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PEST MANAGEMENT

Performance of *Bemisia tabaci* (Genn.) Biotype B (Hemiptera: Aleyrodidae) on Weeds

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Abstract
Bemisia tabaci (Genn.) biotype B (Hemiptera: Aleyrodidae) is regarded as a pest with a large number of hosts, including crops and weeds. The performance of this whitefly on seven weeds was evaluated in order to identify the most suitable host. The following weeds that are very common in intense agricultural areas in the state of São Paulo, Brazil, were selected for this study: spurge (*Euphorbia heterophylla*), beggarticks (*Bidens pilosa*), red tasselflower (*Emilia sonchifolia*), small-flower galinsoga (*Galinsoga parviflora*), pigweed (*Amaranthus viridis*), black nightshade (*Solanum americanum*), and morning glory (*Ipomoea* sp.). In free-choice tests, adult preference and oviposition were greatest on spurge. In contrast, morning glory was the least attractive and least oviposited plant. In assays carried out for egg–adult development, egg viability was greater than 87% over all weeds, whereas nymph viability ranged from 74 to 97%. The developmental period from egg to adult ranged from 26.7 to 49.1 days among the hosts under study. The lowest nymph density rate was observed for beggarticks and morning glory. Cluster analysis resulted in a single group formed by spurge, indicating its superiority as a host for *B. tabaci* biotype B. Even though the parameters evaluated indicate that spurge is the most suitable host among the weeds, all the others allow the reproduction of *B. tabaci* biotype B. For this reason, they should be observed during cropping and the intercrop period in areas infested by this whitefly.

Introduction

In Latin America, *Bemisia tabaci* (Genn.) is recognized as an important pest and a phytovirus vector (Hilje & Morales 2008, Morales 2011). This species is a complex of biotypes that are morphologically indistinct. These biotypes show differences in phytovirus transmission, in adaptation to hosts, and in their ability to induce physiological anomalies in plant species of economic importance (Brown *et al* 1995, Hilje & Morales 2008). Twenty-four different populations, of the at least 41 that have been reported, have been classified into biotypes (Perring 2001). However, according to De Barro *et al* (2011), *B. tabaci* is a complex of at least 24 morphologically indistinguishable species that can be clearly defined by comparison to consensus sequences and delimited by 3.5% mtCOI sequence pairwise genetic distance divergence.

Bemisia tabaci biotype B is one of the most harmful biotypes to agriculture worldwide. It was introduced to Brazil in the 1990s (Lourenção & Nagai 1994). Direct damages from this biotype are related to the removal of phloem sap, such as changes in vegetative and reproductive plant development. There are also indirect damages, such as the occurrence of sooty mold and phytovirus transmission (Inbar & Gerling 2008, Morales 2011).

Cropping practices are used as preventive measures, and they perform an important role in whitefly management in the agricultural system (Hilje *et al* 2001). Among the cropping practices for whitefly management, crop rotation with non-

host species, residue management, crop-free periods, and weed management have been proven to be effective when used in large areas (Hilje & Morales 2008). There is a wide range of weed species in tropical and subtropical areas, and these species may serve as hosts for many pests and diseases (Arnaud *et al* 2007). *Bemisia tabaci* biotype B is a pest with many hosts, including cultivated plants and weeds (Mound & Halsey 1978, Berry *et al* 2004, Brown 2010).

In the face of the large variety of weeds present in intensively farmed areas of the state of São Paulo, Brazil, the aim of this study was to evaluate the performance of this whitefly on the seven most abundant weed species in these areas, identifying those most suitable for this insect. This knowledge will contribute to crop management, indicating to the farmer which weeds must be monitored and eliminated in crop areas to control *B. tabaci* biotype B.

Material and Methods

This research was performed at the Experimental Center, Instituto Agronômico (IAC), in Campinas, São Paulo, Brazil, in 2008 and 2009. Two different greenhouses were used: one for obtaining the whitefly colony and another for the experiments. Data on the temperatures inside the greenhouses during the experiments were obtained from a maximum minimum glass thermometer under shade.

Weed selection

First, a survey was carried out to determine the main dicotyledonous weed species found in crop areas in the state of São Paulo. The species selected were spurge (*Euphorbia heterophylla*), beggarticks (*Bidens pilosa*), red tasselflower (*Emilia sonchifolia*), small-flower galinsoga (*Galinsoga parviflora*), pigweed (*Amaranthus viridis*), black nightshade (*Solanum americanum*), and morning glory (*Ipomoea* sp.). Plants of these species were obtained from seeds collected in the IAC and surrounding areas.

Bemisia tabaci *biotype B rearing*

The colony was established by collecting whitefly adults from a tomato crop in Paulínia, São Paulo, and transferring them to soybean (*Glycine max*) and kale (*Brassica oleracea* var. *acephala*) plants maintained under greenhouse conditions. Soybean and kale plants were used for rearing the whitefly since they are suitable hosts that are easy to obtain and maintain in greenhouses. After a few generations, adults were sent to Dr. Judith K. Brown, University of Arizona, USA, who identified them as *B. tabaci* biotype B. Recently, adults of the colony were molecularly characterized and confirmed to belong to biotype B (Valle *et al* 2012b).

Attractiveness to adults and oviposition preference in a free-choice test

The plants were grown in plastic pots (1.8 L) containing an earth-organic compost mixture and Tropstrato® in a 3:1 ratio, with the pH corrected to 6. Five pots were used for each weed species and one plant per pot was kept after thinning. For artificial infestation, pots of tomato plants were placed in the greenhouse containing the whitefly colony for 4 h and subsequently transferred to the greenhouse of the experiment. Each pot of tomato plants, with nearly 300 whitefly adults per plant, was placed in the middle and at equal distance from four pots with the weeds. Adults were counted at 24, 48, and 72 h after infestation on the abaxial surface of two leaves from the upper third of each plant. Counting was performed with the aid of a mirror to avoid disturbing the adults during sampling. On the sixth day after plant infestation, the leaves used in the counting were detached and placed in plastic bags in the refrigerator for further evaluation of the oviposition. A stereoscope with 16× magnification was used to count the eggs found on the abaxial side of the leaf. To obtain the number of eggs per area (cm^2), the leaves under evaluation were reproduced on tracing paper and passed through a LI-COR (LI-3100A) leaf area meter.

A randomized block experimental design was used, composed of eight treatments (seven weed species and soybean) with five replicates, for a total of 40 experimental units. Each experimental unit consisted of a pot with a plant. The mean values from counting one pair of leaves per plant provided the values for analysis. The selections made by the adult *B. tabaci* biotype B of simultaneously offered host plants were compared based on the mean proportions of the adult whitefly selecting one type of host plant over the observation period from 24 to 72 h and the overall mean for the period, as well as the mean number of eggs laid (eggs/cm^2). The data were tested under the null hypothesis that no selection behavior implies the expectation of an equal 50:50 ratio. These analyses were performed using a non-parametric procedure, which consisted of the Proc FREQ of SAS (SAS Institute 2002) and interpretation through the χ^2 test at a 5% significance level.

Oviposition and nymph density in a no-choice test

This experiment was carried out with all species of plants used in the adult and oviposition non-preference test. The no-choice test is necessary to complement the free-choice procedures to confirm resistance (Smith *et al* 1994). When the seven species of weeds and the soybean had two pairs of completely developed leaves, infestation was carried out. Cloth cages made of voile fastened on cylindrical iron frameworks (60 cm height×35 cm Ø) were used for whitefly confinement on plants. Two hundred adults captured from

the colony were placed in each cage, which was sealed at mid-height with cotton string.

A randomized block experimental design was used with eight treatments and five replicates, for a total of 40 experimental units. Each experimental unit consisted of a pot with a plant. The value for each plant was the mean value from the counting performed on a pair of leaves. The analysis was performed using a non-parametric procedure, which consisted of the Proc FREQ of SAS (SAS Institute 2002) and interpretation through the chi-squared test at a 5% significance level.

Sixteen days after starting the experiment, nymph density was estimated through leaf colonization by nymphs. Fully developed leaves were removed from the upper third of the plants and evaluated using a technique based on a visual rating scale that ranged from 0 to 6 in which 0=leaf with no infestation, 1=leaf with few eggs and nymphs, and successively up to 6=leaves totally colonized by eggs and nymphs. This was adapted from a scale proposed by Coelho *et al* (2009). The final score of each experimental plot was the mean value of two leaves per plant. As the data did not present normality, nymph density was analyzed by the non-parametric test of Friedman, and the mean values were compared through multiple comparisons ($p<0.05$) using the SAS statistical program.

Egg-adult development on plants in the vegetative stage

In the first experiment, which was carried out in the greenhouse in the second half of August 2009, pigweed, black nightshade, and red tasselflower were compared with soybean. When the second leaf of the plants was completely expanded, the pots were transferred to the whitefly colony greenhouse and left there for a 4-h oviposition period to minimize the age difference among the eggs. The potted plants were then taken out of the oviposition greenhouse, and the adults were removed. Then, one area per leaf with 20 eggs and two leaves per plant were marked for a total of 40 eggs per plant for purposes of monitoring. Five plants per weed species were used, for a total of 200 eggs per weed species. After demarcating the areas with an OHP marker (fine tip, 1 mm), the plants were arranged in a greenhouse in a randomized block design. Insect development was observed daily with the aid of a stereoscope. The length and viability of the incubation period and of the nymph stage were determined. After that, in the second half of September 2009, a second experiment was set up and carried out in the same way with morning glory, beggarticks, small-flower galinsoga, and spurge, and these were also compared to soybean.

The data on the incubation and nymph periods were subjected to analysis of variance with no transformation. The viability data were transformed into arc sen √x/100. The mean values were compared using the Tukey's test ($p<0.05$).

Egg–adult development on plants in the reproductive stage

To evaluate the suitability of weeds in the reproductive stage as hosts for *B. tabaci* biotype B, a third experiment was set up in the second half of April 2009. The experiment was set up, conducted, and evaluated in a way similar to the experiments in the vegetative stage, this time with plants in full flower. The data on the incubation and nymph periods were subjected to analysis of variance with no transformation, and the viability data were transformed into arc sen √x/100. The mean values were compared using the Tukey's test ($p<0.05$).

UPGMA cluster analysis

Cluster analysis was carried out for all the variables in the experiment, except for the biological variables of the *B. tabaci* biotype B with plants in the vegetative stage. The division of this experiment into two phases made it impossible to use these data for analysis.

Results and Discussion

Attractiveness to adults and oviposition preference in a free-choice test

Spurge was the most attractive plant to *B. tabaci* biotype B, with a mean of 12.2 adults/cm^2, differing from all the other weeds (Table 1). This corroborates with Gachoka *et al* (2005), who evaluated the attraction of *B. tabaci* adults belonging to two biotypes, the cassava biotype and okra biotype, to five different weed plant species in Ghana. According to these authors, spurge hosted the greatest number of adult whiteflies. In relation to the less attractive plants, similar results were obtained by Calvitti & Remotti (1998) in Italy, who also noted the low attractiveness of pigweed to *B. tabaci*.

Regarding oviposition, spurge (171.1 eggs/cm^2) and black nightshade (65.2 eggs/cm^2) were the weeds that presented the highest mean values, in contrast to beggarticks (22.5 eggs/cm^2), morning glory (20.1 eggs/cm^2), and small-flower galinsoga (20.0 eggs/cm^2), which were the least oviposited. Differences in the intensity of oviposition of *B. tabaci* biotype B are common in resistance studies in cultivated plants, such as in soybean (McAuslane 1996, Valle *et al* 2012a), cotton (Torres *et al* 2007), tomato (Oriani *et al* 2011), common bean (Oriani *et al* 2008), melon (Coelho *et al* 2009), potato (Silva *et al* 2008), and pumpkin (Alves *et al* 2005), among others. Therefore, from the present results, a discriminating

Table 1 Adult attractiveness (adults/cm^2) (mean+/- SE) and oviposition preference (eggs/cm2) (mean+/- SE) of *Bemisia tabaci* biotype B in seven weeds as compared to soybean in free- and no-choice experiments, in greenhouse (n=5).

Treatment[a]	Free-choice test					Non-choice test
	Adults/cm^2				Eggs/cm^2	Eggs/cm^2
	24 h	48 h	72 h	Mean	Mean	Mean
Spurge	12.2±1.32a	12.4±1.81a	12.2±2.14a	12.2±0.06 a	171.1±26.79 a	59.0±4.35 a
Red tasselflower	4.5±0.14 b	4.6±0.27 b	4.2±0.31 b	4.4±0.12 b	58.0±6.83 d	12.6±1.59 d
Soybean	3.5±0.42 b	3.3±0.55 b	3.7±0.58 b	3.5±0.11 b	83.5±8.21 b	23.5±7.50 c
Black nightshade	4.2±0.48 b	4.2±0.51 b	3.7±0.40 b	4.1±0.16 b	65.2±5.32 c	37.2±4.75 b
Small-flower galinsoga	3.8±0.82 b	3.7±1.19 b	3.2±1.03 b	3.5±0.18 b	20.0±3.72 e	37.5±4.23 b
Beggarticks	1.4±0.37 b	0.8±0.16 b	2.0±1.26 b	1.4±0.34 b	22.5±3.25 e	37.5±4.32 b
Pigweed	2.6±0.52 b	1.7±0.78 b	2.0±0.65 b	2.1±0.26 b	40.7±10.04 d	15.6±1.56 d
Morning glory	1.3±0.29 b	1.5±0.52 b	1.5±0.46 b	1.4±0.06 b	20.1±7.00 e	6.7±0.47 e

[a] Means followed by the same letter within columns do not differ by pairwise chi-squared test (p>0.05).

preference in oviposition of *B. tabaci* biotype B among the weeds was also noted.

Oviposition and nymph density in a no-choice test

A strong preference of *B. tabaci* biotype B for oviposition on spurge (Table 1) was corroborated in this experiment, with spurge having the highest mean value of oviposition (59.0 eggs/cm^2). Morning glory also confirmed the performance observed in the free-choice experiment; this weed showed the lowest number of eggs (6.7 eggs/cm^2), differing from all the other plants.

As for nymph density, the lowest numbers were observed in beggarticks and morning glory, with mean scores of 1.2 and 1.0, respectively (Fig 1). These two species had the lowest adult attractiveness, the lowest oviposition in both free- and no-choice tests, and the lowest viability of eggs and nymphs, and were considered the least suitable for this whitefly. In contrast, soybean and spurge showed mean values of 5.8 and 5.6, respectively, which, in light of the other tests carried out, proved to be good hosts for the insect.

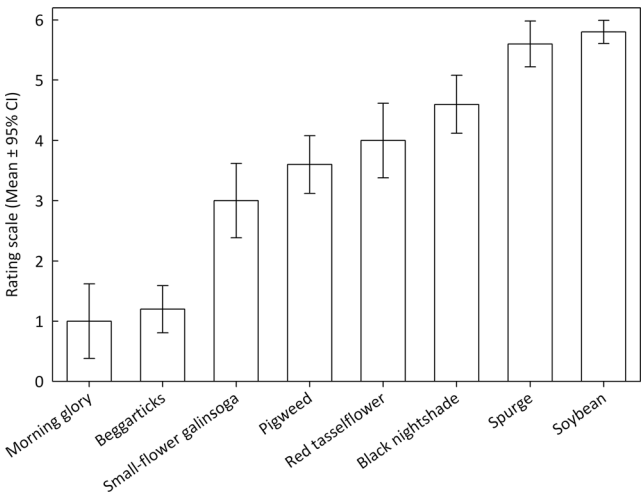

Fig 1 Rating scale (scores varying from 0 (no infestation) to 6 (leaf completely infested by eggs and nymphs), according to Coelho *et al* (2009)) determined for densities of nymphs of *Bemisia tabaci* biotype B infesting seven weeds as compared to soybean in greenhouse (n=5) by using a visual rating technique.

The data obtained in the present study corroborate the results from two other studies. Kiill *et al* (1998) observed a high level of infestation of *Bemisia* sp. in spurge, characterized by having over 20% of the leaf area infested by eggs, nymphs, and adults. Villas Bôas *et al* (2003) also noted high infestation of adults and nymphs in spurge when evaluating weed species exposed to *B. tabaci* biotype B.

Egg–adult development on plants in the vegetative stage

In the first experiment, the incubation period was not affected by the plants on which the eggs were placed, presenting mean values ranging from 13.3 to 13.7 days for soybean, black nightshade, red tasselflower, and pigweed (Table 2). In the egg stage, the insect absorbs water and possibly solutes through the pedicel (Walker *et al* 2010), and, for this reason, great changes are not expected in the duration of this stage due to the effects of the plant. However, temperature has a significant effect on the time of development in all stages of *B. tabaci* (Butler-Junior *et al* 1983). Thus, the long incubation period in this study, when compared to data from experiments in which temperature control was used in ranges more favorable to the insect (25–30°C), may have been due to the time of year in which this experiment was carried out, that is, in lower temperature months. In this experiment, during the egg stage, the mean temperature was 20.8°C (with range of

Table 2 Egg, nymphal and egg–adult periods (days), and egg and nymphal viability (%) (mean+/-SE) of *Bemisia tabaci* biotype B reared in seven weeds at vegetative stage as compared to soybean in greenhouse (n=5).

Treatment	Egg stage		Nymphal stage		Egg–adult
	Duration[a] (days)	Viability[a,b] (%)	Duration[a] (days)	Viability[a,b] (%)	Duration[a] (days)
Experiment 1					
Black nightshade	13.3±0.23 a	94.0±2.31 ab	18.6±0.13 a	85.5±2.00 b	32.0±0.23 a
Red tasselflower	13.7±0.19 a	96.5±1.00 ab	19.0±0.67 a	89.0±1.69 b	32.5±0.51 a
Soybean	13.5±0.25 a	97.0±1.45 b	20.0±0.16 a	95.0±1.36 c	33.3±0.40 a
Pigweed	13.5±0.04 a	87.5±1.36 a	22.2±0.16 b	75.0±0.79 a	35.7±0.20 b
CV (%)	3.0	8.4	4.3	4.0	2.6
Experiment 2					
Spurge	8.4±0.09 ab	97.0±1.45 a	18.3±0.11 a	91.5±1.27 b	26.7±0.20 a
Morning glory	9.1±0.11 c	93.5±2.03 a	19.1±0.09 b	75.5±2.78 a	28.1±0.18 b
Small-flower galinsoga	8.7±0.09 abc	92.5±2.23 a	19.8±0.14 c	89.5±1.65 b	28.5±0.09 b
Soybean	8.2±0.06 a	97.5±1.36 a	21.4±0.12 d	93.0±1.22 b	29.6±0.15 c
Beggarticks	8.8±0.17 bc	90.5±2.42 a	26.2±0.11 e	79.5±2.15 a	35.0±0.24 d
CV (%)	2.7	9.2	1.3	4.4	1.3

[a] Means followed by the same letter in columns do not differ by Tukey's test (p>0.05).

[b] Original data. For analysis (ANOVA), data of viability were transformed to arc sen$\sqrt{x}$/100.

12.8 to 28.4°C), which was lower than the ideal temperature for the insect. Albergaria & Cividanes (2002) observed an 11.9-day incubation period of *B. tabaci* biotype B at 20°C, close to the result found in this research.

The viability of the eggs remained above 94% for all treatments except pigweed, which had a mean value of 87.5% (Table 2). Nava-Camberos *et al* (2001) also found viabilities over 90% for the egg stage in many cultivated plants. Similarly, Campos *et al* (2009) found values from 97 to 100% when evaluating the biological parameters of this insect in cotton genotypes.

Bemisia tabaci biotype B had a shorter nymph stage when reared on black nightshade (18.6 days), red tasselflower (19.0 days), and soybean (20.0 days) than on pigweed (22.2 days). The shorter duration of the nymph stage indicates better suitability of these three weeds for the whitefly since the presence of resistance type antibiosis in plants can prolong development periods in the immature stages (Smith 1989).

Considering the egg–adult cycle, the differences observed for the duration of the nymph stage were consistent, showing that both black nightshade (32.0 days) and red tasselflower (32.5 days) led to development times similar to soybean (33.3 days), which is considered an excellent host for the insect (Valle *et al* 2012a). The cycle in pigweed, however, was the longest, reaching 35.7 days, and it differed from all the others.

Concerning nymph viability (Table 2), the greatest mean value was induced by soybean (95.0%), while pigweed induced the lowest rate (75.0%). Similar to the egg viability, Gachoka *et al* (2005) found nymph viabilities below 20% for the weed plants tested. Nymph viability on cultivated plants in this study was very similar to those in studies by Coelho *et al* (2009), in which adult emergence rates ranged from 68.2 to 90.9%. In contrast to these results, Mizuno & Villas Bôas (1997) obtained a nymph viability percentage of 50% on cabbage and 47.5% on tomato at 25°C.

Differences in the egg stage were found in the second experiment as the eggs deposited on soybean were the first to originate nymphs (8.2 days), whereas the ones placed on morning glory took 9.1 days (Table 2). When comparing the incubation periods of this experiment with those in the first experiment, there was a difference in mean time, which was 13.5 days in the first study and 8.6 in this study. The differences in the time for nymphs to hatch are due to the increase in temperature in this second experiment, in which the mean temperature was 21.15°C, with a range of 15.1 to 30.0°C in the egg stage and 12.4 to 30.6°C in the nymph stage. There was no difference among the treatments for egg viability (Table 2), which ranged from 90.5% (beggarticks) to 97.5% (soybean), showing values that are similar to the ones obtained in the first experiment.

The nymph stage differed among all treatments, with the longest duration observed in beggarticks (26.2 days) and the shortest in spurge (18.3 days). These results suggest that when *B. tabaci* biotype B colonizes spurge in the field, more generations occur in a certain period of time

than for the other weeds tested. Nymph viability ranged from 75.5% for morning glory to 93% for soybean, with this leguminous plant differing from spurge (91.5%) and beggarticks (89.5%).

Considering the egg–adult cycle, the tendencies observed in the nymph stage were the same, such that spurge showed the fastest development (26.7 days) and beggarticks showed the slowest (35 days), differing from the other weeds tested.

Egg–adult development on plants at the reproductive stage

The incubation period (Table 3) was not affected by the plants evaluated. In this period, the mean temperature was 20.8°C, with a range of 12.8 to 28.4°C. The mean values, which did not differ among themselves, varied from 12.3 days in black nightshade, morning glory, and spurge to 13.0 days in pigweed, and these values are very close to the range of 13.3 to 13.7 days obtained in the first experiment with plants in the vegetative stage (Table 2). When examining the mean viability of eggs, it was noted that soybean and red tasselflower induced 100% viability, differing from pigweed with 92%. As for the other treatments, the viabilities reached 99% (beggarticks), 98% (spurge and small-flower galinsoga), 97.5% (black nightshade), and 96.5% (morning glory), which are within the values normally found for this stage of the insect and similar to studies by Albergaria & Cividanes (2002), who found egg viability ranging from 58.6 to 97.7% in soybean.

As for the duration of the nymph period, in which the main temperature was 20.2°C (11.6–29.2°C), mean values from 24.0 to 26.2 days were found for black nightshade, morning glory, spurge, soybean, and red tasselflower, the plants that promoted the fastest development in this stage, and 30.7 and 36.1 days for beggarticks and pigweed, respectively, the weeds that induced the slowest development. Thus, the last two were the least suitable to the insect. Smith (1989) asserts that when a plant provides unsuitable nutrition to an insect, the insect's development may be harmed, prolonging its life cycle and/or interfering in the viability of one or more life cycle stages. This nutritional inadequacy may have occurred with nymphs that were fed with pigweed and beggarticks, in which a longer nymph stage was observed.

Nymph viability also differed among plants; pigweed and beggarticks (74%) and morning glory (80.5%) had the lowest, while the highest were obtained in soybean and spurge (97%), red tasselflower (93.5%), and small-flower galinsoga (92%), indicating that they are the most suitable plants for nymph development.

For plants in the vegetative stage, nymphs presented viabilities similar to the nymphs reared on plants in the reproductive stage, since pigweed, morning glory, and beggarticks presented the lowest viabilities for both. Similar to the values obtained in the reproductive stage, it was noted that spurge and soybean in the vegetative stage were the most suitable hosts for the development of the insect. Thus, it can be inferred that in both the vegetative and the reproductive stages, these weeds provide similar conditions for *B. tabaci* biotype B development.

The egg–adult period differed among treatments, ranging from 36.3 (black nightshade) to 49.1 (pigweed). Pigweed and beggarticks thus prolonged the cycle of the insect, whereas the lowest values were found for red tasselflower, soybean, spurge, morning glory, and black nightshade, which induced faster development.

Table 3 Egg, nymphal and egg–adult period (days), and egg and nymphal viability (%) (mean+/-SE) of *Bemisia tabaci* biotype B in seven weeds at reproductive stage as compared to soybean in greenhouse (n=5).

Treatment	Egg stage		Nymph stage		Egg–adult
	Duration[a] (days)	Viability[a,b] (%)	Duration[a] (days)	Viability[a,b] (%)	Duration[a] (days)
Black nightshade	12.3±0.10 a	97.5±1.22 ab	24.0±0.56 a	87.5±2.09 ab	36.3±0.49 a
Morning glory	12.3±0.17 a	96.5±1.69 ab	24.5±1.06 a	80.5±1.45 a	36.8±1.13 a
Spurge	12.3±0.21 a	98.0±1.22 ab	25.0±0.45 a	97.0±1.27 b	37.3±0.62 a
Soybean	12.4±0.30 a	100.0±0.00 b	26.1±0.59 a	97.0±0.55 b	38.5±0.64 a
Red tasselflower	12.4±0.22 a	100.0±0.00 b	26.2±0.79 a	93.5±2.31 b	38.6±0.85 a
Small-flower galinsoga	12.5±0.20 a	98.0±1.11 ab	27.1±0.45 ab	92.0±3.20 b	39.6±0.40 ab
Beggarticks	12.6±0.14 a	99.0±0.61 ab	30.7±1.07 b	74.0±2.31 a	43.3±0.96 b
Pigweed	13.0±0.09 a	92.0±2.89 a	36.1±1.12 c	74.0±1.87 a	49.1±1.17 c
CV (%)	6.8	7.8	3.5	6.8	4.7

[a] Means followed by the same letter in columns do not differ by Tukey's test (p>0.05).

[b] For statistical analysis (ANOVA), data of viability were transformed to arc sen$\sqrt{x}$/100.

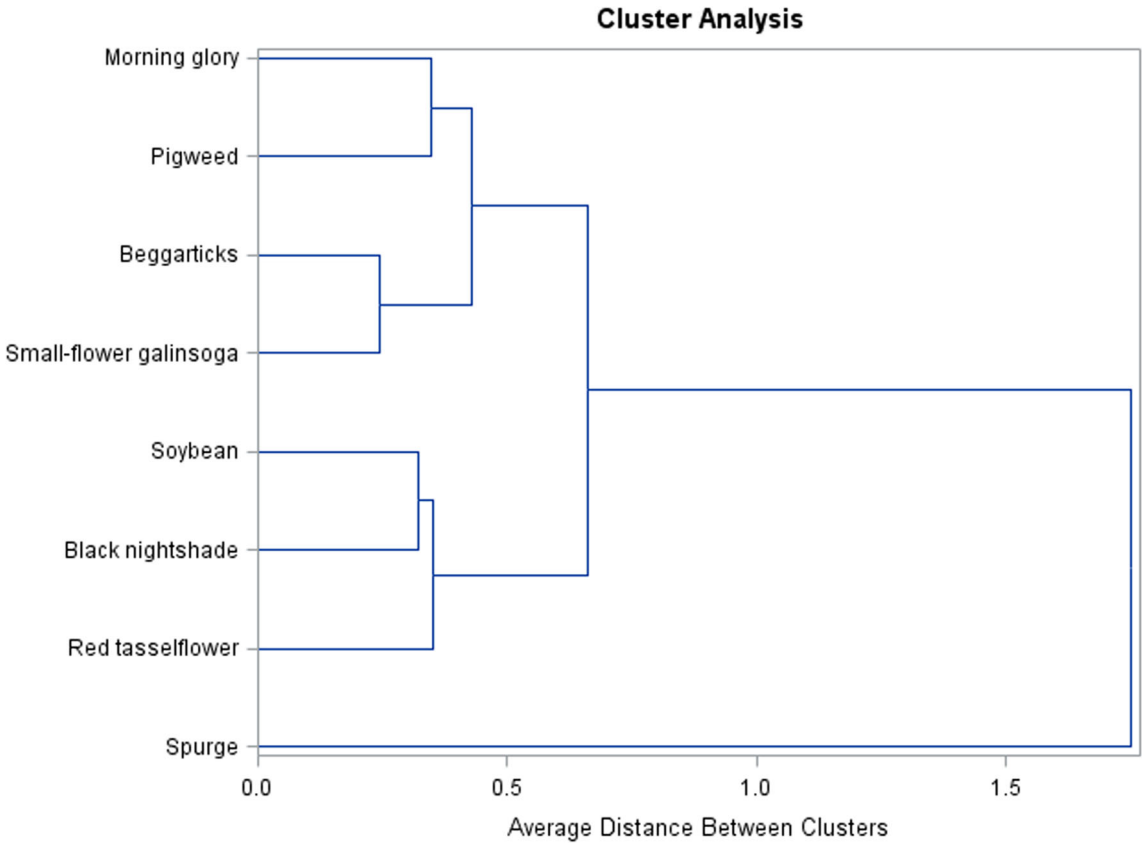

Fig 2 Hierarchical classification of weeds as hosts of *Bemisia tabaci* biotype B by Euclidean distance calculated from the variables "adult attractiveness (adults/cm^2)," "egg–adult development," "eggs and nymphal viability on plants at reproductive stage," "free-choice and no-choice oviposition experiments," and "nymphal density," by UPGMA clustering.

UPGMA clustering analysis

UPGMA analysis yielded three distinct groups, as shown in the dendrogram (Fig 2). The outermost distinct group is formed by spurge, which is different from all of the others. This confirms that this weed is the best host for *B. tabaci* biotype B. The second group is formed by black nightshade, red tasselflower, and soybean, plants considered to be intermediate hosts for the insect. The third group, represented by small-flower galinsoga, beggarticks, pigweed, and morning glory, was considered to be the group least preferred by this whitefly.

The families with the greatest number of host species of *B. tabaci* are Fabaceae, Compositae, Malvaceae, Solanaceae, and Euphorbiaceae (Mound & Halsey 1978). In the last family, these authors listed 24 hosts (most of the *Euphorbia* genus) for this species of whitefly, including spurge and *Euphorbia pulcherrima* (Willd.), commonly known as poinsettia. These two Euphorbiaceae are generally used in rearing this insect for experiments in IAC due to their fast egg–adult development and the high viability of the immature stages. Soybean (second group) belongs to Fabaceae, a family that has the greatest number of known host plants for *B. tabaci*, 56 species (Mound & Halsey 1978). The second group also includes red tasselflower, from Compositae, with 33 known host species, and black nightshade, belonging to Solanaceae, with 27 known host species (Mound & Halsey 1978).

The least suitable plants for *B. tabaci* biotype B were classified into the third group: small-flower galinsoga and beggarticks, from Compositae; pigweed, from Amaranthaceae; and morning glory, from Convolvulaceae. Few species are listed as hosts of *B. tabaci* in Amaranthaceae; Mound & Halsey (1978) cite seven species, including two weeds (*Amaranthus retroflexus* and *Gomphrena globosa*), but neither with economic impact as weeds.

Among the weeds evaluated, spurge was found to be the most suitable host for *B. tabaci* biotype B. However, all of the weeds evaluated allowed insect reproduction, thus showing an ability to maintain *B. tabaci* biotype B populations under field conditions. This should be considered with regard to the cropping time or during the intercrop period in areas where there are high populations of this whitefly and susceptible crops.

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