

# Chemical Control and Integrated Pest Management of Woolly Whitefly<sup>1</sup>

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## Abstract

Eight foliar insecticide treatment regimes (single applications of Esteem, Danitol + Lorsban, Applaud, Provado and Prev-am, and two applications of Applaud, Provado and Prev-Am) were evaluated for management of woolly whitefly infestations in grapefruit. All of these products demonstrated efficacy in mitigating woolly whitefly populations. Danitol + Lorsban appeared to be the best knock-down treatment evaluated, but Provado and Prev-Am also demonstrated good activity. For sustained control, all of the treatments were effective; however, Prev-Am required an additional application to achieve equivalent control. Soil injections of 16 and 32 fl-oz/ac of Admire were very effective against WWF, and there were no detectable differences between the two rates. The Admire appeared to require about 27 days after injection to demonstrate consistent activity.

## Introduction

Woolly whitefly (WWF), *Aleurothrixus floccosus*, first appeared in Yuma County in dooryard citrus in 1996. Since that time it has spread throughout much of the commercial citrus grown on the Yuma Mesa. WWF causes damage by sucking phloem sap, which causing leaves to wilt and drop when populations are large. Honeydew droplets collect dust and support the growth of sooty mold; large infestations where copious amounts of honeydew are produced, can result in the blackening of entire trees. This reduces photosynthesis, resulting in decreased fruit size. Honeydew and sooty mold can also contaminate the fruit. Although this contamination can be washed off at the packing shed, harvest is slowed in infested groves and harvest crews are hesitant to pick heavily contaminated fruit.

WWF infestations often appear to be flared by insecticide applications targeting citrus thrips, *Scirtothrips citri*. This probably occurs due to the elimination of parasitic wasps, *Eretmocerous* spp. by the insecticides targeting the thrips. Because of the lack of a sufficient number of selective insecticides for controlling citrus thrips, flaring WWF is unavoidable during most years. Where *Eretmocerous* spp. have been found parasitizing WWF and where they were not eliminated by broad-spectrum insecticides, WWF populations are usually reduced to negligible levels. Because of the effectiveness of *Eretmocerous* spp. in controlling WWF, it is important that we identify insecticides that are efficacious towards WWF, yet have little impact on *Eretmocerous* spp. However, in cases where heavy WWF infestations occur in the absence of *Eretmocerous* spp., it is important to identify fast acting broad-spectrum insecticides that quickly reduce the WWF populations.

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The goal of this study was to evaluate the efficacy of a several foliar insecticides and soil applications of Admire for control of WWF on flood irrigated citrus.

## Materials and Methods

The foliar test was conducted on flood irrigated 11-year old 'Ruby Red' grapefruit grown on the Yuma Mesa near Yuma, Arizona. Foliar-applied insecticides consisted of an untreated check, Applaud applied at 0.5 lb/ac on 29 June, Applaud applied at 0.5 lb/ac on 29 June and 26 July, Esteem applied at 10 fl-oz/ac on 29 June, Provado applied at 10 fl-oz/ac on 29 June, Provado applied at 10 fl-oz on 29 June and 26 July, Danitol at 16 fl-oz/ac + Lorsban at 1.5 qt/ac applied on 29 June, Prev-Am at 0.4% v/v applied on 29 June, and Prev-Am at 0.4% v/v applied on 29 June and 26 July. The treatments were applied using an air-assisted vertical boom, calibrated to deliver 100 gal/ac. Evaluations were made on 6, 12, 20 and 25 July, and 3, 9, 17 and 23 August.

The soil applied test was conducted on flood-irrigated ~12-yr-old lemons grown on the Yuma Mesa near Somerton, AZ. The soil type was Superstition Sand. Soil-applied insecticide treatments included: an untreated check, Admire 2F at 16 and at 32 fl-oz/ac. Treatments were applied on 28 June. The injection implement consisted of two injection shanks spaced 6 ft apart and with a forward shank to open the furrow. The treatments were injected approximately 8 inches deep at a spray volume of 9 gal/ac at 20 psi. The shanks were positioned laterally to place the product near the tree's drip line. Evaluations were made on 5, 12, 19 and 25 July, and 3, 9, 16, and 23 August.

Adult WWF were sampled by in field by counting their number from 10 new fully expanded leaves per plot. The eggs and nymphs were estimated by removing five fully expanded leaves per plot, transporting them to the laboratory, and counting their number on the underside of the leaf using a dissecting microscope. All data were analyzed using ANOVA and an F protected LSD ( $P \leq 0.05$ ).

## Results and Discussion

### Foliar-Applied Test

Since there were no statistical differences between the paired treatment timings (29 June and 26 July applications) prior to the 26 July application, data collected prior to the 26 July application were pooled for analysis. At seven days after treatment (7 DAT), Danitol + Lorsban, Provado and Prev-Am all contained statistically fewer WWF adults and nymphs than the untreated (Table 1). Esteem and Applaud were not expected to affect WWF adult populations shortly after application because these materials are IGRs and primarily affect immatures stages in a slow manner, or in the case of Esteem, also cause adult sterility. Additionally, all of the treatments contained fewer eggs than the untreated. The reason for the decrease in eggs is not certain in the treatments that did not exhibit a reduction in adults; egg deposition usually correlates closely with adult numbers. At 13 DAT, adult numbers were very low, averaging  $< 1$  per leaf. However, statistical differences were still evident. All of the treatments contained fewer adults than the untreated. Among the insecticide treatments, Danitol + Lorsban and Prev-Am had fewer adults than Applaud. Danitol + Lorsban, Provado. Prev-Am also had fewer eggs and nymphs than the untreated. At 21 DAT, all of the treatments had fewer adults than the untreated; Danitol + Lorsban numerically had the fewest adults. The number of eggs were low across the entire test and no differences were detected; however, all of the treatments contained fewer nymphs than the untreated. At 26 DAT, all of the treatments except Prev-Am had fewer adults and eggs than the untreated, and all of the treatments contained fewer nymphs.

After the second application timing, WWF numbers increased within the test (Table 2). At 8 DAT following the second application timing (35 DAT for those treatments only receiving the first application) adults and eggs were greater in the untreated than in any of the insecticide treatments; there were no differences in nymphs. By 14 DAT, application timing 2, neither Prev-Am treatment timing differed from the untreated in adult WWF. All of the insecticide treatments contained fewer eggs and nymphs than the untreated. By 22 DAT, application timing 2, the only treatment that did not differ from the untreated in WWF adults or eggs was the single application of Prev-Am. Additionally, this treatment contained more nymphs per leaf than the other insecticide treatments. Prev-Am is an oil based contact insecticide and appears to have shorter residual activity than the other treatments. Among the other

insecticide treatments/timings, single applications of Esteem, Provado, Danitol + Lorsban, and two applications of Applaud, Provado and Prev-Am had the fewest eggs. However, all of the treatments except the single application of Prev-Am were providing good control of the nymphs. Based on these data, the only treatment that benefited from a second application appears to be Prev-Am. By 23 Aug, the WWF population had declined across the entire test and the only statistical differences detected were for nymphs where all of the treatments were lower than the untreated.

Overall, Danitol + Lorsban appeared to be the best knock-down treatment evaluated, but Provado and Prev-Am also demonstrated good activity. For sustained control, all of the treatments were effective; however, Prev-Am required an additional application to achieve equivalent control.

#### Soil-applied Test

Soil injections of Admire at 16 and 32 fl-oz/ac both appeared very effective in managing WWF. Because this application technique requires the insecticide to be taken up by the roots and distributed to the leaves, immediate remediation of the WWF population should not be expected. Adults WWF were fairly low across all treatments until 36 days after injection (Figure 1). At that point the number of adults increased substantially in the untreated until 16 August after which they began to decline. Both rates of Admire had significantly fewer adults than the untreated from 3 August on, but did not differ from each other. Nymphs were somewhat more variable, and only demonstrated significant differences beginning 25 July when both rates of Admire contained fewer nymphs than the untreated (Figure 2). Similar to the adults, these differences continued until the end of the sampling period. It appears that Admire began showing consistent activity towards nymphs 27 days after injection. Overall, in this test both the 16 and the 32 fl-oz rates of Admire injected in the soil appear to be valid options for managing WWF.

Table 1. Mean number of adult and immature woolly whiteflies on fully expanded grapefruit leaves following the first application timing.

Treatment	Rate amt product/acre	Timing	6 July (7 DAT)			12 July (13 DAT)			20 July (21 DAT)			25 July (26 DAT)		
			adults	eggs	nymphs	adults	eggs	nymphs	adults	eggs	nymphs	adults	eggs	nymphs
Untreated	--	--	2.70a	42.65a	30.48a	0.93a	9.08a	18.53a	0.73a	2.50a	23.23a	4.63a	3.28a	18.38a
Applaud	0.5 lbs	29 Jun	2.51a	4.79b	22.75a	0.44b	6.66a	11.24ab	0.26bc	0.70a	4.41b	0.61b	0.61b	1.21b
Esteem	10 fl-oz	29 Jun	2.08a	16.35b	25.68a	0.33bc	6.73a	10.60ab	0.28bc	9.15a	3.73b	0.45b	0.08b	1.53b
Provado	10 fl-oz	29 Jun	0.63b	9.69b	6.68b	0.21bc	1.55b	0.39c	0.19bc	0.56a	0.65b	0.85b	0.64b	1.64b
Danitol + Lorsban	16 fl-oz + 1.5 qt	29 Jun	0.45b	7.45b	4.70b	0.08c	1.38b	0.50c	0.13c	0.28a	0.18b	0.45b	0.50b	0.13b
Prev-Am	0.4% v/v	29 Jun	1.34b	13.24b	10.56b	0.30bc	1.73b	6.16bc	0.43b	1.04a	6.98b	2.11ab	2.40ab	4.39b

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD ( $P > 0.05$ ).

Table 2. Mean number of adult and immature woolly whiteflies on fully expanded grapefruit leaves following the second application timing.

Treatment	Rate amt product/acre	Timing	3 Aug (35 DAA 1, 8 DAA 2)			9 Aug (41 DAA 1, 14 DAA 2)			17 Aug (49 DAA 1, 22 DAA 2)			23 Aug (55 DAA 1, 28 DAA 2)		
			adults	eggs	nymphs	adults	eggs	nymphs	adults	eggs	nymphs	adults	eggs	nymphs
Untreated	--	--	21.68a	23.75a	3.63a	8.85a	75.95a	15.73a	8.55a	29.38a	25.40a	1.08a	6.18a	8.33a
Applaud	0.5 lbs	29 Jun	3.33b	10.63b	2.30a	2.43b	15.48b	0.70b	2.10cd	15.75bc	3.83c	0.08a	4.80a	2.53b
Applaud	0.5 lbs	29 Jun, 26 Jul	4.08b	9.63b	1.20a	2.53b	5.80b	0.28b	2.75cd	3.03d	0.03c	0.25a	4.48a	0.33b
Esteem	10 fl-oz	29 Jun	2.85b	2.30c	1.40a	2.35b	2.93b	0.05b	1.68cd	1.85d	0.68c	0.43a	4.92a	1.23b
Provado	10 fl-oz	29 Jun	2.18b	1.38c	0.90a	1.15b	4.90b	0.45b	3.28c	9.15cd	3.68c	0.25a	2.38a	0.03b
Provado	10 fl-oz	29 Jun, 26 Jul	2.05b	1.38c	1.00a	1.80b	0.90b	0.08b	2.80cd	1.65d	0.20c	0.10a	1.68a	0.63b
Danitol + Lorsban	16 fl-oz + 1.5 qt	29 Jun	1.18b	0.63c	0.03a	0.48b	1.20b	0.03b	1.08d	0.35d	0.38c	0.08a	0.60a	0.45b
Prev-Am	0.4% v/v	29 Jun	6.88b	13.78ab	2.53a	7.63a	7.33b	0.48b	7.05ab	25.25ab	17.00b	0.20a	6.23a	2.53b
Prev-Am	0.4% v/v	29 Jun, 26 Jul	2.15b	5.78b	1.50a	5.65ab	10.20b	0.33b	4.45bc	9.45cd	2.35c	0.45a	2.25a	2.38b

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD ( $P > 0.05$ ).

"SN = small nymphs, LN = large nymphs, and EP = eclosed pupae.

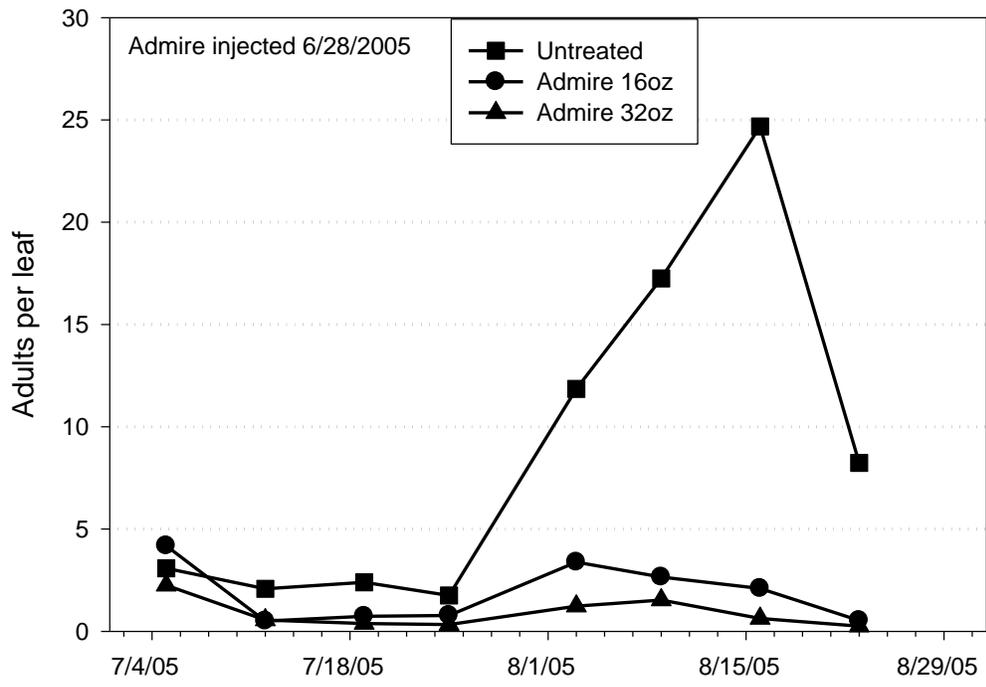


Figure 1. Mean number of woolly whitefly adults on lemons following soil injection.

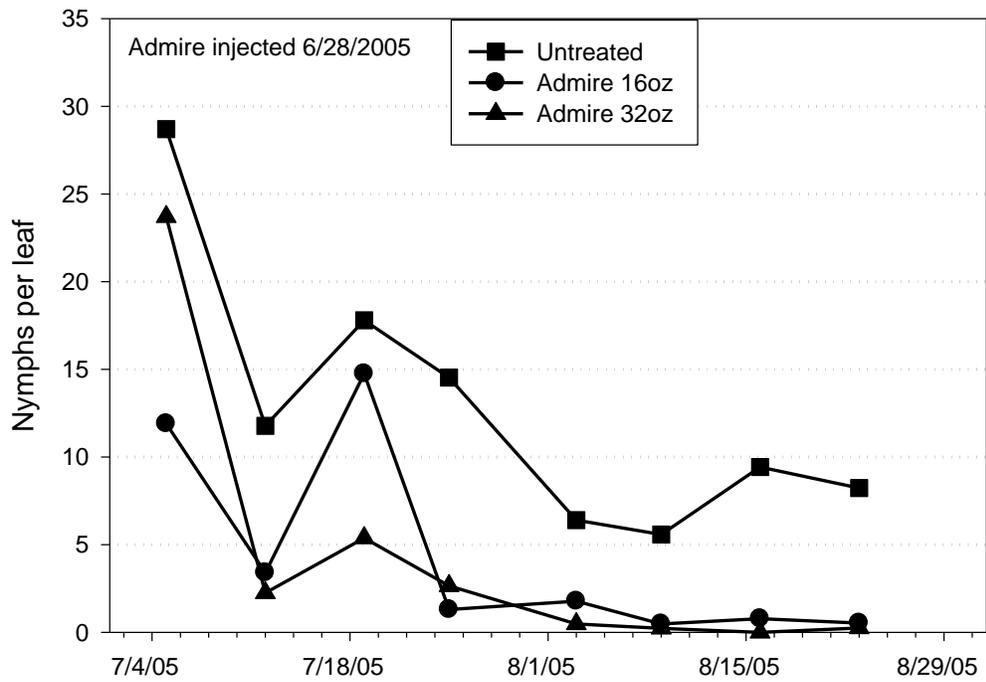


Figure 2. Mean number of woolly whitefly nymphs on lemons following soil injection.