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ORIGINAL PAPER

Host preferences and biotic potential of *Trialeurodes vaporariorum* and *Bemisia tabaci* (Hemiptera: Aleyrodidae) in tomato and pepper

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Abstract Whiteflies *Bemisia tabaci* (Gennadius) and *Trialeurodes vaporariorum* (Westwood) (Hemiptera: Aleyrodidae) are important pests in pepper (*Capsicum annuum* L.) and tomato (*Solanum lycopersicum* L.) crops in many countries. Contrary to what is observed for all other countries, in Uruguay, *B. tabaci* is mainly found on pepper and rarely on tomato, while *T. vaporariorum* is exclusively found on tomato. This study tested the oviposition preferences and biotic potential of these two whiteflies reared on both host plants. The developmental time, survival rates, longevity, fecundity and main population parameters were characterized. Both whitefly species showed different preference patterns regarding their host plants. *T. vaporariorum* preferred tomato instead of pepper to oviposit. Their developmental time is longer on pepper. *B. tabaci* preferred pepper, but the difference from tomato was not very strong. Pepper affects the biotic expression of *T. vaporariorum* negatively, while *B. tabaci* is able to develop equally on both host plants. These results show that the distribution differences of both whiteflies observed on both host plants could have a biological basis.

Keywords Development time · Fecundity · Longevity · Population parameters · *Solanum lycopersicum* · *Capsicum annuum*

Introduction

The sweet potato whitefly, *Bemisia tabaci* (Gennadius), and the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) (Hemiptera: Aleyrodidae), are highly polyphagous species that colonize more than 600 plant species, including crop plants, weeds and other wild plants (Byrne and Bellows 1991; Park et al. 1998, 2004; Ellsworth and Martinez-Carrillo 2001; Naranjo and Ellsworth 2001; Oliveira et al. 2001; Bi et al. 2002; Stansly et al. 2004; Simmons et al. 2008). The biotype Q is one of the most invasive of the *B. tabaci* complex, and it is characterized by a high biotic potential compared with other biotypes (including the B biotype), high resistance to insecticides (Bonato et al. 2006; Dinsdale et al. 2010; Xu et al. 2010; De Barro et al. 2011) and a mutualistic relationship with the virus that favor the feeding of the insect and the transmission of the virus (Rodríguez Dos Santos and Del Pozo Nuñez 2003; Moreno-Dela Fuente et al. 2013). Both whitefly species are important pests in horticultural and ornamental crops, grown in either greenhouses or open fields. Damages are due to losses of sap sucking by the insects and lowering of photosynthetic activity, reducing plant vigor, and also losses in fruit quality due to more favorable conditions for the development of sooty mold (*Capnodium* sp.) as a consequence of the excretion of honey dew by the insects (Berlinger 1986; Bellotti and Vargas 1986; van Lenteren and Noldus 1990; Byrne and Bellows 1991; Park et al. 1998; Bi et al. 2002; Hodges and Evans 2005; Arnó et al. 2006).

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The most important economic damage, however, is caused by virus transmission. For example, *B. tabaci* is able to transmit about 300 different phytopathogenic viruses. Among them, the TYLCV (*Tomato Yellow Leaf Curl Begomovirus*) stands out, which can cause very important yield losses (Berlinger 1986; Picó et al. 1996; Sánchez-Campos et al. 1999).

Despite their polyphagous capability, whiteflies show a preference for certain host plants on which their biotic potential is enhanced. The plants are not only a source of food for phytophagous insects, but also of shelter and a place for oviposition and mating. Localization as well as acceptance of a host plant by a phytophagous insect is therefore a key process in the dynamics of its populations (Gómez 2010). The selection and acceptance process of a host plant by a phytophagous insect depends on its perception of the characteristics (physical and chemical signals) of that host plant and its behavioral response to those signals (Verschoor-van der Poel and van Lenteren 1978; Lei et al. 1999; Schoonhoven et al. 2005). Insects are able to recognize host plants through visual, olfactory, taste and tactile stimuli (Prokopy and Owens 1983; Visser 1988; van Lenteren and Noldus 1990), and they use these characteristics for estimating the location and quality of plants (Singer 2000).

Bemisia tabaci and *T. vaporariorum* are important pests in horticultural crops in Uruguay. They cause important damage and make repeated chemical treatments necessary (Bernal and Buenahora 1996; Rodríguez Dos Santos and Del Pozo Nuñez 2003). In a pepper protected crop (*Capsicum annuum* L.), *B. tabaci* is controlled with *Amblyseius swirskii* Athias-Henriot (Acari: Phytoseiidae) in only 20 % of the total area of cultivation, while in the tomato protected crop only chemicals are used for controlling the whiteflies. *B. tabaci*, which was reported on pepper in Uruguay for the first time in 1999 (Grille and Basso 2001), is rarely found on tomato (*Solanum lycopersicum* L.). The opposite is observed for *T. vaporariorum*, which is never found on pepper, while it is very abundant on tomato (Grille et al. 2003). It should be noted that in the main horticultural area of the country (Salto), the tomato and pepper greenhouses are very close to each other, and the crop schedules are the same (from February to December). Therefore, both whiteflies face the same temperature regime. Because in Uruguay the preference of both whiteflies for tomato and pepper is different from that in other countries, the main objective of this work was to study the plant-whitefly relationships in order to understand and explain this distribution on these two important commercial crops. To achieve this, preferences and biological traits (developing time, survival, longevity and fecundity) of *T. vaporariorum* and *B. tabaci* were characterized on tomato and pepper.

Materials and methods

Insect and plant materials

The *Bemisia tabaci* (Q biotype, Grille et al. 2011) and *T. vaporariorum* used in the tests originated from commercial tomato and pepper crops in the horticultural region in Northwestern Uruguay (Salto) (S 31°21′W 57°53). They were multiplied on tobacco plants (*Nicotiana tabacum* L., Virginia, cv. K-326) under controlled conditions (25 ± 3 °C and 60 ± 5 % RH) in the San Antonio Experimental Station belonging to the Faculty of Agronomy-University of the Republic (Salto, Uruguay) following the same procedure as Pascal et al. (2003). The whiteflies were multiplied on tobacco plants for three generations before being removed to undergo the tests.

The tomato plants (cv. Elpida) and peppers (cv. Bilano) were multiplied in plastic pots, 20 cm in diameter and 10 cm deep, filled with sterile soil and located in a plastic greenhouse under controlled climatic conditions until they were 20–30 cm tall.

Preferences of *T. vaporariorum* and *B. tabaci* for tomato and pepper

The preference of *T. vaporariorum* and *B. tabaci* for tomato and pepper plants was studied by means of a “non-conditioned” test, in which the whiteflies did not have either access or previous experience with host plants. The experiments were carried out in a glass greenhouse (22 ± 2 °C and 65 ± 5 % HR) located in the Experimental Station of the National Institute of Agricultural Research “Salto Grande” (Salto, Uruguay).

Tomato plants (9 weeks old; approximately 33 cm tall) and pepper plants (11 weeks old; approximately 31 cm tall) were arranged alternatively with 20 cm distance between them, shaping a square with six rows and six columns. One hundred adults of both whitefly species (1 day old, both sexes), previously collected with a vaccum where they were counted, were released at different points among the plants. Whitefly adults were transported from the breeding place in small plastic bags and underwent a 30-min acclimatization period to the new conditions, and then the bags were opened. One, 6, 24, 48 and 72 h after release, the leaves (upperside and underside) of each plant were observed and the number of adults counted.

Ten and 28 days after releasing the adults, the number of eggs and nymphs (taking into account preimaginal stages) of *T. vaporariorum* and *B. tabaci* were counted at the underside of the leaves to evaluate the settling of the populations. Ten tomato plants and ten pepper plants were selected at random, and from each plant one leaf from each third of the plant (upper, middle, lower) was taken. In the laboratory under a stereoscopic microscope (Nikon SMZ 1B-X 35), the number of eggs and immature stages of both whitefly species was counted in a 2.5-cm-diameter circle located on the middle area of a leave (pepper) or leaflet (tomato).

Biological traits

Developmental time and preimaginal survival

One hundred adults of *T. vaporariorum* and *B. tabaci* were placed on four tomato and four pepper plants and left for oviposition for 24 h at a temperature of 25 ± 1 °C. Then, the adults were removed with a manual vacuum cleaner and the plants introduced in two growth chambers (KOXKA model MEC-185/F) under controlled climatic conditions (25 ± 5 °C, 70 ± 10 % RH, 4000 lx and a photoperiod of 16:8 h L:O). Twenty eggs of each whitefly species and each host plant were selected and isolated with a “clip cage” (Liu and Stansly 1996; Grille et al. 2012). Eggs were then followed daily using a hand magnifying glass. Observation stopped when the fourth nymphal instar was reached. Afterwards, the fourth nymphal instars were placed on petri dishes, 10 cm diameter, until adult emergence. The newly emerging adults were sexed under the stereomicroscope (Nikon SMZ 1B-X 35) to establish the proportion of both sexes (Bellotti and Vargas 1986).

Survival in each stage was estimated using the following formula:

$$\begin{aligned}&\text{Survival in each stage}\\&\quad=\text{Number of individuals entering stage }(i+1)\\&\qquad/(\text{number of individuals entering in stage }i)\times 100\end{aligned}$$

Female longevity and fecundity

Twenty (20) females of *T. vaporariorum* and *B. tabaci*, aged between 0 and 2 h, were placed on the underside of tomato and pepper leaves, using clip cages similar to the ones used in the former test. Two males of the same species were also placed with each female inside the clip cages. The plants were placed in growth chambers under controlled conditions (25 ± 5 °C, 70 ± 10 % RH, 4000 lx and a photoperiod of 16 L). The male insects were withdrawn as soon as the females started to lay eggs. For reducing the influence of leaf aging on egg production, the females were moved every 2 days to a new leaf (always covered by the clip cages) until their death. The circles on the leaves formerly covered by the clip cages were cut and observed under a stereomicroscope (Nikon SMZ 1B-X 35) and the number of eggs in each circle counted. To estimate fecundity, only the egg-laying females were taken into account. The insects that died in the first 24 h or that did not lay eggs were discarded.

Demographic parameters

Based on the development time and female fertility, life tables for *T. vaporariorum* and *B. tabaci* on both host plants were drawn up. The net reproduction rate (R_0), average generation time (T) and natural intrinsic rate of population increase (r_m) were estimated using the program developed by Hulting et al. (1990), in which the parameters are estimated following the method recommended by Birch (1948). The program, based on the Jacknife procedure, shows a standard deviation for each parameter that allows the statistical comparison of values.

Statistical analysis

A mono-factorial analysis of variance (ANOVA) was performed to test the influence of host plants on the duration of the preimaginal stages, total development time (from egg to adult), survival rate, and fecundity and longevity of *B. tabaci* and *T. vaporariorum* females. When ANOVA showed a significant difference, means were compared using the Student-Newman-Keuls test (SNK). In order to evaluate the preferences of adult whiteflies for each host plant, proportions were compared with a Z test. All statistical evaluations were performed with XLSTAT software (2010.1.01).

Results

Preferences of *T. vaporariorum* and *B. tabaci* for tomato and pepper

The number of adults of *T. vaporariorum* counted on tomato plants was larger than that found on pepper during the whole observation period (1, 6, 24, 48, 72 h) ($Z = 1.96$; $p < 0.001$). On tomato, this number increased with time, from 67.6 to 96.3, while the opposite was observed on pepper (from 32.4 to 3.7). On the other hand, the proportion of *B. tabaci* adults was larger on pepper than on tomato during the whole study period ($Z = 1.96$; $p < 0.001$). For *T. vaporariorum*, the number of adults remained unchanged during the whole observation time (pepper = 68.8 average, SE = 1.5; tomato = 31.2 average; SE = 1.5) (Fig. 1).

The number of eggs and immature (nymphs 1st–4th) of *T. vaporariorum* and *B. tabaci* counted on each plant at day 10 and day 28 after the release of the adults was different

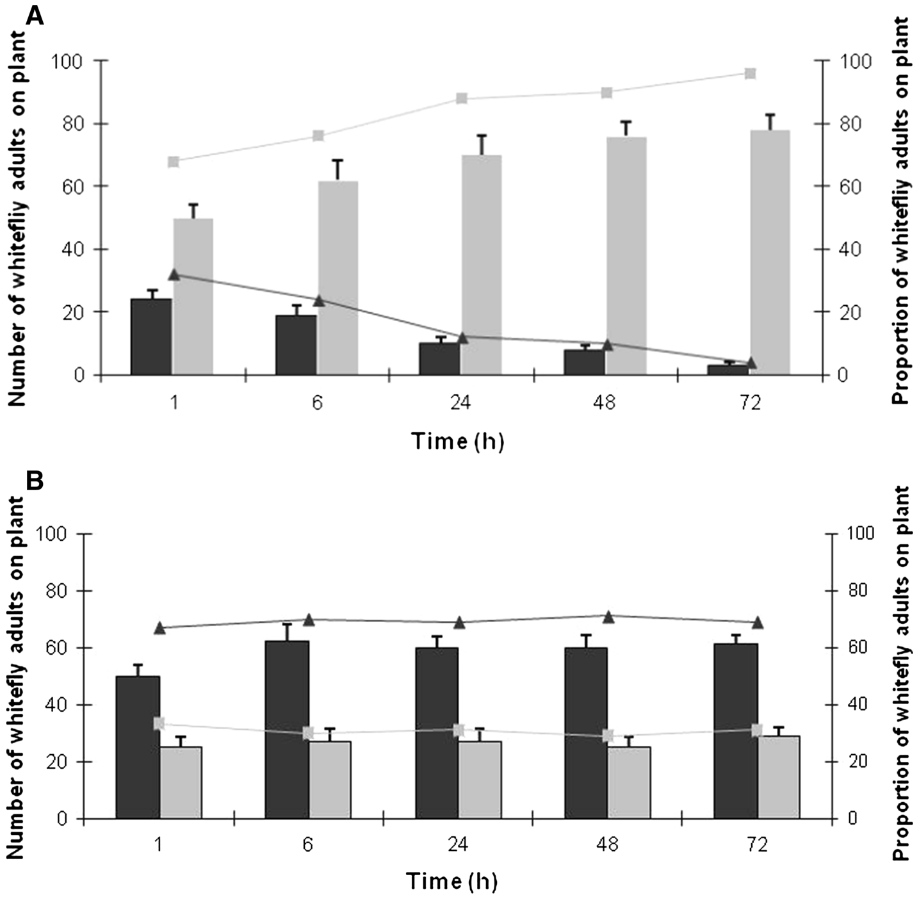

Fig. 1 Average number (bar = standard error) (*bars*; *light* tomato; *dark* pepper) and proportion (*lines*) of whitefly adults observed on tomato and pepper plants in each observation period. **a** *Trialeurodes vaporariorum*; **b** *Bemisia tabaci*

Table 1 Number of eggs and nymphs (1st–4th) of *Trialeurodes vaporariorum* and *Bemisia tabaci* on tomato and pepper plants after 10 and 28 days of releasing adult individuals (statistical analysis for each sampling period)

	10 days		28 days	
	Tomato	Pepper	Tomato	Pepper
Trialeurodes vaporariorum				
Eggs	81.8 (12.0)a	4.7 (1.7)b	32.9 (1.7)a	2.4 (2.3)b
Nymphs (1st–4th)	2.9 (1.7)a	0a	73.6 (8.9)a	2.2 (1.7)b
Total	110.8a	4.7b	106.5a	4.6b
Bemisia tabaci				
Eggs	41.5 (11.2)a	44.1 (10.4)a	14.9 (5.2)b	26.2 (8.4)a
Nymphs (1st–4th)	2.7 (1.5)a	4.7 (1.2)a	37.4 (5.6)b	44.6 (5.1)a
Total	44.2a	48.8a	52.3b	70.8a

Numbers followed by different letters within the same row are significantly different ($p < 0.001$)

In brackets = standard error

according to the whitefly species and host plant (Table 1). At day 10, a larger number of *T. vaporariorum* eggs was found on the tomato than on the pepper ($F_{7,\ 71} = 88.48$; $p < 0.001$), while no difference was found between the numbers of *B. tabaci* on both host plants ($p = 0.504$). At day 28, the number of *T. vaporariorum* eggs was larger on tomato than on pepper ($p < 0.001$), and the opposite was observed for *B. tabaci* ($p = 0.004$). It is important to underline that while *T. vaporariorum* laid almost 14 times more eggs on tomato than on pepper plants, the larger number of *B. tabaci* eggs in pepper never exceeded twice the number of eggs laid on tomato.

The total number of nymphs (1st–4th) developed on both plants differed at day 28 ($F_{7,\ 71} = 73.31$; $p < 0.001$), showing the same plant preference as those obtained for eggs. The same differences were confirmed while analyzing the total number of immature individuals [eggs, nymphs (1st–4th); $F_{7,\ 71} = 78.68$; $p < 0.001$]. The number of immature *T. vaporariorum* was 33 times larger in tomato than in pepper ($p < 0.001$), while in the case of *B. tabaci* the number of immature individuals on pepper was only 1.2 times larger than on tomato ($p < 0.001$) (Table 1). Therefore, adults of *T. vaporariorum* showed a clear preference for tomato over pepper for laying eggs and obviously the development of nymphs. *B. tabaci* showed a preference for pepper at day 28 only.

Expression of the biotic potential

Preimaginal developmental time and survival

The host plant had an influence on the duration of the preimaginal development of both species of whiteflies ($F_{3,\ 52} = 17.13$, $p < 0.001$; Table 2). *T. vaporariorum* developed faster on tomato (22.44 days) than on pepper (26.05 days), while *B. tabaci* reached its adult stage sooner on pepper (19.12 days) than on tomato (22.69 days). No difference was found in egg hatching ($p = 0.723$) on both host plants for both whiteflies ($p = 0.757$). On pepper *B. tabaci* showed a shorter development time than *T. vaporariorum* ($p < 0.001$). No significant differences were found in the development time of the male and female of both whitefly species ($F_{3,\ 52} = 23.74$, $p = 0.672$).

The survival rate of the nymph stage of both whiteflies was different according to host plant ($F_{3,\ 58} = 18.33$, $p < 0.001$). No significant difference of *B. tabaci* survival on tomato or pepper was found, while the survival rate of *T. vaporariorum* on pepper was two times less important than on tomato ($p < 0.001$). The highest mortality rate happened in the first nymph stage (N1) and in the last nymph stage (N4) for both species of whiteflies and on both plants (Table 3).

Female longevity and fecundity

Females of *B. tabaci* showed the largest longevity when they developed (from egg to adult) on pepper rather than on tomato ($F_{3,\ 76} = 145.28$; $p < 0.001$). The contrary was observed for *T. vaporariorum* (the largest longevity when they developed on tomato). On tomato, the longevity of *T. vaporariorum* was larger than the longevity of *B. tabaci* ($p < 0.001$), while on pepper the opposite was noticed, i.e., the longevity of *B. tabaci* females was larger ($p < 0.001$) (Table 4).

Total and daily fecundity was larger for *T. vaporariorum* developing on tomato than individuals developing on pepper ($F_{3,\ 77} = 230.68$; $p < 0.001$). Again, the opposite was observed with *B. tabaci*, which showed larger fertility values when reared on pepper than when the individuals developed on tomato ($p < 0.001$).

In the case of *T. vaporariorum* on pepper, not only was fertility lower but also 30 % of the females did not lay eggs (Table 4). Females of both whitefly species started oviposition within the 24 h following their hatching, with no long pre-oviposition period to be observed.

Demographic parameters

The host plant significantly influenced the following demographic parameters: the net reproduction rate (R_0) ($F_{3,\ 75} = 20.79$, $p < 0.001$), the generation time (T) ($F_{3,\ 75} = 10.82$, $p < 0.001$) and the intrinsic rate of natural increase (r_m) ($F_{3,\ 75} = 177.57$, $p < 0.001$). According to the obtained values, pepper is a better host than tomato for the fitness of *B. tabaci* (higher R_0 and r_m and lower T), while for the fitness of *T. vaporariorum*, tomato is better than pepper (Table 5).

Discussion

Both whitefly species showed preferences for a different host plant (tomato for *T. vaporariorum*, pepper for *B. tabaci*), but with different preference patterns. Almost all adults of *T. vaporariorum* reared on pepper switched to tomato after some hours, while *B. tabaci* adults, even those

Table 2 Duration of preimaginal development, in days (average and standard deviation between brackets), of *Bemisia tabaci* and *Trialeurodes vaporariorum* on two different species of host plants at 25 °C

	Bemisia tabaci		*Trialeurodes vaporariorum*	
	Tomato $n = 20$	Pepper $n = 20$	Tomato $n = 20$	Pepper $n = 20$
Egg	6.31 (1.14)a	6.18 (1.29)a	6.56 (1.03)a	6.75 (1.28)a
N1	3.63 (1.20)ab	2.94 (0.90)b	4.12 (1.02)a	3.88 (0.99)ab
N2	4.06 (1.06)a	2.59 (0.62)b	2.86 (0.68)b	3.25 (1.04)b
N3	3.50 (1.15)a	2.65 (0.61)a	2.81 (0.66)a	3.50 (0.76)a
N4	5.19 (0.91)bc	4.76 (1.03)c	5.93 (0.73)b	8.62 (2.00)a
From egg to adult	22.69 (2.87)b	19.12 (1.65)c	22.43 (2.10)b	26.05 (2.27)a

Numbers followed by different letters within the same row are significantly different ($p < 0.001$)

N1, first nymph stage; N2, second nymph stage; N3, third nymph stage; N4, fourth nymph stage; *n*, number of eggs at the beginning of the test

Table 3 Survival rate for each one of the developmental stages of *Bemisia tabaci* and *Trialeurodes vaporariorum* on tomato and pepper plants (shown as percentage)

	Bemisia tabaci		*Trialeurodes vaporariorum*	
	Tomato $n = 20$	Pepper $n = 20$	Tomato $n = 20$	Pepper $n = 20$
Egg	95.0	98.9	97.9	96.6
N1	77.5	96.5	92.2	38.5
N2	94.0	97.2	98.3	78.3
N3	92.3	94.4	94.6	86.7
N4	79.1	93.4	97.2	55.4
From egg to adult	80.0a	85.0a	80.1a	40.2b

Numbers followed by different letters within the same row are significantly different ($p < 0.001$)

N1, first nymph stage; N2, second nymph stage; N3, third nymph stage; N4, fourth nymph stage; n, number of eggs at the beginning of the test

Table 4 Total and daily fertility each female (average and standard deviation in brackets) and longevity of *Bemisia tabaci* and *Trialeurodes vaporariorum* in tomato and pepper at 25 °C

	Bemisia tabaci		*Trialeurodes vaporariorum*	
	Tomato $n = 17$	Pepper = 18	Tomato $n = 18$	Pepper $n = 28$
Fertility (eggs/female)	53.7 (11.5)c	85.7 (22.4)b	121.6 (20.2)a	4.5 (2.2)d
Daily fertility (eggs/female)	2.9 (0.5)c	4.2 (0.6)b	5.1 (0.6)a	0.5 (0.2)d
Longevity (days)	18.9 (3.9)c	21.4 (3.3)b	23.7 (2.4)a	8.6 (1.1)d

Numbers followed by different letters within the same row are significantly different ($p < 0.001$)

n, number of females considered

Table 5 Demographic parameters of *Bemisia tabaci* and *Trialeurodes vaporariorum* in tomato and pepper at 25 °C (average and standard deviation between brackets)

	Bemisia tabaci		*Trialeurodes vaporariorum*	
	Tomato ($n = 17$)	Pepper ($n = 18$)	Tomato ($n = 18$)	Pepper ($n = 28$)
R_0 (eggs/female)	41.97 (0.98)c	73.38 (1.34)b	93.51(1.76)a	1.73 (0.04)d
r_m (day^{-1})	0.12 (0.001)c	0.15 (0.001)a	0.15 (0.001)b	0.02 (0.001)d
T (days)	29.36 (0.07)c	28.16 (0.06)d	30.43 (0.06)b	31.24 (0.03)a

Numbers followed by different letters within the same row are significantly different ($p < 0.001$)

R_0, net reproduction rate; r_m, population increase rate; T, average generation time; n, number of females used in the analysis

showing preference for pepper, when initially reared on tomato stayed on that plant. These results show that adults of *B. tabaci* accepted tomato plants as host after testing the plant tissues and did not change their original decision guided by visual and olfactory signals. The number of adults remained constant on that plant. This observation is congruent with the reports of Verschoor-van der Poel and van Lenteren (1978) and Lei et al. (1999), who pointed out that only after visiting and directly exploring the host plant with its stylet can the whitefly estimate its quality as a substrate for food and reproduction. In these cases different mechanisms implied in host resistance have been identified, such as physical and/or chemical defenses. These mechanisms could influence the insects' choices (Harman et al. 1996; Smith and Boyko 2007; Alba et al. 2009). Studies on plant resistance to *B. tabaci* have established that the insect is affected mainly by the characteristics of the plant surface, such as the hairiness, glandular trichomes, shape and color of the leaves (Berlinger 1986; Oriani and Vendramim 2010).

The developmental time measured for *B. tabaci* and *T. vaporariorum* was similar to the developmental time mentioned by Ahn et al. (2001) and Bonato et al. (2007), working on the same plants at the same temperature. Coudriet et al. (1985), working at 30 °C, obtained a development time of 19.78 days for *B. tabaci* on pepper, a value similar to the one obtained in the present study at 25 °C. On the other hand, the duration of the preimaginal stage of *T. vaporariorum* on tomato was a little bit shorter than the duration of 25 days at 25 °C reported by Movasaghi et al. (2009). The influence of different host plants on the development time of *B. tabaci* was also reported by Coudriet et al. (1985) and our results, which showed that *B. tabaci* has a shorter development time on pepper than on tomato, agreeing with the findings of Kakimoto et al. (2007).

For both whiteflies the duration of the egg stage was not affected by the host plant, in accordance with Sánchez et al. (1997), who pointed out that at this stage the host plant could have the least influence on the insect because of the fact that the whiteflies do not feed on their host. For other authors, the whitefly's eggs attach to the leaves through a pedicel that carries solutes and water from the host plant to the egg; therefore a plant effect could exist. The plant could influence the duration of the egg stage because of the different solute absorption rates under the influence of the structure of the leaf tissues (Iida et al. 2009).

The survival rate of immature stages in both species was similar to the results reported by Wang and Tsai (1996), which showed a higher mortality (50–60 %) during the first and last nymphal stadiums. Even when the survival is linked to environmental conditions (temperature, humidity, host plant), it is lower in the first nymphal stage (Ravinovich 1980). Later on, when the insect has attached itself, mortality risks are lower. The estimated survival rate for *B. tabaci* on both host plants and for *T. vaporariorum* on tomato was high compared to the wide ranges cited by Byrne and Bellows (1991) for different whitefly species (between 10 and 93 %). The resistance of the pepper to *T. vaporariorum* could be linked to antibiosis, but it is necessary to carry out more experiments in order to confirm this mechanism. Antibiosis to whiteflies has been observed in other host plants, especially due to low quality foliage and also to the presence of anti-nutritional compounds or toxic secondary metabolites (Nombela et al. 2000; Rodríguez-López et al. 2011).

In our study, the longevity found for *B. tabaci* on both host plants does not agree with the one reported by Coudriet et al. (1985) and Ahn et al. (2001). Both authors found a lifetime of only 14 days for adults. The cultivar/genotype used for the tests could have influenced it, as already reported by Boiça et al. (2007). On the other hand, the larger longevity of *T. vaporariorum* found on tomato plants than on pepper agrees with the reports of van de Merendok and van Lenteren (1978).

The total fecundity obtained for *B. tabaci* is within the range mentioned by Muñiz and Nombela (1997) on pepper plants: 66.53–226.20 eggs/female at 25 °C. Females reared on tomato showed a fecundity below the values reported by Yang and Chi (2006) (114 eggs/female) and by Bonato et al. (2007) (105 eggs/female). For this species, the fecundity is usually very variable and depends, among other factors, on age and temperature (Enkegaard 1993), and also on the host plant (Liu and Oetting 1994).

In our study, *B. tabaci* showed some differences in its biological traits, which were considered better for the development of the whitefly on pepper plants. However, *B. tabaci* was also able to develop, reproduce and survive on tomato plants. The lower oviposition rate found on tomato compared with pepper could possibly be influenced by the pubescence of the tomato leaves, as reported by Butler and Henneberry (1984) and McAuslane (1996). These authors showed that this species of whitefly prefers leaves with hairy surfaces to smooth ones, until the hairs become an obstacle to feeding, and also to stick the eggs to the epidermis. Based on this information, it is possible that the hairiness of tomato leaves could have some influence on the oviposition of *B. tabaci*. Moreover, the presence of glandular trichomes type IV and the production of acylsucrose discourage the contact and settling of *B. tabaci* on tomato, as has been verified by Rodríguez-López et al. (2011).

In the case of *T. vaporariorum,* a lower reproductive rate observed in individuals developing on pepper compared with whiteflies reared on tomato agrees with the reports of van de Merendok and van Lenteren (1978) when considering the mortality, oviposition and offspring development on both host plants. These results confirm that the insects prefer to lay their eggs on hosts that provide the best conditions for their feeding and/or offspring development (Courtney and Kibota 1990).

Trialeurodes vaporariorum and *B. tabaci* have different preferences for tomato and pepper that result in differences on their biotic potential. On pepper, *T. vaporariorum* shows a lengthy preimaginal stage and a low survival rate, longevity and fertility. In a choice situation between tomato or pepper, *T. vaporariorum* prefers mostly tomato, and almost all those specimens that initially go to pepper move afterwards to tomato. Although *B. tabaci* shows a preference for pepper, individuals are able to develop and survive on both host plants, and their populations remain stable in time.

The ability of *B. tabaci* to develop easily on a tomato variety widely grown in Uruguay, as shown in this study, contrasts with the fact that the whitefly is rarely found on the tomato plots. This points to the need to carry out further research from an ecological and agronomical perspective (succession and spatial and time distribution of tomato and pepper crops, apparent and interference competition between both whitefly species, draft of the food web) in order to determine the cause of the observed situation. In addition, detailed monitoring of the populations of the two whiteflies in the horticultural region would be necessary for early detection of changes in the relative abundance of these pests on tomato. The recent invasion of *B. tabaci* in the country and the possible dire consequences for the tomato crops and the horticultural damage (especially transmission of the virus) justify paying attention to this case study.

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