Preliminary Screening of Different Cottons for Resistance to Sweetpotato Whitefly Infestations

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Abstract

Cotton, Gossypium spp., varying in leaf color (green vs. red), leaf shape (normal vs. okra) and leaf hairs per cm^2 of leaf area were evaluated for sweetpotato whitefly (SPW), Bemisia tabaci (Gennadius) Biotype B preference. Regression analysis showed SPW adults, eggs and nymphs were significantly related to leaf hairiness. Seasonal mean numbers of SPW adults, eggs, and nymphs were high variable within and between leaf color, shape, and hairiness types. Further studies are justified since some of the cottons may be potential sources of SPW resistant germplasm.

Introduction

Sweetpotato whitefly (SPW), *Bemisia tabaci* (Gennadius) Biotype B, causes crop damage from direct feeding and associated yield reductions, contamination of produce and cotton (*Gossypium* spp.) lint with honeydew, and transmission of plant-pathogenic viruses. The 1986 outbreaks in Florida resulted in estimated losses of $140 million in the tomato (*Lycopersicon esculentum* Mill.) industry (Schuster et al. 1996). In 1991, losses for cotton and vegetables in Texas were estimated to be $24 and $29 million, respectively (Riley and Sparks 1993). In southern California, crop losses of over $100 million a year and a reduction in 3,000 agricultural jobs annually were reported from 1992 to 1995 (Birdsall et al. 1995). SPW has also been a serious problem in greenhouse culture throughout the world, with 1991 losses for ornamentals in the United States alone reported to have exceeded $23 million (Barr and Drees 1992).

The number of SPW plant hosts currently listed exceed 500 (Debarro 1995). However, there is great variation in preference and infestations on different hosts. For example, in cotton the hirsute leaf character has been reported by many investigators to result in higher SPW populations than the glabrous leaf types. Some authors (Cohen et al. 1996a) have hypothesized that lamina trichomes of cotton leaves that originate from elongated epidermal cells overlying leaf veins provide cues to first instar crawlers to locate leaf vascular tissue. Access to phloem tissue was postulated as a limiting factor to SPW feeding because of the geometric relationships of the length of the stylet, the abaxial leaf plan, and the distance of vascular tissue from the point of stylet insertion (Cohen et al. 1996b). This has recently been largely discounted (Freeman et al. 2001). Okra-leaf cottons have also been found to support lower SPW populations as compared with normal-leaf plant types. The difference between the two types has been attributed to smaller leaf area and more open canopy for okra leaf plants that provide a less suitable habitat (Chu et al. 2001).

Wilson et al. (1993) evaluated 19 cultivars, germplasm lines, and species accessions of cotton and wild relatives in the field for resistance to SPW. The rate of SPW increase in Arizona wild cotton, *G. thurberi* Todaro, was significantly slower and numbers of SPW eggs and nymphs were significantly lower than for ‘Deltapine 50’ and ‘Stoneville 506’ (*G. hirsutum* L.). No differences in numbers of eggs were observed among the pubescent cotton, the glabrous entries averaged fewer nymphs than moderately pubescent or pubescent, but not fewer than the single highly pubescent entry, *G. raimondii* Ulbrich. The control upland cultivars, three upland germplasm lines, and the single *G. barbadense* L. cultivar 'Pima S-6' wilted, defoliated and opened bolls prematurely because of extreme SPW infestations. In spite of very high numbers of SPWs, none of the other entries except *G. raimondii* showed visible wilting and defoliation.

Meagher et al. (1997) evaluated several *Gossypium* species and genotypes in the field and greenhouse in the Lower Rio Grande Valley, Texas, for preference to the SPW Biotype B. Genotypes within *G. hirsutum*, *G. barbadense*, *G. herbaceum*, and *G. arboretum* were examined, including commercial and obsolete cultivars and modern and diploid genotypes. Results showed that the highest SPW populations occurred on 'Stoneville 453' and the modern genotype 89F46h. The lowest populations were on the obsolete 'Lone Star' and genotypes 88G104 and 'MACAOS'. Greenhouse choice bioassays indicated that several genotypes from *G. hirsutum* had lower egg or nymph numbers than 'Deltapine 50' including Lone Star, Macaos, 88G104, and 89E62. Greenhouse bioassays appeared to provide information comparable to field testing, at least for SPW oviposition. SPW remains an important pest of cotton, vegetable, and ornamentals worldwide. The objectives of our current studies were to screen additional cottons to locate potential sources of resistant germplasm.

Materials and Methods

Fifteen cotton entries were evaluated including four near-isolines of the cultivar 'DES 119': DES 119 N H Ne (Normal leaf, Hairy, Nectaried), DES 119 S Sm ne (Sub-Okra, Smoothleaf, Nectariless) and DES 119 L H Ne (Okra, Hairy, Nectaried) that were obtained from W. Meredith, USDA-ARS, Stoneville, MS; two near-isolines of Texas Marker-1 (TM-1 and TM-1 R_1), from R.J. Kohel, USDA-ARS, College Station, TX; 'Acala 44', 'Sacton Red Acala', 'Acala Okra', 'Acala Red Okra' and 'Super Okra', from A.E. Percival, National *Gossypium* Germplasm Collection, USDA-ARS College Station, TX; 'MACAOS' from P.M. Thaxton, Texas A&M University; 'Deltapine 50' (DPL-50); WC-Red, from the seed increase of a volunteer plant of unknown origin found growing in the field at the Western Cotton Research Laboratory, USDA-ARS, Phoenix, AZ. Also included in the evaluation were 'Pima S-6' and Pima R_1, *G. barbadense* lines from R.G. Percy, USDA-ARS, Maricopa, AZ.

Seeds of the described cottons were planted in peat pots in a greenhouse at Phoenix, AZ. Seedlings were transplanted in the field at Phoenix, AZ on May 5, 2003. Seedlings were spaced 46 cm apart in rows spaced 1.01 m apart. Agronomic practices were standard for the area. Plots were not treated with insecticide. The experimental design was a randomized complete block with four replicates. Each plot consisted of a single row of 10 plants. Cantaloupe, *Cucumis melo* L. var. *cantalupensis* was planted in alternate rows in the field to encourage the development of SPW populations.

SPW data obtained were numbers of adults, eggs and immature forms. Sampling dates were 4, 11, 18 and 25 August and 2 and 8 September, 2003. At each sampling date, leaves per plot were harvested, one per plant from the fifth node below the plant apex. Adults were sampled using the turn-leaf method of Naranjo and Flint (1994) and eggs and nymphs using the leaf disk method of Naranjo and Flint (1995). The numbers of eggs and nymphs were counted with the aid of a dissecting microscope. Leaf hairs were also counted on the disks and expressed as number per cm^2.

Regression analyses were used to evaluate SPW adult, egg, and nymph relationships to numbers of leaf hairs per cm^2 of leaf disk. Data were also analyzed using ANOVA and means separated using the method of least significant differences following a significant F test ($P \leq 0.05$).

Results

Seasonal mean numbers of SPW adults per leaf and eggs and nymphs per cm^2 of leaf disk were significantly related to the numbers of leaf hairs per cm^2 of sampled leaves (r^2 = 0.32, 0.54, and 0.41, respectively, ($P \leq 0.05$). DPL 50, Sacton Red Acala and MACAOS had the fewest numbers of leaf hairs compared with other plant entries. For green normal leaf cottons, DES 119 N H Ne was significantly more hairy than TM-1 and Acala 44 and Acala 44 had significantly fewer leaf hairs than DES 119 L H Ne or Acala Okra leaf. For red normal leaf cotton, TM-1 R_1 had fewer hairs than WC-Red cotton. Acala Red Okra had significantly more hairs than MACAOS and Super Okra. Pima S-6 green normal leaf had significantly higher numbers of hairs compared with Pima R_1 red normal leaf cotton.

Numbers of adults per green normal leaf Acala 44 and DPL 50, DES 119 L H Ne, Acala Red Okra, MACAOS red okra leaf, and Pima R_1 red leaf were not significantly different but had fewer adults compaired with green normal leaf TM-1, green normal leaf DES 119 N H Ne, green leaf color Acala Okra, normal leaf TM-1 R_1 and green normal leaf Pima S-6. SPW egg and nymph populations followed similar patterns of differences with regards to leaf color, shape and hairiness with only a few exceptions.

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Table 1. Seasonal mean number sweetpotato whitefly adults, eggs or nymphs on leaf samples from different cottons varying in leaf color, shape, and hairiness.

Test Entry[1/]	Leaf[2/]			Sweetpotato Whitefly		
	Color	Shape	Hairs/cm^2	Adults	Eggs	Nymphs
Gossypium hirsutum						
TM-1	G	N	34.88 e	4.82 b	1.38 b	0.77 c
Acala 44	G	N	18.69 f	1.58 d-f	0.41 cd	0.32 de
DPL 50	G	N	1.73 g	1.93 ed	0.15 d	0.22 de
DES 119	G	N	80.77 a	6.38 a	3.60 a	2.23 a
DES 119 okra leaf	G	O	37.51 de	1.04 d-f	0.35 cd	0.25 de
Super okra	G	O	17.00 f	0.38 ef	0.12 d	0.09 e
DES 119 Sm Ne	G	SO	13.69 f	1.36 d-f	0.27 cd	0.17 de
Acala okra	G	SO	57.02 c	3.23 c	1.76 b	0.99 c
TM-IRI	R	N	43.47 d	1.71 c-e	0.73 c	0.41 d
Sacton red Acala	R	N	1.84 g	0.12 f	0.904 d	0.08 e
WC-red	R	N	72.64 b	1.19 d-f	0.52 cd	0.20 de
Acala red okra	R	O	37.70 de	0.49 d-f	0.13 d	0.11 e
Macaos	R	O	5.22 g	0.38 ef	0.05 d	0.08 e
G. barbadense						
Pima S6	G	N	51.09 c	6.05 ab	1.80 b	1.72 b
Pima R1	R	N	33.22 e	1.39 d-f	0.23 cd	0.20 de
F; df = 14,41	-	-	102.90	14.17	23.39	39.45

[1/] Means of 4 replications on each of 6 sampling dates in a column not followed by the same letter are significantly different. Method of least significant differences $P \leq 0.05$.

[2/] Color; G = green, R = red

Shape; N = normal, SO = super okra, O = okra