ISSN 0034-737X

Antibiosis of eight *Lycopersicon* genotypes to *Tuta absoluta* (Lepidoptera: Gelechiidae)

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ABSTRACT

Antibiosis of eight *Lycopersicon* Genotypes to *Tuta Absoluta* (Lepidoptera: Gelechiidae)

Tomato leafminer [*Tuta absoluta* (Meyrick)] is the most important pest in a numerous regions of tomato production in Brazil. Wild species of *Lycopersicon*, such as *L. hirsutum* and *L. peruvianum* have been used in breeding programs in the attempt of obtaining tomato cultivars with resistance to pests. In this paper, is reported a study on the development and survival of *T. absoluta* under laboratory conditions on eight tomato genotypes: *L. esculentum* cv. Santa Clara, *L. pimpinellifolium* (PI 126931), *L. peruvianum* (PI 306811; PI 128659; LA 444-1; BG 3286; CNPH 374) and *L. hirsutum* f. *glabratum* (PI 134417). Newborn caterpillars were individualized in glass tubes with sand where a leaflet petiole was fixed (petioles per glass). The tubes were covered with PVC film and maintained inside a seed incubator at 25° C and 70% relative humidity. Caterpillar development was observed when leaflets were changed, every 3 days, until the second insect generation. Genotype effect on caterpillar mortality was observed only at the second generation (90% on PI 134417 against 33.3% on Santa Clara). PI 134417 caused pupae mortality of 50.68% and 100%, at the first and second generations, respectively, confirming their antibiosis effects. Mortality of genotype Santa Clara was12.12% of pupae, at the second generation. The oviposition period was 5.5 and 8.5 days on PI 134417 and Santa Clara, respectively. The longest developmental period of caterpillars occurred on *L. peruvianum* and *L. hirsutum* f. *glabratum*.

Key words: Solanaceae, tomato, tomato leafminer, plant resistance.

RESUMO

Antibiose de oito genótipos de Lycopersicon a Tuta absoluta (Lepidptera: Gelechiidae

A traça-do-tomateiro [*Tuta absoluta* (Meyrick)] é a praga mais importante em várias áreas de produção de tomate no Brasil. Espécies silvestres de *Lycopersicon*, como *L. hirsutum* e *L. peruvianum*, têm mostrado possibilidades de utilização em programas de melhoramento visando à obtenção de variedades comerciais resistentes a pragas. Este trabalho teve como objetivo avaliar o desenvolvimento e a sobrevivência de lagartas recém-eclodidas de *T. absoluta* em oito genótipos de tomateiros: Santa Clara; *L. pimpinellifolium* (PI 126931); *L. peruvianum* (PI 306811; PI 128659; LA 444-1; BG 3286; CNPH 374); e *L. hirsutum* f. *glabratum* (PI 134417). Lagartas recém-eclodidas foram individualizadas em vidros contendo areia aos quais foram fixados pecíolos de folhas de tomate (um pecíolo por vidro). Em seguida, os vidros foram recobertos com filme plástico de PVC e colocados em BOD sob temperatura de 25 °C e umidade relativa de 70%. Acompanhou-se o desenvolvimento nas trocas de folhas, a cada três dias, até se obter a segunda geração do inseto. Houve efeito dos genótipos na mortalidade de lagartas somente na segunda geração (90,0% para PI 134417

Recebido para publicação em dezembroo de 2006 e aprovado em fevereiro de 2009

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contra 33,3% para Santa Clara). Para pupas, PI 134417 causou mortalidade de 50,68 e 100% nas primeiras e segundas gerações, respectivamente, reafirmando seu efeito de antibiose. A mortalidade no genótipo Santa Clara observada na segunda geração foi de 12,12% de pupas. O período de oviposição foi de 5,5 e 8,5 dias para PI 134417 e Santa Clara, respectivamente. A maior duração da fase de lagarta ocorreu nos genótipos de *L. peruvianum* e *L. hirsutum* f. *glabratum.*

Palavras-chave: Solanaceae, tomateiro, traça do tomateiro, resistência de plantas.

INTRODUÇÃO

Tomato, *Lycopersicon esculentun* Mill, is cultivated worldwide and it is one of the most important vegetable crops in Brazil, both for fresh and industrial use. Large number of insect pests can decrease tomato productivity. In one cycle, growers apply up to 40 spraying treatments with different synthetic products. This poses growing threat to human health and the environment. Besides, the frequent use of insecticides might induce resistance in insects to these compounds (Leite *et al*., 2001; Picanço *et al*., 2000; Siqueira *et al*., 2000).

Tomato leafminer *Tuta (Scrobipalpuloides) absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is the most important pest of tomato crop in Brazil. This pest is relatively new in this country (1980) and feeds on leaf parenchyma, stems and fruits. It is able to complete 3 to 5 generations during one crop season. Few insecticides are efficient, and control of the pest is only partial. Although growers frequently use chemical control, damage still varies from 14 to 68% (Picanço *et al*., 2000; Siqueira *et al*., 2000; Vilela & Michereff, 2001).

Dependence on insecticides is undesirable for both economical and environmental reasons. The adverse effect of insecticides on natural enemies is a serious problem as well. A possible solution to these problems is the development and use of resistant cultivars (Kennedy, 2003; Lara, 1991).

Wild species of *Lycopersicon*, like *L. hirsutum* and *L. peruvianum* are potential candidates for use in breeding programs in order to obtain resistant tomato cultivars to pests (Eingenbrode & Trumble, 1993; Kennedy, 2003; Leite *et al*., 1995), diseases (Ritchie & Dittapongpitch, 1991) or nematodes (Sakhuja *et al.*, 1991).

MATERIALS AND METHODS

This research was conducted at the Federal University of Viçosa (UFV), Viçosa, Minas Gerais State, Brazil. Tomato genotypes: *L. hirsutum* f. *glabratum* (PI 134417), *L. peruvianum* (PI 306811; PI 128659; LA 444-1; BG 3286; CNPH 374), *L. pimpinellifolium* (PI 126931) and *L. esculentum* (cv. Santa Clara) were obtained from CNPH - EMBRAPA and the UFV germoplasm collection. *L. hirsutum* f. *glabratum* and *L. esculentum* cv. Santa Clara (susceptible) were used as references (Leite *et al*., 2001).

Tomato leafminer rearing

Tuta absoluta adults were collected in tomato crops and kept inside wooden cages (0.2x0.2x0.2 m) covered with 1-mm mesh fabric. The insects were fed with tomato leaves which were immersed in a glass jar with water. Leaves with eggs were collected daily and placed on 1-month-old plants inside metal cages and covered with mesh fabric (0.50 x 0.25 m in diameter). Larvae developed until adults on these plants. The adults were collected with an aspirator and taken back inside the wooden cages (Leite *et al*., 2001).

Experimental set up

One day old eggs were pulled out from the tomato leaves using a fine paint brush and then placed inside 20 mL glass tubes sealed with parafilm and taken into a seed incubator (BOD) for 5 days at 25 ± 2°C until larvae hatched from the eggs.

Five newborn larvae were transferred to leaflets from each genotype and placed inside glass tubes with 1 cm of autoclaved sand soaked with nutritive solution (Hogland - ½ power). Tubes were sealed with parafilm that was punctured with a needle to prevent water condensation and then incubated inside a BOD with a 12 h photoperiod, at 25 ± 1ºC and 65 ± 5% relative humidity.

For a period of 12 days, larval mortality and developmental period were recorded every 3 days and more frequently afterwards until pupal stage. At this time, larvae were transferred to fresh leaflets, from the same plant by opening the mines with disposable syringe needles. Larvae were maintained inside the tubes until the pupation period and then sexed (Coelho & França, 1987; Leite *et al*., 2001).

Pupae were transferred to 200 mL plastic pots with a hole in the center of the lid (3 centimeters), which was covered with mesh fabric and observed daily until the emergence of adults to determine the length of the developmental period. Then, one leaflet of the same genotype was placed inside the pot to determine oviposition. Eggs were counted until the death of adults and 10 eggs from each replicate were used to continue the second generation as described above.

The experimental design was a completely randomized block with eight treatments (genotypes) and 12 replicates (tubes with five larvae each). Data were analyzed with ANOVA and means were separated with Scott-Knott test ($P < 0.05$).

RESULTS

In the first generation, all the genotypes in test to provide the shortest larval period in relation to the susceptible genotype (cv. Santa Clara) used as reference of resistance (PI 134417). In the second generation, all introductions of *L. peruvianum* (except the BG 3286) and *L. pimpinellifolium* also *L. hirsutum* f. *glabratum* showed a longer larval period than *L. esculentum* cv. Santa Clara (Table 1).

On the first generation, there were no significant differences in the larval mortality detected among genotypes. On the second generation, *T. absoluta* showed the greatest larval mortalities in *L. hirsutum* f. *glabratum* (PI 134417) and *L. pimpinellifolium* (PI 126931). The other genotypes were intermediary or equal to the control (cv. Santa Clara) (Table 2).

Tuta absoluta showed the greatest pupal mortality in *L. hirsutum* f. *glabratum* PI 134417 (both generations) and *L. peruvianum* CNPH 374 (second generation) (Table 3).

On the first generation of *T. absoluta* the smallest oviposition period occurred on *L. hirsutum* f. *glabratum* (PI 134417), on the second generation, *T. absoluta* showed the smallest oviposition period on *L. pimpinellifolium* (PI 126931) and *L. peruvianum* (CNPH 374), but could not be evaluated on *L. hirsutum* f. *glabratum* (PI 134417) since pupal mortality on this genotype was 100% (Table 4).

Except for *L. esculentum* cv. Santa Clara, larval stage was larger in the second than in the first generation.

DISCUSSION

Prolongation of larval period was already reported by other authors as the effect of antibiosis of genotypes on larvae (Leite *et al*., 2001).

Mine holes left by larvae was frequently observed in *L. hirsutum* f. *glabratum*, as well as penetration holes that had not become into mines, suggesting antibiosis of that genotype. This behavior can be caused by physical barriers due to the presence of trichomes and exudates (Leite *et al*., 2001). The combination of the antibiosis and antixenosis mechanisms become the plant less susceptible to the insect that is a desirable characteristic in commercial cultivars.

A possible explanation for the high mortality in *L. hirsutum* f. *glabratum* (PI 134417) is provided by Leite *et al*. (2001) and Farrar & Kennedy (1987), who detected larval mortality caused by trichomes and leaf lamellae. However, the high larval mortality caused by *L. pimpinellifolium* (PI 126931) is possibly associated to the great ∝-tomatine level in this genotype.

According to Suinaga *et al*. (1999), *L. peruvianum* resistance to *T. absoluta* could be associated with heptacane.

Insects that feed on genotype with toxic effects can have the development and viability changed in a subsequent generation and show a decrease in survival. This process decreases the pre-imaginal effect, when larvae tend to

Table 1. Length of larval developmental period in days (mean ± standard error) and number of observations (n) of *Tuta absoluta* on different *Lycopersicon* spp. genotypes

Genotype	Larval developmental period *	
	Generation 1	Generation 2
L. esculentum cv. Santa Clara	13.20 ± 0.38 (12) aA	13.40 ± 0.47 (6) aB
L. pimpinellifolium (PI126931)	12.19 ± 0.32 (12) bB	16.10 ± 0.10 (5) aA
L. peruvianum (PI306811)	11.92 ± 0.22 (12) bB	16.00 ± 0.00 (6) aA
L. peruvianum (PI128659)	11.79 ± 0.22 (12) bB	15.92 ± 0.58 (6) aA
L. peruvianum (LA 444-1)	12.78 ± 0.38 (12) bB	16.20 ± 0.20 (5) aA
L. peruvianum (BG 3286)	12.23 ± 0.49 (12) bB	14.18 ± 0.62 (5) aB
L. hirsutum f. *glabratum* (PI134417)	14.83 ± 0.48 (12) bA	16.00 ± 0.00 (2) aA
L. peruvianum (CNPH 374)	12.03 ± 0.36 (12) bB	15.15 ± 0.49 (4) aA

* Means followed by the same small letter in the line or capital letter in the column are not significantly different by the Scott-Knott test at $P < 0.05$.

Table 2. Larval mortality (mean ± standard error) and number of observations (n) of *Tuta absoluta* on different genotypes of *Lycopersicon* spp.

Genotype	Larval mortality *	
	Generation 1	Generation 2
L. esculentum cv. Santa Clara	31.67 ± 7.57 (12) aA	33.33 ± 8.43 (6) aC
L. pimpinellifolium (PI 126931)	25.83 ± 7.12 (12) aA	76.67 ± 6.54 (6) aA
L. peruvianum (PI 306811)	35.00 ± 6.09 (12) bA	50.00 ± 6.83 (6) aB
L. peruvianum (PI 128659)	26.67 ± 6.19 (12) aA	36.67 ± 10.85 (6) aC
L. peruvianum (LA 444-1)	36.67 ± 6.89 (12) bA	56.67 ± 12.02 (6) aB
L. peruvianum (BG 3286)	26.67 ± 7.11 (12) bA	46.67 ± 12.29 (6) aC
L. hirsutum f. *glabratum* (PI 134417)	45.00 ± 7.02 (12) bA	90.00 ± 4.47 (6) aA
L. peruvianum (CNPH 374)	36.67 ± 6.43 (12) bA	70.00 ± 11.25 (6) aB

* Means followed by the same small letter in the line or capital letter in the column are not significantly different by the Scott-Knott test at $P < 0.05$.

Table 3. Pupal mortality (mean ± standard error) and number of observations (n) of *Tuta absoluta* on different genotypes of *Lycopersicon* spp.

Genotype	Pupal mortality *	
	Generation 1	Generation 2
L. esculentum cv. Santa Clara	15.28 ± 7.59 (12) aC	12.22 ± 5.81 (6) aC
L. pimpinellifolium (PI126931)	34.31 ± 9.27 (12) aB	53.34 ± 22.61 (5) aB
L. peruvianum (PI306811)	20.83 ± 5.75 (12) aB	33.34 ± 13.95 (5) aB
L. peruvianum (PI128659)	15.42 ± 5.20 (12) bC	47.22 ± 13.21 (6) aB
L. peruvianum (LA 444-1)	22.35 ± 6.26 (12) bB	59.72 ± 18.56 (6) aB
L. peruvianum (BG 3286)	17.63 ± 7.29 (12) bC	44.45 ± 16.48 (6) aB
L. hirsutum f. *glabratum* (PI134417)	50.68 ± 9.65 (12) bA	100.00 ± 0.00 (5) aA
L. peruvianum (CNPH 374)	18.06 ± 7.17 (12) bB	77.78 ± 10.24 (6) aA

* Means followed by the same small letter in the line or capital letter in the column are not significantly different by the Scott-Knott test at $P < 0.05$.

Table 4. Oviposition period in days (mean ± standard error) and number of observations (n) of *Tuta absoluta* on different genotypes of *Lycopersicon* spp.

Genotype	Oviposition period *	
	Generation 1	Generation 2
L. esculentum cv. Santa Clara	8.50 ± 0.45 (l2) aA	8.67 ± 0.56 (6) aA
L. pimpinellifolium (PI126931)	7.92 ± 0.79 (12) aA	4.50 ± 2.03 (6) bB
L. peruvianum (PI306811)	9.00 ± 0.32 (12) aA	6.00 ± 1.24 (6) bA
L. peruvianum (PI128659)	8.58 ± 0.26 (12) aA	6.83 ± 1.42 (6) bA
L. peruvianum (LA 444-1)	8.67 ± 0.22 (12) aA	7.00 ± l.59 (6) aA
L. peruvianum (BG 3286)	8.75 ± 0.28 (12) aA	7.50 ± 1.50 (6) aA
L. hirsutum f. *glabratum* (PI134417)	5.50 ± 0.99 (12) B	**
L. peruvianum (CNPH 374)	8.58 ± 0.29 (12) aA	3.17 ± 1.42 (6) bB

* Means followed by the same small letter in the line or capital letter in the column are not significantly different by the Scott-Knott test at $P < 0.05$.

** No data available due to mortality of all pupae on the second generation (Table 3).

develop better on the plant where they have fed before (Lara, 1991). This may explain why a second generation is important to detect resistance sources since some interference from the susceptible genotype *(L. esculentum* cv. Santa Clara) used to rear *T. absoluta* may occur in the first generation.

Resistance of *L. hirsutum* f. *glabratun* to a number of insect species was associated with the presence of 2-tridecanone (2-TD) on the type IV trichome exudates, a substance 72 fold more abundant in the wild tomato than in the cultivated tomato *L. esculentum* (Williams *et al*., 1980).

PI 134417 showed two antibiosis effects. Similarly, Erb *et al.* (1993) observed the effect of trichome exudates and mortality of *L. trifolli* larvae within the leaves of the LA 1735 genotype.

The results showed that *L. peruvianum* genotypes, as already demonstrated for *L. hirsutum* f. *glabratum*, could be used in breeding programs for resistance to *T. absoluta*, however *L. esculentum* and *L. peruvianum* show incompatibility in interspecific crosses (Segeren *et al*., 1993).

According to Fery & Kennedy (1987), the high 2-TD concentration (i.e., at least three genes) is responsible for the high level of resistance of PI134417 to *Manduca sexta*. Although Maluf *et al.* (1997) concluded that 2-TD mediates resistance to *T. absoluta*, they suggested that an additional factor other than 2-TD may also play a role in resistance. Therefore, studies of the resistance inheritance and also molecular assisted selection must be developed in order to obtain a resistant cultivar to this important tomato leafminer.

The shortest oviposition period occurring for *L. hirsutum* f. *glabratum* (PI134417) (first generation) and *L. pimpinellifolium* (PI 126931) and *L. peruvianum* (CNPH 374) (second generation) (Table 4) may be due the presence of toxic substances in leaves of genotypes that could quickly resume oviposition after having stayed on the leaf. The resistance of *L. hirsutum* to *T. absoluta* is usually attributed to the allomones tridecan-2-one and undecan-2-one present in leaf glandular trichomes of this tomato species, which are absent in *L. esculentum* (Giustolin & Vendramim, 1994).

ACKNOWLODGMENTS

The authors would like to thank Dr. WiIlem Jan de Kogel (CPRO-DLO) for reading the manuscript. This study has been financed by CAPES (Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) and FAPEMIG (Fundação de Amparo à Pesquisa do Estado de Minas Gerais), to whom we thank for the scholarships, fellowship, and grants received.

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