UNDERSTANDING WHITEFLY CONTROL: THRESHOLD, INSECTICIDE ROTATION, & GROUND AND AIR COMPARISONS

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Abstract

Ground and were compared within a 2 x 2 x 3 factorial experiment on a commercial scale (200 A) at the Maricopa Agricultural Center Demonstration Farm. Whiteflies were effectively controlled in all treatments, but fewer applications were needed when the highest threshold (5 adults per leaf) was used. aerial insecticide application, two insecticide regimes, and three thresholds for applying the insecticides A chemical use regime which delayed pyrethroid use and maximized rotation of chemical classes required an average of 0.5 sprays more per season and resulted in delayed onset of insecticide resistance compared to a regime of pyrethroid-organophosphate mixtures only. By the end of the study, the susceptibility to pyrethroid mixtures was reduced regardless of the management strategy. Analyses of efficacy, resistance development, and economics of the contrasted practices is presented.

Introduction

We conducted a commercial scale (190 A), replicated study of whitefly [*Bemisia tabaci* (Genn.) (Strain B)] control dynamics at the University of Arizona's Demonstration Farm located at the Maricopa Agricultural Center. This study was brought about through a collaboration of the University of Arizona, USDA-ARS Western Cotton Research Laboratory, and the USDA-ARS Southern Crops Research Laboratory with additional financial support from Cotton Incorporated. This project compared ground and aerial application of insecticides, three thresholds for triggering sprays, and two insecticide rotation schemes. The objective was to better understand whitefly control dynamics under commercial conditions in order to formulate grower-relevant recommendations.

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Materials and Methods

The experimental design was a 3 x 2 x 2 factorial with 3 replications of 5 A plots. Three sets of factors were contrasted simultaneously: two methods of conventional insecticide application (ground [15 gpa] and air [5gpa]), three adult whitefly action thresholds (1, 3 and 5 per leaf), and two insecticide rotational regimes (a proposed insecticide resistance management [IRM] plan (Dennehy 1995, Dennehy *et al.* 1995 a & b) and a pyrethroid + organophosphate regime [Pyr]).

Plots were sampled regularly (Ellsworth *et al.* 1995) and insecticides were applied when adult whitefly numbers averaged either 1, 3, or 5 per leaf. In half the plots, the combination of insecticides applied was rotated each time as outlined in the U of A Extension publication IPM Series No. 3: Whitefly Management in Arizona Cotton 1995 (Dennehy *et al.* 1995a). In the rest of the plots, a combination of a pyrethroid and an organophosphate insecticide was used each time with minimal rotation of compounds.

We also monitored the whitefly populations in these fields to determine the effect of the rotational scheme on the development of resistance to the insecticides, as inferred by bioassays of adult *Bemisia* with various concentrations of fenpropathrin + acephate (Dennehy *et al.* 1995b, 1996).

Results and Discussion

Efficacy

Whitefly populations were apparently under control for most of the season.

Thresholds:

There were, however, more eggs and nymphs as the threshold was increased approximately in proportion to the adult threshold (i.e., 1:3:5 ratio). This statistically significant separation held true during July and August. By September, spray intervals were reduced to their minimum, just seven days for all treatments. Both egg and nymph numbers increased approximately 10- to 50-fold with no significant differences among the three thresholds.

Application Methods:

There were no significant differences in egg, nymph or adult numbers attributable to ground or aerially applied insecticides. Though both methods simulated a commercial application, our pilot took care in depositing the spray swath into the canopy from a low altitude. This may or may not be equivalent to local practice.

Insecticide Regimes:

There were no differences in preimaginal *Bemisia* numbers due to the insecticide regime during the months of July and August. However, by September, the pyrethroid regime was subject to the largest increases in whitefly eggs, nymphs and adult numbers. There were about four times as many nymphs in the Pyr regime vs. the IRM regime in September in spite of the fact that both regimes were using pyrethroids by this time. This large change in control could be the result of reduced susceptibility or resistance in the whiteflies.

Resistance

Bioassays indicated rather sharp changes in whitefly susceptibility to fenpropathrin+acephate from mid-July (pre-spray) to early-September (after 3–6 sprays), regardless of application method, adult whitefly threshold, or insecticide use regime. The overall shift from July to September represents a 100- to 1000-fold decrease in whitefly susceptibilities to fenpropathrin + acephate.

Thresholds:

In general, susceptibities were more rapidly and severely compromised in the lowest thresholds which required the greatest numbers of sprays.

Application Methods:

There were some indications that susceptibilities to the assayed compounds were lowest for the aerially applied insecticides, indicating either more rapid or more severe selection for resistance in these plots.

Insecticide Regimes:

Both regimes resulted in seriously compromised susceptibilities in *Bemisia* adults by September. However, the IRM regime, especially in conjunction with the 5/leaf threshold, resulted in a relative slowing of the progression towards resistance. This difference was most pronounced in the mid- August bioassays. Nevertheless, "resistance" was also evident by the mid- August sampling for all treatment combinations and most severe in the pyrethroid, 1 / leaf threshold, by air, treatment. For more information on the assessment of resistance in this study, see Dennehy *et al.* (1996).

Economics

The economics of the contrasted practices may be measured in terms of inputs (number of insecticidal applications and their cost), yield, and quality (or lack of stickiness). In general and in spite of compromised susceptibilities across all treatment combinations, yield and quality measures indicated that the entire test area produced high yielding and high quality (sticky- free) cotton. Commercially picked yields averaged 2.9 bales per acre which was better than the farm's current (2.56 bales/A) and long-term historical averages (2.75 A). Final grades were exceptional, and thermodetector readings of stickiness were below 5, a level considered ‘non- sticky.’

Thresholds:

The number of insecticide applications needed was greatly reduced using a threshold of 5 compared to a threshold of 1 adult whitefly per leaf. The 5 per leaf threshold resulted in 3 to 5 less sprays than the other two lower thresholds. A decrease in the number of applications resulted in a lower cost of whitefly control as the threshold used increased. Considering both cost and number of applications, the 5 per leaf threshold (average= $112.63/A) required $76.52 per acre less than the 1 per leaf and $21.52 per acre less than the 3 per leaf thresholds. Statistically less yield was produced in the 5 per leaf threshold (P=0.051), but this may have been due to secondary pest suppression (e.g., *Lygus* bug control) or the relatively poor performance of one set of treatments (i.e., located on sandier ground). Some stickiness was detected on the lowest bolls collected at 10% open bolls on 8/30 (for 5 per leaf, IRM). This was reduced to a non-sticky condition by 9/11 when about 50% of the bolls were open which remained below 5 thermodetector spots by the time of harvest (10/10; 100% open). By harvest, there were no significant differences in stickiness among thresholds (P=0.32). Other studies have confirmed that 5-10 adults per leaf is an appropriate threshold for *Bemisia* management (Naranjo *et al.* 1996).

Application Methods:

The number of applications required for each application method was similar (for each threshold); however, on a test-wide average of 7.25 sprays, ground applied plots required 0.5 fewer sprays than aerially applied plots. Yields (P=0.45) and stickiness (P=0.39) were not different between the two methods. When considering cost and number of applications over the entire test, the ground treatment required on average only $0.50 per acre more to maintain than the aerial treatment in spite of the higher application costs associated with ground (on an average whitefly control cost of $145.31 per acre).

Insecticide Regimes:

The number of applications to maintain the IRM regime was 0.5 sprays and about $12 per acre more than the Pyr regime. Yields (P=0.17) and stickiness (P=0.50) at harvest were not different, though 8/10 and 9/11 hand- harvested bolls in the IRM did tend to have more thermodetector spots than the Pyr regime (P=0.00 & P=0.04). In each case, however, the average levels were below the “stickiness” standard of 5 thermodetector spots.

References

1. Dennehy, T.J. 1995. IPM Series Number 4. Building a resistance management program for whitefly in Arizona Cotton. University of Arizona Cooperative Extension.

2. Dennehy, T.J., P.C. Ellsworth & R.L. Nichols. 1995a. IPM Series Number 3: Whitefly management in Arizona cotton 1995. University of Arizona Cooperative Extension.

3. Dennehy, T.J., A. Simmons, J. Russell & D. Akey. 1995b. Establishment of a whitefly resistance documentation and management program in Arizona. *In* Cotton, A College of Agriculture Report. The University of Arizona. pp. 287-297.

4. Dennehy, T.J., L. Williams III, J.S. Russell, X. Li, and M. Wigert. 1996. Monitoring and management of whitefly resistance to insecticides in Arizona. *In* Cotton, A College of Agriculture Report. The University of Arizona. (in press).

5. Ellsworth, P.C., J.W. Diehl, T.J. Dennehy and S.E. Naranjo. 1995. IPM Series Number 2: Sampling sweetpotato whitefly in cotton. University of Arizona Cooperative Extension.

6. Naranjo, S.E., C.C. Chu, P.C. Ellsworth, T.J. Henneberry, R.L. Nichols, D.G. Riley, N.C. Toscano, and T. F. Watson. 1996. Results of a two year regional project to determine an action threshold to manage whitef lies in cotton. *In* Proceedings Beltwide Cotton Conferences. D.J. Herber & D.A. Richter (eds.) National Cotton Council, Memphis, TN. (this volume).