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Research Article

The Effecacy of Some Biological and Chemeical Compounds against *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae)

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Abstract | Tomato leaf miner, *Tuta absoluta* is one of the most serious pest that causes significant economic losses in tomato production. Chemical insecticides is the first and effective choice for controlling *T. absoluta* however, the usage of such chemicals was aossciated with many environmental and health problems in addition to the development of resistance. The present study was therefore suggested to compare the efficiency of three biological insecticides with two chemical insecticides to control of *T. absoluta* in two seasons. Results obtained showed that Dipel 2x 6.4% SC (*Bacillus thuringiensis*) was the most effective in reduction the infestation by *T. absoluta*. These results indicated that biopesticides could be used as best alternatives to ovoide the problems of chemical insecticides.

Keywords | Tomato, Leaf miner, Control, Insecticides, Biopesticides

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INTRODUCTION

The tomato leaf miner *T. absoluta* is an invasive insect pest causing severe loss of tomato production in many countries either in open field or greenhouses (Ferracini et al., 2019; Erasmus et al., 2021). Severely attacked tomato fruits lose their commercial value (EPPO, 2008). Spraying with insecticides is the principal method for *T. absoluta* control (Guedes et al., 1994; Picanco et al., 1996). Therefore, several studies have been carried out to evaluate the effectiveness of theses insecticides. These studies concluded that the effectiveness of chemical control was limited due to the capability of insect to rapidly develop insecticide resistant strains and most of these insecticides were harmful to both humans and the environment (Picanco et al., 1998; Siqueira et al., 2000; Lietti et al., 2005). Recently, biological insecticides, or biopesticides were crucial alternatives for the chemical ones as they are more-selective with less-polluting products (Siegwart et al., 2015). Therefore, many studies tried to compare these pesticides to find out the advantages and disadvantages of them and to provide a better sustainability for these products. Derbalah et al. (2012) evaluated the effect of indoxacarb, imidacloprid, filtrate of *Bacillus thuringensis, Artemisia cina* extract, clove oil and nanosilica against *T. absoluta* in tomato plants under greenhouse condition. They found that nanosilica was the most effective treatment against *T. absoluta* followed by *Atremisia cina* extract, combination of imidacloprid and *A.* cina, indoxacarb, filtrate of *Bacillus thuringensis*, imidacloprid, combination of indoxacarb and *A. cina*, and finally clove oil depending on the reduction of larvae and mine blotch counts in treated plants. Also, Lo Bue et al. (2012) realized that only combination of azadirachtin and *B. thuringiensis* was able to reduce the impact of tomato leaf miner. They concluded that the biorational insecticides are good alternative to synthetic ones. Similarly, Hanafy and El-Sayed (2013) found that the bioinsecticides were more effective in the control of *T. absoluta* infesting tomato leaves

than the chemical insecticides. In contrary, Moussa et al. (2013) show that chemical pesticides such as indoxacrab 15%, spinosad 24% and emamectin benzoate 50% provide excellent control against *T. absoluta* , while a biopesticide *B. thuringiensis* provide moderate control. Meanwhile, Larain et al. (2014) found that soil application of cyantraniliprole significantly reduced the damage caused by the tomato leaf miner larva in both the foliage and fruit of tomato. In addition, Barakat et al. (2015) evaluated five pesticides for their efficacy in the control of *T. absoluta* on tomato plant. They found that Emamecitin benzoate caused highest reduction in percentage of eggs while the highest reduction in percentage of larvae occurred by Tracer and Challenger both after 7 days from application. Continuing this effort, the present study is therefore aiming to evaluate the efficiency of Dipel 2x 6.4% SC (*Bacillus thuringiensis*), Lannate 90% SC (Methomyl), Avaunt 15% SC (indoxacarb), Radiant 12% SC (spinetoram) and Tracer 24% SC (spinosad) against *T. absoluta* in two seasons.

MATERIALS AND METHODS

The efficiency of the tested compounds; Dipel 2x 6.4% SC (*Bacillus thuringiensis*), Lannate 90% SC (Methomyl), Avaunt 15% SC (indoxacarb), Radiant 12% SC (spinetoram) and Tracer 24% SC (spinosad) was evaluated against *T. absoluta* in two seasons.

In two seasons, seedlings (age 40 days) of tomato variety N23 were planted at the beginning of March. All culture methods and fertilizers were followed as commonly practiced. The experimental area was divided according to the complete randomized block design including four replicate for each treatment. Each replicate was 12×7 m^2 (2/100 fed.). Spray application using air-assisted knapsack sprayer (CP-3) was utilized to apply the pesticides as foliar treatment diluted with water. One afternoon spray was held against *T. absoluta* larvae in each growing seasons.

The untreated control plots were sprayed with water. In two seasons, spraying started with high infestation of *T. absoluta* larvae. Infestation of *T. absoluta* larvae was noticed before spraying and after 1, 3, 5, 7, 10, 15 days of spraying. The reduction percentages of *T. absoluta* larvae in infested leaves were calculated according to Henderson and Tilton (1955) formula. Brefiely, ten plants were randomly slected from each block, 5 leaves or fruits from each plant were examined and counted to record percentage infestation of *T. absoluta*. Data was presented as an average.

RESULTS

The effecacy of five compounds; Dipel 2x 6.4%, Lannate 90%, Avaunt 15%, Radiant 12% and Tracer 24% against *T. absoluta* was evaluated in a field located in Beni- Suef Governorate during the first season 2014/2015. The infestation percentage of tomato leaves before and after application of these compounds were shown in Table (1). The percentage of infestation before spraying ranged between 67.25 % and 79.50 % in the control treatments before spraying. The percent of infestation before spraying in the treatments with Dipel 2x 6.4%, Lannate 90%, Avaunt 15%, Radiant 12% and Tracer 24% were 71.00, 68.50, 69.75, 67.25 and 73.50 % respectively. The corresponding values after 1 day of spraying were 35.25, 25.50, 43.25, 34.56 and 67.50 while it reached to 44.25, 44.45, 60.50, 76.25 and 89.75 after 15 days of application, respectively. Pesticides treatments were varied in their toxicity against *T. absoluta* after 1, 3, 5, 7, 10 and 15 days of application. It was found the percentage of infestation of *T. absoluta* in Tracer treatment was higher than those in the other treatment while the lowest percentage of infestation after application was found in Dipel 2x treatments.

Mean of percentage of infestation in the different treatments was ranged from 35.69 to 71.87 compared to 88.24 % in control treatment. Dipel 2x and Lannate were the most effective compounds against *T. absoluta*, followed by Avaunt and Radiant. Tracer was the least effective, which recorded high mean of percentage of infestation reached to 71.87% compared to 88.24% in control treatment.

Table (2) showed the percent of reduction in the infestation in tomato leaves calculated after 1, 3, 5, 7, 10 and 15 days of treatment. The percent of reduction in infestation of *T. absoluta* indicated that Dipel 2x and Lannate caused high reduction. Tracer was the lowest effective of tested pesticides against *T. absoluta* larvae during experimental periods. It was found that the highest mean of reduction in infestation was associated with Dipel 2x, whereas the lowest level was associated with Tracer. All applied pesticides could be categorized into three groups according to the mean of percent reduction in infestation. The first group containing Dipel 2x (54.88%) and Lannate (51.13%), which gave more than 50% of reduction. The second group including Avaunt (39.83%) and Radiant (41.41%) which induced middle effect. The third group contained Tracer, which caused lowest protection for tomato seedling with mean of percent reduction in infestation reached to 12.18 %.only. Results indicated that Dipel 2x and Lannate were the most efficient compounds in reducing the infestation of *T. absoluta* larvae in the first season of tomato leaves.

In the second season 2015/2016 of tomato leaves in the different treatments as shown in Table (3). According to mean of infestation percentage, the efficacy of tested pesticides can be arranged ascendingly as Lannate (14.81%), Dipel 2x (23.16%), Radiant (26.43%), Avaunt (31.93%)

Table 1: Infestation percentage of tomato leaves by *Tuta absoluta* larva before and after application of the tested compounds during first season.

No.	Compounds	% of infestation before application	% of infestation after application at indicated days						Mean
			1 day	3 days	5 days	7 days	10 days	15 days	
1	Dipel 2x 6.4%	71.00	35.25	31.50	29.45	30.85	42.85	44.25	35.69
2	Lannate 90%	68.50	25.50	32.45	38.00	41.50	42.25	44.45	37.36
3	Avaunt 15%	69.75	43.25	56.75	33.45	24.25	62.75	60.50	46.83
4	Radiant 12%	67.25	34.56	32.25	31.00	22.15	72.00	76.25	44.70
5	Tracer 24%	73.50	67.50	63.25	62.50	72.00	76.25	89.75	71.87
6	Control	79.50	81.25	83.75	85.50	87.25	92.35	99.35	88.24

Table 2: Percent reduction in infestation of *Tuta absoluta* larva after application of the tested compounds during first season.

No.	Compounds	Rate	% of infestation reduction at indicated days after application						Mean
			1 day	3 days	5 days	7 days	10 days	15 days	
1	Dipel 2x 6.4%	200gm	51.42	57.89	61.43	60.41	48.05	50.13	54.88
2	Lannate 90%	120gm	63.58	55.03	48.42	44.80	46.90	48.07	51.13
3	Avaunt 15%	25ml	39.33	22.77	55.41	68.32	22.55	30.59	39.83
4	Radiant 12%	100ml	49.72	54.48	57.14	69.99	7.83	9.27	41.41
5	Tracer 24%	30ml	10.14	18.31	20.93	10.74	10.69	2.29	12.18

Table 3: Infestation percentage of tomato leaves by *Tuta absoluta* larva before and after application with tested compounds during second season.

No.	Compounds	% of infestation before application	% of infestation after application at indicated days						Mean
			1 day	3 days	5 days	7 days	10 days	15 days	
1	Dipel 2x 6.4%	106	45.75	38.75	11.25	16.5	15.25	11.45	23.16
2	Lannate 90%	99	22.75	19.0	17.0	11.6	10.0	8.5	14.81
3	Avaunt 15%	93	46.7	38.4	21.5	12.0	18.45	21.5	26.43
4	Radiant 12%	80	63.5	37.0	24.7	15.1	27.8	23.5	31.93
5	Tracer 24%	69	58	38.7	31.0	29.2	25.1	23.5	34.25
6	Control	70	87	92	112	119	103	98	101.83

Table 4: Percent reduction in infestation of *Tuta absoluta* larva after application with tested compounds during second season.

No.	Compounds	Rate	% of infestation reduction at indicated days after application						Mean
			1 day	3 days	5 days	7 days	10 days	15 days	
1	Dipel 2x 6.4%		65.27	72.19	93.37	90.84	90.22	92.28	84.03
2	Lannate 90%		81.51	85.40	89.27	93.11	93.14	93.87	89.38
3	Avaunt 15%		59.60	68.58	85.55	92.41	86.52	83.49	79.36
4	Radiant 12%		36.14	64.81	80.70	88.90	76.38	79.02	70.99
5	Tracer 24%		32.37	57.33	71.92	75.11	75.28	75.67	64.61

and then Tracer (34.25%).

Regarding the efficacy mean of the examination periods, it is clearly evident that Lannate proved to be superior to all other treatments, which gave (89.38%) reduction to *T. absoluta* larvae, while Tracer was the last one, which cause (64.61%) reduction. The mean of percent reduction of *T .absoluta* infestation reached to 84.03, 79.36, and 70.99 %in the treatments of Dipel 2x, Avaunt and Radiant, respectively (Table 4).

DISSCUSION

Many studies have shown that chemical pesticides are more effective than biological pesticides however, the use of chemical insecticides to control this pest caused several problems such as pollution and toxicity to human and environment, harmful pesticide residues in plant, development of resistance from pest against pesticides and non-selectivity to other useful pest. Therefore, the bio-insecticides can be best alternative to avoid all these issues (Erasmus et al., 2021). Barham et al. (2012) found that chemical insecticides induced residual problems with possibility of pest resistance development and environmental pollution. Also, tomato borer resistance has been reported for the widely used chemical such as spinosad (Haddi et al., 2012; Guedes and Siqueira, 2013; Campos et al., 2015; Ferracini et al., 2019).

During the present study we therefore, compared the efficiency of two types of pesticides; biological pesticides (Dipel 2x 6.4% SC (*Bacillus thuringiensis*), Radiant 12% SC (spinetoram) and Tracer 24% SC (spinosad)) and chemical pesticides (Lannate 90% SC (Methomyl) and Avaunt 15% SC (indoxacarb)) against tomato leaf miner *T. absoluta*. The percent of infestation before spraying in the treatments with Dipel 2x 6.4%, Lannate 90%, Avaunt 15%, Radiant 12% and Tracer 24% were 71.00, 68.50, 69.75, 67.25 and 73.50 % respectively. These results confirmed that this trail was conducted during the high level of infestation of *T. absoluta* and there was similarity in the percentage of infestation in the different treatments before spraying. After praying, Dipel 2x showed the highest effect followed Radiant and Tracer with lowest effect while Lannate showed the best effect off the used chemical pesticides followed by Avaunt with moderate in controlling of *T. absoluta*. In this study the tested pesticides; bio-insecticide Dipel 2x 6.4% provide excellent control against *T. absoluta.*, that agree with, the result of Hanafy and El-Sayed (2013) show that bio-pesticides were more effective than the chemical pesticides. Also, Lo Bue et al. (2012) resulted show that only combination of *Azadirachin* and *B. thuringiensis* was able to reduce impact of tomato leaf miner and the bio-insecticides are a good alternative to chemical insecticides. Hafsi et al. (2012) informed that *B. thuringiensis* had an impact on *T. absoluta* and could be used instead of chemical insecticides.

Gonzales-Cabrera et al. (2011) and Ladurner et al. (2011) found that *B. thuringiensis* are able to reduce the impact of *T. absoluta* to very low levels. This is in agreement with result of Nazarpour et al. (2016) who reported that *B. thuringiensis* significantly suppressed the larval density and caused significant reduction in leaf, stem and fruit damage. Also, Reda and Hatem (2012) reported that the bio-pesticides compound *B. thuringiensis* proved the most potent against larvae of *T. absoluta*. Conversely, Moussa et al. (2013) show that a bio-pesticide *B. thuringiensis* provides moderate control.

Although, Radiant and Tracer were belonging the same group (Spinosyn) but their efficacy varied, where Radiant was more potent than Tracer against *T. absoluta*. Conversely, the results of Barakat et al. (2015) showed that the highest reduction percentage of larvae occurred by Tracer. Also, Braham and Hajji (2012) showed that spinosad was effective in ratio of 91% on *T. absoluta*. Conversely, Nannini et al. (2011) found that spinosad proved to be highly effective against tomato borer larvae *T. absoluta*.

Lannate and Avaunt are chemical pesticides where, Lannate was more effective than Avaunt against *T. absoluta*. While, the result of Moussa et al. (2013) show that chemical pesticides provide excellent control against *T. absoluta*, while a biopesticide *B. thuringiensis* provide moderate control. Derbalah et al. (2012) show high efficacy of indoxacarb against *T. absoluta*. Soliman et al. (2014) showed that Lannate and Avaunt were effective in ratio of 80% and 78%, respectively on *T. absoluta*. Nazarpour et al. (2016) reported that significant short term effect of indoxacarb on the pest larvae. Indoxacarb reduced *T. absoluta* density and damage. Santos et al. (2011) reported that indoxacarb was numerically the best treatment reaching 96.1% mortality three days after application and 93.6% mortality seven days after application.

In conclusion *T. absoluta* can cause sgnficant threat to agricultural production and first choice to management strategy was applying chemical insecticides which can cause several problems to the human and envirment in addition to insecticides resistance. The results of the present study indicated that biopesticides could be used as best alternatives to ovoide the problems of chemical insecticides.

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CONFLICT OF INTEREST

No conflict of interest

AUTHORS CONTRIBUTION

Amany R. Sultan: Conceptualization, Methodology, Investigation, Data Curation, Writing - original draft. Gamal A. Morsi and Hoda El-Fayoumi: Validation, Formal analy-

sis, Writing - original draft.Abdel-Azeem S. Abdel-Baki: Conceptualization, Methodology, Data Curation, Writing - original draft and revising the final version.

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