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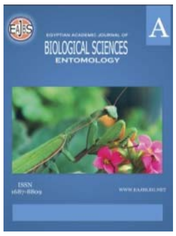

Interpretation of Susceptibility Phenomenon of Four Tomato Cultivars to *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae).

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ABSTRACT

The selected four tomato cultivars {(Alissa F1, Super strain B, G.S 12 F1and Logain (E603 F1)} differed in their susceptibilities to the tomato borer, *Tuta absoluta* in the two studied successive years (2013 and 2014). Seasonal abundance of this pest was higher in early summer and summer plantations of year 2013 than that recorded in year 2014. The highest seasonal mean number was recorded on Alissa cultivar for both studied years followed by Super strain cultivar then G.S. cultivar. While the lowest mean number was achieved with Logain cultivar.

The essential oil analysis by GC/MS of four tomato cultivars leaves revealed the presence of 33 peaks. A total of 33 components of the essential oil were identified. Aliphatic hydrocarbons terpenes compounds were found to be the most abundant volatiles in the four tomato cultivars except G.S. cultivar. The analyses revealed that the major identified aliphatic hydrocarbon components in the leaves oil of Logain and Alissa tomato cvs. (The lowest and the highest infestation with *T. absoluta*) were Octacosane, Hexacosane, Triacontane, Heptacosane, Nonacosane, Tetratriacontane, Hexatriacontane and Tetracosane. Susceptibility interpretation of Logain and Alissa tomato cvs. to *T. absoluta* may be attributed to the presence of high contents of the toxic and repellent hydrocarbons octacosane and hexacosane in Logain tomato cv. and high content of the attractant hydrocarbon tetracosane in Alissa cv. From these results it can be recommend to use the tolerable Logain tomato cultivar in breeding programs and also, preparing a commercial product/formulation from hydrocarbons octacosane and hexacosane to be used as repellent and tetracosane as a trap to *T. absoluta*.

INTRODUCTION

Tomatoes, *Lycopersicon esculentum* Mill are one of the most important vegetable crop around the world. 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, United States, India, Turkey, Egypt, Italy and Iran. According to Egyptian Ministry of Agriculture and Land Reclamation in 2013, tomato production was 16,636 tons/feddan with a total yield of 8,571,050 tons from 515,225 feddans (Anonymous 2013 and FAO STAT 2014). It is also considered one o f the crops that are used for export. Tomato plants are infested with many important pests, such as, whitefly, aphids, potato tubers moth and recently, the tomato borer, *Tuta absoluta*.

Tomato borer, *T. absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is considered one of most important pests on tomato crop and cause severe losses. *T. absoluta* is native to South America and present in Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Perú, Uruguay and Venezuela (EPPO 2005). Arno *et al*. (2009) reported that *T. absoluta*, an important pest, was firstly detected in Spain in 2006 and currently presented in several Mediterranean countries. *T. absoluta* firstly appeared in 2009 in Western Egypt. Larvae are the most damaging stage, which stays from 12 to 15 days (Temerak, 2011). *T. absoluta* was considered to be one of the most damaging pests of tomato production, both in open fields and under greenhouse conditions. It can cause up to 80-100% yield losses (Desneux *et al*., 2010).

Plants synthesize a broad range of volatile compounds that are toxic to insects and so are believed to act as defense compounds. Aragao *et al*., (2000) and Maluf *et al*. (2010) showed that, tomato plants produce the allelochemicals associated with resistance. So, this study aimed to explain the role of the volatile compounds which produced by tomato cultivars to interpretation of susceptibility phenomenon of four tomato cultivars {Alissa F1, Super strain B, G.S. 12 F1 and Logain (E603 F1)} to *T. absoluta*.

MATERIALS AND METHODS

Experimental area and design:

This study was conducted in an area of about 1600m² at Qaha region, Qalyubiya Governorate for evaluating abundance of *T. absoluta* on four tomato cultivars {Alissa F1, Super strain B, G.S 12 F1 and Logain (E603 F1))} during early and late summer plantations throughout years 2013 and 2014. Twenty four equal plots were cultivated with the different cultivars as three replicates for each treatment in complete randomized block design. The area of each plot was 7*8m². Early summer plantation date was on the first of Feb. and seedlings G.S. were transplanted to open field at the end of Feb. Summer plantation date was on Mid-June and seedlings G.S. were transplanted to open field on 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 one week after seedlings G.S. transportation and continued weekly in the morning before noon, until the end of each growing plantation throughout both successive years. Direct counting of *T. absoluta* larvae on thirty leaflets of each cultivar of tomato plant (10 leaflet * 3 replicates) was conducted. The mean count of larvae/ 10 leaflets for tomato plant were calculated.

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

The mean counts of *T. absoluta* larvae of obtained data from conducted experiments on different cultivars of tomato plant were used to detect the susceptibility of these cultivars to infestation. Obtained data was subjected to statistical analysis.

Isolation and identification of tomato leaves volatile compounds.

Extraction of the essential oil

Volatile components were extracted from fresh tomato leaves using the Porapak Q method (PQM) as described by Kobayashi *et al*. (2012).Crushed leaf sample (100 g FW) were added to 100 ml of distilled water and the resulting mixture was stirred overnight at room temperature. The samples were then centrifuged at 10,000 rpm for 30 min, and the supernatant was filtered with a glass filter under reduced pressure. At room temperature, the extract was then poured into a PQ column (i.d. 2 × 40 cm) to adsorb the volatile compounds on the PQ resin, and the column was washed with 100 ml of distilled water. The volatile compounds were then dissolved in 100 ml diethyl ether to elute the absorbed compounds. The volatile compounds was dried over hydrous sodium sulfate overnight at 4°C, and then concentrated to 4 ml under a nitrogen stream. One-microliter samples of the extracts were drawn for GC-MS analysis.

Gas Chromatography-Mass Spectrometry Analysis

Agilent Technology, 7890B GC-MS system, 5977 A MSD, with a DB-WAX fused silica capillary column 30 x 0.025mm, HP, 5 MS, 0.025 Mickon was used to identify the volatile compounds in tomato leaf. The injector, interface, and ion source temperatures were 280°C and pressure 19.41. The oven temperature was held at 50°C for 0.5 min, then increased to 190°C by 10°C/min and held for 15 min, then increased to 220°C by 10°C/min and held for 3 min, finally increased to 300°C by 10°C/min and held for 11 min. The flow rate of helium carrier gas was 30 cm/s. Qualitative identification of the essential oil was achieved by library searched data base Willey 229 LIB as well as by comparing their retention indices and mass fragmentation patterns with those of the available references and with published data, (Adams, 2007). The percentage composition of components of the volatile was determined by computerized peak area measurements. The GC-MS experiment was carried out in triplicate.

Statistical Analysis:

Statistical analysis was conducted using SAS Program (1988). Proc ANOVA was used to evaluate the significant differences among cultivars, and means were separated using Duncan's multiple range test.

RESULTS AND DISCUSSION

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

Results of seasonal abundance of *T. absoluta* population density on the four tomato cultivars are represented in Tables 1, 2 and 3.

Early summer plantation:

In year 2013, significant differences among different seasonal means of *T. absoluta* population density was found (F= 3.20 and LSD= 2.14) where the highest seasonal mean number was recorded on Alissa F1 cultivar with mean number of 8.00 larvae/10 leaflets, followed by Super Strain B cultivars with mean numbers of 7.31,then G.S. 12 F1 (4.76 larvae/10 leaflets). On the other hand, the lowest mean number was recorded on Logain (E603 F1) cultivar (4.67 larvae/10 leaflets). In year 2014, high significant differences among different seasonal means of *T. absoluta* population density were detected (F= 8.43 and LSD=1.75) where the highest seasonal mean numbers were recorded for Alissa F1 and Super Strain B cultivar being 7.00 and 6.45 larvae/10 leaflets, respectively, followed by G.S. 12 F1 cultivar with mean number of 5.81 larvae/10 leaflet. The lowest seasonal mean number was recorded on Logain E603 F1 cultivar (2.62 larvae/10 leaflets) (Table 1).

Summer plantation:

In year 2013, results among different seasonal means of *T. absoluta* population density indicated moderate significant differences (F=4.55 and LSD=0.74). Higher seasonal mean numbers were recorded on Super Strain B, Alissa F1 and G.S. 12 F1 cultivars with mean numbers of 3.67, 3.62, 3.45 and 3.40 larvae/10 leaflets, respectively. The lower seasonal mean number of population density was 2.29 larvae/

10 leaflet on Logain E603 F1 cultivar. In year 2014, results showed insignificant and differences among different seasonal means of *T. absoluta* population density (F=2.05 and LSD=0.88).

Table 1: Weekly mean numbers of *T. absoluta* larvae/10 leaflets on four cultivars of tomato plants during 2013 and 2014 early summer plantations at Qaha, Qalyubiya Governorate.

	2013				2014				
Sampling date	**Alissa**	**Logai**	**Super strain**	**G.S.**	**Sampling date**	**Alissa**	**Logai**	**Super strain**	**G.S.**
Mar. 05	0.00	0.00	0.33	2.67	**Mar. 04**	4.67	0.67	3.00	2.00
12/03	9.67	1.33	8.67	4.67	**11/03**	7.67	1.67	7.00	5.33
19/03	3.00	9.00	11.67	11.67	**18/03**	4.67	7.00	6.67	10.67
26/03	7.33	4.33	7.33	0.67	**25/03**	7.33	7.67	5.33	13.00
02/04	5.67	1.67	7.67	1.67	**01/04**	9.00	4.67	18.33	10.67
09/04	3.00	2.00	5.00	1.33	**08/04**	6.00	3.00	14.00	6.67
16/04	3.67	5.00	6.33	3.00	**15/04**	6.67	4.00	5.00	7.67
23/04	8.00	3.67	6.67	5.33	**22/04**	12.33	2.00	7.00	6.67
30/04	3.33	0.67	4.67	2.00	**29/04**	7.00	2.00	4.33	3.33
07/05	11.67	6.67	7.00	9.67	**06/05**	8.00	2.00	5.00	4.67
14/05	25.33	6.33	8.67	9.67	**13/05**	8.00	0.67	7.00	5.33
22/05	21.00	10.67	17.33	10.33	**21/05**	10.33	1.33	5.00	4.00
28/5	9.33	10.33	7.67	4.00	**27/05**	4.33	0.00	2.00	1.00
04/06	1.00	3.67	3.33	0.00	**03/06**	2.00	0.00	0.67	0.33
Mean	**8.00a**	**4.67c**	**7.31ab**	**4.76c**	**Mean**	**7.00a**	**2.62c**	**6.45a**	**5.81ab**

F = 3.20 P = 0.001 LSD = 2.14 F = 8.43 P = 0.0001 LSD = 1.75

Higher seasonal mean numbers were recorded on Alissa F1, Super Strain B and G.S. 12 F1 cultivars with mean numbers of 3.52, 3.24 and 3.14 larvae/10 leaflets, respectively. The lower seasonal mean number of population density was 2.31 larvae/10 leaflets on Logain E603 F1 cultivar (Table 2).

Table 2: Weekly mean numbers of *T. absoluta* larvae/10 leaflets on four cultivars of tomato plants during 2013 and 2014 summer plantations at Qaha, Qalyubiya Governorate.

	2013				2014				
Sampling date	**Alissa**	**Logain**	**Super strain**	**G.S**	**Sampling date**	**Alissa**	**Logain**	**Super strain**	**G.S.**
Jul. 02	4.33	1.00	4.67	2.00	**Jul. 01**	1.33	0.00	0.33	1.33
09/07	5.33	1.33	3.67	1.67	**08/07**	1.67	0.00	2.00	2.67
16/07	3.67	2.33	3.00	4.33	**15/07**	2.67	0.00	3.00	2.33
26/07	4.00	4.33	3.33	6.00	**22/07**	3.67	0.00	4.33	3.33
30/07	4.33	2.33	3.33	5.33	**29/07**	5.67	2.33	2.33	5.67
06/08	3.00	2.67	5.00	4.00	**05/08**	5.00	5.00	2.67	5.00
13/08	3.33	4.00	4.67	6.33	**12/08**	7.00	6.33	2.33	3.00
20/08	3.33	5.00	3.33	5.33	**19/08**	5.67	5.67	5.33	3.33
27/08	4.00	4.33	3.33	3.00	**26/08**	3.67	3.33	5.00	3.00
03/09	2.33	3.00	2.67	1.33	**02/09**	2.00	1.67	3.67	2.67
10/09	4.67	1.33	3.33	2.33	**09/09**	2.67	2.67	4.67	2.67
17/09	3.67	0.33	3.33	0.67	**16/09**	1.33	1.00	4.67	1.33
24/09	4.00	0.00	3.67	4.33	**22/09**	5.00	2.33	3.33	5.00
01/10	0.67	0.00	4.00	1.67	**30/09**	2.00	2.00	1.67	2.67
Mean	**3.62a**	**2.29b**	**3.67a**	**3.45a**	**Mean**	**3.52a**	**2.31b**	**3.24a**	**3.14ab**

F = 4.55 P = 0.001 LSD = 0.74 F = 2.05 P = 0.09 LSD = 0.88

Results of seasonal abundance of *T. absoluta* population density on the four tomato cultivars during (early summer and summer plantations 2013) and (early and summer plantations 2014) are represented in Table 3. These results indicated that seasonal abundance was higher in 2013 early and summer plantations than in 2014 with seasonal mean numbers of 4.72 and 4.26 larvae/10 leaflets, respectively.

From the aforementioned results it could be concluded that the most susceptible cultivars for *T. Absoluta* were Alissa F1 and Super strain B cultivars with seasonal mean numbers of 5.53 and 5.16 larvae/10 leaflets, followed by G.S 12 F1 cultivar with seasonal mean number of 4.29 larvae/10 leaflets. Logain E603 F1 showed highly resistance against *T. absoluta* infestation with seasonal mean number of population density of 2.97 larvae/10 leaflets (Table 3).

Table 3. Total mean numbers of *T. absoluta* larvae on four Cultivars of tomato plants during early and summer plantations 2013 and 2014 at Qaha farm, Qalyubiya Governorate.

Cultivars	**Year**						
	2013			**2014**			**2013 and 2014**
	Early summer	**Summer**	***Mean***	**Early summer**	**Summer**	***Mean***	***General mean***
Alissa	8.00	3.62	5.81	7.00	3.52	5.26	5.53
Logain	4.67	2.29	3.48	2.62	2.31	2.47	2.97
Super strain	7.31	3.67	5.49	6.45	3.24	4.85	5.16
G.S	4.76	3.45	4.11	5.81	3.14	4.48	4.29
Mean	**6.18**	**3.26**	**4.72**	**5.47**	**3.05**	**4.26**	**4.49**

Our results of seasonal abundance of *T. absoluta* population density on the four tomato cultivars were in agreement with many authors in the differences of tomato cultivar susceptibility degrees to *T. absoluta* infestation. Alissa tomato variety was more susceptible to *T. absoluta* infestation than Super strain B (Ata and Megahed, 2014). Also, Shawir *et al*. (2014) found that tomato varieties, Fyrouz and H9780 were the most susceptible to *T. absoluta* infestation followed by Alissa, Hadir, and Elbasha 1077, while Allal *et al.* (2011) found that the most susceptibility varieties to larval attacks of *T. absoluta* were "Doucen, Zahra and Kartier" whereas "CLX" and "Pietro" had lower infestation rates. These results supported by Abou-Ghadir *et al.* (2015) who showed that, TH99806 tomato variety was more susceptible to *T. absoluta* infestation than TH99807 during winter season. E448 hybrid was more susceptible to *T. absoluta* infestation than Super Jakal during summer season.

Chemical analysis of constituents of four tomato cultivars leaves oils.

The chemical compositions of the essential oils of the four tomato cultivars leaves (Alissa, Logain, Super and G.S.) are presented in Table 4 and Figs. 1, 2, 3 and 4. The oil analysis by GC/MS of the essential oil revealed the presence of 33 peaks, approximately all peaks were identified and representing74.12%, 99.76%,83.83%and 72.45% of the essential oil of Alissa, Logain, Super and G.S. cultivars, respectively. The oils of the four cultivars yields were 1.05%, 1.65%, 1.55% and 1.15%, respectively. Aliphatic hydrocarbons terpenoids compounds were found to be the most abundant volatiles in the four tomato cultivars except G.S. cultivar.

These analyses also revealed that the major identified aliphatic hydrocarbon components in the leaves oil of Logain and Alissa tomato cvs. (The lowest and the highest infestation with *T. absoluta*) were Octacosane (25.35%, 12.52%), Tetratriacontane (22.07%,4.30%), Hexacosane (18.69%,6.26%), Triacontane (10.55%,5.92%), Heptacosane (8.43%,14.00%), Nonacosane (6.56%,4.26%), Hexatriacontane (1.83%, 0.00%) and Tetracosane (1.58%, 8.87%), respectively.

The major hydrocarbon components of Super strain tomato cv. were Nonacosane (18.50%), Tetratriacontane (18.34%), Octacosane (15.80%), Triacontane (14.11%), Hexacosane (4.26%), Eicosane (2.94%) and Heptacosane (1.83%). whereas, the principal constituents in the leaves of G.S. tomato cv. were Octacosane (11.74%), Tetratetraiacontane (8.77%), Limonene (6.02%), Benzyl alcohol (5.01%), β-caryophyllene (2.75%), α-Bergamotene (2.75%), γ-Muurolene (2,66%) and Thymol (2.30%).

Table 4: Chemical composition of essential oils from leaves of four tomato cultivars.

	Components	RT (min.)	Ratio (%)			
			Cultivars			
			Alissa	Logain	Super	G. S.
	MonoterpeneHydrocarbon					
1	D-Limonene	5.73	1.08	0.53	0.74	6.02
	Total	-	**1.08**	**0.53**	**0.74**	**6.02**
	Oxygenated Monoterpenes					
2	Estragole	8.29	0.83	0.33	0.30	1.85
3	Thymol	9.71	0.49	0.17	0.26	2.30
4	Anethole	9.55	0.75	0.15	-	-
	Total	-	**2.07**	**0.65**	**0.56**	**4.15**
	SesquiterpeneHydrocarbons					
5	β- Bourbonene	10.97	-	0.06	-	-
6	β-Caryophyllene	11.44	0.95	0.24	0.31	2.75
7	α- Bergamotene	11.58	0.82	0.19	0.30	2.75
8	Humulene	11.88	-	0.05	-	0.00
9	β- Copaene	11.97	-	0.06	-	-
10	Trans-Calamene	12.72	-	0.12	0.19	1.61
11	Aromndendrene	13.62	-	0.06	-	-
12	γ-Muurolene	14.14	0.47	0.17	0.30	2.66
	Total	-	**2.24**	**0.95**	**1.10**	**9.77**
	Oxygenated Sesquiterpenes					
13	Caryophyllene oxide	13.62	-	0.13	-	-
14	α-Cadinol	14.12	1.11	-	-	-
	Total	-	**1.11**	**0.13**	**-**	**-**
	Hydrocarbons					
15	Octadecene	12.20	1.41	0.08	0.14	-
16	Hexadecene	12.45	-	-	0.22	-
17	Tertradecane	11.95	1.24	-	-	-
18	Heptadecane	14.65	-	0.18	-	-
19	Eicosane	15.93	1.37	0.09	2.94	1.49
20	Octadecane	19.17	1.40	0.07	1.01	
21	Hexadecane	20.74	0.49	-	0.10	1.39
22	Nonadecane	21.34	0.51	-	-	-
23	Tetracosane	22.85	8.87	1.58	1.55	-
24	Heptacosane	23.78	14.00	8.43	1.83	-
25	Hexacosane	24.65	6.26	18.69	4.26	-
26	Octacosane	25.47	12.52	25.35	15.80	11.74
27	Nonacosane	26.97	4.26	6.56	18.50	-
28	Triacontane	27.67	5.92	10.55	14.11	-
29	Tetra triacontane	28.42	4.30	22.07	18.34	-
30	Hexatriacontane	28.80	-	1.33	-	-
31	Tetra tetraacontane	29.27	-	1.03	-	8.77
	Total	**-**	**62.55**	**96.01**	**78.80**	**23.39**
	Other compounds					
32	Benzyl alcohol	5.86	0.53	0.29	0.48	5.01
33	Diisooctylphthlate	24.27	4.63	0.20	2.18	24.42
	Total	-	**5.16**	**0.49**	**2.66**	**29.43**
	Total identified compounds		**74.21**	**98.76**	**83.86**	**72.76**
	Oil yields		***1.05%***	***1.65%***	***1.55%***	***1.15%***

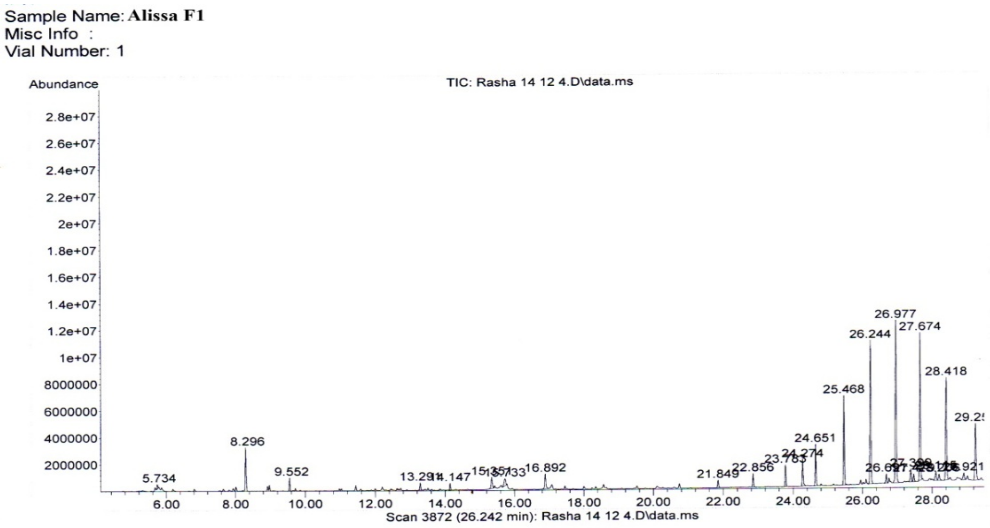

Fig. 1: Chromatogram (GC-MS) ofAlissa F1 tomato hybridanalysis

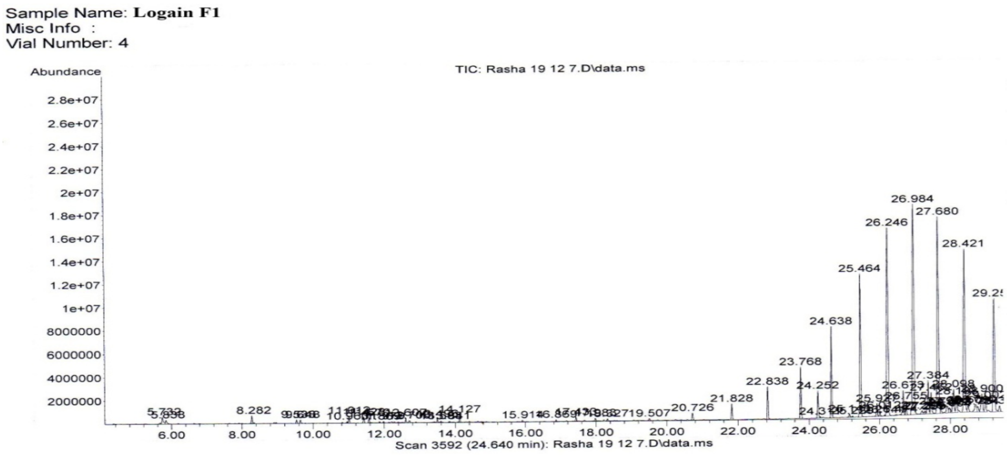

Fig. 2: Chromatogram (GC-MS) of Logain E603 F1 tomato hybridanalysis

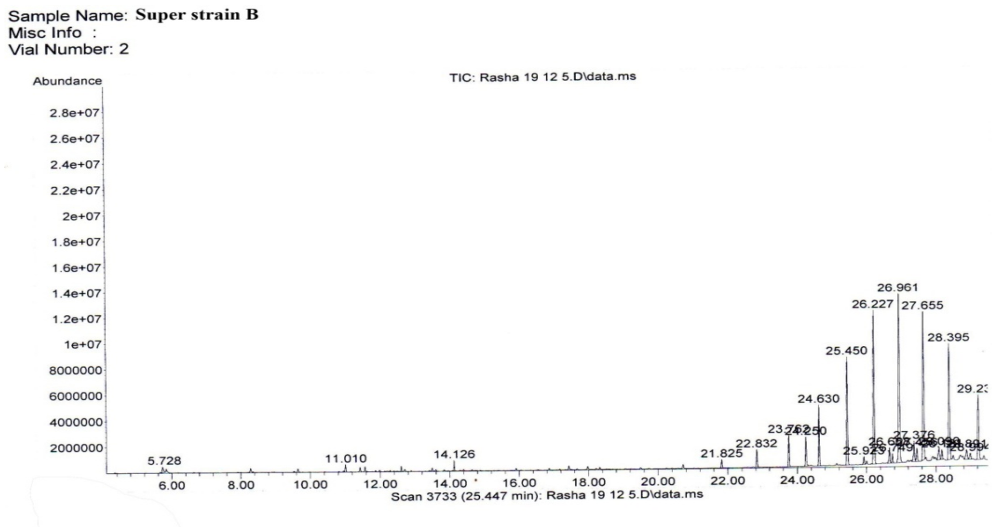

Fig. 3: Chromatogram (GC-MS) analysis of Super strain tomato hybrid

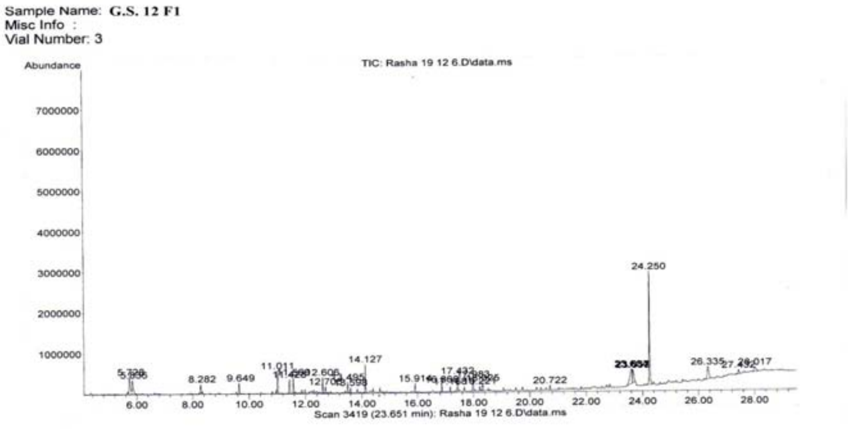

Fig. 4: Chromatogram (GC-MS) analysis of G.S. tomato hybrid

Also, important differences between the percentages of the active compounds, Octacosane (25.35%, 12.52%), Hexacosane (18.69%, 6.26%) and Tetracosane (1.58%, 8.87%) of the leaves essential oil contents were found in Logain and Alissa tomato cvs. respectively. These results are agreement with Fernandes *et al*. (2011), who showed that, the main compounds of tomato leaves were called nonane, decane, undecane, dodecane, tridecane, tetradecane, pentadecane, hexadecane, heptadecane, octadecane nonadecane, eicosane, herreicosane, docosane, tetracosane, pentacosane, hexacosane, octacosane, nonacosane and triacontane, respectively. Also, Ponsankar *et al*. (2016) found that, analyses of fraction F6 of *Couroupita guianensis L* indicated eight chief compounds with significant matches to octacosane (31.86%); and hexacosane (17.54%) major peak area.

The results in the Table (4) also showed that there are other important compounds presented in the leaves oils of the four tomato cultivars such as D-Limonene, Benzyl alcohol, Estragole, Thymol, β-Caryophyllene, γ-Muurolene and α-Bergamotene. The G.S. cultivar have the highest percentages of these compounds and this results interpretated the absence of some hydrocarbons such as Hexacosane, Heptacosane, Nonacosaneand Triacontane,in this cultivar.

Role of mojor hydrocarbon compounds in the susceptibility of the four tomato cultivars to *T. absoluta*.

Plants synthesize a broad range of volatile compounds that are toxic to insects and so are believed to act as defense compounds. There are three mechanisms that may be involved in the resistance of *Solanum spp*. to arthropod pests: antixenosis, antibiosis and tolerance. This attributed to presence of trichomes, chemical compounds and/or physical morphology, which may be associated with resistance (Panda and Krush 1995). Oliveira *et al*. (2009) observed that the HGB 1497 subsample of *Solanum lycopersicum* presented resistance by antixenosis to the tomato plant miner *T. absoluta*. Silva, (2009) and Goncalves Neto *et al*., (2010) showed that, tomato plants produce the allelochemicals associated with resistance.

The major compounds identified in the four tomato cultivars are hydrocarbons and they are associated with the susceptibility to *T. absoluta*. These hydrocarbons compounds are components of the lipid layer of the plant cuticle surface they can also be a chemical barrier to insect attack (Schoonhoven*et al*. 2005). According to Eigenbrode and Espelie (1995), differences in the lipid layer composition can explain the variation in the level of resistance to herbivore insects.

The major hydrocarbons octacosane and hexacosane in Logain cv. (Table 5 and Figure 5) have insecticidal and repellent activities against insects. Ponsankar *et al.* (2016) found that, the hydrocarbon octacosane was establish to be the prominent chemical compound associated with causing mortality and changes in development of *Spodoptera litura* at low dosages and they suggest that octacosane may be one of the major insecticidal compounds affecting *S. litura* survival.

Table 5: Role of the active hydrocarbon compounds percentages in susceptibility of Logain and Alissa tomato cvs. to *T. Absoluta*.

Cultivars	**Attractant**	**Repellent**		**Larvae/ 10 leaflets**
	Tetracosane (%)	**Hexacosane (%)**	**Octacosane (%)**	
Logain	**1.58**	**18.69**	**25.35**	**2.62**
Alissa	**8.87**	**6.26**	**12.52**	**7**

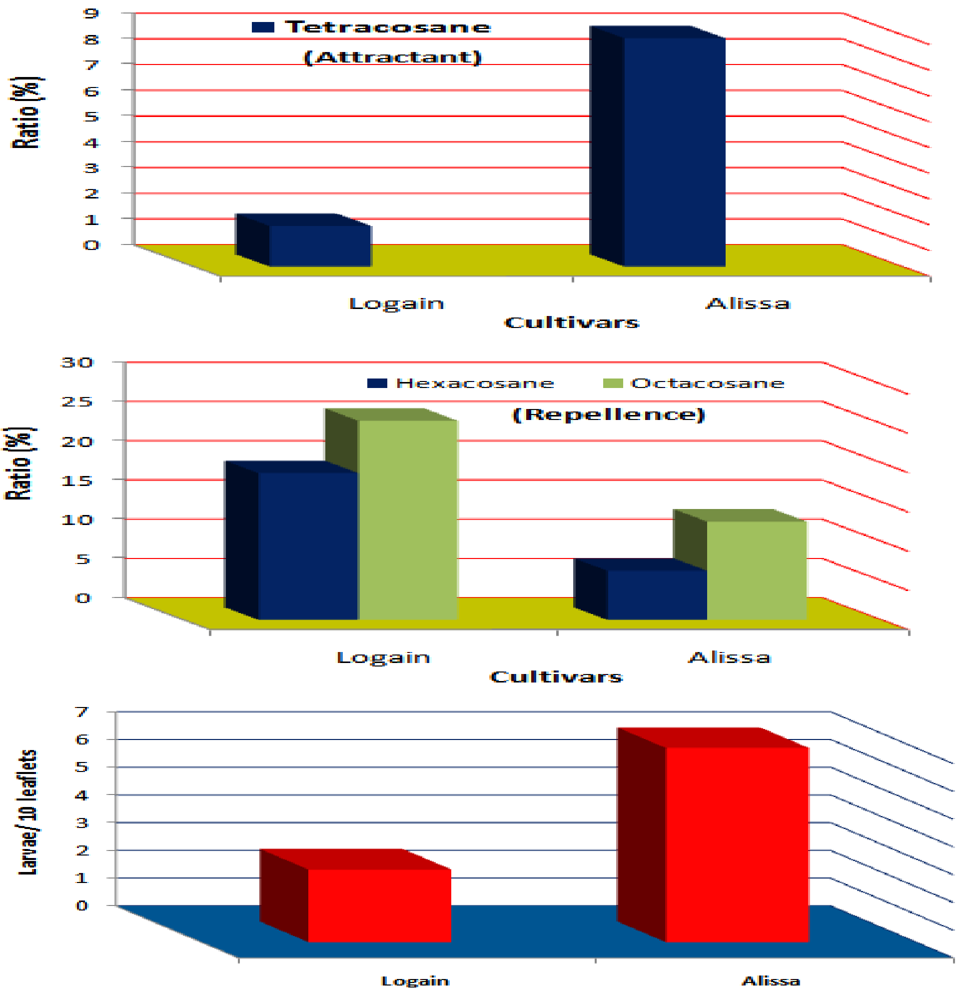

Fig. 5: Role of the active hydrocarbon compounds percentages insusceptibility of Logain and Alissa tomato cvs. to *T. absoluta*.

Rajkumar and Jebanesan, (2004) showed, octacosane have toxicity to early third instars of *Culex quinquefasciatus* (Say). Octacosane was also shown to be producing larvicidal activity against *Anopheles pharoensis* (Theobald) (Mansour *et al*., 2014). Octacosane derived from *Moschosma polystachyum* (Lamiaceae) was effective in repelling the vector *C. quinquefasciatus*. (Rajkumar and Jebanesan 2004).

In addition, Suinaga *et al.* (1999) demonstrated that, heptadecane was the main compound associated with the reduction of the number and viability of leafminer of tomato plant in *Lycopersicon peruvianum*. Logain cultivar also contains hydrocarbon hexacosane compound in their leaves. Hexacosane, in the leaf oil of *Solanum sarrachoides*, exhibits oviposition deterrence against red spider mites, *Tetranychus evansi* (Murungi *et al*. 2013). The chemical analyses suggests that compounds present, possibly octacosane, are producing high mortality rate against the lepidopteran pest .But there are other chemical derivatives present which have been reported to also cause developmental changes in lepidopterans (Ponsankar *et al*. 2016). According to Yang *et al*. (1993), the effect of each compound may influence the presence of other compounds. The mode of action of bioactive natural monoterpinoids (hydrocarbons, alcohols and ketons) from oils may be due to inhibition of acetylcholine esterase (Lee *et al*. 2000). The compounds may be proving toxic when penetrating the insect body via the respiratory system (Park *et al*., 2003).

Oliveira *et al*. (2009) observed positive and significant correlations of hydrocarbons with the attack by *T. absoluta* in some tomato samples. Also, observed in some tomato samples a positive and significant correlation between tetracosane concentrations and the susceptibility to attack by *T. absoluta*, the present results showed high concentration of this compound in Allisa cv. (Table 5 and Figure 5).

The subsamples HGB-7236 and 243 with a higher percentage of mined leaves had higher tetracosane concentrations, suggesting their susceptibility to *T. absoluta*. Also, Suinaga *et al*. (1999) attributed the *Solanum lycopersicum* susceptibility to *T. Absoluta* because of the presence of tetracosane.

In general, our results indicated that the repellence and toxic effects of the completely tolerable Logain tomato cv. leaves essential oil to *T. absoluta* could be related to the high contents of the two hydrocarbons octacosane and hexacosane. The presence of hydrocarbon tetracosane with high concentration in essential oil of the high susceptible Alissa cv. may be the reason for the high susceptibility of Alissa tomato cv. to *T. absoluta* infestation. In conclusion, from these results we recommend to use the tolerable logain tomato cultivar in breeding programs and also the active volatile compound(s) (Especially octacosane and tetracosane) responsible for repellent and attractant activities should be utilized if possible, in preparing a commercial product/formulation to be used as *T. absoluta* repellent (Octacosane) and as a trap (Tetracosane).

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ARABIC SUMMERY

تفسير ظاهرة قابلية إصابة أربعة أصناف من الطماطم بحشرة حافرة الطماطم*Tuta absoluta*

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يهدف هذا البحث إلي دراسة وتفسير ظاهرة قابلية إصابة أوراق أربعة أصناف من الطماطم {(اليسا F1 سوبر استرين B ، جى اس ١٢ F1 ، لوجين (E603) } بحشرة حافرة الطماطم *Tuta absoluta* خلال العامين المتتاليين 2013 و 2014. وقد أظهرت النتائج اختلاف الأربعة أصناف المختارة من الطماطم في قابليتها للإصابة بحافرة الطماطم في سنتي الدراسة. الوفرة الموسمية كانت أعلى في عروة الصيفي المبكر والعروة الصيفية في عام 2013 مقارنة بعام 2014. وقد سجل أعلى كثافة تعداد موسمي للحشرة على صنف اليسا F1 خلال سنتي الدراسة ثم الصنف سوبر استرينB ثم الصنف جى اس ١٢ F1 بينما كان أدنى كثافة تعدادسجلت مع صنف لوجين (E603).

تم فصل والتعرف علي ٣٣ مركب من الزيوت المستخلصة من أوراق الأربعة أصناف المختارة بجهاز الكروماتوجرافي الغازي- الكتلي. المركبات الهيدروكربونات الأليفاتية كانت أكثر المواد توجداً في أصناف الطماطم الأربعة باستثناء صنف جى اس وأظهر التحليل أيضاً أن المكونات الهيدروكربونية الأليفاتية الرئيسية في زيت أوراق صنف الطماطم لوجين (E603) واليسا F1 (الأدنى والأعلى إصابة) كانت كالتالي:

Octacosane, Hexacosane, Triacontane, Heptacosane, Nonacosane, Tetratriacontane, Hexatriacontane and Tetracosane.

تفسير إختلاف قابلية إصابة أوراق كل من صنف لوجين (E603) واليسا F1 لحشرة حافرة الطماطم *T. absoluta* يمكن أن يعزى إلى وجود محتويات عالية من الهيدروكربونات السامة والطاردة Hexacosane وOctacosane في صنف لوجين (E603) وكذلك المحتوى العالى من الهيدروكربون الجاذب Tetracosane صنف اليسا F1. من هذه النتائج يمكن التوصية باستخدام صنف الطماطم لوجين (E603) في برامج التربية وأيضا إعداد منتج تجاري من الهيدروكربونات Octacosane, Hexacosane لاستخدامها كمواد طاردة لحشرة *T. absoluta* والهيدروكربون الجاذب Tetracosane كمصيدة لحشرة *T. absoluta*