Preliminary study on fluctuation of the *Bemisia tabaci* (Hemiptera: Aleyrodidae) in greenhouse tomato and pepper crops, Tucumán, Argentina

Estudio preliminar sobre la fluctuación de *Bemisia tabaci* (Hemiptera: Aleyrodidae) en cultivos de tomate y pimiento bajo cubierta, Tucumán, Argentina

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Abstract

The aim of this study was to determine the abundance and population fluctuations of *Bemisia tabaci* (Gennadius) in greenhouse tomato and pepper crops in Lules department, Tucumán province (Argentina). Entomological sampling was carried out from July 2008 to March 2009. Adults were collected using sticky traps while immature individuals were collected from the leaflets of the different plant strata. A total of 121.075 individuals of *B. tabaci* were collected, from which 12.630 corresponded to eggs, 8.718 to nymphs, 262 to pupae, and 99.465 to adults. In general terms, the abundance of *B. tabaci* increased considerably from the third week of sampling and stayed high, with pepper crops showing the highest number of individuals.

Key words:
whitefly; abundance; pests insect; *Solanum lycopersicum; Capsicum annum*

Resumen

El objetivo del trabajo fue determinar la abundancia y fluctuación poblacional de *Bemisia tabaci* (Gennadius) en cultivos de tomate y pimiento bajo cubierta en el departamento Lules, provincia de Tucumán (Argentina). Los muestreos entomológicos se realizaron desde julio de 2008 a marzo de 2009, recolectándose adultos mediante trampas adhesivas e inmaduros en los foliolos de los diferentes estratos de las plantas. Se recolectó un total de 121,075 individuos de *B. tabaci*, de los cuales 12,630 corresponden al estado de huevo, 8,718 a ninfa, 262 a pupa y 99,465 a adulto. En líneas generales, la abundancia de *B. tabaci* aumentó considerablemente a partir de la tercera semana de muestreo y se mantuvo elevada, siendo el cultivo de pimiento el que presentó mayor número de individuos.

Palabras clave:
mosca blanca; abundancia; insecto plaga; *Solanum lycopersicum; Capsicum*

Bemisia tabaci (Gennadius) (Hemiptera: Aleyrodidae) is among the most economically important pests in the world. In Latin America and the Caribbean, the whitefly has led to losses that have diminished the productivity of socioeconomically important crops, such as *Ipomea batatas* L. (sweet potato) (Convolvulaceae), *Citrullus lanatus* (Thunb.) Matsum and Nakai (watermelon), *Cucumis melo* L. (melon), *Cucumis sativus* L. (cucumber), *Cucurbita maxima* Duchesne (squash), *Cucurbita argyrosperma* Huber (cushaw pumpkin), *Cucurbita moschata* Duchesne (crookneck squash) (Cucurbitaceae); *Glycine max* L., (soybean) and *Phaseolus vulgaris L.* (bean) (Leguminosae); *Gossypium hirsutum* L. (cotton), *Abelmoschus esculentus* (L.) Moench (okra) (Malvaceae); *Capsicum annum* L. (pepper), *Solanum lycopersicum* L. (tomato), *Solanum melongena* L. (eggplant), *Solanum tuberosum* L. (potato) and *Nicotiana tabacum* L. (tobacco) (Solanaceae) (Byrne *et al.*, 1990; Brown, 1993; Caballero and Pitty, 1995; Lourenção and Nagai, 1994).

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Bemisia tabaci causes both direct and indirect damage to crops. It causes direct damage through the sucking of phloem sap causing the weakening of the plant, chlorosis, and foliage deformation (López-Ávila, 2005). And it also causes indirect damage due to the accumulation of excreted honeydew, which favors the development of sooty mold fungi, causing plant asphyxia, reduction of the photosynthesis process, and interference in the deposition of chemical products used for controlling whiteflies, ultimately leading to the loss of the commercial value of fruits (Vet *et al.*, 1980; Llorens Climent and Garrido Vivas, 1992; Salguero, 1993 López-Ávila, 2005). However, the more serious damage is the transmission of bacterial and virus-borne diseases, the most important being the geminivirus. Among them the tomato yellow mosaic virus (TYMV) and the tomato yellow leaf curl virus (TYLCV) are the most relevant (Vet *et al.,* 1980; Llorens Climent and Garrido Vivas, 1992; Salguero, 1993; García Marí *et al.,* 1994; Naranjo *et al.,* 2004; Polack, 2005).

In Argentina, *B. tabaci* was cited for the first time in 1943, on cotton crops in Chaco province (Mound and Halsey, 1978), and in 1955 it was registered in Tucumán province (Viscarret, 2000). However, in 1994 the first studies of the population dynamics of the white fly and its associated parasitoids in northern Argentine appeared (Viscarret, 2000), as well as studies of the presence of the geminivirus, associated to *B. tabaci* in soybean, tomato, bean and pepper crops (Mound and Halsey, 1978; Viscarret *et al.,* 2001).

In northwest Argentina, one of the main limiting factors for production of tomato and pepper crops is the attack of whitefly, whose population dynamics is poorly known. Thus, the aim of this study was to determine the abundance and population dynamics of *B. tabaci* in greenhouse tomato and pepper crops in Tucumán Province.

The study was carried out in Lules department (26°55'60" S 65°20'60" O; 382 AMSL), Tucumán province, Argentina. This area is part of the humid and per humid piedmont agrological region, whose main characteristic is its high soil fertility due to the presence of Lules river alluvial fan (Zuccardi and Fadda, 1992).

Sampling took place from July 2008 to March 2009 in four crop plots with Almeria type cover: two Temporada variety tomato crops (I and II) and two pepper crops APL-82 variety (III and IV), both under conventional pest management, but with rational use of insecticides: in tomato BIO SPAN was used, while pepper crops were treated with Lamdex. Plots I and II contained 2.200 and 2.180 plants respectively. Plots III and IV contained 2.080 and 2.140 pepper plants respectively. The whole production cycle of both crops was recorded. Adults were sampled using yellow sticky traps 5 x 7 cm, replaced every 15 days. For their placement, the number of plants and rows of each plot was considered, and a diagonal pattern was followed, including the extremes and center of evaluated area. The immature forms (eggs, nymphs, and pupae) were collected fortnightly from the top, medium, and lower strata, extracting one leaflet per strata, established according to the size of each plot, and to the total number of plants. The sampling was carried out following the criterion of Bueno *et al.* (2005) to encompass all the developmental stages of *B. tabaci*. Subsequently, the leaflets were placed in individual plastic bags and transferred in cases to the Laboratory of Agricultural Zoology of the Estación Experimental Agroindustrial Obispo Colombres (EEAOC) (Las Talitas, Tucumán). The identification and quantification of the immature and adult stages was performed through stereoscopic microscopes following specific keys (Caballero, 1994, 1996; Caballero and Pitty, 1995), and the data was recorded into a spreadsheet where the date, plant number, stratum, crop, and producer were registered for immature forms; and the date, place, crop, producer, and trap number were registered for adults.

The relative abundance (%) of the different developmental stages of *B. tabaci* by crop type and sampled plot was determined, calculated as the abundance of each of stages in relation with total abundance of collected specimens. Aditionally, population fluctuation of the different developmental stages throughout the sampling period was determined, obtaining abundance variation graphs by crop type and plot. Prior to the analyses, abundance values were transformed logarithmically (ln (n + 1)), to improve data visibility. Finally, Spearman non-parametric correlation analyses were performed, using InfoStat statistic software (INFOSTAT, 2007), to determine the relation between number of eggs and number of adults.

A total of 121.075 specimens of *B. tabaci* were collected, of which 12.630 corresponded to eggs, 99.465 to adults, 8.718 to nymphs, and 262 to pupae. In tomato plot I, a higher number of adults (92.4 %) was recorded, followed by nymphs (5.6 %), eggs (1.7 %), and pupae (0.2 %). In Plot II, a higher abundance of adults (89.5 %) was also registered, followed by eggs (6.1 %), nymphs (4.2 %), and pupae (0.2 %). In pepper plot III, a higher number of adults (79.5 %) was also found, followed by eggs (12.8 %), nymphs (7.5 %), and pupae (0.2 %) and in plot IV a higher number of adults (75.7 %) was observed as well, followed by nymphs (13.1 %), eggs (11.1 %), and pupae (0.1 %).

In general, the behavior of different developmental stages of *B. tabaci* by plot showed variations throughout the sampling period, and a population increase in the two last weeks was observed. In plot I, *B. tabaci* showed an increase in the number of eggs by week 15, and an increase of nymphs and adults by week 16, both corresponding to November 2018. In plot II, *B. tabaci* showed regular fluctuations throughout the sampling period, with egg and nymph abundance peaks mainly by week 11 and 13 (April, 2009); and two abundance peaks in adults, one during week 5 (March, 2009) and another in week 13 (April, 2009). Furthermore, week 13 had the highest number of specimens (figure 1 a, b).

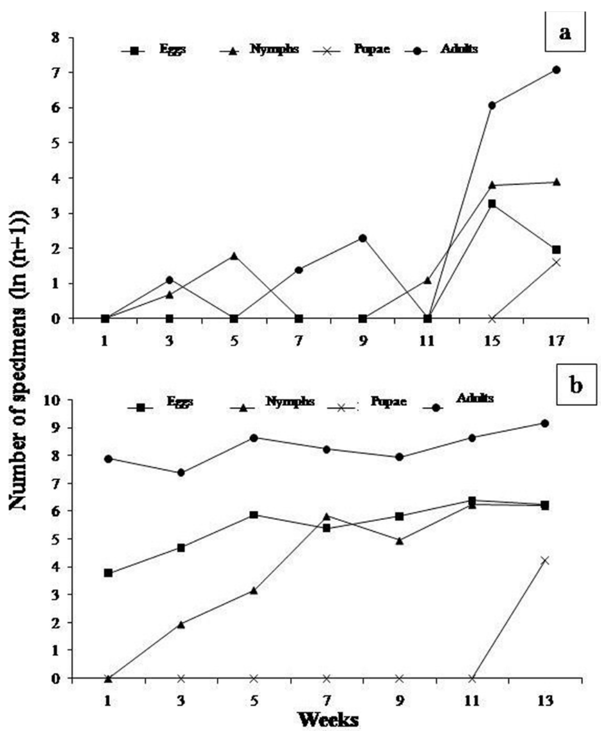

Figure 1. Population fluctuation of different stages of *Bemisia tabaci* collected in tomato crops under cover, a. Plot I; b. Plot II.

The population dynamics of *B. tabaci* in pepper crops showed a similar pattern of behavior to that observed in tomato crops. In plot III, *B. tabaci* fluctuated regularly, with an increase in the number of eggs and nymphs mainly by week 13 (January, 2008), followed by week 22 (March, 2009); and an increase in the number of adults by week 13 (January, 2008), and 18 (February, 2008). In plot IV, the different developmental stages of *B. tabaci* also showed regular distribution patterns, with an increase in number of eggs during week 27 (November, 2008), followed by an increase in number of nymphs by week 25 (November, 2008). In turn, adult specimens showed abundance peaks in week 27 (November, 2008) (figure 2 a, b).

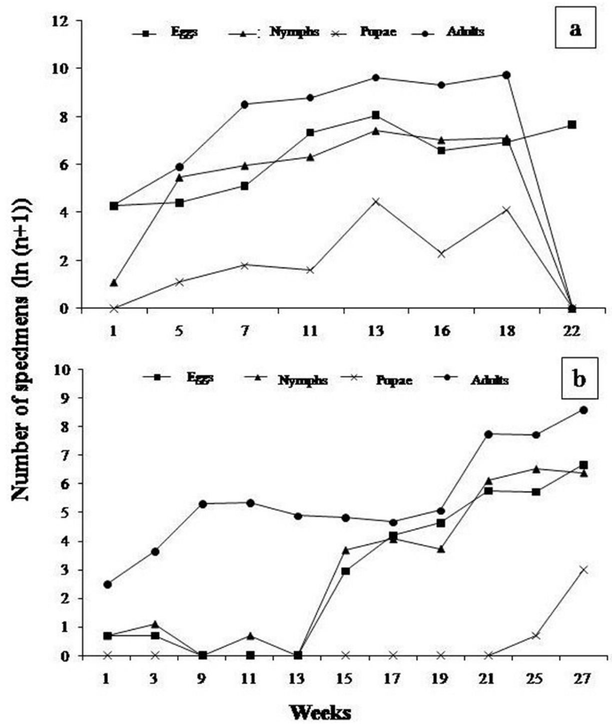

Figure 2. Population fluctuation of different stages of *Bemisia tabaci* collected in pepper crops under cover, a. Plot III; b. Plot IV.

It is worth mentioning that exploratory sampling of *B. tabaci* in the field was performed, in which a higher number of nymphs and adults was registered, and irregular fluctuations were found, with an increase in adult populations by week 6 (October, 2008). When comparing these findings with those observed in under cover crops, it can be suggested that *B. tabaci* populations behave differently, which might be due to the different temperature, humidity, and photoperiod conditions, which are controlled inside greenhouses.

Finally, the correlation analysis between the number of eggs and the number of adults of *B. tabaci* was significant both in tomato crops ($r = 0.94$; $p < 0.01$) and in pepper crops ($r = 0.87$; $p < 0.01$). Thus, *B. tabaci* adult sampling in under cover plots can give an approximation of crop egg density, which is in itself an important tool for decision-making aiming at controlling whiteflies in the region.

According to these results, we could say that the relative abundance of *Bemisia tabaci* differed according to the developmental stage, crop type, plot, and sampling week; and a higher abundance of *B. tabaci* was found in pepper crops. Certain studies report the existence of *B. tabaci* oviposition and nymph development preferences over plants with pubescent leaves, such as the tomato (Morales and Cermeli, 2001; Sánchez *et al.*, 1997). However, in these studies it was observed that *B. tabaci* took longer to develop in tomato crops in relation to other hots plants (*Phaseolus vulgaris* L., *Gossypium hirsutum* L., *Hibiscus rosa-sinensis* L. y *Euphorbia pulcherrima* Willd.).

Overall, the fluctuation of *B. tabaci* was regular in both crop types, and population increases occurred gradually since infestation, with a higher abundance of adults towards the last weeks of sampling. These results agree with those observed in populations of immature stages of *B. tabaci* in Almería, Spain where a gradual increase towards the end of the greenhouse pepper crop period was observed, and where adult populations exhibited three abundance peaks that might have been due to different generations (González Zamora and Moreno Vázquez, 1996). Likewise, in Maracaibo, Venezuela, under abiotic controlled conditions it was determined that *B. tabaci* can present 13 to 14 generations per year in tomato crops, and approximately four to five cycles in host plants in 120 days (Sánchez *et al.*, 1997).

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