Resistance of tomato genotypes to the silverleaf whitefly mediated by acylsugars

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ABSTRACT

Acylsugars in the leaflets of the wild accession LA-716 (Lycopersicon pennellii) gives resistance to Bemisia spp., which causes expressive losses to the tomato crop. The goal of this work was to evaluate the resistance to the silverleaf whitefly (Bemisia tabaci) of previously selected genotypes, based on the level of acylsugars in the leaflets. Families, such as Solanaceae species, distributed in 74 different countries, mainly of 2,3,4-tri-O-acylated glucose esters having fatty acids with four to twelve carbon atoms (Burke et al., 1987). This phytochemical can prevent oviposition, feeding, or acting deleteriously effect on the development of certain phases of arthropod pests (Goffreda et al., 1995; Shapiro et al., 1994; Resende et al., 2001; Constandin et al., 2006; Gonnalves et al., 2006; Resende et al., 2008).

B. tabaci adaptive ability led to an accelerated proliferation and significant damage in crops in Brazil and all over the world (Duffus, 1996). With poliphagous habits, B. tabaci can survive in more than 600 different vegetable species, distributed in 74 different families, such as Solanaceae (Oliveira et al., 2001). The adaptive ability of the whitefly, ally to intensive agricultural practices and ecological disturbances lead to its accelerated proliferation, making the chemical control inefficient. So, the use of resistant genotypes (e.g. LA-716) Lycopersicon pennellii (Correll) with high acylsugar contents) becomes the best way to it control.

Several studies with LA-716 L. pennellii have demonstrated high resistance levels of this access to important arthropods-pest, such as the tomato pinworm (Azevedo et al., 2003; Resende et al., 2006), whiteflies (Berlinger & Dahan, 1984; Ponti et al., 1975; Pamplona, 2001; Resende, 2006) and mites (Resende et al., 2002; Resende, 2003). The resistance of L. pennellii LA-716 has been associated with the presence of acylsugars, which are viscous allelochemicals, composed mainly of 2,3,4-tri-O-acylated glucose esters having fatty acids with four to twelve carbon atoms (Burke et al., 1987). This phytochemical can prevent oviposition, feeding, or acting deleteriously effect on the development of certain phases of arthropod pests (Goffreda et al., 1989; Shapiro et al., 1994; Resende et al., 2002; Resende et al., 2006; Goncalves et al., 2006; Resende et al., 2008).

Keywords: Bemisia tabaci biotype B, Lycopersicon esculentum, Lycopersicon pennellii, allelochemicals, plant breeding, host plant resistance.

RESUMO

Resistência de genótipos de tomateiro a Bemisia tabaci biótipo B, mediada por acilaçúcares

Aciñaçúcares presentes nos folíolos do acesso selvagem 'LA-716' (Lycopersicon pennellii) conferem resistência a moscas-brancas (Bemisia spp.), causadoras de danos expressivos à cultura do tomate. O objetivo do trabalho foi avaliar a resistência de genótipos de tomateiro à mosca-branca Bemisia tabaci biótipo B, com base nos teores de acilaçúcares nos folíolos. Foram selecionadas plantas F1, [F1(Lycopersicon esculentum TOM 584 x L. esculentum ‘TOM 584’ x L. pennellii LA-716)] de teores extremos de acilaçúcares: BPX-370B pl#30-275, BPX-370B pl#79-278, BPX-370B pl#30-380, BPX-370B pl#25-271 (altos teores), BPX-370B pl#30-02, BPX-370B pl#30-142 (baixos teores). Esses genótipos, juntamente com os parentais TOM 584 e LA-716, foram submetidos à infestação da mosca-branca. Avaliaram-se a oviposição e o desenvolvimento de ninfas. A oviposição e o desenvolvimento de ninfas foram significativamente inferiores nos genótipos BPX-370B pl#25-271 e BPX-370B pl#79-278 (altos teores), BPX-370B pl#30-02, BPX-370B pl#30-142 (baixos teores). Esses genótipos, juntamente com os parentais TOM 584 e LA-716, foram submetidos à infestação da mosca-branca. Avaliaram-se a oviposição e o desenvolvimento de ninfas. A oviposição e o desenvolvimento de ninfas têm sido reduzido, indicando que, mesmo havendo a oviposição sobre os folíolos, provavelmente os acilaçúcares exerceram efeito adverso ao desenvolvimento do inseto.

Keywords: Bemisia tabaci biotype B, Lycopersicon esculentum, Lycopersicon pennellii, alleloquímicos, melhoramento vegetal, resistência a pragas.

Palavras-chave: Lycopersicon esculentum, Lycopersicon pennellii, alleloquímicos, melhoramento vegetal, resistência a pragas.

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decrease in the adult insect population of *B. Argentifolii (= B. tabaci biotype B)* with the use of pulverizations on the plants prepared with purified acylsugars extracted from *L. pennellii*. The oviposition was also affected by the acylsugars, resulting in a smaller number of nymphs and eggs; the nymph development was not affected though.

Resende et al. (2002) and Gonçalves et al. (2006) indicate the monogenic heritance as the most probable explanation for the high levels of acylsugars in the plants, as well as the action of a recessive allele with incomplete dominance. The transferring of genes involved in the synthesis of these alelochemical compounds for commercial genotypes is one of the objectives of the tomato plant breeding concerning the resistance to the silverleaf whitefly. Therefore, in this research we aimed at studying the possible correlation between the acylsugar contents in the tomato leaflets and the resistance to the silverleaf whitefly (*B. tabaci* biotype B) based on oviposition and occurrence of nymphs in F$_{RC_1}$ (= plants F$_{L. esculentum ‘TOM-584’ x L. esculentum Mill. ‘TOM-584’ x L. pennellii ‘LA716’)}; plants.

**MATERIAL AND METHODS**

The experiment was performed under greenhouse conditions, in Lavras, Minas Gerais State, Brazil, on October 2001. Plants of F$_{1}$ (*L. esculentum ‘TOM-584’ x L. pennellii ‘LA-716’*) population were selected for high levels of acylsugars in the leaflets, and these were backcrossed with ‘TOM 584’ (recurrent parent) and self-pollinated. From the generated F$_{RC_1}$ population, the following genotypes were selected based on acylsugar contents in the leaflets, according to the methodology described by Resende et al. (2002): BPX-370B pl#30-275, BPX-370B pl#79-278, BPX-370B pl#30-380, BPX-370B pl#30-271 (selected with high level of acylsugars), BPX-370B pl#30-02, BPX-370B pl#30-142 (selected with low levels of acylsugars).

The whiteflies for infestation were bred in tomato plants (cultivar Santa Clara), in a greenhouse. Adults of the whitefly were identified in the entomology laboratory of the Universidade Federal de Lavras.

The selected genotypes, along with the parents ‘TOM-584’ and ‘LA-716’, used as check, comprised the eight treatments, which were evaluated in a randomized blocks design. Three clones (replications) of each of the eight genotypes were cultivated in polyethylene vases of up to five L until the pre-flowering stage and kept together for 48 hours in the greenhouse under the infestation of the silverleaf whitefly population. The leaflets sampled for oviposition evaluation were taken from the middle of the leaves placed on the higher third of each plant, according to Toscano et al. (2002), and the number of eggs per 2 cm$^2$ of four sampled leaflets was counted, using a magnifier. Then, the plants were transferred and kept in screened cages (blocks), free of infestation. Eighteen to twenty days after the counting of eggs, samples of four expanded leaflets from the higher third of the plants were evaluated for the development of nymphs (number of nymphs in the last instar) with a magnifier. The analysis of variance (ANOVA) was performed and the means were compared through the Skott Knott test (p<0.05) using a SISVAR statistical package. The Pearson’s correlation of the acylsugar level in the leaflets, the oviposition and the average number of nymphs of silverleaf whitefly nymphs were estimated.

**RESULTS AND DISCUSSION**

The silverleaf whitefly oviposition in the BPX-370B pl#30-275 and BPX-370B pl#30-380 genotypes, selected for high levels of acylsugars, was significantly lower than the oviposition in the ‘TOM-584’ genotype and other genotypes evaluated from the F$_{RC_1}$ population. However, the genotypes also selected for high levels of acylsugars (BPX-370B pl#25-271 and BPX-370B pl#79-278) presented high levels of oviposition, similar to that observed in TOM-584 and the genotypes with low levels of acylsugars (BPX-370B pl#30-02 and BPX-370B pl#30-142). A low and non-significant value for the correlation between the levels of acylsugars and silverleaf whitefly oviposition ($r$=-0.36) was observed (Table 1).

Maciel (2008) and Silva (2009) reported that genotypes selected for high levels of acylsugars, obtained from the same crossing of this work, showed low levels of *B. tabaci* biotype B oviposition. These results were not significant enough to claim that there is not a preference for oviposition in the genotypes with high levels of acylsugars. However, Pamplona (2001) evaluated the oviposition of *B. tabaci* on genotypes of a F$_2$ (*L. esculentum ‘TOM-584’ x L. pennellii ‘LA-716’) population and reported an evident action of acylsugars upon the whitefly in the genotypes with high contents of this substance because the insects were trapped in the exudates and died without ovipositing. The author related the non preference type for oviposition both in confined and free choice experiments and the association of the high acylsugars contents to the density of type IV trichomes.

The average number of nymphs was significantly higher in the two F$_2$RC$_1$ genotypes with a low level of acylsugars than in the four ones with a high level of acylsugars. In all the low acylsugars level genotypes (BPX-370B pl#30-02 and BPX-370B pl#30-142), the number of nymphs was similar to the susceptible check (TOM-584). On the other hand, in the four F$_{RC_1}$ genotypes with high levels of acylsugars, the number of nymphs was lower than in the other treatments, except for *L. pennellii ‘LA 716’. Unlike what happened with the oviposition, the average number of nymphs per leaflet was negatively and significantly ($r$=-0.94) correlated with the acylsugar level in the leaflets (Table 1). Selection of the genotypes was only based on the acylsugars levels in the leaflets, although viscosity and other factors (not yet identified) present in LA-716 can contribute to the resistance. Nevertheless, some of these additional factors were not incorporated (or selected) in the improved genotypes from backcross generation, which explain
Acylsugar levels in the leaflets, average number of eggs and nymphs, and their Pearson’s correlations, involving eight tomato plant genotypes selected for extreme levels of acylsugars in the leaflets (níveis de acilaçúcares nos folíolos, número médio de ninhas e de ovos, e suas correlações de Pearson, envolvendo oito genótipos de tomateiro selecionados para níveis extremos de acilaçúcares nos folíolos). Lavras, UFLA, 2001.

| Genotype              | Acylsugar level (nmol cm⁻²) | Average number of eggs (per 2 cm² of leaflet) | Average number of nymphs (per leaflet) |
|-----------------------|-----------------------------|----------------------------------------------|----------------------------------------|
| BPX-370Bpl#30-142 (=Low 1) | 4.7±0.8 b                  | 66.7±6.2 c                                  | 115.1±4.8 c                             |
| BPX-370Bpl#30-02 (=Low 2) | 4.9±1.1 b                  | 88.6±5.6 c                                  | 155.5±7.3 c                             |
| TOM-584 (=Low)         | 7.5±1.3 b                  | 131.7±9.2 c                                 | 154.3±6.9 c                             |
| LA716 (=High)          | 32.5±5.8 a                 | 0 a                                          | 0.1 a                                   |
| BPX-370Bpl#25-271 (=High 1) | 36.4±7.2 a              | 110.3±4.6 c                                 | 66.1±3.1 b                              |
| BPX-370Bpl#30-380 (=High 2) | 38.2±5.4 a              | 30.7±3.3 b                                  | 60.6±5.7 b                              |
| BPX-370Bpl#79-278 (=High 3) | 40.1±8.1 a               | 108.6±7.0 c                                 | 51.6±3.6 b                              |
| BPX-370Bpl#30-275 (=High 4) | 43.2±5.6 a              | 38.5±4.5 b                                  | 31.1±7.3 b                              |

Linear correlations (r):

-0.36 n<sup>1</sup>

-0.94**

 Mean(s) followed by the same letter in the columns do not differ according to the Skott Knott test (p<0.05) (médias seguidas das mesmas letras, nas colunas não diferem significativamente entre si pelo teste de Skott Knott com p<0.05); n<sup>1</sup>non significant; **significant by the F test at 1%.

The negative correlation between the acylsugars levels in the leaflets and the number of nymphs of B. tabaci biotype B in the last instar was high (r=-0.94), indicating that the indirect selection of genotypes with high levels of acylsugars in the leaflets leads to the repression of the silverleaf whitefly nymph development (Table 1).

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The differences in resistance among LA-716 and high acylsugars selected genotypes from F<sub>R,RC</sub> <sup>1</sup>. Many studies have associated tomato pesticides resistance to trichomes present in leaflets, related to changes in oviposition and survival of whitefly nymphs. Vendramim et al. (2009) related that oviposition of *B. tabaci* biotype B was concentrated near to non glandular trichromes. On the other hand, Gonçalves et al. (2007) verified that acylsugars levels were correlated with neither glandular nor non-glandular trichome densities.

The *L. pennellii* ‘LA-716’ resistance to the silverleaf whitefly, which is attributed to the acylsugars in the literature (Goffreda et al., 1989), was confirmed by Freitas et al. (2002); Maciel (2008); Pereira et al. (2008) and Silva (2009). Liedl et al. (1995) reported that acylsugars applications, extracted from the LA-716 accession and pulverized on the *L. esculentum* plants reduced oviposition and the number of nymphs of *B. tabaci* biotype B.

Maciel (2008) reported that tomato hybrids obtained through the crossing of contrasting lines for acylsugars contents (low x high levels) presented fewer oviposition and lower survival of silverleaf whitefly nymphs than lines with low levels of acylsugars and these parameters do not differ from high levels of acylsugars lines. Silva (2009) reported that both oviposition and survival of nymphs of *B. argentifolii* (= *B. tabaci* biotype B) were reduced by the presence of high acylsugars contents in tomato genotypes, especially when compared to control with low acylsugars levels (the commercial hybrid Débora Max and the experimental line TOM 684).

This research shows that acylsugars are responsible for resistance of tomato to *B. tabaci* biotype B. So, these genotypes selected with high levels of this alelochemical are promising in breeding programs, aiming through backcrossing to obtain advanced lines that could be used to obtain hybrids.

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