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Evaluation sensitivity of some tomato varieties to the insect infestation by tomato leaf miners, *Tuta absoluta* (Meyrick) under plastic greenhouses

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Abstract
This study was carried out to evaluation sensitivity of some tomato varieties to the insect infestation by Tomato leaf miners, *Tuta absoluta* (Meyrick). Experiments were carried out on five varieties of tomato, *Solanum lycopersicum* (Solanales: Solanaceae); Floraded, Preged, Mader, Beto86 and Alex63 at two locations (governorates), Perkash (Giza Governorate) and Tokh (Qaliobya Governorate) during season 2021 under plastic greenhouses. The study was carried out throughout three steps: first step includes studied the population fluctuations of *T. absoluta* on the successive tomato varieties at both of the two successive locations. Second step includes determination concentration of the most internal components of the successive tomato varieties such as (total proteins, total carbohydrates, total phenols and total lipids). And the third step includes determination the physiological changes in the successive insect *T. absoluta* throughout determination the changes in the important internal substances secreted by the insect such as total proteins, total carbohydrates, total lipids and the important enzymes such as: Chitinase, Lipase, Phosphatase, Kinase, Alpha esterase, Beta esterase, Oxidation enzymes and Digestive enzymes. Data obtained showed that the successive tomato varieties were arranged ascending in terms of the infestation by the successive insect *T. absoluta* at both of the two successive locations as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively. Data obtained showed also that concentration of the most internal components of the successive tomato varieties such as: total proteins, total carbohydrates, total phenols, total amino acids, tannins and flavonoids were arranged descending in the successive tomato varieties as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively. Lastly, data obtained showed that concentration of the internal components which secreted by the successive insect *T. absoluta* in insects which fed on the successive tomato varieties were arranged ascending as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively.

Keywords: *Tuta absoluta*, tomato plants, five varieties, sensitivity, greenhouses, internal components, physiological changes

Introduction

Tomato fruits, *Solanum lycopersicum* (Solanales: Solanaceae) is one of the most important vegetable fruits all over the world (Neelima 2008) [19]. And Goda *et al*. (2015) [12]. Indicated that tomato plants consider one of the important vegetables plants in Egypt which cultivated in both of the open fields and under plastic greenhouses and it cultivated annually in 2-3 plantations. Also, Jewel *et al*. (2019) [14] indicated that tomato (*Solanum lycopersicum*) is the most popular vegetable crop in Bangladesh as well as in the world and huge amount of tomato fruits became lost due to attack of insect pests such as Tomato leafminers, *T. absoluta*.

Tomato leaf miners, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is one of the most serious pests infesting tomato plants in both of the open fields and under plastic greenhouses (Gabl 2015 and Megido *et al.* 2014) [11, 17]. And Desneux (2017) [5] indicated that tomato plants are the main host plant of Tomato leafminers, *T. absoluta* and it causes serious damages to tomato fruits (crops). Also, Bekheit (2011) [3] in Egypt indicated that Tomato leafminers, *T. absoluta* was found for the first time in Egypt at Nubaria (Beheira Governorat) at season 2009. Also, Joel *et al.* (2011) [15] referred to that The tomato borer, *T. absoluta* (Lepidoptera: Gelechiidae) is considered to be one of the most devastating pests affecting tomato crops in South America, where crop losses range from 60 to 100% in the high infestation.

This study was carried out to evaluation sensitivity of some tomato varieties to the insect infestation by Tomato leaf miners, *T. absoluta* (Meyrick).

Materials and methods

Experimental design

Experiments were conducted on tomato plants, *Solanum lycopersicum* (Solanales: Solanaceae) during season 2021 at two locations (governorates), Perkash (Giza Governorate) and Tokh (Qaliobya Governorate). Tomato seedlings were cultivated at the same time at mid of January month season 2021 (early summer planting) at both of the two successive locations. Study was carried out on plastic greenhouses at both of the two successive locations, each plastic greenhouse divided into five parts for five tomato varieties. Each part includes 3 replects (plots). Recommended agricultural operations were applied and non-chemical control was applied during experiments. An artificial infestation by Tomato leafminers, *T. absoluta* was done at both of the two successive locations at the same time. It is proven accurate observations and directly counting of *T. absoluta* numbers was done weekly at tomato plants from beginning of February month during successive season 2021 at both of the two successive locations.

Laboratory design

Laboratory experiments were carried out throughout two ways, the first one include determination the concentration of the most internal components in different tomato varieties

such as: total proteins, total carbohydrates, total amino acids, total phenols, tannins and flavonoids. Plant components were extracted from 200 g fresh weight of tomato leaves. Leaves were ground in liquid nitrogen with a mortar and pestle according to the method of Laemmli (1970) [16] and total soluble protein was extracted and estimated according to Daughaday *et al*. (1952) [4]. Amino acids extraction and estimation were carried out following the methods of Wasfi (1970) [25] and Muting and Kaiser (1963). The method applied for extraction and estimation of alcohol soluble phenolic compounds was that of Diaz and Martin (1972) [6] and recommended by AOAC (1975) [2]. Total carbohydrates were extracted and estimated using the method of Homme *et al*. (1992) [13] and Fairbairn (1953) [10]
And the second way include determination the physiological changes in the successive insect *T. absoluta* throughout determination the changes in the important internal substances secreted by the insect such as total proteins, total carbohydrates, total lipids and the important enzymes such as: Chitinase, Lipase, Phosphatase, Kinase, Alpha esterase, Beta esterase, Oxidation enzymes and Digestive enzymes (mg/100g). The insect nymphs were collected and examined in the entomology lab, Faculty of Science, Ain Shams University.

Statistical analysis
Mean numbers of captured *T. absoluta* males was analyzed statistically using one way analysis of variance. When ANOVA indicates that significant differences were found ($P<0.05$) means it separated by a Least Significant Difference Test (L.S.D), simple correlation (r) and regression coefficient value (b) were adopted to clarifies the changes in the insect population *T. absoluta* due to the changes in the tomato variety and the changes in concentration of the internal components also due to the changes in the tomato variety and the mean values compared with the least significant differences as well as, SAS program (SAS Institute 1988) [23].

Results and discussion
This study was carried out to evaluation sensitivity of some tomato varieties to the insect infestation by Tomato leaf miners, *Tuta absoluta* (Meyrick). Experiments were carried out on five varieties of tomato, *Solanum lycopersicum* (Solanales: Solanaceae); Floraded, Preged, Mader, Beto86 and Alex63 at two locations (governorates), Perkash (Giza Governorate) and Tokh (Qaliobya Governorate) during season 2021 under plastic greenhouses.

Population fluctuation of *T. absoluta* on tomato varieties
Data tabulated in Table (1) show the population fluctuation of *T. obsoluta* on tomato varieties at both of Giza and Qaliobya Governorates during season 2021. Data obtained showed that tomato varieties were arranged ascending in terms of the infestation by the successive insect in both of the two successive locations as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively. Whereas the mean numbers of *T. absoluta* at Giza Governorate at the successive tomato varieties Floraded, Preged, Mader, Beto86 and Alex63 were: 21.0, 25.3, 29.8, 32.2 and 34,7 nymph /leaf respectively. While in Qaliobya Governorate the mean numbers were: 23.0, 27.9, 31.9, 33.8 and 36.3 nymph /leaf respectively.
The statically analysis showed that were highly significantly differences between the mean population of *T. absoluta* which infesting the successive tomato varieties whereas F(0.05) and L.S.D values in Giza Governorate were (375.92, 1.035) respectively, while in Qaliobya Governorate were (425.73, 1.042) respectively.
These results were agreement with those obtained by Goda *et al*. (2015) [12] in Egypt who reported that Tomato Leaf miner, *T. absoluta* is one of the recent dangerous pests which attacking tomato varieties and it cultivated annually in 2-3 plantations. Also, Patricia and Norma (2006) [21] indicated that *T. absoluta* is an important tomato pest and also feeds on other host-plants from the Solanceae family and showed also that tomato plants was a more suitable host-plant and had a better nutritional quality than potato. Andrew and James (2013) [1] in South America found that Tomato leafminer, *T. absoluta* is a major pest of tomato plants in South America, and the optimum temperature for Tuta development ranged from 19-23 C. Also, Doaa *et al.* (2020) [7] in Egypt studied the seasonal abundance of *Tuta absoluta* in early summer plantation and nili plantation and found that the seasonal abundance of this pest was higher in early summer plantation than nili one.

Table 1: Population fluctuation of *T. absoluta* on tomato varieties at both of Giza and Qaliobya Governorates during season 2021

Date	Giza Governorate					Qaliobya Governorate				
	Floraded	Preged	Mader	Beto86	Alex63	Floraded	Preged	Mader	Beto86	Alex63
1/2/2021	15.3	18.3	20.8	22.7	24.9	16.5	20.3	22.5	23.8	26.5
8/2/2021	16.8	20.5	22.7	25.9	27.5	17.9	22.7	24.3	26.5	28.9
15/2/2021	18.3	21.4	25.4	26.8	29.3	20.5	24.3	27.5	27.4	31.6
22/2/2021	19.7	23.7	27.2	28.5	31.5	21.7	26.5	29.7	29.3	33.7
1/3/2021	21.5	25.1	29.5	31.7	34.7	22.9	27.3	31.5	33.5	35.9
8/3/2021	23.1	27.5	31.7	33.2	36.1	25.5	29.8	33.9	35.9	37.8
15/3/2021	25.4	29.7	33.5	35.5	38.5	27.4	32.5	35.6	37.2	39.9
22/3/2021	26.2	30.5	35.2	37.2	40.8	28.5	33.4	37.5	39.3	43.3
29/3/2021	27.5	32.1	37.5	39.5	41.7	29.6	35.5	39.7	41.0	42.5
5/4/2021	24.1	29.3	35.1	37.2	39.5	27.5	32.1	37.5	39.5	40.7
12/4/2021	21.3	26.8	32.4	35.6	37.2	23.3	29.4	34.2	37.2	38.5
19/4/2021	18.5	23.5	29.3	33.2	35.6	20.5	26.3	31.5	35.1	36.9
26/4/2021	15.3	20.7	26.5	31.5	33.8	17.3	23.5	28.7	33.7	35.6
Total	273.0	329.1	386.8	418.5	451.1	299.1	363.6	414.1	439.4	471.8
Mean	21.0	25.3	29.8	32.2	34.7	23.0	27.9	31.9	33.8	36.3
F (0.05)	375.92					425.73				
L.S. D	1.035					1.042				

Means within columns bearing different subscripts are significantly different ($P<0.05$)

Determination concentration of the most internal components of the successive tomato varieties

Data tabulated in Table (2) show determination concentration of the most internal components of the successive tomato varieties such as: total proteins, total carbohydrates, total phenols, total amino acids, tannins and flavonoids. Data obtained showed that these components were arranged descending in the successive tomato varieties as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively. Statically analysis show that was highly significant differences between concentrations of these internal components in the successive tomato varieties.

Table 2: Determination concentration of the most internal components of the successive tomato varieties

	Floraded	Preged	Mader	Beto 86	Alex 63	$F_{0.05}$	LSD
Total proteins mg/100g	19.85	18.64	17.42	16.31	15.11	325.45	1.025
Total carbohydrats mg/100g	21.96	20.75	19.43	18.32	17.01	476.82	1.033
Total phenols mg/100g	17.87	16.65	15.43	14.31	13.10	393.74	1.046
Amino acids mg/100g	15.54	14.43	13.32	12.21	11.10	318.75	1.072
Tannins mg/100g	11.86	10.75	9.54	8.33	7.12	471.52	1.083
Flavonoids mg/100g	9.68	8.57	7.46	6.34	5.11	345.98	1.035

Means within columns bearing different subscripts are significantly different ($P < 0.05$)

By linking Tables (1) and (2) found that the successive tomato varieties were arranged in terms of the degree of the insect infestation by *T. absoluta* ascending as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively while the same tomato varieties were arranged in terms of concentrations of the internal components descending as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively. Whereas the tomato variety which contain high concentrations of the important internal components (total proteins, total carbohydrates, total phenols, amino acids, tannins and flavonoids) was low infestation by *T. absoluta* and vice versa the tomato variety which contain low concentrations of these important internal components was high infestation by *T. absoluta*.

The obtained results were agreement with those obtained by Eman *et al*. (2021) [9] who studied the susceptibility of some tomato varieties to the tomato borer, *T. absoluta* infestation in Egypt and found that the tomato variety which had low levels of total proteins, carbohydrates and free amino acids was high infestation by *T. absoluta* and vice versa the tomato variety which had high levels of these components was low infestation by *T. absoluta.* Also, Peng *et al.* (2014) [22] examined the effects of various levels of nitrogen inputs and water inputs to tomato plants (*Solanum lycopersicum*) on survival and development of an invasive tomato leafminer, *Tuta absoluta* and found that tomato plant which had high number of nodes declined under insufficient or excessive nitrogen treatment was significantly reduced the leafminer *T. absoluta* survival rate and slowed down its development and vice versa. And also, Doaa *et al.* (2020) in Egypt studied the susceptibility of eight tomato cultivars to infestation with tomato leafminer *T. absoluta* in relation to leaves chemical composition during the years 2018-2019 under Egyptian field condition and found that there were significant differences between the tested compounds in all cultivars in healthy and infested plants and remarkable decrease of these compounds in infested plants.

Determination the physiological changes in the successive insect *T. absoluta*

Data tabulated in Table (3) show determination the physiological changes in the successive insect *T. absoluta* throughout determination the changes in the important internal substances secreted by the insect such as total proteins, total carbohydrates, total lipids and the important enzymes such as: Chitinase, Lipase, Phosphatase, Kinase, Alpha esterase, Beta esterase, Oxidation enzymes and Digestive enzymes. Data obtained showed that concentration of these components which secreted by the successive insect *T. absoluta* were arranged ascending in the insects which fed on the successive tomato varieties as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively. Statically analysis show that was highly significant differences between concentrations of these internal components which secreted by the successive insect *T. absoluta*.

Table 3: Determination the changes in the important internal substances secreted by *T. absoluta*

	Floraded	Preged	Mader	Beto 86	Alex 63	$F_{0.05}$	LSD
Total proteins mg/100g	23.20	24.32	25.53	26.64	27.75	325.73	1.067
Total carbohydrats mg/100g	6.30	7.41	8.53	9.73	10.84	433.36	1.054
Total lipids mg/100g	11.42	12.53	13.64	14. 76	15.98	386.91	1.025
Lipase enzyme mg/100g	23.53	24.75	26.54	27.68	29.75	348.21	1.073
Phosphatase enzyme mg/100g	20.12	21.33	22.43	23.57	25.63	495.82	1.082
Chitinase enzyme mg/100g	11.31	12.42	13.53	14.65	15.78	287.33	1.033
Kinase Enzyme mg/100g	16.10	17.22	18.32	19.43	20.56	392.54	1.045
Alpha Esterase mg/100g	8.21	9.32	10.42	11.54	12.75	450.83	1.062
Beta Esterase mg/100g	6.31	7.54	8.65	9.77	10.89	375.66	1.035
Oxidation enzymes mg/100g	5.20	6.31	7.43	8.55	9.67	394.32	1.041
Digestive enzymes mg/100g	4.30	5.41	6.52	7.63	8.84	425.11	1.072

Means within columns bearing different subscripts are significantly different ($P < 0.05$)

By linking Tables (1) and (3) found that the successive tomato varieties were arranged in terms of the insect infestation by *T. absoluta* ascending as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively while concentration of the internal components which secreted by the successive insect *T. absoluta* were arranged ascending in

the insects which fed on the successive tomato varieties as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively. Whereas *T. absoluta* insects which fed on Floraded tomato variety secreted low concentrations of these internal components and vice versa *T. absoluta* insects which fed on Alex63 tomato variety secreted high concentrations of the same internal components.

The results obtained were agreement with those obtained by Sharma and Verma (2020) [24] in India who reported that concentration of lipids and proteins which secreted by *T. absoluta* adults depends on tomato variety it fed on and it different from variety of tomato plants to other and also it different from tomato plants to other plants such as potatoes. Also, Nozad *et al.* (2017) [20] indicated that *T. absoluta* is one of the serious pests of tomatoes and changes in chemical and biological vitals inside this insect depends on variety of tomato which it fed on it and its internal components different from variety of tomato to other. Doaa and Abd-El-Aziz (2022) [8] found in their laboratory studies on *T. absoluta* larval that secreted digestive enzymes, total proteins, total carbohydrates, total lipids and total free amino acids depends on tomato variety it fed on it.

Conclusion

Data obtained showed that the successive tomato varieties were arranged ascending in terms of the infestation by the successive insect *T. absoluta* in both of the two successive locations as follows: Floraded, Preged, Mader, Beto86 and Alex63 respectively. Data obtained showed also that concentration of the most internal components of the successive tomato varieties such as: total proteins, total carbohydrates, total phenols, total amino acids, tannins and flavonoids were arranged descending in the successive tomato varieties as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively. Lastly, data obtained showed the concentration of the important components which secreted by the successive insect *T. absoluta* such as: (total proteins, total carbohydrates, total lipids and the important enzymes such as: Chitinase, Lipase, Phosphatase, Kinase, Alpha esterase, Beta esterase, Oxidation enzymes and Digestive enzymes) were arranged ascending in the insects which fed on the successive tomato varieties as follow: Floraded, Preged, Mader, Beto86 and Alex63 respectively.

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