Research Article

Varietal Preferences of Leafminer, *Tuta absoluta* on Tomatoes in Field

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Abstract | Tomato leafminer, *Tuta absoluta* has emerged as a serious oligophagous pest of tomatoes and other allied vegetables. It has recently been reported from Sindh, Pakistan, where studies on its biology and management are lacking. Therefore, studies were conducted to determine the relative resistance of widely grown hybrid (Rota F1, Early King, G1612, NAGA F1 and T-1057) and local tomato varieties (Desi Local and Shimlo) of Sindh, Pakistan against *T. absoluta*. All the varieties grown with standard agronomic practices as data on infestation of *T. absoluta* was taken weekly since the fifteen days of tomato transplanting depending on its characteristic damage symptoms. Both local tomato varieties were found significantly more susceptible than hybrid varieties that also differ in their relative resistance against *T. absoluta*. Overall, significantly the highest *T. absoluta* infestation on tomato leaves and fruits was recorded on Desi local (27.19±9.10 and 9.10±0.44%) and Shimlo (26.47±8.76 and 8.76±0.43%) varieties, whereas T1057 (9.70±3.54 and 3.54±0.19%) suffered the lowest infestation. Among hybrid varieties, the highest *T. absoluta* infestation on leaves and fruits was recorded on Rota F1 (21.22±7.07 and 7.07±0.33%) variety. A significant effect of *T. absoluta* infestation was also recorded on tomato yield of various varieties as the highest yield (735.20±9.49 maunds/acre) was recorded for T1057 variety, followed by Early King (676.40±8.21 maunds/acre). The lowest yield was observed in Desi Local (407.60±7.03 maunds/acre) and Shimlo (412.60±8.60 maunds/acre). Therefore, further studies should be planned to evaluate the mechanism of resistance among different tomato varieties against *T. absoluta* so that better breeding strategies could be employed to develop more resilient varieties with good yield potential.

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Introduction

During the recent years, tomato leafminer *Tuta absoluta* has been considered as one of the key pest of tomato outside its native range of South American countries. It has been reported to be available in tomato growing areas (either cultivated or greenhouse) of European, South American and Asian

countries, mainly because of its capacity to disperse rapidly as it can travel up to 800 kilometers in a year (Biondi *et al*., 2018; Han *et al*., 2019; Verheggen and Fontus, 2019). Recently it has also been reported from the tomato growing area of Punjab, KPK (Ishtiaq *et al*., 2020; Sadique *et al*., 2022), and Sindh (Gabol *et al*., 2023) provinces of Pakistan as losses to leaves, stems, buds, and fruits have been reported due to the feeding of all larval instars (Desneux *et al*., 2010). Nevertheless, there was a significant variance in the amount of *T. absoluta* on tomatoes across the nation, and this may be due to either the effects of the region's studies on climatic change or the different tomato cultivars produced there (Oliveira *et al*., 2009; Sawadogo *et al*., 2022). Studies have also suggested the development and use of resistant tomato cultivars as one of the significant measures to reduce the level of *T. absoluta* damage (Oliveira *et al*., 2009; Rakha *et al*., 2017; Sawadogo *et al*., 2022). The importance of resistant tomato cultivars is also getting importance because farmer's most reliable method for pest control i.e., use of synthetic chemicals is not so effective against *T. absoluta* because of the cryptic nature of larvae during feeding inside the mines (Uzun *et al*., 2015; Sawadogo *et al*., 2022). Moreover, most of the synthetic insecticides has adverse effects on the humans and other non-target organisms, whereas pest has also developed resistance against many of the widely used insecticides (Siqueira *et al*., 2000; Silva *et al*., 2011; Campos *et al*., 2015; Roditakis *et al*., 2015).

As the incidence and spread of *T. absoluta* is increasing in various tomato growing areas of the Pakistan including Sindh province, but so far, no systematic study has been done to determine the relative preference of *T. absoluta* on widely grown local and hybrid varieties. Therefore, this study was conducted to determine the relative preference of *T. absoluta* on widely grown tomato varieties of Sindh province so that the information obtained could be used for the development of cultivars that should be resistant to the pest along with a potential yield.

Materials and Methods

Study location and varieties used

The study was conducted at a farmer's filed located at district Shaheed Benazir Abad, Sindh. Following varieties were used in the study:

T1 = Rota F1(Semillas Almeria Seeds)
T2 = Early King (Hybrid F1) (Millan Agro Seeds)
T3 = G1612 (Hybrid F1) (Gulistan Seed Corporation Pvt. Ltd)
T4 = NAGA F1 (Tarnab Seed Corporation)
T5 = T-1057 (Syngenta Pak Ltd.)
T6 = Desi Local
T7 = Shimlo

Experimental design, data collection, and analysis

Each variety was raised in nursery and then transplanted in field as per their recommended rate of 150 grams/ acre. A row-to-row distance of 4 feet and plant to plant distance of 2 feet was maintained during the plantation. The size of each replicated plot was 10*10 square feet as five replications were maintained for each variety. All agronomic practices were used as per standard, whereas no synthetic chemicals were applied throughout the study.

The data collection was started fifteen days after the transplanting of tomato nursery and then continued on weekly basis till the final harvesting. Ten plants were randomly selected from the individual replicated plot of each variety as all above ground parts were observed for the recording to TLM infestation as the infestation percentage was calculated using the formula given below:

$$\%\ Damage = (Number\ of\ infested\ part\ /total\ number\ of\ part) * 100$$

Yield data of all the varieties was also calculated by recording the entire yield of all the replicated plot. All the collected data was analyzed using the analysis of variance, whereas the least significant difference test was used to determine the means with significant difference. The STATISTIX 8.1 computer software was used for the analysis.

Results and Discussion

Figure 1 illustrated the results for mean weekly *T. absoluta* infestation on tomato leaves of various varieties under field conditions. The results confirmed that a significant variation ($F = 1.67, P < 0.001$) was recorded among various tomato varieties for their susceptibility to *T. absoluta* infestation on leaves as local varieties were found comparatively more susceptible than evaluated hybrid varieties. The *T. absoluta* infestation on tomato leaves of all the varieties was observed since the first week after their transplanting with maximum (4.00±0.70%) infestation recorded on Desi

Local, followed by Shimlo (3.08±0.53%) and Rota F1 (2.28±0.38%) varieties. The lowest mean weekly infestation during first week after transplanting was recorded on leaves of T1057 variety (1.28±0.26%). Afterwards, a gradual increase in weekly mean infestation of *T. absoluta* was recorded that reached its peak during 20th or 21st week of the transplanting. Accordingly, the maximum mean weekly *T. absoluta* infestation on leaves was observed in Desi Local variety (46.72±3.81%), followed by 45.12±4.19% and 37.48±3.21% infestation recorded on Shimlo and Rota F1 varieties, respectively. The maximum weekly mean *T. absoluta* infestation recorded on remaining varieties i.e., Early King, FG1612, NAGAF1 and T1057 was 34.72±2.92, 32.00±2.33, 30.99±2.69, and 14.31±1.60%, respectively, all observed during week 18 to 21 after the transplanting of tomatoes.

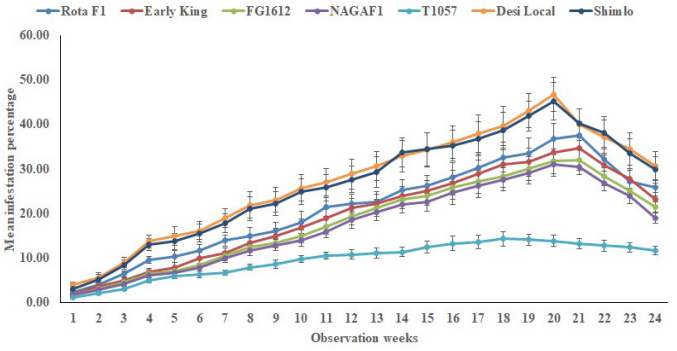

Figure 1: *Mean weekly percentage infestation of Tuta absoluta on leaves of different tomato varieties (LSD = 6.1742).*

The weekly mean *T. absoluta* infestation on fruits of various tomato varieties is illustrated in Figure 2, showing that the first infestation was recorded during 5th week of the tomato transplantation. It was observed that *T. absoluta* showed feeding preference on local varieties than widely cultivated hybrid varieties. Initially, the highest infestation on fruits was recorded in Shimlo variety (0.32±0.13%), followed by Desi Local (0.24±0.10%), Early King (0.12±0.09%) and NAGAF1 (0.12±0.07%) varieties. Afterwards, a rise in *T. absoluta* infestation on fruits of all the varieties was observed, especially Shimlo, Desi Local, and Rota F1 varieties suffered a significant infestation. The peak infestation on tomato fruits was recorded towards the maturity of the crop i.e., after 21st week of the transplanting. Thus, weekly the maximum *T. absoluta* infestation was recorded on Shimlo variety (22.48±2.34%), followed by 22.24±2.23 and 17.20±1.35%, infestation recorded in Desi Local and Rota F1 varieties. Among remaining varieties i.e., Early King, FG1612, NAGAF1, and T1057, the maximum infestation recorded on fruits was 15.00±1.15, 13.80±1.26, 13.68±1.08, and 9.28±0.95%, respectively. The statistical data analysis confirmed a substantially significant (F= 4.11, P < 0.001) variation in weekly mean *T. absoluta* infestation on various tomato varieties evaluated.

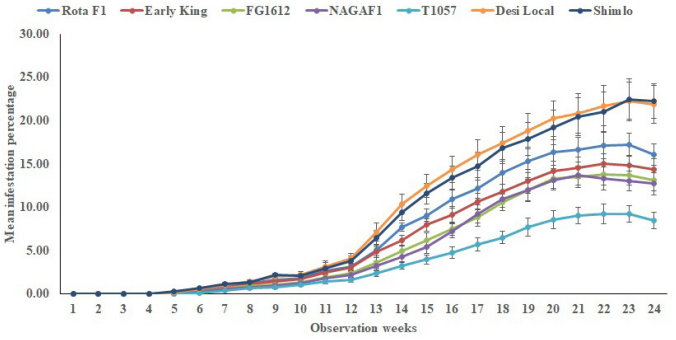

Figure 2: *Mean weekly percentage infestation of Tuta absoluta on fruits of different tomato varieties (LSD = 2.5934) F = 4.11 P < 0.001.*

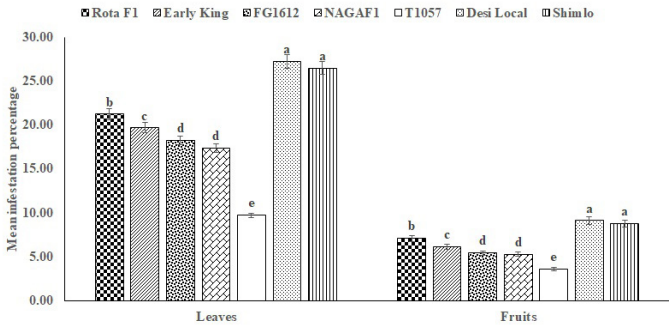

Figure 3: *Overall percentage infestation of Tuta absoluta on leaves and fruits of different tomato varieties.*
**Means followed by same letters are not significantly different from each other (P < 0.05, LSD values leaves = 1.2603, fruits = 0.5294).*

The overall infestation percentage of *T. absoluta* on leaves and fruits of various tomato varieties is given in Figure 3. Results of the study confirmed a substantial difference among tomato varieties for *T. absoluta* infestation on tomato leaves (F = 170.38, P < 0.001) and fruits (F = 108.66, P < 0.001). According to the results, Desi Local (27.19±9.10%) and Shimlo (26.47±8.76%) varieties suffered maximum infestation of the miner on their leaves, followed by Rota F1 (21.22±7.07%) and Early King (19.66±6.15%) varieties. Significantly, the minimum infestation of *T. absoluta* on tomato leaves was recorded on T1057 (9.70±3.54%) tomato variety, whereas infestation recorded on FG1612 (18.24±5.41%) and NAGAF1 (17.37±5.26%) was significantly similar. Like tomato leaves, significantly the highest infestation on fruits was recorded in Desi Local (9.10±0.44%) and Shimlo (8.76±0.43%) varieties, that was followed by infestation recorded Rota F1 (7.07±0.33%) and Early

King (6.15±0.28%) fruits. The *T. absoluta* infestation recorded on FG1612 (5.41±0.27%) and NAGAF1 (5.26±0.26%) fruits was not significantly different from each other, whereas T1057 variety suffered the lowest infestation (3.54±0.19%) on tomato fruits.

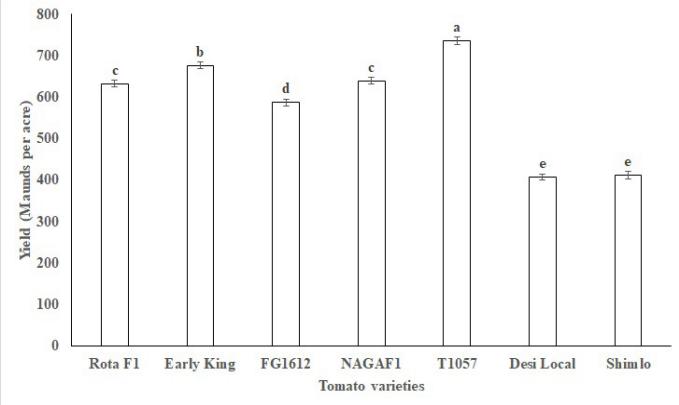

Figure 4: *Impact of Tuta absoluta infestation on yield of different tomato varieties.*
**Means followed by same letters are not significantly different from each other (P < 0.05, LSD = 23.659).*

It was observed that various tomato varieties not only differ in their susceptibility to the infestation of *T. absoluta*, but they also differ significantly (F = 243.00, P < 0.001) in their yield potential (Figure 4). According to results, significantly the highest tomato yield was recorded for T1057 variety (735.20±9.49 maunds/acre), followed by Early King (676.40±8.21 maunds/acre). No significant difference was recorded in the tomato yield recorded for Rota F1 (632.20±7.70 maunds/acre) and NAGAF1 (639.00±7.97 maunds/acre) varieties. Moreover, significantly the lowest tomato fruit yield was recorded for Desi Local variety (407.60±7.03 maunds/acre) that was not significantly different from yield obtained for Shimlo variety (412.60±8.60 maunds/acre).

It was observed in the study that *T. absoluta* showed relatively more preference to local varieties of Sindh province (Desi Local and Shimlo) as compared to widely grown hybrid cultivars. However, there was also a significant difference among hybrid varieties for their preference for the *T. absoluta* with respect to number of mines on leaves and fruits. The differential preference of *T. absoluta* among various local and hybrid varieties evaluated may be attributed to the chemical composition of evaluated varieties as earliest studies of Kennedy and Dimock (1983) also demonstrated the role of naturally available toxicants in wild varieties of the tomatoes for their capability to induce resistance against insect pests. Among other factors that may be responsible for the variable preference of *T. absoluta* on various tomato varieties include the presence of trichomes and their arrangement on various parts i.e., leaves, stems (de Resende et al., 2008, 2021; Pereira *et al.*, 2008; Silva *et al.*, 2011; Oliveira *et al.*, 2012). All these studies also reported that all advanced tomato varieties that possess quantities of AA, ZGB, and 2-TD allele chemicals exhibited almost same level of resistance towards the *T. absoluta*. Khederi *et al.* (2014) also reported that little density of glandular trichomes on various regions of tomato leaves may be responsible for their susceptibility towards *T. absoluta*. Above mentioned studies also confirmed negative relationship of *T. absoluta* infestation with trichomes density on the leaves.

Several studies have been conducted to evaluate tomato genotypes against *T. absoluta* as Mohamed *et al.* (2020) in their studies at University of Gezira found Rioking cultivar highly susceptible towards *T. absoluta* infestation on tomato fruits and leaves, whereas Salama and RILG3-162 genotypes were the least preferred by the miner. Sohrabi *et al.* (2017) identified the key role of higher densities of leaf trichomes towards the resistance of Berlina, Golsar, Poolad, and Zaman tomato genotypes among the eleven cultivars evaluated against the *T. absoluta*. Moreover, Gharekhani and Salek-Ebrahimi (2014) while evaluating eleven tomato cultivars for their resistance against the *T. absoluta* at 45-days after transplanting. They found significant differences among the varieties as the CLUSE variety was found relatively resistant with lower levels of infestation, but not significantly different from those of SERVENT, KUBRA, ATABAY, and MILAS, whereas Y-32-227 variety was found highly susceptible with the highest infestation of *T. absoluta*. They also demonstrated that varieties with strong vegetative and reproductive growth may have the potential to compensate for the early damage of the *T. absoluta* by producing more fruits, however, a strong and positive correlation of number of mines was calculated with the number of leaflets and plant height. Rakha *et al.* (2017) evaluated various tomato accessions of *Solanum galapagense, S. cheesmaniae* and *S. pimpinellifolium* which were known to be resistant against *Bemisia tabaci* Genn. and *Tetranychus urticae* Koch against *T. absoluta* based on the level oviposition along with the larval and adult mortality. The experiments conducted at two separate locations i.e., World Veg Eastern and Southern Africa (World Veg) and the International

Centre for Insect Physiology and Ecology (ICIPE) confirmed that *S. galapagense* VI063177 was found most resistant, whereas *S. pimpinellifolium* accession VI030462 was found susceptible at ICIPE.

The relative susceptibility of seven tomato cultivars based on their role to support various damage and reproductive parameters of *T. absoluta* suggested that Cal JN3 was the most susceptible variety, whereas Primo Early and Early Urbana was the found to be most resistant varieties (Ghaderi *et al*., 2017). Another study determined the level of resistance among tomato cultivars based on the antibiosis (by observing larval survival and weight of male, females pupae) and antixenosis (by observing oviposition) criteria (Vitta *et al*., 2016). Among the wild varieties evaluated, *S. habrochaites* (RCAT030597) genotype was found resistant based on the antibiosis with lower larval survival. However, *S. chilense* showed low oviposition preference for the *T. absoluta*, but it supported the highest larval survival among all the cultivars evaluated.

In continuation of the above-mentioned studies, high susceptibility of local Sindh province varieties (Shimlo and Desi Local) towards *T. absoluta* may be due to the lack of availability of defense chemicals in them due to the less breeding done among them for their better resistance against insect pests. Moreover, continuous improvements in the hybrid varieties to get higher and better yields along with their advanced pest protection may have played role in their relatively more resistance against the *T. absoluta*. Accordingly, T1057, FG1612, and NAGAF1 hybrid varieties were found more resistant against *T. absoluta* with least infestation on tomato leaves and fruits. Moreover, it is also evident from the above discussion that *T. absoluta* have the potential to prefer some of the tomato cultivars over others with role of various chemicals along with number and setting of trichomes has been identified as key in this regard. However, most of these characteristics are generally found in the wild tomato cultivars, and the incorporation of these characteristics into the cultivated edible varieties seems to be more complex (de Falco *et al*., 2019; Rasheed *et al*., 2018). Therefore, it is aways suggested to understand this complex mechanism of resistance of wild tomato cultivars against *T. absoluta* and its incorporation into the edible varieties with all the desirable features required by the consumers (Dias *et al*., 2019; Vitta *et al*., 2016).

Conclusions and Recommendations

All the tomato varieties evaluated showed the infestation of *T. absoluta* on their leaves and fruits, however they differ in their level of susceptibility against the pest. Desi Local and Shmilo varieties were found most susceptible to *T. absoluta* infestation, whereas T1057 hybrid variety was most relatively resistant, followed by FG1612 and NAGAF1. Moreover, significantly the highest tomato yield was recorded in T1057 and Early King varieties. However, there is a need to conduct additional studies to determine the mechanism of resistance among different tomato varieties against *T. absoluta* so that better breeding strategies could be employed to develop more resilient varieties with good yield potential.

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There is no acknowledgment for this paper to anyone because authors use their own resource during the entire study

Novelty Statement

The results of this study could provide a base to understand the relative resistance of widely grown local and hybrid tomato varieties against *Tuta absoluta,* hence the same may be considered by the growers in their cultivation to maximize their yield with less dependance on chemicals.

Author's Contribution

Abdul Hayee Gabol, Arfan Ahmed Gilal and Lubna Bashir Rajput: Designed the study.
Abdul Hayee Gabol and Ghulam Qader Mangrio: Conducted the experiments.
Jamal-U-Ddin Hajano and Jam Ghulam Mustafa Sahito: Analyzed data.
Muhammad Ishaque Mastoi and Arfan Ahmed Gilal: Wrote and finalized the manuscript.

Conflict of interest
The authors have declared no conflict of interest.

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