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ORIGINAL PAPER

Comparison of the performance of *Bemisia tabaci* MEAM1 (Hemiptera: Aleyrodidae) on weed and cultivated plant species

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Abstract
The whitefly, *Bemisia tabaci* MEAM1 (Hemiptera: Aleyrodidae), is considered one of the most invasive and destructive pests for agriculture worldwide. Whitefly populations are maintained throughout the year by continuous exploitation of different plant species and, in this context, weeds can serve as alternative hosts, making permanent populations possible in the field with the migration of individuals to cultivated plant species. Invasive plant species can also serve as inoculum sources of whitefly-transmitted viruses, being more favorable to disease dissemination in agricultural fields. Thus, studies investigating *B. tabaci* performance on different hosts are highly relevant for a better understanding of the insect's population dynamics. Further study may assist in directing management actions and eradication of the most suitable plants for the whitefly development. With these goals in mind, the present study assessed biological aspects of *B. tabaci* MEAM1 on 14 weed species commonly found in Brazilian agricultural fields, in addition to five cultivated plant species. It was verified that the species *Ipomoea grandifolia*, *Solanum lycopersicum* and *Emilia sonchifolia* required the shortest development periods (egg-adult) (23.90 to 24.67 days), indicating high susceptibility. High nymphal viability rates (98.33 to 80.83%) were observed in *S. lycopersicum*, *Gossypium hirsutum*, *Raphanus raphanistrum*, *Glycine max*, *Amaranthus viridis*, *Euphorbia heterophylla*, *Commelina benghalensis*, *Galinsoga parviflora*, *Sida rhombifolia*, *E. sonchifolia*, *Merremia aegyptia* and *I. grandifolia*, also indicating susceptibility. These plant species were revealed to be suitable hosts for whitefly development and, with the exception of the cultivated species, should be monitored and eradicated, expanding the management strategies for *B. tabaci* MEAM1 populations in agricultural scenarios.

Keywords Whitefly · Invasive plants · Alternative hosts · Performance

Introduction

Among the more than 1,500 known whitefly species (Martin and Mound 2007), *Bemisia tabaci* (Hemiptera: Aleyrodidae) stands out among the most destructive to crops worldwide (Nauen et al. 2014). This pest causes direct damage to plants through feeding and indirect damage, especially from the transmission of several viruses, being capable to generate losses of up to 100% of production (Navas-Castillo et al. 2011; Polston et al. 2014; Lourenção et al. 2015).

After decades of study on this hemipteran, it was found that *B. tabaci* corresponds to a complex of cryptic species with wide genetic diversity and that, although morphologically identical, they differ in some biological aspects, such as the ability to transmit viruses, expression of insecticide resistance, ability to induce physiological disorders, and host range (Dinsdale et al. 2010; De Barro et al. 2011; Tay et al. 2012). *Bemisia tabaci* became globally distributed during the 1980s, after multiple invasions of the cryptic Middle East Minor-Asia Minor 1 (MEAM1) (formerly referred to as biotype B), likely via ornamental plant trade between countries (Cheek 1994; De Barro et al. 2011). As a result, this whitefly started to cause severe damage to several crops

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of economic importance since it promoted a significant increase in the incidence of begomoviruses on a global scale (Brown 1994; Jones 2003; Gilbertson et al. 2015).

The cryptic species MEAM1 stands out for its high degree of polyphagia, being able to infest a wide range of plant species including agricultural crops, vegetables, ornamental plants, as well as weed species (Abd-Rabou and Simmons 2010). Given the extensive range of hosts, and the notorious ability to adapt to different environments, *B. tabaci* MEAM1 is considered one of the most invasive and predominant cryptic species worldwide, with a long history of displacement of native cryptic species (Chen et al. 2002; Wang et al. 2017). As it is a multivoltine insect, which does not go through diapause or inactive periods during its life cycle, *B. tabaci* populations are maintained throughout the year by continuous exploitation of a wide variety of hosts, with the insect's dispersal being an important factor for the colonization in different environments (Naranjo et al. 2010). Thus, aspects of the interaction between *B. tabaci* and different hosts are of great relevance for understanding the population dynamics of this insect and its management in agricultural crops (Zalom et al. 1995). Although traditionally the cultivated plants have received greater focus from studies regarding the biological performance of *B. tabaci*, it is known that some weeds play an important role as alternative hosts of the insect, offering an opportunity to maintain populations during the year and enabling the migration of this pest to cultivated plants (Chu et al. 1995; Gachoka et al. 2005). In addition, several weed species can act as inoculum sources for a variety of viruses transmitted by whiteflies who favor the spread of diseases in crop areas (Silva et al. 2010; Barreto et al. 2013; Fariña et al. 2019).

Given the significant importance of *B. tabaci* MEAM1 as a key pest in several crops, and the high potential of some weed species to act as alternative hosts of this insect, this study aimed to evaluate the biological aspects of this whitefly in 14 species of weeds present in crops in Brazil, and five species of cultivated plants. A greater knowledge of the differences in insect performance in invasive plant species commonly associated with agricultural cropping systems may guide management actions and eradication of the most suitable plants for the development of the insect.

Materials and methods

Selected weed species

To carry out the tests, 14 species of common weeds in crops of economic importance in Brazil were selected (Table S1). Five cultivated species were also evaluated, including tomato (*Solanum lycopersicum* L. – cv. Candieiro), soybean (*Glycine max* L. – cv. TMG 7062 IPRO), cotton (*Gossypium hirsutum* L. – cv. FMT 707), corn (*Zea mays* L. – cv. 30F53 VYHR), and bell pepper (*Capsicum annuum* L. – cv. Cascadura Ikeda).

Stock colony of *Bemisia tabaci* MEAM1

The insects used in the tests were provided from a previously established colony identified according to De Barro et al. (2003). The colony was kept in a greenhouse (2.5 × 2.5 × 2.0 m), with the sides and roof partially closed with glass and covered with an anti-aphid screen. Soybean and kale (*Brassica oleracea* var. *acephala* L.) plants were offered to maintain the insects and were kept in 2.5 L plastic pots. The deteriorated plants were replaced by healthy ones as needed.

Biological performance assessment

Pots with plants of the 19 plant species, with four to six expanded leaves, were protected by metallic cages covered with voile fabric to monitor the insect's biological parameters. Four pots, each containing one plant of each species, were infested with 50 whitefly couples for 24 h to obtain oviposition. After checking the presence of eggs on the leaves under a stereoscopic microscope, areas with 30 eggs of *B. tabaci* MEAM1 were delimited (hydrographic pen) on one leaf of each plant. Each leaf corresponded to one repetition, in a total of four per treatment (n = 120), following a completely randomized design. Performance evaluations were performed daily, verifying the following biological parameters: duration of the incubation period, duration of nymphal instars (n1 to n4), nymphal viability, and duration of the period from egg to adult. The instar determination was made according to described by Naranjo and Ellsworth (2017). The test was carried out under greenhouse conditions (26.2 °C, with a maximum of 33.0 °C and a minimum of 19.3 °C; mean relative humidity of 54.14%, natural photophase).

Statistical analysis

Generalized linear mixed models employed in the statistical package PROC MIXED-SAS 9.2 (SAS Institute 2001) were used for analyzing the obtained data. The least squared means (LS-MEANS) statement of the GLIMMIX procedure in SAS, adjusted for Tukey, was used to compare treatment means at the 5% level of significance according to Fisher's least significant difference (Fisher's LSD).

Results

Biological performance assessment

Significant differences were found between the evaluated species in relation to all insect biological parameters (Table 1). The incubation period of *B. tabaci* MEAM1 on the different plants ranged from 7.40 to 9.16 days, with emphasis on bell pepper, *C. benghalensis*, *I. grandifolia*, soybean, *E. sonchifolia* and *C. canadensis*, which allowed the shorter incubation periods (7.40 to 7.80 days). The longest periods were observed in the species *S. rhombifolia*, *G. parviflora* and *R. raphanistrum*, with averages between 9.16 and 8.96 days.

The shortest duration periods (> 2.00 days) for the first instar of *B. tabaci* MEAM1 were observed in *R. raphanistrum* (1.60 days), *G. parviflora* (1.84) and tomato (1.98) (Table 1). These species differed from corn, bell pepper, *C. benghalensis* and *C. canadensis*, which provided the longest periods in this phase (3.39 to 5.02 days).

In the second nymphal instar, cotton stood out with the shortest time (1.67 days), followed by *S. obtusifolia* and *M. aegyptia*, which showed averages of 1.74 and 1.85 days, respectively. The longest periods observed were in bell

Table 1 Means (± EP) of incubation period, nymphal instars, nymphal period and development period of *Bemisia tabaci* MEAM1 in 14 weed species and five species cultivated in a greenhouse

Species	Duration (days)[1]					Nymphal period[1]	Development period (egg-adult)[1]
	Egg	1st instar	2nd instar	3rd instar	4th instar		
Ipomoea grandifolia	7.69 ± 0.11 de	2.70 ± 0.25 bcde	3.12 ± 0.19 bcd	3.89 ± 0.15 abcde	4.73 ± 0.17 d	16.21 ± 0.27 f	23.90 ± 0.31 f
Solanum lycopersicum	7.95 ± 0.09 cde	1.98 ± 0.10 cde	2.75 ± 0.10 cde	2.98 ± 0.27 cdef	7.50 ± 0.23 bcd	16.29 ± 0.24 ef	24.24 ± 0.21 f
Emilia sonchifolia	7.73 ± 0.08 de	2.95 ± 0.19 bcde	1.97 ± 0.19 cde	2.91 ± 0.18 cdef	7.82 ± 0.37 bcd	16.93 ± 0.33 ef	24.67 ± 0.40 f
Commelina benghalensis	7.67 ± 0.14 de	3.41 ± 0.15 b	2.69 ± 0.06 cde	2.12 ± 0.18 f	7.72 ± 0.73 bcd	17.50 ± 0.55 ef	25.16 ± 0.68 ef
Glycine max	7.72 ± 0.13 de	3.08 ± 0.11 bcd	2.34 ± 0.20 cde	3.16 ± 0.18 cdef	7.17 ± 0.36 bcd	17.82 ± 0.26 def	25.53 ± 0.39 def
Gossypium hirsutum	8.13 ± 0.27 abcde	2.87 ± 0.19 bcde	1.67 ± 0.17 e	2.72 ± 0.25 def	8.76 ± 0.43 bc	17.81 ± 0.22 def	25.94 ± 0.33 cdef
Euphorbia heterophylla	8.30 ± 0.05 abcde	2.36 ± 0.34 bcde	2.22 ± 0.29 cde	3.46 ± 0.37 bcdef	8.89 ± 0.64 bc	18.07 ± 0.50 def	26.37 ± 0.54 bcdef
Bidens pilosa	8.32 ± 0.06 abcde	2.53 ± 0.07 bcde	2.81 ± 0.24 cde	3.93 ± 0.35 abcde	5.63 ± 0.52 cd	19.10 ± 0.54 bcdef	27.42 ± 0.52 bcdef
Raphanus raphanistrum	8.96 ± 0.10 abc	1.60 ± 0.04 e	2.14 ± 0.17 cde	3.51 ± 0.18 abcdef	9.56 ± 0.54 b	18.47 ± 0.52 def	27.43 ± 0.57 bcdef
Galinsoga parviflora	9.09 ± 0.56 ab	1.84 ± 0.33 de	2.42 ± 0.18 cde	4.87 ± 0.35 ab	8.27 ± 0.46 bcd	18.70 ± 0.26 cdef	27.79 ± 0.72 bcdef
Sida rhombifolia	9.16 ± 0.31 a	3.25 ± 0.13 bc	2.12 ± 0.15 cde	3.46 ± 0.28 bcdef	8.13 ± 0.83 bcd	18.70 ± 0.78 cdef	27.86 ± 0.57 bcdef
Merremia aegyptia	7.97 ± 0.08 bcde	2.94 ± 0.45 bcde	1.85 ± 0.14 de	2.69 ± 0.10 def	10.46 ± 0.51 b	20.07 ± 0.35 bcdef	28.05 ± 0.30 bcdef
Richardia brasiliensis	8.11 ± 0.37 abcde	3.25 ± 0.59 bc	2.52 ± 0.47 cde	3.72 ± 0.26 abcde	8.29 ± 0.62 bcd	20.06 ± 0.74 bcdef	28.17 ± 0.82 bcdef
Senna obtusifolia	8.76 ± 0.10 abcd	2.76 ± 0.22 bcde	1.74 ± 0.11 e	4.32 ± 0.66 abc	8.35 ± 0.54 bcd	20.27 ± 0.58 bcde	29.03 ± 0.57 bcde
Amaranthus viridis	7.85 ± 0.07 cde	2.92 ± 0.19 bcde	3.27 ± 0.40 bc	3.96 ± 0.16 abcde	9.80 ± 0.34 b	21.82 ± 0.36 abcd	29.67 ± 0.36 abcd
Zea mays	7.90 ± 0.17 cde	5.02 ± 0.30 a	5.02 ± 0.30 a	5.02 ± 0.30 a	9.81 ± 0.12 b	21.83 ± 1.01 abcd	29.73 ± 1.15 abcd
Capsicum annuum	7.40 ± 0.03 e	3.46 ± 0.20 b	5.13 ± 0.22 a	2.87 ± 0.21 cdef	8.83 ± 0.27 bc	22.60 ± 0.69 abc	30.00 ± 0.71 abc
Conyza canadensis	7.80 ± 0.32 de	3.39 ± 0.34 b	4.30 ± 0.61 ab	4.02 ± 0.16 abcd	7.86 ± 0.86 bcd	22.79 ± 1.66 ab	30.59 ± 1.94 ab
Spermacoce latifolia	8.13 ± 0.17 abcde	3.15 ± 0.27 bcd	2.08 ± 0.16 cde	2.49 ± 0.44 ef	15.89 ± 2.32 a	25.78 ± 1.97 a	33.91 ± 1.80 a
P	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[1] Means followed by the same letters in the column show no significant difference by the Fisher LS-Means test. set to Tukey ($P \leq 0.05$)

pepper (5.13 days), corn (5.02 days) and *C. canadensis* (4.30 days), which also had the lowest averages in the first instar. The shortest periods of third instar duration were observed in *C. benghalensis*, *S. latifolia*, *M. aegyptia* and cotton, with averages between 2.12 and 2.72 days. Corn presented the highest average (5.02 days) of duration for the third instar of *B. tabaci* MEAM1, followed by *G. parviflora* (4.87) and *S. obtusifolia* (4.32).

For the fourth nymphal instar of *B. tabaci* MEAM1, a shorter duration was observed in *I. grandifolia*, with an average of 4.73 days. The highest time averages in this phase were observed in *S. latifolia*, *M. aegyptia*, *(A) viridis*, corn and *R. raphanistrum* (15.89 to 9.56 days). Regarding the total duration of the nymphal period of *(B) tabaci* MEAM1, *I. grandifolia* stood out again with the lowest average (16.21 days) among the evaluated species, followed by tomato, *E. sonchifolia* and *(C) benghalensis* (16, 29; 16.93 and 17.50 days, respectively). On the other hand, the longest nymphal periods for the whitefly were observed in *S. latifolia*, *C. canadensis* and bell pepper, with averages between 25.78 and 22.60 days.

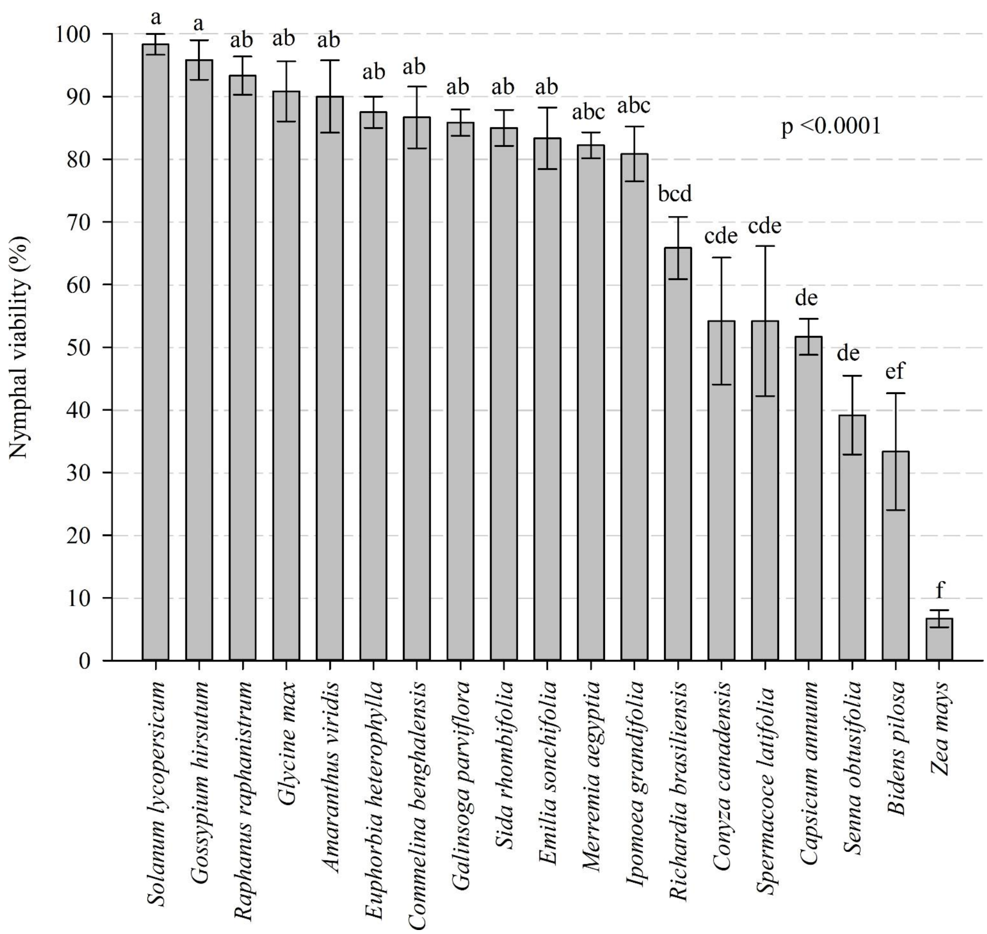
The development period (egg-adult) of the insect ranged from 23.90 to 33.91 days among the evaluated species (Table 1). The lowest duration averages were observed in *I. grandifolia* (23.90 days), tomato (24.24 days) and *E. sonchifolia* (24.67 days), which differed from *S. latifolia*, *C. canadensis*, bell pepper, corn, *A. viridis* and *S. obtsusifolia*, species in which longer development periods were verified (33.91 to 29.03 days).

As for *B. tabaci* MEAM1 nymph viability, the highest percentage of emergence was found in nymphs confined to tomato (98.33%), followed by cotton, *R. raphanistrum*, soybean, *(A) viridis*, *E. heterophylla*, *C. benghalensis*, *G. parviflora*, *S. rhombifolia*, *E. sonchifolia*, *M. aegyptia* and *I. grandifolia*, which presented indices ranging from 95.83 to 80.83% (Fig. 1). The species that provided the lowest levels of nymphal viability were corn (6.67%), *(B) pilosa* (33.33%), *S. obtusifolia* (39.17%), and bell pepper (51.67%). Different effects of plant species were observed during the development of insect nymphs, with varying levels of impact on adult emergence (Fig. 2).

Discussion

In the present study, variable performances of *B. tabaci* MEAM1 on different plant hosts were observed. All the species that were evaluated allowed the insect to complete the

Fig. 1 Means (± EP) of nymphal viability (%) of *Bemisia tabaci* MEAM1 in 14 weed species and five cultivated species in greenhouse
Note: Means followed by the same letters do not show a significant difference by the Fisher LS-Means test adjusted to Tukey ($P \leq 0.05$)



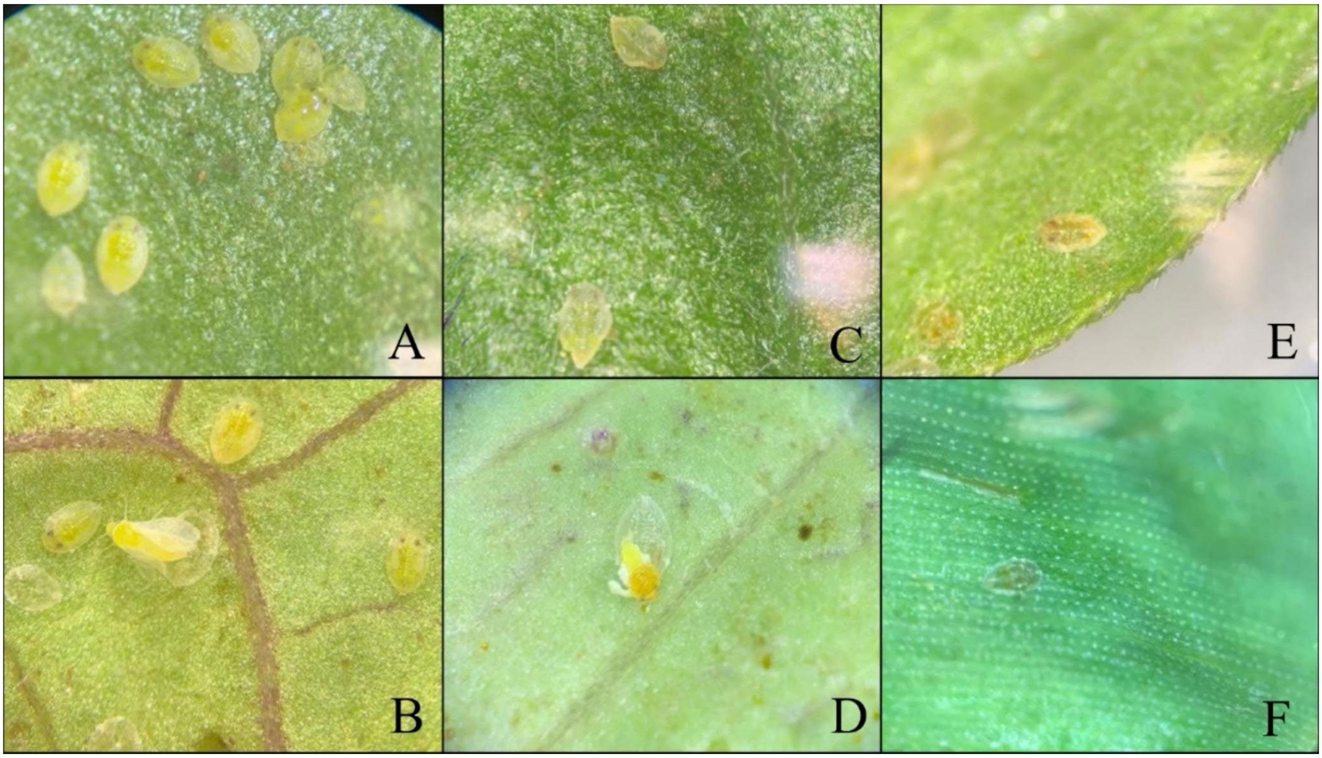


Fig. 2 *Bemisia tabaci* MEAM1 nymphs observed under a stereoscopic microscope (40x) in a biological performance assessment with different plant species. **A** and **B**) fourth instar nymphs in normal development on *Solanum lycopersicum* and adult emerging on *Ipomoea grandifolia*, respectively; **C**) deformed fourth instar nymphs during development in *Conyza canadensis*; **D**) adult killed during adult emergence in *Bidens pilosa*; **E**) dry nymph during development in *Richardia brasiliensis*; **F**) nymph resected during development in *Z. mays*

life cycle. However, some of them proved to be unsuitable hosts, requiring longer cycles (*S. latifolia*, *C. canadensis* and bell pepper) or reducing nymph viability (corn and *B. pilosa*) compared to the others.

Incubation periods ranging from 7.40 to 9.16 days were verified, while the nymphal period ranged from 16.21 to 25.78 days. In a study that evaluated the performance of *B. tabaci* MEAM1 on seven weed species, Sottoriva et al. (2014) found incubation periods between 8.20 and 9.10 days. In work carried out on the same whitefly species and kale genotypes, this period ranged from 6.08 to 7.03 days (Baldin et al. 2022). *Bemisia tabaci* eggs are laid on a pedicel, which is responsible for transporting water and solutes from the host plant to the eggs (Buckner et al. 2002; Walker et al. 2010). Thus, variations in the duration of the egg phase may be directly related to the temperature of the environment (Bonato et al. 2007) or even to specific characteristics of the epidermis' surface in different plant tissues (Shah and Liu 2013).

Some of the weed species proved to be highly favorable to the development of *B. tabaci* MEAM1, providing short cycle durations (egg-adult) and high percentages of nymphal viability. For example, morning glory (*I. grandifolia*) stood out with the shortest egg-adult period of the whitefly (23.90 days), indicating high susceptibility, with an average similar to tomato, the insect's preferred host. In this sense, Jiao et al. (2012) found that tomato was nutritionally superior to other hosts, justifying a shorter development period in the whitefly cycle. Besides tomato, cotton and soybean showed to be suitable hosts to *B. tabaci* MEAM1 among the cultivated species tested as expected, providing high nymphal viabilities and short development periods. The severe outbreaks of whiteflies on cotton fields observed in desert regions of North America, in 1990s, were attributed to the invasion of MEAM1 followed by the displacement of the native cryptic species, highlighting the great performance of the insect in this host (Ellsworth and Martinez-Carrillo 2001; Oliveira et al. 2001; Perring et al. 2001). Soybean is also known to harbor large whitefly populations in the field, with increasing outbreaks of this pest affecting Brazilian soybean production (Tamai et al. 2006; Arnemann 2018). Although the host-plant used for the rearing of whiteflies may potentially display influence in the performance on the subsequent host (Costa et al. 1991), the insects used in the present study were reared mostly in kale, besides soybean. Yet, other cultivated plant species (bell pepper, corn, cotton and tomato) were tested with no potential benefit of the condition of host adaption in advance, allowing robust comparisons between insect performance on weeds and cultivated plants.

The development period averages obtained in this study ranged from 23.90 to 33.91 days and were most similar to those whitefly studies by other authors who studied the species' interaction with soybean, cowpea, tomato, zucchini, cabbage, poinsettia and cassava (17–27 days) plants (Villas-Bôas et al. 2002; Lima and Lara 2004; Cruz et al. 2014). Variable fitness patterns of phytophagous insects might be influenced by factors such as host nutritional value and presence of defense compounds in the plant tissues (Bernays and Chapman 1994). In a study comparing the performance of *B. tabaci* MEAM1 and Mediterranean (MED) in three different hosts, it was verified lower survivorship and longer nymph development periods for both whiteflies fed in *Euphorbia pulcherrima* Wild., which was considered the most inferior host, presenting lower nitrogen and higher carbohydrate and phenolic compounds in comparison with tomato and cotton (Jiao et al. 2012).

The ingestion of deleterious compounds produced by non-host plants or resistant genotypes (antixenosis or antibiosis) can cause behavioral and/or physiological changes to the arthropod that tries to colonize it (Smith 2005; Baldin et al. 2019), resulting in different levels of mortality, as already documented for this whitefly species in other hosts (Baldin et al. 2005, 2022; Baldin and Beneduzzi 2010; Silva et al. 2012; Cruz et al. 2014; Cruz and Baldin 2017; Pantoja et al. 2018; Novaes et al. 2020; Santos et al. 2021). However, *B. tabaci* MEAM1 exhibits a remarkable host adaptability, which has been corroborated by recent findings regarding the ability of this insect to circumvent plant defenses, such as phenolic glucosides, by acquiring host-plant genes via horizontal transfer, enabling it to neutralize plant defense compounds (Xia et al. 2021). This expressive adaptation capacity was also observed in studies assessing *B. tabaci* Mediterranean (MED) in tobacco, a non-preferred host for this cryptic species. Therefore, Xia et al. (2017) found that whiteflies improved their performance in tobacco after 10 generations being reared in this host, with up-regulation of genes providing larger body volume and muscle, which allowed the insect to overcome plant morphological defenses. In a study that evaluated a wide variety of plant species as possible hosts of *B. tabaci* MEAM1, Simmons et al. (2008) identified the largest group of new hosts as belonging to the genus *Ipomoea*, with 32 species. Plants belonging to this genus have been identified as potential hosts for the maintenance of native cryptic species of *B. tabaci* in Brazil and Argentina (Alemandri et al. 2012; Barbosa et al. 2014). In addition, several species of geminiviruses associated with plants of the genus *Ipomoea* have been globally disseminated (Varma et al. 2011). Among the species belonging to this genus, *I. grandifolia* stands out for its greater interference on cultivated plants, due to the aggressiveness and long growing cycle (Barroso et al. 2019). In the present study, *I. grandifolia* induced the shortest development period, and provided 80% nymphal viability for the whitefly, which reinforces the importance of monitoring the insect in agricultural scenarios.

The species *E. sonchifolia* and *C. benghalensis* were also among the plants that provided the shortest development periods for the whitefly, with lower averages than those of soybean and cotton, allowing nymphal viability to reach higher than 83.00%. Sottoriva et al. (2014) also found high viability of the immature phase of *B. tabaci* MEAM1 on *E. sonchifolia* (89.00%); however, the duration of the nymphal period observed in this species was 19 days, differing from the 16.93 days verified in the present study. These same authors found the shortest nymphal (18.30) and egg-to-adult (26.70) periods in *E. heterophylla* among the evaluated species, obtaining duration averages similar to those obtained in the present study (18.07 and 26.37, respectively). In a study conducted in the Brazilian semiarid region, Bezerra et al. (2004) found that the species *E. heterophylla* was the most infested by *B. tabaci* MEAM1 among the evaluated weeds, proving to be highly favorable to the maintenance of this pest in the field.

Corn, bell pepper, *C. canadensis* and *S. latifolia* caused the longest cycle lengths (29.73 to 33.91 days) and were among the least suitable hosts for *B. tabaci* MEAM1 evaluated in the present study. Results from corn, especially, showed the lowest nymphal viability (6.67%). Despite the fact that some studies have indicated corn as a potential host for *B. tabaci* MEAM1 (Quintela et al. 2016), grass species are generally unsuitable hosts for *B. tabaci*, barely allowing the insect to complete its cycle (Simmons et al. 2008). The unsuitability of grass species for *B. tabaci* was also observed in this work.

Brazil has no intense climatic amplitudes between regions and weed populations vary in different locations due to different edaphic factors. Plants and insects have adapted around Brazilian agricultural systems and their landscapes. This could justify differences in the occurrence of insect-host plant species between the northern, midwestern and southern regions of the country, as well as the transmission of associated pathogens. Additionally, in regions where significant temperature drops are common over the winter, the presence of alternative hosts such as ornamental plants and weeds is of great importance for the survival of *B. tabaci* MEAM1 populations throughout the year. In China, for example, a strong influence of alternative hosts was observed in protected crops for *B. tabaci* to survive over the winter, since the maintenance of the insect and plants under field conditions is unlikely. In many cases, the whitefly migrated to field crops during the summer, returning to be more problematic in greenhouses in the winter (Lin et al. 2007).

In general, the results obtained in this study reveal that, although there are variations in the performance of *B. tabaci* MEAM1 depending on the hosts evaluated, all the plant species that were studied allowed the insect to reach the adult stage. This indicated that these plants have variable potential as alternative hosts for the whitefly, especially in situations where there are no preferred plants. Species such as *I. grandifolia*, *E. sonchifolia* and *C. benghalensis* were highly susceptible and favorable to the insect, providing short development periods and high nymphal viability. In the case of *E. heterophylla*, it should be noted that this invasive species has already been identified as a reservoir of *Tomato severe rugose virus* (ToSRV) in the state of Goiás, Brazil (Barreto et al. 2013). This increases its importance, especially in areas destined for tomato cultivation, since the begomovirus is predominant in tomato-growing regions of south-central Brazil (Federal District, Minas Gerais, São Paulo and Goiás) (Inoue-Nagata et al. 2016). Eradication programs and periods without the presence of hosts can play an important role in the integrated management of whitefly and insect-transmitted viruses, reducing inoculum sources within and adjacent to the crop (Gilbertson et al. 2011). In this sense, the monitoring and control of these species can contribute to management strategies aimed at controlling populations of *B. tabaci* MEAM1 and its associated diseases under field conditions.

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Declarations

Conflict of Interest M. G. Sacilotto, F. S. F. Souza, E. L. L. Baldin, C. A. Carbonari and A. L. Lourenção declare that they have no competing interests.

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