Sweetpotato Whitefly (*Bemisia tabaci Gennadius*) Population Relationships to Cotton Yield and Quality

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Abstract

Sweetpotato whitefly (SPWF) Bemisia tabaci Gennadius strain B has been a devastating pest of cotton in Arizona and California in recent years. Management systems involving cultural procedures, SPWF population monitoring, crop sanitation, crop sequencing, chemical control and other technology are developing slowly. SPWF population information in relation to cotton yield and quality losses are urgently needed. Preliminary studies with cotton insecticide treatments initiated each week from shortly after cotton seedling emergence to late in the cotton season were conducted at the Irrigated Desert Research Station, Brawley, CA in 1993. The results suggest significant correlations for numbers of SPWF per leaf disc from cotton leaves vs. cotton yield and lint stickiness. Cotton lint yield was negatively correlated to all stages of SPWF populations (-0.783 or higher). Lint stickiness was high positively correlated to SPWF populations (0.707 or higher) and cotton defoliation was positively correlated to SPWF populations (0.876 or higher).

Introduction

In the southwestern United States, a total of 734,000 acres of cotton were reported infested with SPWF in 1992 and yield losses were estimated at 87,300 cotton bales (Head, 1993).

The need to maximize insecticide effectiveness, prevent excessive use and avoid resistance development prompted us to conduct studies to determine the relationship between insecticide use, SPWF populations and cotton yields and quality, particularly sticky cotton caused by SPWF honeydew contamination. Previous studies showed that the mixture of fenpropathrin (Danitol® 2.4EC, α-Cyano-3-phenoxybenzyl 2,2,3,3,-tetramethylcyclopropane-carboxylate) and acephate (Orthene®, O,S-Dimethyl acetylphosphoramidothioate) effectively reduced numbers of SPWF nymphs in cotton and was a promising insecticide control mixture (Akey et al. 1991, 1993; Chu et al. 1993). We conducted studies in 1993 at Brawley, CA using a Danitol and Orthene mixture to regulate SPWF populations and determine relationships to cotton yield, quality and defoliation.

Materials and Methods

Cotton (*Gossypium hirsutum* L.) cultivar 'Deltapine 5461' was planted and irrigated for germination on March 22, 1993. The experimental design was a randomized complete block with four replications. Each plot was 4 rows wide and 60 ft long with rows spaced at 40 inches apart. There were 4 unplanted rows between plots and 30 ft fallow alleys that separated blocks. Treatments were calendar dates when insecticide applications were initiated and total numbers of applications. The first series of 4 plots were treated on April 27 when cotton was in the 1-2 true leave (nodes) stage of plant growth. Thereafter, insecticide applications were initiated weekly until July 7 in a new series of plots for a total of eleven treatment initiation dates. Following the initial treatment of each series of plots, subsequent applications were made at weekly intervals until August 4. Thus the first series of plots treated on April 28, received a total 15 applications with plots for each succeeding treatment initiation date receiving 14, 13, 12, 11, 10, 9, 8, 7, 6, and 5 applications, respectively. Untreated plots (4) were controls. The insecticide mixture was Danitol® plus Orthene® at the rates of 0.1 and 0.5 lb ai/ac, respectively. The treatments were applied with a backpack sprayer using three 6002 TeeJet nozzles operated at 20 psi. One nozzle in the center of the boom was directed to plant tops. Drops 13 inches in length to reach into the cotton canopy were attached on each side of the boom and 20 inches from the center nozzle. The drop-nozzles were oriented at 45° angles to direct spray up into the canopy and obtain underleaf coverage. All applications were made shortly after dawn so that ambient temperature variations (minimums at 16 - 21 °C) between the consecutive applications were minimized.

Adult SPWF populations were sampled with 3 X 5 inch yellow sticky traps. One yellow sticky trap was placed in each plot 24 and 48 h, respectively, before each insecticide application and in each case exposed for 24 h before retrieval. Ten leaf samples from leaf node position number 5 from the top of mainstem terminals as described by Naranjo and Flint (1993) were taken 24 h before each insecticide application to estimate numbers of SPWF eggs, nymphs, and pupae. A total of 16 leaf samplings were made during the season. The first leaf samples were taken April 27, one day before the first insecticide application, and subsequently each week thereafter until August 10, six days after the 15th and last application.

In addition, 10 mature open cotton bolls from each plot were taken on July 27, August 3 and 10 to determine lint stickiness by the methods of Brushwood and Perkins (1993). Weekly ratings of leaf defoliation due to SPWF infestations were made four times from July 21 to August 10. Cotton seed and lint yields were estimated from two 1/1000 acre samples taken on August 24. Number of open bolls from the two 1/1000 acre samples from each plot and weight of 100 seeds randomly selected from the ginned seed cotton from each plot were also determined. SPWF resistance ratios to the Danitol and Orthene scheduled sprays were determined on July 21 and 25 using methods developed by Prabhaker (unpublished data).

Data were analyzed using ANOVA for each sampling date and data criteria. Means were separated with orthogonal comparisons at the 5% level of probability. Additional analyses were made by combining the 16 yellow trap and leaf samples into two periods according to the statistically significant differences between treatments. The two periods were the first seven samples from April 27 to June 8 when the differences between treatments were not significant and the nine samples from June 15 to August 16 when the differences between treatments were significant. From the regression of cotton lint yield and the number of insecticide applications during the second period of estimating SPWF populations, the number of insecticide applications that maximized lint yield was determined. This figure was used to identify the SPWF population estimates occurring at that time. The determined SPWF populations were considered action thresholds for different stages of SPWF. Correlations between the various plant and SPWF parameters measured were made to indicate their significance levels. Regression analysis was also accomplished to establish lint yield, sticky cotton, cotton defoliation and SPWF population relationships.

Results and Discussion

Highest yields were attained between 9 and 15 applications of the Danitol and Orthene mixture (Table 1). Regression analysis indicates that lint yield was maximized at 12.3 applications. The SPWF seasonal average numbers derived from the maximized lint yield were: eggs 0.64, all stage of nymphs 0.22, pupae 0.0065, and nymphs and pupae 0.22 per cm^2 of leaf sample (Table 2), and 2.22 adults per cm^2 of yellow sticky trap surface. Low numbers of pupae found on leaf samples, frequent SPWF adult dispersal, and lint and foliage contamination with honeydew excreted by SPWF, as well as associated fungi, are additional considerations for examining the SPWF impact on cotton yields. Our current information suggest that SPWF nymphs may be the best index for development of action thresholds. Further research is needed to verify the thresholds found in this study.

Correlation coefficients between all parameters measured in the study suggested significant SPWF population relationships and cotton yield and quality and defoliation. A partial list of correlation coefficients is shown in Table 2.

Minicard lint stickiness values were also highly correlated to increasing numbers of SPWF immature forms (nymphs and pupae) on leaf samples. Our results suggest that 51.6, 63.8 and 66.7% of the variation in minicard lint stickiness was explained by the differences in SPWF populations occurring for 20 July, 3 and 10 August leaf samples.

Using a laboratory reared susceptible SPWF strain for comparison, the average resistance ratio of SPWF adults to the Danitol and Orthene mixture was 3.6. A resistance ratio for SPWF of 5.0 and above is considered cause for concern. The low average resistance ratio even after as many 13 weekly applications of the insecticide mixture to some plots may be due to the constant dispersal of untreated SPWF adults from other fields and hosts and other locations in the region. However, the low resistance ratio of SPWF adults found in this study indicates that the influence of SPWF resistance in the present study was negligible.

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Table 1. Effect of initiation of insecticide[1] application on number of open bolls and lint yield on cotton plants in Imperial Valley, CA, 1993

Date of first application	Main stem nodes at application	Total number application	Number of open bolls /plant	Lint yield lbs/ac
4/28	2	15	11.2 a[2]	1381 a
5/05	5	14	12.1 a	1482 a
5/12	8	13	11.9 a	1392 a
5/19	11	12	12.5 a	1488 a
5/26	13	11	10.9 a	1411 a
6/02	14	10	13.4 a	1465 a
6/09	16	9	12.1 a	1548 a
6/16	18	8	10.7 a	1161 b
6/23	22	7	8.6 b	1285 b
6/30	24	6	8.1 b	745 b
7/07	25	5	9.8 b	1072 b
Untreated	-	0	7.2 b	537 c

[1] Mixture of Danitol and Orthene at 0.2 and 0.5 lb ai/ac, respectively.
[2] Means in a column with different letters differ significantly (orthogonal comparison $P \leq 0.05$).

Table 2. Seasonal average number of SPWF/cm^2 of cotton leaf area from June 15 and August 8, 1993, and maximum cotton lint yield in Imperial Valley, CA

Stage SPWF	No./cm^2 leaf	95% Confidence interval
Eggs	0.64	0.46-0.87
All stages of nymphs	0.22	0.10-0.36
Pupae	0.0065	-0.03-0.05
Nymphs and pupae	0.22	0.10-0.36
Adults	2.22[1]	1.85-2.66

[1] /cm^2 of yellow sticky trap surface.

Table 3. Correlation coefficients for lint yield and SPWF population relationships on cotton in Imperial Valley from June 15 and August 8, 1993

	Correlation coefficients			
	Eggs	Nymphs	Pupae	Adults
Lint lb/ac	-0.824[1]	-0.830	-0.822	-0.783
Lint stickiness on 8/10	0.726	0.728	0.744	0.707
Defoliation on 8/10	0.934	0.952	0.933	0.876

[1] All correlation coefficients are significant at $p \leq 0.001$, $n = 48$.