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PERFORMANCE OF CERTAIN INSECTICIDES AND THEIR MIXTURES AGAINST, *Tuta absoluta* (MEYRICK) AND *Helicoverpa armigera* (HUBNER) INSECTS ON TOMATO CROP AT SOUTH VALLEY REGION

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ABSTRACT

Impact of certain insecticides and their mixtures (emamectin benzoate, imidaclopride, chlorfenapyr, indoxacarb, profenofos, pyridalyl, methomyl, teflubenzuron) were evaluated against tomato leaf miner, *Tuta absoluta* (Meyrick) and *Helicoverpa armigera* (Hubner) populations on tomato crop at south valley region. LC_{50} values indicated that emamectin benzoate was the most toxic compound (LC_{50} 0.461 %) against *T. absoluta*, larvae. The carbamate insecticide, methomyl showed almost similar toxicity followed by in a descending order while teflubenzuron and chlorfenapyr were less effective (LC_{50} 1.054 and 3.165 %), respectively. Pyridalyl was found to be the most effective insecticide against *H. armigera*. (LC_{50} 0.513 %). The corresponding toxicities of the other tested insecticides, arranged according to their LC_{50}'s in descending order were as follow: methomyl, emamectin benzoate, profenofos, imidaclopride, teflubenzuron, indoxacarb and chlorfenapyr. The LC_{50}'s were ranged between (0.513 and 0.872 %), while, their toxicity indexes were ranged between (92.432 and 58.830 %). On the other hand, there were no differences occurred among the treatments.

Mean of percent infestation were decreased 6 weeks after six sprayings, and the percent reduction in infestation were 79.73, 80.22, 78.41, 80.88, 80.50, 78.30, 79.64 and 78.25 % by using emamectin benzoate, methomyl, imidaclopride, pyridalyl, profenofos, indoxacarb, teflubenzuron and chlorfenapyr, respectively. The efficiency of the tested insecticides was increased with increasing the number of sprays from 2 to 6 causing reduction in insect leaf miner infestation ranged between 68.02 to 80.88 %, respectively. Generally, the tested insecticides and their mixtures achieved a considerable reduction in *T. absoluta* and *H. armigera* population.

Keywords: *Tuta absoluta*, *Helicoverpa armigera*, insecticides and tomato crop.

INTRODUCTION

Invasive species of insect pests represent a major threat to both natural (Clavero and Garcia-Berthou 2005; Samways 2007) and agronomic ecosystems (Olson 2006; Haack *et al*. 2010) Agricultural pests can reduce yield, increase costs (related to their management), and lead to the use of pesticides which utility lead to the disruption of existing integrated pest management (IPM) systems (Thomas 1999).

Tomato is susceptible to a wide range of insect pests and pathogens that attack the crop at all stages. The leaf miner and fruit borers are the most important ones (Lopes Filho, 1990; Picanço *et al*., 2000).

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The tomato borer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae), first described in Peru in 1917, is now found throughout South America, where it is considered to be one of the most devastating pests for tomato crops (Barrientos *et al*. 1998; Joel Gonzalez-Cabrera, *et al*. 2011). Larvae of this pest throughout the growing cycle of caused losses of up to 100 % by attaching leaves, flowers, stems, and especially fruits (Lopez 1990; Apablaza 1992). In Spain, it was first detected at the end of 2006 (Urbaneja *et al*. 2008). During 2007, *T. absoluta* was detected in several locations throughout the Spanish Mediterranean Basin. Since then, its presence has also been confirmed in Algeria, Canary Islands, France, Italy, Morocco, and Tunisia in 2008, and in Albania, Bulgaria, Cyprus, Germany, Malta, Portugal, Switzerland, The Netherlands, and the United Kingdom in 2009 (Desneux *et al*. 2010; EPPO 2010).

Tomato is thought to be the most preferable host plant for *T. absoluta* (Pereyra and Sanchez 2006), and tomato cultivation could be a determining factor for *T. absoluta* establishment in Europe and Mediterranean Basin countries. Nine Mediterranean countries (i.e. Turkey, Egypt, Italy, Spain, Greece, Morocco, Portugal, Tunisia, and Algeria) are considered key tomato producers (FAO data 2008). Larvae can damage tomato plants during all growth stages, producing large galleries in their leaves, burrowing stalks, apical buds, green and ripe fruits (Cáceres 1992). It can cause important yield losses in different production regions and under diverse production systems (Benavent *et al*. 1978, Cáceres 1992).

Since its introduction, chemical control has been the main method of control used against *T. absoluta* in all tomato produced regions. Horticultural growers have tried to decrease it's injure applying insecticides two times a week during a single cultivation period. Effective chemical control was difficult to achieve because of the mine-feeding behaviour of larvae, lack of a threshold action, and deficient spraying technology (Singh, D. and Chahal, B.S. 1978).

The tomato fruit borer, *Helicoverpa armigera* Hub. is a polyphagous pest attacking cotton, tomato, okra, chilli, cabbage, pigeon pea, gram etc. throughout the world as well as in Egypt (Ghosh *et al*. 2010). Tomato fruit borer, *Helicoverpa armigera* is an important pest which causes considerable losses in quantity as well as quality of tomato fruits **(**Singh and Chahal, 1978; Tewari and Moorthy, 1984; Reddy and Zehrm, 2004). To control this insect pest and to save the crop, pesticides are being used in large quantities. But the excessive use of same or similar groups of pesticides causes problem of pesticide residues in foodstuff and other environmental contamination.

The objective of this work was to evaluate the toxicity of eight insecticides and their mixtures against tomato borers, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) and *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) in tomato crop in south valley region.

MATERIALS AND METHODS

Insecticides used

Various insecticides recommended by Ministry of Agricultural, Egypt were evaluated for their toxicity to tomato borers, *T. absoluta* and *H*. *armigera* through laboratory and field assessments. The concentration, trade names and their mixtures are given in Table (1). Application of these insecticides was accomplished, two weeks after transplanting for *T. absoluta* and 6 weeks for *H*. *armigera*. Control plots were sprayed with water only.

Table (1): Insecticides and trade names their mixtures

Emamectin benzoate (Proclaim 5 % SG)	Emamectin benzoate + Profenofos
Imidaclopride (Confidate 35 % SC)	Emamectin benzoate + Imidaclopride
Chlorfenapyr (Challenger 36 % SC)	Emamectin benzoate + Chlorfenapyr
Indoxacarb (Avanut 15 % SC)	Emamectin benzoate + Methomyl
Profenofos (Cord 72 % EC)	Pyridalyl + Teflubenzuron
Pyridalyl (Pleo 50 % EC)	Emamectin benzoate + Indoxacarb
Methomyl (Lannate 90 % SP)	
Teflubenzuron (Nomolt 15 % SC)	

Bioassay

Laboratory bioassay experiments were carried out to evaluate the relative toxicity of the tested insecticides. LC_{50} for each of the tested chemicals against 3^{rd} instars larvae of either *Tuta absoluta* (Meyrick) or *Helicoverpa armigera* (Hubner) was determined by using a residual film technique (Iwuala *et al*. (1981). *T. absoluta* and *H. armigera* larvae were collected from tomato field and brought into the laboratory. A known volume for each tested concentration was evenly spread at the bottom of Petri dish surface (7 and 5 cm in diameter) and kept until dryness. Five concentrations for each treatment were used and each one replicated five times. After completing film dryness, three larvae of *T. absoluta* were placed in each of the treated Petri dish (7 cm diameter), but in case of *H. armigera* one larva was placed in each of Petri dish (5 cm diameter), then covered and incubated at 28 ± 2 ºC. The percentage of mortality was calculated after 24 h. Then, mortality counts were corrected according to formula (Abbott, 1925), then submitted to probit analysis and the relative toxicity was calculated in each case according to (Finney 1971).

Field Evaluation

Field experiments were carried out at the experimental station of Faculty of Agriculture, South Valley University, Qena Governorate, Egypt. Tomato (*Lycopersicon esculentum* Mill. Solanaceae) was planted at mid of December 2010 under normal field and agricultural practices. The experimental area was divided into plots 42 m^2 ($^1/_{100}$ fed.). Treatments including untreated check replicated four times in completely randomized design. Eight insecticide and six mixtures of them were tested as shown in Table (1). A Cifarelli knapsack sprayer 20 L capacity was used in applying the tested compounds as foliar treatment, after diluting with water at the rate 200 L / feddan. The tomato plants were sprayed after about 35 days from sowing.

For each compound and mixture, spraying were conducted 2, 4 or 6 times against *T. absoluta* and 4 and 6 times for *H. armigera* throughout the reproductive stage. All counts of treatments and control were recorded before spraying and at 1, 2, 3, 4, 5 and 6 weeks after spraying. For assessing the reduction of borers infestation were calculated according to Henderson and Tiliton (1955) formula.

RESULTS AND DISCUSSION

Toxicity of tested insecticides against *T. absoluta* and *H. armigera*

Results, representing the toxic effect of emamectin benzoate, methomyl, imidaclopride, pyridalyl, profenofos, indoxacarb, teflubenzuron and chlorfenapyr insecticides on larval stage of *T. absoluta* and *H. armigera*, are shown in Tables (2 and 3). On the basis of LC_{50} values presented in Table (2), emamectin benzoate was the most toxic compound (LC_{50} 0.461 %) against larval stage of *T. absoluta*. The carbamate insecticide, methomyl came next in its toxicity, while chlorfenapyr was the least effective (LC_{50} 3.165 %) and was less toxic than teflubenzuron (LC_{50} 1.054 %). It is evident from the data that shown in Table (3) pyridalyl was found to be the most effective insecticide against larval stage of *H. armigera*. The LC_{50} and LC_{90} values were 0.513 and 1.036 %, respectively. Toxicity of the other tested insecticides were arranged according to their LC_{50}'s in descending order as follow: Methomyl, Emamectin benzoate, Profenofos, Imidaclopride, Teflubenzuron, Indoxacarb and Chlorfenapyr. The LC_{50}'s of these insecticides were 0.513, 0.556, 0.691, 0.707, 0.776, 0.778, 0.867 and 0.872 %, nevertheless, their toxicity indexes were 92.432, 74.240, 72.560, 66.108, 65.938, 59.170 and 58.830 %, respectively.

Table (2): Toxicity of insecticides against tomato borer, *Tuta absoluta*

Treatment	LC_{50} (%)	LC_{90} (%)	Slope ± SD	Toxicity index at LC_{50}	Confidence limits at LC_{50}	
					Lower	Upper
Emamectin benzoate	0.461	1.315	2.810 ± 0.2302	100	0.4104	0.5119
Methomyl	0.468	1.794	2.1976±0.2247	98.504	0.3999	0.5432
Pyridalyl	0.511	1.282	3.2004±0.2616	90.215	0.4645	0.5573
Imidaclopride	0.621	1.850	2.697±0.2331	74.235	0.2672	1.0887
Profenofos	0.643	2.185	2.4048±0.2137	71.695	0.5755	0.7141
Indoxacarb	0.753	2.515	2.4397±0.2141	61.222	0.6653	0.8492
Teflubenzuron	1.054	2.612	2.0045±0.2023	39.469	0.7189	0.9658
Chlorfenapyr	3.165	6.613	3.654±0.2856	5.095	0.7574	1.7265

Table (3): Toxicity of insecticides against tomato borer, *H. armigera*

Treatment	LC_{50} (%)	LC_{90} (%)	Slope ± SD	Toxicity index at LC_{50}	Confidence limits at LC_{50}	
					Lower	Upper
Pyridalyl	0.513	1.036	1.660 ± 0.214	100	0.411	0.618
Methomyl	0.556	1.177	3.926 ± 0.572	92.432	0.487	0.608
Emamectin benzoate	0.691	3.779	1.737± 0.166	74.240	0.571	0.820
Profenofos	0.707	2.752	2.171± 0.182	72.560	0.628	0.804
Imidaclopride	0.776	3.953	1.812 ± 0.195	66.108	0.680	0.903
Teflubenzuron	0.778	1.864	3.376 ± 0.325	65.938	0.70	0.860
Indoxacarb	0.867	2.332	2.981 ± 0.280	59.170	0.779	0.964
Chlorfenapyr	0.872	4.152	1.891± 0.177	58.830	0.761	1.011

Efficiency of certain insecticides and their mixture on *T. absoluta*

Tuta absoluta is crossing boarders and devastating tomato production both protected and open fields. Recently *Tuta absoluta* considered to be a serious threat to tomato production in Mediterranean region. Chemical is the only method available, but the limited efficacy of insecticides against *T. absoluta* larvae forcing growers to adopt heavy insecticide applications, sometimes 36 spraying per season (Miguel Micheref Filho *et al* 2000). Data given in Tables (4 and 5) and Figures (1 and 2) show the efficiency of the tested insecticides and their mixtures against *T. absoluta*. The tested insecticides were emamectin benzoate, methomyl, imidaclopride, pyridalyl, profenofos, indoxacarb, teflubenzuron and chlorfenapyr.

Data concerning mean number and percentage reduction in infestation of tomato borer, *T. absoluta* insect are shown in (Tables 4, 5 and Figs. 1, 2). Results in Table 4 and Fig. 1 indicate that there were differences between the control and treatments at the mean numbers of percent infestation and reduction in infestation. On the other hand, there were no differences occurred among the treatments.

Table (4): The efficacy of certain insecticides against tomato borer, *Tuta absoluta* after 2nd spray, 4th spray and 6th spray

Treatment		Before treatment	Mean number larvae and % Percent reduction as indicated weeks after treatments												General mean	
			1		2		3		4		5		6			
			No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.
Emamectin benzoate	A	8.9	3.0	75.49	2.4	82.74	3.4	79.26	3.6	79.07	4.6	74.79	5.8	69.70	3.80	76.84
	B	9.0	3.2	74.14	2.8	80.09	2.0	87.82	1.8	89.74	3.4	81.57	5.2	73.13	3.07	81.08
	C	9.0	3.2	74.14	2.8	80.09	2.2	86.61	2.0	88.60	1.4	92.41	1.4	92.76	2.17	85.90
Methomyl	A	8.5	2.8	76.04	2.6	80.42	3.0	80.66	5.2	68.63	6.4	63.27	7.8	57.32	4.63	71.06
	B	9.0	5.6	54.75	5.0	64.44	4.0	75.65	2.2	87.46	5.8	68.56	5.4	72.09	4.67	70.50
	C	8.4	4.0	65.39	3.4	74.10	3.0	80.43	2.6	84.13	2.2	87.22	1.8	90.03	2.80	80.22
Imidaclopride	A	8.7	3.0	74.92	2.6	81.00	3.4	78.59	5.6	67.00	7.0	60.75	8.0	57.23	4.93	69.92
	B	9.0	4.6	62.83	4.2	70.13	3.6	78.08	2.4	86.32	5.6	69.65	5.6	71.06	4.33	73.13
	C	8.8	5.0	58.68	3.8	72.36	3.6	77.58	3.0	82.52	2.2	87.80	1.6	91.54	3.20	78.41
Pyridalyl	A	8.9	3.0	75.49	2.8	79.87	3.4	79.07	4.8	72.34	7.2	60.54	7.8	59.24	4.83	71.09
	B	8.8	5.0	58.68	4.6	66.55	4.0	75.10	2.6	84.85	5.0	72.28	5.6	70.40	4.47	71.31
	C	9.0	4.0	67.68	3.6	74.40	3.4	79.30	2.6	85.19	2.4	87.00	1.6	91.73	2.93	80.88
Profenofos	A	8.5	3.6	69.20	3.0	77.41	3.6	76.80	5.4	67.42	6.4	63.27	8.4	54.04	5.07	68.02
	B	8.6	4.8	59.41	4.0	70.23	3.6	77.06	3.0	82.11	4.8	72.77	6.0	67.55	4.37	71.52
	C	8.6	4.0	66.17	3.4	74.70	3.0	80.90	2.6	84.50	2.4	86.39	1.8	90.26	2.87	80.50
Indoxacarb	A	8.7	2.8	76.60	2.2	83.82	3.4	78.60	5.0	70.53	7.0	60.75	8.2	56.16	4.77	71.08
	B	8.6	5.0	57.72	3.8	71.72	3.4	78.34	2.6	84.50	4.8	72.77	4.8	74.04	4.07	73.18
	C	8.8	4.8	60.58	4.0	70.91	3.6	77.58	3.2	81.35	2.2	87.80	1.6	91.59	3.23	78.30
Teflubenzuron	A	8.5	3.6	69.20	3.0	77.41	3.0	80.66	4.6	72.25	7.0	59.83	8.0	56.22	4.87	69.26
	B	9.0	4.8	61.21	4.4	68.71	3.2	80.52	2.6	85.19	5.6	69.65	6.4	66.92	4.50	72.03
	C	8.7	4.4	63.22	3.8	72.05	3.2	79.85	2.6	84.67	2.2	87.66	1.8	90.38	3.00	79.64
Chlorfenapyr	A	8.8	3.0	75.21	2.2	84.00	3.8	76.34	5.0	70.86	7.2	60.09	8.2	56.66	4.90	70.43
	B	8.8	5.4	55.37	4.4	68.00	3.6	77.58	2.6	84.85	5.2	71.18	6.8	64.06	4.67	70.17
	C	8.7	5.4	54.86	3.8	72.05	3.0	81.11	2.8	83.50	2.4	86.54	1.6	91.45	3.17	78.25
Control		8.0	11.0		12.5		14.6		15.6		16.4		17.2		14.55	

A = Received two applications **B = Received four applications**
C = Received six applications **No. = Average number of larvae**
% R = Reduction in infestation

Table (5): The efficacy of certain insecticides mixtures against tomato borer, *T. absoluta* after 2nd spray, 4th spray and 6th spray

Treatment		Before treatment	Mean number larvae and % percent reduction as indicated weeks after treatments												General mean	
			1		2		3		4		5		6			
			No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.
Emamectin benzoate + Profenofos	A	13.0	2.4	84.30	2.0	88.95	3.2	82.52	4.0	78.87	4.8	75.45	5.6	71.96	3.70	80.33
	B	12.6	3.6	75.70	3.4	80.61	3.0	83.09	2.2	88.00	3.0	84.17	5.4	72.10	3.43	80.61
	C	13.4	3.2	79.70	2.8	85.00	2.6	86.22	2.0	89.76	1.4	93.05	0.6	97.08	2.10	88.47
Emamectin benzoate + Imidaclopride	A	12.0	4.8	66.00	3.4	79.65	3.8	77.51	4.6	73.67	5.4	70.08	6.2	66.36	4.70	72.21
	B	13.4	4.0	74.62	3.8	79.63	3.6	80.92	3.0	84.62	4.2	79.16	5.6	72.80	4.03	78.63
	C	13.0	5.4	64.68	5.0	72.37	3.0	83.61	2.0	89.43	1.8	90.80	1.2	94.00	3.07	82.48
Emamectin benzoate + Chlorfenapyr	A	12.6	5.0	66.26	3.6	79.47	3.8	78.60	3.8	79.30	5.0	73.17	6.0	69.00	4.53	74.35
	B	13.0	4.8	68.60	3.8	79.00	3.2	82.52	2.8	85.21	5.4	72.38	5.8	70.95	4.30	76.44
	C	14.2	5.6	71.48	4.6	76.73	3.2	84.00	2.8	86.46	1.6	92.51	1.2	94.50	3.17	84.28
Emamectin benzoate + Methomyl	A	13.6	4.6	71.24	3.2	83.10	4.2	78.07	5.2	73.74	5.8	71.64	6.2	70.32	4.87	74.69
	B	13.4	4.2	73.35	4.0	78.56	3.6	80.92	2.2	88.72	5.2	74.20	6.4	68.91	4.26	77.44
	C	13.6	4.6	71.24	3.4	82.04	2.4	87.45	1.8	91.00	1.6	92.18	1.4	93.30	2.53	86.20
Pyridalyl + Teflubenzuron	A	12.6	4.8	67.61	3.0	82.90	3.8	78.58	4.3	76.56	5.2	72.56	6.4	66.93	4.58	74.11
	B	13.2	4.4	71.66	4.2	77.14	3.2	82.78	2.8	85.43	4.2	78.84	5.8	71.39	4.10	77.88
	C	14.4	5.4	68.11	4.6	77.05	2.6	87.18	1.8	91.41	1.6	92.61	1.4	93.67	3.07	85.00
Emamectin benzoate + Indoxacarb	A	13.2	4.8	69.08	3.4	81.50	4.2	77.40	5.4	71.90	5.7	71.29	6.0	70.41	4.92	73.60
	B	12.6	5.2	64.91	3.4	80.61	2.8	84.22	2.2	88.00	4.6	75.73	5.8	70.03	4.00	77.25
	C	13.6	5.6	65.00	4.2	77.81	2.8	85.38	1.6	91.92	1.4	93.16	1.2	94.26	2.80	84.89
Control		12.5	14.7		17.4		17.6		18.2		18.8		19.2		14.52	

A = Received two applications **B = Received four applications**
C = Received six applications **No. = Average number of larvae** **% R = Reduction**

Mean of percent infestation were decreased 6 weeks after six sprayings. It were decreased from 9, 8.4, 8.8, 9.0, 8.6, 8.8, 8.7 and 8.0 to 2.97, 2.80, 3.20, 2.93, 2.87, 3.23, 3.0 and 3.17, respectively, and the percent reduction in infestation were 85.9, 80.22, 78.41, 80.88, 80.50, 78.30, 79.64 and 78.25 % by using emamectin benzoate, methomyl, imidaclopride, pyridalyl, profenofos, indoxacarb, teflubenzuron and chlorfenapyr, respectively (Table 4). The efficiency of the tested insecticides was increased with increasing the number of sprays. The tested insecticides caused reduction in insect borer infestation ranged between 68.02 – 80.88 % following two, four and six treatments.

Data in Table (5) and Fig. (2) showed the efficacy of the six tested insecticides mixture against the borer insect, *T. absoluta*. The insecticide mixture emamectin benzoate + profenofos were effective against *T. absoluta.* It is evident from the present investigation that tested insecticides and their mixtures achieved a considerable reduction in *T. absoluta* population.

IPM strategies are being developed in South America to control *T. absoluta*. Studies are being done on the use of synthetic sex pheromones in order to monitor population levels and trigger applications of chemicals (Salas, 2004). Various active substances are effective and can be used in combination with biological control agents.

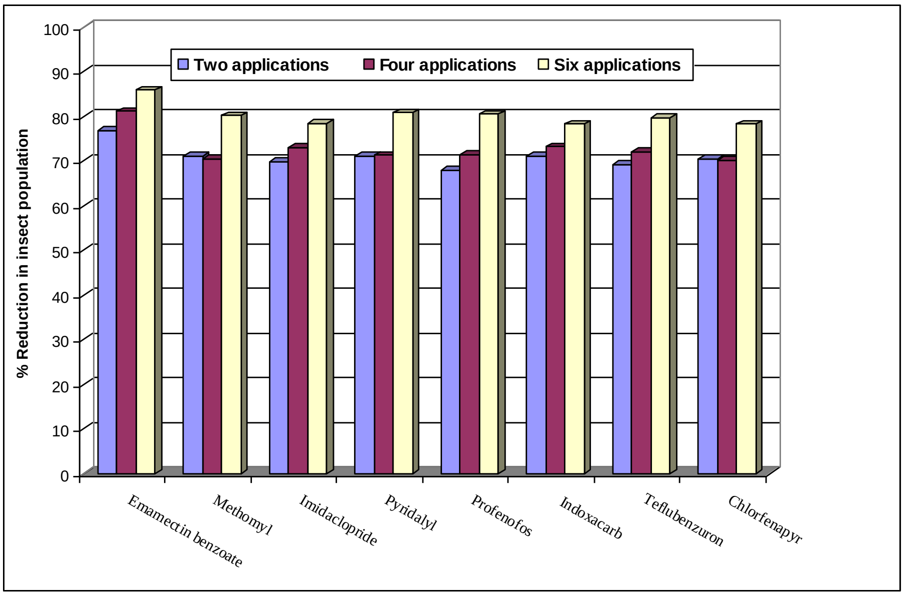

Fig. 1: Percentages reduction of tomato borer, *T. absoluta* larval stage after spraying with the tested insecticides

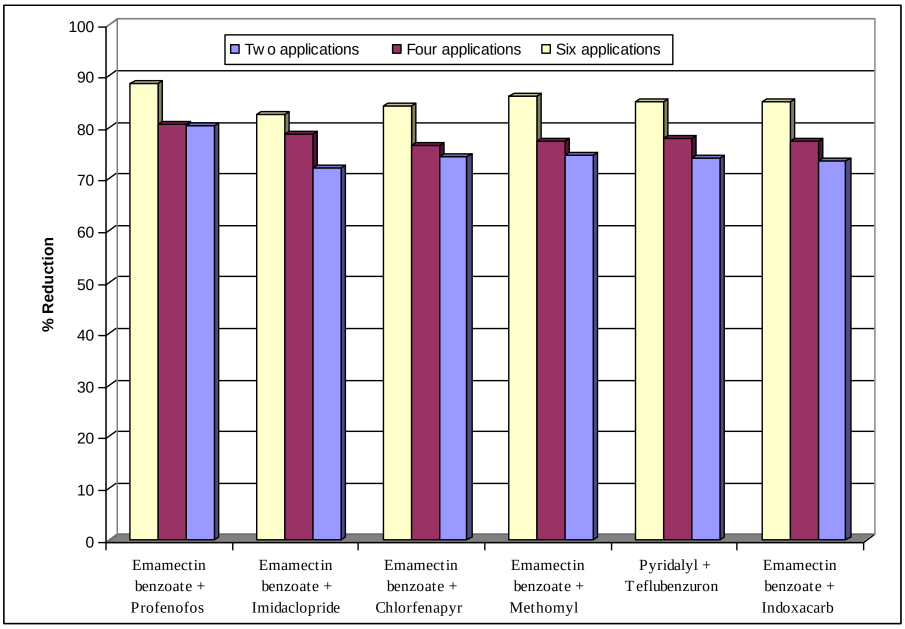

Fig. 2: Percentages reduction of tomato borer, *T. absoluta* larval stage after spraying with the tested insecticides mixtures.

Concerning chemical control, several treatments are required per growing season and it must be noted that a decrease of the efficacy of products used against *T. absoluta* has been observed since the 1980s in tomato crops. Resistance to some insecticides has been reported in several countries, for example to abamectin, cartap and permethrin in Brazil (Siqueira *et al*., 2000). Parasitoids (e.g. *Trichogramma pretiosum*) or predators (e.g. *Podisus nigrispinus*) can be used, and research is being done on biological control (Villas Boas & Franca, 1996; Torres *et al*., 2002). Other control methods include cultural practices (rotation with non-solanaceous crops, ploughing, adequate fertilization, irrigation, destruction of infested plants and of post-harvest plant debris, etc.). Finally, the susceptibility of tomato cultivars to *T. absoluta* varies and plant resistance is being investigated.

Efficiency of certain insecticides and their mixture on *H. armigera*

Data given in Tables (6 and 7) and Figures (3 and 4) show the efficiency of the tested insecticides and their mixtures against *H. armigera*. The tested insecticides were emamectin benzoate, methomyl, imidaclopride, pyridalyl, profenofos, indoxacarb, teflubenzuron and chlorfenapyr. Data concerning mean number and percentage reduction in infestation of tomato borer, *H. armigera* insect are shown in (Tables 6, 7 and Figs. 3, 4).

Results in Table 6 and Fig. 3 indicate that there were differences between the control and treatments at the mean numbers of percent infestation and reduction in infestation. On the other hand, there were no differences occurred among the treatments. Mean of percent infestation were decreased 6 weeks after six spraying.

Table (6): The efficacy of certain insecticides against tomato borer, *H. armigera* after 4th spray and 6th spray

Treatment		Before treatment	Mean number larvae and % percent reduction as indicated weeks after treatments												General mean	
			1		2		3		4		5		6			
			No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.
Chlorfenapyr	A	16.2	5.6	68.89	4.4	76.60	4.0	79.17	2.6	86.80	4.0	80.77	4.6	78.10	4.20	78.39
	B	16.6	5.0	72.89	3.8	80.27	3.0	84.75	2.2	89.10	2.0	90.62	1.6	92.56	2.93	85.03
Profenofos	A	16.4	5.8	68.17	5.0	73.80	4.2	78.39	1.6	92.00	3.6	82.90	4.4	79.30	4.10	79.10
	B	16.4	4.4	75.85	3.6	81.08	2.8	85.60	1.8	91.00	1.8	91.45	1.6	92.47	2.67	86.24
Pyridalyl	A	16.6	5.8	68.55	4.6	76.12	3.8	80.69	2.0	90.10	3.0	85.92	4.0	81.41	3.87	80.47
	B	16.2	4.8	73.30	3.4	81.91	2.8	85.42	2.0	89.85	2.2	89.42	1.8	91.43	2.83	85.22
Emamectin benzoate	A	16.8	5.4	71.07	4.0	79.48	3.4	82.92	2.2	89.23	4.0	81.46	4.8	78.00	3.97	80.36
	B	16.2	5.0	72.22	3.6	80.85	2.6	86.50	2.0	89.85	2.0	90.38	1.6	92.38	2.80	85.36
Imidaclopride	A	16.6	6.0	67.50	5.2	73.00	4.4	77.64	2.2	89.10	4.0	81.23	4.8	77.69	4.43	77.69
	B	16.4	5.2	71.46	3.8	80.03	2.8	85.60	2.0	90.00	1.8	91.45	1.8	91.53	2.90	85.01
Indoxacarb	A	16.4	5.8	68.17	4.6	75.83	4.0	79.42	1.8	91.00	3.8	81.95	5.0	76.48	4.17	78.81
	B	16.2	4.8	73.33	4.0	78.73	3.0	84.40	1.8	90.86	1.6	92.31	1.4	93.30	2.93	82.83
Teflubenzuron	A	16.2	5.2	71.11	4.8	74.47	4.2	78.13	2.0	89.85	2.8	86.54	4.8	77.14	3.97	79.54
	B	16.4	4.6	74.76	3.6	81.08	3.0	84.57	2.0	89.97	1.4	93.35	1.4	93.41	2.67	86.19
Methomyl	A	16.6	6.0	67.50	5.0	74.04	4.0	79.67	2.4	88.11	2.6	87.80	3.8	82.34	3.97	79.91
	B	16.2	4.2	76.67	3.2	83.00	2.4	87.50	1.6	91.88	1.6	92.31	1.6	92.38	2.43	87.29
Control		16.2	18.0		18.8		19.2		19.7		20.8		21.0		19.58	

A = Received four applications B = Received six applications
No. = Average number of larvae % R = Reduction in infestation

Table (7): The efficacy of certain insecticides mixtures against tomato borer, *H. armigera* after 4th spray and 6th spray

Treatment		Before treatment	Mean number larvae and % percent reduction as indicated weeks after treatments												General mean	
			1		2		3		4		5		6			
			No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.	No.	% R.
Emamectin benzoate + Profenofos	A	17.0	5.4	69.50	3.8	79.01	3.0	84.63	1.6	91.93	3.4	83.43	4.0	81.50	3.53	81.67
	B	17.4	5.8	68.00	4.8	74.10	3.8	81.00	2.6	87.13	2.4	88.57	1.4	93.68	3.47	82.09
Emamectin benzoate + Imidaclopride	A	17.8	5.2	71.95	3.4	82.07	2.2	89.23	1.6	92.29	4.2	80.45	4.4	80.57	3.50	82.76
	B	17.2	5.8	67.62	4.0	78.17	3.2	83.80	2.4	88.03	1.6	92.30	1.4	93.60	3.07	83.92
Emamectin benzoate + Chlorfenapyr	A	17.8	5.0	73.03	3.4	82.07	2.0	90.21	1.4	93.25	3.8	82.31	4.4	80.57	3.34	83.57
	B	17.4	5.4	70.20	3.6	80.57	2.6	87.00	2.2	89.15	1.6	92.38	1.2	94.58	2.77	85.57
Emamectin benzoate + Methomyl	A	17.2	4.6	74.32	3.2	82.53	2.0	90.00	1.4	93.02	3.4	83.62	4.2	80.81	3.13	84.05
	B	17.0	5.4	69.50	3.2	82.33	2.4	78.70	1.6	91.93	1.4	93.18	1.2	94.45	2.53	86.52
Pyridalyl + Teflubenzuron	A	17.4	4.8	73.51	2.8	84.90	1.8	91.00	1.2	94.08	3.4	83.81	3.8	82.83	2.97	85.02
	B	17.2	6.0	66.50	3.4	81.44	2.2	88.86	1.6	92.02	1.4	93.26	1.0	95.43	2.60	86.25
Emamectin benzoate + Indoxacarb	A	17.0	4.4	75.15	3.0	83.43	1.8	90.78	1.0	95.00	2.4	88.30	3.2	85.20	2.63	86.31
	B	17.2	4.6	74.32	3.6	80.35	2.0	89.87	1.6	92.02	1.2	94.22	0.8	96.34	2.30	87.85
Control		16.9	17.6		18.0		19.4		19.7		20.4		21.5		19.43	

A = Received four applications B = Received six applications
No. = Average number of larvae % R = Reduction in infestation

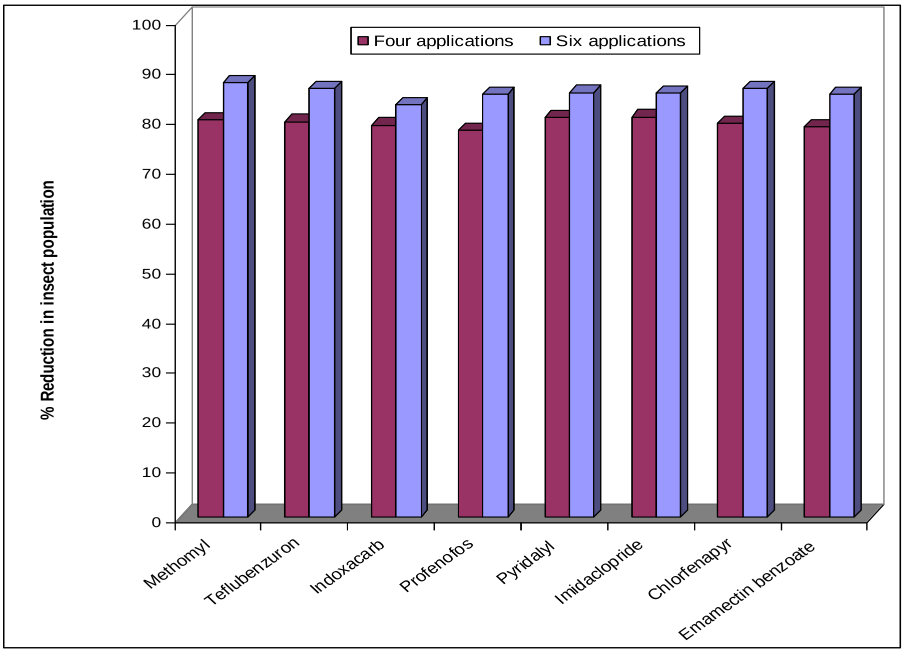

Fig. 3: Percentages reduction of tomato borer, *H. armigera* larval stage after spraying with the tested insecticides

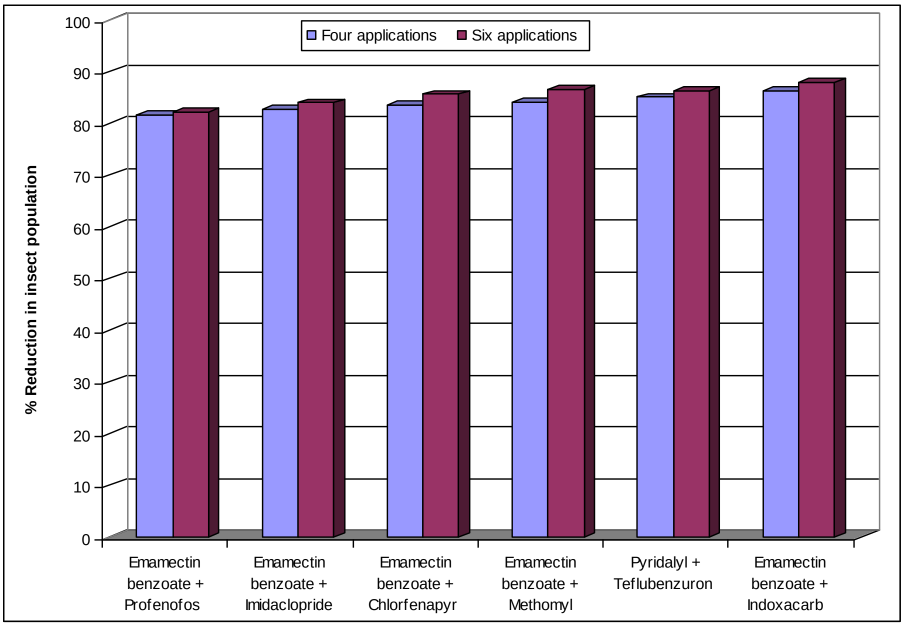

Fig. 4: Percentages reduction of tomato borer, *H. armigera* larval stage after spraying with the tested insecticides

It was decreased from 16.6, 16.4, 16.2, 16.2, 16.4, 16.2, 16.4 and16.2 to 1.6, 1.6, 1.8, 1.6 1.8, 1.4, 1.4 and 1.6 larvae, respectively and the percent reduction in infestation were 92.56, 92.47, 91.43, 92.38, 91.53, 93.30, 93.41 and 92.38 % reduction by using chlorfenapyr, profenofos, pyridalyl, emamectin benzoate, imidaclopride, indoxacarb, teflubenzuron and methomyl, respectively. The efficiency of the tested insecticides was increased with increasing the number of sprays. The efficacy of the tested insecticides mixture against the borer insect, *H. armigera*. The insecticide mixture emamectin benzoate + indoxacarb was effective against *H. armigera*. It is evident from the present investigation that tested insecticides and their mixtures achieved a considerable reduction in *H. armigera* population (Table 7 and Fig. 4) which ranged from 80.57 to 96.34 % reduction in infestation.

Efficacy of insecticides is judged on the basis of its ability to protect the crop from target pest to reduce the fruit damage, larval population and therefore directly resulted to increase in fruit yield and retrievable loss on tomato in different treatments. Ulaganathan and Gupta (2004) and Lavekar *et al*., (2004) who reported that imidaclopride treatments were more effective against *H. armigera*. Further various synthetic pyrethyroids were found effective against this pest (Fitt, 1989; Puri, 1997). Therefore, it is contemplated that as compared to conventional insecticides (chlorpyrifos, and endosulfan). Imidaclopride and synthetic pyrethyroids due to their quick knock down effect, low mammalian toxicity and longer persistence on the treated surface can safely be used in controlling the fruit borer infesting tomato (Mishra, 1986; Singh and Singh 1990; Bhatt and Patel, 2002)

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أداء بعض المبيدات الحشرية ومخاليطها ضد حشرتي *Tuta absoluta* و*Helicoverpa armigera* على محصول الطماطم في منطقة جنوب الوادي

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تـم تقييم فعاليـة المبيـدات التاليـة ومخاليطهـا (emamectin benzoate, imidaclopride, chlorfenapyr, indoxacarb, profenofos, pyridalyl, methomyl, teflubenzuron على حشرتي صـانعة الأنفـاق ودودة ثمـار الطمـاطم *Tuta absoluta* (Meyrick) and *Helicoverpa armigera* (Hubner) علـى محصـول الطمـاطم فـي منطقـة جنـوب الـوادي. تـم تقيـيم فعاليـة هـذه المبيـدات معمليا ومن خلال قيم التركيز النصفي (الـLC_{50}) توضح أن مبيد البروكليم (emamectin benzoate) والمبيد الكرباماتى اللانيت methomyl أكثرهما سمية على يرقات حشرة صانعات الأنفاق بينما كان كل من مبيد الشالنجر(chlorfenapyr) ومبيد النومولوت (teflubenzuron) الأقل فعالية وكانت قيم الـLC_{50} 1.054 و3.165 % على الترتيب. كما وجد أن مبيد البليو(Pyridalyl) أكثر سمية على حشرة دودة ثمار الطماطم وكانت قيمة الـLC_{50} (0.513 %). بينما كانت بقية المبيدات المختبرة اقل في السمية ويمكن ترتيبها كما يلي: methomyl, emamectin benzoate, profenofos, imidaclopride, teflubenzuron, indoxacarb and chlorfenapyr وقد تراوحت قيم التركيز النصفي الـLC_{50} بين (0.513 و 0.872 %) ومن النتائج نجد انه لا توجد فروق في سمية هذه المعاملات ضد حشرة دود ثمار الطماطم.

ومن خلال النتائج المتحصل عليها في التجربة الحقلية لتقييم كفاءة هذه المبيدات على حشرة دودة الثمار نجد أن متوسط الإصابة انخفضت بالنسب التالية: 79.73, 80.22، 78.41، 80.88، 80.50، 78.30، 79.64 و 78.25 % على الترتيب باستخدام المبيدات التالية: methomyl, imidaclopride, pyridalyl, profenofos, indoxacarb, teflubenzuron and chlorfenapyr وتدل النتائج المتحصل عليها أن كفاءة المبيدات المختبرة ازدادت بزيادة عدد الرشات المطبقة على النباتات في الحقل من رشتين إلى ستة رشات وسببت خفض في تعداد الآفة بنسبة تراوحت بين 68.02 إلى 80.88 %

يتضح أيضا من النتائج أن جميع المبيدات المختبرة ومخاليطها حققت خفضا مناسبا لتعداد حشرتي صانعة الأنفاق ودودة ثمار الطماطم في محصول الطماطم

قام بتحكيم البحث

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