

SUSCEPTIBILITY OF CERTAIN TOMATO CULTIVARS TO INFESTATION WITH *TUTA ABSOLUTA* (MEYRICK) (LEPIDOPTERA:GELECHIIDAE) IN RELATION TO LEAFLET TRICHOMES

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(Manuscript received 1 September 2016)

Abstract

The tomato leaf miner; *Tuta absoluta* (Meyrick) is one of the most important pests of tomato all over the world. Choosing of tomato cultivar plays an important role in controlling this insect pest. The susceptibility of some tomato cultivars to infestation with this pest in relation to leaflet trichomes was studied. Five tomato cultivars; Alissa F1, Super strain B, G.S 12 F1, E603 F1(Logain) and Indos were planted in both early summer and summer plantations. Results indicated that the most susceptible cultivars to the infestation were Alissa F1 and Super strain B while Logain cultivars was the least susceptible one. Two trichome types were detected in all tomato cultivars leaflet; one of them is glandular and the other is non glandular. Glandular trichomes length and density showed high significant negative correlation with *T. absoluta* infestation and length of normal trichomes showed significant negative correlation. So it is suggested that density of glandular trichomes might plays an important role in tomato cultivars susceptibilities.

Key words: Tomato borer, *Tuta absoluta*, Susceptibility, Trichomes, Seasonal abundance, Cultivars, Egypt.

INTRODUCTION

Tomatoes, *Lycopersicon esculentum* Mill. are one of the most important vegetable crops around the world and they are also the most popular garden vegetable and commercially in 159 countries. There are more than 700 varieties of tomatoes all over the world. The major producers of tomatoes in 2009 were China, the United States, India, Turkey, Egypt, Italy and Iran. According to the last estimates from the Egyptian Ministry of Agriculture and Land Reclamation in 2013, the tomato production increased to 16,636 tons/feddan with a total yield of 8,571,050 tons from a total area of 515,225 feddan (Anonymous 2013; FAOSTAT 2014). Tomato borer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is one of the most important pests of tomato. Larvae are the most damaging stage, which stay from 12 to 15 days. This

pest invaded Egypt in 2009. It is a pest with high damage potential. It has 10–12 generations per year. Females lay approximately 250 eggs. Tomato plants can be attacked at any developmental stage, from seedlings to mature plants. *T. absoluta* causes yield losses up to 100%. The highest population of *T. absoluta* occurred between April - Jun. and September – October. in Italy. Viability of *T. absoluta* larvae was 36.6, 45.1 and 65.4% when fed on tomato plant stages (before flowering, before developing fruits and after developed fruits, respectively)(EPPO, 2005; Torres *et al.*, 2001; Nannini *et al.*, 2011; Roditakis and Seraphides, 2011; Temerak, 2011; Khanjani, 2013).

Trichomes are epidermal protuberances that have distinguishing height/width ratios. Trichomes can be single-cell or multicellular, but the criterion that is mostly used to classify them is whether they are glandular or not. The presence of trichomes and their exudates have an inhibitory effect on the insect oviposition. In genus *Lycopersicon* different metabolites are secreted by leaves and stems glandular trichomes. (Behnke, 1984; Werker *et al.*, 2000; Gilardon *et al.*, 2001). Leite *et al.* (2001) found a significant negative relationship between egg and larva density and type of non-glandular trichomes on leaf vein and caused a negative effect on individual moth population fitness like egg deposition and larva feeding. Glandular trichomes are known to secrete a variety of secondary metabolites that are able to physically entangle insects. (Williams *et al.*, 1980; Kennedy and Dimock, 1983; Weston *et al.*, 1989; Eigenbrode and Trumble, 1993; Simmons *et al.*, 2003).

This study aimed to determine the susceptibility of different tomato cultivars to infestation with *Tuta absoluta* and the relation of leaflet Trichomes to these susceptibilities.

MATERIALS AND METHODS

Experimental Area and Design:

To detect the susceptibility of certain tomato cultivars to infestation with *T. absoluta*, five tomato cultivars; Alissa F1, Super strain B, G.S 12 F1, E603 F1(Logain) and Indos were cultivated in 15 equal plots (three replicates of each cultivar) in complete randomized block design at Qaha region (Qalyubiya Governorate) during early and late summer plantations throughout two successive seasons; 2013 and 2014. Early summer plantation date was on the first February and seedlings were transplanted to the open field in the end of Feb. Summer plantation date was in mid June and seedlings were transplanted to the open field in mid July. All usual

agricultural practices were applied and the whole experimental chemical control measures were entirely avoided during the studied duration.

Sampling procedures:

Sampling started after one week of seedlings transportation and continued weekly until the end of each growing season throughout both successive seasons. Direct counting of *T. absoluta* larvae on thirty leaflets of each cultivar (10 leaflet * 3 replicates) was conducted.

Scanning of Leaflet Surface Features:

For estimating different leaflet surface trichomes type and density, five young tomato leaflets were chosen from each cultivar for using the Analytical a Scanning Electron Microscopic Technique (SEM) (Joel jsm.6390LA) at the Central Laboratory of Water Station Fustat, Greater Cairo Water Company.

Samples were washed in 0.1 M phosphate buffer (pH 7) and post-fixed in 2% Osmium tetroxide (OsO₄) (pH 7). Samples were then taken through an alcohol dehydration series (15%, 25%, 40%, 50%, 70%, and 95% EtOH). SEM samples were critical point dried, sputter-coated to 20 nm with gold/paladium, and mounted on aluminum stubs for observation under a Phillips (SEM at 10-15 kV), Karnowsky (1965) and Fischer *et al.* (2012). Trichomes were counted using Compu Eye, Leaf and Symptom Area soft were according to Bakr (2005).

Statistical Analysis:

Statistical analysis was conducted using SAS program (1998). The ANOVA test was used to evaluate the significant differences among cultivars, and means were separated using Duncan's multiple range test. Also, correlation coefficient (r) was used to determine the relation of different trichomes of tomato leaflet and *T. absoluta* infestation.

RESULTS AND DISCUSSION

Susceptibility of certain tomato cultivars to *T. absoluta* infestation:

Early summer plantation:

Results of seasonal abundance of *T. absoluta* population density on the five tomato cultivars were represented in Table 1. These results indicated that seasonal abundance was higher than in season 2013 that was recorded in season 2014 with seasonal mean numbers; 5.93 and 5.20 larvae/10 leaflets for the two seasons, respectively.

In season 2013, statistical analysis of variances among different seasonal means of *T. absoluta* population density indicated significant differences (F= 3.2), where the

highest seasonal mean number recorded on Alissa F1cultivar with mean number 8 larvae/10 leaflets, followed by Super Strain B and Indos cultivars with mean numbers, 7.31 and 4.93 larvae/10 leaflets. On the other hand, on GS 12 F1 and Logain (E603 F1) cultivars the lowest mean numbers were recorded (4.76 and 4.66 larvae/10 leaflets, respectively).

In season 2014, statistical analysis of variances among different seasonal means of *T. absoluta* population density indicated high significant differences ($F= 8.43$), where the highest seasonal mean numbers were recorded for Alissa F1 and Super Strain B cultivar being 7 and 6.45 larvae/10 leaflets, respectively, followed by GS 12 F1 cultivar with mean number of 5.81 larvae/10 leaflets, then Indos cultivar with mean number 4.07 larvae/10 leaflets. While the lowest seasonal mean number was recorded for Logain E603 F1cultivar (2.68 larvae/leaflet).

Summer plantation:

Results of seasonal abundance of *T. absoluta* population density on the five tomato cultivars were presented in Table 2. These results indicated that seasonal abundance was higher, in season 2013, than that was recorded in season 2014 with seasonal mean numbers of 3.28 and 3.04 larvae/10 leaflets, respectively.

In season 2013, statistical analysis of variances among different seasonal means of *T. absoluta* population density indicated moderate significant differences ($F= 4.55$), where the higher seasonal mean numbers were recorded on Super Strain B, Alissa F1, GS 12 F1 and Indos cultivars with mean numbers of population density; 3.67, 3.62, 3.45 and 3.40 larvae/10 leaflets. While the lower seasonal mean number of population density was 2.29 larvae/ 10 leaflets on Logain E603 F1 cultivar.

In season 2014, statistical analysis of variances indicated insignificant differences among different seasonal means of *T. absoluta* population density ($F= 2.05$). The highest seasonal mean numbers were recorded on Alissa F1, Super Strain B and GS 12 F1 cultivars (3.52, 3.24 and 3.14 larvae/10 leaflets for the three cultivars, respectively). followed by Indos cultivar with mean number of 3.02 larvae/10 leaflets. While the lowest mean number (2.31 larvae/10 leaflets) was recorded on Logain (E603 F1) cultivar.

From the aforementioned results it could be concluded that the most susceptible cultivars for *T. absoluta* infestation were Alissa F1 and Super strain B cultivars with seasonal mean numbers of 5.53 and 5.16 larvae/10 leaflets, followed by both G.S 12 F1and Indos cultivars with seasonal mean numbers of 4.29 and 3.85 larvae/10 leaflets. While Logain (E603 F1) showed highly resistance against *T. absoluta* infestation with seasonal mean number of population density 2.97 larvae/10 leaflets.

Highest population density of the *T. absoluta* on tomato were between Mar. – Jun and in Sep.-Oct. (Picanco *et al.* (2000), Ecole *et al.* (2001), Miranda *et al.* (2005), Nannini *et al.* (2011)). And The most Susceptibility varieties to larval attacks of *T. absoluta* were "Doucen, Zahra and Kartier" whereas "CLX" and "Pietro" had lower infestation rates. (Allal *et al.* 2011). Alisa tomato variety was more susceptible to the *T. absoluta* infestation than Super strain B (Ata and Megahed 2014). Tomato varieties, Fyrouz and H9780 were the most susceptible to *T. absoluta* infestation followed by Alissa, Hadir, and Elbasha 1077 (Shawir *et al.* 2014).

Effect of tomato leaflet morphology on *T. absoluta* infestation:

Tomato leaflet surfaces morphology was scanned by the scanning electronic microscope to detect the relationship among different trichome's type, density, length and width of the five tomato cultivars and *T. absoluta* infestation. Results in fig. 1 indicated that there are two types of trichomes in both tomato leaflet surfaces in all the five tomato cultivars; one of them is a non glandular type (III) and the other one is a glandular type (VI). This identification is based on Glas *et al.*, (2012).

Statistical analysis of simple correlation among these two types of trichome's density, length and width of five tomato cultivars and *T. absoluta* infestation (Table 3) showed a negative significant relationship ($r = -0.89 - p = 0.04$) between the glandular trichome (VI) density (numbers) and *T. absoluta* infestation. The highest mean number of this trichome type was detected in Logain (E603F1) cultivar (22.6 trichome/ Imm² leaflet), followed by Indos, Super strain B, GS 12F1 and Alissa F1 with mean numbers of 8, 5.4, 3.8 and 3.2 trichomes/ Imm² leaflet. Also there is a negative relationship among glandular trichome' length and positive relationship to their width. In addition, the length of non glandular trichomes was negatively correlated with *T. absoluta* infestation .

From the above mentioned results it could be suggested that glandular trichome (VI type) might play an important role in tomato cultivar resistance against *T. absoluta* infestation. Obtained results were in agreement with those obtained by Gilardon *et al.* (2001), Leite *et al.* (2001) and Glas *et al.* (2012) who mentioned that in genus *Lycopersicon* different metabolites and substances are secreted by glandular trichomes of leaves and stems. These substances have evolved to provide the plant with protection against herbivores and pathogens.

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Table 1. Weekly mean numbers of *T. absoluta* larvae/leaflet on five tomato cultivars throughout early summer season during year, 2013 and 2014 at Qaha farm, Qalyubiya Governorate.

Sampling dates	Alissa F1		Indos		Logain E603 F1		Super strain B		G.S 12 F1	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
5 March	0.00	4.67	1.00	1.33	0.00	0.67	0.33	3.00	2.67	2.00
12/03	9.67	7.67	4.00	3.67	1.33	1.67	8.67	7.00	4.67	5.33
19/03	3.00	4.67	18.3	8.33	9.00	7.00	11.7	6.67	11.67	10.67
26/03	7.33	7.33	5.33	9.33	4.33	7.67	7.33	5.33	0.67	13.00
02/04	5.67	9.00	1.33	7.67	1.67	4.67	7.67	18.33	1.67	10.67
09/04	3.00	6.00	2.33	4.33	2.00	3.00	5.00	14.00	1.33	6.67
16/04	3.67	6.67	3.00	6.67	5.00	4.00	6.33	5.00	3.00	7.67
23/04	8.00	12.3	4.33	3.00	3.67	2.00	6.67	7.00	5.33	6.67
30/04	3.33	7.00	1.33	2.67	0.67	2.00	4.67	4.33	2.00	3.33
07/05	11.67	8.00	5.67	3.67	6.67	2.00	7.00	5.00	9.67	4.67
14/05	25.33	8.00	4.33	2.67	6.33	0.67	8.67	7.00	9.67	5.33
21/05	21.00	10.3	6.67	3.33	10.67	1.33	17.3	5.00	10.33	4.00
28/05	9.33	4.33	6.00	0.33	10.33	0.00	7.67	2.00	4.00	1.00
04/06	1.00	2.00	5.33	0.00	3.67	0.00	3.33	0.67	0.00	0.33
Mean	8.0a	7.0 a	4.9ab	4.1bc	4.7c	2.7c	7.3ab	6.4a	4.8c	5.8ab

F value for season 2013 = 3.20* LSD= 2.49 F value for season 2014 = 8.43*** LSD= 1.79

Table 2. Weekly mean numbers of *T. absoluta* Larvae/leaflet on five tomato cultivars throughout summer season during year 2013 and 2014 at Qaha farm, Qalyubiya Governorate.

Sampling dates	Alissa F1		Indos		Logain E603 F1		Super strain B		G.S 12 F1	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
02 July	4.33	1.33	3.33	0.33	1.00	0.00	4.67	0.33	2.00	1.33
09/07	5.33	1.67	2.67	1.33	1.33	0.00	3.67	2.00	1.67	2.67
16/07	3.67	2.67	4.67	2.67	2.33	0.00	3.00	3.00	4.33	2.33
23/07	4.00	3.67	6.67	4.33	4.33	0.00	3.33	4.33	6.00	3.33
30/07	4.33	5.67	5.67	2.67	2.33	2.33	3.33	2.33	5.33	5.67
06/08	3.00	5.00	2.67	2.67	2.67	5.00	5.00	2.67	4.00	5.00
13/08	3.33	7.00	3.67	2.33	4.00	6.33	4.67	2.33	6.33	3.00
20/08	3.33	5.67	3.67	5.67	5.00	5.67	3.33	5.33	5.33	3.33
27/08	4.00	3.67	3.00	5.00	4.33	3.33	3.33	5.00	3.00	3.00
03/09	2.33	2.00	1.33	3.67	3.00	1.67	2.67	3.67	1.33	2.67
10/09	4.67	2.67	1.67	4.67	1.33	2.67	3.33	4.67	2.33	2.67
17/09	3.67	1.33	1.67	4.33	0.33	1.00	3.33	4.67	0.67	1.33
24/09	4.00	5.00	4.00	2.00	0.00	2.33	3.67	3.33	4.33	5.00
01/10	0.67	2.00	3.00	0.67	0.00	2.00	4.00	1.67	1.67	2.67
Mean	3.62 a	3.5 a	3.4 a	3.0 ab	2.29 b	2.3 b	3.7 a	3.2 a	3.45 a	3.14 a

F value for season 2013 = 4.55** LSD= 0.74 F value for season 2014 = 2.05 Insig.

Table 3. Density and Dimensions of trichomes of five tomato cultivars in relation to mean numbers of *T. absoluta* population density.

Tomato cultivars	Trichomes					Larvae/ leaflet
	Glandular			Non glandular		
	Mean number	Length(μ m)	Width(μ m)	Mean number	Length(μ m)	
Alissa F1	3.2 d	106.50 ab	55.06 a	169	163.97 d	7
Indos	8 b	114.55 ab	53.18 a	177	172.44 d	4.07
E603 F1 (Logain)	22.6 a	124.71 a	52.95 a	210	270.54 a	2.62
Super strain B	5.4 c	109.59 ab	58.04 a	245	199.25 c	6.45
G.S 12 F1	3.8 cd	119.82 ab	55.48 a	233	244.3 b	5.81
Correlation value	- 0.894	-0.815	0.774	0.087	-0.567	-
P value	0.041	0.093	0.125	0.889	0.318	-

Glandular: L.S.D.(Mean number = 2.00 Length= 17.83 Width= 11.34)

Non glandular: L.S.D.(Length= 15.69)

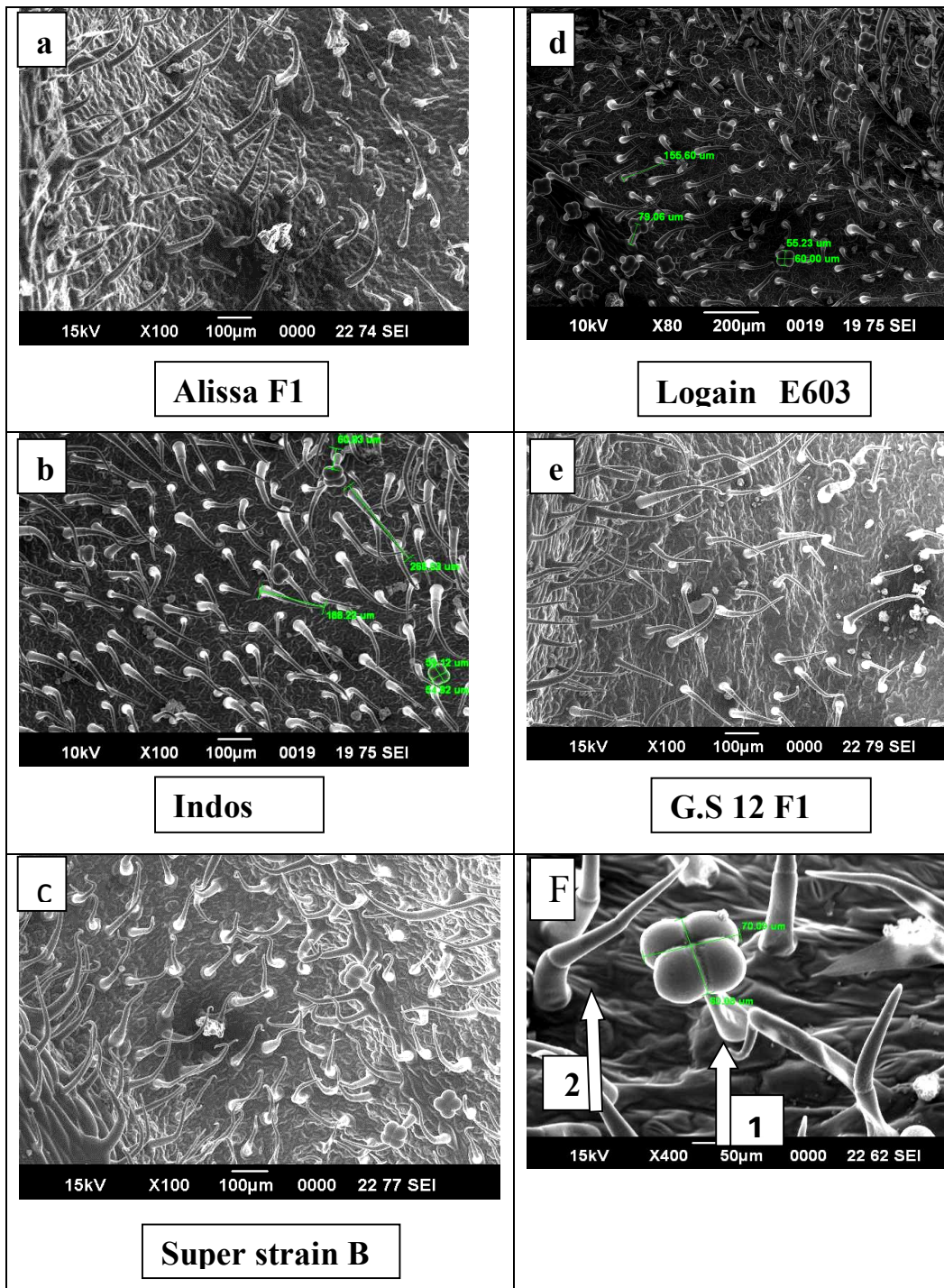


Fig. 1. Scanning electron microscopic images of five tomato cultivars showing different trichome types a Alissa F1; b Indos; c Super strain B; d Logain (E603) ; e G.S 12 F1; f, 1 Glandular trichomes (thick and short glandular trichomes of two stalk cells and a head made up of secretory cell), 2 non-glandular trichomes composed of one basal and thick cell with a leaning cell in the tip.

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حساسية بعض أصناف الطماطم للاصابة بحشرة التوتا ايسليوتا وعلاقة الشعيرات الموجودة على وريقات نبات الطماطم بالاصابة

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تعتبر حشرة حافرة أوراق الطماطم *Tuta absoluta* من أهم آفات الطماطم على مستوى العالم وقد وجد أن أصناف الطماطم تلعب دورا هاما فى مكافحة هذه الافة .تم دراسة حساسية خمسة أصناف طماطم للاصابة بهذه الافة وعلاقة هذه الحساسية بالشعيرات الموجودة على وريقة الطماطم . وقد تم زراعة خمسة أصناف اليبسا F1 ، سوبر استرين B ، جى اس ١٢ F1 ، لوجين (E603) وصنف اندوس فى موسمى الصيفى المبكر والصيفى لسنتى ٢٠١٣ و٢٠١٤ وكانت النتائج المتحصل عليها هى أن أكثر الاصناف حساسية للاصابة هما صنفى اليبسا F1 و سوبر استرين B أما الصنف لوجين كان أقل الاصناف حساسية للاصابة كما وجد نوعين من الشعيرات على وريقات نبات الطماطم (شعيرات غدية وشعيرات عاديه) ومن الدراسة وجد أن عدد وطول الشعيرات الغدية ارتبطت ارتباط سالب عالى المعنوية مع أعداد الحشرة وكذلك ارتبطت طول الشعرة عاديه ارتباط سالب معنوى مع اعداد الحشرة .