A THREE YEAR STUDY ON THE DECLINE OF FENPROPATHRIN (DANITOL) EFFICACY IN ARIZONA COTTON

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Abstract

A dramatic decline in the efficacy of fenpropathrin was documented over a three year period (1993-1995) in an areawide whitefly suppression program conducted near Gila Bend, Arizona by the Arizona Cotton Research & Protection Council.

High efficacy and extended control activity were demonstrated after the initial treatment of fenpropathrin in 1993. More than 37% of the 228 contiguous cotton fields treated required no additional insecticide treatments for three full weeks post fenpropathrin treatment. However, in 1994 and 1995, all fields required additional insecticide treatment during the 2nd or 3rd week following the initial treatment with fenpropathrin. In addition, the percent of fields not showing a reduction in adults three weeks after treatment increased from 17 to 55 to 68 % in 1993, 1994 and 1995 respectively.

A significant reduction of whitefly eggs and nymphs was found three weeks after fenpropathrin treatment in 1993 but no significant reductions were found in 1994 and 1995. The supplemental use of organophosphates and pyrethroids for control during the three weeks post treatment increased dramatically, from 0.115 to 0.560 to 1.920 lbs AI/a in 1993, 1994 and 1995 respectively.

These results verify that the high levels of suppression of all life stages demonstrated by initial application of fenpropathrin in 1993 deteriorated significantly during both the 1994 and 1995 cotton program seasons.

Introduction

Explosive and in many instances, economically devastating populations of silverleaf whitefly *Bemisia argentifolii* infested the 1992 cotton crop throughout central and western Arizona. Rapid escalation of both insecticide control costs and lint stickiness due to whitefly honeydew contamination threatened the viability of the cotton industry. In an effort to remedy this critical situation, the Arizona Cotton Research & Protection Council initiated a three year demonstration program to address whitefly suppression through an areawide management approach. Fenpropathrin had shown excellent promise in preliminary testing and was selected as the primary insecticide for this demonstration. An initial insecticide application of fenpropathrin was used and followed as needed with a variety of insecticide combinations in a rotational cycle to manage resistance.

Methods and Materials

The project was carried out in the Paloma/Painted Rock area near Gila Bend, AZ. This represented a relatively isolated cotton producing area with good isolation to the north and south and limited cotton to the east and west. In 1993, 228 contiguous cotton fields (6,148 ha) were selected for areawide management, 182 (5,660 ha) in 1994 and 104 (6,023 ha) in 1995. Planting dates varied from March 15 to April 30. The average field size was 25.5 ha. Infield adult whitefly populations were sampled weekly using 33 x 20 x 5 cm aluminum pans. The pan interiors were painted black and scored with a 2.5 cm grid on the inside bottom surface. A total of 3 samples were taken weekly from each of rows 1, 5, 15 and 25 (or the equivalent distance) from all 4 sides of each field and from 4 rows (approximately 3.8 m apart) in the center. With the pan near the plant terminal, each sample was taken by tapping the upper 15-20 cm of the plant with a 30 x 4 x 0.5 cm stick using the same force (as much as possible) on each plant to dislodge the whitefly adults into the oil coated bottom of the pan. Each sample was comprised of the total number of whiteflies collected from 10 alternating plants in the same row. The treatment threshold was an average of 30 adults per pan sample. Since whitefly populations demonstrate known edge effects, survey counts were designed to determine the need for either full field or edge insecticide treatments.

In addition, randomly selected fields (19, 31, & 5 in 1993, 94, & 95 respectively) were monitored for immature whitefly populations by collecting the 5th main stem leaf from the tops of five alternating plants according to the row and earlier protocol established for adult samples. Leaf samples were collected before treatment and three weeks after first fenpropathrin application. Eggs and immatures were counted on 2.5 cm^2 leaf disks from the lower central portion of all leaves collected.

Insecticidal applications were made based only on population density as determined by the pan sampling technique. Treatment decisions were made on a field-by-field basis. Applications were made with one swath 21.4 m around the field perimeters (edge treatment) when population density reached the threshold only on the periphery. Full field treatments were initiated when population density in the center of the field reached the

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threshold. Care was taken to use fenpropathrin no more than 1-2 times during the growing season separated by two to four week time frames. The same treatment protocol was repeated for all three years. Except for slight variation in numbers of fields and total acreage planted to cotton, weekly sampling protocol for centers and edges of all fields remained constant throughout the three year study period.

The initial fenpropathrin application was made on July 17, 1993, July 9, 1994 and July 29, 1995. This insecticide combination used each year consisted of fenpropathrin (Danitol 2.4 EC) at 227 AI (0.78 l/ha) mixed with acephate (Orthene® 90S) at 0.57 kg/ha.

Evaluation

Adult samples taken from field center pan counts were utilized to evaluate the efficacy of fenpropathrin over time since these were less influenced by adult migration pressure. More than 70,000 plant samples collected from 1993-1995 provided the data base for the analysis presented in this paper. Adult samples were compared with a one way analysis of variance for each year and weekly means were compared with LSD test. Egg and nymph counts from leaf samples were compared with a "t" test.

Results and Discussion

Analyses of data taken from field centers utilizing the oil pan sampling technique indicate that the percent reduction of adult whiteflies was consistently high for two full weeks following the initial treatment with fenpropathrin in 1993. While week 3 retained a relatively high percentage of reduction, it did show significant differences from weeks one and two ($F = 8.23$, $df = 2,641$, $p \leq 0.05$). The percentage reduction for weeks 2 and 3 in 1994-95 was significantly less than corresponding samples from 1993. ($F = 104.73$, $df = 2,534$, and $F = 43.83$, $df = 2,258$, respectively, $P \leq 0.05$) (Figure 1.) The LSD values = 6.47, 6.95, and 9.58 for 1993, 94, and 95 respectively.

As a measure of material effectiveness more than 37% of 1993 fields required no additional insecticide applications for three full week post fenpropathrin treatment. In 1994 and 1995, however, all fields required additional supplemental insecticide use during weeks 2 and 3 post fenpropathrin.

In addition, the percent of full fields that did not show a reduction in adults for three week post treatment ranged from a high of 17 percent in 1993 to 55 and 68 percent in 1994 and 1995 respectively (Figure 2). Analysis for both eggs and nymphs collected from randomly selected fields for evaluation purposes were significantly lower three weeks post fenpropathrin treatment in 1993. No significant difference was demonstrated for either 1994 or 1995 as judged by a "t" test at $P \leq 0.05$ (Table 1).

Loss of efficacy was further documented by the increasing amounts of pyrethroids and organophosphates required for supplemental treatments in weeks 1-3 post fenpropathrin which increased from 0.115 lbs in 1993 to 0.560 and 1.920 lbs AI/a in 1994 and 1995 (Figure 3).

These results verify the superior levels of control for all silverleaf whitefly life stages demonstrated by initial use of fenpropathrin in 1993. Correspondingly significant declines in product efficacy were documented with respect to suppression of adults, eggs and nymphs for both 1994 and 1995. This resulted in the need for substantially higher amounts of supplemental insecticide use in a losing effort to achieve whitefly population control.

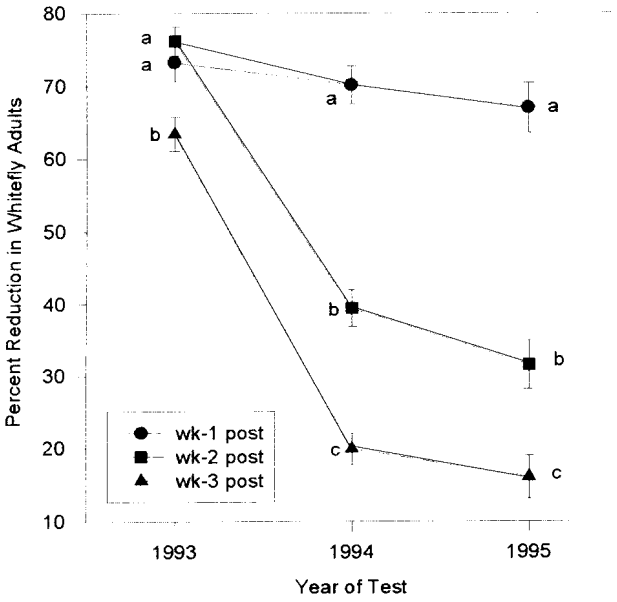

Figure 1. Percent reduction of adult whiteflies in field centers for 1 to 3 weeks post fenpropathrin plus acephate applications, Maricopa County, AZ, 1995.

Table 1. Overall mean number of eggs and nymphs per and three week post fenpropathrin treatment, Maricopa County, AZ.

	Treatment		Treatment		
Year	Pre Eggs	Post Eggs	Per Nymphs	Post Nymphs	# Fields Sampled
1993	7.26a	2.77b	2.07a	0.52b	19
1994	10.88a	11.75a	2.58a	3.20a	31
1995	1.02a	70.05a	0.74a	22.67a	5

[a]Means in a row for eggs or nymphs not followed by the same letter are significantly different as judged by "t" test at $p \leq 0.05$.
[a]Means for a year not followed by the same letter differ significantly as judged by LSD at $p \leq 0.05$.

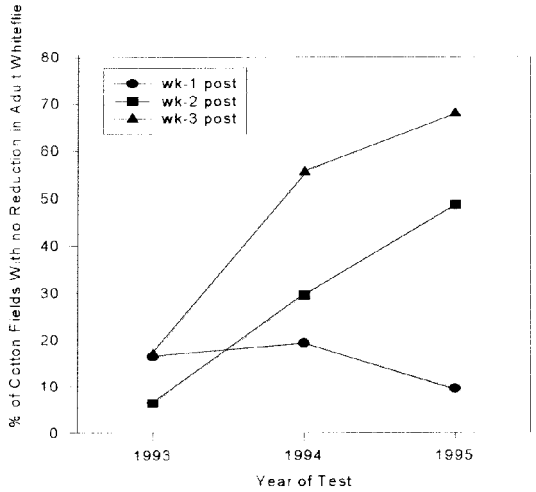

Figure 2: Percent of cotton fields showing no reduction in adult whiteflies for 1 to 3 weeks post fenpropathrin plus acephate applications, Maricopa County, AZ, 1995.

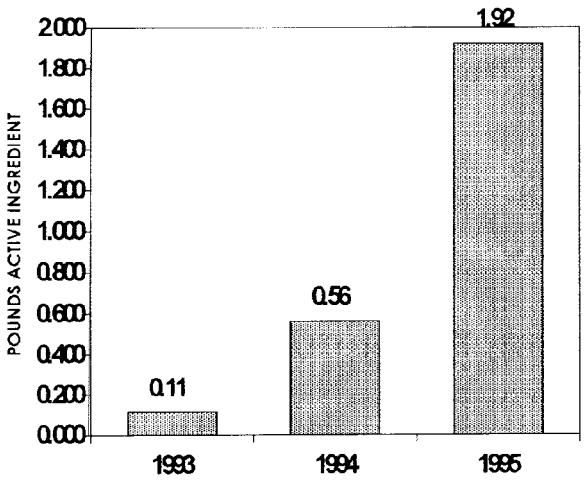

Figure 3: Average amounts of combined pyrethroids and organophosphates applied per field in Paloma over the three week period post fenpropathrin treatment, Maricopa County, AZ.