ADULT ATTRACTIVENESS AND OVIPOSITION PREFERENCE OF *Bemisia tabaci* (GENN.) (Homoptera: Aleyrodidae) B-BIOTYPE IN COTTON GENOTYPES

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ABSTRACT: The silverleaf whitefly *Bemisia tabaci* B-biotype is an important pest of cotton; it affects plant vigour, transmits geminivirus and reduces lint quality. In order to evaluate the resistance of cotton genotypes, *Gossypium hirsutum* (L.), to the whitefly *Bemisia tabaci* B-biotype, both free-choice and no-choice attractiveness and non-preference for oviposition tests were carried out in a shade house, at room temperature. Low attractiveness to adults of this whitefly was observed for plants of genotypes Fabrika, CNPA Ita 90, Makina, Coodetec 407, and IAC 01-639 CPA 02-24, which may represent a resistance component of these genetic materials to the insect. Genotypes BRS Aroeira, Coodetec 406, Fabrika, and Coodetec 401 presented the non-preference-for-oviposition type of resistance in the free-choice and no-choice tests. The numbers of trichomes and gossypol glands per cm^2 were not suitable to evaluate non-preference for oviposition of whitefly adults on cotton genotypes.
Keywords: *Gossypium hirsutum* L., Aleyrodidae, insecta, silverleaf whitefly, host plant resistance

ATRATIVIDADE DE ADULTOS E PREFERÊNCIA PARA OVIPOSIÇÃO DE *Bemisia tabaci* (GENN.) (Homoptera: Aleyrodidae) BIÓTIPO B EM GENÓTIPOS DE ALGODOEIRO

RESUMO: Considerada importante praga do algodoeiro, a mosca-branca *Bemisia tabaci* biótipo B pode através de sua alimentação, diminuir o vigor das plantas, trasmitir vírus e prejudicar a qualidade da fibra. Visando avaliar a resistência de genótipos de algodoeiro, *Gossypium hirsutum* (L.), à mosca-branca *Bemisia tabaci* biótipo B, realizaram-se testes de atratividade e não-preferência para oviposição, com e sem chance de escolha, em telado, a temperatura ambiente. Verificou-se baixa atratividade das plantas dos genótipos Fabrika, CNPA Ita 90, Makina, Coodetec 407 e IAC 01-639 CPA 02-24 a adultos dessa mosca-branca, o que pode representar um componente de resistência destes materiais genéticos ao inseto. Os genótipos BRS Aroeira, Coodetec 406, Fabrika e Coodetec 401 apresentaram resistência do tipo não-preferência para oviposição, nos testes com e sem chance de escolha. Os números de tricomas e de glândulas de gossipol por cm^2 não foram adequados para se avaliar a não-preferência para oviposição de adultos da mosca-branca em genótipos de algodoeiro.
Palavras-chave: *Gossypium hirsutum* L., Aleyrodidae, insecta, mosca-branca, resistência de plantas a insetos

INTRODUCTION

For the control of the whitefly *Bemisia tabaci* (Genn.) B-biotype, plant resistance should be used as an additional control tactic within the integrated pest management strategy in order to minimize the damages caused by this insect (Norman Jr. et al., 1996). Such resistance can be characterized by the occurrence of plant morphological and/or physiological traits that make them less or more preferred for feeding and oviposition by the insects. Among the morphological traits, trichome density (McAuslane, 1996) and plant architecture can be underlined as important (Sippel et al., 1987). Also leaf pubescence in cotton has been reported as a very important morphological trait for oviposition preference. This trait was studied by Butler Jr. & Henneberry (1984), who verified that the number of *B. tabaci* adults on glabrous-leaved cotton genotypes was smaller than in semi-glabrous or pubescent plants.

With regard to the presence of chemical substances, the concentration of gossypol (Butter et al., 1990), sugars, tannin, o-dihydroxyphenol (Butter et al., 1990), as well as plant nutrition (Bentz et al., 1995) have been highlighted as the most important biochemical characteristics. Gossypol glands on the internodes favor *B. tabaci* populations, while their occurrence on the leaf area is considered detrimental (Butter & Vir, 1989).

Considering the lack of data about effective control methods and the importance of *B. tabaci* B-biotype in cotton, we attempted to study the attractiveness and non-preference for oviposition of this whitefly for cotton genotypes as mechanisms involved in the resistance.

MATERIAL AND METHODS

The experiments were carried out in a shade house at room temperature. Attractiveness/repellency and non-preference for oviposition of the whitefly were evaluated for the following cotton genotypes PR 94-227-918, IAC 01-639 CPA 02-24, CNPA Ita 90, IAC-23, Coodetec 406, BRS Aroeira, MG 405, Fabrika, BRS Ipê, Fibermax 986, Coodetec 407, IAC-24, Makina, IAC 20-233, Shrow Grow 618, Coodetec 401, Delta Opal, CNPA Acala I, IAC-22, and BRS Itaúba.

Whitefly rearing - Adults were acquired from colonies in Campinas, São Paulo State, Brazil, previously identified as *B. tabaci* B-biotype by silvering induction in pumpkin leaves. The insects were multiplied (stock rearing) in a shade house, on cabbage (*Brassica oleraceae* var. *capitata*) and drunkard's dream plants (*Euphorbia pulcherrima* Willd). New plants were introduced every fifteen days to replace old plants already weakened by the high whitefly population present during rearing.

Attractiveness test - A split-plot design was used, with plots arranged in randomized blocks, in which the 20 genotypes represented treatments, with six replicates. Twenty-day-old cotton plants were submitted to artificial infestation with 100 non-sexed *B. tabaci* B-biotype adults per plant. Adult whitefly counts per genotype were determined 24, 48, and 72 hours after infestation. These counts were performed at sunset, on the underside of the first completely developed leaf from the apex, when the adults showed little mobility.

Non-Preference for oviposition tests - A randomized block design with 20 treatments and six replicates was used in the free-choice and no-choice tests. Twenty-day-old cotton plants were submitted to artificial infestation with 100 non-sexed *B. tabaci* B-biotype adults per plant. In the no-choice test, a cylindrical iron cage, measuring 0.40 m in diameter by 0.60 m in height was used in each pot; the cage was wrapped with voile fabric to protect the plant before the release of whitefly adults. The first completely developed leaf from the apex of each plant was collected three days after infestation. Upon identification, the leaves were taken to the laboratory to count the number of eggs per cm^2. A $1cm^2$ template and a stereoscopic microscope were used to count the eggs. The trichome and gossypol gland densities per cm^2 on the abaxial surface were also evaluated in the free-choice test.

The values obtained for each variable were submitted to analysis of variance and test F. When significant, the means were compared by Tukey test, at 5%.

RESULTS AND DISCUSSION

Attractiveness test - No differences were observed among the cotton genotypes evaluated with regard to the mean number of *B. tabaci* B-biotype adults during each evaluation period (F = 0.99^{ns}); (Table 1). One day after infestation, the number of whiteflies in the genotypes varied from 4.5 to 55.8 adults per plant. In this period, the genotypes CNPA Acala I and IAC 20-233 had higher number of adults than 50, while Coodetec 407 attracted less than 5. The variation in number of whiteflies per plant among cotton genotypes (10 to 58.8 and 5.3 to 82.2 adults per plant), observed two and three days after infestation, respectively, indicates that factors of a morphological and/or chemical nature present in the plants accounted for greater or smaller whitefly attractiveness.

A higher number of adults was found in CNPA Acala I, while IAC 01-639 CPA 02-24, Coodetec 407, Shrow Grow 618, and Makina had less. Differences among cotton genotypes were observed for the mean number of *B. tabaci* B-biotype adults during the three evaluation periods (F=3.03**). Genotype CNPA Acala I proved to be the most attractive, and genotypes Fabrika, CNPA Ita 90, Makina, Coodetec 407, and IAC 01-639 CPA 02-24 were the least attractive. When the means for the adult populations at 24, 48, and 72 h are compared in the horizontal direction (Table 1), they underwent non-significant variation, indicating that the plant/adult whitefly relationships during the evaluations did not interfere with the attractiveness test results.

The selection of more suitable plants for feeding and oviposition by *B. tabaci* (Van Lenteren & Noldus, 1990) is conditioned by visual (Prokopy & Owens, 1983), olfactive (Visser, 1988; Van Lenteren & Noldus, 1990); taste (Stadler, 1986); shape and

Table 1 - Mean (± SE) number *Bemisia tabaci* B-biotype adults for 20 cotton genotypes, 24, 48, and 72 hours after infestation, in a free-choice test. Jaboticabal-SP, 2004.

Genotype	Evaluation period (hours)			Mean
	24	48	72	
CNPA Acala I	55.8 ± 15.92	58.8 ± 17.92	82.2 ± 24.47	65.6 a
MG 405	49.8 ± 16.17	57.5 ± 12.33	38.8 ± 16.40	48.7 ab
Coodetec 401	36.3 ± 3.04	38.7 ± 9.85	43.5 ± 12.80	39.5 ab
IAC 20-233	51.5 ± 19.73	35.7 ± 9.28	28.7 ± 12.15	38.6 ab
IAC-22	38.0 ± 5.50	31.0 ± 5.39	38.8 ± 17.33	35.9 ab
BRS Ipê	21.5 ± 4.75	39.8 ± 16.43	39.8 ± 14.68	33.7 ab
BRS Aroeira	24.0 ± 6.89	30.2 ± 11.67	30.7 ± 7.10	28.3 ab
PR 94-227-918	26.8 ± 12.37	27.7 ± 13.41	32.2 ± 12.75	28.9 ab
BRS Itaúba	21.0 ± 9.20	22.2 ± 9.84	21.0 ± 9.28	21.4 ab
Delta Opal	17.8 ± 5.82	29.2 ± 9.84	12.3 ± 4.30	19.8 ab
IAC-23	9.5 ± 2.23	25.2 ± 11.47	23.8 ± 6.80	19.5 ab
Coodetec 406	11.7 ± 5.52	25.5 ± 10.34	13.5 ± 5.12	16.9 ab
IAC-24	19.2 ± 5.59	10.2 ± 3.05	15.2 ± 6.78	14.8 ab
Fibermax 966	20.2 ± 8.36	13.2 ± 3.17	10.7 ± 4.54	14.7 ab
Shrow Grow 618	15.7 ± 5.43	13.7 ± 2.81	9.5 ± 2.95	12.9 ab
Fabrika	7.8 ± 2.18	10.7 ± 2.97	24.8 ± 11.98	14.4 b
CNPA Ita 90	30.7 ± 25.97	12.8 ± 9.67	10.0 ± 2.38	17.8 b
Makina	13.2 ± 5.47	10.0 ± 3.06	11.0 ± 3.71	11.4 b
Coodetec 407	4.5 ± 1.06	15.7 ± 8.49	10.7 ± 3.74	10.3 b
IAC 01-639 CPA 02-24	7.7 ± 1.80	10.3 ± 3.76	5.3 ± 1.20	7.8 b
Mean	24.1 A	25.9 A	25.1 A	
F (treatment)				3.03^{**}
F (hours)				0.44^{NS}
F (treatment × hours)				0.99^{NS}
CV (treatment) (%)				72.26
CV (hours) (%)				33.58

SE = Standard error of the mean; Original and analysis data were transformed to $(x + 0.50)^{1/2}$ for ANOVA; Means followed by the same letter do not differ by Tukey test, (P = 0.05). **denotes the F value is significantly at P = 0.01.

structural (Van Lenteren & Noldus, 1990); and leaf-color stimuli (Husain & Trehan, 1940; Mau & Kessing, 2002) in addition to their quality, chemical makeup and age (Walker & Perring, 1994). In this respect, Chu et al. (1995) believe that preference for oviposition sites by *B. tabaci* B-biotype in cotton plants is influenced by gravity, light, and their interactions with the leaf structure, as well as by environmental conditions and natural enemies.

Non-Preference for oviposition tests - In the free-choice test (Table 2), higher quantities of eggs per cm^2 (F=6.96**) were observed for genotypes IAC-23, Coodetec 407, Shrow Grow 618, and CNPA Acala I, and lower quantities were observed for IAC-24, BRS Ipê, Fabrika, Coodetec 406, and BRS Aroeira. Trichome density of genotype Coodetec 401 was higher than those observed for the other evaluated genotypes. CNPA Acala I, IAC 20-233, and BRS Aroeira were more pubescent, while IAC-23, Coodetec 407, Makina, CNPA Ita 90, BRS Itaúba, Delta Opal, Fibermax 966, IAC-24, BRS Ipê, Fabrika, and Coodetec 406 were glabrous. The results for Makina, CNPA Ita 90, Fabrika, Delta Opal, and BRS Itaúba, without trichomes, and for Coodetec 401, pubescent, were coincident with those found by Campos (2003) in an investigation developed in Ilha Solteira-SP, Brazil, while genotypes IAC-23, BRS Aroeira, BRS Ipê, and IAC-22 presented differences with regard to number of trichomes per cm^2. This variation in number of trichomes per cm^2 from place to place may be influenced by the environmental conditions, such as moisture, light, temperature, and soil characteristics (Lara, 1991).

Table 2 - Mean (± SE) number of *Bemisia tabaci* B-biotype eggs, mean number of trichomes, and mean number of gossypol glands for 20 cotton (*G. hirsutum*) genotypes, in a free-choice test. Jaboticabal-SP, 2004.

Genotype	Eggs cm^{-2}	Trichomes cm^{-2}	Gossypol Glands cm^{-2}
IAC-23	57.1 ± 8.19 a	0.0 ± 0.00 f	128.0 ± 5.13 ab
Coodetec 407	49.8 ± 6.90 ab	0.0 ± 0.00 f	104.5 ± 6.45 bcdef
Shrow Grow 618	49.2 ± 5.63 ab	15.0 ± 3.31 de	136.8 ± 3.10 a
CNPA Acala I	49.3 ± 9.81 abc	44.2 ± 9.21 b	99.8 ± 4.90 bcdef
Makina	38.8 ± 6.52 abcd	0.0 ± 0.00 f	89.2 ± 4.51 def
IAC 20-233	37.3 ± 5.82 abcd	40.2 ± 6.31 bc	111.8 ± 3.53 abcd
PR 94-227-918	33.4 ± 3.36 abcd	7.3 ± 2.40 e	92.8 ± 5.85 def
IAC 01-639 CPA 02-24	30.8 ± 3.54 abcd	0.2 ± 0.17 f	78.0 ± 5.41 f
CNPA Ita 90	27.5 ± 4.81 abcde	0.0 ± 0.00 f	100.8 ± 6.27 bcdef
BRS Itaúba	26.5 ± 7.09 bcde	0.0 ± 0.00 f	106.5 ± 6.06 abcde
IAC-22	24.6 ± 9.26 bcde	16.2 ± 2.99 de	80.0 ± 5.89 ef
Delta Opal	24.0 ± 2.76 bcde	0.0 ± 0.00 f	101.0 ± 6.01 bcdef
Fibermax 966	21.9 ± 3.45 bcde	0.5 ± 0.34 f	94.3 ± 5.70 def
MG 405	21.5 ± 2.15 bcde	23.8 ± 3.29 cd	95.0 ± 5.59 cdef
Coodetec 401	19.8 ± 4.49 cde	151.3 ± 8.04 a	127.7 ± 6.10 abcd
IAC-24	16.5 ± 3.88 de	0.0 ± 0.00 f	104.5 ± 6.90 bcdef
BRS Ipê	15.3 ± 1.59 de	0.0 ± 0.00 f	124.8 ± 7.33 abc
Fabrika	14.3 ± 3.56 de	0.0 ± 0.00 f	89.2 ± 1.72 def
Coodetec 406	13.9 ± 2.21 de	0.0 ± 0.00 f	111.0 ± 3.96 abcd
BRS Aroeira	8.8 ± 2.81 e	36.5 ± 5.84 bc	111.3 ± 8.41 abcd
F (treatment)	6.96**	92.86**	7.15**
CV (%)	22.88	27.29	6.70

SE = Standard error of the mean; Original and statistical analysis data were transformed to $(x + 0.50)^{1/2}$ for ANOVA; Means followed by the same letter do not differ by Tukey test (P = 0.05). **denotes the F value is significantly at P = 0.01.

The glabrous genotypes IAC-24, BRS Ipê, Fabrika, and Coodetec 406 showed a small number of eggs, while the pubescent genotype CNPA Acala I a high number. These results were also found by Mound (1962), Butler Jr. & Henneberry (1984), Berlinger (1986), Butter & Vir (1989), Wilson et al. (1993), Toscano et al. (2003), and Campos (2003), who observed a smaller number of eggs in less-pubescent or glabrous genotypes, and a higher number of eggs in pubescent genotypes. However, higher oviposition was verified for genotypes IAC-23 and Coodetec 407, with glabrous leaves; BRS Aroeira, a pubescent-leaved genotype, received little oviposition; and relatively little oviposition was observed for Coodetec 401, a highly pubescent genotype, which suggests that other traits of these genotypes may be influencing the oviposition process.

With reference to gossypol (Table 2), the number of glands ranged from 78.0 per cm^2 for genotype IAC 01-639 CPA 02-24 to 136.8 glands per cm^2 for genotype Shrow Grow. In general, the results do not allow a correlation to be established between number of eggs per cm^2 and number of trichomes per cm^2 (r = 0.09), number of eggs per cm^2 and gossypol glands per cm^2 (r = 0.19), and number of trichomes per cm^2 and gossypol glands per cm^2 (r = 0.11) in the free-choice test. Butter et al. (1990) found a negative correlation (r = - 0.45) between gossypol content and the egg density of *B. tabaci* A-biotype, while Butter & Vir (1989) reported a positive correlation (r = 0.53) between number of *B. tabaci* A-biotype adults and number of gossypol glands on the internodes of the main stem of cotton plants.

In the no-choice oviposition preference test (Table 3), the mean number of eggs/cm^2 for genotypes Shrow Grow 618, Coodetec 401, BRS Aroeira, Coodetec 407, Fabrika, and Coodetec 406 were lower (F=12.77**) than those observed for genotypes CNPA-Acala I and IAC-23. Considering the free-choice and no-choice tests, BRS Aroeira, Coodetec 406, Fabrika, and Coodetec 401 were the least oviposited, indicating the occurrence of non-preference for oviposition in these genotypes, consisting in sources of resistance to this whitefly. In Ilha Solteira-SP, Campos (2003)

Table 3 - Mean (± SE) number of *Bemisia tabaci* B-biotype eggs for 20 cotton (*G. hirsutum*) genotypes in a no-choice test. Jaboticabal-SP, 2004.

Genotypes	Eggs cm^{-2}
CNPA Acala I	20.5 ± 1.91 a
IAC-23	18.5 ± 1.71 ab
BRS Itaúba	16.7 ± 2.00 abc
IAC-24	16.5 ± 2.28 abc
IAC 01-639 CPA 02-24	16.3 ± 3.07 abc
BRS Ipê	16.2 ± 2.18 abc
IAC 20-233	15.8 ± 1.89 abc
Delta Opal	14.8 ± 2.32 abcd
Makina	13.9 ± 1.01 abcde
PR 94-227-918	13.6 ± 2.06 abcde
IAC-22	12.5 ± 1.77 abcdef
MG 405	10.6 ± 1.80 bcdefg
CNPA Ita 90	9.7 ± 2.53 cdefgh
Fibermax 966	9.1 ± 1.34 cdefgh
Coodetec 406	6.9 ± 0.82 defghi
Fabrika	6.3 ± 1.19 efghi
Coodetec 407	5.1 ± 1.00 fghi
BRS Aroeira	4.1 ± 0.80 ghi
Coodetec 401	3.1 ± 0.93 hi
Shrow Grow 618	2.2 ± 0.31 I
F (treatment)	12.77**
CV (%)	18.09

SE = Standard error of the mean; Original and statistical analysis data were transformed to $(x + 0.50)^{1/2}$ for ANOVA; Means followed by the same letter do not differ by Tukey test (P = 0.05). **denotes the F value is significantly at P = 0.01.

found lower *B. tabaci* B-biotype oviposition preference for genotypes BRS Aroeira and Fabrika.

The low attractiveness of plants from genotypes Fabrika, CNPA Ita 90, Makina, Coodetec 407, and IAC 01-639 CPA 02-24 to *B. tabaci* B-biotype may represent a resistance component of these genetic materials to the *B. tabaci* B-biotype whitefly. Genotypes BRS Aroeira, Coodetec 406, Fabrika, and Coodetec 401 presented the non-preference-for-oviposition type of resistance to whitefly in the free-choice and no-choice tests. The numbers of trichomes and gossypol glands per cm^2 were not suitable to evaluate non-preference for oviposition of whitefly adults on cotton genotypes.

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