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Population Density of Tomato Leafminer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) under Protected Cultivation in Egypt.

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ABSTRACT

The aim of this work was to determine the effect of two tomato (*Lycopersicon esculentum* Mill.) plant varieties (Alisa and Hybrid Super Strain B (H.S.S.)) and the climatic factors, temperature and relative humidity on the population density and infestation percentage of the tomato borer, *Tuta absoluta* (Meyrik) (Lepidoptera:Gelechiidae), under plastic houses conditions in Nasr city, Cairo, Egypt in 2011. The results showed significant differences in number of mines/leaf and number of larvae/leaf on the two tomato varieties. The mean number of *T. absoluta* larvae/leaf was 3.3 and 2.8 in Alisa and H.S.S varieties respectively. While the general mean numbers of *T. absoluta* mines/leaf was 5.5 and 4.0 in Alisa and H.S.S varieties, respectively. The highest insect attack occurred in the final stage of the culture, the highest percentage of infestation was recorded in July as 100% and 97.6% for Alisa and H.S.S. varieties respectively. The correlations between the climatic factors (daily range, daily mean of temperature and daily relative humidity) and insect population activities were positive but insignificant, except in the case of the daily mean temperature; where it was significant and positive.

***Kew words*: *Tuta absoluta*, population density, tomato, Egypt.

Introduction

Tomato (*Lycopersicon esculentum*) is considered as one of the most essential vegetable crops for human nutrition in most countries. In Egypt, tomato is the First vegetable crop that occupies about one third of the total cultivated area with vegetables. It is consumed as fresh table vegetable and as an essential raw material for a variety of food processing industries. According to Food and Agriculture Organization 2010, tomato was planted in the world reached 2.9 million Feddan`s and in Egypt the planted area is about 454,000 Feddan`s. Egypt is considered as one of the important tomato producers in the world (WPTC, 2011). Tomatoes can be grown virtually all the year round in the different regions, with ideal conditions and the availability of new irrigation systems. They are grown amongst other places in Tahrir, Bahaira, Alexandria, Menya, Bani Sweif, Menufia and Giza, governorates.

Tomato production faces many problems from several causes such as seasonal weather, temperature, humidity, diseases and insect pests. There are several insect species feed on tomato, for examples: thrips, whitefly, tomato fruitworm, leafminer, leafhopper, aphid, mites and mealybug. Recently, the tomato borer, *Tuta absoluta*, is an invasive insect pest causing severe loss of tomato production in many countries either in open field or greenhouses. Severely attacked tomato fruits lose their commercial value (EPPO, 2008). It is one of the most devastating pests of tomato crops in South America (EPPO, 2010). After its initial detection in eastern Spain in 2006, it rapidly invaded various other European countries and spread through the Mediterranean basin (Desneux *et al*. 2010). The tomato leafminer, invaded Egypt in the nearest Governorate to Libya (Matrooh) in 2009 and by 2010 it had reached Giza, coming well established in all Governorates of Egypt and reaching the border and north part of Sudan on June 2011 (Tamerak, 2011 & Gaffar, 2012). Since that time, this pest spread quickly in all tomato growing areas in Egypt, destroying entire open fields and tomato in plastic houses. Ramirez *et al*. (2010) reported that the damage by *T. absoluta* can be 100% in unprotected crops and it was considered in its region distribution area as a significant tomato insect pest (Leite *et al.* 2001), due not only to the intensity of its attack but also to its occurrence during all crop cycle (Oliveira *et al*. 2008). It can develop on other Solanaceous plants, like potato (Pereyra and Sanchez, 2006), eggplant and wild species (Garcia and Espul, 1982). Abbes and Chermiti, (2011) concerning the use of pheromone traps for pest monitoring, reported that the trap catches can be correlated with larval damage. In this way, the minimal amount of spraying is required to control the pest population.

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Materials and Methods

Study area:

To carry out this work, one plastic greenhouse 33x8.5m located in Faculty of Agriculture, Al-Azhar University, Nassr-City, Cairo, Egypt during 2011 season, was used to perform the research.

Weather factors assumed to affect the populations of this insect, (i.e. daily range, daily mean of temperature and daily mean of relative humidity) were obtained for Cairo area from the internet (www.wunderground.com).

For the investigation, the plastic greenhouse was cultivated with tomato seedlings (35 days old), the plant leaves were free from leafminer damage. Two tomato varieties fungicide-treated (Alisa and Hybrid Super Strain B) were planted on (March 5th 2011). The planting distance between seedlings was 50cm. The investigation was carried out from 5 March to 3 July 2011.

Experiment procedure:

To study the infestation level and development of *T. absoluta* population on tomato crop, the procedures were done as follows:

To calculate the larvae and mines number of *T. absoluta*, one plastic house was divided into three subareas approximately 100m² /each. Each subarea with a similar number of plants to ensure that all the area is represented in the samplings.

The infestation with *T. absoluta* was carefully observed, counted and recorded weekly on 24 plant leaves (leaf per plant). At each selected plant one leaf were collected and individually packed in labeled plastic cans then transported to the laboratory. The number of mines and larvae (alive and dead) per leaf was examined and recorded (Leite *et al*. 2001). The leaves were chosen randomly from the cultivated plants and the percentage of the infested leaves was calculated. The effect on insect population changes was assumed to be the reflection of the influence of the weather factors prevailing during the past seven days before the date of inspection.

The obtained data were subjected to ANOVA test and partial regression analysis procedures in SAS. (Statistical Analysis System). Mean differences were conducted by using the Duncan multiple range test in SAS (SAS, 1988).

Results and Discussion

Population fluctuation of *T. absoluta* larvae on two tomato plant varieties:

The obtained results presented in (Table 1, Fig. 1 and Fig. 2), showed that *T. absoluta* infestation started after one week from planting at 20th of March, with 0.5 & 0.4 larvae/leaf and 0.4 & 0.4 mine/leaf in Alisa and H.S.S varieties; respectively. Throughout March 2011, the overall density of biological instars of the pest hardly exceeded 1.7 & 1.3 larvae/leaf and 0.5 & 0.3 mine/leaf in Alisa and H.S.S varieties, respectively. The number of larvae has increased gradually to reach to the first peak at 3rd April with 4.0 and 3.3 larvae/leaf and 1.4 & 0.9 mine/leaf in Alisa and H.S.S varieties; respectively, with daily range of temperature, daily mean of temperature and daily mean of relative humidity of 8.7°C, 17.7°C and 55.4%, respectively.

Table 1: Weekly mean numbers of larvae and mines of *T. absoluta* and the corresponding climatic factors on tomato during 2011, at Nassr-City, Cairo.

Date	Larvae		Mines		Temperature (°C)		
	Alisa	H.S.S	Alisa	H.S.S	Daily Range	Daily Mean	R.H %
13 Mar.2011	0.0	0.0	0.0	0.0	12.7	19.0	62.8
20 Mar.	0.5	0.4	0.4	0.4	9.3	15.4	49.5
27 Mar.	1.7	1.3	0.5	0.3	14.2	17.8	48.6
3 Apr.	4.0	3.3	1.4	0.9	8.7	17.7	55.4
10 Apr.	2.6	2.3	1.6	1.1	12.7	20.0	51.1
17 Apr.	2.0	1.5	1.9	2.0	9.4	19.2	58.3
24 Apr.	2.8	2.3	2.2	1.8	11.7	23.2	39.4
1-May	3.8	3.2	4.2	3.6	9.4	22.6	41.6
8-May	4.8	4.2	6.1	4.8	10.4	22.6	51.3
15-May	3.9	3.3	5.7	3.7	11.9	26.1	42.1
22-May	3.0	2.3	6.0	4.6	10.3	22.3	48.1
29-May	4.0	3.4	6.5	4.9	12.3	24.5	50.4
5-Jun	5.8	5.2	8.7	6.2	13.4	28.2	44.6
12-Jun	5.5	4.8	9.0	7.2	11.8	26.0	55.5
19-Jun	4.3	3.5	9.9	7.6	13.2	29.3	45.6
26-Jun	3.4	2.9	12.6	8.1	10.6	26.9	53.5
3-Jul	4.1	3.7	12.4	7.6	12.0	28.4	55.4
10-Jul	4.4	4.0	13.9	9.4	9.9	26.5	53.9
Total	72.6	61.4	120.8	87.5	249.8	415.6	1108.5
Mean	3.3±1.5	2.8±1.4	5.5±4.5	4.0±3.0	11.4±1.6	22.9±4.1	50.4±6.3

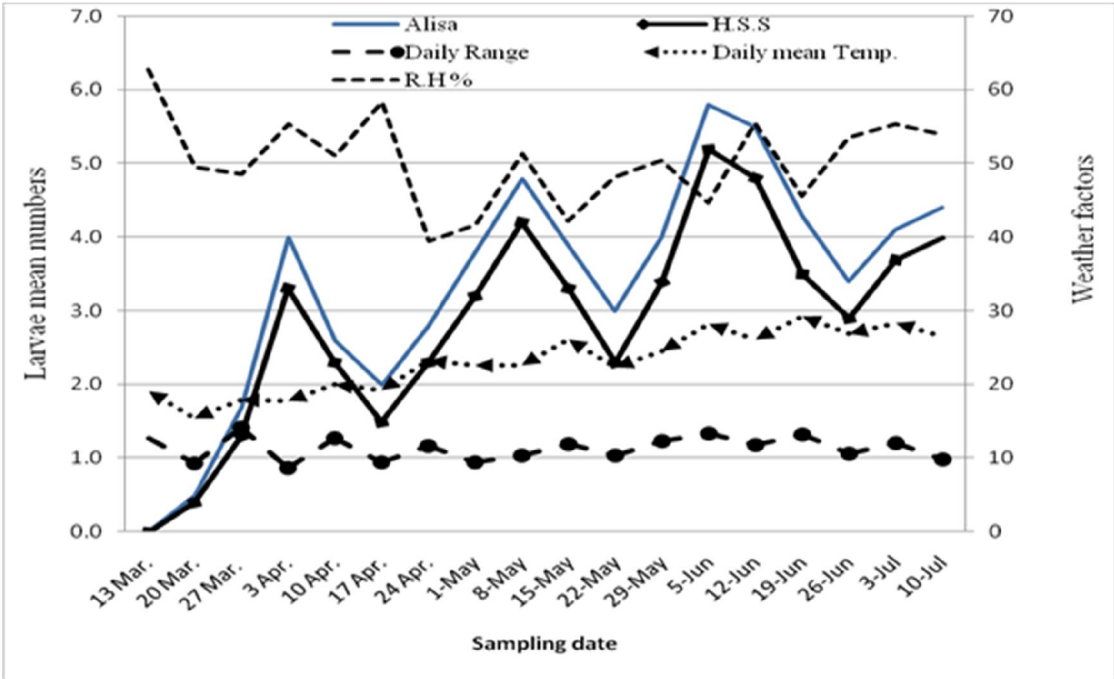

Fig. 1: Average number of *T. absoluta* larvae/leaf on two tomato plant varieties (Alisa and H.S.S.).

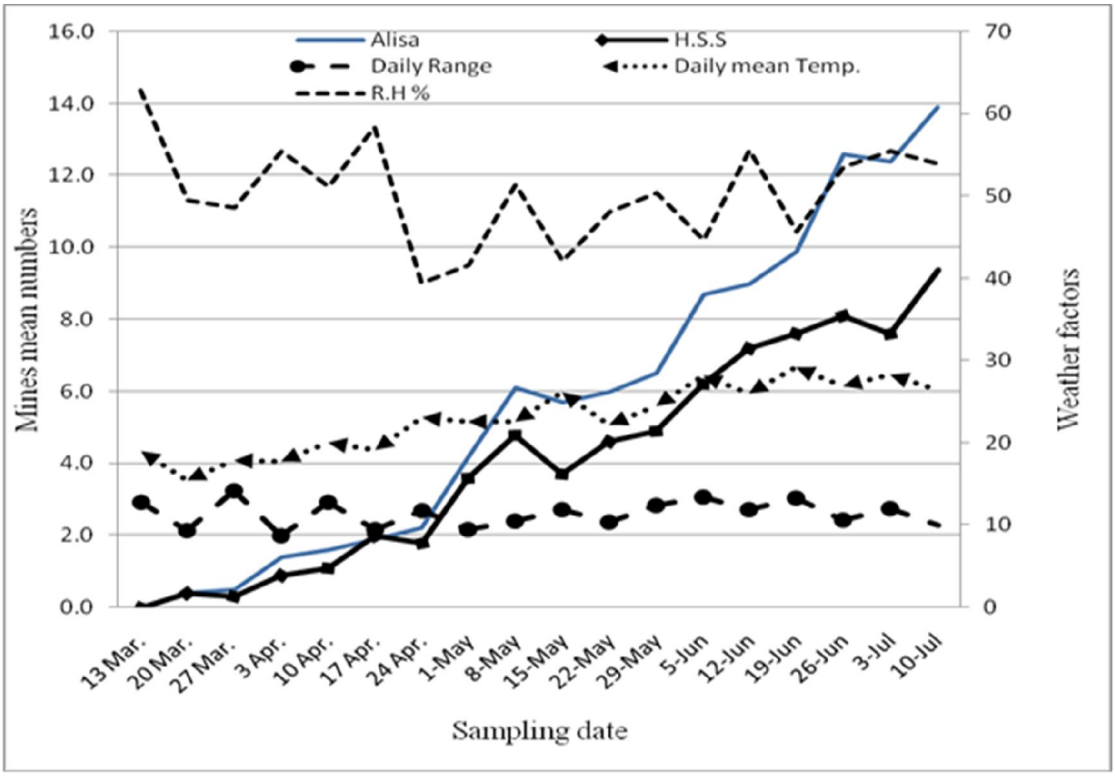

Fig. 2: Average number of *T. absoluta* mines/leaf on two tomato plant varieties (Alisa and H.S.S.).

The numbers of larvae were fluctuated in the two investigated varieties within two weeks, then, gradually increased to reach to the second peak at 8th May with 4.8 and 4.2 larvae/leaf and 6.1 & 4.8 mine/leaf in Alisa and H.S.S varieties respectively, at daily range of temperature, daily mean of temperature and daily mean of relative humidity of 10.4°C, 22.6°C and 51.3% respectively. The third peak of infestation was after about one month at 5th of June with 5.8 and 5.2 larvae/leaf and 8.7 & 6.2 mine/leaf in Alisa and H.S.S varieties, respectively, and the daily range of temperature, daily mean of temperature and daily mean of relative humidity

were 13.4°C, 28.2°C and 44.6% respectively. From the obtained results presented in (Table 1 and Fig. 1), the *T. absoluta* has four generations through investigation period extended to four months. Allache and Demnati (2012) mentioned that in Biskra (Algeria), during the first phonologic stages of the crop, tomato plants are free from attack of *T. absoluta* .Harizanova and Mohamedova (2009) pointed that the leaves were the most heavily damaged plant parts with an average of 9.42 and 8.75 mines per leaf on the middle and upper layers of the canopy respectively, followed by the fruits.

Susceptibility of two tomato varieties to *T. absoluta* infestation:

The data represented in table (2) showed that the tomato plant variety of Alisa is more susceptible to the infestation with *T. absoluta* larvae than the other variety (H.S.S.), the general mean number of *T. absoluta* Larvae /leaf was 3.3 and 2.8 /leaf in Alisa and H.S.S varieties; respectively. While the general mean numbers of *T. absoluta* Mines/leaf were 5.5 and 4.0 in Alisa and H.S.S varieties; respectively. The infestation percentage of leaves take the same trend with mean numbers of mines and larvae/leaf, it was very low in March as 0.9% and 0.2% in Alisa and H.S.S varieties respectively, and it was gradually increased reaching to 100% and 97.6% of infestation in Alisa and H.S.S varieties, respectively at the end of the season.

Table 2: Mean numbers of mines & larvae and the infestation percentage of leaves during the study season.

Variety	Average No. Larvae /leaf	Average No. Mines /leaf	Leaves Infestation Percentage %				
			March	April	May	Jun	July
Alisa	3.3 a	5.5 a	0.9 a	34.6 a	82.7 a	100 a	100 a
H.S.S.	2.8 b	4.0 b	0.2 b	29.2 b	73.1 b	95.2 b	97.6 b

Means followed by the same letter within the same Column are not significantly different at the 5% level by DMRT.

The number of leafmines was closely related to the density of *T. absoluta* larvae, which the damage caused by larvae on tomato leaves led to high density of mines/leaf.

Statistical analysis showed a significant difference in leafmines, larvae and Leaves Infestation percentage between the two varieties, Alisa and H.S.S (Tab.2), this variation may be due to several morphological and chemical factors of plants influencing the pest population (Letourneau *et al.*, 1996; Picanço *et al*., 1998 and Leite *et al.,* 1999a). Also, the leaf position on the plant canopy has been reported to influence *T. absoluta* attacks, with preferential oviposition on the apical leaves probably due to the fact that these leaves are more tender and of higher nutritional value (Silva *et al.,* 1998; Leite *et al.,* 1999a, b and Oliveira, 1999). The possible effect of trichomes on insects can result from chemical and/or mechanical factors; the chemical factor could partly be due to exudates produced by glandular trichomes which can contain compounds that are toxic to insects (Fery and Kennedy, 1987; Leite *et al.,* 2001). Other possible resistance factors include mechanical barriers, density, length and form of trichomes (Leite *et al.,* 1999a, b). The presence of crystals in the leaves is another factor that can difficult feeding by insects (Franceschi and Horner Júnior, 1980; Leite *et al.,* 1999c), with high occurrence of calcium oxalate crystals in tomato leaves (Leite *et al.,* 1997; Leite *et al.,* 1999c).

Effect of abiotic factors on the population activities of *T. absoluta:*

The obtained results presented in Table (3) showed the relations between abiotic factors, (the daily range of temperature, daily mean of temperature and the daily mean of relative humidity, one week before inspection) and the population activity of *T. absoluta*. These factors played different roles in the population fluctuations of these insects during the season.

Table (3) shows that the relation between the populations activity of *T. absoluta* larvae and the daily range of temperature is insignificant positive relation, with correlation coefficient value (r. = +0.047 and +0.062) in Alisa and H.S.S varieties respectively., while in the daily mean temperature, this relation was highly significant and positive (r. = +0.744 and +0.752) in Alisa and H.S.S varieties, respectively. The relative humidity had insignificant negative relation, (r. = -0.271 and -0.242) in Alisa and H.S.S varieties, respectively.

It could be concluded that the daily mean of temperature are below the optimal range of population activity while the daily range of temperature and the relative humidity in the optimal range of activity for *T. absoluta.*

The relation between the mines caused by *T. absoluta* and the daily range of temperature is insignificantly positive, (r. = 0.042 and 0.036) in Alisa and H.S.S varieties, respectively; while the daily mean temperature, was highly significant and positive, (r. = 0876 and 0.888) in Alisa and H.S.S. varieties, respectively. The relative humidity had insignificant positive relation, (r. = 0.006) in Alisa and negative in H.S.S. (r. = -0.024). That means the daily mean of temperature are below the optimal range of population activity while the daily range of temperature and the relative humidity were in the optimal range for population activity.

The partial regression shows the precise data between the change of the abiotic factors effects and *T. absoluta* larvae mean numbers. The data showed b. values were -0.215, 0.295 and -0.028 in Alisa variety, while, in H.S.S. variety it were -0.179, 0.269 and -0.017 with a significant relationships (P=0.0037) and the combined effects of weather factors (daily range of temperature, daily mean of temperature and R.H.%) on the larvae population, were 60.66 and 60.65%, in Alisa and H.S.S. varieties; respectively. On the other hand, b. values of the relation between the weather factors (daily range of temperature, daily mean of temperature and R.H.%) and the mines caused by the

larvae were -0.677, 1.10 and 0.16 in Alisa variety, whereas, in H.S.S. variety were -0.492, 0.74 and 0.93 with a significant relationship (p= 0.0001) and combined effects were 88.23% and 89.05%, in Alisa and H.S.S. varieties; respectively.

From the obtained data, the increasing in the populations of *T. absoluta* larvae lead increasing in the mean numbers of mines, which caused by larvae feeding in the tomato leaves. It was frequent according to Lacordaire and Feuvrier (2010) that the larvae of *T. absoluta* left their galleries and reinstalled in another leaf or leaflet as suggested by Torres *et al.,* (2001).

It could be observed also from (Table 3) that the explained variance of a biotic factors affecting *T. absoluta* population activity was 60.6% from the effect of all factors affecting the population.

This result agreed with Lacordaire and Feuvrier (2010) who reported that the number of *T. absoluta* was influenced perhaps by abiotic factors.

Table 3: Simple correlation coefficients, partial regression values and explained variance (E.V.) between three tested weather factors and population activities of *T. absoluta* on tomato during 2011, at Nassr-City, Cairo.

Season	Simple correlation and regression analysis				Partial regression analysis				
	W. Factor	r.	b.	P.	b.	p.	"F"	Prob>F	E.V.
Alisa larvae	Daily range of Temp.	0.047	0.045	0.852	-0.215	0.229	7.19	0.0037	60.66%
	Daily mean of Temp.	0.744	0.278	0.000	0.295	0.001			
	R.H.%	-0.271	-0.069	0.276	-0.028	0.535			
H.S.S. Larvae	Daily range of Temp.	0.062	0.053	0.808	-0.179	0.264	7.19	0.0037	60.65%
	Daily mean of Temp.	0.752	0.253	0.000	0.269	0.001			
	R.H.%	-0.242	-0.055	0.333	-0.017	0.668			
Alisa mines	Daily range of Temp.	0.042	0.136	0.848	-0.677	0.026	34.98	0.0001	88.23%
	Daily mean of Temp.	0.876	0.956	0.000	1.100	0.000			
	R.H.%	0.006	0.005	0.978	0.162	0.036			
H.S.S. mines	Daily range of Temp.	0.036	0.068	0.887	-0.492	0.014	37.95	0.0001	89.05%
	Daily mean of Temp.	0.888	0.648	0.000	0.743	0.000			
	R.H.%	-0.024	-0.012	0.926	0.093	0.059			

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