



Population development and infestation rate of Tomato Leafminer [*Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae)] in tomato and eggplant greenhouses in Absheron region of Azerbaijan

Azərbaycan'ın Abşeron Bölgəsi'ndeki domates ve patlıcan seralarında Domates Güvesi [*Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae)]'nin popülasyon gelişimi ve bulaşıklık oranı

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ABSTRACT

Tomato Leafminer [*Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae)] is a pest of great economic importance in tomato production. The aim of this research was to evaluate the population development and the infestation rate of Tomato Leafminer in the tomato and eggplant greenhouses in the Republic of Azerbaijan. The study was conducted for the first time in the greenhouses located in Absheron economic region of Azerbaijan during 2019. Adult population dynamics of *T. absoluta* were monitored using sexual pheromone traps. According to the results obtained from the study, the pest formed the peaks of adult population on March 12th, March 26th and April 9th with 197, 91 and 76 adults/trap respectively. The pest population with respect to the eggplant greenhouse was lower compared with the tomato greenhouse. The results showed that *T. absoluta* was able to complete 2-3 generations in tomato and eggplant greenhouses during March and April in Absheron region of Azerbaijan. The infestation rate of *T. absoluta* in tomato greenhouse interpreted increasing trend starting from the beginning of March till April 12th. Thus so, the infestation rate caused by the pest was 30% at the beginning of March and reached 66.7% in the middle of the March. It reached its maximal level (100%) on April 12th. Interestingly, *T. absoluta* reached its significant infestation rate (96.7%) in eggplant in late April. The harmful effects of the pest recorded in the greenhouses was also described in this report. Consequently, this study reveals that *T. absoluta* population development should be monitored in greenhouses in Azerbaijan and control measures should be taken against the pest with appropriate management programs.

Key Words: *Tuta absoluta*, Tomato, Eggplant, Population, Infestation rate

ÖZ

Domates güvesi [*Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae)] domates üretiminde önemli bir zararlı olup yüksek kalite ve kantite kayıplarına sebep olmaktadır. Bu çalışma, 2019 yılında Azerbaycan'ın Abşeron ekonomik bölgesinde domates ve patlıcan seralarında ilk kez Domates güvesi [*Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae)]'nin popülasyon gelişimi ve bulaşıklık oranını belirlemek amacıyla yürütülmüştür. Bu çalışma aynı zamanda Azerbaycan'da *T. absoluta*'nın popülasyon gelişimi ve bulaşıklık oranı ile ilgili patlıcanda yapılan ilk çalışmadır. Domates güvesinin ergin popülasyon dinamikleri, eşeyssel çekici feromon tuzakları kullanılarak belirlenmiştir. Çalışmadan elde edilen sonuçlara göre zararlı domates serasında, 12 Mart, 26 Mart ve 9 Nisan'da sırasıyla 197, 91 ve 76 ergin/tuzak ile pik noktalarını oluşturmuştur. Patlıcan serasındaki zararlı popülasyonu domatesten daha düşük olarak belirlenmiştir. Çalışmada elde edilen verilere göre *T. absoluta*'nın

Azerbaycan'ın Abşeron bölgesinde Mart ve Nisan aylarında domates ve patlıcan seralarında 2-3 döl tamamlayabileceği anlaşılmıştır. Zararlıının domates serasında bulaşıklık oranı Mart ayı başında %30, Mart ayı ortasında ise %66.7 iken bu oranın 12 Nisan'da % 100'e ulaştığı belirlenmiştir. Çalışma sonucunda, domatese göre zararlıının patlıcanda geç tarihlerde de olsa önemli zararlar meydana getirdiği ve bulaşıklık oranının yüksek olduğu tespit edilmiştir. Patlıcan serasında en yüksek bulaşıklık oranı (%96.7) Nisan ayının son haftasında belirlenmiştir. Bu çalışmada, ayrıca *T. absoluta*'nın beslenme özellikleri ve bitkilerdeki zarar verme semptomları ayrıntılı olarak açıklamıştır. Azerbaycan'daki seralarda önemli zararlar meydana getirdiği belirlenen *T. absoluta*'nın popülasyon gelişiminin takip edilmesi, uygun zamanda ve uygun metotlarla mücadele edilmesi gerektiği çalışmadan anlaşılmıştır.

Anahtar Kelimeler: *Tuta absoluta*, Domates, Patlıcan, Popülasyon, Bulaşıklık oranı

Introduction

Tomato (*Solanum lycopersicum* L.) and eggplant (*Solanum melongena* L.) are widely consumed in the world as vegetables belonging to the family Solanaceae. They are grown in all regions of Azerbaijan both in greenhouses and in the open fields. In Azerbaijan, 609.2 thousand tons of tomato (281.3 thousand tons in greenhouses, 327.9 thousand tons in the open field), 168 thousand tons of eggplant (88.3 thousand tons in the greenhouses, 79.7 thousand tons in the open field) are produced (Anonymous, 2018).

There are several pests of tomatoes and eggplants in Azerbaijan. *Aphis gossypii* Glover, 1877, *Trialeurodes vaporarium* Westwood, 1856, *Bemisia tabaci* Gennadius, 1889, *Agriotes obscurus* (Linnaeus, 1758), *Gryllotalpa gryllotalpa* (Linnaeus, 1758), *Helicoverpa armigera* (Hübner, 1805), *Spodoptera exigua* (Hübner, 1808), *Liriomyza bryoniae* (Kaltenbach, 1858), *Pieris rapae* (Linnaeus, 1758) are the most common pests. However, the most dangerous and widespread pest for tomato in Azerbaijan is Tomato Leafminer, *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae) (Ismailzada et al., 2016).

If no control measures are taken, *T. absoluta* can easily cause up to 80-100% in yield loss (Apablaza, 1992; Barrientos, 1995; EPPO, 2005; Mamay and Yanik, 2012).

Tuta absoluta belongs to the group of polyphagous pests and feeds on many hosts such as tomato (*Lycopersicon esculentum* L.), potato (*Solanum tuberosum* L.), eggplant (*S. melongena* L.), Jimson weed (*Datura stramonium* L.) and *S. dubium* Fresen from family Solanaceae, broad

bean (*Vicia faba* L.) and alfalfa plant (*Medicago sativa* L.) from family Fabaceae, Watermelon (*Citrullus lanatus* L.) from family Cucurbitaceae, Physic nut (*Jatropha curcas* L.) from family Euphorbiaceae, spiny amaranth (*Amaranthus spinosus* L.) from family Amaranthaceae, and Ramtouk (*Xanthium brasiliicum* Vellozo) from family Asteraceae (Bayram et al., 2015; Mohamed et al., 2015).

It is known that *T. absoluta* damages tomato, eggplant, peppers and potatoes in Azerbaijan (Ismailzada et al., 2016; Ismailzada, 2018).

Tuta absoluta is expanding its spreading in the world day by day via its many extraordinary characteristics such as high adaptability to the different ecological conditions, high productivity of the female individual, large number of generations, covert lifestyle (not visually clearly visible inside the food plant and the product being transported), not going to the diapause in the presence of food or going to the diapause in three stages of development (egg, pup, imago), depending on environmental factors, damage to all surface organs of the plant, high resistance to insecticides formed in a short time (Zhimerikin and Mironova, 2012). In addition to these properties of *T. absoluta*, the lack of a resistant variety against this pest provide it to expand the spreading area in a short time. intercalarily, the nutritional properties of larvae protect it from the direct effects of several pesticides (Urbaneja et al., 2005).

The pest was first reported in South America in the early 1980s and, since then, has rapidly spread in Europe, Africa, the Middle East and parts of Asia. Because it is a dangerous pest of tomato, it has been the subject of several studies in the countries where it is spread. (Estay, 2000;

Siqueira et al., 2000; Lietti et al., 2005; Desneux et al., 2010; Kılıç, 2010; Mamay and Yanık, 2012; Goda et al., 2015; Erdoğan, 2016; Biondi et al., 2018; Adly and Gehan, 2019).

Tuta absoluta was discovered in Azerbaijan (Absheron region) for the first time in 2010 and now the pest is found in all regions of Azerbaijan (Hüseynov et al., 2019). The pest is included in the A2 list of EPPO (Anonymous, 2018).

Several studies were carried out on different topic related to *T. absoluta* in open field tomato cultivation (Mamay and Yanık, 2012; Bayram et al., 2014) while few studies performed in tomato and eggplant greenhouses (Erler et al., 2010; Özkan et al., 2017). Although some studies were carried out to determine the population and infestation rate of *T. absoluta* in open field tomato cultivation in Azerbaijan (Ismailzada et al., 2016; Huseynov et al., 2019), there is no study performed in tomato and eggplant greenhouses in Azerbaijan. This study was conducted to determine population development and infestation rate of *T. absoluta* in tomato and eggplant greenhouses for the first time in Absheron economic region of Azerbaijan.

Materials and Methods

Materials

Tomato Leafminer, *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae), Durinta F1, Enygma F1 varieties of tomato (*Solanum lycopersicum* L.), a local variety of eggplant (*Solanum melongena* L.) and sexual pheromone traps were the main materials in the study. Binocular microscope, handheld magnifier, scissors, tweezers, scalpel, plastic containers of different sizes, plastic bags were also used in the different period of the study.

Methods

Determination of adult population development of *Tuta absoluta*

Studies were conducted to determine the population development of *T. absoluta* in polyethylene-covered tomato and eggplant

greenhouses located in Pirshagi settlement of Absheron region (N 40029'32" E 50008'20"). in Azerbaijan. Each greenhouse had 1500-2000 m² area. Tomato and eggplant were grown in coconut fiber. Sexual pheromone traps (0.8 mg E 3, Z 8, Z 11 Tetradecatrienyl acetate) have been used to catch the adult individuals of the pest. 3 traps were hung in each greenhouse in the end of February and at the beginning of March. The traps were set at a height of 1.5 –2.0 m from the ground surface. Trapped male butterflies were periodically counted, registered and the data was plotted into graphics. Pheromone trap lures were replaced once every 4 weeks; replaced lures were discarded away from the experimental orchards. Pheromone trap sticky plates were replaced when the adhesive surface becomes dirty.

Determination of infestation rate of *Tuta absoluta*

In order to determine infection of tomato and eggplant plants with *T. absoluta*, 3 repetitions each with 10 plants were checked in the diagonal direction of the greenhouses. In this way, 30 tomato plants and 30 eggplant plants were marked and controlled periodically in each greenhouse. The aboveground parts of the marked plants such as leaves, shoots, flowers, ripe and unripe fruits were inspected several times a week during March and April. Samples of infected leaves and fruits were brought to the laboratory and examined under a binocular microscope.

Percent of infestation rate caused by *T. absoluta* was calculated for each plant using the following equation:

$$\text{Infestation rate (\%)} = \frac{\text{Infested plant number}}{\text{Examined total plant number}} \times 100 \quad (1)$$

Results and Discussion

Determination of adult population development of *Tuta absoluta*

Sexual pheromone traps were placed in the end of February at the blooming stage of tomato. The first adult occurrence was observed on March 5th in the tomato greenhouse (Figure 1).

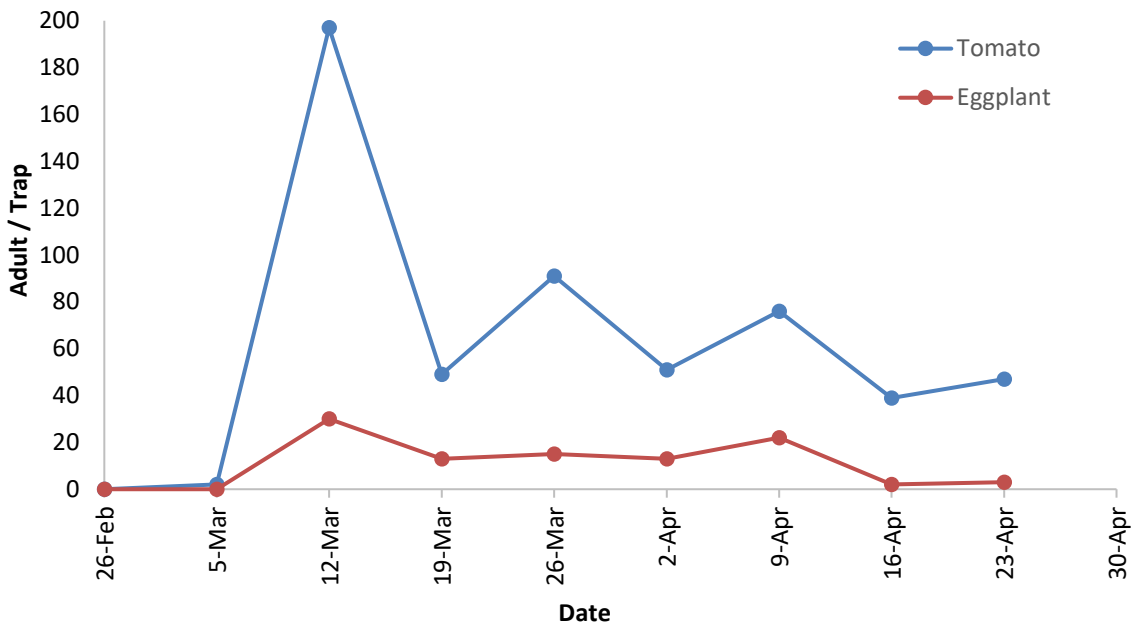


Figure 1. *Tuta absoluta* adult population development in tomato and eggplant greenhouse in Absheron during 2019

As can be seen from Fig. 1, the population development fluctuated during March and April. A dramatic surge was recorded between March 5th and March 12th following an unexpected drop that remained at 60 adult/trap. It is noticeable that the highest number of adult pests was caught using sexual pheromone traps on March 12th with 197 adult/trap over the time period. Özkan et al. (2017) reported that the highest peak point was determined with 548 adult/trap on March 27th in tomato greenhouse in Konya (Turkey). Interestingly, the population propagation was observed two times both in March and April. The adult population, which declined after the first week of April, started to rise again after in the middle of the month. The lowest count of adults was on April 16th (Figure 1).

In order to determine adult population development of *T. absoluta* in eggplant greenhouse, the sexual pheromone traps were established at the beginning of March. The first adult detection was observed on March 6, with 5 adults/trap. The highest number of males trapped was 30 adults per trap on March 12th, the period coincided with the flowering stage of the eggplant, in eggplant greenhouse. Followed by this date, the next high levels of adult population were recorded on March 26th and April 9th with 15 and 22 adult/trap, respectively. After this period,

the population fluctuated towards a decline until the end of April and the maximum number of adults caught was 3 on April 23rd.

Although it has been shown in the recent studies that the highest population of *T. absoluta* coincides with the date of harvest (Balzan and Moonen, 2011), the maximum adult trapped during the blossoming period and the first fruiting period tomato greenhouse in this study. Since the tomato plants were completely destroyed by *T. absoluta* in the greenhouse, the monitoring has been proceeded until the 30th of April 2019 (Fig. 2). Almost no green mass of the plant remained on the mentioned date.

In the study, it was observed that the number of pests and the rate of infestation decreased as the eggplant getting older unlike tomato. Furthermore, the damage of eggplant fruits was determined to be far less than the tomato fruits in the study. This can be explained by the fact that the leaves of the eggplant are thicker than those of tomato plant. Kanle Satishchandra et al. (2019) suggested in their study that *T. absoluta* may develop on tomato, eggplant and potato but tomato plant was the most preferred one. In the same study it is also mentioned that *T. absoluta* has a potential to become a serious pest on potato and even on eggplant under favorable conditions.

Considering the data obtained from the study and in the framework of the Figure 1, we can say that *T. absoluta* may form 2-3 generations in two months, March – April, in a tomato and eggplant greenhouses in Absheron. Supporting this information, depending on the ecological conditions *T. absoluta* can give 7-8 to 10-12 generations in Azerbaijan (Ismailzada, 2018; Huseynov et al., 2019).

Based on the visual observation of the tomato plants in the greenhouse, the larvae, as soon as hatched, begin to feed between two epidermis layers of leaves. Larvae mainly feed on the upper part of the plant, leaves, flowers and shoots. It was discovered in the study that the density of

the larvae was higher around the large veins of the leaves, and they were able to be seen under the transparent epithelium tissue without a magnifying device. In terms of high larval population, up to 10 larvae were found on a leaf, depending on the first and second instar of the larva and the area of the leaf axil. In damaged leaves, shoots, and ripe fruits, the black granular excrement of the larvae was clearly distinguished.

On the other hand, adults were active at night and hide in dense vegetation during the day. As a matter of fact, it was possible to see moths flying in the daytime if the plants were touched. In case of high population, the mass flight of adults during the day can be observed as well.



Figure 2. *Tuta absoluta* damage in the tomato greenhouse in case of high population

Determination of the infestation of Tuta absoluta

In the study, along with the population development of *T. absoluta*, the infestation rate of the pest in tomato and eggplant greenhouses was also studied (Figure 3).

In this context, the aboveground organs of the plants selected randomly from different parts of the greenhouse was analyzed in detail. The infestation rate of *T. absoluta* in tomato greenhouse was determined 30% at the beginning of March while it was 66.7% in the middle of March. The infestation rate reached to 100% on April 12th. These data indicate that the pest infected all plants controlled in the greenhouse in

a short time (Fig. 3).

In this way, it was determined that the rate of infestation went up in parallel with the increase in temperatures. As a matter of fact, Mamay and Yanık (2012) reported that there is a strong direct proportion between the infestation rate and the temperature. Similarly, Hüseyinov et al. (2019) observed that as the temperature increased, the population density and damage of the pest also increased. Likewise, Zaid et al. (2019) reported that the major factor was temperature and of the targeted solanaceous species on the dynamics of *T. absoluta* populations and on the dynamics of plant infestations by the larval stages.

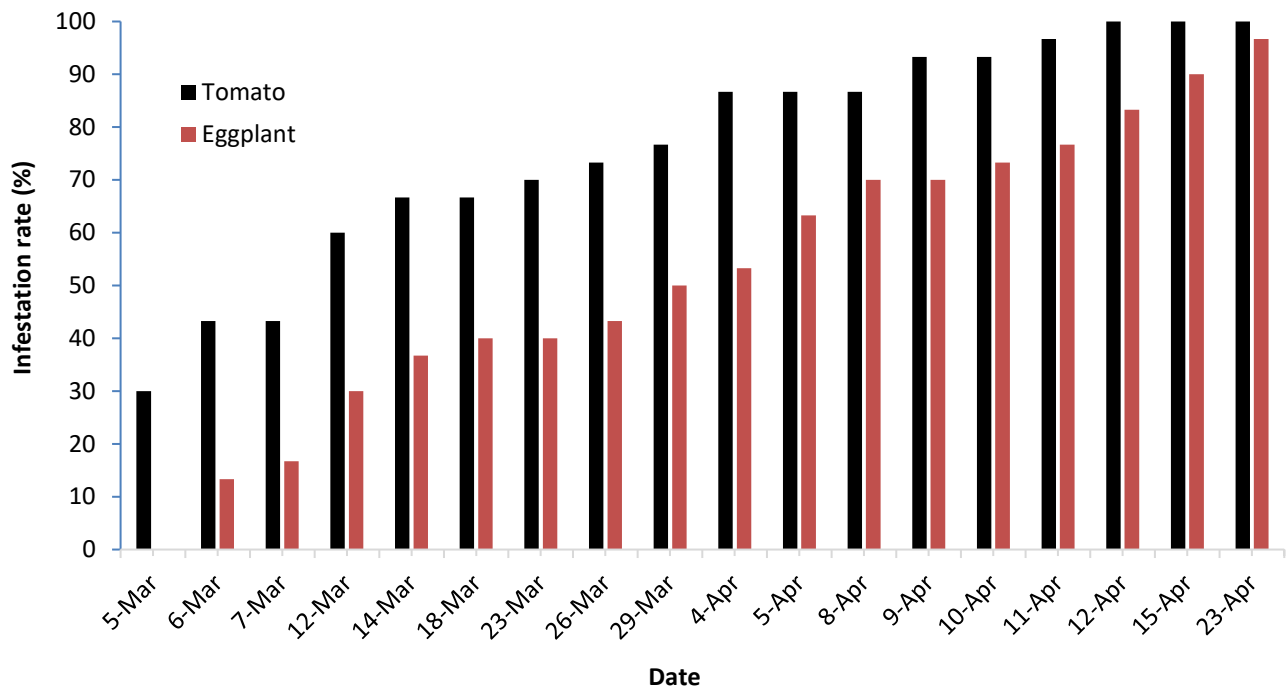


Figure 3. *Tuta absoluta* infestation rate in tomato and eggplant greenhouse in Absheron during 2019

As can be seen in the Figure 3, the infestation rate in the eggplant greenhouse was determined approximately 10% at the beginning of March. The infestation rate of *T. absoluta* increased over two months with a short plateau phase by 40% in 18-23 March and 70% in 8-9 April. The pest formed high infection on eggplant toward to the end of April since the infestation rate was reached 90% on April 15th. These data showed that the pest caused high infestation on eggplant in Azerbaijan. Similarly, Sivakumar et al. (2017) reported that the pest caused heavy defoliation of crops in eggplant cultivation in southern of India.

Comparing infestation rate of the pest in tomato and eggplant greenhouses, it is seen clearly that the damage of the pest in tomato and eggplant greenhouse were different. In support of this opinion; the infestation rate of *T. absoluta* in the first week of March was exceeded 40% while this ratio wasn't reached to 20% in eggplant greenhouse in the same date. Similarly, the pest infestation rate in tomato greenhouse was 70% on March 23rd while this ratio was determined in eggplant greenhouse 15 days later (April 8th). Moreover, the infestation rate for tomato was 100% on April 12th while it was 96.7% for eggplant on April 23rd. It is clear that the pest infected tomatoes at a higher rate in earlier dates,

however reached a significant infestation rate in eggplant though in late date. In parallel with our findings, Zaid et al. (2019) reported that tomato chronologically the first crop attacked by *T. absoluta* in Algeria. Similarly, a study concluded that *T. absoluta* highest infestation level was on tomato, followed by eggplant and other hosts in Sudan and Egypt (Shehata et al., 2016; Idriss Yagoup, 2019)

Although *T. absoluta* damaged all aboveground organs of the plant (shoots, flowers, stems, leaves, ripe and unripe fruits) the old leaves were the main targets according to the observations in the study. Thus, when there is no control application against the pest during high population all leaves can be dry and fall (Fig. 2).

As a result of infested with the pest, the photosynthetic ability of green leaves decreased. When the pest damaged the young plants, it opened gallery inside the trunk and caused the plant to dry out in a short time. Tomato plants became infected with saprophyte pathogens such as fungi after damaged by *T. absoluta* severely. The blackening and rotting images of ripe and unripe fruits can be given as examples of these infections.

According to our observations during the study, it was discovered that the larvae often enter from the part of the fruit closest to the

calyx and large fruits are more damaged than small fruits. Two rows of cherry tomatoes (*Solanum lycopersicum* var. *cerasiforme*) were also planted in the greenhouse. The pest damaged the leaves of cherry tomato while the fruits were remained undamaged.

In the study, it was monitored that the tip of the plant and the flowers at the top were also the most damaged parts of the tomato plant by *T. absoluta*. As a matter of fact, similar damage

types have been expressed in previous study (Bayrambekov, 2019). At first glance, yellow spots on the leaves infected with the pest was appeared. But on closer inspection, it was understandable that it was dried epithelium after the parenchyma of the leaf axil eaten by the larva of the pest. As the number of larvae increases, so does the dried area of the leaf axil, which consists only of epithelium (Figure 2; 4).



Figure 4. *Tuta absoluta* damage on tomato leaf axil

Although it was noted that the pest damaged the sweet pepper plant (*Capsicum annum* L.) (Zharmukhamedova and Shlyakhtich, 2017), pepper was not damaged by *T. absoluta* according to observations in this study.

Conclusions

As a pest of great economic importance, it was inevitable to study the population density and the infestation rate of *T. absoluta*. This is the first study carried out in the tomato and the eggplant greenhouses in the Republic of Azerbaijan. It has been understood from the study that the pest formed high population in tomato and eggplant greenhouse specially in March. Similarly, the infestation of the pest occurs chronologically first on tomato then on eggplant. The pest caused

significant damage on both hosts. To recapitulate our results, it is recommended that *T. absoluta* population development should be monitored in the greenhouses in Azerbaijan, and besides control applications, appropriate pest management programs should be applied against *T. absoluta*.

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Authors Contributions

GG designed the study and carried out the experiments. MM evaluated the data. GG and MM wrote the manuscript. Both authors read and approved the final manuscript.

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