FIELD & GREENHOUSE PERFORMANCE OF MUSTANG 1.5 EW AND CAPTURE 2EC ON IMMATURE AND ADULT WHITEFLY

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Abstract

Greenhouse studies were conducted to determine the most vulnerable white-fly stage to various pyrethroid treatment regimes and to determine if differ-ences in insecticide efficacy are due to speed of kill. The order of immature whitefly susceptibility overall was crawler to second instar > egg hatch to crawler > 3rd-4th instar to redeye nymph. All insecticide treatments tested appeared to take approximately the same length of time to take lethal action. Small plot field trials were conducted in 1994 to evaluate season long control of whitefly with competitive pyrethroid combinations and in 1995 to compare the efficacy of rotating nonpyrethroid and pyrethroid insecticide combinations with continuous pyrethroid insecticide treatment regimes. Large field plots also established in 1995 determined Mustang 1.5 EW whitefly efficacy improves ± 5% when a surfactant is added (CSO or Bivert) or the rate of Orthene is increased (2X) in insecticide tankmixtures applied by air.

Introduction

The sweetpotato whitefly (SPWF) *Bemisia tabaci* Genn. was first reported in the United States on California cotton (Russell 1957) and has since climbed to an economic pest status during the last decade throughout the southwestern agricultural regions of the country. Severe outbreaks of the B strain SPWF, now known as the silverleaf whitefly (SLWF) *Bemisia argentifolii* Bellows and Perring (Perring, Cooper, Rodriguez, Farrar & Bellows 1993; Bellows, Perring, Gill, & Headrick 1994), dramatically reduced cotton yields in Arizona and southern California during the 1991 cotton production season by contaminating lint with honeydew which caused leaf drop and defoliation in many fields. The appearance of this more destructive "new" biotype and its rapid displacement of the indigenous biotype stress the importance of developing whitefly management strategies that prolong the effective use of insecticides while minimizing the risk of insecticide resistance. The objec-tives of this research were to: 1) determine the most vulnerable immature whitefly stage to various pyrethroid treatment regimes, 2) determine if differences in insecticide efficacy are due to speed of kill, 3) evaluate season long control of whitefly with competitive pyrethroid combinations, 4) evaluate efficacy of rotating nonpyrethroid and pyrethroid insecticide combinations with continuous pyrethroid insecticide treatment regimes, and 5) demonstrate improved efficacy against whitefly when surfactants are added to tankmixtures with Mustang 1.5 EW and applied by air.

Materials and Methods

Greenhouse studies

Cotton, var. 'DP 5461' were transplanted to 15.0 cm pots and maintained in the greenhouse at ± 25◦C. Plants of uniform size were arranged in a complete randomized design with three replications for all whitefly stage evaluations. An experimental unit consisted of a cotton plant with a ventilated cylindrical clip cage attached to a single cotton leaf to prevent movement of adult whitefly from plant to plant during infestation. Plants were infested with 30 adult female whitefly per plant for ± 2 - 4 hours followed by fumigation of each clip cage with CO_2 and removal of adult whitefly from all leaf surfaces in an effort to synchronize whitefly development across treatments and replications regardless of the whitefly stage under evaluation. Three developmental stages were evaluated for whitefly susceptibility to different insecticide treatments: egg hatch to crawler (stage 1), crawler to 2nd instar (stage 2), and 3rd-4th instar to redeye nymph (stage 3). All insecticide treatments were applied with a spray bottle until the cotton leaves were thoroughly covered and began to drip.

Stage one bioassays were sprayed the same day whitefly egg counts were laid. Whitefly egg counts were initiated 4 days after seeding plants with eggs and every day thereafter until the majority of crawlers had hatched in the untreated control or 6 to 7 DAT. The percentage of viable eggs (EGG), whitefly crawlers dying during egg emergence (DOE), and whitefly crawlers successfully hatched from the egg and apparently healthy (HATCH) were calculated based on pretreat egg evaluations for each treatment.

Stage two bioassays were sprayed 9 days after egg laying when whitefly were at the crawler (1st) to 2nd instar stage. Immediately prior to spraying, whitefly immatures were counted and marked for easier location after treatment. Percent survival and percent mortality were assessed 48 hrs after spraying and calculated from the number of immatures determined pretreat for each treatment. Percent control for each treatment was determined from the untreated control 48 hrs after spraying. Immatures were destructively sampled and scored dead or alive based on movement detected when pricked with a dissecting probe consequently additional evaluations (72 hr, 96 hr etc.) are not possible for an individual bioassay.

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Stage three bioassays were similar to stage two with the exception of spraying whitefly immatures 15 days after egg laying when late instars (3rd to 4th) were just prior to developing into the redeye pupae stage. Greenhouse bioassays were replicated at least twice for all developmental stages evaluated and replications that were not significantly different were pooled for data analyses.

Small Plot Field Studies, 1994

Cotton, var. 'DP 5415', was direct seeded on 17 March 1994 into beds spaced 40 inches apart at the University of Arizona, Yuma Valley Agricultural Center, Yuma, AZ. Plots were 4 beds wide and 50 ft long with 10 ft within row buffers and 2 rows between plots. Plots were arranged in a randomized complete block design with 4 replicates. Insecticide treatments were applied on the following dates: 21, 29 July, 10, 26 August, and 9 September 1994. Insecticide treatments were applied using a Massey Ferguson 135 tractor with a rear mounted 2 row spray boom equipped with 3 TX18 hollow cone nozzles per row, one nozzle on each side and one nozzle directly over the row. The sprayer was calibrated to deliver thirty gallons per acre at 40 psi.

Immature whitefly were sampled from 5 mainstem node leaves on randomly selected plants from the 5th position below the terminal of the plant on 25 July, 1, 8, 15, 22, 31 August, 6, 13, and 20 September 1994. Two circular leaf discs were examined from the lower quadrants on each leaf using a binocular dissecting microscope. The numbers of eggs, 1st through 4th instar nymphs and redeye nymphs were recorded.

Adult whitefly were sampled from each plot on 25 July, 1, 8, 16, 22, 31 August, 6, 13, and 20 September 1994 using a 9x13" black rectangular Teflon™ cake pan divided into square grids and coated with a fine film of PAM® vegetable oil. Adult whitefly were dislodged from plants by twice beating the terminal portion into the pan with the palm of the hand. Whitefly adults were trapped in the oil film and counted from 4 randomly selected grids (50 cm^2 total area) from each of two pan samples per plot.

Small Plot Field Studies, 1995

Cotton, var. 'DP 5415', was directed seeded at the University of Arizona, Yuma Valley Agricultural Center, Yuma, AZ with the same plot size and configuration as the previous year. Plots were arranged in a randomized complete block design with 5 replications. Insecticide treatments consisted of nonpyrethroid combinations rotated with pyrethroid combinations or continuous applications of two are more tankmix partners. All insecticide treatment regimes were applied on 13 July, 1, 11, 17, 25 August and 7 September 1995 with rotational regimes starting with nonpyrethroid combinations. Insecticide treatments were applied with the same spray equipment used in 1994 with the tractor calibrated to deliver 20 gallons per acre at 40 psi.

Immature whitefly were sampled from 10 mainstem node leaves on randomly selected plants from the 5th position below the terminal of the plant on 18 July, 7, 16, 22, 30 August, and 7 September 1995. One circular leaf disc was examined from the lower quadrant on each leaf using a binocular dissecting microscope. The numbers of whitefly eggs and total whitefly nymphs were recorded.

Adult whitefly were sampled from each plot on 18, 25, 31 July, 7, 10, 16, 22, 30 August, and 7 September 1995 using the leaf turn method. Twenty-five mainstem node leaves at the 5th position below the terminal of the plant were sampled from randomly selected plants from each plot. Populations were monitored weekly and insecticide applications were initiated when whitefly adults reached a spray threshold of ± 5 per leaf. Yield samples were recorded as pounds of seed cotton per plot harvested (inner 2 rows) with a commercial picker 7 October 1995.

Large Field Plot Studies, 1995

Large field plots were established in Parker, AZ in 1995 to demonstrate improved efficacy against whitefly when surfactants were added to Mustang 1.5 EW tankmixes. All treatments were applied by air in 5 gallons per acre on 3 August 1995 with Mustang 1.5 EW (0.0469 lb (AI)/ac) and Tri-Fol (1 qt/100 gallons water). Mustang + Orthene (0.50 lb (AI)/ac) + buffer was applied alone, with Bivert (1:1 ratio with Mustang), with Emulsifiable Cottonseed Oil (1 pt/ac), or with a hi rate of Orthene (1.0 lb (AI)/ac) Adult whitefly populations were assessed 24-48 hrs after treatment using black pan and leaf turn evaluation methods. Six samples per treatment were taken of each evaluation method type. Black pan samples consisted of tapping ten consecutive cotton plants 3 times against a pan marked with 1 $inch^2$ grids and the total number of adult whitefly per 3 grids selected at random were counted. Leaf turn method evaluated the total number of adult whitefly per 25 5th mainstem node leaves.

Data Analysis

Analysis of variance (ANOVA: Gylling Data Management, Inc. 1992) was used to determine the effects of various insecticide treatment regimes on different whitefly developmental stages for all greenhouse and small plot field studies. Means were separated with Duncan's multiple range test (DMRT) ($P \leq 0.05$).

Results and Discussion

Greenhouse studies

Effect of insecticide treatments on egg hatch, survival of whitefly crawlers during and immediately after egg hatch on cotton under greenhouse conditions is summarized in Table 1. Mustang (0.0375) combined with Orthene (0.50) or applied alone apparently was the best ovicide treatment tested with half of the eggs never emerging 7 DAT and 88.2 and 89.7% control, respectively. Although > 50% of the eggs treated with

Capture (0.08) hatched 6 DAT, 63.1% of the crawlers died during egg emergence by 7 DAT producing 84.3% overall control. Asana (0.04) applied alone caused 34.9% crawler death immediately after egg hatch and 26.6% of eggs resulting in live nymphs 7 DAT. The untreated control had a high egg to nymph survival rate with only 0.6% crawler death occurring immediately after egg hatch and 81.7% reaching the nymph stage 7 DAT.

Results from greenhouse bioassays targeted at the whitefly crawler stage determined Mustang/Orthene (0.0375/0.5) had < 1% nymph survival (Table 2) followed by Capture alone (0.08) with 1.9% nymph survival 48 hours after treatment. Mustang/Thiodan (0.0375/1.0) and Mustang alone (0.0375) had 5.9% whitefly nymph survival compared to Asana (0.04) treatments which produced almost double the nymph survival rate (11.1%). The untreated control had a high survival rate with 89.9% crawlers reaching the 2nd instar 48 hours after treatment.

Significant reductions were detected in control of last nymphal instar/redeye pupae stage compared with earlier immature stages tested (egg to crawler or late 1st instar). Apparently, late instar nymphs just prior to developing into the redeye pupae stage are the most difficult immature whitefly stage to control (Table 3). Mustang/Orthene combination was the most effective treatment tested on this stage with 58.5% nymph survival rate, 41.5% mortality rate and only 39.1% control. Capture alone and Mustang/Thiodan resulted 75.7% and 78.4% survival of late instar nymphs, 23.4 and 21.6% mortality, and 21.3% and 18.4% control, respectively. Mustang alone had 81.3% whitefly nymph surviving compared to Asana treatments with 86.3% survival rate. The untreated control had a high survival rate with 96.1% last instar nymphs reaching the redeye pupae stage 48 hours after treatment. Individual field populations with higher percentages of this stage could be harder to control or take longer periods of time to become effective compared to a younger population typically found earlier in the growing season.

In conclusion, Mustang did not take longer than the comparative pyrethroids to control any of the whitefly stages tested to date. Real treatment differences seem to lie in individual product efficacy (maximum % mortality achieved at a given rate) and not in the length of time for the product to take lethal action since all products performed at approximately the same speed.

Small Plot Field Studies, 1994

In 1994, differences among treatment means for whitefly egg, nymph, redeye nymph, and adult whitefly were very similar with respect to the efficacy of insecticide treatments (Tables 4-7). Seasonal percent control ranged from 86-93%, 55-72%, 56-83%, and 82-90% for whitefly egg, nymph, redeye nymph, and adult whitefly, respectively. Whitefly egg, nymph and adult mean values were significantly lower than the untreated control for all insecticide treatments after the third application and for redeye nymphs after the fourth application. All treatments performed equally with no one treatment consistently providing the best control across all whitefly life stages.

Small Plot Field Studies, 1995

In 1995, seasonal mean percent control for all whitefly stages was typically 10% lower for treatment regimes that alternated between nonpyrethroid and pyrethroid insecticide combinations throughout the season compared with the continuous use of pyrethroid treatment regimes (Tables 8-10). Whitefly egg, nymph and adult mean values were significantly lower than the untreated control for all insecticide treatments after the first application. Capture (0.08) combinations with either Monitor (0.50) or Curacron (0.50) and Danitol (0.031) + Mustang (0.045) + Orthene (0.50) treatments consistently provided the highest level of control for all whitefly life stages. Mean yield values (Table 9) as pounds of seed cotton per plot were significantly higher than the untreated control (20.7 lbs) for all insecticide treatments. Danitol + Mustang + Orthene was the highest producing treatment (40.9 lbs), followed by Thiodan (0.75) + Penncap-M (0.75) alternating with Mustang (0.045) + Ovasyn (0.25) (37.9 lbs) and Capture + Monitor (36.8 lbs) treatments.

There was not a noticeable economic impact detected in this trial that could be directly related to alternating chemistries for whitefly control. However, the importance of resistance management should be emphasized in terms of slowing the rate at which resistance may increase during the season. Constant bombardments of pyrethroid treatments throughout the growing season can only lead to rapid development of resistance. Cross-resistance between major pyrethroid players in the cotton arena is a very real threat that intensifies the need to preserve whitefly susceptibility to pyrethroids, especially when considering pyrethroids are a key insecticide class for controlling a large majority of other cotton insect pests.

Large Field Plot Studies, 1995

Adult whitefly were evaluated by pan and leaf turn methods 1 and 2 DAT (Figure 1). Control ranged from 85-91% and 82-88% when evaluated by pan and leaf turn methods, respectively. Adding Bivert, CSO or doubling the rate of Orthene increased efficacy ± 5% over Mustang + Orthene + Buffer treatment regimes regardless of which evaluation method was used to determine numbers of adult whitefly.

References

1. Bellows, T.S. , Jr., T.M. Perring, R.J. Gill, and D.H. Headrick. 1994. Description of a species of *Bemisia* (Homoptera: Aleyrodidae). Ann. Entomol. Soc. Amer. 81: 195-206.

2. Gylling Data Management Inc. 1992. Pesticide Research Manager, For IBM and IBM-Compatible Personal Computers, Reference Manual, Version 4.06c. Brookings, SD.

3. Perring, T.M., A.D. Cooper, R.J. Rodriguez, C.A. Farrar & T.S. Bellows, Jr. 1993. Identification of a whitefly species by genomic and behavioral studies. Science. 259: 74-77.

4. Russell, L.M. 1957. Collection records of *Bemisia tabaci* (Gennadius) in the United States (Homoptera: Aleyrodidae), USDA Coop. Econ. Ins. Rpt. 25: 229-230.

Table 1. Effect of insecticide treatments on egg hatch, survival of whitefly crawlers during and immediately after egg hatch on cotton under greenhouse conditions.

	Rate	5 DAT		6 DAT		
Treatment	lb ai/ac	EGG[a]	DOE[b]	EGG[a]	DOE[b]	HATCH[c]
Mustang 1.5 EW	0.0375	97.7 a	0.0 a	71.1 ab	2.4 a	21.7 ab
Capture 2 EC	0.08	96.6 a	0.0 a	47.6 bcd	0.0 a	52.0 a
Asana 0.66	0.04	89.3 a	0.0 a	35.3 cd	1.3 a	19.5 b
Mustang 1.5 EW + Thiodan 3 EC	0.0375 + 1.0	90.7 a	1.0 a	59.4 abc	1.3 a	24.8 ab
Mustang 1.5 EW + Orthene 75S	0.0375 + 0.50	94.7 a	0.0 a	75.2 a	0.0 a	13.6 b
Untreated	--------	98.6 a	0.0 a	22.4 d	0.0 a	33.6 ab

Table 1. (cont'd).

	Rate	7 DAT			
Treatment	lb ai/ac	EGG[a]	DOE[b]	HATCH[c]	CTRL[d]
Mustang 1.5 EW	0.0375	49.2 a	30.6 b	9.6 b	88.2
Capture 2 EC	0.08	14.3 bc	63.1 a	12.8 b	84.3
Asana 0.66	0.04	15.4 bc	34.9 b	26.6 b	67.4
Mustang 1.5 EW + Thiodan 3 EC	0.0375 + 1.0	39.4 ab	42.2 ab	14.4 b	82.4
Mustang 1.5 EW + Orthene 75S	0.0375 + 0.50	50.1 a	26.5 b	8.4 b	89.7
Untreated	--------	8.1 c	0.6 c	81.7 a	0.0

Means within a column followed by the same letter are not significantly different ($P \leq 0.05$; DMRT).
[a] EGG: Percent of whitefly eggs present based on pretreat egg evaluations.
[b] DOE: Percent of whitefly crawlers dying during egg emergence based on pretreat egg evaluations.
[c] HATCH: Percent of whitefly crawlers successfully hatched from the egg and appear healthy based on pretreat egg evaluations.
[d] CTRL: Percent control of whitefly based on pretreat egg evaluations.

Table 2. Effect of insecticide treatments on whitefly crawler stage on cotton under greenhouse conditions.

	Rate	Percent Crawler		
Treatment	lb ai/ac	Survival	Mortality	Control
Mustang 1.5 EW	0.0375	5.9 bc	92.3 ab	93.5 bc
Capture 2 EC	0.08	1.9 bc	99.1 a	97.9 bc
Asana 0.66	0.04	11.1 b	86.8 b	87.6 b
Mustang 1.5 EW + Thiodan 3 EC	0.0375 + 1.0	5.9 bc	93.7 ab	93.5 bc
Mustang 1.5 EW + Orthene 75S	0.0375 + 0.50	0.8 c	98.1 a	99.1 c
Untreated	--------	89.9 a	3.7 c	0.0 a

Means within a column followed by the same letter are not significantly different ($P \leq 0.05$; DMRT).

Table 3. Effect of insecticide treatments on late instars of whitefly on cotton under greenhouse conditions.

	Rate	Percent Late Instar		
Treatment	lb ai/ac	Survival	Mortality	Control
Mustang 1.5 EW	0.0375	81.3 bc	18.7 bc	15.4 bc
Capture 2 EC	0.08	75.7 c	23.4 b	21.3 c
Asana 0.66	0.04	86.3 b	13.7 c	10.2 b
Mustang 1.5 EW + Thiodan 3 EC	0.0375 + 1.0	78.4 c	21.6 bc	18.4 c
Mustang 1.5 EW + Orthene 75S	0.0375 + 0.50	58.5 d	41.5 a	39.1 d
Untreated	--------	96.1 a	3.9 d	0.0 a

Means within a column followed by the same letter are not significantly different ($P \leq 0.05$; DMRT).

Table 4. Efficacy of competitive pyrethroid combinations for control of whitefly eggs on cotton, 1994.

	Rate	# WF eggs per 10 cm^2 leaf discs			
Treatment[a]	lb (AI)/ac	4 DAT	3 DAT	10 DAT	5 DAT
Capture 2 EC	0.06	22.3 a	18.0 a	11.0 a	15.3 b
Capture 10 WP	0.06	83.0 a	84.3 a	14.3 a	7.5 b
Scout X-TRA 0.9 EC	0.019	30.5 a	27.3 a	21.3 a	14.0 b
Danitol 2.4 EC	0.20	104.3 a	50.3 a	7.3 a	5.5 b
Karate 1.0 EC	0.03	46.3 a	40.8 a	7.5 a	11.5 b
Asana XL 2.4 EC	0.036	12.8 a	13.8 a	9.5 a	11.8 b
Mustang 1.5 EW	0.05	79.5 a	34.0 a	11.0 a	20.8 b
Untreated	-------	101.3 a	54.3 a	24.3 a	68.5 a

Table 4. (cont'd).

	Rate	# WF eggs per 10 cm^2 leaf discs			
Treatment[a]	lb (AI)/ac	12 DAT	5 DAT	11 DAT	4 DAT
Capture 2 EC	0.06	10.8 b	12.5 b	36.3 b	20.0 b
Capture 10 WP	0.06	12.3 b	21.5 b	24.5 b	18.3 b
Scout X-TRA 0.9 EC	0.019	13.0 b	34.3 b	36.3 b	32.0 b
Danitol 2.4 EC	0.20	5.8 b	7.3 b	14.8 b	16.5 b
Karate 1.0 EC	0.03	11.8 b	10.8 b	27.8 b	36.5 b
Asana XL 2.4 EC	0.036	10.8 b	14.5 b	19.8 b	31.3 b
Mustang 1.5 EW	0.05	18.5 b	29.8 b	31.3 b	27.3 b
Untreated	-------	386.3 a	357.8 a	341.8 a	314.8 a

Table 4. (cont'd).

Treatment[a]	Rate lb (AI)/ac	# WF eggs per 10 cm^2 leaf discs 11 DAT	Season X (% Control)
Capture 2 EC	0.06	17.3 b	18.2 (92)
Capture 10 WP	0.06	16.8 b	31.4 (86)
Scout X-TRA 0.9 EC	0.019	50.0 b	28.7 (87)
Danitol 2.4 EC	0.20	8.3 b	24.5 (89)
Karate 1.0 EC	0.03	16.3 b	23.3 (90)
Asana XL 2.4 EC	0.036	16.5 b	15.6 (93)
Mustang 1.5 EW	0.05	8.3 b	28.9 (87)
Untreated	-------	406.8 a	228.4

Means within a column followed by the same letter are not significantly different ($P \leq 0.05$; DMRT).
[a] All pyrethroid treatments tankmixed w/Orthene 75 S (0.50 lbs AI/ac).

Table 5. Efficacy of competitive pyrethroid combinations for control of whitefly nymphs on cotton, 1994.

Treatment[a]	Rate lb (AI)/ac	# WF nymphs per 10 cm² leaf discs 4 DAT	3 DAT	10 DAT	5 DAT
Capture 2 EC	0.06	60.0 a	37.3 a	18.8 a	33.8 a
Capture 10 WP	0.06	69.0 a	78.0 a	19.3 a	9.8 a
Scout X-TRA 0.9 EC	0.019	62.0 a	34.5 a	25.0 a	12.8 a
Danitol 2.4 EC	0.20	75.8 a	56.0 a	12.8 a	12.3 a
Karate 1.0 EC	0.03	62.0 a	54.5 a	15.8 a	17.0 a
Asana XL 2.4 EC	0.036	35.5 a	27.3 a	14.5 a	13.5 a
Mustang 1.5 EW	0.05	84.0 a	46.3 a	20.8 a	16.3 a
Untreated	-------	74.3 a	74.0 a	24.8 a	31.3 a

Table 5. (cont'd).

Treatment[a]	Rate lb (AI)/ac	# WF nymphs per 10 cm² leaf discs 12 DAT	5 DAT	11 DAT	4 DAT
Capture 2 EC	0.06	11.5 b	12.3 b	8.0 b	19.8 bc
Capture 10 WP	0.06	10.3 b	9.0 b	9.0 b	17.5 bc
Scout X-TRA 0.9 EC	0.019	14.0 b	25.3 b	16.3 b	25.5 bc
Danitol 2.4 EC	0.20	6.8 b	7.8 b	8.5 b	11.8 c
Karate 1.0 EC	0.03	6.8 b	12.0 b	4.8 b	23.5 bc
Asana XL 2.4 EC	0.036	11.5 b	7.5 b	11.0 b	35.5 b
Mustang 1.5 EW	0.05	15.3 b	20.8 b	7.5 b	23.0 bc
Untreated	-------	109.8 a	69.5 a	51.0 a	63.5 a

Table 5. (cont'd).

Treatment[a]	Rate lb (AI)/ac	# WF nymphs per 10 cm² leaf discs 11 DAT	Season X (% Control)
Capture 2 EC	0.06	29.5 b	25.7 (65)
Capture 10 WP	0.06	37.5 b	28.8 (61)
Scout X-TRA 0.9 EC	0.019	78.5 b	32.7 (55)
Danitol 2.4 EC	0.20	14.3 b	22.9 (69)
Karate 1.0 EC	0.03	20.3 b	24.1 (67)
Asana XL 2.4 EC	0.036	27.0 b	20.4 (72)
Mustang 1.5 EW	0.05	21.8 b	28.4 (61)
Untreated	-------	159.8 a	73.1

Means within a column followed by the same letter are not significantly different ($P \leq 0.05$; DMRT).
[a] All pyrethroid treatments tankmixed w/Orthene 75 S (0.50 lbs AI/ac).

Table 6. Efficacy of competitive pyrethroid combinations for control of redeye whitefly nymphs on cotton, 1994.

Treatment[a]	Rate lb (AI)/ac	# redeye WF nymphs per 10 cm² leaf discs 4 DAT	3 DAT	10 DAT	5 DAT
Capture 2 EC	0.06	1.5 ab	1.5 a	0.0 a	1.5 a
Capture 10 WP	0.06	1.8 ab	5.3 a	3.0 a	1.5 a
Scout X-TRA 0.9 EC	0.019	2.0 ab	2.8 a	2.3 a	0.3 a
Danitol 2.4 EC	0.20	3.5 ab	1.3 a	0.5 a	0.8 a
Karate 1.0 EC	0.03	2.0 ab	3.0 a	1.3 a	1.3 a
Asana XL 2.4 EC	0.036	0.5 b	1.5 a	0.5 a	0.5 a
Mustang 1.5 EW	0.05	1.5 ab	1.8 a	0.5 a	0.5 a
Untreated	-------	5.0 a	5.3 a	1.0 a	1.0 a

Table 6. (cont'd).

Treatment[a]	Rate lb (AI)/ac	# redeye WF nymphs per 10 cm² leaf discs 12 DAT	5 DAT	11 DAT	4 DAT
Capture 2 EC	0.06	0.8 a	0.3 b	0.3 b	1.3 b
Capture 10 WP	0.06	0.3 a	0.5 b	0.3 b	0.3 b
Scout X-TRA 0.9 EC	0.019	0.8 a	1.0 b	0.3 b	0.5 b
Danitol 2.4 EC	0.20	0.0 a	0.5 b	0.3 b	0.3 b
Karate 1.0 EC	0.03	0.5 a	0.5 b	0.3 b	1.0 b
Asana XL 2.4 EC	0.036	0.3 a	0.3 b	0.0 b	0.3 b
Mustang 1.5 EW	0.05	0.3 a	0.3 b	0.0 b	1.5 b
Untreated	-------	1.5 a	2.8 a	4.0 a	3.8 a

Table 6. (cont'd).

Treatment[a]	Rate lb (AI)/ac	# redeye WF nymphs per 10 cm² leaf discs 11 DAT	Season X (% Control)
Capture 2 EC	0.06	1.8 b	1.0 (72)
Capture 10 WP	0.06	1.5 b	1.6 (56)
Scout X-TRA 0.9 EC	0.019	2.8 b	1.4 (61)
Danitol 2.4 EC	0.20	0.3 b	0.8 (78)
Karate 1.0 EC	0.03	0.8 b	1.2 (67)
Asana XL 2.4 EC	0.036	1.5 b	0.6 (83)
Mustang 1.5 EW	0.05	1.3 b	0.9 (75)
Untreated	-------	8.3 a	3.6

Means within a column followed by the same letter are not significantly different ($P \leq 0.05$; DMRT).
[a] All pyrethroid treatments tankmixed w/Orthene 75 S (0.50 lbs AI/ac).

Table 7. Efficacy of competitive pyrethroid combinations for control of adult whitefly on cotton, 1994.

Treatment[a]	Rate lb (AI)/ac	# adult WF per black pan sample[b] 4 DAT	3 DAT	10 DAT	5 DAT
Capture 2 EC	0.06	0.5 b	0.3 b	5.8 a	14.0 b
Capture 10 WP	0.06	2.3 b	2.0 b	31.5 a	7.5 b
Scout X-TRA 0.9 EC	0.019	4.0 b	5.3 b	6.5 a	19.5 b
Danitol 2.4 EC	0.20	1.3 b	0.8 b	3.3 a	5.5 b
Karate 1.0 EC	0.03	2.5 b	3.3 b	10.5 a	11.5 b
Asana XL 2.4 EC	0.036	2.0 b	1.8 b	9.0 a	10.3 b
Mustang 1.5 EW	0.05	1.5 b	1.8 b	8.3 a	7.3 b
Untreated	-------	24.5 a	26.5 a	33.8 a	115.5 a

Table 7. (cont'd).

Treatment[a]	Rate lb (AI)/ac	# adult WF per black pan sample[b] 12 DAT	5 DAT	11 DAT	4 DAT
Capture 2 EC	0.06	10.5 b	22.0 b	65.8 b	2.8 b
Capture 10 WP	0.06	10.8 b	23.5 b	43.8 b	5.0 b
Scout X-TRA 0.9 EC	0.019	13.0 b	26.8 b	69.3 b	6.3 b
Danitol 2.4 EC	0.20	4.0 b	15.0 b	49.5 b	1.0 b
Karate 1.0 EC	0.03	8.0 b	18.0 b	68.5 b	8.0 b
Asana XL 2.4 EC	0.036	13.5 b	31.8 b	59.8 b	3.5 b
Mustang 1.5 EW	0.05	13.3 b	29.0 b	57.0 b	9.5 b
Untreated	-------	120.8 a	198.3 a	266.8 a	24.8 a

Table 7. (cont'd).

Treatment[a]	Rate lb (AI)/ac	# adult WF per black pan sample[b] 11 DAT	Season X (%Control)
Capture 2 EC	0.06	7.5 ab	14.4 (84)
Capture 10 WP	0.06	7.5 ab	14.9 (84)
Scout X-TRA 0.9 EC	0.019	18.0 a	18.7 (80)
Danitol 2.4 EC	0.20	2.8 b	9.2 (90)
Karate 1.0 EC	0.03	2.0 b	14.7 (84)
Asana XL 2.4 EC	0.036	18.0 a	16.6 (82)
Mustang 1.5 EW	0.05	2.0 b	14.4 (84)
Untreated	-------	18.0 a	92.1

Means within a column followed by the same letter are not significantly different ($P \leq 0.05$; DMRT).
[a] All pyrethroid treatments tankmixed w/Orthene 75 S (0.50 lbs AI/ac).
[b]Two black pan samples taken per plot with four squares counted per pan sample (50 cm^2 total area sampled per pan).

Table 8. Efficacy of insecticide treatments for control of whitefly eggs on cotton, 1995.

Treatment	Rate lb (AI)/ac	# WF eggs / 10 cm^2 leaf disc (% Control) 18 July	7 Aug	16 Aug
Thiodan + Ovasyn[a] Mustang + Orthene	0.75 + 0.25 0.045 + 0.50	70.6 ab (24.3)	108.8 b (55.6)	238.4 b (66.5)
Thiodan + Curacron[a] Capture + Vydate	0.75 + 0.75 0.08 + 0.50	76.4 ab (18.0)	119.0 ab (51.4)	252.0 b (64.6)
Thiodan + Vydate[a] Mustang + Curacron	0.75 + 0.50 0.045 + 0.50	48.8 b (47.6)	63.6 b (74.0)	168.2 b (76.4)
Thiodan + Ovasyn[a] Mustang + Monitor	0.75 + 0.25 0.045 + 0.50	95.6 a (2.6)	124.0 ab (49.4)	277.0 b (61.1)
Thiodan + Penncap-M[a] Mustang + Ovasyn	0.75 + 0.50 0.045 + 0.25	69.6 ab (25.3)	60.6 b (75.3)	106.8 b (85.0)
Orthene + Mustang + Capture	0.50 + 0.045 + 0.031	60.8 ab (34.8)	101.2 b (58.7)	140.2 b (80.3)
Orthene + Mustang + Danitol	0.50 + 0.045 + 0.031	69.0 ab (26.0)	49.2 b (79.9)	47.6 b (93.3)
Capture + Curacron	0.08 + 0.50	55.8 b (40.1)	73.2 b (70.1)	40.8 b (94.3)
Capture + Monitor	0.08 + 0.50	79.6 ab (14.6)	48.6 b (80.2)	43.0 b (94.0)
Untreated	----------	93.2 a	245.0 a	711.6 a

Table 8. (cont'd).

Treatment	Rate lb (AI)/ac	# of WF eggs / 10 cm^2 leaf disc (% Control) 22 Aug	30 Aug	7 Sept	Season X (% Ctrl)
Thiodan + Ovasyn[a] Mustang + Orthene	0.75 + 0.25 0.045 + 0.50	5.0 b (93.8)	50.4 b (86.7)	29.2 b (91.3)	93.7 (70)
Thiodan + Curacron[a] Capture + Vydate	0.75 + 0.75 0.08 + 0.50	131.6 b (87.4)	71.8 b (81.1)	37.2 b (88.9)	114.7 (65)
Thiodan + Vydate[a] Mustang + Curacron	0.75 + 0.50 0.045 + 0.50	95.0 b (90.9)	60.0 b (84.2)	70.4 b (79.1)	84.3 (75)
Thiodan + Ovasyn[a] Mustang + Monitor	0.75 + 0.25 0.045 + 0.50	127.6 b (87.8)	64.0 b (83.1)	55.8 b (83.4)	124.0 (60)
Thiodan + Penncap-M[a] Mustang + Ovasyn	0.75 + 0.50 0.045 + 0.25	66.2 b (93.7)	74.2 b (80.4)	25.8 b (92.3)	67.2 (75)
Orthene + Mustang + Capture	0.50 + 0.045 + 0.031	52.4 b (95.0)	25.4 b (93.3)	4.8 b (92.6)	67.5 (86)
Orthene + Mustang + Danitol	0.50 + 0.045 + 0.031	33.8 b (96.8)	26.8 b (92.9)	18.6 b (94.5)	40.8 (91)
Capture + Curacron	0.08 + 0.50	45.6 b (95.6)	73.0 b (80.8)	11.4 b (96.6)	49.9 (89)
Capture + Monitor	0.08 + 0.50	30.6 b (97.1)	26.6 b (93.0)	14.2 b (95.8)	40.4 (91)
Untreated	----------	1044.6 a	379.2 a	336.0 a	468.3

Means within a column followed by the same letter are not significantly different ($P \leq 0.05$; DMRT).
[a]Applications were initiated with nonpyrethroid combinations and alternated with pyrethroid combinations throughout the season for a total of 3 applications each.

Table 9. Efficacy of insecticide treatments for control of whitefly nymphs on cotton, 1995.

Treatment	Rate lb (AI)/ac	# of WF nymphs / 10 cm^2 leaf disc (% Control) 18 July	7 Aug	16 Aug
Thiodan + Ovasyn[a] Mustang + Orthene	0.75 + 0.25 0.045 + 0.50	5.2 ab (39.5)	15.2 abc (48.7)	44.0 bc (76.0)
Thiodan + Curacron[a] Capture + Vydate	0.75 + 0.75 0.08 + 0.50	4.2 ab (51.2)	23.2 ab (21.6)	84.4 b (54.0)
Thiodan + Vydate[a] Mustang + Curacron	0.75 + 0.50 0.045 + 0.50	2.0 b (76.7)	8.0 bc (73.0)	35.4 bc (80.7)
Thiodan + Ovasyn[a] Mustang + Monitor	0.75 + 0.25 0.045 + 0.50	4.2 ab (51.2)	17.2 abc (41.9)	59.2 bc (67.8)
Thiodan + Penncap-M[a] Mustang + Ovasyn	0.75 + 0.50 0.045 + 0.25	1.6 b (81.4)	5.0 bc (83.1)	38.4 bc (79.1)
Orthene + Mustang + Capture	0.50 + 0.045 + 0.031	1.2 b (86.1)	10.8 bc (63.5)	19.4 bc (89.4)
Orthene + Mustang + Danitol	0.50 + 0.045 + 0.031	2.0 b (76.7)	3.2 c (89.2)	2.0 c (98.9)
Capture + Curacron	0.08 + 0.50	1.8 b (79.1)	5.4 bc (81.8)	24.4 bc (86.7)
Capture + Monitor	0.08 + 0.50	3.0 ab (65.1)	3.8 c (87.2)	8.4 c (95.4)
Untreated	----------	8.6 a	29.6 a	183.6 a

Table 9. (cont'd).

Treatment	Rate lb (AI)/ac	# WF nymphs / 10 cm² leaf disc (% Control) 22 Aug	30 Aug	7 Sept	Seas. X (%Ctrl)
Thiodan + Ovasyn[a] Mustang + Orthene	0.75 + 0.25 0.045 + 0.50	14.8 b (95.5)	6.0 b (89.5)	13.0 b (90.5)	16.3 (73)
Thiodan + Curacron[a] Capture + Vydate	0.75 + 0.75 0.08 + 0.50	23.6 b (92.8)	1.4 b (97.5)	5.8 b (95.8)	23.8 (69)
Thiodan + Vydate[a] Mustang + Curacron	0.75 + 0.50 0.045 + 0.50	19.0 b (94.2)	2.8 b (95.1)	36.6 b (73.3)	17.3 (82)
Thiodan + Ovasyn[a] Mustang + Monitor	0.75 + 0.25 0.045 + 0.50	33.4 b (89.8)	5.6 b (90.2)	12.2 b (91.1)	22.0 (72)
Thiodan + Penncap-M[a] Mustang + Ovasyn	0.75 + 0.50 0.045 + 0.25	7.8 b (97.6)	4.4 b (92.3)	3.2 b (97.7)	10.1 (89)
Orthene + Mustang + Capture	0.50 + 0.045 + 0.031	10.0 b (97.0)	0.6 b (99.0)	3.4 b (97.5)	7.6 (89)
Orthene + Mustang + Danitol	0.50 + 0.045 + 0.031	3.4 b (99.0)	2.0 b (96.5)	3.0 b (97.8)	2.6 (93)
Capture + Curacron	0.08 + 0.50	7.2 b (97.8)	11.6 b (79.7)	1.0 b (99.3)	8.6 (87)
Capture + Monitor	0.08 + 0.50	4.8 b (98.5)	3.6 b (93.7)	2. 6 b (98.1)	4.4 (90)
Untreated	----------	328 .6 a	57.0 a	136.8 a	124.0

Means within a column followed by the same letter are not significantly different ($P \leq 0.05$; DMRT).
[a]Applications were initiated with nonpyrethroid combinations and alternated with pyrethroid combinations throughout the season for a total of 3 applications each.

Table 10. Efficacy of insecticide treatments for control of adult whitefly on cotton, 1995.

Treatment	Rate lb (AI)/ac	# adult WF per 25 cotton leaves (% control) 5 DAT	12 DAT	18 DAT
Thiodan + Ovasyn[a] Mustang + Orthene	0.75 + 0.25 0.045 + 0.50	49.0 bc (52.7)	90.8 bc (40.3)	165.2 bcd (53.2)
Thiodan + Curacron[a] Capture + Vydate	0.75 + 0.75 0.08 + 0.50	65.4 abc (36.9)	99.0 bc (35.0)	241.6 b (31.6)
Thiodan + Vydate[a] Mustang + Curacron	0.75 + 0.50 0.045 + 0.50	40.2 bc (61.2)	115.8 ab (23.9)	214.6 bc (39.2)
Thiodan + Ovasyn[a] Mustang + Monitor	0.75 + 0.25 0.045 + 0.50	69.4 ab (33.0)	92.8 bc (39.0)	245.0 b (30.6)
Thiodan + Penncap-M[a] Mustang + Ovasyn	0.75 + 0.50 0.045 + 0.25	30.6 bc (70.5)	67.6 c (55.6)	118.8 d (66.4)
Orthene + Mustang + Capture	0.50 + 0.045 + 0.031	53.4 bc (48.5)	129.4 ab (15.0)	246.4 b (30.2)
Orthene + Mustang + Danitol	0.50 + 0.045 + 0.031	40.0 bc (61.4)	61.4 c (59.7)	118.8 d (66.4)
Capture + Curacron	0.08 + 0.50	21.6 c (79.2)	52.4 c (65.6)	142.8 cd (59.6)
Capture + Monitor	0.08 + 0.50	36.8 bc (64.5)	68.8 c (54.8)	120.2 d (66.0)
Untreated	----------	103.6 a	152.2 a	353.2 a

Table 10. (cont'd).

Treatment	Rate lb (AI)/ac	# adult WF per 25 cotton leaves (% control) 6 DAT	9 DAT	5 DAT
Thiodan + Ovasyn[a] Mustang + Orthene	0.75 + 0.25 0.045 + 0.50	102.4 c (64.1)	351.0 bcd (42.5)	182.8 b (80.7)
Thiodan + Curacron[a] Capture + Vydate	0.75 + 0.75 0.08 + 0.50	173.4 b (39.2)	428.4 bc (29.8)	106.0 b (88.8)
Thiodan + Vydate[a] Mustang + Curacron	0.75 + 0.50 0.045 + 0.50	77.0 cd (73.0)	380.4 bcd (37.7)	263.4 b (72.1)
Thiodan + Ovasyn[a] Mustang + Monitor	0.75 + 0.25 0.045 + 0.50	160.4 b (43.8)	469.6 b (23.1)	206.8 b (78.1)
Thiodan + Penncap-M[a] Mustang + Ovasyn	0.75 + 0.50 0.045 + 0.25	101.0 cd (64.6)	257.8 def (57.8)	141.2 b (85.1)
Orthene + Mustang + Capture	0.50 + 0.045 + 0.031	83.8 cd (70.6)	297.8 cde (51.2)	52.0 b (94.5)
Orthene + Mustang + Danitol	0.50 + 0.045 + 0.031	52.2 d (81.7)	145.8 f (76.1)	44.8 b (95.3)
Capture + Curacron	0.08 + 0.50	66.2 cd (76.8)	194.0 ef (68.2)	34.6 b (96.3)
Capture + Monitor	0.08 + 0.50	58.4 cd (79.5)	131.8 f (78.4)	24.6 b (97.4)
Untreated	----------	285.2 a	610.6 a	944.6 a

Table 10. (cont'd).

Treatment[a]	Rate lb (AI)/ac	# of adult WF per 25 cotton leaves (% control) 5 DAT	5 DAT	5 DAT
Thiodan + Ovasyn[a] Mustang + Orthene	0.75 + 0.25 0.045 + 0.50	39.2 b (92.3)	76.4 b (92.6)	36.8 b (89.7)
Thiodan + Curacron[a] Capture + Vydate	0.75 + 0.75 0.08 + 0.50	33.0 b (93.5)	114.6 b (88.8)	28.8 b (91.9)
Thiodan + Vydate[a] Mustang + Curacron	0.75 + 0.50 0.045 + 0.50	30.2 b (94.1)	132.6 b (87.1)	31.4 b (91.2)
Thiodan + Ovasyn[a] Mustang + Monitor	0.75 + 0.25 0.045 + 0.50	32.8 b (93.6)	95.4 b (90.7)	41.2 b (88.5)
Thiodan + Penncap-M[a] Mustang + Ovasyn	0.75 + 0.50 0.045 + 0.25	28.0 b (94.5)	33.2 b (96.8)	32.0 b (91.0)
Orthene + Mustang + Capture	0.50 + 0.045 + 0.031	16.0 b (96.9)	23.2 b (97.7)	26.0 b (92.7)
Orthene + Mustang + Danitol	0.50 + 0.045 + 0.031	8.0 b (98.4)	12.6 b (98.8)	11.0 b (96.9)
Capture + Curacron	0.08 + 0.50	13.0 b (97.5)	31.8 b (96.9)	14.4 b (96.0)
Capture + Monitor	0.08 + 0.50	9.2 b (98.2)	8.2 b (99.2)	9.4 b (97.4)
Untreated	----------	509.6 a	1025.2 a	356.6 a

Table 10. (cont'd).

Treatment[a]	Rate lb (AI)/ac	Season X (% control)	Yield (lbs) Seed Cotton
Thiodan + Ovasyn[a] Mustang + Orthene	0.75 + 0.25 0.045 + 0.50	124.8 (76)	29.4 c
Thiodan + Curacron[a] Capture + Vydate	0.75 + 0.75 0.08 + 0.50	147.5 (72)	30.2 c
Thiodan + Vydate[a] Mustang + Curacron	0.75 + 0.50 0.045 + 0.50	150.7 (71)	32.4 bc
Thiodan + Ovasyn[a] Mustang + Monitor	0.75 + 0.25 0.045 + 0.50	163.2 (69)	28.4 c
Thiodan + Penncap-M[a] Mustang + Ovasyn	0.75 + 0.50 0.045 + 0.25	92.8 (82)	37.9 ab
Orthene + Mustang + Capture	0.50 + 0.045 + 0.031	105.9 (80)	31.8 bc
Orthene + Mustang + Danitol	0.50 + 0.045 + 0.031	57.0 (89)	40.9 a
Capture + Curacron	0.08 + 0.50	64.7 (88)	33.2 bc
Capture + Monitor	0.08 + 0.50	53.5 (90)	36.8 ab
Untreated	----------	519.6 (0)	20.7 d

Means within a column followed by the same letter are not significantly different ($P \leq 0.05$; DMRT).

[a]Applications were initiated with nonpyrethroid combinations and alternated with pyrethroid combinations throughout the season for a total of 3 applications each.

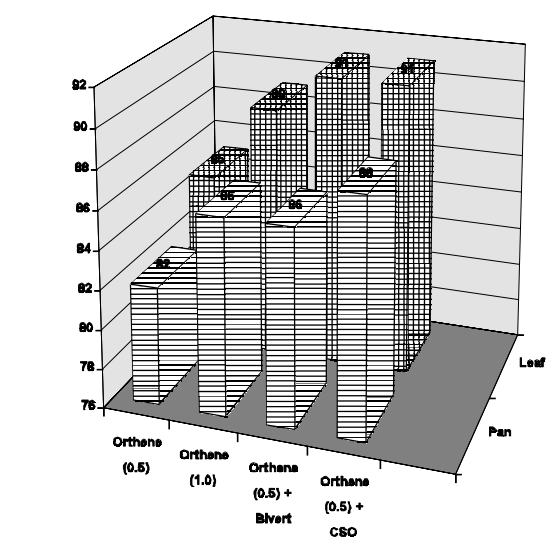

Figure 1. Efficacy of Mustang 1.5 EW combinations for control of Whitefly Adults on Cotton, Parker, AZ, 1995.