-transmitted cotton leaf crumple disease, caused by the begomovirus *Cotton leaf crumple virus* (CLCrV), can also cause reduction in yield (Dickson et al. 1954, Duffus and Flock 1982).

The silverleaf whitefly is a prolific pest with a broad host range infesting commercial crops in Southern California and Western Arizona year around. Insecticidal chemical applications provide temporary control of this pest (Chu et al. 1993). Insecticides present an efficacious and economical solution for silverleaf whitefly control in commercial cotton crops in the southwestern United States (Natwick 1993).

Material and Methods

Silverleaf whitefly insecticide efficacy research trials were conducted during the cotton seasons of 1997 through 2000 at the University of California Desert Research and Extension Center in the Imperial Valley, CA. Cotton stands, var. DPL 5415, were established at UC Desert Research and Extension Center in March for each year of study for the establishment of silverleaf whitefly insecticide efficacy trials. Each year the insecticides treatments and non-treated controls were replicated four times in randomized complete design experiments. Plots measured 15 m long and 8 m wide. Insecticide treatments and treatment dates for each experiment are listed by registered trade name in Table 1.

Silverleaf whitefly adults were sampled using the leaf turn method (Naranjo & Flint 1995) from 10 plants at random in each plot. Silverleaf whitefly eggs and nymphs were counted on single leaf disks of 1.65 cm^2 from the lower left hand quadrant on the undersides of 5th node leaves extracted from 10 plants at random in each plot. Leaf samples were taken weekly from June through August each year. Seed cotton was hand picked from 0.002 acre per plot each year. Seed cotton samples were ginned and percentages of lint turnout and pounds of lint per acre were calculated each year.

Seasonal silverleaf whitefly adult, egg, and nymph densities, and lint weights were analyzed using ANOVA (MSTAT-C 1989).Least significant difference (LSD) was employed for means separations.

Results

Among the insecticide treatments, only Phaser® 3 EC and Assail® 70 WP at 0.05 lb ai/acre had post-treatment silverleaf whitefly adults means greater than the non-treated control, $P \leq 0.05$, in the 1997 experiment (Table 2). In 1998, the non-treated control had a seasonal mean for silverleaf whitefly adults that was greater than the means for any of the insecticide treatments (Table 3). Treatments with Ovasyn® 1.5 EC + Phaser® 3 EC and with Assail® 70 WP at 0.022 lb ai/acre had greater silverleaf whitefly adult seasonal means than the seasonal means for Danitol® 2.4 EC + Orthene® 90S and Assail® 70 WP at 0.1 lb ai/acre treatments in 1998. There were no differences among the insecticide treatments for adult whitefly seasonal means in 1999, but all insecticide treatments had whitefly adult seasonal means that were lower than the non-treated control (Table 4). There were no differences among the insecticide treatment seasonal means and the non-treated control for silverleaf whitefly adults in the 2000 experiment (Table 5). During the four study years, there was no difference between the pyrethroid standard treatment (Danitol® 2.4 EC + Orthene® 90S) and the neonicotinoid treatments (Assail®, Actara® and Provado®) for levels of silverleaf whitefly adult.

In the 1997 experiment, there were no differences among the insecticide treatment seasonal means for whitefly eggs, but all of the insecticide treatments had whitefly egg seasonal means that were lower than the non-treated control , $P \leq 0.05$, (Table 2). Whitefly egg seasonal means for all insecticide treatments were lower than the non-treated control in 1998 (Table 3). The Assail® 70 WP at 0.1 lb ai/acre treatment had a whitefly egg seasonal means that was lower than all other insecticide treatments except the Assail® 70 WP at 0.075 lb ai/acre treatment in 1998. The Ovasyn® 1.5 EC + Phaser® 3 EC treatment whitefly egg seasonal mean was greater than any of the other insecticide treatments in 1998. During 1999, there were no differences among the insecticide treatments for whitefly eggs, but all of the insecticide treatments had whitefly egg seasonal means that were lower than the non-treated control (Table 4). There were no differences among the insecticide treatment seasonal means and the non-treated control for silverleaf whitefly eggs during 2000 (Table 5). During the four study years, there was no difference between the pyrethroid standard treatment (Danitol® 2.4 EC + Orthene® 90S) and the neonicotinoid treatments (Assail®, Actara® and Provado®) for levels of silverleaf whitefly eggs.

All of the insecticide treatment seasonal means for whitefly nymphs were lower than the non-treated control in the 1997 experiment, $P \leq 0.05$, (Table 2). The whitefly nymph seasonal mean for the Phaser® 3 EC treatment was greater than the highest rates of Assail® 70 WP at 0.075 lb ai/acre and 0.1 lb ai/acre in 1997. Whitefly nymph seasonal means for all insecticide treatments were lower than the non-treated control in 1998 (Table 3). The Ovasyn® 1.5 EC + Phaser® 3 EC treatment whitefly nymph seasonal mean was greater than any of the other insecticide treatments in 1998 except the Assail® 70 WP at the lowest rate of 0.022 lb ai/acre. During 1999, there were no differences among the insecticide treatments for whitefly nymphs, but all of the insecticide treatments had whitefly nymph seasonal means that were lower than the non-treated control (Table 4). Danitol® 2.4 EC + Orthene® 90S and the highest rates of Assail® 70 WP at 0.075 lb ai/acre and 0.1 lb ai/acre were the only treatments with seasonal means for silverleaf whitefly nymphs lower than the non-treated control in 2000 (Table 5). During the four study years, there was no difference between the

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pyrethroid standard treatment (Danitol® 2.4 EC + Orthene® 90S) and the neonicotinoid treatments (Assail®, Actara® and Provado®) for levels of silverleaf whitefly nymphs.

There were no differences in pounds of cotton lint per acre, among the treatments in 1997 and 1998, $P \geq 0.05$ (Table 2 and 3). In 1999, the non-treated control had a lint yield lower than any of the insecticide treatments (Table 4). Only Assail® 70 WP at 0.1 lb ai/acre and Thiodan® 3 EC at 1.0 lb ai/acre had cotton lint yields greater than the non-treated control in 2000 (Table 5).

Summary

During four years of study, lint yields were not often different between the pyrethroid standard treatment (Danitol® 2.4 EC + Orthene® 90S) and the neonicotinoid treatments (Assail®, Actara® and Provado®). Treatments resulting in lower numbers of whitefly adults, eggs, and nymphs generally produced higher values of seed cotton pounds per acre and lint pounds per acre. In these experiments other factors that could influence yield included relative susceptibility of western flower thrips, cotton leafperforator and *Empoasca* sp. leafhoppers to the various insecticides. Insecticides in these studies vary in their spectra of activity. Danitol®, Orthene® 90S and endosulfan are active against a broad range of cotton insect pests and Assail®, Actara®, and Provado® have narrower ranges of activity.

The neonicotinoid insecticides provide silverleaf whitefly control in cotton at levels similar to the pyrethroid plus organophosphate standard Danitol® + Orthene®. The 0.06 lb ai/acre rate of Actara® and the 0.01 lb ai/acre and 0.075 lb ai/acre rates of Assail® 70 WP, and Danitol® + Orthene® maintain similar levels of silverleaf whitefly adult, egg, and nymph throughout the cotton season.

The Assail® 70 WP insecticide applied at rates of 0.044 to 0.1 lb ai/acre provided silverleaf whitefly control in cotton at levels equal to the pyrethroid plus organophosphate standard Danitol® + Orthene® with equal or fewer applications. Assail® 70 WP and Actara® 25 WP have favorable mammalian and environmental toxicological profiles and look promising as alternative insecticides for whitefly control in cotton.

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Disclaimer

Mention of trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the University of California nor does it imply approval to the exclusion of other products that may be suitable.

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Table 1. Cotton Insecticide Treatments, Rates and Application Dates.

Year	Treatment	lb ai/acre	Treatment dates
1997	Phaser 3EC	1.13	18 , 25 Jun, 2, 9, 16, 23, 30 Jul
1997	Danitol 2.4EC + Orthene 90S	0.20 + 0.50	18 , 25 Jun, 2, 9, 16, 23, 30 Jul
1997	Assail 70 WP	0.05	18, 25 Jun, 2, 30 Jul
1997	Assail 70 WP	0.075	18, 25 Jun, 2, 30 Jul
1997	Assail 70 WP	0.10	18, 25 Jun, 2, 30 Jul
1998	Ovasyn 1.5EC + Phase 3 EC	0.25 + 0.75	7, 14, 21, 28 Jul, 4 Aug
1998	Danitol 2.4EC + Orthene 90S	0.20 + 0.50	7, 21, 28 Jul, 4 Aug
1998	Assail 70 WP	0.022	7, 21 Jul, 4 Aug
1998	Assail 70 WP	0.044	7, 21 Jul, 4 Aug
1998	Assail 70 WP	0.075	7, 21 Jul, 4 Aug
1998	Assail 70 WP	0.10	7, 21 Jul, 4 Aug
1999	Danitol 2.4EC + Orthene 90S	0.20 + 0.50	15 Jun, 14 Jul, 3 Aug
1999	Assail 70 WP	0.044	15 Jun, 14 Jul, 3 Aug
1999	Assail 70 WP	0.10	15 Jun, 14 Jul, 3 Aug
2000	Assail 70 WP	0.075	7, 21 Jun, 5, 19 Jul, 2 Aug
2000	Assail 70 WP	0.10	7, 21 Jun, 5, 19 Jul, 2 Aug
2000	Actara 25 WP	0.06	7, 21 Jun, 5, 19 Jul, 2 Aug
2000	Actara 25 WP	0.05	7, 21 Jun, 5, 19 Jul, 2 Aug
2000	Provado 1.6 F	0.05	7, 21 Jun, 5, 19 Jul, 2 Aug
2000	Danitol 2.4EC + Orthene 97S	0.20 + 0.50	7, 21 Jun, 5, 19 Jul, 2 Aug
2000	Thiodan 3 EC	1.00	7, 21 Jun, 5, 19 Jul, 2 Aug

Table 2. Post-Treatment Means for Silverleaf Whitefly Adults per Leaf, Eggs per cm^2, Nymphs per cm^2, and Pounds of Lint per Acre Following Various Insecticide Treatments, Holtville, CA, 1997.

Treatment	lbai/a	Adult	Egg	Nymph[1]	Lint
Control	-------	3.8 c	31.0 a	28.4 a	1419 a
Phaser 3EC	1.13	6.1 a	13.4 b	6.8 b	1354 a
Danitol 2.4EC + Orthene 90S	0.2 + 0.5	3.5 c	10.5 b	5.1 bc	1908 a
Assail 70 WP	0.05	4.7 b	14.7 b	4.8 bc	1664 a
Assail 70 WP	0.075	3.3 c	11.8 b	4.4 c	1624 a
Assail 70 WP	0.1	3.5 c	11.3 b	4.1 c	1518 a

[1]Log transformed data used in analysis, reverse transformed means reported.
Mean separations within columns by Least Significant Differences, P≤0.05.

Table 3. Seasonal Means for Silverleaf Whitefly Adults per Leaf, Eggs per cm^2, Nymphs per cm^2, and Pounds of Lint per Acre for Various Insecticide Treatments and Non-Treated Control, Holtville, CA, 1998.

Treatment	lb ai/a	Adult	Egg[1]	Nymph[1]	Lint
Control	------	24.3 a	3.9 a	3.0 a	1070 a
Ovasyn 1.5EC + Phaser 3EC	0.25 + 0.75	15.7 b	2.2 b	1.1 b	1426 a
Danitol 2.4EC + Orthene 90S	0.20 + 0.50	5.5 d	1.0 cd	0.8 cd	1346 a
Assail 70 WP	0.022	8.1 c	1.1 c	0.9 bc	1345 a
Assail 70 WP	0.044	7.1 cd	1.0 cd	0.8 cd	1447 a
Assail 70 WP	0.075	6.9 cd	0.8 de	0.6 d	1218 a
Assail 70 WP	0.10	5.9 d	0.7 e	0.7 cd	1442 a

[1]Log transformed data used in analysis, reverse transformed means reported.
Mean separations within columns by Least Significant Differences, P≤0.05.

Table 4. Seasonal Means for Silverleaf Whitefly Adults per Leaf, Eggs per cm^2, Nymphs per cm^2, and Pounds of Lint per Acre for Various Insecticide Treatments and Non-Treated Control, Holtville, CA, 1999.

Treatment	lbai/a	Adult	Egg	Nymph	Lint
Control	-------	7.7 a	46.7 a	37.1 a	1240 b
Danitol 2.4EC + Orthene 90S	0.2 + 0.5	5.1 b	28.3 b	12.6 b	1636 a
Assail 70 WP	0.044	5.9 b	31.5 b	11.7 b	1623 a
Assail 70 WP	0.1	5.7 b	24.5 b	10.2 b	1708 a

Mean separations within columns by Least Significant Differences, P≤0.05.

Table 5. Seasonal Means for Silverleaf Whitefly Adults per Leaf, Eggs per cm^2, Nymphs per cm^2, and Pounds of Lint per Acre for Various Insecticide Treatments and Non-Treated Control, Holtville, CA, 2000.

Treatment	lbai/a	Adult	Egg	Nymph	Lint
Control	-------	9.2 a	2.0 a	3.9 a	1224 cd
Provado 1.6	0.05	7.9 a	1.6 a	2.7 ab	1293 bcd
Actara 25 WP	0.05	10.5 a	2.0 a	2.7 ab	1136 d
Actara 25 WP	0.06	8.8 a	2.0 a	2.5 abc	1435 abcd
Thiodan 3 EC	1.0	7.2 a	2.0 a	2.5 abc	1627 ab
Danitol 2.4EC + Orthene 97S	0.2 + 0.5	7.3 a	1.5 a	2.0 bc	1153 d
Assail 70 WP	0.075	7.8 a	1.3 a	1.6 bc	1526 abc
Assail 70 WP	0.1	6.5 a	1.3 a	1.0 c	1678 a

Mean separations within columns by Least Significant Differences, P≤0.05.