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The Relative Susceptibility of Certain Tomato Hybrids to the Moth *Tuta absoluta* (TLM), With Reference to the Role of Plant Age on the Level of Infestation

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Abstract:

The tomato leaf miner (TLM), *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae), is one of the major pests that attacks tomato and other solanaceae plants. It is currently considered a key agricultural threat to tomato production in Egypt, within its spread on 2008.TLM is becoming resistant to many of the pesticides used in tomato fields. One of the potential alternative methods of control is host plant resistance as a tool in IPM program. We examined the susceptibility of certain tomato hybrids (TH99806, TH99807, E.448 and Super Jakal) against the TLM infestation, during the winter and summer seasons of two successive years (2012 and 2013). The results revealed that the TLM showed different states of preference towards the investigated tomato cultivars. This finding may be important in breeding programs aiming to develop tomato cultivars resistant to this pest. The intensity of TLM infestation was arranged according to the level of leaves on the plant, it was found that the eldest leaves harbored the highest level of infestation which attributed to the accumulation of larvae through the growing of host plant.

Key word: Tomato hybrids, *Tuta absoluta*, tomato leafminer.

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Introduction:

The tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is one of the serious pests that attacks tomato crops both in the field and under protected conditions (Khanjani, 2013). It is an oligophagus insect that feeds on solanaceous plant species. Recently, bean: *Phaseolus vulgaris* was identified as a host of TLM, the pest attacks preferentially tomato plant (Desneux *et al*, 2010). *T. absoluta* is native to South America, while it was reported in Europe at the end of 2006 on tomato crop in Spain. It has spread to neighboring European and Mediterranean countries with alarming speed. Since the time of its initial detection, the pest has caused serious damages to tomato in invaded area, and is currently considered a key agricultural threat to European and North Africa tomato production (Desneux *et al*, 2010). Egypt among many of North African and Mediterranean countries reported as a site of this pest infestation (Bloem and Spaltenstein, 2011). Larvae of *T. absoluta* attack leaves, buds, stems, flowers, calyces and tomato fruit. Both yield and fruit quality can be significantly reduced by direct feeding by the larvae, and subsequently by secondary pathogens and causing fruit rot. Severely attacked tomato loses their most commercial value (Robredo Junco and Cardenoso Herrero, 2008). The tomato leaf miner represents a serious problem for tomato production due to both the intensity of the attack and its persistence throughout the entire tomato growing cycle.

Chemical methods have been the most common control measures used by growers. However, the indiscriminate use of insecticides has led to several adverse effects, such as the selection of resistance biotypes, causing growers to use ever increasing dosages and results less satisfactory results over time (Siqueira *et al*, 2000). Moreover, due to the hazards and adverse consequences caused by the use of pesticides to both man and the environment, researchers are currently working on more eco – friendly control methods. Host – plant resistance within IPM strategies can represent a suitable method for pest control. Plant resistance can be expressed by antixenosis, antibiosis, tolerance, or combinations to these mechanisms (Smith 2005).

The objective of this study is to examine the susceptibility of four commercial hybrid varieties of tomato to leaf miner infestation, allover the extended growing life time, at the winter and summer seasons. The intensity of infestation was arranged according to the level of leaves on the host plant, to declare the most preferable site for larval development.

Materials and Methods:

The present study was conducted at the experimental Farm of Plant Protection Department, Faculty of Agriculture, Assiut University during 2012 to 2014 seasons.

Area of studies:

An area of about ca. half Feddan (2100 m^2) was cultivated with tomato. The normal agricultural practices were performed with no insecticidal treatments during the study period. Tomato was planted in two successive seasons (2012-2013 and 2013-2014). In each season, tomatoes were sown in two planting

dates, summer and winter plantations. In summer plantations the seedlings were transplanted on February 23, 2012 and on March 14, 2013; whereas in winter plantations the seedlings were transplanted on October 14, 2012 and October 28, 2013.

Tomato varieties:

Four tomato hybrids were used in this study: both hybrids Nirouz (TH99806) and Nirouz (TH99807) were chosen for summer plantations while hybrids EL Otts (E.448) and Super Jakal were used for the winter plantations.

Direct count:

Throughout the two seasons, 5 leaves from the nonadjacent randomly selected plants were taken from each plot as standard sample size. Each leaf was picked carefully and sealed separately in a polyethylene bag. Samples were examined in the laboratory under stereomicroscope for count the number of tomato leaf miner (eggs, larvae and tunnels). At the beginning of fruiting stage 40 fruits were randomly selected in four replicates to estimate the leaf miner infestation.

Effect of plant level and age:

This test was also performed during two successive seasons (2013 and 2014) in the same experimental plots. From each plot, when plants aged two months, three samples (each of 25 leaves / week) were collected from different plant heights (i.e. lower, middle and upper plant parts). Sampling extended from January through March. The mean numbers of larvae and tunnels were calculated.

Effect of tomato variety on infestation levels of the leafminer:

Two tomato hybrids were cultivated in each planting dates, summer and winter plantations, during the two seasons to study the relative susceptibility of these hybrids on the tomato leafminer.

Statistical analysis:

Data were subjected to statistical analysis using T- test in pair and F-test and means were compared according to (L.S.D) at 5% level of probability calculated as mentioned by Gomez and Gomez (1984).

Results and Discussion:

Two hybrids of tomato TH99806 & TH99807 were planted during two successive winter seasons of 2012 and 2013. The plants were observed to estimate the percentage of TLM infestation (number of larvae per 10 leaves) throughout the growing season. The obtained results of 2012 season are presented in Figure 1. Comparing the infestation of the TLM on the first date of observation (39- day after planting) showed similar figures on both the examined varieties (12.625 and 12.75 larva for TH99806 and TH99807). The same was observed till the 60-day of planting. The infestation reached to 29.5 and 24.75 larvae on the 67 day, showed superiority of TH99806 over TH99807. It means that TH99806 seems to be more preferable for insect infestation than the later; during these two inspected days of 60 and 67 ages. The higher peak of infestation was recorded on 74- day of plant growing age, with remarkable figure on TH99806 over TH99807 (46.5 and 35.375 larvae). The preference superiority of tomato TH99806 over TH99807 was relatively visible till the destination date of observation (130- day). The

insect infestation ranged from 12.25 to 46.5 larvae on TH99806 compared with 7.00 to 35.37 larvae over the tomato growing age from 74 to 130 days (Figure 1). The statistical analysis of t-test in pair's designs to compare the two encounters of TLM infestation at each date of sampling indicated the highly significant difference among the two tomato hybrids that insured the superiority of TH99806 as a preferable host to TLM over the TH99807.

Figure 2 illustrated data of TLM infestation detected on the two tomatoes TH99806 during 2013 season. It can be observed that the result obtained is closely related to that obtained on 2012 season. TH99806 was more preferable than TH99807 for TLM infestation, ranged between 5.75 to 16.5 and 3-90 to 11.41 larvae/ leaves, for two respective hybrids. Again, the t-test assured the significant difference among the two hybrids of tomato as well as the previous year, which supports the result of former season on 2012, indicating the significant preference of TH99806 over TH99807. Comparing data of the two seasons exhibited that TLM infestation was more abundant during 2012 season than that on 2013 season. Moreover, the two season's results revealed also that the insect infestation grew exceedingly toward the plant ageing.

The previous investigation was subjected on the other two tomato hybrids of E448 and Super Jakal during the two successive summer seasons of 2012 and 2013. Data obtained during the first year was depicted in Figure 3, while those for the second year were reported in Figure 4. The TLM infestation was more abundant on 2012 season than that on 2013. Number of larvae per plant leaf reached the peak of 14.3 on hybrid E448 at 2012 season comparing with a peak of 4.25 larvae at 2013 season.

The statistical analysis of t- test in pair suggested the significant difference of TLM infestation among the two tomato hybrids, since the E448 hybrid was more favorable than Super Jakal allover the encountered inspected dates, during the two years of investigation.

The infestation of TLM on the tomato leaves picked at three levels of plant height (low, middle and high) were observed over the growing season of the two tomato hybrids TH99807 and TH99807, during two successive winter seasons of 2012 and 2013. Data of first year were represented graphically on Figure 5.

The factorial design was used to examine the significant difference in infestation among the two tomato hybrids at the three levels of leaves on the plant, as well as an interaction may be found between the two variables. The results indicated that the infestation at the eldest leaves (at the low level) was superior over those on either middle or high positions of leaves. This finding was supported over the two hybrids (Figure 5) while there is no significant difference of infestation was observed for the interaction among the hybrids and the level of leaves, it can be arranged the TLM infestation in a descendant manner as following: low, middle and high levels (97.88, 79.13 and 51.38) larvae for TH99806; and 95.00, 69.38 and 33.50; for TH99807).

When the investigation was repeated on 2013 winter, the previous finding of 2012 season was insured

(Figure 5). The TLM infestation on TH99806 were arranged decadently as 104.25, 91.25 and 49.13 on the low, middle and high levels of leaves, respectively. The larval infestation on TH99807 descended from 81.25 to 65.00 to 46.25 larvae on the former mentioned levels.

The two tomato hybrids of E448 and Super Jakal were compared together in regard to the preference level of plant leaves to infestation, at the two successive years of 2012 and 2013. The factorial design was used to examine the significant difference among the tested hybrids at three levels of plant leaves. Data reported in Figure 6 for the two consecutive years.

While, there is no significant difference among the two variable, it can arrange the average level of infestation as larvae per leaf decadently as 52.63, 22.00 and 8.25 on 2012 season and 59.13, 24.25 and 20.25 on 2013 season on E448 for the high, middle and low levels; respectively. The encounter levels of infestation on Super Jakal were 46.88, 11.38 and 2.63 larvae on 2012 season; and 50.38, 32.25 and 16.13 larvae on 2013 season. These results indicated that the lower position of plant (older leaves) harbored the most larval infestation over those on the middle and high positions. This finding agrees with that formerly obtained when the tomato hybrids 6 and 7 were compared together.

It can be concluded from the obtained results that the tomato leaf miner showed different states of preference towards the investigated tomato host plants. The tomato "TH99806" was more favorable than "TH99807" on the winter season, whilst E448 was the favorite on summer season over Super Jakal, allover the observed period of 2012 and 2013. Collectively, these results suggest that some of the tomato hybrids showed a relative preference to TLM infestation in which we can suggest to depend upon hybrids that show the host resistance character in pest management program. When the intensity of TLM infestation was arranged according to the level of leaves on the plant, it was found that the eldest leaves harbored the highest level of infestation, over those on middle or high positions. This finding may explained that the invader larvae accumulate in the older leaves exceedingly toward the plant ageing.

The role of natural toxicant in the wild tomato responsible for insect resistance has been documented early by Kennedy and Dimock (1983). Then, Resende *et al* (2008), Pereira *et al* (2008), Silva *et al* (2009) and Oliveira *et al* (2012) explained the role of different trichome style in the resistance of tomato strains to the moth *Tuta absoluta*. They found the advanced strains of tomato which are rich in the allele chemicals AA, ZGB and 2- TD that had similar levels of resistance to TLM. The work of Khederi *et al* (2014) demonstrated that the susceptible genotype of tomato, to TLM infestation, showed little density of glandular trichomes on different parts of the leaf than sensitive one. They also reported the significant negative relationship between egg and larval density and the trichomes in leaf viens, which probably caused a negative effect on individual moth population fitness, like egg deposition and larval feeding. These findings may be important in breeding programs aiming to develop varieties resistant

to TLM. The promising results of transfer the resistant factors from these accessions to the commercial tomato could lead to develop tomato cultivars more resistant to *T. absoluta* attack and consequently, reduce the use of chemical pesticides. The host-plant resistant as a tool within IPM strategy can be suitable method for TLM control. The intensive cooperation among the plant breeders and entomologists is needed to obtain such resistant tomato cultivars to TLM.

Figure 1: Difference between two genotypes of tomatoes (TH99806 and TH99807) in the infestation of *T. absoluta* on summer season, 2012.

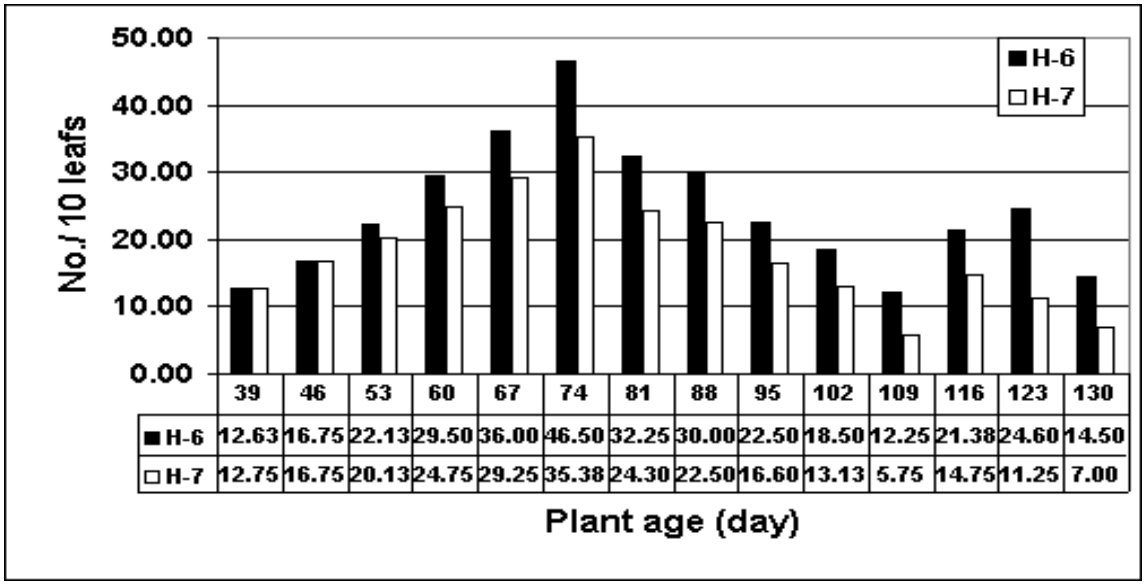


Figure 2: Difference between two genotypes of tomatoes (TH99806 and TH99807) in the infestation of *T. absoluta* on summer season, 2013.

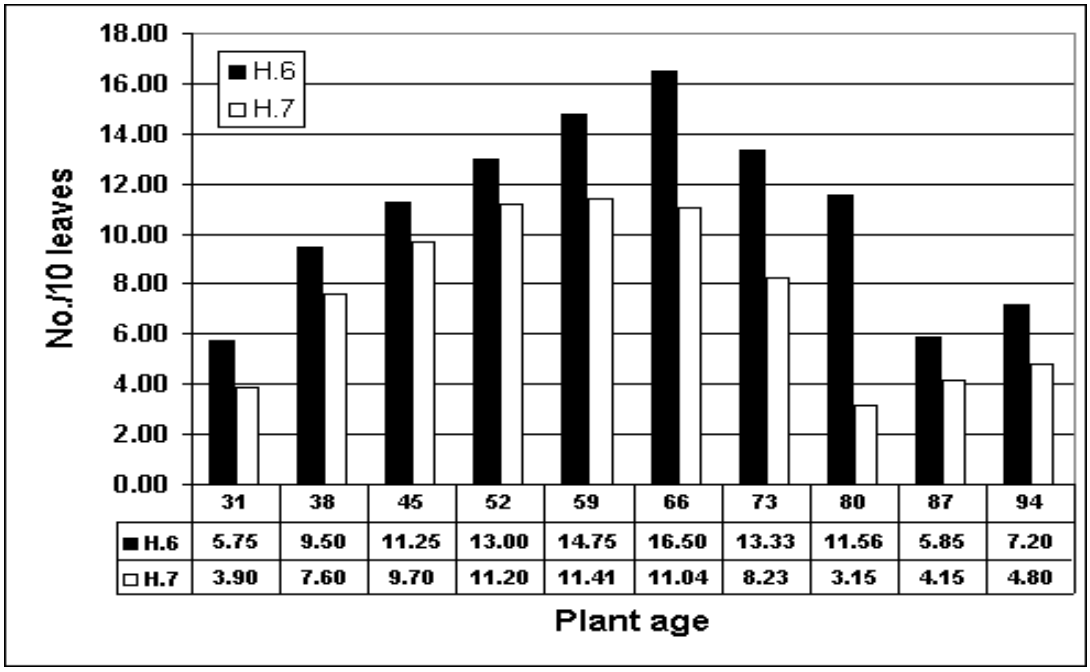


Figure 3: Difference between two genotypes of tomatoes (E.448 and Super Jakal) in the infestation of *T. absoluta* on winter season, 2012.

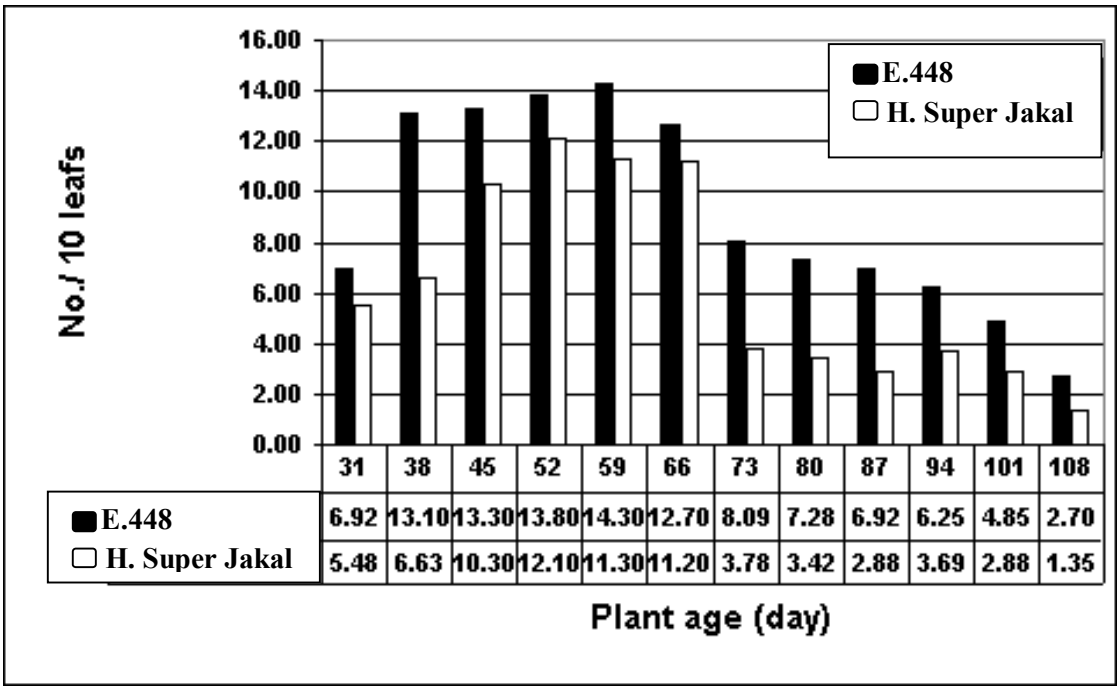


Figure 4: Difference between two genotypes of tomatoes (E.448 and Super Jakal) in the infestation of *T. absoluta* on winter season, 2013.

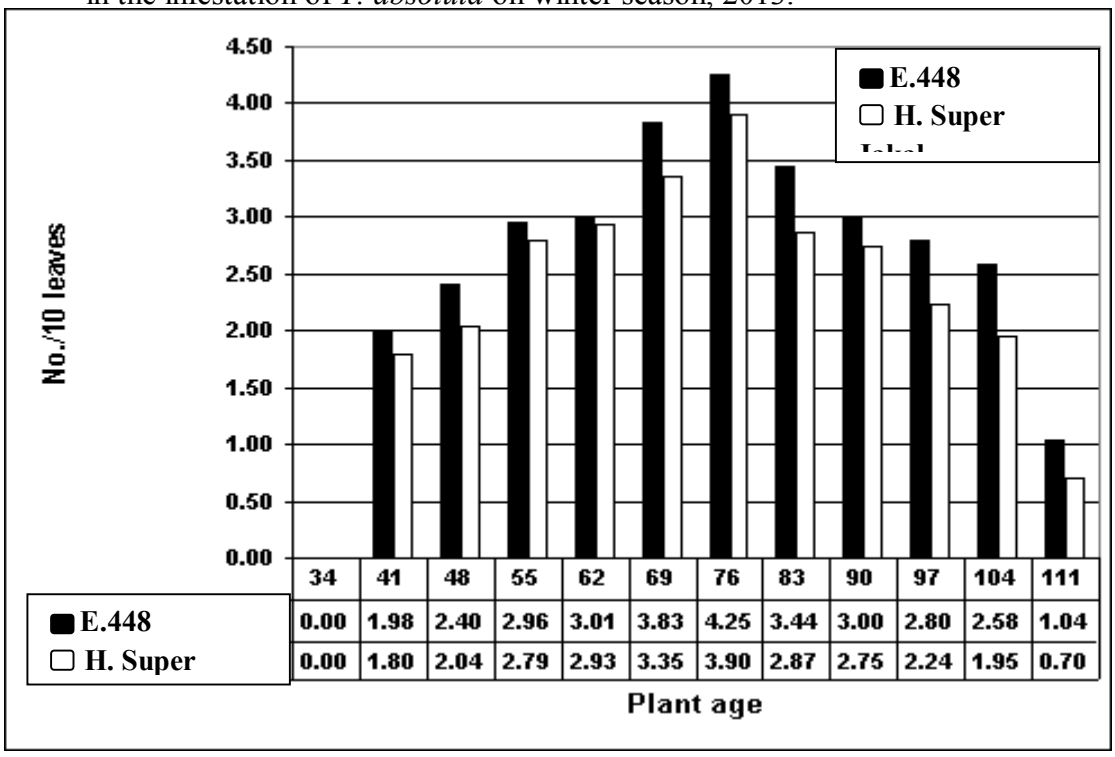
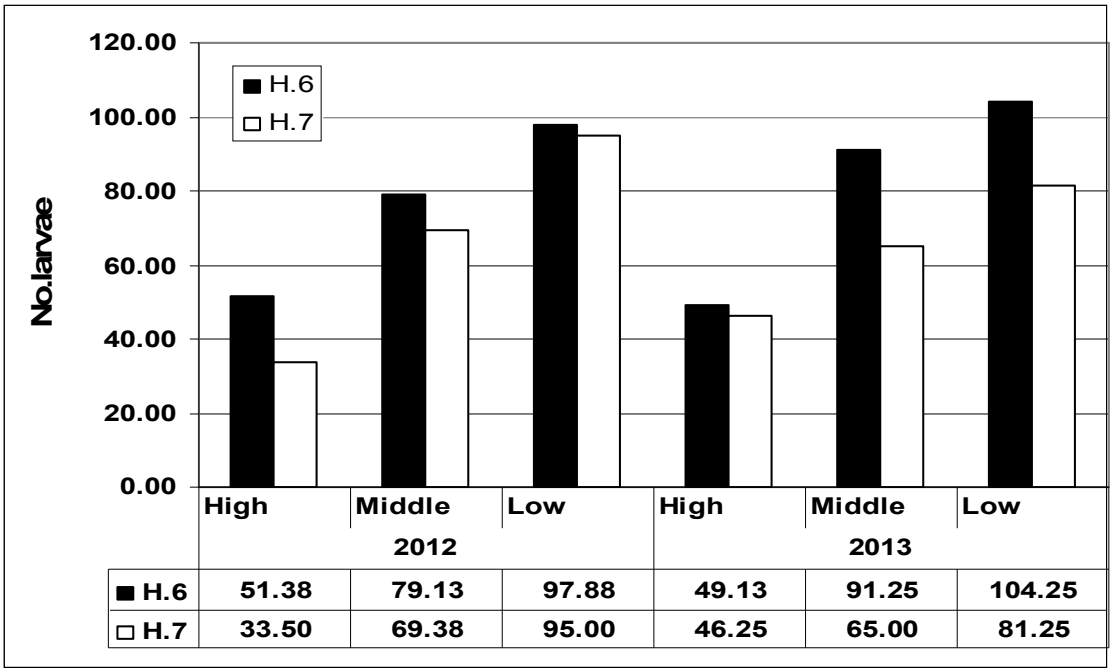
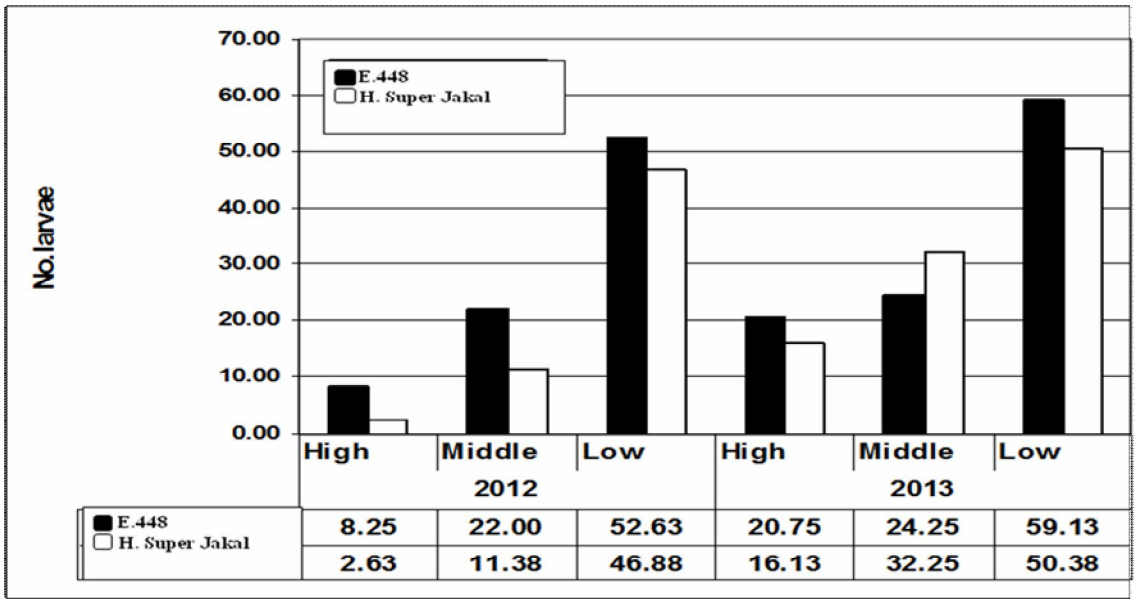


Figure 5: The infestation of TLM on the two genotypes tomato leaves picked at three levels of plant height (low, middle and high) through out 2012-2013 seasons.



	High	Middle	Low	High	Middle	Low
	2012			2013		
H.6	51.38	79.13	97.88	49.13	91.25	104.25
H.7	33.50	69.38	95.00	46.25	65.00	81.25

Figure 6: The infestation of TLM on E.448 and Super Jakal tomato leaves picked at three levels of plant height (low, middle and high) throughout 2012-2013 seasons.



	High	Middle	Low	High	Middle	Low
	2012			2013		
E.448	8.25	22.00	52.63	20.75	24.25	59.13
H. Super Jakal	2.63	11.38	46.88	16.13	32.25	50.38

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اختبار القابلية النسبية لبعض أصناف الطماطم للإصابة بحشرة صانعات أنفاق الطماطم مع الإشارة إلى دور عمر النبات على مستوى الإصابة بالحشرة

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الملخص:

حشرة صانعة أنفاق الطماطم *Tuta absoluta* هى واحدة من الآفات الرئيسية التى تهاجم محصول الطماطم وغيره من محاصيل العائلة الباذنجانية الأخرى. وهى تشكل تهديدا رئيسيا لإنتاج محصول الطماطم فى مصر، منذ انتشارها بعد دخولها مصر عام ٢٠٠٨م. وقد اصبحت هذه الحشرة مقاومة لكثير من المبيدات الحشرية التى استخدمت بكثافة لمكافحتها مما استوجب البحث عن طرق بديلة للمكافحة فى برنامج المكافحة المتكاملة لها. ومن ضمن هذه الطرق زراعة الأصناف التى تبدى درجة من المقاومة الطبيعية للإصابة.

فى هذا البحث تم اختبار القابلية النسبية للإصابة لبعض هجن الطماطم خلال موسمى الشتاء والصيف فى عامين متتاليين ٢٠١٢ ، ٢٠١٣. وأظهرت النتائج أن هجين TH99807 أقل نسبيا فى الإصابة بهذه الحشرة عن مثيله TH99806 فى الموسم الشتوى. كما أن هجين Super Jakal أظهر أنه أقل إصابة نسبية من قرينه E.448 فى الموسم الصيفى. مما يظهر أن بعض أصناف الطماطم يمكنها أن تظهر خاصية مقاومة الإصابة حيث ينصح باستخدامها فى الزراعة بديلاً عن تلك الأكثر قابلية للإصابة. قد تكون هذه النتائج مهمة فى البرامج التى تهدف إلى تطوير أصناف طماطم مقاومة لهذه الآفة.

من ناحية التأثير النسبي لعمر أوراق النبات على مستوى الإصابة بهذه الحشرة فقد اتضح أن أوراق النبات الأكبر عمراً (عند قاعدة النبات) هى التى تحوى عدداً كبيراً من يرقات هذه الحشرة بالمقارنة بالمستويات الأخرى المختبرة (الطرفية والوسطى من النبات) ويعزى ذلك الى تراكم اليرقات فى الأوراق مع تقدم العمر خلال فترة النمو.