Feeding non-preference by *Spodoptera frugiperda* and *Spodoptera eridania* on tomato genotypes

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ABSTRACT

Larvae of the genus *Spodoptera* spp. are highly polyphagous and can cause economical losses in several agricultural crops. Given their growing importance in the tomato crop, especially for industry, this work aimed to evaluate the feeding non-preference by larvae of *Spodoptera frugiperda* (J. E. Smith, 1797) and *Spodoptera eridania* (Cramer, 1782) on tomato genotypes and classify them by the levels of resistance. The commercial cultivar Santa Clara was set as the susceptible standard and line PI 134417 as the resistant standard to evaluate the lines PI 134418, PI 126931, LA 462 and LA 716. Feeding non-preference tests were performed under non-choice and free-choice conditions to evaluate the genotype attractiveness to larvae at predetermined times after their release, as well as the leaf area consumed. Overall, the genotypes LA 716 and PI 126931 were the least attractive to *S. frugiperda*, whereas Santa Clara was the most attractive and consumed. For *S. eridania*, the genotypes PI 126931, LA 462, LA 716 and PI 134418 were the least preferred for feeding, and Santa Clara and PI 134417 were the most attractive and consumed. The genotypes LA 716 and PI 126931 are moderately resistant to *S. frugiperda* and *S. eridania*; PI 134418 and LA 462 are moderately resistant to *S. eridania*; PI 134417 is susceptible to *S. frugiperda* and *S. eridania*; and Santa Clara is highly susceptible to both *S. frugiperda* and *S. eridania*.

Key words: host plant resistance, fall armyworm, southern armyworm, *Lycopersicon* spp.

RESUMO

Não preferência para alimentação em genótipos de tomateiro por *Spodoptera frugiperda* e *Spodoptera eridania*

Lagartas do gênero *Spodoptera* spp. são altamente polífagas, podendo causar danos econômicos em diversas culturas agrícolas. Em vista de sua emergente importância na cultura do tomate, principalmente o destinado à indústria, este trabalho teve por objetivo avaliar a não preferência, para alimentação, de lagartas de *Spodoptera frugiperda* (J. E. Smith, 1797) e *Spodoptera eridania* (Cramer, 1782) por genótipos de tomateiro, e classificá-los quanto aos graus de resistência. Como padrão susceptível, utilizou-se o cultivar comercial Santa Clara e, como resistente, a linhagem PI 134417, sendo avaliadas, ainda, as linhagens PI 134418, PI 126931, LA 462 e LA 716. Realizaram-se testes de não preferência, para alimentação, com e sem chance de escolha, avaliando-se a atratividade dos genótipos de tomateiro para as lagartas, em tempos pré-estabelecidos após sua liberação, além da massa foliar consumida. Em geral, os

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genótipos LA 716 e PI 126931 foram os menos atrativos para a *S. frugiperda*, enquanto Santa Clara foi o mais atrativo e consumido. Quanto a *S. eridania*, os genótipos PI 126931, LA 462, LA 716 e PI 134418 foram os menos preferidos, para a alimentação, pelas lagartas, e Santa Clara e PI 134417 foram os mais atrativos e consumidos. Os genótipos LA e PI 126931 são moderadamente resistentes, do tipo não preferência para alimentação, para a *S. frugiperda* e *S. eridania*; PI 134418 e LA 462 são moderadamente resistentes a *S. eridania*; PI 134417 é susceptível a *S. frugiperda* e *S. eridania*; Santa Clara é altamente susceptível a *S. frugiperda* e *S. eridania*.

Palavras-chave: resistência de plantas a insetos, lagarta-militar, lagarta-das-vagens, *Lycopersicon* spp.

INTRODUCTION

Species of the genus *Spodoptera* Guenée are worldwide distributed and most described species are major pests of several crops (Pogue, 2002). Larvae of *Spodoptera* cause damage in different plant structures, which can occur with severity in maize (Cruz, 1995), cotton (Santos et al., 2005), soybean (Capinera, 2005), peanut (Teixeira et al. 2001), wheat (Salvadori & Rumiatto, 1982), sorghum (Costa et al., 2006), rice (Busato et al., 2005), potato (Bertels, 1962), onion (Bavaresco et al., 2003), tomato (Embrapa, 2006), sunflower (Soares et al., 2010) and others.

Among the species of this genus, *Spodoptera frugiperda* (JE Smith, 1797) and *Spodoptera eridania* (Cramer, 1782) (Lepidoptera: Noctuidae) are important pests for several crops. Larvae of these species have a polyphagous feeding habit (Luginbill, 1928; Soo Hoo & Fraenkel, 1966) and in recent agricultural years, larger infestations of these pests have been detected in soybean (Santos et al., 2005), cotton (Fernandes et al. 2002; Santos et al., 2005) and tomato (Czepak et al. May 2011), mainly because of the agricultural systems used for these crops, in close areas or in succession, providing a continuous supply of food for the insects (Santos et al., 2009).

In tomato, mainly intended for industrial processing, the damages caused by larvae of *S. frugiperda* and *S. eridania* begin after transplanting the seedlings to the field and can extend throughout plant development.

Larvae initially group and feed together, scraping the leaf parenchyma and, along their development, are distributed throughout the plant, feeding on different structures (Czepak et al., 2011), especially leaves, and piercing fruits (King & Saunders, 1984). For their greed voracious behavior and difficult control, the *Spodoptera* larvae have been considered important pests, increasingly common in tomato crops, especially in regions of the Brazilian Cerrado (Czepak et al., 2011).

These insect pests have mainly been controlled with synthetic insecticides, which indiscriminate use can lead to the evolution of resistance in the field, among other adverse factors (Schmidt, 2002). There are several reports of pest resistance to insecticides, which is also observed for species of *Spodoptera* (Diez-Rodriguez & Omoto, 2001; Morillo & Notz, 2001).

Thus, the host-plant resistance (HPR) is a tactical control method within the precepts of integrated pest management (IPM), especially for reducing the population density of the insect pest below the economic damage level, not causing imbalances within the agroecosystem, not adding additional costs to the farmer, for having persistent effect during the phenological crop cycle and also for being compatible with other control methods (Lara, 1991).

Several species of the genus *Lycopersicon* exhibit resistance of the types antibiosis and nonpreference, which are related mainly to the action of chemicals present in the leaf trichomes (Gianfagna et al., 1992; Ecole et al., 1999). In tomato, four types of trichomes were identified, namely I, IV, VI and VII, in which exudates such as glycosidic flavonoids (rutin), nitrogen phenolic compounds (chlorogenic acid), methyl ketones (2-tridecanone and 2-undecanone) and sesquiterpenes (zingiberene) are synthesized (Lin et al. 1987; Juvik et al. 1988). Besides, physical characteristics, such as cuticle layer thickness, and chemical characteristics of the fruit, as well as growth habit, are factors that may also be involved in resistance to insects (Leite et al. 2003).

Studies on feeding preference and biology of *S. frugiperda* and *S. eridania* have been conducted in various hosts, including maize (Boiça Junior et al., 2001), peanut (Campos et al., 2010), soybean (Veloso, 2010; Souza, 2011) and cotton (Campos, 2008). However, with respect to the tomato crop, studies are scarce in the literature, in spite of genotypes resistant to attack of these two pests.

Given the growing importance of the damage caused by larvae of *Spodoptera* spp. in tomato crops, especially crops intended for industry, as well as the lack of information on resistant genotypes, this study aimed to evaluate the feeding nonpreference by *S. frugiperda* and *S. eridania* on tomato genotypes and classify these genotypes by their levels of resistance.

MATERIAL AND METHODS

The experiment was conducted at the Laboratory of Plant Resistance to Insects of the College of Agriculture and Veterinary Sciences - FCAV/UNESP, SP.

The experimental conditions were maintained at temperature of 25 ± 1 ºC, RH of 70 ± 10% and photophase of 12 h.

Tomato plants of the commercial genotype Santa Clara (*Lycopersicum esculentum*) (Suinaga et al., 2003) were used as the susceptible standard and the line PI 134417 (*L. hirsutum* f. *glabratum*) (Bottega, 2010) as the resistant standard, both selected by the levels of resistance to tomato leafminer (*Tuta absoluta*) (Lepidoptera: Gelechiidae) (Meyrick, 1917). Besides these genotypes, the lines PI 134418 (*L. hirsutum* f. *glabratum*), PI 126931 (*L. pimpinellifolium*), LA 462 (*L. peruvianum*) and LA 716 (*L. pennellii*), all from the germplasm bank of the Agronomic Institute of Campinas (IAC), were also evaluated.

Plants were grown in 7-L pots (40 cm x 20 cm in diameter) containing soil, sand and manure in the ratio of 2:1:1 in a greenhouse. Irrigation was performed daily.

Larvae of *S. frugiperda* and *S. eridania* used in the experiments derived from field collections in corn and soybean crops, respectively, and were maintained for six generations (about six months) in a laboratory with artificial diet based on beans, wheat germ, soybean meal, casein and yeast, as described by Greene et al . (1976).

The feeding non-preference test for the free-choice condition was carried out using leaves from the middle part of plants of the different tomato genotypes, with approximately 60 days after emergence (between 40 and 60 cm, depending on the genotype). The leaves were collected, washed with a solution of sodium hypochlorite at 0.5%, and dried with paper towels. Leaflets, one of each genotype, were placed so as to be equidistant from each other in Petri dishes (14 cm in diameter) lined with filter paper moistened with distilled water, totaling six leaflets per plate. Then, a third instar *S. frugiperda* larva or a fourth instar *S. eridania* larva was released at the center of the plate per tomato genotype. The experiment was arranged in a randomized blocks design, with ten repetitions.

The non-choice test was conducted in Petri dishes (8 cm in diameter) using only one tomato leaf (one genotype) per plate, in which a third instar *S. frugiperda* larva or a fourth instar *S. eridania* larva was released. For this test, a completely randomized design was used with 15 replications. According to Lara (1991), it is essential to carry out non-choice tests to confirm the resistance of a genotype, since a plant can be less damaged in the presence of various genotypes. However, this characteristic cannot be maintained when the insect is confined with only one plant or when the plant is cultivated alone.

In both tests, the attractiveness of tomato genotypes were evaluated for the two species of *Spodoptera* in relation to the leaflets at 1, 3, 5, 10, 15, 30, 60, 120, 360, 720 and 1440 minutes after their release, ending the assay after this last assessment or when the consumption reached approximately 75% of the total leaf area. The evaluation of insect preference using non-preference tests, free and non-choice, is important since they can show mainly the presence of allelochemicals (kairomones and allomones) in leaflets of different genotypes. When these allelochemicals volatilize, they act in the chain of stimuli between insect and plant, playing positive or negative effect on the feeding behavior of the pest.

To obtain the mass consumed, the projection of leaves of each genotype was drawn in typing paper before being supplied to larvae. After the test, what was left of the leaves, after consumption by larvae, was again drawn over the drawing of the whole leaves. Then, the part consumed was cut up from the paper and weighed on an analytical balance.

The Kolmogorov-Smirnov test was applied to ascertain that the data had a normal distribution and the Bartlett test to check whether there was homogeneity of variance. Because the data were not normally distributed, but homoscedastic, they were transformed into $(x + 0.5)^{1/2}$ and then subjected to analysis of variance (ANOVA), by the F-test. When significant, the means were compared by the Tukey test at 5% probability using the software Assistat version 7.6 (Silva & Azevedo, 2002).

The hierarchical cluster analysis (Sneath & Sokal, 1962) was also performed, using the method of Ward (Ward Jr., 1963) and the Euclidean distance as dissimilarity measure. The cluster analysis was based on the mean data of larva preference for the tomato genotypes, on the several evaluated times, the patterns of leaf consumption and on the free-choice and non-choice tests, aiming to classify the genotypes that showed the highest similarity between groups and categorize them according to the resistance levels of the type non-feeding preference, using the software Statistica version 7.0 (Statsoft, 2004).

RESULTS AND DISCUSSION

Analysis of the data from the feeding non-preference test, free-choice, for *S. frugiperda*, showed significant differences in the preference of third instar larvae for the different tomato genotypes, at 1, 3, 5, 10, 15, 30, 60, 120 and 360 minutes after release (Table 1). Generally, the Santa Clara genotype was the most attractive for the larvae during the evaluated times, while LA 716 and PI 126931 were less preferred by *S. frugiperda* (Table 1).

Table 1. Mean number of third instar larvae of *Spodoptera frugiperda* attracted at different times (minutes) and leaf mass consumed (LMC) of tomato genotypes, in free and non-choice tests. Temperature: 25 ± 1 ºC; RH.: 70 ± 10%; photophase: 12 h. Jaboticabal, SP, 2010

	TIMES[1]											
GENOTYPES	**1'**	**3'**	**5'**	**10'**	**15'**	**30'**	**60'**	**120'**	**360'**	**720'**	**1440'**	**LMC (mg)[1,2]**
FREE-CHOICE TEST												
PI 134417	0.80 ab	1.00 ab	1.00 ab	0.80 ab	0.80 ab	0.70 ab	0.80 ab	0.20 a	0.70 ab	0.80 a	0.60 a	47.55 a
Santa Clara	1.50 b	1.40 b	1.40 b	1.50 b	1.30 b	1.40 b	1.60 b	1.10 b	1.10 b	0.60 a	0.40 a	58.73 a
LA 716	0.30 a	0.20 a	0.10 a	0.10 a	0.10 a	0.10 a	0.00 a	0.30 ab	0.30 ab	0.60 a	0.90 a	52.61 a
PI 134418	0.60 ab	0.80 ab	0.70 ab	0.80 ab	0.80 ab	0.60 ab	0.50 a	0.30 ab	0.30 ab	0.20 a	0.20 a	11.26 a
LA 462	0.70 ab	0.80 ab	0.90 ab	0.80 ab	0.80 ab	0.90 ab	0.70 a	0.70 ab	0.20 ab	0.30 a	0.50 a	27.45 a
PI 126931	0.40 a	0.30 a	0.40 ab	0.40 a	0.20 a	0.30 a	0.20 a	0.10 a	0.00 a	0.50 a	0.50 a	58.76 a
F	2.80*	3.43*	3.40*	3.66**	4.17**	3.23*	7.55**	3.81**	2.85*	1.18^{NS}	1.13^{NS}	1.58^{NS}
C.V.(%)	33.48	32.08	33.24	32.73	31.20	34.88	28.94	30.49	36.31	33.08	33.83	4.31
NON-CHOICE TEST												
PI 134417	0.33 ab	0.27 ab	0.33 a	0.13 a	0.33 a	0.40 a	0.33 a	0.00 a	0.27 a	0.20 a	0.47 a	13.83 ab
Santa Clara	0.66 b	0.47 ab	0.33 a	0.40 a	0.40 a	0.53 a	0.40 a	0.67 b	0.33 a	0.40 a	0.53 a	27.79 b
LA 716	0.07 a	0.07 a	0.07 a	0.13 a	0.07 a	0.13 a	0.00 a	0.00 a	0.20 a	0.27 a	0.07 a	5.94 ab
PI 134418	0.47 ab	0.53 b	0.40 a	0.40 a	0.40 a	0.47 a	0.20 a	0.33 ab	0.33 a	0.40 a	0.20 a	6.63 ab
LA 462	0.27 ab	0.20 ab	0.13 a	0.07 a	0.27 a	0.33 a	0.33 a	0.33 ab	0.40 a	0.47 a	0.33 a	1.97 a
PI 126931	0.20 ab	0.13 ab	0.13 a	0.27 a	0.20 a	0.27 a	0.27 a	0.27 ab	0.27 a	0.27 a	0.53 a	9.31 ab
F	3.36**	2.81*	1.64^{NS}	1.81^{NS}	1.26^{NS}	1.37^{NS}	1.64^{NS}	6.06**	0.33^{NS}	0.70^{NS}	2.59^{NS}	2.97*
C.V.(%)	26.21	26.10	26.13	26.00	27.21	27.67	26.58	24.03	28.19	28.13	26.79	1.94

Means followed by the same letter in the column are not significantly different by the Tukey test at 5% probability. [1]Data were transformed to $(x + 0.5)^{1/2}$. [2]Leaf Mass consumed (LMC) converted from the typing paper.

^{NS} = non significant, * = significant at 5%, ** = significant at 1%.

The leaf mass consumed by the larvae showed no significant differences between genotypes in the free-choice test; however, it was found that genotype PI 134418 was numerically less consumed in relation to the others (Table 1).

In the non-choice test, there was a significant difference in the preference for genotypes by the larvae only at 1, 3 and 120 minutes after the release, so that Santa Clara and LA 716 remained, respectively, as the most and least attractive genotypes to *S. frugiperda* (Table 2).

The leaf mass consumed by the larvae differed significantly between the genotypes in the non-choice test (Table 2); the genotype Santa Clara stood out as being the most consumed, while LA 462 was the least consumed. However, the other genotypes did not differ significantly from both (Table 2).

Genotype LA 716, whose attractiveness was the lowest among the genotypes, showed a slightly higher consumption than LA 462 in the non-choice test, without significant difference. These results possibly indicate the presence of characteristics of chemical and/or morphological nature in their leaves that made this genotype less attractive and less consumed by larvae of *S. frugiperda* (Table 2).

The results obtained in the feeding non-preference test, free-choice, for fourth instar larvae of *S. eridania* for the tomato genotypes, showed significant difference at 15, 30, 60, 120, 360 and 720 minutes after release (Table 2). At these times, the genotypes PI 134417 and Santa Clara, in general, had the highest means for attracted larvae, while PI 134418, PI 126931, LA 462 and LA 716 were less attractive (Table 2).

The tomato genotypes differed significantly for leaf mass consumed. The genotypes PI 134417 and Santa Clara were the most consumed, whereas PI 126931, LA 462 and LA 716 were the least preferred by larvae of *S. eridania* (Table 2).

In the non-choice test, there was significant difference in relation to attractiveness among genotypes by *S. eridania* at 15, 30, 60 and 720 minutes, and, in general, the commercial genotype Santa Clara was the most attractive (Table 2). The other genotypes were equally less attractive to fourth instar larvae of *S. eridania* (Table 2).

There was no significant difference in leaf consumption between the genotypes (Table 2). However, LA 716 was numerically less consumed compared with the others (Table 2).

It is noteworthy that the free and non-choice tests for *S. eridania* ended at 720 minutes after the release of larvae, unlike the assay with *S. frugiperda*, which ended at 1440 minutes. This fact was expected, since the larvae of *S. eridania* were in a more advanced developmental stage and hence their leaf consumption was greater.

Bottega (2010) studied the feeding preferences of *T. absoluta* for tomato genotypes, including the ones used in this study, and reported that PI 134417 (*L. hirsutum* f. *glabratum*) showed resistance of the non-preference type, which was evidenced by the lower attractiveness and lower leaf consumption by 12 day-old larvae in free and non-choice tests, respectively.

The hierarchical cluster analysis based on data of feeding preference of third instar larvae of *S. frugiperda* at the different times and the leaf area consumed in the free and non-choice tests showed that there were differences between the tomato genotypes, separating them into groups according to the degree of similarity (Figure 1). The first cluster was formed at the Euclidean distance of 4.57, grouping the genotypes PI 126931 and LA 716 and showing that they are more similar to each other, given the smaller Euclidean distance (Figure 1). At the distance of 4.77, genotype LA 462 grouped to PI 134418, and at the distance of 5.73, PI 134417 joined this group, forming a single cluster, indicating the existence of similar characteristics between them (Figure 1). The commercial genotype Santa Clara joined this group at the distance of 7.89 and, finally, all genotypes were grouped at 10.44 (Figure 1).

Using the phenon line, which represents the average similarity between pairs of genotypes and indicates the reference point for their division into groups (Sneath & Sokal, 1962), the Euclidean distance was set at 6.00, forming three groups: PI 126931 and LA 716 were isolated on the left side of the dendrogram; LA 462, PI 134418 and PI 134417 remained in a single group on the right side; Santa Clara formed the third group, isolated from the other genotypes, in the central part (Figure 1). Thus, different levels of resistance of the non-preference type can be established for the tomato genotypes, according to the preference and leaf consumption by *S. frugiperda* larvae: PI 126931 and LA 716, moderately resistant; LA 432, PI 134418 and PI 134417, susceptible; and Santa Clara, highly susceptible.

With respect to *S. eridania*, the genotypes LA 716 and PI 126931 were also more similar to each other, grouping at the distance of 4.00 (Figure 2). The second cluster was formed at 4.21, grouping the genotypes PI 134418 and LA 462, which were joined to the first group at 4.98 (Figure 2). Then, PI 134417 joined to these four genotypes at 6.37 and, finally, a single cluster was formed at 11.89 with the genotype Santa Clara (Figure 2).

The phenon line was drawn at the distance of 6.00, separating the tomato genotypes into three groups: LA 716, PI 126931, PI 134418, and LA 462 formed the first group in the center of the dendrogram; PI 134417 formed the second group, on the right of the dendrogram; Santa Clara was isolated from the other genotypes in the third

Table 2. Mean number of fourth instar larvae of *Spodoptera eridania* attracted at different times (minutes) and leaf mass consumed (LMC) of tomato genotypes, in free and non-choice tests. Temperature: 25 ± 1 ºC; RH.: 70 ± 10%; photophase: 12 h. Jaboticabal, SP, 2010

GENOTYPES	TIMES[1]										
	1’	**3’**	**5’**	**10’**	**15’**	**30’**	**60’**	**120’**	**360’**	**720’**	**LMC (mg)[1,2]**
	FREE-CHOICE TEST										
PI 134417	0.80 a	0.80 a	0.60 a	0.90 a	1.20 b	1.30 b	1.00 b	0.70 a	0.50 a	1.00 b	30.33 c
Santa Clara	1.20 a	1.20 a	0.90 a	1.30 a	1.10 b	1.10 b	1.40 b	1.30 b	1.10 b	1.00 b	26.46 bc
LA 716	0.70 a	0.20 a	0.30 a	0.70 a	0.00 a	0.30 a	0.40 a	0.50 a	0.80 ab	0.50 ab	8.98 ab
PI 134418	0.40 a	0.30 a	0.30 a	0.50 a	0.40 ab	0.50 a	0.30 a	0.20 a	0.30 a	0.30 a	20.84 abc
LA 462	0.60 a	0.70 a	0.70 a	0.60 a	0.60 ab	0.20 a	0.30 a	0.50 a	0.40 a	0.60 ab	3.41 a
PI 126931	0.80 a	0.40 a	0.50 a	0.30 a	0.30 ab	0.40 a	0.40 a	0.50 a	0.40 a	0.30 a	3.34 a
F	0.88^{NS}	1.20^{NS}	1.30^{NS}	1.91^{NS}	2.65*	4.19**	5.06**	3.92**	9.67**	3.31*	7.53**
C.V.(%)	37.89	40.58	39.39	42.34	41.33	39.18	38.37	42.30	32.03	31.62	1.32
	NON-CHOICE TEST										
PI 134417	0.53 a	0.60 a	0.40 a	0.40 a	0.40 a	0.33 a	0.27 a	0.33 a	0.20 a	0.40 ab	18.93 a
Santa Clara	0.87 a	0.87 a	0.87 a	0.87 a	0.87 b	0.93 b	0.80 b	0.60 a	0.60 a	0.47 ab	22.91 a
LA 716	0.73 a	0.53 a	0.53 a	0.53 a	0.53 a	0.47 a	0.40 ab	0.47 a	0.40 a	0.20 a	7.09 a
PI 134418	0.60 a	0.53 a	0.53 a	0.53 a	0.47 a	0.27 a	0.13 a	0.27 a	0.33 a	0.67 b	23.27 a
LA 462	0.67 a	0.60 a	0.53 a	0.47 a	0.47 a	0.13 a	0.27 a	0.27 a	0.20 a	0.13 a	17.00 a
PI 126931	0.67 a	0.53 a	0.40 a	0.60 a	0.80 b	0.33 a	0.53 ab	0.53 a	0.47 a	0.07 a	23.19 a
F	0.89^{NS}	1.05^{NS}	1.83^{NS}	1.64^{NS}	2.53*	6.08**	4.14**	1.26^{NS}	1.62^{NS}	4.19**	1.76^{NS}
C.V.(%)	23.07	24.76	25.63	25.33	24.29	24.56	25.72	27.64	27.50	25.64	1.76

Means followed by the same letter in the column are not significantly different by the Tukey test at 5% probability. [1]Data were transformed to $(x + 0.5)^{1/2}$. [2]Leaf Mass consumed (LMC) converted from the typing paper.

^{NS} = non significant, * = significant at 5%, ** = significant at 1%.

group (Figure 2). Considering the preference and leaf consumption by *S. eridania*, the following levels of resistance of the nonpreference type can be established for the tomato genotypes: LA 716, PI 126931, PI 134418, and LA 462 are moderately resistant, PI 134417 is susceptible; and Santa Clara is highly susceptible.

Several studies with the line LA 716 showed a high resistance to many arthropods, such as the tomato leafminer (Resende et al., 2006), the white fly and mites (Baldin et al., 2005). Goffreda et al. (1990) reported that the causes of resistance of the genotype LA 716 have been identified and are involved with glandular trichomes.

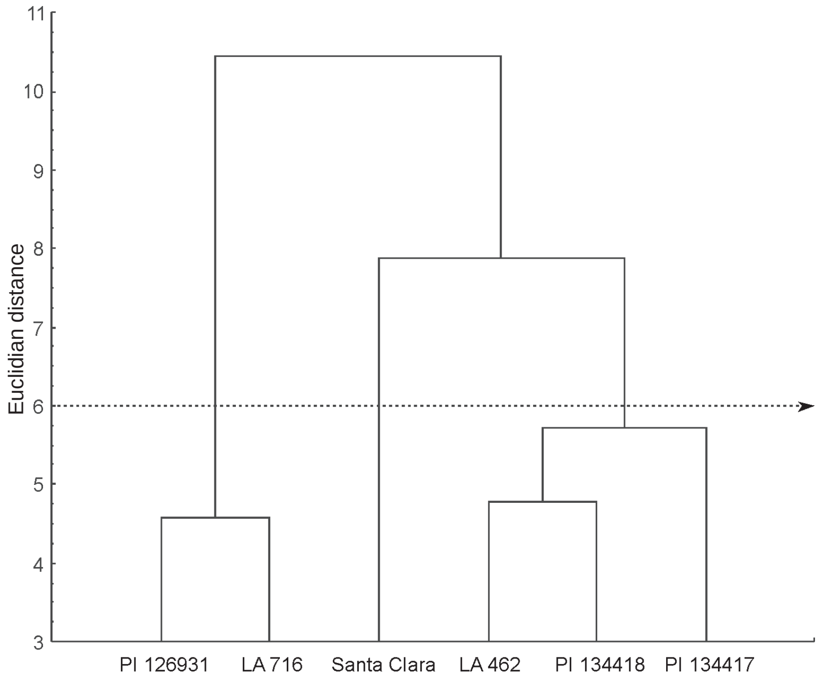

Figure 1. Dendrogram based on attractiveness and consumption of leaves of tomato genotypes by third instar larvae of *Spodoptera frugiperda*, in free and non-choice tests. The hierarchical cluster analysis was carried out using the Ward's method with the Euclidean distance as dissimilarity measure. Arrow indicates the Euclidean distance used for the separation of groups (phenon line).

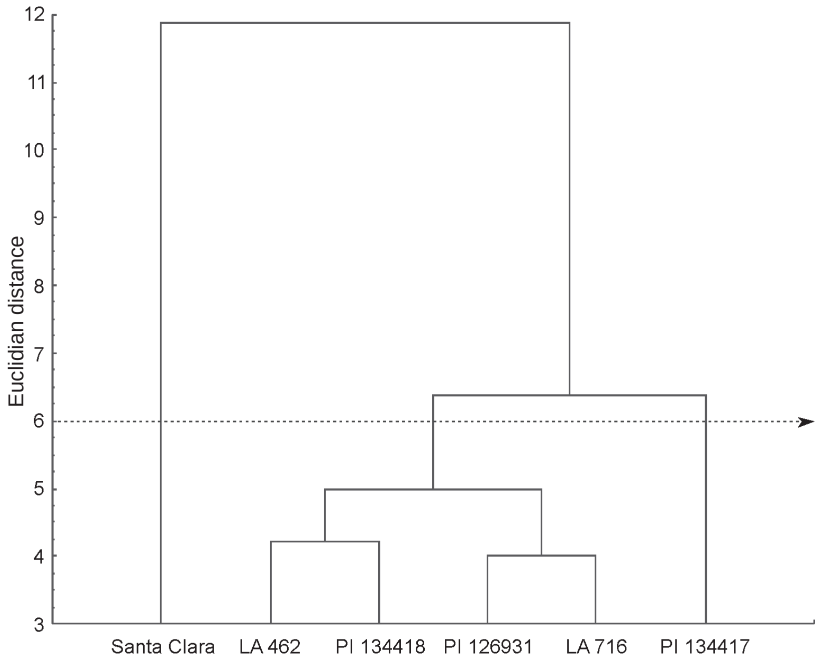

Figure 2. Dendrogram based on attractiveness and consumption of leaves of tomato genotypes by fourth instar larvae of *Spodoptera eridania* in free and non-choice tests. The hierarchical cluster analysis was carried out using the Ward's method with the Euclidean distance as dissimilarity measure. Arrow indicates the Euclidean distance used for the separation of groups (phenon line).

Thus, we can conclude that the genotype LA 716 (*L. pennelli*) has multiple moderate resistance, since it was moderately resistant to the insects mentioned above and to the larvae of *S. frugiperda* and *S. eridania*, as it was demonstrated in this work, which was also verified for genotype PI 126931 (*L. pimpinellifolium*).

The causes of the *L. pimpinellifolium* resistance to pests like *T. absoluta* and *Spodoptera exigua* (Lourenção et al., 1984; Eigenbrode & Trumble, 1993) are related to chemical factors such as the presence of α-tomatine, and physical factors such as the hardness of the fruit cuticle (Juvik & Stevens, 1982). In *L. hirsutum* f. *glabratum*, the allelochemical 2-tridecanone confers resistance of the non-preference type (Barbosa, 1994) and antibiosis (Gonçalves-Gervais, 1998) to the tomato pinworm.

However, particularly the genotypes LA 716 and PI 126 931 have potential for use in tomato breeding programs, to incorporate the genes conferring resistance to larvae of *Spodoptera* spp. into cultivars with desirable agronomic traits.

CONCLUSIONS

The genotypes LA 716 (*L. pennellii*) and PI 126931 (*L. pimpinellifolium*) are moderately resistant, of the feeding nonpreference type to *S. frugiperda* and *S. eridania*;

The genotypes PI 134418 (*L. hirsutum* f. *glabratum*) and LA 462 (*L. peruvianum*) are moderately resistant to *S. eridania*;

The genotype PI 134417 (*L. hirsutum* f. *glabratum*) is susceptible to *S. frugiperda* and *S. eridania*;

The genotype Santa Clara (*L. esculentum*) is highly susceptible to *S. frugiperda* and *S. eridania*.

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