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SCIENTIFIC COMMUNICATION

NATURAL FACTORS INFLUENCING WHITEFLY ATTACK IN TOMATO

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ABSTRACT

The objective of this study was to determine the effects of total rainfall and mean temperature, predators and parasitoids, height within the canopy, leaf chemical composition, levels of leaf N and K and densities of leaf trichomes and crystalliferous idioblasts on the intensity of *Bemisia tabaci* (Genn.) biotype B (Homoptera: Aleyrodidae) attack in six tomato (*Lycopersicon esculentum* var. "Santa Clara") plantations in two municipalities. Whitefly adults population positively correlated with mean temperature (r = 0.41, P = 0.0334). A higher density of nymph and adults of whitefly adults was observed at the base as compared to the apex of the plant. No significant effects of total rainfall, natural enemies, leaf chemical composition, levels of leaf N and K and trichome and crystalliferous idioblasts densities were observed on the whitefly population in tomato plants.

KEY WORD: *Bemisia tabaci* biotype B, *Lycopersicon esculentum*, population dynamic, nitrogen, temperature.

RESUMO

FATORES NATURAIS AFETANDO O ATAQUE DE MOSCA-BRANCA EM TOMATE. O objetivo deste estudo foi determinar os efeitos de pluviosidade, temperatura média, predadores e parasitóides, altura do dossel, composição química foliar, níveis de N e K foliares e densidades de tricomas e de idioblastos cristalíferos foliares na intensidade de ataque de *Bemisia tabaci* (Genn.) biótipo B (Homoptera: Aleyrodidae) em seis plantações de tomate *Lycopersicon esculentum* var. "Santa Clara" em dois municípios. Observou-se que a população de adultos de mosca-branca se correlacionou positivamente com a temperatura média (r = 0,41; P = 0,0334). Um maior número de ninfas e de adultos de mosca-branca foi observado no terço basal, quando comparado ao terço apical das plantas. Não se detectou efeito significativo de pluviosidade, de inimigos naturais, de composição química foliar, de níveis de N e de K foliares e de densidade de tricomas e de idioblastos cristalíferos foliares na população de mosca-branca em plantas de tomate.

PALAVRAS-CHAVE: *Bemisia tabaci* biótipo B, *Lycopersicon esculentum*, dinâmica populacional, nitrogênio, temperatura.

The whitefly *Bemisia tabaci* (Genn.) biotype B (Homoptera: Aleyrodidae) is a serious pest of tomato (*Lycopersicon esculentum*) in several countries, including Brazil (Hirano et al., 1995; Leite et al., 1998). Control of this insect consists primarily of blanket extensive use of insecticides. One of the main reasons for this intense application is the lack of information on the factors regulating insect-pest population. Such information could facilitate the prediction of insect attack which in turn can reduce economic losses caused (Dent, 1995).

Population density of *B. tabaci* are affected by several factors such as temperature and rainfall (Horowitz et al., 1984; Horowitz, 1986; Hirano et al., 1995), crop fertility, the position of the leaves on the tomato canopy, trichomes and compounds present in them (Leite et al., 1998) and natural enemies (Horowitz & Ishaaya, 1995). Also, Franceschi & Horner (1980) and Leite et al. (1999) associated the presence of crystals in the leaves of several vegetables, including L. hirsutum f. glabratum (PI 134417), with resistance to attack from herbivores. Presence of calcium oxalate crystals in Solanaceae leaves and small crystal idioblasts in *Lycopersicon* has been reported by Metcalfe & Chalk (1957).

The objective of this study was to determine the effects of total rainfall and mean temperature, predators and parasitoids, height within the canopy,

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leaf chemical composition, levels of leaf N and K and densities of leaf trichomes and crystalliferous idioblasts on the intensity of whitefly attack in six tomato plantations, in two municipalities.

This experiment was conducted using three tomato (*L. esculentum* var. "Santa Clara") plantations (distance between plantations was 200 m) in Viçosa (20º44'38.7" S, 42º49'18" W and 649 m), from April to July of 1998 and from February to December of 1999, and three tomato plantations (distance between plantations was 1 km) in Guidoval (21º08'36" S, 42º47'54" W and 239 m), from April to July and from September to December of 1999. Both municipalities are located in Minas Gerais state. The experimental design was entirely randomiized with six replicates (each of the six plantations). The tomato plantations had 1,000 plants spaced 0.5 m apart within rows and 1.0 m between rows, trellised and pruned above the 7th branch, to maintain the main branch. The four periphery rows and the first ten plants on each side of the row formed the outer border and the remaining plantation was considered to be the useful area.

The beating tray method (Stansly, 1995) was used to estimate the number of adult whitefly, predators and parasitoids present in one leaf from each of 10 plants / plantation. The sampling frequency was once a week in Viçosa and once a month in Guidoval. This method consisted in beating the first expanded leaf / apex of the plant into a 34 x 26 x 5 cm white tray, counting the insects that felt in the tray. Insects lodged into the tray were collected using an aspirator or tweezers and held individually in 8 x 2 cm glass flasks containing 70% ethanol for further identification. Direct counting was used to estimate the number of *B. tabaci* (Horowitz, 1993) adults and nymphs (determined as 3rd and 4th instars by visual inspection), predators and parasitoids in the bottom, middle and apical parts of 30 plants / plantation (one leaf / plant) (Leite et al., 1999). Nymphal parasitism index, number of *B. tabaci* biotype B eggs and spatial distribution of the eggs in the tomato plant was evaluated with 40 x magnifying lens. One apical leaflet from each part of the canopy (apical, medium and bottom) of 30 plants / plantation was collected and conditioned in transparent white plastic bags, sealed and transported to the laboratory for evaluating. For each sample, six fields in the median part (field equidistant between the median vein and the margin) were analyzed.

Trichome and crystalliferous idioblast densities were evaluated in one apical leaflet, collected monthly, from each part of the canopy (apical, medium and bottom) of nine plants / plantation. The preparation of slides and counting of trichomes and crystalliferous idioblast were made according to Leite (2000). Level of N and K in leaves of the tomato was monthly determined in the laboratory in one expanded leaf from the upper part of each of 12 plants / plantation. These leaves were dried and ground, then K was determined with flame photometer and N was analysed by the Nessler method. The gas chromatography / mass spectrometry (GC / MS) analysis was made monthly with fully expanded leaves from the upper part of 12 plants / plantation. Fresh leaves (10 g) were cut with scissors and immersed in a 100 mL hexane for 24 h. The hexane extract was evaporated to dryness at 30º C in a rotatory evaporator, sealed in nitrogen and stored in a freezer until analysis. The hexane extract was analysed with GC / MS and only compounds with a similarity index higher than 80% were considered. The morphological, nutritional and chemical analysis were made with three evaluations monthly for each of the six plantations.

Total rainfall and median temperature (minimum + maximum / 2) data were obtained daily with pluviometer and thermometer (minimum and maximum), respectively, in Guidoval (1999) and by the "Estação Climatológica Principal" of Federal University of Viçosa (UFV) (INMET / 5ºDISME / UFV) in Viçosa (1998-1999). Data was submitted to the variance analysis and the means were separated by Tukey's multiple range test ($P \leq 0.05$) and used to verify the effect of canopy height on trichome and crystalliferous idioblast densities, on the number of eggs, nymphs and adults of whitefly and its predators and parasitoids. Pearson's correlations ($P < 0.05$) were used to evaluate the relationships of total rainfall, median temperature, predators and parasitoids, leaf chemical composition, leaf N and K levels, leaf trichome and crystalliferous idioblasts densities with the number of eggs, nymphs and adults of the whitefly.

A higher number of whitefly adults (2.20 ± 0.96 / leaf), nymphs (13.29 ± 4.72 / leaf) and eggs (0.11 ± 0.06 / cm^2) was detected in Guidoval as compared to Viçosa (0.21 ± 0.07 / leaf, 0.00 ± 0.00 / leaf and 0.00 ± 0.00 / cm^2, respectively) due to the higher temperatures, such as related by Horowitz (1986) in cotton and Leite et al. (2002) in *Solanum gilo*. The average temperature in Guidoval in the year 1999 was 23.62 ± 1.34º C while in Viçosa the temperature in the years 1998 and 1999 was 21.67 ± 0.79º C and 20.85 ± 0.73º C, respectively, since the adults of whitefly correlated with the mean temperature ($r = 0.41$, $P = 0.0334$). Horowitz et al. (1984) concluded that the temperature and the relative humidity were the most important factors relating to population changes of whitefly in the cotton fields in Israel.

No significant effects ($P > 0.05$) of leaf N and K and leaf chemical composition were observed on the whitefly population. Four peaks with retention times of 25.488, 28.238, 42.802 and 48.356 min. were recorded in the TIC of the hexane extracts of the *L. esculentum*

and leaves on GC / MS analysis. The peak eluting at 25.488 min was identified as palmitic acid with a similarity index (SI) of 87%. The peak eluting at 28.238 min was identified as one of the following terpenes: mircene / farnesol / a-humulene / trans caryophyllene with a SI of 83%. The peaks eluting at 42.802 and 48.356 min were identified as hexacosane and triacontane with a SI index of 95 and 90%, respectively.

Trichome and crystalliferous idioblasts densities did not show relationships with the whitefly populations. However, canopy height affected the whitefly population and trichome and crystalliferous idioblast densities. A higher nymph and whitefly / leaf adults density was recorded at the base (23.47 and 9.16, respectively) and medium (20.31 and 7.32, respectively), which were statistically different from those of the apex of the plant (2.84 and 3.12, respectively). No significant difference ($P > 0.05$) was detected between the number of whitefly eggs and canopy height. Leaf trichome and crystalliferous idioblast densities were higher in the apical part (20.02 and 14.29, respectively) than in the medium (11.11 and 9.24, respectively) and lower parts (8.12 and 6.87, respectively). The percentage of broken trichomes was higher in the medium (21.83) and bottom (24.88) parts as compared to the apical (4.10) parts. A higher leaf trichome density / mm^2 was recorded in the abaxial face (21.29 ± 1.52) than on the adaxial (8.19 ± 0.57) with the trichomes being mostly non-glandular (99.65%).

B. tabaci lays its eggs on the younger leaves, often found at the apical part of the plants (Liu & Stansly, 1995). The second instar nymphs do not move much, and since the plant continues to grow the adults emerge on the inferior third part of the tomato plant (Liu & Stansly, 1995; Leite et al., 1998). In this study, the number of whitefly eggs was not found to be significantly correlated with position in the tomato canopy but higher adult and nymph densities on the plant inferior were observed. A plausible explanation of the non-occurrence of oviposition preferentially on the apical leaves may be due to the fact that these leaves have abundant nonglandular trichomes which can make locomotion, feeding and oviposition of insects difficult (Leite et al., 1999), despite of the absence of a significant relationship between them.

The parasitoid observed in the tomato plantations in Viçosa and Guidoval was *Encarsia* sp. (Hymenoptera: Aphelinidae) (0.01 ± 0.01 and 0.02 ± 0.02 / leaf, respectively) and the predators observed included spiders [*Misumenops* spp. (Thomisidae) and Anyphaenidae] (0.08 ± 0.04 and 0.09 ± 0.04 / leaf, respectively), Carabidae (Coleoptera) (0.06 ± 0.02 and 0.00 ± 0.00 / leaf, respectively), *Chrysoperla* spp. (Neuroptera: Chrysopidae) (0.01 ± 0.01 and 0.00 ± 0.00 / leaf, respectively) and Syrphidae (Diptera) (0.01 ± 0.01 and 0.00 ± 0.00 / leaf, respectively). The number of natural enemies was not significantly correlated with whitefly population and no parasite-infected whitefly nymphs were detected, probably due to the number of natural enemies being low in the regions studied. *Encarsia* sp. and the predators *Chrysoperla* spp. and Coccinellidae have been used to control whitefly population in several plants (Legaspi et al., 1996; Liu & Stansly, 1996) and in some cases a positive effect was obtained (Hoelmer et al., 1994; Heinz & Nelson Hagler & Naranjo, 1996). Was observed that *Hippodamia convergens* Guérin-Menéville (Coleoptera: Coccinellidae) appeared to be capable of locating whitefly present in low density even at the beginning of the season.

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