Research Article

Resistance of tomato cultivars to *Tuta absoluta* (Lepidoptera: Gelechiidae) under field condition

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**Abstract**: Tomato leaf miner, *Tuta absoluta*, is the most destructive pest of tomato in Iran. Resistance levels of six tomato cultivars to the pest damage were evaluated during two tomato growing seasons (2014-2015). Samplings were done weekly. Leaf and fruit damages as well as the total yield of the cultivars were compared. Furthermore, leaf trichome density was evaluated. The highest to lowest leaf infestation rates were recorded for the Primo early, CaljN3, Petomek, Rio grande, Early urbana and Super 2270 cultivars respectively. Fruit infestation rate in Early urbana was significantly lower than the other cultivars in both growing seasons. Total yield of tomato (from the highest to the lowest) belonged to Super 2270, Early urbana, Rio grande, Petomek, Calj N3 and Primo early cultivars.

**Keywords**: Tomato leaf miner, Host plant resistance, Leaf and fruit damage, Ramin, Khuzestan

**Introduction**

The tomato leaf miner (TLM), *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae), is considered as one of the most dangerous pests in greenhouse and field grown tomatoes. The pest is an invasive pest native to South America (Yankova, 2012) and it is newly distributed in Iran (Baniameri and Cheraghian, 2011). The female usually lays eggs on leaves, stems, and to a lesser extent on fruits. The young larvae mine the leaves or stems producing large galleries and burrow into the fruit. On leaves, the larvae feed only on mesophyll cells, leave the epidermis intact and make irregular leaf mines, which may later become necrotic (OEPP/EPPO, 2005) and affect photosynthesis in the plant (Desneux et al., 2010). Damage from this pest throughout the entire growing cycle of tomatoes can significantly reduce both yield and fruit quality by the direct feeding of *T. absoluta* and secondary pathogens that may enter through the wounds made by the insect. In the absence of control strategies, larval feeding damage can reach up to 100% (Yankova, 2012). Large amounts of chemical insecticides have been applied against the pest in both field and greenhouse (Lietti et al., 2005). The applications cause many problems such as increase the insecticide costs, destroy natural enemy populations, leave pesticide residues in fruits and make the pest population resistant to chemical compounds (Braham and Hajji, 2012). Also, the general endophytic behaviour of the larval instars makes it difficult to conduct
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effective control practices against this pest (Lietti et al., 2005; Guedes and Picanço, 2012).

Host plant resistance is economic and ecologically friendly strategy in integrated pest management (IPM) programs (Pedigo, 2002; Sharma and Ortiz, 2002). Use of cultivars resistant to the pest cause a major reduction in chemical insecticide application that can lead to increase in beneficial organism activity and decrease of pesticide residues in the environment and human food (Sharma and Ortiz, 2002). In many cases, use of resistant host plant is near compatible with other control strategies in IPM programs (Pedigo, 2002). Finding cultivars resistant to a pest is the primary step in the use of host plant resistance in IPM programs (Panda and Khush, 1995). Host plant defense in resistant cultivars may be related to morphological, biochemical and molecular traits to counter/offset herbivore attack (War et al., 2012). Trichomes are hair-like appendages that develop from cells of the aerial epidermis and are produced by most plant species and contribute to host plant resistance against herbivore insects (Dalin et al., 2008).

Resistance levels of some tomato cultivars to T. absoluta have been previously investigated by some researchers (Gharekhani and Salek-Ebrahimi, 2014a, b; Proffit et al., 2011; Oliveira et al., 2009; Sohrabi et al., 2016; Ghaderi et al., 2017). In this study, resistance level of six tomato cultivars to T. absoluta were studied in field condition. Also, the effect of leaf trichome on the resistance levels was evaluated.

Materials and Methods

Experimental design

Experiments were done in an experimental field, 5000 m², in Chogha Kabod region, Kermanshah, West Iran, during two tomato growing seasons 2015-2016. Six tomato cultivars including Río gande, Super 2270, Calj N3, Early Urbana, Primo early and Petomek were cultivated (18000 plants per hectare). Between each plot (150 m²) a ridge (2 m) was made. Experiments were arranged in a randomized complete block design with four replications (plots). Cultural practices were conducted according to instructions of the Kermanshah province agricultural organization.

Sampling

Sampling was performed weekly from primary phential step, 5-7 leaves, to end of the growing season. At each sampling date, ten randomly selected plants were checked by traveling in an X-shaped pattern through each plot. From each selected plant, three leaves and fruit were randomly chosen and the numbers of the pest larval mines in each leaf and fruit were separately recorded. At the end of growing season, total fruit yield in each plot was separately weighed.

Effect of leaf trichome

For evaluation of leaf trichome effect on host plant resistance level, three cultivars with high, moderate and the low resistance level were chosen. Seeds of the cultivars were sown in plastic pots (12 cm diameter and 22 cm height). Ten pots were provided for each selected cultivar. The pots were kept in germinator at 27 ± 2 ºC, photoperiod 16: 8 (light: dark) and RH 60 ± 5%. At the eight leaf stage, six leaves were randomly detached from the potted plants. A paper quadrat, 5 × 5 mm, was randomly placed under each leaf and number of trichomes in each quadrate was recorded under stereomicroscope.

Data analysis

The data were statistically analyzed by one way analysis of variance (one-way ANOVA) and the group means were compared by Duncan's multiple range test using SAS program (SAS Institute, 2003).

Result

Leaf and fruit damage

Leaf and fruit Infestation rates in various experimental cultivars during first (2015) and second (2016) growing seasons are presented in Table 1. Significant differences were observed between leaf infestation rates in various experimental varieties. In both growing
seasons, infestation levels in Primo early were significantly higher than the other cultivars (22.7 and 26.6% in the first and second growing season, respectively). While, infestation of Super 2270 was significantly lower than other cultivars (9.5 and 10.3% in the two growing seasons, respectively). Totally, order of infestation rates to TLM (from the highest to the lowest) was Primo early, CaljN3, Petomek, Rio grande, Early urbana and Super 2270.

Fruit infestation rate between various experimental cultivars was significantly different. Fruit infestation rates in Early Urbana were significantly lower than other cultivars in both growing seasons (0.5 and 6.5% during the first and second growing season, respectively). The highest fruit infestation rate was observed in Calj N3 (4.82%) and Petomek (12.42%) during the first and second growing season, respectively.

### Table 1 Percentages of damaged leaf, damaged fruit and total yield in tomato cultivars in response to *Tuta absoluta*.

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Damaged leaf (%)</th>
<th>Damaged fruit (%)</th>
<th>Total yield (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primo early</td>
<td>22.7 ± 3.3a*</td>
<td>26.6 ± 6.4a</td>
<td>2.2 ± 0.4b</td>
</tr>
<tr>
<td>Calj N3</td>
<td>18.7 ± 0.5b</td>
<td>24.1 ± 2.4a</td>
<td>4.8 ± 0.2a</td>
</tr>
<tr>
<td>Early Urbana</td>
<td>8.0 ± 0.4d</td>
<td>12.4 ± 3.2b</td>
<td>0.5 ± 0.5c</td>
</tr>
<tr>
<td>Peto mck</td>
<td>18.0 ± 2.8b</td>
<td>22.7 ± 2.6a</td>
<td>1.6 ± 0.2c</td>
</tr>
<tr>
<td>Supper 2270</td>
<td>9.5 ± 1.9dc</td>
<td>10.4 ± 1.7b</td>
<td>1.0 ± 1.9d</td>
</tr>
<tr>
<td>Rio grande</td>
<td>12.0 ± 0.8c</td>
<td>14.7 ± 3.8b</td>
<td>1.5 ± 0c</td>
</tr>
<tr>
<td>F (df = 5, 23)</td>
<td>33.29</td>
<td>13.55</td>
<td>106.8</td>
</tr>
<tr>
<td>P-value</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Means followed by the same letters in each column indicate non-significant differences (Duncan’s Multiple Range Test, P ≤ 0.05).

### Total Yield

Total fruit yield of different cultivars in the first (2015) and second (2016) growing seasons is presented in Table 1.

Results indicated that there were significant differences between total yields of various cultivars. In both growing season, the highest fruit yield was obtained in Super 2270 (207.35 and 175.4 kg per plot) and the lowest yield was that of Primo early (131.85 and 127.4 kg per plot). In the first growing season, total yield in decreasing order was that of Petomek, Super 2270, Early Urbana, Rio grande, Calj N3, Primo early and Early Urbana. Whereas in in the second growing season it was that of Super 2270, Early Urbana, Rio grande, Petomek, Calj N3 and Primo early.

### Trichome density

According to the results of leaf infestation rates with TLM larvae, Super 2270, Early urbana and Primo early were selected as experimental cultivars with the highest, moderate and lowest resistance level to the pest, respectively. Trichome densities in these cultivars indicate significant difference among them (Table 2). The highest and lowest trichome density were recorded in Super 2270 (the most resistant cultivar) and Primo early (the most susceptible cultivar), respectively (Table 2). Moreover, significant positive correlation was observed between trichome density and resistance level to TLM larvae (r = 0.740).

### Table 2 Density of leaf trichome in tomato cultivars.

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Trichome density ± SE (cm²)</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primo early</td>
<td>7.94 ± 1.57a*</td>
<td>Low</td>
</tr>
<tr>
<td>Early Urbana</td>
<td>23.38 ± 2.34b</td>
<td>Medium</td>
</tr>
<tr>
<td>Super 2270</td>
<td>73.11 ± 4.56c</td>
<td>High</td>
</tr>
<tr>
<td>F (df = 2, 5)</td>
<td>120.92</td>
<td></td>
</tr>
<tr>
<td>P-value</td>
<td>&lt; 0.0001</td>
<td></td>
</tr>
</tbody>
</table>

Means followed by the same letters in each column indicate non-significant differences (Duncan’s Multiple Range Test, P ≤ 0.05).

### Discussion

The study revealed that there are significant differences between leaf damage, fruit damage
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and total yield caused by TLM in the tested tomato cultivars. The relative resistance of the cultivars according to leaf damage and total yield data were in the decreasing order of: Super 2270, Early Urbana, Rio grande, Petomek, Calj N3 and Primo early.

Our findings are in line with the results of Gharehkhani and Salek-Ebrahimi (2014a, b) who demonstrated that different resistance levels can be observed in various tomato cultivars. Resistance levels of ten tomato cultivars to T. absoluta were investigated by Sohrabi et al. (2016) based on number of mines per leaf, holes on the stem and holes per fruit in field condition. Among the tested cultivars, those with high density of leaf trichome, were more resistant to the pest. The researchers concluded that leaf trichome density is possibly the reason of resistance to TLM larvae. Similarly, Mulusew et al. (2013) showed that resistance level of different tomato cultivars was related to leaf trichome density. Navarro et al. (2015) reported that oviposition rates of TLM females were different in various tomato cultivars (antixenosis). But there was no antibiosis based resistance among the tested cultivars (Navarro et al., 2015). Life table parameters of TLM on seven tomato cultivars, Primo early, Rio grande, Calj N3, Petomek, Early Urbanam, Super 2270 and Super strain B showed that the longest and the shortest developmental times of immature stages of TLM were on Early Urbana and Calj N3, respectively (Ghaderi et al., 2017). The lowest and the highest values of the intrinsic rate of increase (r) and finite rate of increase (λ) were on Early Urbana Y and Cal JN3, respectively. This laboratory study showed that Calj N3 and Primo early were the most susceptible and most resistant cultivars, respectively (Ghaderi et al., 2017). Difference in susceptibility of the cultivars may be due to different experimental conditions in laboratory and/ or field. Shahbaz et al. (2017) demonstrated that performance of TLM larvae fed on tomato cultivars with different resistance level was different. The larvae feeding on resistant cultivars reached the lowest final weight, whereas those reared on the susceptible cultivars reached the highest body weight. Also, host plant resistance significantly affects the TLM physiology. The highest proteolytic and amylolytic activity were detected in larvae feeding on resistant cultivars, whereas larvae reared on the susceptible cultivar had the lowest enzymatic activity for both third and fourth instar larvae.

In conclusion, there are different resistance levels in tomato cultivars to TLM damage. The cultivars with dense leaf trichome are more resistant to the pest. These cultivars can be considered as candidates for use in integrated management programs of the TLM.

Acknowledgements

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References


 مقاومت ارقام گوجه‌فرنگی به شبیه مینوز برگ گوجه‌فرنگی
در شرایط مزرعه‌ای T. absoluta (Lep: Gelechiidae)

فاتمه آزادي، علي رجبپور، امین لطفی جلال‌آبادی و مهدی محجوی

چکیده: شبیه مینوز برگ گوجه‌فرنگی (Tuta absoluta) خطرناک‌ترین آفت گوجه‌فرنگی در ایران است. سطح مقاومت شبیه رقیم گوجه‌فرنگی به خسارت این آفت طی دو فصل زراعی (1394-1395) مورد ارزیابی گرفته و نمونه‌برداری به صورت هفته‌ای انجام شد. خسارت‌های برگی و میوه به‌همراه عملکرد کل میوه در این ارقام مورد مقایسه قرار گرفت. علاوه بر این، تراکم تریسومهای برگی نیز مشخص شد. ترتیب بیش‌تری به کمترین نرخ بروز برگ‌یاری و برداشت یافت و کاهش ضرر بالینی در این ارد که با کاهش میزان بروز برگ‌یاری به این اردکام (آفرینیک) به این اردکام و بالایی به این اردکام 2270 ارکی تهیه شد. در هر دو فصل زراعی، نرخ بروز برگ‌یاری در این ارد که با کاهش میزان بروز برگ‌یاری به این اردکام (آفرینیک) به این اردکام و بالایی به این اردکام 2270 ارکی تهیه شد.

واژگان کلیدی: شبیه مینوز برگ گوجه‌فرنگی، مقاومت گیاه میزبان، خسارت برگی و میوه، عملکرد کل