EVALUATION OF PEANUT BREEDING LINES FOR RESISTANCE TO SILVERLEAF WHITEFLY (HOMOPTERA: ALEYRODIDAE)

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ABSTRACT

Silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring, n. sp., is a new and occasionally damaging pest of peanut, *Arachis hypogaea* L., in Florida and other southern states. In 1992 and 1993, elite germplasm from the peanut breeding program at the University of Florida and several commercial cultivars were evaluated for resistance to silverleaf whitefly. In 1992, 52 genotypes that were chosen based on their performance in previous trials were evaluated. Numbers of whitefly red-eyed nymphs on peanut genotypes differed significantly. However, only two genotypes supported fewer whiteflies (although not significantly) than the cultivar 'Southern Runner'. In 1993, we evaluated selections of crosses between Florida parent material (81206 and 567A) and a North Carolina parent (GP-NC343) with multi-insect resistance. All selections tested had higher numbers of whitefly eggs and red-eyed nymphs than either 'Florunner' or 'Southern Runner'. No resistance to silverleaf whitefly was found in the peanut germplasm tested.

Key Words: Plant resistance, *Arachis hypogaea*, *Bemisia argentifolii*, pest management

RESUMEN

La mosco blanca, *Bemisia argentifolii* Bellows & Perring, n. sp., es una nueva plaga que ocasionalmente daña el maní, *Arachis hypogaea* L., en la Florida y otros estados del sur. En 1992 y 1993, la resistencia a la mosca blanca fue evaluada en germoplasma élite del programa de propagación de maní de la Universidad de la Florida y en varios cultivares comerciales. En 1992, fueron evaluados 52 genotipos escogidos sobre la base de su comportamiento en pruebas previas. El número de ninfas en estado de ojos rojos sobre los genotipos de maní difirió significativamente. Sin embargo, solamente dos genotipos sportaron menos moscas blancas que el cultivar "Southern Runner". En 1993, evaluamos selecciones de cruces entre material parental de Florida (81206 y 567A) y de Carolina del Norte (GP-NC343) con resistencia a múltiples insectos. Todas las selecciones probadas tuvieron mayor número de huevos de mosca blanca y ninfas en estado de ojos rojos que "Florunner" y "Southern Runner". No se encontró resistencia a la mosca blanca en el germoplasma de maní probado.

The silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring [previously known as B strain of the sweetpotato whitefly, *Bemisia tabaci* (Gennadius)], has become a key pest of many agronomic, ornamental and vegetable crops since its first appearance in 1986 in Florida greenhouses (Price et al. 1987). *B. argentifolii* differs from *B. tabaci*, present in Florida since at least 1897 (Quaintance 1900), in host range (Byrne & Miller 1990), virus transmission capabilities, biology (Bethke et al. 1991, Costa & Brown 1991), production of honeydew (Byrne & Miller 1990), and insecticide resistance (Prabhaker et al. 1985). This whitefly caused at least $500,000,000 in losses to the agricultural community in 1991 alone (Perring et al. 1993). The damage produced by the whitefly includes plant debilitation due to feeding by immature stages and adults, product contamination with honeydew and resulting sooty mold, transmission of plant-pathogenic viruses and induction of physiological disorders.

Peanut, *Arachis hypogaea* L., is one of the new host plants infested by the silverleaf whitefly. Whiteflies were observed feeding in large numbers on peanut in northern Florida in 1988 and 1989, and many growers resorted to weekly applications of broad spectrum insecticides in an attempt to reduce populations (F.A.J., unpublished data). Despite heavy use of insecticides, some growers attributed yield losses of 459.5 kg per ha (2,500 lb per acre) to this whitefly (Leidner 1991).

In 1991, we initiated a search for resistance to silverleaf whitefly among common cultivars and breeding lines from the University of Florida peanut breeding program. Field trials in Georgia indicated that 'Southern Runner' appeared to be more resistant than 'Florunner' (Lynch & Chamberlin 1993); however, we found no significant differences among these cultivars and another four cultivars commonly grown in Florida (McAuslane et al. 1994). We screened 150 breeding lines and cultivars in 1991, and chose 52 of those with low whitefly infestations for further evaluation in 1992. This paper presents the results of the 1992 evaluation, and a 1993 test of several breeding lines incorporating North Carolina germplasm containing multi-insect resistance. The North Carolinan germplasm (GP-NC343) was originally released for resistance to southern corn rootworm, *Diabrotica undecimpunctata howardi* Barber (Campbell et al. 1971). Later field research revealed that crosses incorporating GP-NC343 were resistant to thrips, leafhoppers, and defoliators (Campbell et al. 1987).

MATERIALS AND METHODS

Tests-1992. On 29 June, 52 peanut selections (42 elite breeding lines and 10 released cultivars) were planted in a 0.3-ha field on the campus of the University of Florida, Gainesville, Alachua County. Plots were single rows, 6.1 m in length, spaced by 90 cm, and were replicated four times in a randomized complete block design. *Bacillus thuringiensis* [Dipel 2X, Abbott Laboratories, North Chicago, IL, (1.12 kg formulation per ha)] was applied on 18 and 23 September, and 9 October for control of lepidopterous defoliators. Chlorothalonil [Bravo 720, ISK Biotech Corp., Mentor, OH, (1.18 kg AI per ha)] was applied on 13 and 25 August, 11 and 23 September, and 9 and 27 October for control of early leaf spot, *Cercospora arachidicola* Hori, and late leafspot, *Cercosporidium personatum* Berk & Curt Deighton.

Plots were sampled at 10-d intervals from 6 August until 4 November by selecting 10 leaflets per plot. Leaflets were chosen from the fourth fully expanded leaf (any one of the four leaflets in the tetrafoliolate) below the terminal leaf on lateral branches. Previous research indicated that the greatest densities of red-eyed nymphs occurred in this region of the plant canopy (McAuslane et al. 1993). Leaflets were transported to the laboratory in a cooler, then refrigerated until immature whiteflies could be counted (48 h maximum). Red-eyed nymphs were counted on the bottom surface of each leaflet under 12x magnification. We measured the areas of leaflets sampled on 26 October using a leaf area meter (LI-COR, Model 3000, Lincoln, NE). Counts were standardized based on leaflet surface area. All data were converted to numbers of red-eyed nymphs per 5 cm^2 (= approximate area of one leaflet).

Tests-1993. On 3 June, seven pedigreed breeding lines (three produced by crossing 81206 with GP-NC343 and four produced by crossing 567A with GP-NC343), the parent with multi-insect resistance (GP-NC343), and two commercial cultivars ('Florunner' and 'Southern Runner') were planted in the same field that was used in 1992. Plots were two rows wide (row spacing of 90 cm) and 6.1 m long, and were replicated four times in a randomized complete block design. *Bacillus thuringiensis* and chlorothalonil, at the same rates as in 1992, were applied on 16 and 26 July, 6 and 26 August, and 20 September.

Plots were sampled as in 1992 at 10-d intervals from 15 July until 4 October, except that whitefly eggs and red-eyed nymphs were counted on the top and bottom surfaces of 20 leaflets per plot. The areas of leaflets sampled on 4 August and 23 September were measured using a leaf area meter. All data were converted to number of whitefly stages per 5 cm^2. Leaflet areas recorded on 4 August were used to convert whitefly counts obtained on the first five sample dates, and areas recorded on 23 September were used to convert counts on the last four dates.

Data were analyzed using the GLM procedure (SAS Institute 1987). Prior to analysis, count data were square root (x+1)-transformed to correct for nonnormality of the data and proportion data were arcsin (x)-transformed to correct for nonhomogeneity of variance. Means were separated using least significant differences at a significance level of 5% (SAS Institute, 1987). Untransformed means are presented in all tables and figures.

RESULTS AND DISCUSSION

Tests-1992. Numbers of red-eyed nymphs counted on the lower surfaces of leaflets differed significantly among genotypes (F = 1.57; df = 51, 153; $0.01 < P < 0.05$). When genotypes were analyzed by date, they differed significantly on four of ten dates (4, 15, and 25 September and 15 October; F = 1.51; df = 51, 153) (Fig. 1). When genotypes were ranked by season-long infestation, F1138 (0.031 ± 0.011 red-eyed nymphs per 5 cm² leaflet surface) and F1084 (0.044 ± 0.015) were least infested, and 87118 was most infested (0.220 ± 0.042). In an adjacent test [(McAuslane et al. 1994)], 'Southern Runner' was also infested with very low numbers of red-eyed nymphs (0.049 ± 0.009). This adjacent cultivar experiment was treated and sampled in the same manner as the genotype trial. Although whitefly numbers on 'Southern Runner' cannot be compared statistically to numbers of whiteflies on the genotypes in this study, the data indicate that, under these infestation levels, no University of Florida genotypes were more resistant than cultivars already commonly grown in Florida. Up to 80% of whiteflies on the genotypes were parasitized by the end of the season (data not shown). Parasitism may have contributed to the low whitefly infestations observed in this trial.

Tests-1993. Date was a significant source of variability in numbers of eggs (F = 12.54; df = 8, 240; $P < 0.01$) and red-eyed nymphs (F = 10.58; df = 8, 240; $P < 0.01$). There were no interactions between date and cultivar. Genotype significantly influenced number of eggs (F = 20.14; df = 9, 27; $P < 0.01$) and red-eyed nymphs (F = 3.44; df = 9, 27; $P < 0.01$). GP-NC343 and all breeding lines except F1384 supported more whitefly eggs than either 'Florunner' or 'Southern Runner' (Table 1). However, only F1436, F1435 and GP-NC343 supported significantly more red-eyed nymphs than the two cultivars (Table 1). Numbers of eggs on genotypes differed significantly on all dates except the first and the last, while red-eyed nymph counts differed significantly on only four dates (13 and 24 August, and 3 and 23 September) (Fig. 2). Crosses between 81206 and GP-NC343 were significantly more infested with eggs than were crosses between 567A and GP-NC343. Cultivar 81206 is late-maturing and produces new vegetation throughout the season while 567A, which is early-maturing and more determinant, slows vegetative growth at the end of the season. (The presence of suc-

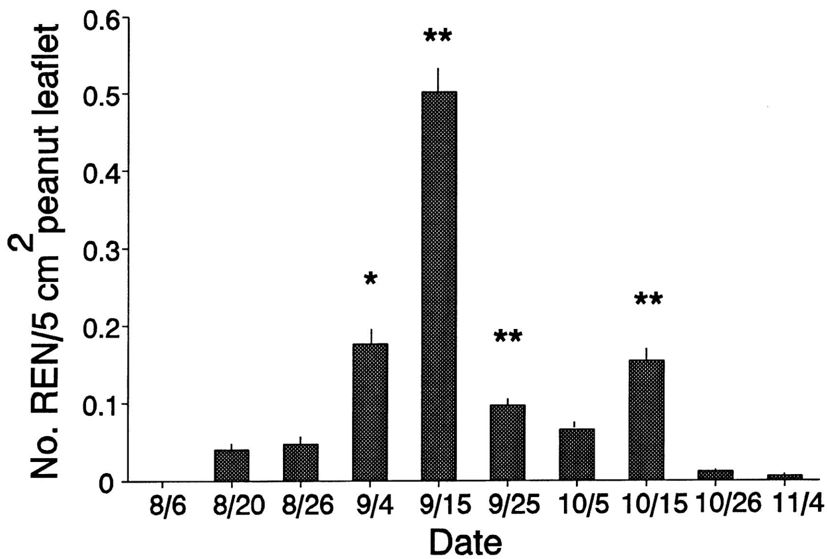

Fig. 1. Average number of red-eyed nymphs per peanut leaflet in Gainesville, FL, 1992. Counts were made on the lower surfaces of leaflets and data from all peanut selections were combined. Asterisks indicate dates on which counts differed significantly among genotypes (***** = 0.01 < P < 0.05, ****** = P < 0.01). Error bars are one standard error of the mean.

TABLE 1. AVERAGE NUMBER OF SILVERLEAF WHITEFLY EGGS AND RED-EYED NYMPHS (REN) PER PEANUT LEAFLET (STANDARDIZED 5 CM^2 AREA) IN GAINESVILLE, FL, 1993.

Accession Number	Parentage	Pedigree/Cultivar	Mean ± SEM[1]	
			Eggs	REN
F1437	81206xGP-NC343	8815B-4-2-2-3-B	2.67 ± 0.18a	0.16 ± 0.02bc
F1436	81206xGP-NC343	8815B-4-2-2-1-B	2.10 ± 0.12b	0.21 ± 0.02ab
F1435	81206xGP-NC343	8815B-3-2-1-1-b3	1.90 ± 0.10b	0.25 ± 0.03a
F1386	567AxGP-NC343	8816B-Bx4-TV-5-b3	1.54 ± 0.11c	0.12 ± 0.01cd
		GP-NC343	1.36 ± 0.08c	0.22 ± 0.02a
F1383	567AxGP-NC343	8816B-Bx4-RV-1-b2	1.36 ± 0.08c	0.13 ± 0.02cd
F1385	567AxGP-NC343	8816B-Bx4-TV-3-b3	1.26 ± 0.07cd	0.13 ± 0.02cd
F1384	567AxGP-NC343	8816B-Bx4-TV-1-b3	1.15 ± 0.08de	0.10 ± 0.02d
		'Florunner'	1.12 ± 0.07e	0.13 ± 0.02cd
		'Southern Runner'	1.07 ± 0.06e	0.14 ± 0.02cd

[1]Numbers within a column followed by the same letter did not differ significantly at $\alpha = 0.05$ (least significant difference test on square root [x + 1] transformed data).

culent new growth may have induced ovipositing whiteflies to lay eggs preferentially on the crosses incorporating 81206 germplasm.

In 1993, whitefly lifestages were counted on both surfaces of the peanut leaflet. McAuslane et al. (1993) found that up to 35% of whitefly red-eyed nymphs may occur on the top surface of peanut leaflets. Lynch & Simmons (1993) reported that the proportion of whitefly immature stages on top and bottom surfaces of 'Florunner' leaves changed over the course of sampling, with whiteflies becoming more common on the upper surface of leaflets at the end of the sample period. In this study, the distribution of eggs between top and bottom leaflet surfaces differed significantly among dates ($F = 23.55$; df = 8, 240; $P < 0.01$), and among cultivars ($F = 9.45$; df = 9, 27; $P < 0.01$), ranging from 76% of eggs on the bottom surface of F1435 leaflets to only 59% on the bottom surface of F1383. There was no date by cultivar interaction for either eggs or red-eyed nymphs. The distribution of red-eyed nymphs between top and bottom surfaces differed among dates ($F = 2.75$; df = 7, 133; $0.01 < P < 0.05$), but not among cultivars ($F = 1.62$; df = 9, 27; $P > 0.05$), averaging 61.3% on the bottom leaflet surface. Distribution of eggs and red-eyed nymphs between top and bottom leaflet surfaces followed a similar trend. Whiteflies were more common on the bottom surface of leaflets early in the season but were about equally abundant on top and bottom surfaces at the end of the sampling period. These results are similar to the findings of Lynch & Simmons (1993).

Three years of sampling silverleaf whitefly on peanut genotypes held by the University of Florida yielded no resistant germplasm. The germplasm evaluated represented an extensive cross-section of all four market types (runner, valencia, Spanish and virginia), and included a wide range of parent material. Many lines tested had multiple insect resistance (*e.g.*, NC-GP343), and multiple pest resistance (*e.g.*, 81206 lines have broad disease and nematode resistance). Under the infestation conditions experienced in 1992 and 1993, the cultivars commonly grown in Florida were more re-

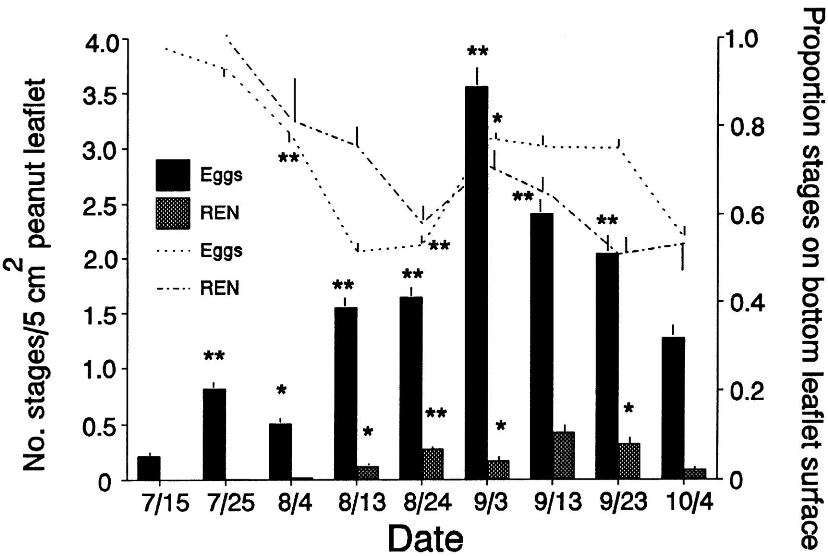

Fig. 2. Average number of eggs and red-eyed nymphs per peanut leaflet (bars) and proportion of each stage occurring on the bottom leaflet surface (lines) in Gainesville, FL, 1993. Whiteflies were counted on upper and lower surfaces of each leaflet, and data from all peanut selections were combined. Asterisks indicate dates on which counts differed significantly among genotypes (* = $0.01 < P < 0.05$; ** = $P < 0.01$). Error bars are one standard error of the mean.

sistant than were the genotypes tested. These data indicate that breeding for peanut resistance to silverleaf whitefly is likely to be difficult, and that alternative management strategies should be emphasized. Previous research (McAuslane et al. 1993, 1994) has indicated that native aphelinid parasitoids contribute heavily to whitefly mortality in peanut fields when *Bacillus thuringiensis* is the only insecticide used. Management of silverleaf whitefly in Florida peanuts may depend on cultural practices (such as early planting or trap cropping), and on conservation of populations of natural enemies by avoiding the use of broad spectrum insecticides.

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