J. of Plant Protection and Pathology, Mansoura Univ., Vol. 11 (4):231 - 236, 2020

Journal of Plant Protection and Pathology

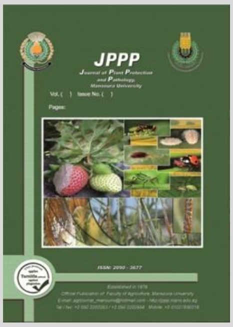
Journal homepage: www.jppp.mans.edu.eg
Available online at: www. jppp.journals.ekb.eg

Influence of Emamectin Benzoate ; Emamectin Nanoformulations and some Weather Factors on the Population Fluctuations of *Tuta absoluta* (Lepidoptera: Gelechiidae)

Cross Mark

Ahmed, M. M. A.[1*]; A. A. Othman[2] and Francisco J Solorio Sánchez[3]

[1]Department of Plant Protection, Faculty of Agriculture, Assiut University (71526), Assiut, Egypt.
[2]Department of Physics, Faculty of Science, Assiut University (71526), Assiut, Egypt
[3]Department of Animal Nutrition, Faculty of Veterinary Medicine and animal science, University of Yucatan (UADY), Mérida, Yucatán, México, KM 15.5 carretera Mérida, Xmatkuil Apdo. P. O. BOX 4-116 Itzimna Merida.



ABSTRACT

The experiment conducted during (2016/ 2017 and 2017/ 2018) at Fac. of Agric. Farm, Assiut Univ. on tomato hybrids to survey arthropods, determine reduction of *Tuta absoluta* by Proclaim® 5% (S_0= 0.3 mm) and nano-formulations (S_1= 17.43± 8.20nm and S_2= 9.75± 3.86nm) by (120 gm/ Fadden) after 5th, 7th, and 10th days of post-treatment under some weather factors (WF): [Daily Maximum Temperature (DMax.T), Daily Minimum Temperature (DMin.T), and Daily relative humidity (DRH%)]. Survey presented nine insect species under nine genera, three mites, three predators and one parasitoid. The highest grand means for mines and immature stages in 18th of Jan., 2017 and 14th of March, 2018, and lowest in 3rd of Nov., 2016 and 4th of Dec., 2017. Meteorological data in 1st season were significant with mines and no significant with larvae on hybrids. In 2nd season, mines regulated by DMax.T (0.447) and DRH% (-0.621) for Vera, and DRH% (-0.540) for 010 with no significance between weather factors and larvae on hybrids. S_2 in the 1st season highly reduced larvae after 10th days (103 ± 18.40 and 69.14 ± 14.21; for Vera and 010), and the lowest by S_0 for Vera (10.40 ± 2.22) after 7th days; and 22.40 ± 1.78 for 010 in 5th days. In 2nd season, highest reduction by S_2 (78.64 ± 1.27 and 105.00 ± 6.34 for Vera and 010 in 10th days; and lowest by S_2 in Vera after 7th days (17.00 ± 0.61); and S_1 for 010 after 5th days (29.64 ± 0.81).

***Keywords**:* Tomato leaf miner, *Tuta absoluta*, Nano insecticides, Emamectin benzoate, Weather factors, Population fluctuations

INTRODUCTION

Tomato, *Lycopersicon esculentum* (Mill) is the most commercial and daily consumed vegetable crop worldwide. Tomato cultivated for various food industries such as Ketchup, preserved tomato juices and dry tomato etc. The global production of tomato currently around 130 million tons, of which 88 million are destined for fresh market and 42 million, are for industry production. China, European Union (EU), India, United States of America (USA), and Turkey are the top producer's countries present about 70% of global production. Egypt ranking the sixth productive country produces about 8.6 million tons from cultivated area of half million Feddan with approximately average production of 17 tons/ Feddan (FAO, 2016).

The tomato leaf miner, *T. absoluta* is geotropically oligophagous pest infest various Solanaceous crops (Lietti *et al.*, 2005) and considered the most serious pest of tomato around the world and very challenging to control (Retta and Behe, 2015). The caterpillars have a strong preference for infesting the leaves, stem, and fruits of tomato. The fruits damage gives an easy access to pathogens and decay the fruits and the total damage could be reached up to 100% in the yield by loss and decreases fruits quality in the open fields and greenhouses (Bueno *et al.*, 2013; Bayindir *et al.*, 2015).

Nano-insecticides could promise a beneficial management method for high soluble abilities in water which makes it more absorbable and penetrative into leaf tissues than normal size of product to deliver active ingredients to target pest into leaf mines (Karny *et al.*, 2018).

The aim of the study to survey tomato Arthropods, investigate reduction % and efficiency of recommended dose of Proclaim® 5% (120 gm/ Fadden) by normal granules size and two different nano sizes of the original productive recommended dose against tomato leaf miner, *T. absoluta* on two tomato hybrids in association to some weather factors: [Daily Maximum (DMax.T), Daily Minimum Temperature (DMin.T), and Daily relative humidity (DRH%)].

MATERIALS AND METHODS

Experimental design and field trials:

The experiment conducted throughout two seasons (2016/ 2017 and 2017/ 2018) at Faculty of Agriculture Farm, Assiut University, Assiut, Egypt on two tomato hybrids (010 and Vera). The infested leaflets were separated from seedlings before plantation to avoid previous infestations by leaf miners. Tomato hybrids were cultivated in two strips; each strip consists of nine plots (replicates), beside one for control with total number of ten plots/ strip. The plot size was 3x3.5 m and contains of three

* **Corresponding author.**
E-mail address: saleh_moda@yahoo.com
DOI: 10.21608/jppp.2020.96010

terraces and each one had five seedlings, with 30 cm spaces between terraces (15 seedlings/ plot).

Assessment protocols of insecticides against *T. absoluta:*

Pesticides applied according to the method of (Ministry of Agriculture and Land Reclamation, 2013) by Knapsack hand spray fitted with one nozzle. The randomized block design used in the experiment and each treatment was replicated three times. Three plots/ hybrid/ strip were separately exposed/ treatment. The insecticide active ingredient is emamectin benzoate, produced by Syngenta Company with trade nameof Proclaim®5% (120 gm/ Fadden 2.4 gm/ 4 L/ Replicate). The original size of product (S_0= 0.3 mm) and two different nano-sized (S_1= 17.43±8.20 nm and S_2= 9.75±3.86 nm).

The collected leaves were examined by binocular and numbers of mines and larvae of *T. absoluta* were directly counted before insecticides spray and regularly after 5, 7, and 10 days as post-treatments. The reduction percent of original and nano-size insecticides were calculated according to Henderson-Tilton's formula (Henderson and Tilton, 1955).

$$\text{Reduction \%} = \left(1 - \frac{n \text{ in Co before treatment} \times n \text{ in T after treatment}}{n \text{ in Co after treatment} \times n \text{ in T before treatment}}\right) \times 100$$

Where: **n = Insect population, T = treated, Co = control**

Survey studies and monitoring the population of *T. absoluta:*

Random collection of 30 leaflets from 30 plants/ treatment was weekly collected in polyethylene bags. The samples were transferred to Laboratory of Economic Entomology/ Plant Protection Department at The Farm of Faculty of Agriculture, Assiut University, Assiut, Egypt. The numbers of mines and immature stages of *T. absoluta* (larvae and pupae) were counted and recorded using binocular microscope and the unknown samples of mites were identification by Dr. Mohamed W. Negm (Associate Professor of Acarology, Dept. of Plant Protec., Fac. of Agric., Assiut Univ.).

Sticky and water traps:

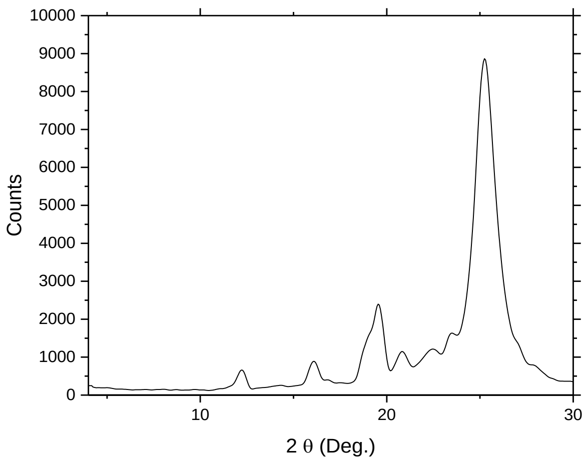
Eight sticky traps and eight water yellow containers were distributed on a wooden stands at 50 cm height from soil surface. The water traps were enhanced by three formaldehyde drops to prevent fungal growth and distributed among tomato plantations for weekly survey.

Preparation of nano-fromulations:

The purchased proclaim micro grain size was measured (2 mm length and 0.3 mm diameter) under laboratory conditions in the Laboratory of Physics, Department of Physics, Faculty of Science, Assiut University, Assiut, Egypt on Proclaim® 5% (micro grain). In order to reduce grain size to nano scale (1 nanometer = 10- 9 meter) samples were prepared and applied by top - down approach for size reduction via high energy ball milling technique (FRITSCH, PULVERSETTE 2). The average crystallite size (D) was determined by Scherrer's equation (Scherrer, 1918): $D = 0.9\ \lambda / \beta.\cos\theta$, here λ is x-ray radiation wave length (λ= 0.1506 nm for k α x-rays), β is full width at half maximum (FWHM), and θ is the Bragg's angle of diffraction. The estimated average <D> values for samples denoted S_0, S_1, and S_2 and X-rays as shown in (Table 1; Fig. 1).

Table 1. Dose and sizes of emamectin benzoate including nano-sized formulations in field experiment.

Compound phase	Size(Mean ± SD)	Dose
S0 Large grain diameter	The original / standard size = 0.3 mm	(120 gm/ Fadden)
S_1 (Nano-sized)	17.43± 8.20 nm	
S_2 (Nano-sized)	9.75± 3.86 nm	



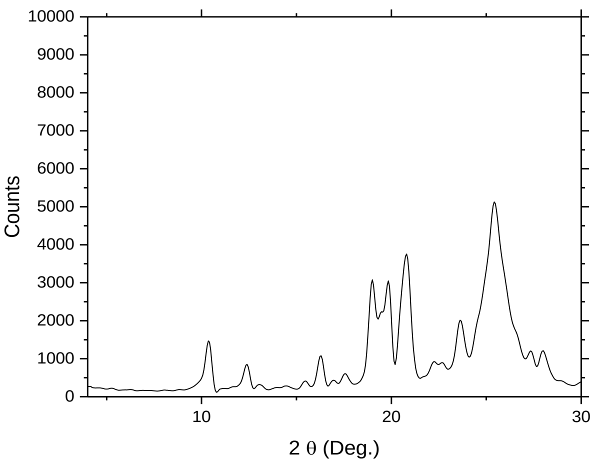


Fig.1. X-ray diffraction pattern of S_1= (17.43 ± 8.20nm) and S_2= (9.75 ± 3.86 nm) of Proclaim ® 5% insecticide (emamectin benzoate) used on tomato hybrids.

4. Statistical analysis:

The Analysis of Variance (ANOVA) was done by Statistix 8.1 (2005) at (LSD at 0.05 level).

RESULTS AND DISCUSSION

Survey of arthropods:

Data arranged in (Table 2) indicated that the presence of nine insect species belonging to nine genera under six families of four orders. Moreover, mites were represented in three genera related to three species under three families of one order. The natural enemies were four genera divided to 3 predator's species and one parasitoid associated to three orders and three families. The most fluctuated arthropods were according to their economic importance are two insect pests related to two different orders and families (*T. absoluta* and *L. trifolii*).

Table 2. The surveyed Arthropods associated with Tomato hybrids during (2016/ 2017 and 2017/ 2018).

Order	Family	Scientific name
Insect pests		
Lepidoptera	Gelechiidae	*Tuta absoluta* (Meyrick, 1917)
		Phthorimaea operculella (Zeller, 1873)
	Noctuidae	*Agrotis ipsilon* (Hufnagel, 1766)
		Spodoptera Littoralis (Boisduval, 1833)
Homoptera	Aleyrodidae	*Bemisia tabaci* (Gennadius, 1889)
	Aphididae	*Aphis gossypii* Glover, 1877
		Myzus persicae (Sulzer, 1776)
Diptera	Agromyzidae	*Liriomyza trifolii* (Burgess, 1880)
Orthoptera	Gryllotalpidae	*Gryllotalpa gryllotalpa* (Linnaeus, 1758)
Mites		
Mesostigmata	Laelapidae	*Laelaspis astronomicus* (Koch, 1839)
	Ologamasidae	*Gamasiphis* sp.
	Pachylaelapidae	*Onchodellus aegypticus* (Hafez & Nasr, 1982)
Natural enemies		
Hymenoptera	Trichogrammatidae	*Trichogramma* sp.
Coleoptera	Coccinellidae	*Coccinella septempunctata* (Linnaeus, 1758)
		C. undecimpunctata (Linnaeus, 1758)
Trombidiformes	Tetranychidae	*Tetranychus urticae*Koch, 1836

A= 010 hybrid; B= Vera hybrid; O= Order; Hyb.= Hybrid

Population fluctuation of T. absoluta during (2016/ 2017):

The infestation of *T. absoluta* recorded in the middle of October after approximately month from the plantation date of seedlings. The population densities (Table 3; Fig. 2) indicated that grand means of *T. absoluta* on Vera cultivar were higher than 010 (avgs. of 628.53 and 571.25 mines and immature stages/ 30 leaflets/ replicates; respectively for Vera and 010) during the two seasons of the study.

The slight invasions were occurred in the beginning of October and November, 2016 on Vera and 010. The population recorded peaks in low mean numbers (avgs. of 20.50 and 20.75 mines and immature stages/ 30 leaflets/ replicates; respectively during October in the 3rd week for Vera and the last week for 010) when the maximum, minimum temperatures, and relative humidity were (36.52 °C, 22.05 °C, and 27.23% for Vera; and 33.21 °C, 20.70 °C, and 33.23% for 010). Afterwards, the means were gradually increased during the weeks of November on both cultivars and the moderate levels of peaks were occurred during the last week (with avgs. of 43.75 and 41.50 mines and immature stages/ 30 leaflets/ replicates; respectively on Vera and 010 cultivars) while, the weather climatic data of maximum, minimum temperatures and relative humidity were (25.52 °C, 11.23 °C, and 42.13%; respectively). Afterwards, the population were recorded high fluctuations from the 1st week of December till end of season with observation of highest peaks in the 3rd week of January for both cultivars with means (avgs. of 71.00 and 60.50 mines and immature stages/ 30 leaflets/ replicates; respectively for Vera and 010) when the degrees of the maximum, minimum temperatures, and relative humidity were (21.10 °C, 6.00 °C, and 48.99 %; respectively).

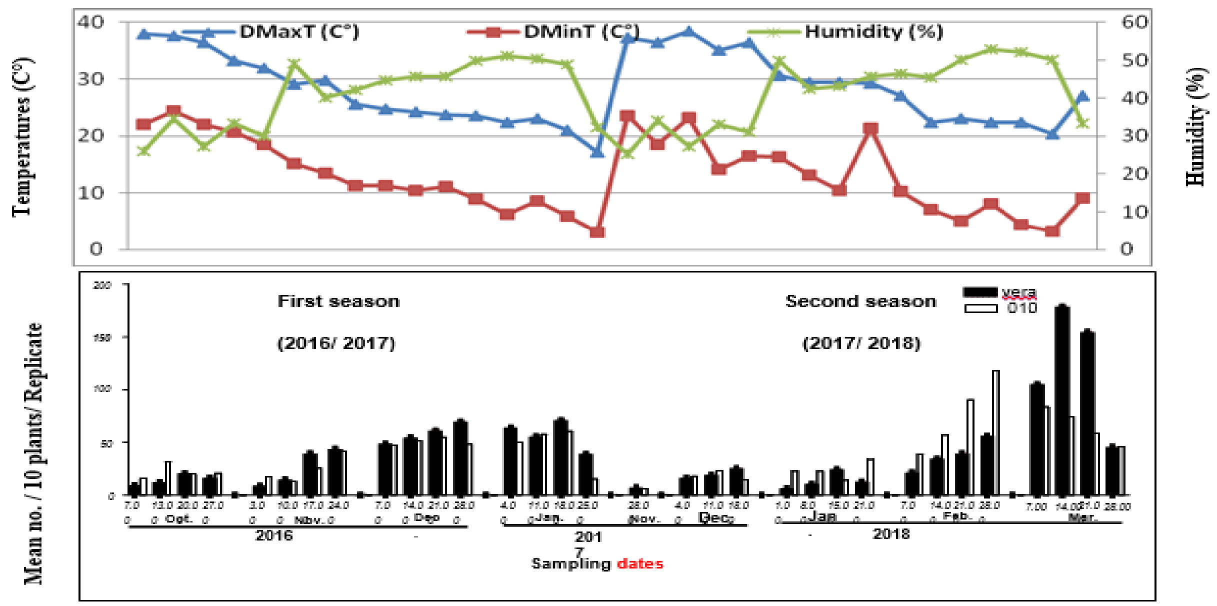


Fig. 2. Meteorological data and population fluctuations of mines and immature stages of *T. absoluta* on Tomato hybrids (010 and Vera) during 2016/ 2017and 2017/ 2018.

Table 3. Mean numbers of mines and *immature stages of *T. absoluta* on Tomato hybrids during 2016/ 2017and 2017/2018.

(S) Dates	M Means Vera	M Means 010	GM	Weather (C°) DMxT	Weather (C°) DMinT	DRH (%)	(S) Dates	M Means Vera	M Means 010	GM	Weather (C°) DMxT	Weather (C°) DMnT	DRH (%)
7-Oct., 2016	9.5	15.8	25.3	38.0	22.0	26.1	28-Nov., 2017	7.3	6.3	13.5	37.3	23.6	25.3
13	12.5	31.8	44.3	37.6	24.5	34.6	4-Dec., 2017	16.5	17.8	34.3	36.5	18.5	34.1
20	20.5	19.5	40.0	36.5	22.1	27.2	11	19.3	23.3	42.5	38.5	23.2	27.3
27	16.5	20.8	37.3	33.2	20.7	33.2	18	25.5	14.3	39.8	35.1	14.2	33.1
3- Nov.	8.8	17.3	26.0	31.9	18.6	30.0	1- Jan., 2018	6.5	23.0	29.5	36.5	16.5	31.1
10	14.8	13.5	28.3	29.0	15.2	49.1	8	10.8	22.8	33.5	30.5	16.3	50.0
17	39.5	25.8	65.3	29.7	13.4	40.0	15	24.5	14.5	39.0	29.4	13.2	42.4
24	43.8	41.5	85.3	25.5	11.2	42.1	21	12.8	33.8	46.5	29.5	10.4	43.2
7-Dec.	48.5	47.5	96.0	24.8	11.2	44.6	7- Feb.	21.5	38.8	60.3	29.3	21.4	45.6

***Immature stages: larvae and pupae; DMax.T: Daily Maximum Temperature; DMin.T: Daily Minimum Temperature; DRH (%): Percentage of Daily Relative Humidity; M: Means of (mines and immature stages)/ 10 leaves/ replicate; GM= Grand Means; (S): Sampling; GM: Grand Means.**

The lowest grand means of *T. absoluta* was recorded in the beginning of the season in the 7th of October, 2016 with grand means (25.5 mines and immature stages/ 30 leaflets/ replicates), and highest grand means was (131.5 mines and immature stages/ 30 leaflets/ replicates).

The regression analysis (Table 4) showed that the relation of correlations between weather temperatures and the mean numbers of mines were negative and significant (r= - 0.831, -0.835 and - 0.617 and - 0.607; respectively for the maximum and minimum temperatures for Vera and 010). Respect to means of mines and relative humidity, the results of correlations were positive and significant (0.851* and 0.767* for Vera and 010, respectively). The coefficient of determination (R^2) stated that all of the considered climatic factors had been participated in arranging the population of *T. absoluta* according to the sequence of mines and larvae by 80; 28 for Vera and 74; 31 % for 010. These results are in agreement with Ata and Megahed, (2014) they found that in Egypt highly significant and positive relation between the daily mean temperatures and mean numbers of *T. absoluta* on two studied verities Alisa and H.S.S (r = +0.744 and +0.752), as well as the effect of relative humidity was the same of our results which shows insignificant negative relation (r= -0.271 and -0.242) for the respective verities.

Population fluctuations of *T. absoluta* during (2017/ 2018):

Data presented in (Table 3; Fig. 2) revealed that, the population density of *T. absoluta* infestation started after month from plantation date in 28th of November 2017. The infestation levels were in low abundance until the end of January 2018 with grand mean fluctuations ranged from (13.5 to 46.5 mines and immature stages/ 30 leaflets/ replicates). Then, the insect pest highly fluctuated from the 1st week of February to the 2nd week of March and the means of the population abundance were determined by the grand means which ranged from (60.25 to 253.25 mines and immature stages/ 30 leaflets/ replicates). The slight peaks occurred on Vera in the 18th of December (avg. of 25.50 mines and immature stages/ 30 leaflets/ replicates), and for 010 were showed in the 1st week of January (avg. of 33.75 mines and immature stages/ 30 leaflets/ replicates), when the climatic factors of maximum temperature, minimum temperature, and relative humidity in the following order were recorded (35.12 °C , 14.23 °C , 33.12% in the 18th of Dec., 2017 for Vera; while in the 21th of Jan., 2018 were 29.45 °C, 10.40 °C, 43.21% for 010). Gradually, the population increased on both cultivars during February and March. Respect to Vera, the population recorded the maximum peak during March with averages (178.75 mines and immature stages/ 30 leaflets/ replicates) under climatic conditions (22.31 °C of maximum temperature, 4.41 °C of minimum temperature, and 52.21%; for relative humidity). On 010 cultivar, the grand peak was occurred in the last week of February (avg. of and 118.25 mines and immature stages/ 30 leaflets/ replicates), while weather factors were (23.12 °C, 5.03 °C, 50.12%; respectively for maximum temperature, minimum temperature, and relative humidity).

Respect to the grand means of *T. absoluta* on both hybrids, the lowest means was recorded in the beginning of the season in the 28th of November, 2017 (13.5 of the sums of mines and immature stages/ 30 leaflets/ replicates), while highest grand means was recorded in the 14th of March, 2018 (253.25 of the sums of mines and immature stages/ 30 leaflets/ replicates).

The weather factors (Table 4) participated in the regulation of the population abundance (R^2) of *T. absoluta* by (51; 44 and 75; 53 %; respectively for mines and larvae in Vera and 010).

Table 4. Regression analysis between meteorological data and the mean numbers of mines and immature stages of *T. absoluta* on Tomato hybrids during (2016/ 2017 and 2017/ 2018 seasons).

Season	Cultivar	Mines and larvae	Regression analysis, Meteorological data: DMax.T (C°)	DMin.T (C°)	DRH (%)	R^2 x 100 (%)
2016/ 2017	Vera	M	-0.831*	-0.835*	0.851*	80.0
		L	-0.376	-0.323	0.340	28.0
	010	M	-0.617*	-0.607*	0.767*	74.0
		L	-0.213	-0.131	0.238	31.0
2017/2018	Vera	M	0.447*	0.131	-0.621*	51.0
		L	-0.052	-0.122	-0.216	44.0
	010	M	0.232	-0.025	-0.540*	75.0
		L	-0.033	-0.212	-0.265	53.0

Significant at 5 % level of probability; R = Multi Regression coefficient; R^2 = Coefficient of determination.

The regression analysis R^2 showed that Vera cultivar has significant correlation with the mean numbers of *T. absoluta* (r= 0.447 and - 0.621; respectively with maximum temperature and relative humidity). Concerning to 010, the relative humidity showed negative and significant correlation with the mean numbers of mines of *T. absoluta* (r= -0.540). These results are in the same line with (Saad *et al.,* 2019) who found that the max. and min. temperatures showed negative correlation with mine's means of tomato leaf miners, *Liriomyza trifolii* (Burgess) in Egypt (r= -0.753 and -0.569). These results could be occurred due to the effect of both max. and min. temperatures which affect the aquatic content of leaves and directly affect the infestation by leaf miners according to the findings of Variya and Buht (2014) whom stated that the mean numbers of mines, larvae, and damage degrees had significant negative correlation with the maximum and minimum temperatures (-0.681, 0.715, and 0.713; respectively).

Influence of insecticides on mines of *T. absoluta* (2016/17 and 2017/ 18):

There were significant differences in the mean numbers of *T. absoluta* larvae with obvious reduction percentages (Table 5 and 6) in the numbers of immature stages in the selected tomato hybrids per 30 plants/ treat during the seasons of the study.

The first season (2016/ 2017):

Vera hybrid showed that the highest mean numbers of larvae (Table 5 under using (S_2) after 10 days of post-treatment (103 ± 18.40 larvae/ 30 plants) and the lowest means were occurred in the 7th day of post-treatment by proclaim (S_0) with mean numbers of larvae (10.40 ± 2.22 larvae/ 30 plants).

Table 5. Mean numbers of *T. absoluta* larvae per 30 plants/ treated of standard proclaim product and two nano-sized formulations on Tomato hybrids during (2016/ 2017 and 2017/ 2018 seasons).

Season	Cv.	Treatment	Before Treatment	Days in post-treatments		
				5	7	10
			Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
2016/ 2017	Vera	S_0	29.00 ± 1.36 a	22.14 ± 3.86 b	10.40 ± 2.22 c	39.00 ± 6.66 b
		S_1	44.40 ± 18.13 a	37.40 ± 5.72 b	24.00 ± 1.46 bc	52.64 ± 15.11 b
		S_2	61.40 ± 1.15 a	48.00 ± 1.07 ab	17.40 ± 0.54 c	103 ± 18.40 a
		Control	51.64 ± 13.84 a	93.40 ± 35.11 a	61.64 ± 12.18 a	105.14 ± 14.51 a
	010	S_0	59.00 ± 21.12 ab	29.40 ± 2.22 b	28.00 ± 3.00 b	61.64 ± 7.15 bc
		S_1	103.40 ± 18.40 a	65.64 ± 2.84 b	33.00 ± 1.76 b	69.14 ± 14.21 b
		S_2	52.64 ± 15.11 b	22.40 ± 1.78 b	28.14 ± 3.11 b	33.00 ± 3.13 c
		Control	105.14 ± 14.50 a	121.00 ± 33.03 a	118.14 ± 7.22 a	128.40 ± 20.38 a
2017/ 2018	Vera	S_0	29.14 ± 1.64 d	24.00 ± 1.57 b	22.64 ± 2.05 c	51.40 ± 3.01 b
		S_1	50.64 ± 1.44 a	29.40 ± 0.54 b	21.64 ± 2.05 c	53.40 ± 3.01 b
		S_2	37.40 ± 3.20 c	22.14 ± 0.74 b	17.00 ± 0.61 c	78.64 ± 1.27 ab
		Control	40.14 ± 1.38 bc	55.14 ± 4.12 a	60.40 ± 2.14 a	105.14 ± 17.40 a
	010	S_0	51.40 ± 3.21 b	40.00 ± 0.81 b	41.40 ± 0.54 bc	96.00 ± 3.02 c
		S_1	48.14 ± 6.11 b	29.64 ± 0.81 b	36.50 ± 0.54 bc	86.00 ± 3.02 c
		S_2	78.64 ± 1.27 ab	37.14 ± 1.20 b	51.00 ± 1.76 b	105.00 ± 6.34 c
		Control	105.14 ± 17.41 a	116.14 ± 23.57 a	118.00 ± 9.27 a	240.00 ± 7.27 a

Means followed by the same litters are not significantly different at 0.05 level of probability; S= size; Av.= average; S_0=0.3 mm; S_1=17.43±8.20 nm; S_2=9.75±3.86 nm.

The reduction percentages of larvae stage (Table 6) on Vera hybrid was occurred by S_2>S_1>S_0; respectively during the 1st and 2nd spray. The highest total of reduction during the 5th, 7th, and 10th days of post-treatments were recorded by S_2 in the 1st spray (average= 53.47%). This reduction results could be obtained due to the small size of S_2 which could makes insecticides more soluble and penetrative. Our results in agreement with Saad *et al.*, (2019) whom found high significant percentages of mines reduction for tomato leaf miners, *L. trifolii* by nano-thiamethoxam than original product size in tomato variety (765).

Table 6. The reduction percentages of immature stages of *T. absoluta* in days after regular treatments with Emamectin benzoate (Proclaim) and two of its nanosized on Tomato hybrids during (2016/ 2017 and 2017/ 2018 seasons).

Season	Spray No.	S	Reduction (%) in days of post-treatment for (Vera)				Reduction (%) in days of post-treatment for (010)			
			5	7	10	Av.	5	7	10	Av.
2016/ 2017	1st spray	S_0	55.09	74.37	15.18	48.21	23.22	63.18	21.50	35.97
		S_1	52.80	50.70	42.15	48.55	42.16	68.78	41.77	50.90
		S_2	58.20	68.50	33.72	53.47	59.78	51.72	45.60	52.37
	2nd spray	S_0	27.91	25.45	17.82	23.73	56.2	69.62	20.2	48.67
		S_1	40.9	37.83	33.78	37.50	51.66	52.19	60.62	54.82
		S_2	55.21	40.2	39.46	44.96	57.66	71.19	61.62	63.49
2017/ 2018	1st spray	S_0	38.11	45.63	30.11	37.95	27.82	25.36	17.72	23.63
		S_1	54.10	67.51	18.10	46.57	40.81	36.74	32.70	36.75
		S_2	55.55	68.14	58.51	60.73	55.12	39.30	40.37	44.93
	2nd spray	S_0	43.9	25.24	32.38	33.84	23.33	65.29	22.61	37.08
		S_1	54.9	53.8	43.16	50.62	57.37	57.28	15.6	43.42
		S_2	57.1	76.48	17.19	50.26	62.89	52.83	48.7	54.81

S= size; Av.= average; S_0=0.3 mm; S_1=17.43±8.20 nm; S_2=9.75±3.86 nm.

Respect to 010 hybrid, the highest means of larvae reduction (Table 6) were registered by S_1 in the 10th day of post-treatment (69.14 ± 14.21 larvae/ 30 plants) and lowest means occurred by (S_2) in the 5th day of post-treatment (22.40 ± 1.78 larvae/ 30 plants). The reduction of 1st and 2nd spray occurred in the following sequences S_2> S_1> S_0 from highest to lower percentage of reduction. The highest total reduction on 010 registered in 2nd spray (average= 63.49%). These results are similar to Saad *et al.*, (2019) in Egypt who found high reduction percentages of mines for tomato leaf miners on tomato variety (765) by nano-formulation of thiamethoxam in original and half-recommended dose of producing company.

The second season (2017/ 2018):

The highest means of larvae on Vera (Table 5) was recorded after 10th days of post-treatment (78.64 ± 1.27 larvae/ 30 plants) and lowest means recorded in the 7th day of post-treatment (17.00 ± 0.61 larvae/ 30 plants) by S_2. The highest total reduction percentage of larvae stage on Vera (Table 5) was registered in 1st spray by S_2 (average= 60.73 %).

In this regard, 010 hybrid showed highest means of larvae (Table 6) in the 10th day of post-treatment resulted from S_2 (105.00 ± 6.34 larvae/ 30 plants), while lowest means were recorded during the 5th day of post-treatment by S_1 (29.64 ± 0.81 larvae/ 30 plants).

CONCLUSION

Tuta absoluta is the most dangerous abundant insect pest among the surveyed arthropods which significantly infest tomato hybrids. The infestation starts in the beginning of the seasons and reached to their maximum approximately in middle of January for the 1st season; and middle of March for the 2nd season. The attack was low in the beginning of Nov. and Dec.; respectively for the 1st and 2nd season. Daily maximum temperature and daily relative humidity significantly impact the numbers of mines on hybrids in the 1st and 2nd season. The smallest nano-insecticides formulation (S_2= 9.75±3.86 nm) is recommended than (S_0 and S_1) for pest reduction (%) in 10th days of post-treatment for tomato hybrids.

Nano-insecticides are recommended for pest control with carefully use because it needs further investigation for nano side effects on the environment and pesticides users.

ACKNOWLEDGEMENT

Authors appreciating the financial support of The Faculty of Agriculture, Assiut University, Assiut, Egypt [Fundamental account for Scientific Researchers], and the internal discount of the Laboratory of Physics, Department of Physics, Faculty of Science, Assiut University, Assiut, Egypt to researchers from the same university (Assiut university), for determination of X-ray and nano-size of nano-insecticides samples.

REFERENCES

Ata, T. E., and Megahed, M. M. M., (2014). Population density of Tomato Leafminer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) under protected cultivation in Egypt. Middle East Journal of Agriculture Research, 3(4): 1242-1247, 2014 ISSN 2077-4605.

Bayindir, A., Ozger, S., Karaca, I., Birgucu, A. K., and Hassan, E., (2015). Effects of some plant extracts on *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae) under laboratory conditions. Advances in Food Sciences; 37:132-137.

Bueno, V. H. P., Van Lenteren, J. C., Lins, J. J. C., Calixto, A. M., Montes, F. C., Silva, D. B., Santiago, L. D. and Perez, L. M., (2013). New records of *Tuta absoluta* (Meyrick (Lepidoptera:Gelechiidae) predation by Brazilian hemipteran predatory bugs. Journal of Applied Entomology, 137: 29-34.

FAO, (2016). Food and Agriculture Organization of the United Nations. http://www.fao.org/ faostat/en/ #home

Henderson, C.F., and Tilton, E.W., (1955). Test with acaricides against the brown wheat mite. J. Econ . Entomol., 48 : 157-161.

Karny, A., Assaf, Z., Ashima, K., Janna, S., Avi, S., (2018). Therapeutic nanoparticles penetrate leaves and deliver nutrients to agricultural crops. Scientific Reports, (2018) 8:7589, pp. 1. DOI: 10.1038/s41598-018-25197-y.

Lietti, M. M. M., Botto, E., and Alzogaray, R. A., (2005). Insecticide resistance in Argentine populations of *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). Neotropical Entomology, 34: 113-119.

Ministry of Agriculture and Land Reclamation. (2013). Evaluation Protocols of the Efficiency of Agricultural Insecticides. Arab Republic of Egypt Pp. 55, ISSN. 978-977-302- 358- 4.

Retta, A. N., and Berhe, D. H., (2015). Tomato leafminer *Tuta absoluta* (Meyrick), a devastating pest of tomatoes in the highlands of Northern Ethiopia: A call for attention and action. Research Journal of Agricultre and Enviromental Management. 4:264-269.

Saad, M.A.A., Ahmed, M.M.A., Gamal, A. M. A., Hosam, A. E. E., Hend, A. M., Ali A. M., (2019). Seasonal incidence and efficacy of nano-thiamethoxam on tomato leaf miner, *Liriomyza trifolii* (Burgess) (Diptera: Agromizidae). Journal of Phytopathology and Pest management, 6 (1) 1-10, 2019.

Scherrer, P, (1918). Estimation of the size and internal structure of colloidal particles by means of roentgen. Nachr. Ges. Wiss Gottingen Math. Phys. Kl. 2, 96–100.

Statistix 8.1., (2005). User's Manual. Analytical Software, Tallahassee.

Variya, M.V., and Buht, J.B., 2014. Effect of weather parameters on incidence of leaf miner *Liriomyza trifolii* (Burgess) on Tomato. International Journal of Plant Protection 7 (1): 196-2

تأثير بنزوات الايمكتين والمستحضرات النانونية لها مع بعض العوامل الجوية علي تذبذب تعداد التوتا ابسلوتا (حرشفية الأجنحة: Gelechiidae)

أحمد محمود محمد[1] ، علي عبد الحميد عثمان[2] و خابير سولوريو سانشيز [3]

[1]قسم وقاية النبات، كلية الزراعة، جامعة أسيوط، مصر

[2]قسم الفيزياء، كلية العلوم، جامعة أسيوط، مصر

[3]قسم تغذية الحيوان، كلية الطب البيطري، جامعة يوكاتان، ميريدا، المكسيك

أجريت التجربة خلال موسمي (2017/2016 و 2018/2017) في كلية الزراعة، جامعة أسيوط، أسيوط، مصر لحصر مفصليات الأرجل في محصول الطماطم، وتحديد نسب الخفض في اعداد *Tuta absoluta* (Meyrick، 1917) بواسطة Proclaim® 5 ٪ (S0 = 0.3 مم) وحجمين نانوميتر مختلفين له (S1 = 17.43 ± 8.20 نانومتر و S2 = 9.75 ± 3.86 نانومتر) واستخدمت جميعا بالجرعة الموصى بها (120 جم / فدان). تم تطبيق الرش الخاص بالاحجام S0 و S1 و S2 بعد 5 و7 و10 ايام على هجينين من الطماطم (Vera و 010) مع الاخذ في الاعتبار تأثير بعض العوامل المناخية: [درجة الحرارة اليومية القصوى (DMax.T)، درجة الحرارة اليومية الدنيا (DMin.T) ، والرطوبة النسبية اليومية (DRH ٪)].أوضحت دراسة الحصر الي وجود تسعة أنواع من الحشرات من تسعة أجناس مختلفة تابعة الي سته عائلات تندرج تحت أربعة رتب،بالاضافة الي ثلاثة أجناس من الحلم تتبع ثلاثة أنواع في نفس الرتبة. الأعداء الحيوية التي تم حصرها هي ثلاثة أنواع من المفترسة وطفيل واحد من ثلاثة رتب وثلاث عائلات. كانت اعداد الافه في بداية الموسمين في تذبذبات منخفضة على صنفي الطماطم ثم بعد ذلك زادت بشكل طفيف وانخفضت في نهاية كل من الموسمين. وسجلت الافةأعلى متوسطات عددية(131.5 و 253.25 أنفاق واطوار غير كاملة/ 10 أوراق/ مكررة في 18 يناير 2017 و 14 مارس 2018 ؛ على التوالي في الموسم الأول والثاني) بينما كانت الأقل (26.03 و 34.25 أنفاق وأطوار غير كاملة/ 10 أوراق/ مكررة في 3 من نوفمبر 2016 و 4 ديسمبر 2017 ؛ على التوالي في الموسم الأول والثاني). أظهرت بيانات الأرصاد الجوية ، في الموسم الأول، تأثيرات معنوية على متوسطات أعداد الأنفاق ولم يكن لها أي تأثيرات معنوية على اليرقات على الصنفين. في الموسم الثاني ، تأثرت متوسطات أعداد الأنفاق بواسطة درجات الحرارة العظمي اليومية (0.447) والرطوبة النسبيةاليومية (-0.621) لصنف Vera ، وكذلك الرطوبة النسبية اليومية (-0.540) لصنف 010 مع عدم وجود تأثيرات معنوية بين العوامل المناخية واليرقات على الصنفين. وقد سجل انخفاض كبير في نسبة اليرقات في الموسم الأول، بواسطة S2 بعد عشرة ايام من المعاملة (103 ± 18.40 و 69.14 ± 14.21 ؛ على التوالي بالنسبة لـ Vera و 010) ، وقد سجلت اقل نسب خفض بواسطة S0 بالنسبة لصنف Vera (10.40 ± 2.22) بعد الأيام السابعة من المعاملة؛ و (22.40 ± 1.78) لصنف 010 في الأيام الخامسة بعد المعاملة. في الموسم الثاني ، كان أعلى نسب خفض بواسطة S2 (78.64 ± 1.27) و (105.00 ± 6.34)؛ على التوالي بالنسبة لـ Vera و 010 في الأيام العشرة بعد المعاملة؛ وكان أقل مستوى خفض للافه بواسطة S2 علي صنف Vera بعد 7 أيام من المعاملات (17.00 ± 0.61) ؛ و S1 علي صنف 010 بعد 5 أيام من المعاملة (29.64 ± 0.81).