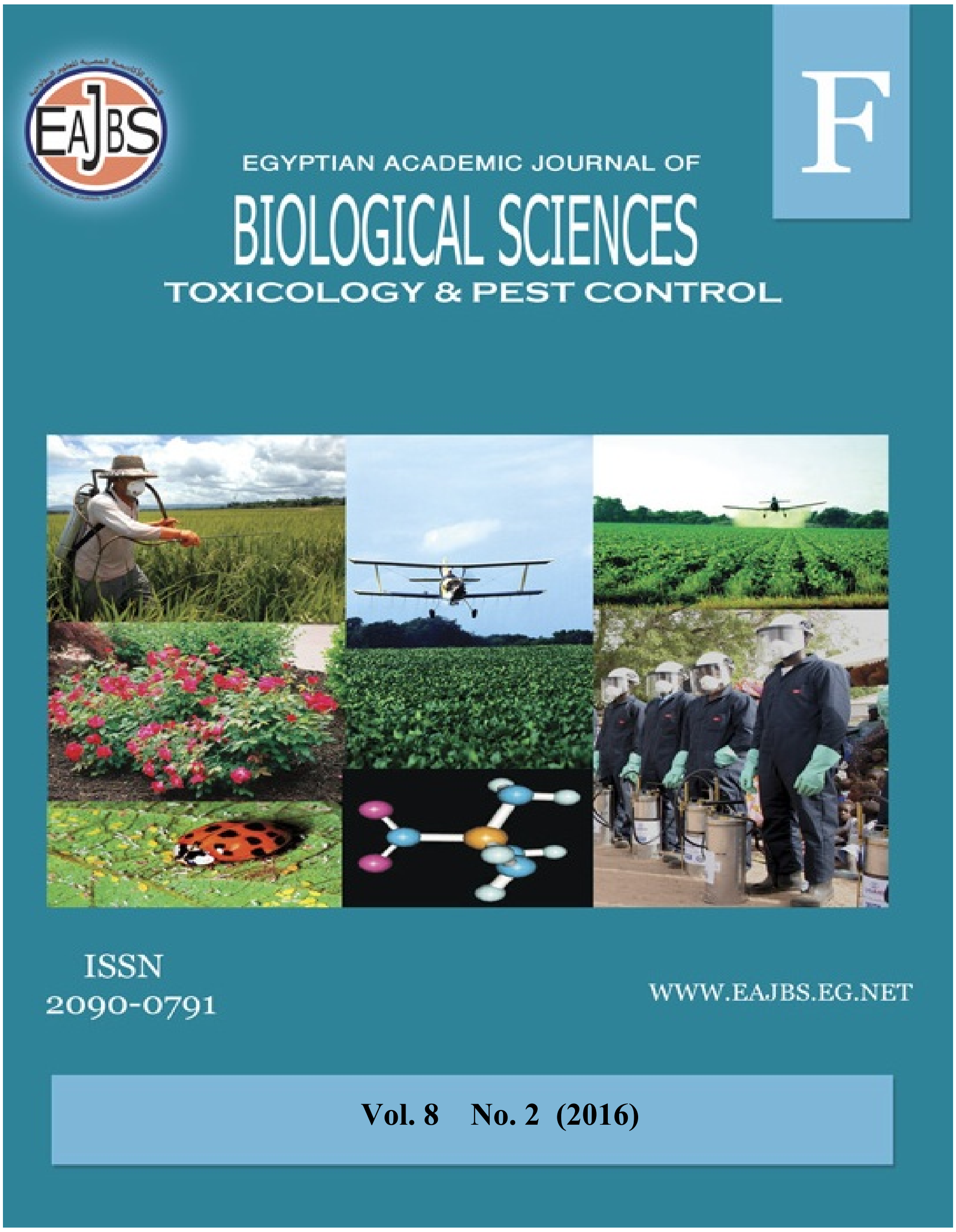

The journal of Toxicology and pest control is one of the series issued twice by the Egyptian Academic Journal of Biological Sciences, and is devoted to publication of original papers related to the interaction between insects and their environment.

The goal of the journal is to advance the scientific understanding of mechanisms of toxicity. Emphasis will be placed on toxic effects observed at relevant exposures, which have direct impact on safety evaluation and risk assessment. The journal therefore welcomes papers on biology ranging from molecular and cell biology, biochemistry and physiology to ecology and environment, also systematics, microbiology, toxicology, hydrobiology, radiobiology and biotechnology.

www.eajbs.eg.net

Citation : *Egypt. Acad. J. Biolog. Sci. (F. Toxicology & Pest control) Vol.8(2)pp.51-61(2016)*

Egypt. Acad. J. Biolog. Sci., 8(2): 51 - 61 (2016)

Egyptian Academic Journal of Biological Sciences
F. Toxicology & Pest control
ISSN: 2090 - 0791
www.eajbs.eg.net

Evaluation Effectiveness of Some Insecticides in Controlling Tomato Leafminer, *Tuta. absoluta* in the Lab.

W. Z. Mikhail[1]; H. Sobhy[1]; S. A. Gaffar[2]; H. I. H. Omar[3] and A.T. Elmasry[3]

1 - Dept. of Natural Resources Inst. of African research & Studies Cairo University
2- Central Laboratory of Organic Agriculture, ARC, Giza, Egypt.
3- Plant Protection Researches Institute, Agricultural Research Center.

ARTICLE INFO

Article History
Received: 6/7/2016
Accepted:10/8/2016

Key words:
Chemical insecticides
Bio-insecticides
Leafminer
T. absoluta larvae
Tomato plant.

ABSTRACT

Four bio-insecticides and one chemical insecticides were evaluated for their effectiveness in the control of *Tuta absoluta* (Meyrick), (Lepidoptera: Gelechiidae) on tomato plant. The effect of insecticides against larvae was estimated after 1, 3, 5, 7 and 14 days from application. The bio-chemical insecticides were Spinosad (Tracer 25%), *Bacillus thurngiensis* (Diple-2x 6.4%), Azadirachtiin (Neemix 4.5%) and Mineral oil (Petroleum derivative). The one chemical insecticide was Chlorantraniliprole (Coragen 20%). The bio-insecticides Mineral oil was more effective in the control of *T. absoluta* infesting tomato leaves, followed by Spinosad 25%, then Azadirachtiin 4.5% and least by *Bacillus thurngiensis* 6.4% after 14 days. But the chemical insecticides Chlorantraniliprole 20% was the most effective in reducing infestation of *T. absoluta* four bio-insecticides, these effects were concentration dependent of the tested bio-insecticides. The different efficacies of the considered bio- or chemical insecticides are discussed with regard to their mode of action. From results indicated Chlorantraniliprole was highest percentage of mortality after 24, 48 and 72 hours in 2nd and 4th instar. But Mineral oil showed lowest percentage of mortality after 24, 48 and 72 hours. Also, current study indicated some larvae were in mine, leaf surface and missing, the larvae number in mine was more from leaf surface and missing after used all insecticides under study.

INTRODUCTION

Tomato crops are normally attacked by a great variety of insects including the tomato leafminer, *Tuta absoluta* (Meyrick), considered the most important tomato pest (Medeiros *et al*., 2005). Both yield and fruit quality can be significantly reduced by the direct feeding of *T. absoluta* and secondary pathogens that may enter through the wounds made by the insect. Different strategies might be applied in an Integrated Pest Management (IPM) program to control *T. absoluta* outbreaks including insecticides and biological control and the association of both. Studies have being done on the use of synthetic sex pheromones in order to monitor population levels and trigger applications of chemicals on the right moment (Michereff Filho *et al*., 2000; Gomide *et al*., 2001; Salas, 2004). Chemical control has been the main method of control used against *T. absoluta* and growers normally choose the insecticide in a diversity of options officially registered and recommended (França *et al*., 2000).

The effectiveness of insecticides alone might be sometimes impaired because of the mine-feeding behavior of larvae or deficient spraying technology (Lietti *et al.*, 2005). Usually, several sprayings are required per growing season and it is noted a decrease of the efficacy of products used against *T. absoluta* since the 1980s in tomato crops. Resistance to some active ingredients has been reported in several countries, for example to abamectin, cartap and permethrin in Brazil (Siqueira *et al.*, 2000). This reinforces the importance of using a sound chemical control to the success of the IPM program in tomato where less noxious insecticides are chosen and applied only when necessary avoiding the side effects on the beneficial arthropods and environment. However, it is important to point out that tomato leafminer is not the only pest found injuring tomato plants. Other important pests that also normally attack tomato are the serpentine leafminer, *Liriomyza* spp., and the small tomato borer, *Neoleucinodes elegantalis* (Guenée). *Bacillus thuringiensis*, an entomopathogenic bacterium, has also been used in the control of tomato plant pests (Prada and Gutierrez, 1974; Souza and Reis, 1992; Marques and Alves, 1996). The efficacy of this micro-organism can be altered due to allelochemicals in the host plant. This efficacy can increase (Kea *et al.,* 1978) or decrease (Krischik *et al.,* 1988; Shepard and Dahlman, 1988; Alves and Lecuona, 1998) due to the effect of these allelochemicals in the insect and in the pathogen. The appeal of spinosad, a fermentation product of the soil actinomycete *Saccharopolyspora spinosa* (Mertz and Yao), includes its safety profile and acceptable use in organically produced tomatoes (Racke, 2006; Puinean *et al.,* 2013). Insecticide efficienc is evaluated by toxicity bioassays. The purpose of these bioassays is to select new biological or organo synthetic insecticides and their most appropriate doses that affect insects, as well as to test pest resistance (Siqueira *et al.,* 2000) and the pesticide selectivity to natural enemies (Picanço *et al.,* 2000; Bacci *et al.,* 2009). Chemical control using insecticides can be considered as an effective management option for this pest (Lietti *et al.* 2005; Silvério *et al.* 2009; Lebdi-Grissa *et al.* 2010).

MATERIALS AND METHODS

The experiments were carried out in Etay-El-Baroud Agriculture Research station, Beheira Governorate, durin, 2014

Chemical insecticides

Chlorantraniliprole 20% E.C. a.i (trade name: Coragen) rate of application (60ml/feddan) were obtained from Dow Agro Science Company Cairo Egypt.

Bio-insecticides

(*B.t*) *Bacillus thuringiensis* var. *kurstaki*, 33 × 106 C.F.U/1ml, rate of application (4800 ml/ feddan); Azadirachtin 4.5% E.C. a.i (trade name Neemix) rate of application (75 ml a.i/100ml water; Petroleum derivative (trade name Mineral oil) rate of application (120 ml/ feddan) were obtained from Plant Protection Research Institute, Agriculture Research Center, Cairo, Egypt; Spinosad 24% SC a.i and 25% WG a.i (trade name Tracer) rate of application (35 ml/feddan) was obtained from Dow Agro Science Company Cairo Egypt.

Insect used:

Tuta absoluta was used in this study. The eggs were collected from cotton fields of El-Behera Governorate. The strain was reared, under laboratory conditions of 25°C ±2 and 60 - 70 % relative humidity for mass production, according to Eldefrawi, *et al.* (1964) rearing technique. The 2nd instar larvae were used for the bioassay

Bioassays of treated insecticides:

To determine LC_{50} and LC_{95} of for treated insecticides, serial tested concentrations for each insecticide were prepared in water. Tomato leaves were dipped into each dilution for 10 seconds and left to dry under laboratory conditions. Treated leaves (one leaf per petro dish) 10 leaves for 2nd instar and 4th instar. Under laboratory conditions of 2 $\pm^{\circ}$C and relative humidity of 60 –70 % according to Eldefrawi, *et al.* (1964). Control (untreated treatment) larvae were allowed to feed on tomato leaves treated only with distilled water. Each treatment was replicated at three times. . Mortality coasts were recorded after 1, 3, 5, 7 and 14 days. The LC_{50}^{s}, LC_{95}^{s} and slope values for each toxicant were calculated, according to (Finny, 1971).

Study of biology and behavior of *Tuta absoluta* after application of tested pesticides:

For each treatment, 20 leaflets were selected which each contained a second and forth instar larvae. The leaves were marked with collared. The marked leaves were sprayed and examined after24 hours of application .The larvae were classified as: Alive and Dead in mine, on surface of leaf and Missing from leaf.

Statistical analysis:

The data was subjected to analysis of variance (ANOVA) and the means were compared by L.S.D. test at 0.05 levels, using SAS program (SAS Institute, 1988).

RESULTS AND DISCUSSIONS

Bioassay study in lab.

Lab study included susceptibility of insecticides against 2nd and 4th in star *Tuta absoluta* larvae after (1, 3, 5, 7, 10 and 14 days) after application bio- and chemical insecticides under study. The results of the toxicity of the insecticides expressed in terms of LC_{50} and LC_{95}.

Spinosad

Effect of Spinosad against 2nd and 4th instar larvae of *Tuta absoluta* (Lab. strain) are shown in Table (1). LC_{50} (Lethal concentration) values after (1, 3, 5, 7, 10 and 14 days) after treatments were 55.07, 99.7, 156, 276.45, 231 and 300.3, respectively, against 2nd instar. But for 4th strain, LC_{50} values were 99.9, 164.6, 199.7, 200, 270 and 844.9 ppm, respectively.

Table 1: Effect of Spinosad against larvae of 2nd and 4nd instar for *Tuta absoluta* in the lab during 2014.

Toxicity of spinosad of *Tuta absoluta*								
Age of instar	**Days**	**LC_{50} (ppm)**	**Confidence Limits**		**LC_{95} (ppm)**	**Confidence Limits**		**Slope**
			Lower	**Upper**		**Lower**	**Upper**	
2nd instar larvae	**1**	300.3	291.1	320	657.7	642.7	677.2	4.8±0.0
	3	276.45	266.2	287.3	443.99	433	463.3	5.8±0.0
	5	231.0	222.11	249.2	271.8	260	382	6.8±0.6
	7	156.00	139.1	176.8	268.93	222.66	352.46	2.3±0.0
	10	99.70	87.18	110.8	260.9	249.8	271	3.9±0.0
	14	55.07	43.38	65.29	236.35	213.7	236.2	15.2±0.0
4th instar Larvae	**1**	844.9	540.9	2606.6)	797.9	569.6	1342.6	1.82±0.2
	3	270.00	248.7	301.7	747.7	592.9	1060	3.7±0.3
	5	200.00	151.9	267.8	440.6	387.5	523.8	4.6±0.4
	7	199.7	183.6	206.9	440.0	1714	50428	2.2±0.5
	10	164.6	153.6	175.9	418.13	366.7	496.7	4.1±0.3
	14	99.9	83.2	115.4	416.2	463.00	1038.6	5.1±0.4

Bacillus thuringiensis* var. *kurstaki

Table (2) summarized the LC_{50} values of *B. t.* against 2nd and 4th instar lab strain of *Tuta absoluta* larvae. The LC_{50} values after (1, 3, 5, 7,10and 14 days) after treatments were 421.8, 343.6, 500.0, 1403.8, 2869.6 and 5706.6, respectively. While LC_{50} values were 1132.3, 745.8, 1522, 3097.5, 7714.4 and 32176ppm, respectively, against 4th instar larvae *Tuta absoluta* (Lab. strain).

Table 2: Effect of *Bacillus thurngiensis* against larvae of 2nd and 4nd instar for *Tuta absoluta* in the lab, during 2014

Toxicity of (*B.T*) of *Tuta absoluta*								
Age of instar	Days	LC_{50} (ppm)	Confidence Limits		LC_{95} (ppm)	Confidence Limits		Slope
			Lower	Upper		Lower	Upper	
2nd instar larvae	1	5706.6	5093.3	38841.9	36293	39110	34934	2.9±0.0
	3	2869.6	2345.6	3744.4	22891.6	13921	47588	1.82±0.0
	5	1403.8	902.9	2697.3	9041.6	8531	45116	2.03±0.0
	7	500.0	402.9	620.56	9978.2	5594	24359	.26±0.14
	10	421.8	360.4	490.4	3194.4	2340	4878.0	1.87±0.0
	14	343.6	206.0	281.8	1405.1	1103	1945.01	2.16±0.0
4th instar Larvae	1	7714.4	5004.3	1620.3	1010.0	3794.4	5874.6	1.4±0.2
	3	3217.6	1355.8	7192.4	8462.4	1036.2	3297.1	0.6±0.2
	5	3097.5	2329.3	1176.2	41228.7	4612.8	1501.70	1.4±0.2
	7	1522.1	1280.1	1861.0	1602.8	1035.5	2930.1	1.6±0.1
	10	1132.3	705.34	2026.6	6606.5	5981	26173	2.14±0.1
	14	745.8	412.5	137.2	740.5	6701	410.10	1.65±0.1

Azadirachtin

Effect of Azadirachtin against 2nd and 4th instar larvae of *Tuta absoluta* (Lab. strain) are shown in Table (3). LC_{50} values after (1, 3, 5, 7,10and 14 days) after treatments were 263.07, 109.83, 43.85, 40.54, 45.9 and 123.07, respectively, against 2nd instar larvae *Tuta absoluta* (Lab. strain). But for 4th strain, LC_{50} values were 856.7, 496.7, 293,188.6, 116.4 and 406.7 ppm, respectively.

Table 3: Effect of Azadirachtin against larvae of 2nd and 4nd instar for *Tuta absoluta* in the lab, during, 2014.

Toxicity of (Neemix4.5%) of *Tuta absoluta*								
Age of instar	Days	LC_{50} (ppm)	Confidence Limits		LC_{95} (ppm)	Confidence Limits		Slope
			Lower	Upper		Lower	Upper	
2nd instar larvae	1	263.07	210.29	328.6	9580.05	15029	42756	0.8±0.0
	3	123.07	93.43	154	7970.2	4286	20226	0.8±0.0
	5	109.83	17.36	173.07	4680.18	4360.	4825	0.8±0.0
	7	45.9	33.55	57.32	2970.5	1855.	5901	1.19±0.0
	10	43.85	13.58	76.16	1501.27	3892.	38809	0.6±0.14
	14	40.54	29.30	61.33	300.99	235.0	431.00	2.01±0.0
4th instar Larvae	1	856.7	693.8	1124.9	19575.8	18674	1461500	1.5±0.2
	3	496.7	296.9	1410.0	17446	14879	1461500	1±0.1
	5	406.7	233.0	926.0	10463.6	5973	156320	0.9±0.1
	7	293.0	143.00	654.0	9695.7	4659	31083	0.9±0.1
	10	188.6	141.80	242.0	6405.0	5868	43768	1.3±0.1
	14	116.4	233	926	6405	5868	98101	1.4±0.1

Mineral oil

Effect of Mineral oil against 2nd and 4th instar larvae of *Tuta absoluta* (Lab. strain) are shown in Table (4). LC_{50} values after (1, 3, 5, 7,10and 14 days) after treatments were 765.34, 473.5, 263.07, 109.83, 43.85 and 42.92, respectively, against 2nd instar larvae *Tuta absoluta* (Lab. strain). But for 4th strain, LC_{50} values were 2004, 1392.5, 856.6, 653.4, 301.9 and 231.9 ppm, respectively.

Table 4: Effect of Mineral oil against larvae of 2nd and 4nd instar for *Tuta absoluta* in the lab, during 2014

Toxicity of (Mineral oil) of *Tuta absoluta*								
Age of instar	Days	LC_{50} (ppm)	Confidence Limits		LC_{95} (ppm)	Confidence Limits		Slope
			Lower	Upper		Lower	Upper	
2nd instar larvae	1	765.34	536.34	1310.46	94611.31	24731	108355	0.7±0.0
	3	473.5	380.7	613.49	15010.3	3892	38809	1.15±0.0
	5	263.07	210.29	328.63	12423.8	6361	33982	1.11±0.11
	7	109.83	17.36	173	9580	15029	427566	0.8±0.0
	10	43.85	13.58	76.16	7970.2	4286	20226	0.6±0.0
	14	42.92	21.12	65.13	2393.7	1209	8375	0.9±0.0
4th instar Larvae	1	2004	1395	3548	61203.1	16312	73716	1.4±0.2
	3	1392.5	1060	2063	35390	13283	177711	1. 5±0. 2
	5	856.6	693	1124	31194.7	12865	13740	1.5±0.2
	7	653.4	491	963	27647	59289	129920	1.5±0.2
	10	301.9	215	434	16696.2	8394	48983	0.7±0.1
	14	231.9	71.4	594.7	10463.5	5973	23776	0.8±0.1

Chlorantraniliprole

Table (5) and summarized the LC_{50} values of Coragen 20% against 2nd and 4th instar lab strain of *Tuta absoluta* larvae. The LC_{50} values after (1, 3, 5, 7,10and 14 days) after treatments were 45.04, 29.6, 63.1, 76.45, 143.49 and 281.48, respectively. While LC_{50} values were 96.2, 76.8, 148.6, 194.5, 422.7, 3848 ppm, respectively, against 4th instar larvae *Tuta absoluta* (Lab. strain).

Table 5: Effect of Chlorantraniliprole against larvae of 2nd and 4nd instar for *Tuta absoluta* in the lab, during 2014

Toxicity of (Coragen 20%) of Tuta absoluta								
Age of instar	Days	LC_{50} (ppm)	Confidence Limits		LC_{95} (ppm)	Confidence Limits		Slope
			Lower	Upper		Lower	Upper	
2nd instar larvae	1	281.48	270	299.2	1141.65	709	2386	1.82±0.0
	3	143.49	123	175.5	1033.94	1003	1051	2.9±0.0
	5	76.45	53.1	107.66	559.75	444	1963	1.9±0.0
	7	63.1	34.75	95.43	532.45	539	353	1.77±0.17
	10	45.04	35.1	66.12	344.37	233	637	1.54±0.0
	14	29.6	21.99	36.56	193.3	181	203	2.6±0.0
4th instar larvae	1	422.7	312	612.5	2340.8	2012	3422	2.2±0.5
	3	384.8	292.1	455.1	1356.6	1231.0	1532.1	1.1±0.4
	5	194.5	181.4	473.9	677.5	819	9942	3.1±0.4
	7	148.6	121.6	313.8	613.8	895.9	7083	2.7±0.3
	10	96.2	99.6	104.2	597	619.9	4133.6	1.8±0.2
	14	76.8	46.4	122.5	292.9	248	365	3.4±0.2

Effect of different concentrations from bio- and chemical insecticides under study against larvae of 2nd and 4nd instar for *Tuta absoluta* in the lab after one, two and three days.

Table (6) summarized percentage of mortality values of Spinosad, Coragen, *B.t.*, Neem and Mineral oil against 2nd and 4th instar lab strain of *Tuta absoluta* after 24, 48 and 72 hours. From results indicated Coragen gave higher percentage of mortality after 24, 48 and 72 hours in 2nd and 4th instar. But mineral oil showed lowest percentage of mortality after 24, 48 and 72 hours against 2nd and 4th instar.

Table 6: Effect of different compounds against tomato leafminer *Tuta absoluta* (larvae) recorded as in mine infesting tomato plants under laboratory conditions, during 2014

Compounds	a.i. /100 liters	Mortality (%) of *T. absoluta* larvae after treatment					
		Second instar larvae			Fourth instar Larvae		
		24h	48h	72h	24h	48h	72h
B.T	**50g**	44.87%	54.50%	71.00%	54.67%	61.77%	76.10%
	100g	65.23%	81.00%	84.77%	60.00%	74.44%	91.44%
	150g	74.98%	93.76%	100.00%	66.11%	96.12%	100.00%
Neem	**25ml**	41.32%	50.45%	76.99%	51.55%	65.00%	74.55%
	50ml	49.12%	63.00%	60.00%	60.00%	70.00%	81.50%
	75ml	64.43%	84.96%	95.00%	76.44%	84.98%	100.000%
Spinosad	**30ml**	31.23%	40.00%	54.55%	40.00%	51.54%	65.00%
	50ml	46.10%	66.02%	75.00%	56.01%	70.00%	82.06%
	100ml	59.13%	85.00%	100.0%	65.00%	92.93%	100.00%
Mineral oil	**100ml**	8.25 %	13.83%	14.00%	11.89%	48.50%	23.44%
	150ml	14.45%	21.45%	25.00%	25.00%	25.00%	25.00%
	200ml	25.67%	35.00%	36.00%	31.55%	43.00%	43.33%
Coragen 20%	**10ml**	55.98%	65.00%	86.80%	65.33%	75.50%	100.00%
	20ml	72.08%	82.77%	100.0%	80.00%	84.00%	100.00%
	40ml	100.00%	100.00%	100. %	100.00%	100.00%	100.00%
Control	**0**	0%	0%	4%	0%	0%	4%

Behavior of *Tuta absoluta* larvae after application of bio-and chemical insecticides under study in the field and lab.

The results in Table (7) showed the effect of insecticides after 24 hours application on behavior of 2nd and 4th instar of *tuta absoluta* larvae. The treatments were Spinosad, Coragen, *B.T*., Neem and Mineral oil. The results indicated some larvae were in mine, some of them in leaf surface and some was missing. The results indicated also that, concerning of the mine, the number larvae in mine were more the in leaf surface and missing of all treatments.

Table 7: Study the behavior of *Tuta absoluta* (20 larvae) recorded as in mine, on leaf surface and missing after one day from application of insecticides, during 2014

Treatment	Behavior *Tuta absoluta* larvae after applied insecticides					
	Second instar larvae			Fourth instar Larvae		
	in mine	on leaf surface	missing	in mine	on leaf surface	missing
Neemix	14	4	2	11	6	3
Spinosad	13	3	4	10	5	5
BT	14	2	4	12	4	4
Mineral oil	19	1	-	15	3	2
Coragen	11	6	3	9	7	4
Control	18	2	0	18	2	0

Tuta absoluta produces as many eggs as possible when host plants are available (Desneux et *al*., 2010; Pereya and Sanchez, 2006); its opportunistic nature makes it particularly damaging in the critical phases of the crop, especially when tomato plants are young. Chermiti *et al*. (2009) mentioned also that, at this stage, most eggs are laid on fruit rather than leaves, which become less attractive. Organophosphates and pyrethroids were used in control *T. absoluta* during the 1970's and 1980's until new products introduced in the 1990's (such as abamectin, spinosad, tebufonzide, and chlorfenpyr) became available (Lietti *et al.,* 2005). Also, abamectin, cartap, chlorfenapyr, phenthoate, methamidophos, spinosad, and indoxacarb, were recommended for controlling *T. absoluta* and use in the south, southeastern, and savannah tomato-growing regions, while chlorfenapyr, phenthoate, and spinosad were recommended for use in the northeastern region (IRAC, 2007). Spinosad has been mentioned previously and is a popular bio-insecticide used against *T. absoluta* and other tomato pests (Terzidis, 2011). It is a mixture of two active components, Spinosyn A and Spinosyn B, produced by aerobic fermentation of the actinomycete *Saccharopolyspora spinosa* (Salgado *et al.* 1998). Among the alternatives to the use of conventional broad-spectrum pesticides, eco-friendly plant extracts with bioinsecticide properties (Moreno *et al*. 2011; Tomé *et al*. 2013), Spinosad was introduced commercially in 1997 as the product 'Tracer' (Dow Agrosciences LLC) (Salgado *et al.* 1998). The current study agreement with (Mordue *et al*., 1998; Wing *et al*., 2000; Cisneros *et al*., 2002) which presented that spinosad have shown high insecticidal effect on lepidopteran pests and much less effect on natural enemies (Schmutterer 1990; Tillman and Mulrooney 2000; Williams *et al*., 2003; Galvan *et al*., 2005). Also, these results in agreement with (Nannini *et al.,* 2011) who found that spinosad proved to be highly effective against tomato borer larvae *T. absoluta*. These results were in agreement with those of Hafsi *et al*. (2012) showed that Spinosad and Spinetoram based insecticides showed high efficiency in controlling all instars of larvae with respectively an average mortality of 66.5% and 85.6% and Gontijo *et al.* (2012) stated that most populations of *T. absoluta* were susceptible to abamectin, chlorfenapyr and spinosad. Also, results agree with Nannini *et al*., (2011) found that in all tests, Spinosad proved to be highly effective against tomato borer larvae.

Pheromone traps are being used for monitoring and forecasting populations and to catch *T. absoluta* males to disrupt mating (F.E.R.A. 2009). Mating disruption is an environmentally friendly control method, compatible with the integrated methods and novel approaches adopted by modern cropping systems and organic agriculture (Vacas *et al*. 2011). mass trapping using tomato leafminer's sex pheromone (Hassan, Alzaidi 2009), application of a pheromone-based mating disruption technique (Cocco *et al.* 2013), and biological control using *Trichogramma* parasitoids (Cabello *et al.,* 2012; Chailleux *et al.,* 2012) may provide environmentally safe and adequate control of this pest these agree with the current study. Reviewing the previous results it could be concluded that *B. thuringiensis* had potential effect when integrated with Neem that increased the reduction in infestation rates with *T. absoluta* larvae. These results supported by Fredon-Corse (2009) which revealed *B. thuringiensis* var. Kurstaki (BtK) used for larval control, natural solutions of BtK applied to crops once per week at the end of the day and registered for use against *T. absoluta* larvae on tomatoes in the United States by Sixmith (2009). Data of the present study are in accordance with those recorded by Servicio de Sanidad Vegetal -Murcia (2008) which recommended for use Azadirachtin as a preventive spray and for infestation (<30 adult catches per week) of *T. absolutain*.

REFERANCES

Alves, S. B. and Lecuona, R. E. (1998). Epizootiologia aplicada ao controle microbiano de insetos. In: Controle Micro- biano de Inseto. Ed. by S. B. ALVES. Piracicaba: FEALQ, 97-169.

Bacci, L. *et al*., (2009). Physiological selectivity of insecticide to predatory wasps (Hymenoptera: Vespidae) of Diamondback moth. Sociobiology, Chico, 53(1): 151-167.

Cabello T., Gámez M., Varga Z., Garay J., Carreño R., Gallego J.R., Fernández F.J. and Vila E. (2012). Selection of *Trichogramma* spp. (Hym.: Trichogrammatidae) for the biological control of *Tuta absoluta* (Lep.: Gelechiidae) in greenhouses by an entomo-ecological simulation model. *IOBC/WPRS Bull.*, 80: 171–176.

Chailleux A., Desneux N., Seguret J., Khanh H.Do.T., Maignet P. and Tabone E. (2012). Assessing European egg parasitoids as a mean of controlling the invasive South American tomato pinworm *Tuta absoluta*. *PLoS ONE* 7: e48068.

Chermiti B, Abbes K, Aoun M, Ben Othmane S, Ouhibi M, Gamoon W. and Kacem S (2009). First estimate of the damage of *Tuta absoluta* (Povolny) (Lepidoptera: Gelecheiidae) and evaluation of the

Cisneros J, Goulson D, Derwent LC, Penagos DI, Herna´ndez O. and Williams T (2002). Toxic effects of spinosad on predatory insects. Biol Control 23:156–163

Cocco A., Deliperi S., Delrio G. (2013). Control of *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in greenhouse tomato crops using the mating disruption technique. J. Appl. Entomol., 137: 16–28.

Desneux N, Wajnberg E, Wyckhuys KAG, Burgio G, Arpaia S, Narvaez-Vasquez CA, Gonzalez-Cabrera J, Ruescas DC, Tabone E, Frandon J, Pizzol J, Poncet C, Cabello T. and Urbaneja A. (2010). Biological invasion of European tomato crops by *Tuta absoluta*: ecology, geographic expansion and prospects for biological control. Journal of Pest Science 83: 1-19.

Eldefrawi, M. E.; A. Toppozada; N. Mansour; and M. Zeid (1964). Toxicological studies on the Egyptian cotton leafworm, *Prodenia litura*. I. Susceptibility of different larval instars of *Prodenia* to insecticides. J. Econ. Entomol. 57: 591-593.

F.E.R.A. (2009) South American tomato moth *Tuta absoluta*, edited by A. D. E. F. R, London.

Finney, D. J. (1971). Propit analysis, Cambridge Univ. Press, Cambridge.

França, F.H.; Villas Bôas, G.L.; Castelo Branco, M. and Medeiros, M.A. (2000). In: *Manejo integrado de pragas*. SILVA J.B.C.; GIORDANO L.B. Tomate para processamento industrial, Brasília, Embrapa SPI, 112-127.

Fredon-Corse (2009). Mesures de lutte contre Tuta absoluta, Fédération Régionale de Défense contre les Organismes Nuisiblesde Corse, <http://www.fredoncorse.com/standalone/1/CE5Bk98q7hNOOAd4qo4sD67a.pdf.

Galvan TL, Koch RL. And Hutchison WD. (2005). Toxicity of commonly used insecticides in sweet corn and soybean to multicolored Asian lady beetle (Coleoptera: Coccinellidae). J Econ Entomo., 98:780–789

Gomide, E.V.A.; Vilela, E.F. and Picanço, M. (2001). Comparação de procedimentos de amostragem de Tuta absoluta (Meyrick) (Lepidóptera: Gelechiidae) em tomateiro estaqueado. *Neotropical Entomology*, 30: 697-705.

Gontijo PC, Picanço MC, Pereira EJG, Martins JC. and Chediak M, et al. (2012). Spatial and temporal variation in the control failure likelihood of the tomato leaf miner, *Tuta absoluta*. Ann Appl Biol 162: 50–59. doi: 10.1111/aab.12000.

Hafsi, A., K. Abbes, B. Chermiti and B. Nasraoui, (2012). Response of the tomato miner *Tuta absoluta* (Lepidoptera: Gelechiidae) to thirteen insecticides in semi-natural conditions in Tunisia. Bull. OEPP/EPPO., 42(2): 312-316.

Hassan M.N., Alzaidi Sh. (2009). *Tuta absoluta* – a serious pest advancing in the Mediterranean region. Role of pheromones in management strategies. *Int. Pest Manage.*, 51: 85–87.

IRAC (Insecticide Resistance Action Committee) (2007). Tomato leafworm resistance managment practice in Brazil. IRAC (Insecticide Resistance

Action Comittee) News-Resistance Managment News, Conferences, and Symposia (15):3. www.iraconline.org/documents/index 15.pdf

Kea, W. C.; Turnipseed, S. G. and Carner, G. R. (1978). In¯uence of resistant soybeans on the susceptility of lepidopterous pests to insecticides. J. Econ. Entomol., 71: 58-60.

Krischik, V. A.; Barbosa, P. and Reichelderfer, C. F. (1988). Three trophic level interactions: allelochemicals, Mandu- ca sexta (L.), and Bacillus thuringiensis var. kurstaki Berliner. Environ. Entomol., 17: 476-482.

Lebdi-Grissa K., Skander M., Mhafdhi M. and Belhadj R. (2010). Lutte intégrée contre la mineuse de la tomate, *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae) en Tunisie. Entomol. Faun. Faun. Entomol., 63: 125–132.

Lietti M., Botto E. and Alzogaray R.A. (2005). Insecticide resistance in Argentine populations of *Tuta absoluta* (Meyrick) (Le pidoptera: Gelechiidae). *Neotrop. Entomol.* 34: 113–119.

Lietti M., Botto E. and Alzogaray R.A. (2005). Insecticide resistance in Argentine populations of *Tuta absoluta* (Meyrick) (Le pidoptera: Gelechiidae). *Neotrop. Entomol.* 34: 113–119.

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: 113-199.

Marques, I. M. R. and Alves, S. B. (1996). Efeito de Bacillus thuringiensis Berl. var. kurstaki sobre Scrobipalpuloides absoluta Meyer. (Lepidoptera: Gelechiidae). An. Soc. Entomol. Brasil. , 25: 39-45.

Medeiros, M. A.; Villas Boas, G. L.; Carrijo, O. A.; Makishima, N. and Vilela, N. J. (2005). *Manejo integrado da traça-do-tomateiro em ambiente protegido*. Embrapa hortaliças, Circular Técnica n. 36, 10p.

Michereff Filho, M.; Vilela, E.F.; Attygalle, A.B.; Meinwald, J.; Svatos, A.; Jham, G.N. (2000). Field trapping of tomato moth, *Tuta abasoluta* with pheromone traps. *Journal of Chemical Ecology*, 26: 875-881.

Mordue AJ, Simmonds MSJ, Ley SV, Blaney WM, Mordue W, Nasiruddin M, Nisbet A. J. (1998). Actions of azadirachtin, a plant allelochemical, against insects. Pestic Sci., 54:277–284.

Moreno S.C., Carvalho G.A., Picanço M.C., Morais E.G.F., Pereira R.M. (2011). Bioactivity of compounds from *Acmella oleracea* against *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) and selectivity to two non-target species. Pest Manage. Sci., 68: 386–393.

Nannini, M., F. Foddi, G. Murgia, R. Pisci and F. Sanna, (2011). Insecticide efficacy trials for management of the tomato borer Tuta absoluta (Meyrick) (LEPIDOPTERA: GELECHIIDAE), A new Tomato pest in Sardinia (ITALY). Acta Hort. (ISHS) 917: 47-53.

Pereyra PC. and Sa´nchez NE (2006). Effect of two solanaceous plants on developmental and population parameters of the tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). Neotropical Entomology, 35:671–676.

Picanço, M.C.; Gusmão, M.R.; Galvan, T.L. (2000). Manejo integrado de pragas de hortaliças. In: Zambolim, L. (Ed.). Manejo integrado de doenças, pragas e ervas daninhas. Viçosa: UFV, pp.275-324.

Prada, M. A. R.; Gutierrez, J. P. (1974). Contribuicion preliminar al control microbiologico de Scrobipalpula absoluta (Meyrick), con Neoaplectana carpocapsae Weisery Bacillus thuringiensis Berl. en tomate Lycopersicon esculentum. Mill. Acta Agron., 24:116-137.

Puinean AM, Lansdell SJ, Collins T, Bielza P, Millar NS (2013). A nicotinic acetylcholine receptor transmembrane point mutation (G275E) associated with resistance to spinosad in Frankliniella occidentalis. J Neurochem 124: 590–601.

Racke KD (2006). A reduced risk insecticide for organic agriculture: spinosad case study. In: Felsot AS, Racke KD, editors. Crop protection products for organic agriculture: environmental, health and efficacy assessment, vol. 947. Washington: ACS. 92–108.

Salas, J. (2004). Capture of *Tuta absoluta* in traps baited with its sex pheromone. *Revista Colombiana de Entomología*, 20: 75–78 (in Spanish).

Salgado VL. (1998). Studies on the mode of action of spinosad: Insect symptoms and physiological correlates. Pestic Biochem Physiol 60(2):91–102.

SAS Institute, (1988). SAS/STAT Users Guide, ver. 6.30. SAS Institute Inc. CryNarolina.

Schmutterer H. (1990). Properties and potential of natural pesticides from the neem tree, Azadirachta indica. Annu Rev Entomol., 35:271–297

Servicio de Sanidad Vegetal-Murcia. (2008). Control de la polilla del tomate (*Tuta absoluta*). Consejería de Agricultura y Agua

Shepard, M.; Dahlman, D. L., (1988). Plant induced stresses as factors in natural enemy ecacy. In: Plant Stresses Insect Interactions. Ed. by Heinrich, E. A. New York: John Wiley, 263-330.

Silvério F.O., de Alvarenga E.S., Moreno S.C., Picanço M.C. 2009. Synthesis and insecticidal activity of new pyrethroids. *Pest Manage. Sci.* 65: 900–905.

Siqueira, H.A.A.; Guedes, R.N.C.; Picanço, M.C. (2000). Insecticide resistance in populations of *Tuta absoluta* (Lepdoptera: Gelechiidae). Agricultural and Forest Entomology, 2(2):147-153.

Siqueira, H.Q.A.; Guedes, R.N.C.; Picanco, M.C. 2000. Insecticide resistance in populations of *Tuta absoluta*. *Agricultural and Forest Entomology*, 2:147–153.

Sixsmith, R. (2009). Call for integrated pest management as Mediterranean tomato pests spread to UK. Horticulture Week (October 9, 2009). Accessed November 5, 2009.

Souza, J. C.; Reis, P. R., (1992). TracËa-do-tomateiro, histoÂ -rico, reconhecimento, biologia, prejuõÂzos e controle. EPAMIG. Bull., 32. Belo Horizonte: EPAMIG, 1-19.

Terzidis A.N (2011). Improving control of Tuta absoluta (Meyrick) on organic tomato production: results froma tomato producer survey and an outdoor field trial, Dissertation, School of Agriculture, Food and Rural Development, Newcastle University, Newcastle Upon Tyne, UK.

Tillman PG, Mulrooney JE (2000). Effect of selected insecticides on the natural enemies Coleomegilla maculata and Hippodamia convergens (Coleoptera: Coccinellidae), Geocoris punctipes (Hemiptera: Lygaeidae), and Bracon mellitor, Cardiochiles nigriceps, and Cotesia marginiventris (Hymenoptera: Braconidae) in cotton. J Econ Entomol 93:1638–1643

Tomé H.V.V., Martins J.C., Corrêa A.S., Galdino T.V.S., Picanço M.C., Guedes R.N.C. (2013). Azadirachtin avoidance by larvae and adult females of the tomato leafminer *Tuta absoluta*. *Crop Prot.* 46: 63–69.

Vacas S, Alfaro C, Primo J, Navarro-Llopis V (2011). Studies on the development of a mating disruption system to control the tomato leafminer, Tuta absoluta Povolny

(Lepidoptera: Gelechiidae). Pest Manag Sci 67(11):1473–1480.

Williams T, Valle J, Vin˜uela E (2003). Is the naturally derived insecticide Spinosad _ compatible with insect natural enemies? Biocontrol Sci Technol, 13:459–475

Wing KD, Sacher M, Kagaya Y, Tsurubuchi Y, Mulderig L, Connair M, Schnee M (2000). Bioactivation and mode of action of the oxadiazine indoxacarb in insects. Crop Prot, 19:537–545.

ARABIC SUMMERY

تقييم كفاءة بعض المبيدات للتحكم فى صانعة انفاق الطماطم توتا ابسليوتا معمليا

وفائى زكى ميخائيل[1] - حسن محمد صبحى[1] - سعد عبد الخالق جعفر[2] - حافظ إسماعيل حافظ عمر[3] عاطف طة المصرى[3]

١-معهد البحوث والدراسات الافريقية جامعة القاهرة

٢-المعمل المركزى للزراعة العضوية-مركز البحوث الزراعية

٣-معهد بحوث وقاية النباتات- الدقي -مركز البحوث الزراعية بالقاهرة

تعد الطماطم (*Lycopersicon esculentum*) من محاصيل الخضروات المهمة والرئسية فى العالم وفى مصر وشمال افريقيا والتى تعود الى العائلة الباذنجانية Solanaceous .وتسبب آفة حافرة الطماطم توتا ابسليوتا اضرارا بالغة لنباتات الطماطم كما تصيب ايضا العائلة الباذنجانية . وتهدف هذة الدراسة الى التقييم الحيوى لخمس مركبات هي Spinosad و Dipel 2x وMineral oil Neemix و coragen 20 للLC50 و LC95 ضد العمر اليرقى الثانى والرابع لل *Tuta absoluta* بعد (١, ٣, ٥,٧, ١٠, ١٤) يوم من المعاملة (١) تم تقييم سمية Spinosad LC50 و LC95 ضد العمر اليرقى الثانى والرابع لل *Tuta absoluta* كانتLC50 بعد (١, ٣, ٥,٧, ١٠, ١٤) يوم من المعاملة ٥٥.٠٧، ٩٩.٧ ، ١٥٦، ٢٧٦.٦ ، ٢٣١، ٣٠٠.٠٠ جزء فى المليون على التوالى للعمر اليرقى الثانى بينما العمر اليرقى الرابع كانت ٩٩.٩، ١٤٦.٦ ، ١٩٩.٧، ٢٠٠ ، ٢٧٠، ٨٤٤.٩.٠٠ جزء فى المليون على التوالى.(٢) بينما قييمت سمية Dipel 2x LC50 و LC95 ضد العمر اليرقى الثانى والرابع للـ *Tuta absoluta* كانتLC_{50} بعد (١, ٣, ٥,٧, ١٠, ١٤) يوم من المعاملة 421.8 ، 343.6 ، 500، 1403.8 ، 2869.6، 5706.6 جزء فى المليون على التوالى للعمر اليرقى الثانى بينما العمر اليرقى الرابع كانت 1132.3، 745.8 ، 1522، 3097.5 ، 7714.4، 32176. جزء فى المليون على التوالى.(٣) بينما قييمت LC_{50} و LC_{95} لـ Neemix ضد العمر اليرقى الثانى والرابع لل Tuta absoluta كانتLC_{50} بعد (١, ٣, ٥,٧, ١٠, ١٤) يوم من المعاملة 263.07، 109.83 ، 43.85، 40.54 ، 45.9 ، 123.0 جزء فى المليون على التوالى للعمر اليرقى الثانى بينما العمر اليرقى الرابع كانت 856.7، 496.7 ، 293 ، 188.6 ، 116.4 ، 406 جزء فى المليون على التوالى.(٤) بينما قييمت سمية Mineral oil LC_{50} و LC_{95} ضد العمر اليرقى الثانى والرابع لل*Tuta absoluta* كانتLC_{50} بعد (١, ٣, ٥,٧, ١٠, ١٤) يوم من المعاملة 765.34، 473.5 ، 263.07، 109.83 ، 43.85، 42.92 جزء فى المليون على التوالى للعمر اليرقى الثانى بينما العمر اليرقى الرابع كانت 2004، 1392.5 ، 856.6، 653.4 ، 301.9 ، 231.9. جزء فى المليون على التوالى.(٥) بينما قييمت سمية coragen 20% LC_{50} و LC_{95} ضد العمر اليرقى الثانى والرابع لل *Tuta absoluta* كانتLC_{50} بعد (١, ٣, ٥,٧, ١٠, ١٤) يوم من المعاملة 45.04 ، 29.6 ، 63.1، 76.45 ، 143.49، 281.48 جزء فى المليون على التوالى للعمر اليرقى الثانى، بينما العمر اليرقى الرابع كانت 96.2 ، 76.8 ، 148.6، 194.5 ، 422.7 ، 3848 جزء فى المليون على التوالى.(٦) اشارت النتائج ان المركب Coragen 20% كان اكثر سمية ضد العمر اليرقى الثانى والرابع لل *Tuta absoluta* بعد ٢٤ و ٤٨ و٧٢ ساعة من المعاملة بينما Mineral oil اقل سمية بعد ٢٤ و ٤٨ و٧٢ ساعة من المعاملة.(٧) اشارت النتائج ان سلوك العمر اليرقى الثانى والرابع لل *Tuta absoluta* للمركبات المستخدمة بعد المعاملة بقيت داخل النفق لجميع المركبات ما عدا المركب Mineral oil.