Silverleaf Whitefly – Trichome Density Relationships on Selected Upland Cotton Cultivars

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Abstract

We studied silverleaf whitefly (SLW) and trichome density relationships on ten selected upland cotton cultivars: Deltapine #20B, 50B and 90B, NuCOTN 33B, Stoneville 474, Fibermax #819 and 832, Siokra L-23, and 89013-114 at Maricopa, in AZ, 1999. Whitefly and stellate trichome densities were counted on leaves on main stem leaf nodes #1, 3, 5 and 7 of each cultivar. Stoneville 474 had about 2-3 times more eggs, nymphs, and adults and also had 3-30 times more branched trichomes on abaxial leaf surfaces compared with the nine other cultivars. The top young leaves on node #1 had about 6 times more stellate trichomes compared with older leaves. However, the top young leaves also had reduced numbers of eggs and nymphs (23 and 1/cm^2 of leaf disk, respectively) compared with older leaves. The results suggest that other factors, in addition to trichomes, at least for young terminal leaves, affect silverleaf whitefly population development.

Introduction

The silverleaf whitefly (SLW), *Bemisia argentifolii* Bellows and Perring, has caused cotton yield losses and reduced lint qualities in Imperial Valley since its first outbreak in 1991. Studies have been conducted to identify cotton cultivars that are less susceptible to silverleaf whitefly colonization (Chu et al., 1998). Hairy-leaf cotton, *Gossypium hirsutum* L., cultivars have been associated with higher *Bemisia* colonization compared with smooth leaf cultivars (Butler and Henneberry 1984, Butler et al. 1991, Flint and Parks 1990). In a three year study from 1994 to 1996, Norman and Sparks (1997) found that *B. argentifolii* populations increased with increasing trichome densities on 15 cotton cultivars in the field. However, the increased whitefly population and trichome density relationship does not appear valid under extremely high trichome density. Butler et al. (1991) reported that adult whitefly density decreased as trichome density increased from 467 to 847 trichomes per cm^2 of cotton leaf. Mound (1965) did not find adult whiteflies or their eggs on the first two top leaves on some exceptionally hairy cotton plants.

The objectives of our studies were to investigate SLW – trichome density relationships on cotton cultivars and compare differences in numbers of leaf trichomes on young and older leaves.

Materials and Methods

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The study was conducted in 1999 at the University of Arizona Agricultural Research Center, at Maricopa in a randomized complete block design with four replicates. Each plot was eight rows wide and 12.2-m long with rows spaced 1-m apart. There were two unplanted rows between plots and 3-m alleys between blocks. Cotton cultivars (Deltapine [DPL] no. 20B, 50B, 90B, NuCOTN 33B, and Stoneville [ST] 474) and five okra-leaf cultivars (Fiber Max no. 819 and 832, Siokra no. L-23, I-4/649 and 89013-114). All entries were smooth leaf cultivars except for the hairy-leaf ST 474. Seeds were planted on 19 April 1999 and seedlings emerged about two weeks later. All plots were treated with diflubenzuron for salt- marsh caterpillars, *Estigmene acraea* (Drury), on 13 August. No other pesticides were applied during the growing season.

Numbers of stellate trichomes were counted on 9 June on leaves picked from main stem leaf nodes no. 1, 3, 5 and 7 down from the terminals. Duplicate leaves were picked from plants in two of the four replicates of each plot for each leaf position. The locations of stellate trichomes on leaves were recorded as located on the veins or located between the veins. We classified the cotton leaf vein complex into main, primary, secondary and tertiary veins. Main veins were those extending from the juncture of petioles and leaf blades to the leaf edges. Veins branching from main veins were primary veins and subsequently secondary and tertiary were veins branching from primary and secondary veins, respectively. Tertiary veins are the smallest veins that can be positively identified under a stereoscope (magnified 10 to 50 times).

Silverleaf whitefly populations were determined by picking leaves from plants in the plots on 11 dates from 21 July to 6 October at 7-day intervals. On each occasion, leaf disks 1.96 cm^2 were taken from each of three leaves from each of the four leaf nodes of each plant and the numbers of silverleaf whitefly eggs and nymphs were counted with the aid of a microscope. Adults per leaf-turn (Naranjo and Flint 1995) were counted on three 5th main stem node leaves on the same sampling dates.

Data for stellate trichome numbers were analyzed using ANOVA (Anonymous 1989) for a randomized complete block design. Means were separated with the protected significant differences. Trichome – whitefly density relationships were plotted to show the general trends.

Results and Discussion

Most of the stellate trichomes were found on main and primary leaf veins of cotton cultivars (Table 1). The exception was ST 474 where stellate trichomes were also found on secondary and tertiary veins. Also, total numbers of stellate trichomes were the highest on ST 474 leaf disks (261.7/cm^2). The results agree with an earlier report of Norman and Sparks (1997). Numbers of trichomes for the nine other cotton cultivars ranged from 8.1 (DPL 90B) to 84.7 (89013-114) per cm^2 of leaf disk. Numbers of silverleaf whitefly eggs/cm^2 of leaf disk were highest on leaves of ST 474, followed by DPL 50B (Fig. 1). Differences in number of eggs/cm^2 of leaf disk were small between the other eight cultivars. Numbers of nymphs/cm^2 were also the highest on leaves of ST 474, followed by DPL 50B, Fiber Max 819, NC 33B and 89013-114, DPL 20B, DPL 90B, Siokra L-23, Fiber Max 832 and Siokra I-4/649. Numbers of stellate trichomes (all leaves combined for each cultivar) and numbers of whitefly eggs, nymphs, and adults relationships were signigicant (R^2 = 0.83, 0.83 and 0.45, n = 10, respectively). However, when leaves on different main stem leaf nodes were compared (all cultivars combined for leaves on each leaf node), relationships between numbers of stellate trichomes and numbers of eggs and nymphs were not significant (R^2 = 0.02 and 0.58, n = 4). Mean numbers of total stellate trichomes per cm^2 of leaf disk were 173.9, 28.3, 26.3 and 21.8 for leaves on leaf nodes #1 (youngest leaf), 3, 5 and 7 (oldest leaf) (Fig. 2), respectively, indicating that numbers of stellate trichomes did not change significantly during leaf expansion after node 3. Additionally, some trichomes could have been dislodged from leaves due to friction between leaves over time and natural shedding of old leaves. Mean numbers of eggs for the leaves from nodes 1, 3, 5 and 7 were 22.6, 80.9, 38.0 and 17.0/cm^2 of leaf disk, respectively, and mean numbers of nymphs were 0.6, 13.6, 25.6, and 16.9/cm2 of leaf disks, respectively. For the average of the 10 cultivars, fewer eggs and nymphs were found on the top young leaves (#1) compared with the older leaves on nodes #3 and #5. Fewer eggs and nymphs were also found on the top young leaves compared with the older leaves (#3) when each cultivar was examined individually. Thus, hairy leaf cotton cultivars had higher numbers of silverleaf whiteflies compared with smooth leaf cotton cultivars, but the top, young hairy leaves had fewer numbers of eggs and nymphs compared the older leaves immediately below regardless of cotton cultivars

studied. Mound (1965) also did not find *B. tabaci* eggs on the top leaves of hairy cotton cultivars. Young cotton leaves located at the tops of plants are thinner with vascular bundles closer to the underleaf surfaces compared with older leaves (Chu et al. 1999a, Chu et al. 2000) and their yellowish green color may attract more whiteflies compared with darker green older leaves (Chu et al. 1999b). These leaf characteristics and higher trichome density have in previous studies been associated with higher whitefly numbers, compared with smooth-leaf cotton types. The conflicting results, in this study, may suggest that cotton leaf characteristics and whitefly-trichome density relationships may be more complex than previous thought. Eggs and nymphs accumulate on leaves over time. A partial explanation for the conflicting results be that leaves on node #1 have not been exposed to adult whitefly oviposition as long as, e.g. leaves on node #5.

It appears that cotton leaf hairiness effects on the plant susceptibility to SLW may be confounded with leaf age and position on the plant. These complications need to be investigated before leaf hairiness can be considered as a leaf trait for plant breeders to consider in development of SLW whitefly resistant cottons (Jenkins 1994).

References

Anonymous. 1989. MSTAT-C, a microcomputer program for the design, management, and analysis of agronomic research experiments. Michigan State Univ., East Lansing, MI.

Butler, G. D., Jr., and T. J. Henneberry. 1984. *Bemisia tabaci*: effect of cotton leaf pubescence on abundance. Southwestern Entomol. 9: 91-94.

Butler, G. D., Jr., and F. D. Wilson. 1984. Activity of adult whiteflies (Homoptera: Aleyrodidae) within plantings of different cotton strains and cultivars as determined by sticky-trap catches. J. Econ. Entomol. 77: 1137-1140.

Butler, G. D., Jr., F. D. Wilson, and G. Fisher. 1991. Cotton leaf trichomes and populaitons of *Empoasca lybica* and *Bemisia tabaci*. Crop protection 10: 461-464.

Chu, C. C., E. T. Natwick, H. H. Perkins, D. E. Brushwood, T. J. Henneberry, S. J. Castle, A. C. Cohen, and M. A. Boykin. 1998. Upland cotton susceptibility to *Bemisia argentifolii* (Homoptera: Aleyrodidae) infestations. J. Cotton Sci. 2: 1-9.

Chu, C. C., A. C. Cohen, E. T. Natwick, G. S. Simmons and T. J. Henneberry. 1999a. *Bemisia tabaci* (Hemisptera: Aleyrodidae) biotype B colonisation and leaf morphology relationships in upland cotton cultivars. Australian J. Entomol. 38: 127-131.

Chu, C. C., P. J. Pinter, Jr., T. J. Henneberry, K. Umeda, E. T. Natwick, Y. Wei, V. R. Reddy, and M. Shrepatis. 1999b. Catches of silverleaf whiteflies, thrips and leafhoppers with different trap base colored CC traps, p. 9. *In* T. J. Henneberry and R. M. Faust (eds.), Silverleaf Whitefly National Research, Action, and Technology Transfer Plan, 1997-2001: Second Annual Review of the Second 5-Year Plant. USDA, ARS 1999-01.

Chu, C. C., and T. J. Henneberry. 2000. *Bemisia argentifolii* (Hemisptera: Aleyrodidae) colonization on upland cottons and relationships to leaf morphology and leaf age. Annals, Entomological Soc. Am (in press).

Flint, H. M., and N. J. Parks. 1990. Infestation of germplasm lines and cultivars of cotton in Arizona by whitefly nymphs (Homoptera: Aleyrodidae). J. Entomol. Sci. 25: 2223-229.

Jenkins, J. N. 1994. Host plant resistance to insects in cotton, pp. 39-372.. *In*: G. A. Constable and . N. W. Forrester (eds.), Challenging the Future: Proc. World Cotton Research Conf. – 1.

Mound, L. A. 1965. Effect of leaf hair on cotton whitefly populations in the Sudan Gezira. Empire Cotton Growing Review 42: 33-40.

Naranjo, S. E., and H. M. Flint. 1995. Spatial distribution of adult *Bemisia tabaci* (Homoptera: Aleyrodidae) in cotton and development and validation of fixed-precision sampling plans for estimating population density. Environ. Entomol. 24: 261-270.

Norman, J. W. and A. N. Sparks, Jr. 1977. Cotton leaf hairs and silverleaf whiteflies in the Lower Rio Grande Valley of Texas three year research summary, p. 1063-1064. *In* P. Dugger and D. A. Ritchter (eds.) Proc. Beltwide Cotton Conf., National Cotton Council of Amer., Nashville, TN 38182.

Table 1. Mean numbers of stellate trichomes on leaves from different main stem leaf nodes of ten upland cotton cultivars, Maricopa, AZ, 9 June 1999.

	No. trichomes/cm^2 of leaf area				
	Vein type				Between
Variable	Main	Primary	Secondary	Tertiary	veins
Cultivar					
DPL 20B	28.17 bc[a]	3.03 b	0.21 b	0.00 b	0.01 b
DPL 50B	56.74 ab	13.24 b	2.39 b	0.00 b	0.00 b
DPL 90B	7.25 c	0.69 b	0.00 b	0.05 b	0.07 b
NuCOTN 33B	10.00 c	0.59 b	0.00 b	0.00 b	0.00 b
ST 474	85.38 a	80.52 a	60.47 a	26.95 a	8.41 a
Fiber Max 819	45.01 abc	10.04 b	0.11 b	0.00 b	0.14 b
Fiber Max 832	34.51 bc	6.60 b	0.00 b	0.00 b	0.03 b
Siokra L-23	24.45 bc	10.40 b	1.30 b	0.00 b	0.00 b
Siokra I-4/649	39.71 bc	8.52 b	0.00 b	0.00 b	0.00 b
89013-114	64.32 ab	19.24 b	1.01 b	0.02 b	0.10 b
Leaf node					
1	104.50 a	45.56 a	13.57 a	7.73 a	2.54 a
3	19.75 b	4.74 b	3.77 b	0.03 b	0.00 b
5	19.03 b	4.57 b	2.60 b	0.09 b	0.06 b
7	18.65 b	2.95 b	0.23 b	0.00 b	0.01 b

[a] Means in the same sub-column not followed by the same letters are significantly different (Protected LSD, P = 0.05).

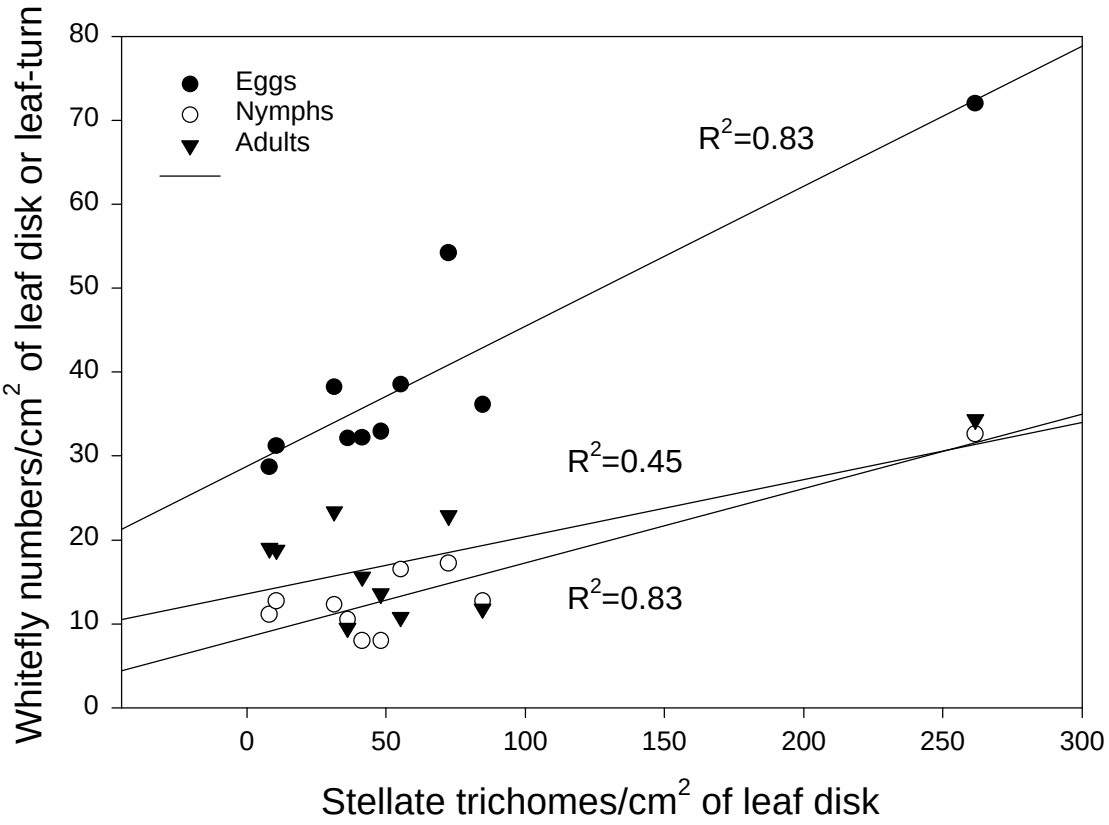

Fig. 1 Relationship between stellate trichome and whitefly densities on upland cottons.

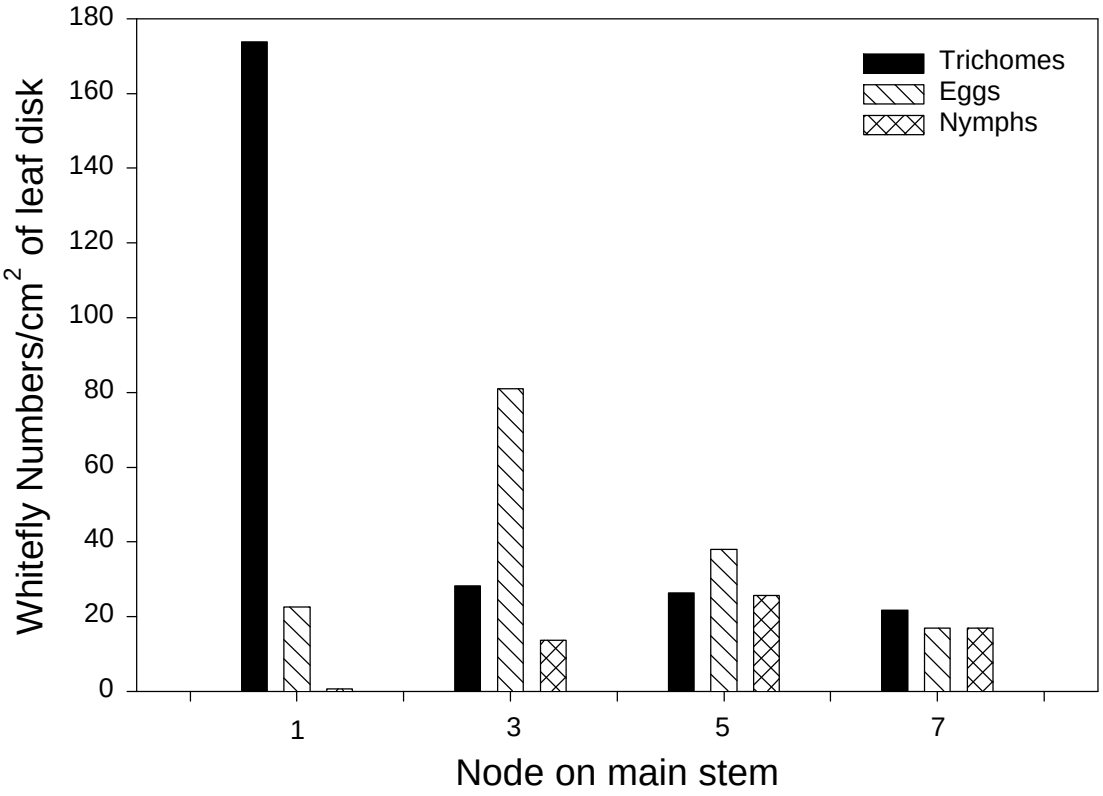

Fig. 2. Relationship between stellate trichome and whitefly densities on leaves on different main stem nodes.