Cooperative Extension

Whiteflies In Arizona: Commercial-Scale Trial 1995

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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 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 (see team composition below). The 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.

Commercial-Scale Whitefly Management Trial Team				
University of Arizona, Maricopa Agricultural Center, Demonstration Farm	Cotton Incorporated	University of Arizona, Department of Entomology	USDA-ARS, Western Cotton Research Laboratory	USDA-ARS Southern Crops Research Laboratory
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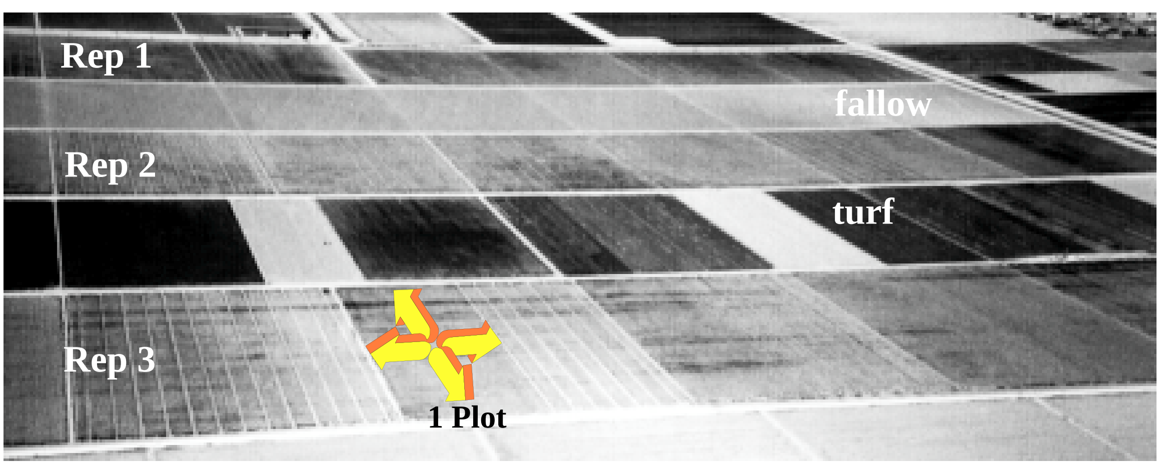
Three sets of factors were contrasted simultaneously: two methods of conventional insecticide application (ground [15 GPA] and air [5 GPA]), three adult whitefly action thresholds (1, 3 and 5 per leaf), and two insecticide rotational regimes (a provisional insecticide resistance management [IRM] plan (Dennehy 1995; Dennehy *et al.* 1995) and a pyrethroid + organophosphate regime [Pyr]; see table at right).

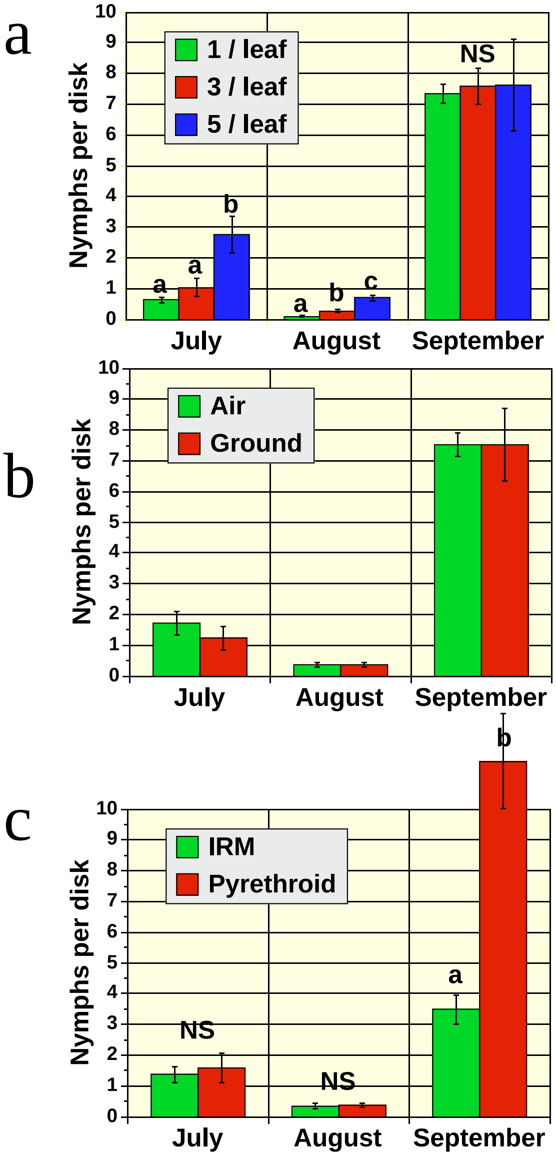
Plots were sampled at least weekly (Ellsworth *et al.* 1995), and insecticides were applied when adult whitefly numbers averaged either 1, 3, or 5 per leaf. In half the plots, the insecticides applied were rotated as outlined in the University of Arizona Extension publication IPM Series No. 3: *Whitefly Management in Arizona Cotton 1995* (Dennehy *et al.* 1995). In the remaining plots, pyrethroid and organophosphate insecticide mixtures were used with minimal rotation of compounds (see table below of insecticide sequences used).

Using laboratory-based bioassays, the susceptibility of the whitefly populations in these fields to Danitol®+Orthene® was monitored to contrast the effect of the rotational scheme on the development of resistance to the insecticides (Dennehy *et al.* 1996).

Application No.	Low Diversity Use Regime (Pyr)	High Diversity Use Regime (IRM)
1	Danitol + Orthene	endosulfan + Ovasyn
2	Danitol + Orthene	Vydate CLV + Curacron
3	Danitol + Orthene	Danitol + Orthene
4	Danitol + Orthene	endosulfan + Ovasyn
5	Capture + Orthene	Danitol + Vydate CLV
6	Karate + Orthene	Capture + Lorsban
7	Asana XL+ Orthene	Karate + PenncapM
8	Baythroid + Orthene	Capture + Lannate
9	Karate + Orthene	Asana XL + Curacron
10	Asana XL + Orthene	Karate + PenncapM



The experimental design was a 3 x 2 x 2 factorial with 3 replications (fields) of 5 acre plots, 36 plots total.



Figures a–c: Bars within a month with different letters are significantly different (Tukey's HSD; $P \leq 0.05$); NS = not significantly different (ANOVA; $P \geq 0.10$)

Insecticide Performance

Whitefly populations were apparently under control through August with applications being less effective in September (figs. a–c).

***Thresholds*:**

During July and August, there were more eggs and nymphs as the threshold was increased approximately in proportion to the adult threshold (i.e., 1:3:5 ratio; fig. a). By September, there were no significant differences among thresholds. Spray intervals were reduced to their minimum (7 days) for all treatments, and both egg and nymph numbers increased approximately 10- to 50-fold.

Application Methods:

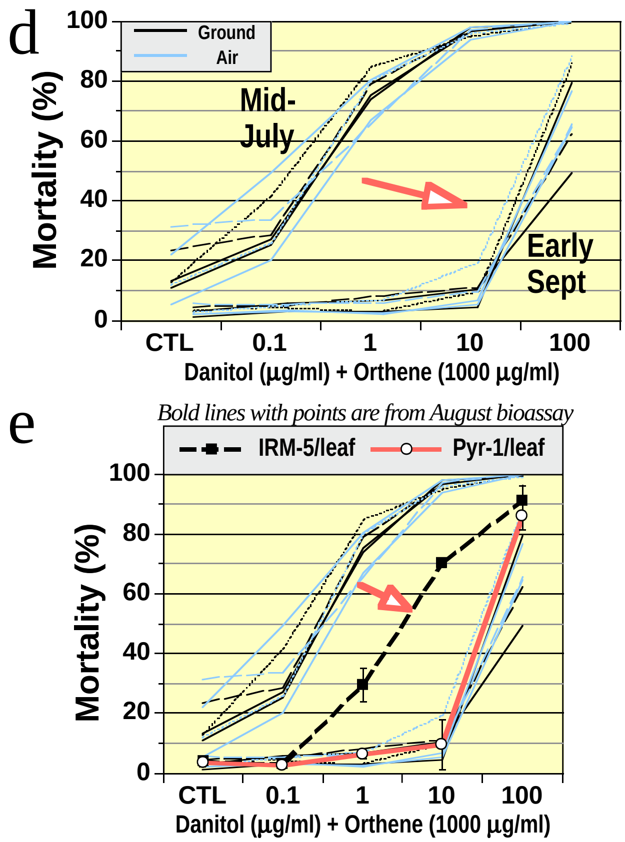
There were no significant differences in egg, nymph or adult numbers attributable to the method of application (fig. b). Though both methods simulated a commercial application, our pilot took care to deposit the spray into the canopy from a low altitude. This may or may not be equivalent to local practice.

Insecticide Regimes:

There were no differences in immature whitefly numbers due to the insecticide regime during the months of July and August (fig. c). 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 as in the IRM regime in September in spite of the fact that both regimes were using pyrethroids by this time. This large change in control is likely the result of reduced susceptibility or resistance in the whiteflies.

Resistance

Bioassays indicated rather sharp changes in whitefly susceptibility to Danitol+Orthene from mid-July (pre-spray) to early-September (after 3–6 sprays), regardless of application method, adult whitefly threshold, or insecticide use regime (fig. d). The overall shift from July to September represented an over 100-fold decrease in whitefly



Figures d–e: Mortalities of adult whiteflies exposed to four different concentrations of Danitol+Orthene in a leaf-disk bioassay. The family of lines at the left are from 8 different treatments from mid-July collections and the family of lines at the right are from the same treatments from September collections indicating a reduction in susceptibility.

susceptibilities to Danitol+Orthene.

Thresholds:

In general, susceptibilities 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 (fig. d).

Insecticide Regimes:

Both regimes resulted in seriously compromised susceptibilities in whitefly adults by September. However, the IRM regime, especially in conjunction with the 5/leaf threshold, resulted in a slowing of the progression of resistance (fig. e). This difference was most pronounced in the mid-August bioassays. Nevertheless, resistance had increased by the mid-August sampling for all treatment combinations and most severely in the 'Pyr', 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 were 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 reduced whitefly susceptibilities across all treatments, yield and quality were high throughout the entire test. Commercially picked yields averaged 2.9 bales per acre which were better than the farm's current (2.56 bales/A) and long-term historical averages (2.75 bales/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 adults compared to a threshold of 1 adult whitefly per leaf (see adjacent table). The 5 per leaf threshold resulted in 1 to 5 less sprays than the two lower thresholds. The decreased number of applications resulted in a lower cost of whitefly control (see adjacent table). 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; fig. f), 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; note '*' treatment in fig. g). 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 (fig. h), and 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; fig. j). Other studies have confirmed that 5–10 adults per leaf is an appropriate threshold for whitefly management (Naranjo *et al.* 1996; Ellsworth *et al*. 1995).

Threshold	Application Method: Ground	Air
1 per leaf	9	10
3 per leaf	6*	7
5 per leaf	5*	5*

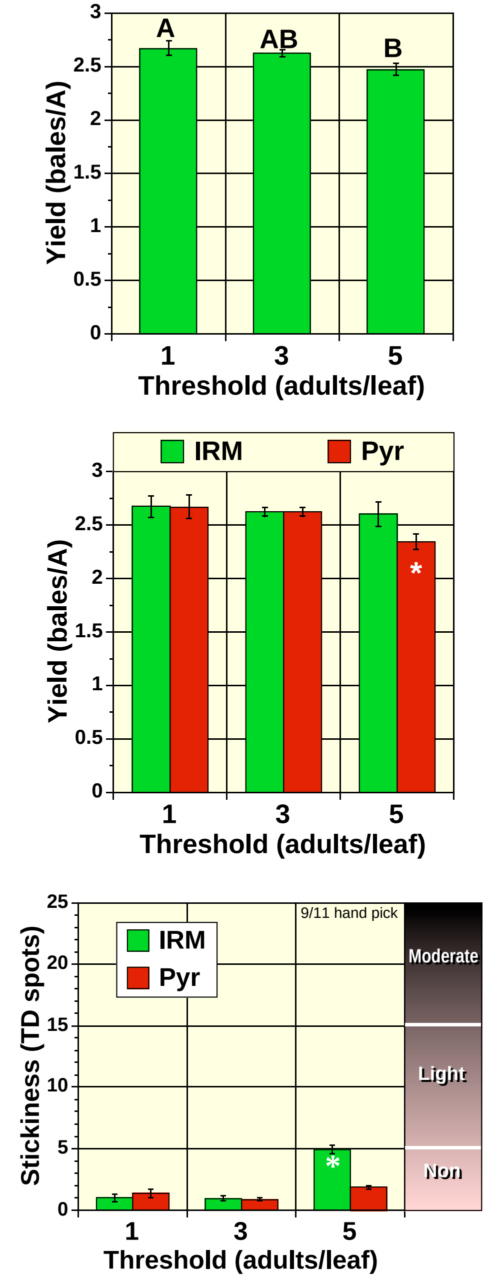
* 1 more spray for IRM

Treatment	Mean Difference in Cost per acre	
Ground	$ 0.50	
5 wfs per leaf	vs. 1	-$76.52
	vs. 3	-$21.52
IRM	$12.31	

f

g

h



Figures f–h: Strip yields and stickiness in relation to adult whitefly thresholds used. Bars followed by the same letter are not significantly different (Tukey's HSD; P ≤ 0.05). '' bars: interactions in fig. g (P = 0.18) & fig. h (P = 0.0004).*

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 (see table on previous page). Yields (P=0.45) and stickiness (P=0.39) were not different between the two methods (fig. i & j). When considering cost and number of applications over the entire

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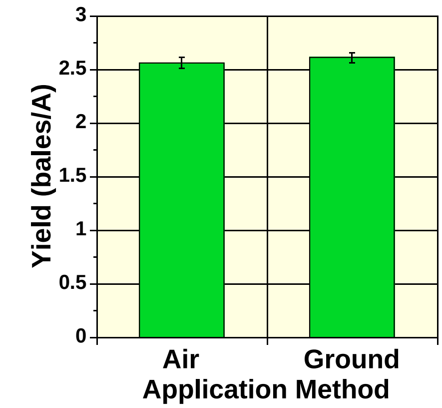

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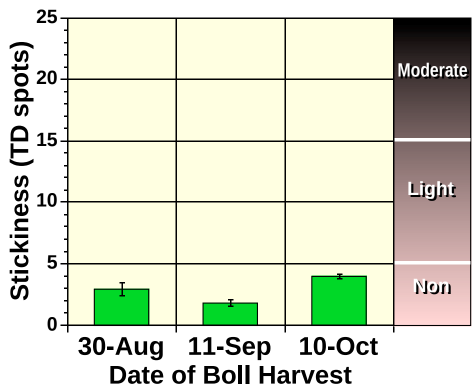


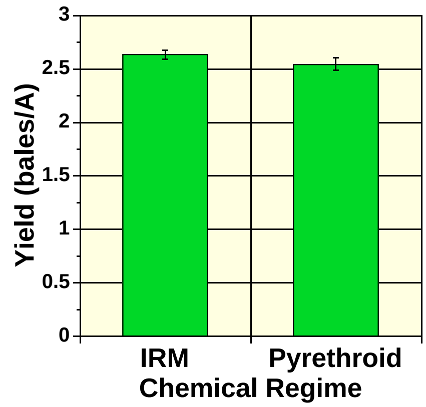
Figures i–j: Strip yields for application method (i) and chemical regime (k). All lint (j) on 10/10 was non-sticky regardless of threshold, application method or chemical regime used.

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 application (see tables; on an average whitefly control cost of $145.31 per acre).

Insecticide Regimes:

The IRM regime required 0.5 sprays and about $12 per acre more than the 'Pyr' regime (see table on previous page). Yields (P=0.17) and stickiness (P=0.50) at harvest were not different (fig. j & k), 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; fig. h) and the 'Pyr' regime at 5/leaf tended to yield less than the rest of the experiment (fig. g). In each case, however, the average levels were below the "stickiness" standard of 5 thermodetector spots.

k



Summary

Whitefly management in 1995 was based on a limited set of chemistry. Resistance to our most effective pyrethroid + organophosphate mixture was apparent in these whitefly populations after as few as two non-pyrethroid sprays. This suggests serious cross-resistance potentials with our current chemistry. Alternative control tactics are needed to combat resistance (e.g., host plant resistance, biological & natural controls, and novel modes of action such as insect growth regulators). Careful attention to the number of sprays made, the action threshold chosen, and the insecticide rotation used should help in slowing the development of resistance in August, while preventing stickiness, and optimizing inputs for maximized returns.

References

1. Dennehy, T.J. 1995. IPM Series No. 4. Building a resistance management program for whitefly in Arizona Cotton. The University of Arizona Cooperative Extension.Publication #195010. Tucson, AZ. 4pp.
2. Dennehy, T.J., P.C. Ellsworth & R.L. Nichols. 1995. IPM Series No. 3: Whitefly management in Arizona cotton 1995. The University of Arizona Cooperative Extension.Publication #195008. Tucson, AZ. 2pp.
3. 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. pp. 263-272. *In* Cotton, A College of Agriculture Report. The University of Arizona.
4. Ellsworth, P.C., J.W. Diehl, T.J. Dennehy and S.E. Naranjo. 1995. IPM Series No. 2: Sampling sweetpotato whitefly in cotton. The University of Arizona Cooperative Extension.Publication #194023. Tucson, AZ. 2pp.
5. Ellsworth, P.C. & J.W. Diehl. 1995. "Whiteflies in Arizona No. 2: Sampling & Action Thresholds." The University of Arizona Cooperative Extension, 2pp.
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 whiteflies in cotton. *In* Proceedings Beltwide Cotton Conferences. D.J. Herber & D.A. Richter (eds.) National Cotton Council, Memphis, TN.

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