Silverleaf Whitefly: Honeydew Sugars And Relationships To Sticky Cotton

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Abstract

In cotton plots heavily infested with silverleaf whitefly (SLW), Bemisia argentifolii Bellows and Perring, amounts (mg/g of lint) of sugar (fructose, glucose and sucrose combination) on lint from tagged bolls, varied but showed a general trend to increasing amounts with increasing time of exposure (days) for 52 days. Minicard lint stickiness ratings responded in a similar manner and all values were above acceptable thresholds. Lint from harvested mature open bolls that were exposed on trays suspended in the interior of SLW infested cotton plots showed increasing amounts of sugar and higher minicard ratings after 6 days. Amounts of sugar and minicard ratings were drastically reduced following rains of 1.5 inches.

Introduction

Processing honeydew contaminated cotton lint in the textile mill is difficult and sometimes impossible because honeydew induced stickiness may interfere with efficient lint handling at every stage in yarn manufacturing (Perkins 1986). Cotton stickiness has become a limiting factor in cotton production in many countries (Khalifa and Gameel 1982). Sisman and Schenek (1984) reported that 80-90% of cotton stickiness is attributable to insect produced honeydew, particularly that of aphids and whiteflies. The silverleaf whitefly (SLW), *Bemisia argentifolii* Bellows and Perring, a newly described whitefly species, has been an economic problem in the cotton growing areas of Arizona since the early 90's. Increasing SLW populations have been associated with increasing sticky cotton problems and reduced cotton yields (Chu et al. 1994). The current studies were conducted in a cotton field heavily infested with SLW near the Western Cotton Research Laboratory, Phoenix, AZ. The objectives were to study the relationship between field populations of SLW and accumulation of honeydew on cotton lint and the effect on cotton stickiness.

Material and Methods

The accumulation of honeydew on cotton lint in mature open bolls in the field was studied by placing red tags on stems of all open bolls on 9 August 1993, in each of 5 randomly selected plots within a 1 acre 'Deltapine 90' cotton field. Open bolls were first observed in the field on 4 August. Thus, lint in open bolls had been exposed to SLW honeydew accumulation for <1 to 5 days when tagged. On 13 and 18 August all newly opened untagged bolls within each previously tagged boll area were marked with blue or yellow tags, respectively. Twenty open tagged

bolls of each color in each area were collected at weekly intervals following tagging for a total of 59 days.

Adult whitefly populations were estimated in each of the five plots using the black pan sampling technique. Eggs and nymphs were counted on 3.88 cm^2 leaf disks taken from the lower left quadrant of each of 20 leaves per plot as described by Naranjo and Flint (1994).

Honeydew accumulation in cotton lint was also studied by picking 500 open mature cotton bolls with stems and bracts on 12 August 1993 from a 1-ha cotton field. One hundred bolls were randomly selected from the 500 and divided into 5 samples of 20 bolls each. These were considered 0 days exposure for baseline sugar analysis in relation to the experimental exposure times that follow. Of the remaining 400 bolls, 80 were placed in each of 5 open-top wire trays. One tray was placed at each of 5 locations, in untreated and treated cotton plots. Trays were placed within the cotton canopy on 13 August and suspended 40 cm above the ground on cotton plants. The trays were secured in place with wire attached from each tray corner to cotton plant stems. A canopy of SLW infested cotton leaves over each tray was made by wrapping string around plant stems about 30 cm below the top of the plant and pulling the plants toward the center of the tray. Boll samples (20 in each case) were taken from each tray on 16, 19, 24, and 30 August (3, 6, 11, and 17 days exposure).

Minicard cotton lint stickiness ratings for all samples were determined at the USDA-ARS, Cotton Quality Research Laboratory, Clemson, SC, using the methods described by Perkins (1986). The sugar combination of fructose, glucose and sucrose in all samples was determined using the method of Hendrix (1993).

Results and Discussion

Adult SLW populations in the cotton plots averaged 344 per black pan sample on 9 August and increased to 678 on 17 August (Table 1). Heavy (1.5 inch) rains on 26 and 27 August prevented adult sampling until 30 August and slightly reduced numbers of adult SLW occurred for several days following the rains. Peak adult populations occurred on 7 September and numbers decreased thereafter through 18 October. SLW egg and nymph populations were not affected by rains. Numbers were low on 9 August, increased to a peak, in each case, on 4 October and decreased thereafter through 18 October. Minicard stickiness rating increased significantly after 17 days exposure of open bolls in SLW infested cotton fields as compared to lint stickiness ratings for bolls exposed 3 days. No significant differences in minicard sticky cotton ratings occurred from day 24 to day 52 but the stickiness rating was significantly lower on day 59 as compared to day 52. The results were similar for the sugar combination of fructose, glucose and sucrose. The sugar combination of glucose, fructose and sucrose was significantly ($r = 0.68$, $P \leq 0.001$) correlated to minicard cotton stickiness ratings. SLW nymph populations were poorly related to the combination of glucose, fructose and sucrose.

Adult SLW numbers in untreated cotton plots at the University of Arizona, Maricopa Experimental Station were 8765/black pan samples on 9 August decreasing thereafter to 4462 on 31 August (Table 3). Nymph populations peaked (498.9/leaf disc) on 16 August. The sugar combinations of fructose, glucose and sucrose and minicard ratings generally increased in lint from bolls following exposure to SLW populations (Table 4). Minicard ratings and amounts of sugar per gram were reduced dramatically following heavy rains. Mature cotton lint may contain 0.25% reducing sugars of physiological origin from within the cotton plant itself. This amount of reducing sugar is distributed uniformly over the lint and is not sticky (Bourely 1989). The importance of plant physiological sugars in cotton stickiness has not been demonstrated and there remains speculation that plant sugars directly (Price 1988) or indirectly (Mor et al. 1982) contribute to the problem (Hector and Hodkinson 1989). Extensive evidence exists that the main causes of sticky cotton are insect honeydews (Sisman and Schenek 1984, Watson et al. 1982, Rimon 1982). Hendrix et al. (1993) pointed out that a large portion of insect honeydew carbohydrates are not reducing sugars, but are large molecular weight nonreducing sugars that are not detected with much of the chemical methodology used in cotton lint stickiness research and sticky cotton detection. The authors suggested that detailed studies concerning the relationships of whitefly honeydew and cotton lint stickiness should consider carbohydrate analysis for insect produced sugars, particularly trehalulose in the case of studies with SPW and SLW. The results of our current studies provide supporting evidence for the need to analyze cotton lint samples for insect produced sugars if the objective of investigations is to determine whitefly relationships to sticky cotton. The amounts (mg/g

of lint) of fructose, glucose and sucrose were poorly related to SLW populations although significantly related to minicard sticky cotton ratings.

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Table 1. Mean[a] numbers of silverleaf whitefly adults/black pan sample, and nymphs and eggs/leaf disc, in untreated cotton plots at Phoenix, AZ.

Sampling dates	Adults	Eggs	Nymphs
Aug			
9	344	3.3	0.4
17	678	10.8	1.5
26	-	48.7	10.1
30	643	82.1	30.9
Sept			
7	1711	154.0	38.6
15	1112	218.1	121.1
21	623	219.3	133.7
27	1025	226.5	154.7
Oct			
4	932	294.5	136.6
12	508	270.7	97.8
18	128	220.9	93.8

[a] Means of 5 replications. Means in the same column not followed by the same letter are significantly different method of least significant differences $P \leq 0.05$.

Table 2. Mean[a] minicard sticky cotton ratings and sugar analyses for lint from tagged cotton bolls exposed for increasing numbers of days in silverleaf whitefly infested cotton plots.

No. days exposed	Minicard	Fructose[b], Glucose, Sucrose Combination (mg/g lint)
3	1.00 d	2.48 cd
10	1.53 cd	3.22 ac
17	2.07 bc	2.93 b-d
24	2.33 ab	2.68 b-d
31	2.60 ab	3.51 ab
38	2.87 a	3.29 ac
45	2.80 a	3.94 a
52	2.33 ab	3.15 ac
59	1.93 bc	2.19 d

[a] Means of 5 replications. Means in a column not followed by the same letter are significantly different. Method of least significant differences $P \leq 0.05$.

[b] Determined by the method of Hendrix (1993).

Table 3. Mean[a] number of silverleaf whitefly adults/black pan sample and nymphs and eggs/leaf disc in untreated cotton plots 1993. Experiment 2.

August	Adults	Nymphs	Eggs
9	8765	251.5	1282.3
16	8353	498.9	1530.0
23	7855	219.1	697.8
31	4462	298.0	553.4

[a] Means of 6 replication. Means in a row not followed by the same letter are significantly different. Methods of least significant differences $P \leq 0.05$.

Table 4. Mean[a] quantities of sugars extracted from cotton lint after exposure of mature open cotton bolls in trays suspended on cotton plants in untreated and insecticide treated[b] silverleaf whitefly infested cotton plots.

Date	Days exposed (no.)	Combined glucose fructose sucrose (mg/g lint)	Mini card
Aug 13	0[b]	2.5 c	0.4 ± 0.2 dc
Aug 16	3	3.6 ab	1.2 ± 0.4 c
Aug 19	6	4.0 a	2.8 ± 0.2 a
Aug 24	11	2.4 c	2.0 ± 0.4 b
Aug 30[c]	17	0.1 e	0.0 ± 0.0 e

[a] Means of 5 replications, 20 open cotton bolls/ replication.
[b] Mature open cotton bolls picked 13 August, estimated to have been fully opened an average of 3 days.
[c] Heavy rain August 25, 26 and 29.