Seasonal Distribution Of *Bemisia* Honeydew Sugars On Pima And Upland Cotton Lint

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Abstract

Bemisia argentifolii Bellows and Perring populations were higher on Pima S-7 cotton compared with DPL 50 cotton. Higher numbers of mature open cotton bolls occurred earlier for DPL 50 compared with Pima S-7. Also, numbers of open bolls for DPL 50 peaked 8 to 14 days before Pima S-7 and decreased dramatically by 15 September reflecting termination of the first fruiting cycle in August. In contrast, the indeterminate fruiting pattern of Pima S-7 showed that numbers of open bolls per week declined gradually after the peak without a clear cut termination occurrence. About 95 and 80% of the open cotton bolls, of the Deltapine and Pima S-7 cottons, respectively, occurred by mid-September. This suggests that defoliation timing and early harvest can be important management tools to avoid sticky cotton. For upland cotton, extending the cotton season after 95% of the crop matured (≅ 15 September) resulted in development from non-sticky cotton to lightly-sticky cotton within 21 days following the occurrence of increasing whitefly populations after 15 September. Later fruiting and lack of a distinct end of the first cotton fruiting cycle probably precludes using early defoliation for long-staple Pima cotton. At harvest, thermodetector counts for all weekly harvests were greater than amounts found in lint for randomly selected 20 boll samples, and samples from all cotton picked from 4 m of row. This probably occurred because weekly picked cotton escaped rainfall and exposure and other weathering, in 1995 but not 1996, and machine-picked cotton contains more honeydew-contaminated leaf trash. Except in one instance, thermodetector counts and trehalulose and melezitose content in lint for all sampling methods were significantly correlated.

Introduction

The cotton stickiness issue remains a significant problem in the textile industry (Hector and Hodkinson 1989). The authors called attention to the lack of controlled field experimentation to determine factors affecting cotton stickiness, but reported that most often cotton stickiness problems are caused by insect honeydew contamination. Silverleaf whitefly, *Bemisia argentifolii* Bellows and Perring, (formerly *B. tabaci* Gennadius strain B) populations have often occurred in epidemic proportions in cotton in CA, AZ, and TX since 1986 resulting in increased incidences of sticky cotton. Sticky cotton economic losses, in general, have been poorly documented. However, Hector and Hodkinson (1989), after a survey of European spinning mills reported monetary compensation of 500,000 Austrian shillings, the difficulty of spinning mills to obtain subsequent contracts following sticky cotton episodes, increased spinning mill machinery maintenance, actual refusal of spinning mills to process sticky cotton and a price reduction differential greater than 10% for sticky cottons. Price premiums for nonsticky cotton by cotton growers were also reported to be about 10% in the Sudan Gezira (Carlson and Mohamed 1986). Khalifa and

Gameel (1982) reported cotton ginning output reductions up to 25% and economic losses of 5-10% per kg of lint in the Sudan.

In 1996, we conducted studies to determine the seasonal occurrence of *B. argentifolii* honeydew sugars on cotton lint, as measured by thermodetector counts, during the growing season.

Methods and Materials

General. DPL 50 and Pima S-7 cotton seeds were planted 8 April 1995 at approximately 40 thousand plants per acre in a four replicate randomized block experimental design.

Individual plots were 6 rows wide with 40" row spacing. Rows were about 100' long. Treatments were a factorial arrangement of cultivars (DPL 50 or Pima S-7) with an untreated control, one, two, or three insecticide applications. The first application was applied on 10 July 1996 and subsequent applications at 21 day intervals thereafter. Applications were made with a high clearance ground sprayer. Cotton was defoliated on 15 October 1996.

Whitefly Sampling. Adult whiteflies were sampled weekly in all plots 10 June to 15 October, using the sampling method of Naranjo and Flint (1995). Eggs and immatures were counted on one 3.88 cm^2 leaf disks from each of 30 leaves taken on the same dates from the fifth node from the terminal of sampled plants (Naranjo and Flint 1994). Immature life stages are presented as numbers per cm^2 of leaf area.

Seasonal Distribution of Honeydew Sugars. To determine cotton lint stickiness during the season, we hand-picked all open seed cotton from plants in all plots in the same 4 m of row each week beginning 14 August and continuing to 15 October. All cotton samples were ginned, and lint and seed were weighed. Lint samples were analyzed for lint stickiness by the thermodetector method of Brushwood and Perkins (1993) at the USDA-ARS Cotton Quality Research Station, Clemson, SC. Thermodetector analysis is accomplished by spreading 2.5 g lint samples between aluminum foil sheets followed by heating under pressure. Aluminum foil sheets are separated and the number of sticky spots counted. Less than 5 sticky spots indicates nonsticky cotton, 6 to 14, light stickiness, 15-24, moderate stickiness and above 24, heavy stickiness (Perkins and Brushwood 1995).

Statistical Analysis. All data were analyzed using ANOVA methodology (MSTAT-C 1988). Means were separated, following a significant F test, using the method of least significant differences ($P \leq 0.05$). Correlation and regression analysis were conducted to determine relationships between cotton harvest methods and thermodetector and whitefly sugars extracted from lint.

Results

Whiteflies. Numbers of adult whiteflies were significantly higher on Pima S-7 compared with DPL 50 on all sampling dates except 27 August, 9, 11, and 15 October (Fig. 1A). Numbers of eggs, often mid-July, on Pima S-7 and DPL 50 (Fig. 2B) followed a similar pattern for comparable sampling dates. Numbers of nymphs were lower on Pima S-7 from 1 to 22 July compared with DPL 50 but higher on Pima S-7 compared with DPL 50 from 29 July to 15 October, except for 20 August and 10 September (Fig. 2C).

The first insecticide applications were made 10 July. There were no significant differences for adults and eggs on any sampling date between treated and untreated cotton but nymphs were significantly reduced on all individual sampling dates from 22 July to 10 September (except for 12 and 20 August) in plots receiving 2 or 3 pyriproxyfen applications (Fig. 2). Also, numbers of nymphs in plots receiving a single insecticide application were not significantly different from those in untreated plots on 22 July, 3 and 10 September.

Seasonal Distribution of Honeydew. Open cotton bolls for DPL 50 began to occur during the period from 28 July to 7 August but not for Pima S-7 until 5 to 21 August (Fig. 3). Peak numbers of open bolls for DPL 50 occurred 21 August and for Pima S-7 on 4 September. Open bolls for the second fruiting cycle for DPL 50 began to occur 25

September. Numbers of open bolls for Pima S-7 slowly declined following the peak numbers on 4 September. Ninety-four and 89%, respectively of the DPL 50 and Pima S-7 seasonal total open boll production occurred by 18 September.

Amounts of cotton lint (g/4 m of cotton row) were significantly higher for DPL 50 compared with Pima S-7 on 14 and 21 August and higher for Pima S-7 on all other sampling dates (Fig. 3). However, total lint yield for DPL 50 was higher than for Pima S-7. Lint yields from insecticide-treated plots were not significantly different from untreated plots. This probably occurred because of the low level whitefly populations during most of the cotton boll production period.

Low weekly whitefly populations after 22 July and rains (2.2, 0.7, 0.2, 0.3, and 0.3 cm on 25 July, 29 August, 4, 9, and 24 September, respectively) resulted in low thermodetector counts through 18 September (Table 1). Thermodetector counts were below the threshold level (≤ 5) until 25 September. On that date and on 2 and 9 October, thermodetector counts indicated that cotton was lightly sticky.

Discussion

Higher populations of *B. argentifolii* occurred on Pima S-7 cotton compared with upland cottons, which is similar to the results reported by Natwick et al. (1995). Natwick et al. (1995) also compared Pima S-6 and Pima S-7 showing no significant difference between the two, but Pima S-6 also had higher *B. argentifolii* populations than upland cottons. Meagher et al. (1997) verified the results for Pima S-6 and also found significant differences in whitefly populations among other different cotton types. The mechanisms involved that account for the differences are unknown. However, several studies have suggested that cotton leaf hairiness is related to higher whitefly populations compared to smooth leaf cottons (Butler et al. 1991). Meagher (1997) did not find a high correlation for trichome number and whitefly population density possibly because their pubescent types had much lower trichome densities compared with cottons reported in other studies. Pima cottons are hairy as compared to the DPL smooth leaf cottons used in our studies and may partially explain the differences in whitefly populations. The important point seems to be that identifiable differences in plant resistance exist in different types of cotton and can possibly be manipulated genetically to develop cottons less susceptible to whiteflies.

Since all cotton was picked from all plants on each sampling date, the data for whole plant weekly samples do not account totally for the accumulation effect. After picking all open bolls weekly in each plot, the time lag (1 to 7 days) as new bolls open results in variable times of exposure during the 7 day sampling periods. Thus, the total for thermodetector counts we report are probably conservative in relation to the potential amount of honeydew deposition that could occur if all bolls are continually exposed.

Intensifying control efforts during the peak boll opening period does not appear to offer a solution to the sticky cotton problem unless control activity is continued to harvest or early-defoliation and harvest is practiced. Our data show that lint in bolls opening during the entire first fruiting cycle was exposed to low level whitefly populations and frequent rainfalls and escaped honeydew contamination. If the crop had been defoliated by 15 September, when 95% of all upland cotton bolls were open, it would not have been exposed to increasing whitefly populations late in the season. With the entire seed cotton of the first fruiting cycle and a portion of the bolls opening from the second fruiting cycle exposed to increasing whitefly populations, light sticky cotton occurred during a 21-day period after 15 September. Thus, timing of defoliation application in relation to the last insecticide protection or detectable increasing whitefly population can be an important tool to manage the cotton crop to avoid sticky cotton.

References

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Table

Table 1. Thermodetector counts for weekly open cotton boll harvests from 4 m of row in Pima S-7 and Deltapine (DPL) 50 cottons 1996.

	Thermodetector counts	
Sample date/treatment[a]	Pima S-7	DPL 50
Aug 14	– –	0.69 ± 0.12
Aug 21	0.63 ± 0.44 b	2.69 ± 0.67 a
Aug 28	1.00 ± 0.24 b	2.13 ± 0.58 a
Sept 4	2.38 ± 0.40 b	4.50 ± 0.46 a
Sept 11	3.06 ± 0.30 b	4.94 ± 0.54 a
Sept 18	3.69 ± 0.41	– –[b]
Sept 25	5.75 ± 1.16 b	8.00 ± 1.06 a
Oct 2	7.63 ± 0.82 a	6.25 ± 1.05 a
Oct 9	12.45 ± 0.98 a	6.50 ± 1.01 b

[a] Means of 4 replications in a column within the same sampling date not followed by the same letter are significantly different. Method of Least Significant Difference $P \leq 0.05$-0.01.
[b] No open bolls on DPL 50 cotton.

Figures

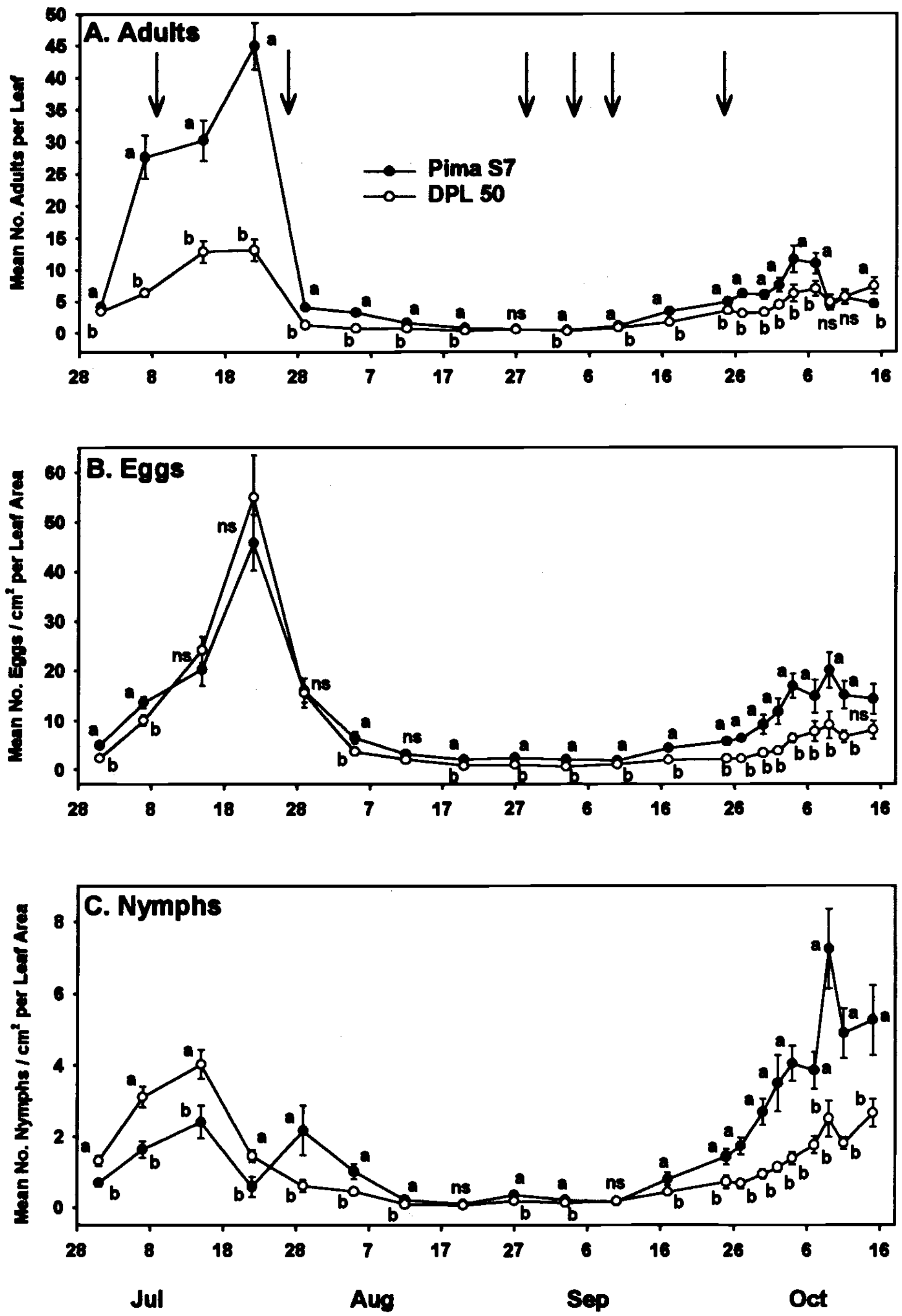

Figure 1. Mean numbers of silverleaf whitefly adults / leaf turn and eggs and nymphs / cm^2 of leaf disk from Pima S-7 and DPL 50 cottons. Means of 4 replications, on the same date and life stage not followed by the same letter are significantly different. Method of least significant differences. $P \leq 0.05$ to 0.01. ns = not significantly different. 1996. Arrows indicate rainfall.

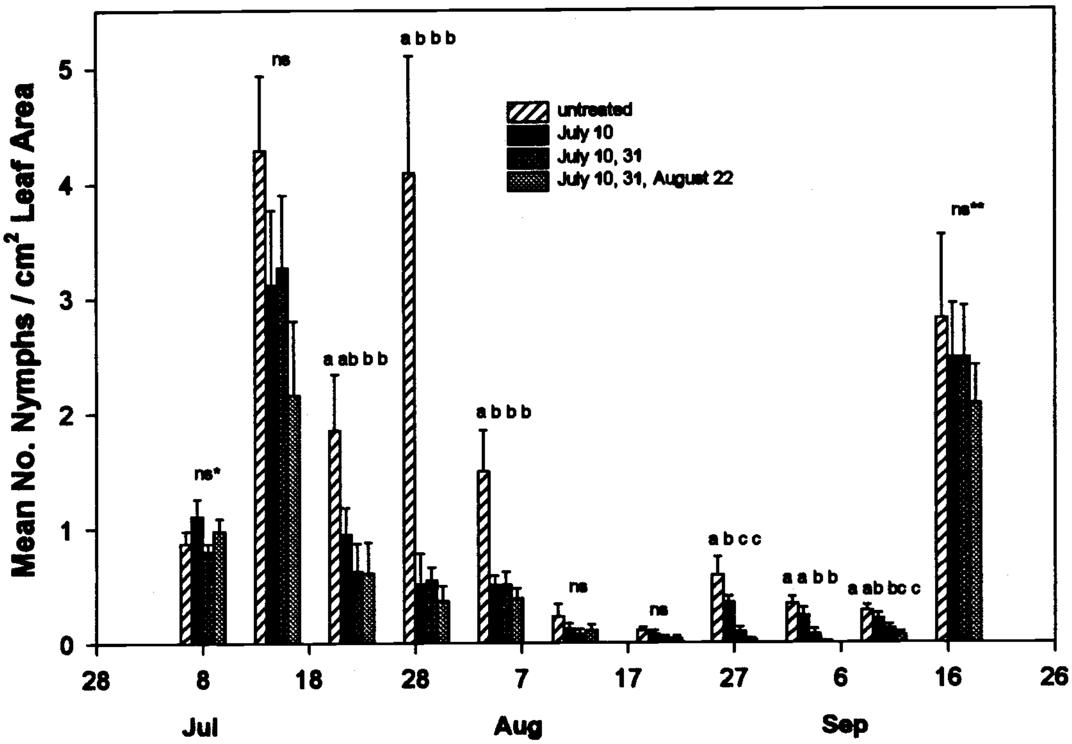

Figure 2. Mean numbers of silverleaf whitefly adults / leaf turn and eggs and nymphs /cm^2 of leaf disk from treated and insecticide-treated cotton plots. Means of 4 replications, on the same date not followed by the same letter are significantly different. Method of least significant differences. $P \leq 0.05$ to 0.01. ns = not significantly different. 1996. * = means of 5 sampling dates, 10 June to July 8, ** = means of 11 sampling dates 17 September to 15 October.

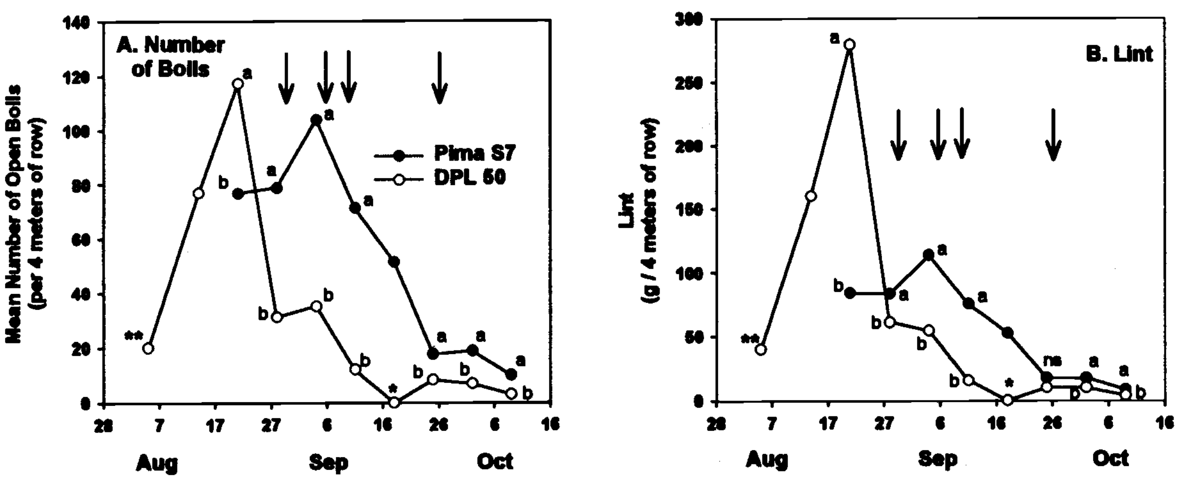

Figure 3. Mean numbers of open bolls (A) and grams of lint (B) per 4 meters of cotton row in Pima S-7, DPL 50 and DPL 5415 cottons. Means of 4 replications, 2 observations per replication, on the same date not followed by the same letter are significantly different. Method of least significant differences. $P \leq 0.05$ to 0.01. ns = not significantly different. 1995. Arrows indicate rainfall.