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OKRA-LEAF AS A POTENTIAL TRAIT FOR WHITEFLY CONTROL

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Abstract

We compared smooth-leaf okra- and normal-leaf upland cotton (*Gossypium hirsutum* L.) cultivars for susceptibility to colonization by *Bemisia tabaci* (Gennadius) biotype B. Seven field studies were conducted, five at Holtville, CA and two at Maricopa, AZ during 1996 to 2000. Okra-leaf cultivars as a group had significantly lower numbers of adults, eggs and nymphs compared to normal-leaf cultivars indicating the potential of okra-leaf genetic traits for reducing *B. tabaci* colonization. Results also suggest that okra-leaf shape may provide less favorable micro-environmental conditions as *B. tabaci* habitat because of more open canopy as evidenced by higher leaf perimeter to leaf area ratio. The okra-leaf cultivar Siokra L-23 appears to have genetic traits that should be examined further as a source of *B. tabaci* resistance.

Introduction

The sweetpotato whitefly (SPW), *Bemisia tabaci* Genn. biotype B, has been an important economic pest of cotton since its epidemic in 1991. A long-term SPW management solution that is both economical and environmentally acceptable is needed. Our objectives have been to identify genetically mediated cotton plant traits that have potential for incorporation into commercially accepted cottons that resist SPW infestations. This report summarizes results of the studies on the differences in leaf shapes, i.e., okra- vs. normal leaf genotypes from 1996 to 2000.

Materials and Methods

Two field experiments were conducted in 1999 and 2000 at the University of Arizona Maricopa Agricultural Research Center at Maricopa, AZ. Five field experiments were conducted from 1996 to 2000 at the University of California Desert Research and Extension Center at Holtville, CA. The experimental design for all studies was a randomized complete block with four replicates. Okra- and normal-leaf cottons compared are listed in Table 1. Both okra- and normal-leaf cultivars were upland cottons having few leaf trichomes, ca. 20/cm^2 disk or less branched trichomes on 5th node main stem leaves as compared with 120/cm^2 disk for hairy leaf cultivar such as Stoneville 474 (Chu et al. 2001). Plots were not treated with insecticides for whitefly control. Plots at Maricopa, AZ were eight rows wide and 12.2 m long with rows 1 m apart. There were two unplanted rows between plots and 3 m wide alleys between blocks. Seeds were planted on 19 and 13 April for 1999 and 2000, respectively and watered at 10-20 days intervals during their growing seasons. Plots at Holtville, CA were four rows wide except in 1999 when plots were eight rows wide. Rows were 14-15 m long and 2 m apart between rows. There were two unplanted rows between plots and 4-5 m wide valleys between blocks. Seeds were planted on 20, 28, 25, 26 and 24 March each year from 1996 to 2000, respectively.

Densities of *B. tabaci* on cotton at Maricopa, AZ, were estimated at 7 day intervals from 21 July to 6 October in 1999 and 10 July to 5 September in 2000. On each sampling date, three plants per plot were randomly selected. Leaves were picked from main stem nodes #1, #3, #5, #7, #10 and #15 in 1999 and from nodes #1 to #5 and #7 in 2000. Nodes were numbered beginning with the first expanded leaf below the plant main terminal. Leaves from node #1 measured ≥ 2.5-cm between the two largest leaf lobes. A 2-cm^2 leaf disk was taken from the leaf area adjacent to the center primary vein. Numbers of eggs and nymphs were counted on underleaf disk surfaces with the aid of a stereoscope. Adults per leaf were counted on three 5th main stem node leaves on plants in each plot in 1999 and on three leaves on plants from each of the six main stem nodes sampled in each plot in 2000 using turn-leaf method on each sampling date. Leaf area and perimeter of each sampled leaf during the growing season were measured with a leaf area meter (CI-400 CIAS Image Analysis, CID, Inc., Vancouver, WA). Densities of *B. tabaci* on cotton at Holtville, CA were estimated by picking leaves at 7 day intervals from 17 June to 29 July, from 6 June to 19 August, from 10 June to 12 August, from 30 June to 25 August, and from 29 May to 7 August in 1996 to 2000, respectively. On each sampling date, 5th main stem node leaves from each of ten plants in each plot were randomly selected. Egg and nymph densities were counted from one 1.54 to 1.65 cm^2 leaf disk punched from each leaf as described earlier. Adults were counted from 5th main stem node leaves of ten plants. Data from each location each year were analyzed using orthogonal comparisons between okra- and normal-leaf cultivars and between Siokra L-23 and other okra-leaf cultivars (Anonymous 1989).

Results and Discussion

Mean numbers of *B. tabaci* adults, eggs, and nymphs for okra-leaf cultivars were significantly lower compared with normal-leaf cultivars in 1999 and 2000 at Maricopa, AZ (Fig. 1) and in 1996 to 2000 at Holtville, CA (Fig. 2). For the overall means of the seven location-year, numbers of adults and eggs of Siokra L-23 were significantly lower compared with other okra-leaf cultivars (7.2 vs. 9.6 adults/leaf and 14.2 vs. 18.0 eggs/cm^2 leaf disk, respectively). Mean numbers of nymphs/cm^2 of leaf disk were not significantly different. Mean leaf areas were significantly smaller (49.6 vs. 59.0 and 55.3 vs. 64.9 cm^2, respectively) and mean leaf perimeters were significantly greater (62.1 vs. 41.4 and 73.4 vs. 46.4, respectively) for okra-leaf cultivars compared with normal-leaf cultivars in 1999 and 2000 at Maricopa, AZ

Our results corroborate results from Sudan that the okra- and super-okra-leaf genotypes confer resistance to B. tabaci (Sippell et al. 1987) and okra-leaf cotton genetic traits may have potential for increasing cotton plant resistance to B. tabaci infestation. Okra-leaf cultivars have been associated with resistance to a number of other cotton pests (Jenkins 1999). Okra-leaf cultivars have greater leaf perimeters to area ratios compared with normal-leaf cultivars resulting in less shaded area compared with normal-leaf cottons. This leaf characteristic may result in higher ambient temperature and lower humidity in the cotton canopy. B. tabaci feed and oviposit almost exclusively on underleaf surfaces (Chu et al. 1995). However, in the United States, nymphal (Flint and Parks 1990) or adult (Butler and Wilson 1984) densities on the okra-leaf variety WC-12NL were not significantly different compared with normal-leaf Deltapine 61 variety. These results imply that B. tabaci resistance in okra-leaf cotton is complex and may be influenced by other factors than leaf shape. Other characteristics suggested from earlier studies are distance from the underleaf surface to the center of nearest minor vascular bundles (Cohen et al. 1996) and leaf hairiness (Flint and Parks 1990, Norman and Sparks 1997). Leaf hairiness is associated with increased boundary layer humidity on leaf surfaces (Burrage 1971). In the desert southwestern United States with extremely high air temperatures and low relative humidity and limited irrigation, a subtle change in underleaf surface humidity could influence B. tabaci egg and nymph survival.

Of the 17 okra-leaf cultivars in our studies, Siokra L-23 appears to support lower *B. tabaci* infestation compared with other okra-leaf cultivars. Siokra L-23 produced similar lint yields compared with other okra-leaf cultivars and should be examined as source of *B. tabaci* resistance.

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Table 1. Smooth okra- and normal-leaf cotton cultivars studied for susceptibility to colonization by *Bemisia tabaci* at Maricopa, AZ and Holtville, CA, 1996 to 2000

	Leaf type	**Holtville**					**Maricopa**	
Cultivar[a]	**O or N[b]**	**1996**	**1997**	**1998**	**1999**	**2000**	**1999**	**2000**
87031-126	O	X						
89013-114	O	X			X			
89230-244-1028	O			X	X			
89230-341-907	O		X					
91209-194	O				X			
91212-265	O			X				
E0223	O					X		X
E0798	O					X		X
E1028	O					X		X
FiberMax 819	O			X	X	X	X	
FiberMax 832	O			X	X	X	X	
FiberMax 975	O			X				
Siokra I-4	O		X				X	
Siokra I-4/649	O	X						
Siokra L23	O	X	X	X	X	X	X	X
Siokra S-101	O		X					
Siokra V-15	O	X	X					
C118-293	N		X					
CS 50	N	X	X					
DP 20	N	X	X	X	X	X		
DP 50	N	X	X	X	X	X		
DP 90	N	X	X	X	X	X		
DP 20B	N						X	X
DP 50B	N						X	X
DP 90B	N						X	X
DP 5415	N	X	X	X	X	X		
DP 5432	N	X	X	X	X	X		
DP 5461	N	X	X	X	X	X		
DP 5557	N			X	X	X		
DP 9050	N	X						
DP 9057	N	X	X					
DPX 9775	N			X				
HCR 7126	N				X			
HCR 9240	N				X	X		
HCR 9257	N				X	X		
NuCOTN 33B	N	X					X	X
Texas 121	N		X	X				

[a]All smooth okra-leaf cultivars and normal leaf CS 50 were developed in Australia. Other cultivars were developed in U.S.

[b]O and N denote smooth okra- and normal-leaf cultivars, respectively.

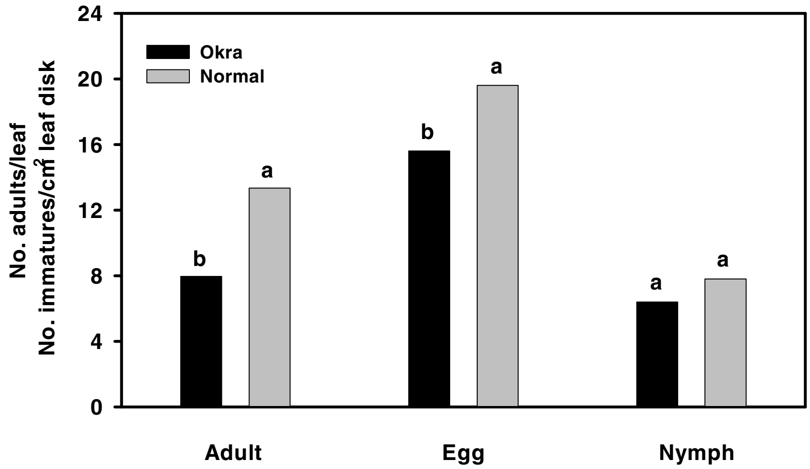

Fig. 1. Comparison of whitefly densities between okra- and normal-leaf upland cottons at Maricopa, AZ in 1999-2000.

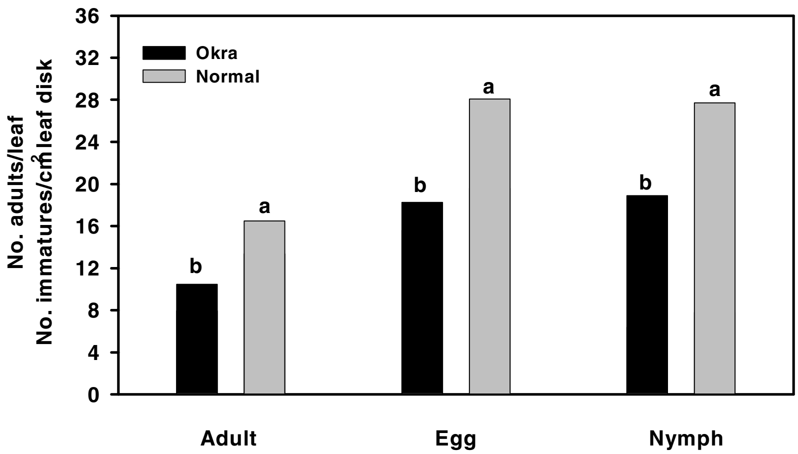

Fig. 2. Comparison of whitefly densities between okra- and normal-leaf upland cottons at Holtville, AZ in 1996-2000.