CROP PROTECTION

Oviposition Preference of *Bemisia tabaci* (Genn.) Biotype B (Homoptera: Aleyrodidae) for Bean Genotypes Containing Arcelin in the Seeds

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Preferência para Oviposição de *Bemisia tabaci* (Genn.) Biótipo B (Homoptera: Aleyrodidae) por Genótipos de Feijoeiros Portadores de Arcelina nas Sementes

RESUMO – Genótipos de feijoeiro (*P. vulgaris*) que contêm arcelina em suas sementes foram avaliados quanto à preferência para oviposição de *Bemisia tabaci* biótipo B (Homoptera: Aleyrodidae). Os testes foram conduzidos em condições de estufa, nas épocas “das águas” e “da seca”, em dois anos consecutivos, com os seguintes genótipos: ARC 3s, ARC 5s (genótipos selvagens portadores de arcelina); ARC 1, ARC 2, ARC 3, ARC 4 (linhagens quase-isogênicas portadoras de arcelina - EMBRAPA), Porrillo 70, Bolinha e IAPAR MD 808 (cultivares sem arcelina). Nos ensaios de preferência para oviposição, em teste com e sem chance de escolha, observou-se que os genótipos Bolinha e Porrillo 70 foram os mais preferidos para oviposição pelo inseto. A suscetibilidade do genótipo Bolinha pode estar relacionada com o grande número de tricomas aciculares presentes em suas folhas. Os genótipos selvagens, ARC 5s e ARC 3s, apresentaram resistência do tipo não-preferência para oviposição. Esta resistência não está relacionada com a arcelina, uma vez que os genótipos melhorados também contêm arcelina em suas sementes e não mostraram-se resistentes a esse biótipo de *B. tabaci*.

PALAVRAS-CHAVE: Insecta, *Phaseolus vulgaris*, mosca branca, antixenose, tricomas.

ABSTRACT - The oviposition preference of *Bemisia tabaci* biotype B (Homoptera: Aleyrodidae) for bean (*Phaseolus vulgaris* L.) genotypes containing arcelin in the seeds was evaluated. The tests were carried out under greenhouse conditions, in the dry and wet seasons, with the following genotypes: ARC 3s, ARC 5s (wild genotypes containing arcelin in the seeds); ARC 1, ARC 2, ARC 3, ARC 4 (near isogenic lines containing arcelin in the seeds - EMBRAPA) and Porrillo 70, Bolinha, IAPAR MD 808 (commercial genotypes without arcelin). In the free choice and no-choice oviposition tests, Bolinha and

Porrillo 70 genotypes were preferred for oviposition by that insect. The Bolinha susceptibility could be related to the great number of acicular trichomes presents on its leaves surface. The wild genotypes, ARC 5s and ARC 3s, showed oviposition nonpreference resistance type. This resistance is not related to the arcelin variants, since the bred genotypes also contain arcelin in its seeds and did not show resistance to *B. tabaci*, biotype B.

KEY WORDS: Insecta, *Phaseolus vulgaris*, whitefly, antixenosis, trichomes.

Beans (*Phaseolus vulgaris* L.) are the primary sources of protein for the diet of many people in the Tropics. *Bemisia tabaci* (Genn.) is supposed to be one of the most harmful pests that attacks bean crops. These insects damage the plants by extracting large quantities of phloem sap and transmitting the bean golden mosaic virus (Costa *et al.* 1973). This disease can induce bean yield losses ranging from 40 to 100% (Faria & Zimmermann 1987, Faria *et al.* 1994). Recently, a new biotype of *B. tabaci,* biotype B, also referred to as *B. argentifolli* (Bellows & Perring) has been associated with high yield losses in several crops. Distinct biological differences have been documented for the two biotypes: biotype B lays significantly more eggs (Bethke *et al.* 1991, Costa & Brown 1991), ingests greater quantities of plant sap during feeding and consequently excretes greater volumes of honeydew (Byrne & Miller 1990) and has greater host range than the biotype A (Bedford *et al.* 1994). Furthermore, biotype B induces phytotoxic disorders, such as: squash silverleaf in cultivars of Cucurbitaceae (Costa & Brown 1991, Costa *et al.* 1993, Jiménez *et al.* 1995), uneven ripening in tomato (Schuster *et al.* 1990) and white stem streaking in cole crops (Brown *et al.* 1991). In 1991, the biotype B of *B. tabaci* was first reported in Brazil infesting tomato, broccoli, eggplant and pumpkin crops (Lourenção & Nagai 1994). The aim of this study was to determine the oviposition preference of *B. tabaci* for bean genotypes containing arcelin in the seeds.

Material and Methods

All trials were carried out in Host Plant Resistance to Insects Laboratories, Department of Entomology, and in an area of the Teaching and Research Farm of Faculdade de Ciências Agrárias e Veterinárias/Universidade Estadual Paulista. The genotypes containing arcelin were obtained from the Centro Nacional de Pesquisa do Arroz e do Feijão/EMBRAPA. The following genotypes of *P. vulgaris* were used: ARC 3s and ARC 5s (wild genotype containing arcelin 3 and 5, respectively); ARC 1, ARC 2, ARC 3 and ARC 4 (genotypes bred by EMBRAPA containing arcelin 1, 2, 3 and 4, respectively); Porrillo 70, IAPAR MD 808 and Bolinha. The seeds were planted in plastic pots containing three parts of soil, one part of sand and one part of organic compound. The plants were watered daily and fertilized as recommended for the crop. When tests were set up, adults of *B. tabaci* biotype B reared on tomato, broccoli and *Brassica oleracea* L. were collected by mouth vacuum apparatus. The infestation took place when bean plants were 21 day-old, characterized by Azael (1976) as stages IV-2 and/or IV-3. After infestation, four leaves were collected of each repetition and the number of eggs laid on the abaxial surface of leaves was counted.

All experiments were carried out under greenhouse conditions and repeated two times with 10 replications, in the wet and dry seasons. Data were submitted to ANOVA test and the means were compared by Tukey test ($P \leq 0{,}05$). When necessary, the original data were transformed to $x^{1/2}$ or $(x + 0.5)^{1/2}$.

Free-Choice Test. Each replication consisted of a pot with two bean plants. In the 1995 dry season trial, a free-choice trial in a randomized block design was set up using cages (2x2x2 m) covered by nylon netting into which approximately 6.000 adults were released having the choice among all nine bean genotypes during four days. For the other trials, the pots with bean plants were transferred to a greenhouse containing broccoli infested by *B. tabaci*, in a completely randomized design and remained there during 24 hours.

No-Choice Test. After sowing, each pot was placed in individual cage (60 cm high and 40 cm diameter) covered by fine mesh nylon clothes. In the 1995 trials, a pot with two bean plants was infested by 200 insects during four days, while in the 1996/97 trials, each pot contained just one bean plant was infested by 200 insects during five days.

Taking into account the previous free and no-choice tests, another no-choice trial was also carried out with the following genotypes: ARC 3s and ARC 5s (resistant genotypes) and Porrillo 70 and Bolinha (susceptible ones). All trials were set up in a completely randomized design.

Trichomes Density. The number of hooked and acicular trichome (assessed by counting the number of hairs in an area of 9.6 mm^2, using a stereomicroscope with clear chamber) was determined at two locations (close to the petiole and at the tip of the leaflet) on the fully expanded central leaflet of the second trifoliolate. Trichome density was calculated as the average densities at those two locations. The methodology was adapted of McAuslane (1996). Ten replicates were performed for each genotype.

Results and Discussion

Free-Choice Tests. The mean density of eggs was significantly lower on ARC 5s genotype followed by ARC 3s, in all free-choice tests (Table 1). In the wet season, the Bolinha genotype showed the highest number of eggs laid on its leaves, in both years tested. In the dry season, Bolinha (1995 trials), and ARC 4, Bolinha, ARC 2 and Porrillo 70 (1996 trials) were the most preferred genotypes. The ovipositional preference results indicate the ARC 5s genotype was the least preferred by *B. tabaci* and Bolinha was the most preferred one in most trials.

The trichome density on bean leaves was measured since Peña *et. al.* 1992, Peña *et. al.* 1993a, Heinz & Zalom 1995, McAuslane *et al*. 1995, McAuslane *et al*. 1996 and others authors detected the influence of trichomes on ovipositional preference of *B. tabaci*.

All three types of trichomes were present on the surface of each cultivar (Fig. 1). According to Dahlin *et al.* (1992), the morphological characteristics of common bean trichomes were described as follow: the acicular type is long (400 mm) and straight (Fig. 1B); the hooked type is smaller (200 mm) (Fig. 1B) and the glandular is short (60 mm) (Fig. 1A). The density of the latter one was not measured since no influence has been detected on *B. tabaci* oviposition preference.

As shown in Table 2, the number of total trichomes/cm^2 was lower on ARC 3, Porrillo 70, ARC 4, ARC 1 and IAPAR MD 808 genotypes (from 116.2 to 167.2 trichomes/cm^2) and significantly greater on ARC 5s (791.2 trichomes/cm^2), Bolinha (643.2 trichomes/cm^2) and ARC 3s (552.6 trichomes/cm^2) genotypes.

The hooked trichomes were the most common on bean leaves, with values varying from 114.6 to 790.1 trichomes/cm^2, representing 95.8% to 100% of total trichomes. On Bolinha genotype, the hooked trichome represented 70% of total pubescence density. The number of acicular trichome was significantly higher on Bolinha genotype (157.8 trichomes/cm^2), while all others genotypes had only a range of 0 to 5.7 trichomes/cm^2 (Table 2). The acicular trichome is found mainly on the central vein and on the primary and secondary veins

Table 1. Mean (± SE) number of eggs laid by *B. tabaci* biotype B per leaflet on nine bean (*P. vulgaris*) genotypes in the dry and wet seasons (free-choice test). Jaboticabal, state of São Paulo, Brazil, 1995/96.

Genotypes	Number of eggs per leaflet			
	Wet season		Dry season	
	1995	1996	1995	1996
Bolinha	574.7 ± 114.45 a	44.6 ± 4.00 a	188.1 ± 67.10 a	37.1 ± 12.15 a
Iapar MD 808	539.9 ± 115.02 a	15.1 ± 2.59 c	51.4 ± 15.72 abc	19.4 ± 2.69 abc
Porrillo 70	505.4 ± 101.95 ab	26.5 ± 3.48 b	152.0 ± 116.72 abc	33.0 ± 5.63 a
ARC 3	331.2 ± 83.42 ab	13.9 ± 1.25 cd	187.7 ± 105.42 ab	26.0 ± 2.59 ab
ARC 2	282.2 ± 87.22 abcd	18.3 ± 3.08 bc	88.9 ± 38.31 abc	34.3 ± 5.01 a
ARC 4	274.1 ± 35.75 abc	15.7 ± 1.41 c	142.7 ± 87.13 abc	41.7 ± 7.26 a
ARC 1	162.6 ± 33.37 bcd	28.5 ± 2.32 b	85.4 ± 23.41 abc	30.3 ± 3.52 ab
ARC 3s	56.9 ± 12.24 cd	12.3 ± 0.88 cd	25.2 ± 10.06 bc	12.3 ± 2.02 bc
ARC 5s	46.4 ± 11.41 d	7.2 ± 0.95 d	20.3 ± 9.35 c	9.1 ± 2.01 c
F	9.16*	22.42*	3.45*	6.15*
CV%	41.45	16.45	58.94	29.50

Original data (duly transformed for analysis); means followed by the same letters within columns are not significantly different by Tukey's test (P ≤ 0,05).

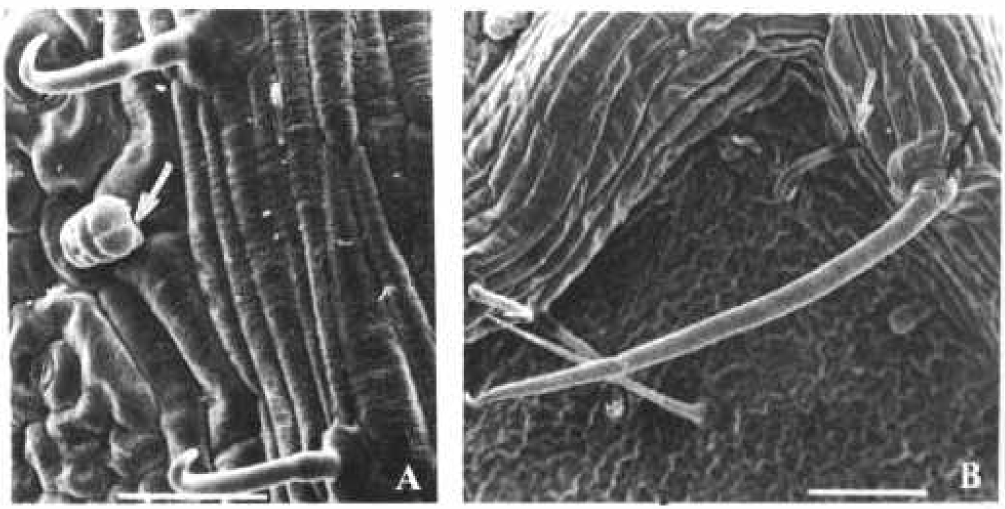

Figure 1. Electron-micrographies of trichomes present on abaxial surface of bean leaves: A) glandular (bar = 50mm); B) black arrow: acicular and white arrow: hooked (bar = 100mm). Jaboticabal, State of São Paulo, Brazil, 1998.

Table 2. Mean (± SE) number of trichomes/cm^2 on abaxial leaf surface of nine bean (*P. vulgaris*) genotypes. Jaboticabal, state of São Paulo, Brazil, 1998.

Genotypes	Number of trichomes/cm^2		
	Total	Hooked	Aciculars
ARC 5s	791.2 ± 8.44 a	790.1 ± 8.44 a	1.0 ± 0.07 b
Bolinha	643.2 ± 4.84 ab	459.4 ± 3.31 b	157.8 ± 4.03 a
ARC 3s	552.6 ± 4.50 b	552.1 ± 4.53 b	0.5 ± 0.05 b
ARC 2	267.2 ± 2.34 c	267.2 ± 2.34 c	0.0 ± 0.00 b
ARC 3	167.2 ± 2.13 cd	166.7 ± 2.10 cd	0.5 ± 0.05 b
Porrillo 70	144.3 ± 1.63 d	141.2 ± 1.50 d	3.1 ± 0.25 b
ARC 4	134.9 ± 1.99 d	129.2 ± 1.84 d	5.7 ± 0.19 b
ARC 1	134.4 ± 2.33 d	133.9 ± 2.33 d	0.5 ± 0.05 b
Iapar MD 808	116.2 ± 0.95 d	114.6 ± 0.95 d	1.6 ± 0.08 b
F	52.68*	48.51*	35.61*
CV%	17.85	17.86	81.05

Original data (duly transformed for analysis); means followed by the same letter within columns are not significantly different by Tukey's test (P ≤ 0,05).

of the leaves. Since such areas were avoided during evaluation, all genotypes had small number of acicular trichome, except for Bolinha genotype, which possesses acicular trichome in other areas besides the veins.

The large number of eggs laid by *B. tabaci* on Bolinha genotype in the free-choice tests (Table 1) could be related to the great number of acicular trichomes present on its leaves surface (Table 2). Peña *et al.* (1993b) verified that *B. tabaci* showed oviposition preference for 27-R and PC-50 genotypes, which had longer acicular trichomes, while A-429 and DOR-303 genotypes (shorter acicular trichomes) had the smallest oviposition. Although several researchers had reported that hooked trichomes can confer resistance in bean genotypes by preventing the attack of *Empoasca fabae* (Pillemer & Tingey 1976, 1978) and *Liriomyza trifolii* (Fagoonee & Toory 1983, Quiring *et al.* 1992), it was not possible to find any relation between these trichomes and oviposition preference by *B. tabaci*. Peña *et al.* (1993b) reported that such mechanism seems not to constitute an effective defense towards *B. tabaci* oviposition.

No-Choice Tests. In the wet season, the wild genotypes ARC 3s and ARC 5s showed significantly less eggs on leaves surface than Porrillo 70 (1995 trial) and ARC 2, ARC 4, ARC 1 and ARC 3 (1996 trial) (Table 3). In the dry season, considering both years, the wild genotypes showed smaller number of eggs laid on its leaves and Porrillo 70 was the most preferred one.

To confirm the resistance index showed by bean genotypes studied in previous free and no-choice tests, two resistant (ARC 3s and ARC 5s) and two susceptible genotypes (Bolinha and Porrillo 70) were selected. The wild genotypes ARC 5s and ARC 3s were the least preferred for oviposition by *B. tabaci* and Bolinha and Porrillo 70 were the most oviposited ones (Table 4).

The ARC 5s and ARC 3s genotypes showed oviposition nonpreference resistance type, with emphasis on ARC 5s. Lara (1997) reported that Mexican bean weevil *Zabrotes subfasciatus* also had oviposition nonpreference for those genotypes. Thus, it suggests that the wild genotypes express multiple resistance, that is, they show resistance to two

Table 3. Mean (± SE) number of eggs laid by *B. tabaci* biotype B per leaflet on nine bean (*P. vulgaris*) genotypes in the dry and wet seasons (no-choice test). Jaboticabal, state of São Paulo, Brazil, 1996/97.

Genotypes	Number of eggs per leaflet			
	Wet season		Dry season	
	1995	1996	1995	1997
Porrillo 70	132.7 ± 28.00 a	188.0 ± 60.57 ab	90.0 ± 23.92 a	186.1 ± 49.30 a
ARC 2	100.7 ± 38.96 ab	327.5 ± 87.02 a	40.3 ± 13.69 ab	87.3 ± 29.79 a
ARC 4	93.1 ± 24.54 ab	315.7 ± 71.19 a	63.5 ± 15.80 ab	97.6 ± 24.71 a
Bolinha	83.1 ± 22.45 ab	177.4 ± 42.01 ab	26.0 ± 6.06 ab	132.3 ± 14.14 a
Iapar MD 808	55.5 ± 15.93 abc	173.7 ± 32.93 ab	71.7 ± 28.14 ab	98.1 ± 18.42 a
ARC 3	48.3 ± 18.04 bc	254.8 ± 67.22 a	45.5 ± 13.89 ab	134.0 ± 38.17 a
ARC 1	46.7 ± 12.35 bc	270.3 ± 84.66 a	49.3 ± 13.49 ab	110.9 ± 32.37 a
ARC 3s	39.7 ± 3.79 bc	88.6 ± 18.66 b	22.1 ± 6.97 b	12.8 ± 5.94 b
ARC 5s	17.9 ± 4.60 c	91.8 ± 24.19 b	39.8 ± 15.13 ab	7.7 ± 1.78 b
F	4.37*	6.24*	2.45*	8.99*
CV%	41.41	32.40	40.22	43.14

Original data (duly transformed for analysis); means followed by the same letters within columns are not significantly different by Tukey's test (P ≤ 0,05).

or more insects species (Lara 1991).

It is important to mention that this resistance is not related to the presence of arcelin, since the bred genotypes (ARC 1, ARC 2, ARC 3 and ARC 4) also possess arcelin in their seeds and did not show resistance to *B. tabaci*. In addiction, if the resistance was linked to the arcelin, the ARC 3 and ARC 3s

Table 4. Mean (± SE) number of eggs laid by *B. tabaci* biotype B per leaflet on bean (*P. vulgaris*) genotypes in the dry and wet seasons (no-choice test). Jaboticabal, state of São Paulo, Brazil, 1997.

Genotypes	Number of eggs per leaflet	
	Dry season	Wet season
Bolinha	43.9 ± 4.83 a	33.9 ± 3.57 a
Porrillo 70	39.9 ± 6.84 a	26.0 ± 2.03 ab
ARC 5s	3.9 ± 3.05 b	12.1 ± 2.25 c
ARC 3s	3.5 ± 2.80 b	14.0 ± 2.23 bc
F	24.49*	11.97*
CV%	21.19	22.95

Original data (duly transformed for analysis); means followed by the same letters within columns are not significantly different by Tukey's test (P ≤ 0,05).

genotypes, which present the same arcelin variant (arcelin 3), should show such resistance. Another factor must be related with the wild genotype resistance, which was not transferred to the bred genotypes. This way, the ARC 5s and ARC 3s genotypes should be used for breeding program towards *B. tabaci* biotype B.

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