LOSS ASSESSMENT AND THE ESTIMATION OF ECONOMIC INFESTATION LEVELS OF *TUTA ABSOLUTA* (MEYRICK) IN TOMATO CROPS AT EL- SHARKIA GOVERNORATE

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Abstract

Experiment was carried out for two successive seasons (2016 and 2017) at EL- Sharkia governorate. In both seasons tomato; plant "alsa" variety were cultivated to obtain different levels of infestation by *Tuta absoluta* of tomato crop were sprayed periodically with King chem 5.7% WG (Emamectin benzoate)**.** Results showed simple correlation "r" values obtained were strong significantly negative indicating a strong negative relationship between the density of infestation (*Tuta absoluta*) and the corresponding crop yield of tomato produced. The simultaneous effect of some tomato pests (*Tuta absoluta, Bemisia tabaci* and *Tetranychus urticae*) infestation on the crop yield indicated that the three factors were responsible for 73% and 93% of variability in the average weight of crop yield in 2016 - 2017 respectively. This study aims to the determination of economic infestation threshold level and economic injury level of *Tuta absoluta* to be used as a tool for controlling *Tuta absoluta* under Field conditions. Data indicated that (General Equilibrium Position (G.E.P.)) between 55 to 61 larvae / 20 leaves, Economic Threshold Level (E.T.L)] between 57 to 72 larvae / 20 leaves, [Economic Injury Level (E.I.L)], 78 to 103 larvae / 20 leaves at this level of infestation control measures must be applied.

INTRODUCTION

Tomato leaf miner (TLM), *Tuta absoluta* (Meyrick), (Lepidoptera: Gelechiidae), is a key pest at tomato plants and in it native at the western part of South America, invaded Brazil around 1980 (Souza & Reis, 1992). It is now a devastating pest of tomatos crop in South America, Europe, Africa and Asia (Tropea Garzia *et al*., 2012; Zappala` *et al*., 2013). This pest is crossing borders and devastating tomato production in both protected and open fields (EPPO, 2008, 2009; FERA, 2009). In Egypt, *T. absoluta* was spread rapidly and it is currently considered a key insect pest on tomato plants, both in greenhouses and open-fields. Damage is caused by larval tunneling and they can penetrate young stems and fruits which finally result in the loss of over 80% of fruits (Desneux *et al*., 2011). During the last decades, TLM were controlled the utilization of chemical insecticides. Environmental safety of the insecticides is the first and foremost criterion for TLM control programs (Tropea Garzia *et al*., 2012). In most countries where *T. absoluta* occurs, the main control strategy includes frequent treatments by chemical insecticides, because without control, *T. absoluta* causes about 100% yield losses and dramatically decreases the fruit quality

in both field and greenhouse tomato plants (Gilardo´n *et al*., 2001; Tropea Garzia *et a*l., 2012).

The main objectives of two studies were: Estimation of Economic levels of Infestation and the simultaneous effect of some tomato pest's infestation on the crop yield as well as the approximate damage threshold.

MATERIALS AND METHODS

Loss assessment and estimation of economic levels of infestation:-

Design of the experiment

This experiment was carried out for two successive seasons (2016 and 2017) at EL- Sharkia governorate. In both seasons tomato plant of variety "alsa" was sown in 15th of May and left until 26th of Augusta in an area of about (2000 m²) divided into fifteen equal rectangular blocks separated from each other by belts of 2 meters wide. Each (treatment) block (133.5 m²) was subdivided into 3 plots (44.5m²) each plot. The plots were then split into two equal divisions (20 rows each); one used for sampling and the other left untouched until harvesting (for the yield estimation).

To obtain different levels of infestation by *Tuta absoluta* of tomato plants were sprayed periodically with King chem 5.7% WG 30cm /200L.treatment /Fadden. The insecticidal formulations were applied by means of a compression knapsack sprayer. In both seasons, spraying started on June 25th according to following schedule (Table 1) All the experimental plots received the same normal agricultural practices.

Estimation of infestation by *Tuta absoluta* (Meyrick)**:**

Starting on June 23 and until end of August and continued till harvest, weakly samples of 20 leaves were collected at random from each replicate. The samples were kept in paper bags and transferred to the laboratory to examine and count the existed pests.

Table 1. Treatment dates by King chem 5.7% WG throughout two successive seasons, 2016- 2017at Sharkia Governorate.

No. of treatment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of sprayer															Control
1	25/6	25/6	25/6	25/6	25/6	25/6	25/6	25/6	25/6	25/6	25/6	25/6	25/6	25/6	
2		24/7	14/7	10/7	7/7	5/7	3/7	2/7	1/7	1/7	30/6	30/6	29/6	29/6	
3			3/8	25/7	19/7	15/7	11/7	9/7	7/7	7/7	5/7	5/7	3/7	3/7	
4				9/8	31/7	25/7	19/7	16/7	14/7	14/7	10/7	10/7	7/7	7/7	
5					12/8	4/8	27/7	23/7	21/7	21/7	15/7	15/7	11/7	11/7	
6						14/8	4/8	30/7	28/7	28/7	20/7	20/7	15/7	15/7	
7							12/8	6/8	4/8	4/8	25/7	25/7	19/7	19/7	
8								14/8	11/8	11/8	30/7	30/7	23/7	23/7	
9									18/8	18/8	4/8	4/8	27/7	27/7	
10										24/8	9/8	9/8	31/7	31/7	
11											14/8	14/8	4/8	4/8	
12												19/8	8/8	8/8	
13													12/8	12/8	
14														16/8	
15															

Tomato were harvested; on Augusta 30, for two seasons 2016 - 2017. The weight of produced by 99 tomato plants in each division was recorded, and the average weight of yield for each treatment was calculated.

RESULTS AND DISCUSSION

Estimation of Economic levels of Infestation:

A. The infestation-yield relationship:

In order to estimate the damage in tomatoes yield due to infestation by TLM at different infestation level, the simple correlation formula was applied.

The population density of the pest was represented by the average number of TLM s^1 larva as independent variable (X), while tomato yield was represented was represented as dependent variable (Y).

The variations that occurred in the yield crop in tomato owing to the infestation by *T. absolute* were detected through the application of the linear regression formula: $\hat{Y}= a + bX$ "prediction equation" (Goulden 1960), where "$\hat{Y}$" is the new estimated yield weights, "X" is the degree of infestation by *T. absoluta*, "a" is the origin of the linear the value of "y" for "x" = "o" and "b" is the slope of the time. Thus "b" represents the decrease in "y" for a unit increase in "x".

The linear regression coefficient "b" was helpful in determining the slope of the straight regression liners.

When simple correlation coefficient "r" was significant the regression coefficient "b" was calculated. Also curved nonlinear regression line (Curvilinear Relations) was estimated for *T. absoluta* and (coefficient of determination r^2) was calculated for *T. absoluta*

Data given in table (2) showed ample sets of infestation that the simple correlation coefficients could be worked out for the relationship between the number of *Tuta absoluta* (x) on one hand and the yield of tomato crop (y) on the other hand, the simple correlation "r" values obtained were negative highest significantly indicating a strong negative relationship between the density of infestation and the corresponding yield of tomatoes production.

Table 2. The fluctuation in tomato yield "y" of tomato plant and number of *Tuta absoluta* during two seasons 2016 - 2017.

Year	2016			2017		
Treatment No.	number of Larvae	yield in kg./ plant	$\hat{Y}1$	number of Larvae	yield in kg./ plant	$\hat{Y}1$
1	50	372	301.16	45	390	350.20
2	53	345	294.11	49	377	333.69
3	58	285	282.36	55	282	308.92
4	60	276	277.66	57	280	300.67
5	61	270	275.31	63	267	275.90
6	72	231	249.45	69	240	251.14
7	78	225	235.35	71	228	242.88
8	78	219	235.35	73	212	234.63
9	79	210	233.00	75	208	226.37
10	82	207	225.95	80	205	205.73
11	88	183	211.85	82	201	197.48
12	89	177	209.50	88	179	172.71
13	92	174	202.44	89	171	168.58
14	103	166	176.59	94	145	147.95
15	142	155	84.92	108	122	90.16
Total	1185	3495	2366.63	1098	3507	3996.16
Mean	79	233	233	73.2	233.8	233.80
Correlation (r)	-0.843***			-0.955***		
Regression co (b)	-2.35***			-4.12***		
Coefficient of determination "r^2"	0.710			0.912		

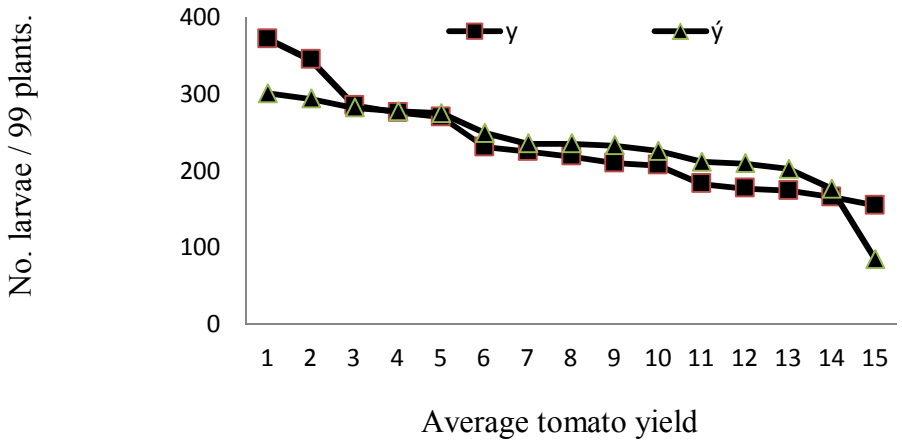

Fig. 1. the linear regression relationship between *Tuta absoluta* infestation levels "x" (expressed as average number of larvae/ 99 plants) and average tomato yield "y" during 2016 season.

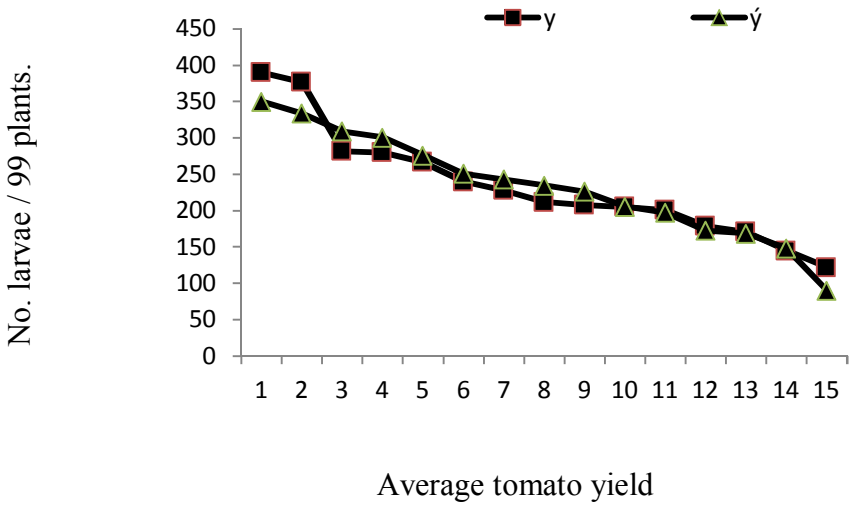

Fig. 2. the linear regression relationship between *Tuta absoluta* infestation levels "x" (expressed as average number of larvae/ 99 plants) for and average tomato yield "y" during 2017 season.

The simultaneous effect of some tomato pests infestation on the yield

The C-multipliers method, to determine the spate effect of each of these pests on the yield together with the actual corrected yield, as being affected by each pest. The independent factors (x_1, x_2 and x_3) referred to the number of *Tuta absoluta* , *Bemisia tabaci* and *Tetranychus urticae* and tomato yield averages represented the dependent factor "Y". The values for the dependent and independent variables (b_1, b_2 and b_3) are given in Table (3). These values indicated that the three factors were responsible for 73% and 93% of variability in the average weight tomato yield in 2016-2017 respectively.

The partial regression values (b_1) for the effect of *Tuta absoluta* on the yield (when the two other factors x_2 and x_3) remained constant around their averages) were significant negative for both seasons 2016and2017, respectively. The partial regression values (b_2) for the effect of *B. tabaci* on the yield (when the three other factors x_1 and x_3) remained constant around their averages) was insignificant and negative for both seasons 2016 and 2017. The partial regression values (b_3) for the effect of *T. urticae* on the yield (when the three other factors x_1-x_2) remained constant around their averages) were insignificant and negative for both seasons 2016 and 2017, respectively.

Table 3. Analysis of variance for three tomato pests (*Tuta absoluta* , *Bemisia tabaci* and *Tetranychus urticae*) together sharkia, 2016-2017.

Year	2016						2017					
Variance data	D.F	S.S	M.S	F	P	Explained variance	D.F	S.S	M.S	F	P	Explained variance
Regression	3	42361	14120	9.37	0.002	72%	1	75302	25101	49.19	<.0001	93%
Error	11	16585	1507.72				3	5612.74	510.24			
Total	14	58946					14	80914				

The approximate damage threshold:

The injury caused by *Tuta absoluta* in tomato during seasonal activity showed that three damage occurred during of vegetative growth and formation of tomato fruit. Statistical analysis showed that population density of these *Tuta absoluta* was highly significant correlated with main yield. This injure are mainly caused decreasing to the amount of tomatoes yield harvested. Therefore, losses assessment must be depend on yield weight decline. Estimation of "Economic Levels of Infestation" will be based on correlation different levels of population density of *Tuta absoluta* and tomato weight yield per plant. Was Pedigo *et al.* (1986) more convenience to illustrate definition of "Economic Levels".

In the first season 2016

Regarding the part of population density during main period of seasonal activity (26, June to 15, August, 2016 and 2017) estimation of economic levels of infestation showed that, when population density of *Tuta absoluta* less than 61 larvae / 20 leaves could be regarded as (General Equilibrium Position), when reached population to 72 larvae / 20 leaves, the chi-square (χ^2) value for the yield (15.36) and significant drop in the weight yield was happened. Therefore, 72 larvae / 20 leaves could be regarded as [Economic Threshold Level (E.T.L)], no need for control measures, but must be ready if population density increases above that level. Afterwards, population density increased upwards from 72 to 103 larvae / 20 leaves, the yield loss decreased from 231 to166 kgs. /weight the obtain significant χ^2 value (10.22). This level of infestation could be regarded as [Economic Injury Level (E.I.L)], at this level of infestation control measures must be applied. Then, population density increased upwards from 103 to 142 individuals/ samples the yield loss decreased to 155 kgs. / weight yield the obtain χ^2 value (5.21) was significant. This level of infestation could be regarded as [Economic Damage Level (E.D.L)], (Table 4).

In second season 2017

Regarding the part of population density during main period of seasonal activity (26, June to 15, August, 2016 and 2017) estimation of economic levels of infestation showed that, when population density of *Tuta absoluta* less than 55 larvae / 20 leaves could be regarded as (G. E. P.). When population reached to 57 larvae / 20 leaves, the chi-square (χ^2) value for the yield was (22.75), highly significant drop in the yield was occurred. Therefore, 57 larvae / 20 leaves could be regarded as (E.T.L), no need for control measures, but must be ready if population density increases above that level. Afterwards, population density increased upwards from 57 to 88 larvae / 20 leaves, the yield loss decreased to 280 to 179 kgs. /weight, the obtain χ^2 value (15.56) was significant. This level of infestation could be regarded as (E.I.L), at this level of infestation control measures must be applied. Then, population density increased upwards from 88 to 108 individuals/ sample the yield loss decreased to 122 kgs. / weight obtain χ^2 value (2.04) was insignificant. This level of infestation could be regarded as (E.D.L)]. (Table 5).

CONCLUSION

This study shows that the determination of economic threshold level and economic injury level could be used as a tool for timely control of *Tuta absoluta* under Field conditions.

The data indicated that (General Equilibrium Position (G.E.P.)) between 55 to 61 larvae / 20 leaves, Economic Threshold Level (E.T.L)] between 57 to 72 larvae / 20 leaves, [Economic Injury Level (E.I.L)], 78 to 103 larvae / 20 leaves at this level of infestation control measures must be applied.

Table 4. Economic injury levels and economic damage threshold in tomato plants infested by *Tuta absoluta* in EL- Sharkia governorate during 2016 and 2017 seasons.

	2016		**2017**	
No. of treatment	**Number of larvae**	**Weight of yield**	**Number of larvae**	**Weight of yield**
1	50	372	45	390
2	53	345	49	377
3	58	285	55 (G. E. P.)	282
4	60	276	57 (E.T.L)	280
5	61 (G. E. P.)	270	63	267
6	72 (E.T.L)	231	69	240
7	78	225	71	228
8	78	219	73	212
9	79	210	75	208
10	82	207	80	205
11	88	183	82	201
12	89	177	88 (E.I.L)	179
13	92	174	89	171
14	103 (E.I.L)	166	94	145
15	142 (E.D.L)	155	108 (E.D.L)	122
Total	**1185**	**3495**	**1098**	**3507**

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تقيم وتقدير الخساره للمستويات الأقتصادية للأصابه *Tuta absoluta* (Meyrick) فى نبات الطماطم فى محافظه الشرقيه

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معهد بحوث وقايه النباتات ،مركزالبحوث الزراعيه ،الجيزة ،الدقى

تم اجراء التجربه خلال موسمين متتالين 2016/ 2017 فى محافظة الشرقيه وفى كلا الموسمين تم رش نبات الطماطم صنف "اليسا " بمجموعه متنوعه من King chem 5.7%WG للحصول على مستويلت مختلفه من الأصابه بالتوتا ابسولوتا. وجدت النتائج أن قيم الارتباط البسيط "r" التي تم الحصول عليها كانت قوية بشكل سلبي مما يشير إلى وجود علاقة سلبية قوية بين كثافة الإصابة (*Tuta absoluta*) وبين إنتاجية المحاصيل المقابلة من الطماطم المنتجة. التأثير المتزامن للأصابه لبعض أفات الطماطم مثل (الذابابه البيضاء– التوتاابسلوتا – الاكاروس) على المحصول، تشير الى ان العوامل الثلاثه مسؤله بنسبه 73% ، 93% من التباين فى متوسط الوزن من المحصول خلال عام 2016 و 2017 على التوالى.وتبين الدراسة أن تحديد مستوى البدايه الاقتصادية للسيطرة في الوقت المناسب من *Tuta absoluta* تحت الظروف الحقليه. أشارت البيانات إلى أن (وضع التوازن العام (GEP)) بين 55 إلى 61 يرقة / 20 ورقة ، مستوى البدايه الاقتصادية (ETL) بين 57 إلى 72 يرقة / 20 ورقة ، [مستوى الإصابات الاقتصادية] ، 78 إلى 103 يرقات يجب تطبيق / 20 ورقة في هذا المستوى من تدابير مكافحة الإصابة.