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Toxic effect of tomato leaves extract against the leaf miner *Tuta absoluta* (Lepidoptera: Gelechiidae) and the cotton leafworm *Spodoptera littoralis* (Lepidoptera:Noctuidae)

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Abstract:

Tomato is one of the most important vegetable crops in Egypt. The present study aims to evaluate the unused part of the tomato plant, leaves, as a botanical and non-toxic pesticide. The leaf miner *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) and the cotton leafworm *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) are the most serious lepidopterous pests on the tomato crop. Also, these two insect pests have awide host range. *T. absoluta* larvae can cause yield losses of up to 80 - 100% by attacking all parts of tomato crops. While *S. littoralis* is a polyphagous and cosmopolitan pest and it can causes an estimated loss of 25.8 to 100% in crop production. Due to the problems of chemical pesticides to all organisms and environment, natural control replaced pesticides. Tomato extract contains many contents of phenolic and flavonoid compounds which were effective in control. Different concentrations of tomato extract were applied in control of *T. absoluta* and *S. littoralis* and caused high mortality proportion. In the present study, LC_{50} was 606.34 ppm for *T. absoluta* and 1161.76 ppm for *S. littoralis*. Although LC_{50} for *T. absoluta* is lower than it in *S. littoralis* and is affected highly with the tomato extract, but the extract of tomato leaves as unused part of plant crop and without any cost, so it considered a great botanical pesticide for controlling serious pests as *T. absoluta* and *S. littoralis*.

Introduction

Tomato (*Lycopersicon* spp.) is one of the most important edible andnutritious vegetable crops in Africa; it grows both on asmall and commercial large scale as a cash crop by thevegetable growers (FAOSTAT, 2010). One of the most important insect pests that are constraining tomato production is the tomato leaf miner *Tuta absoluta* (Meyrick) and the cotton leafworm *Spodoptera littoralis* (Boisd.). The tomato leaf miner *Tuta absoluta* (Lepidoptera: Gelechiidae), originated in South America and is a significant pest of tomato. Currently, Egyptian tomato fields were infested with *Tuta absoluta* since 2009 and it became one of the economic pests of tomato and other Solanaceous plants (NAPPO, 2012). *T. absoluta* larvae can cause yield losses of up to 80 -

100% by attacking tomato leaves, flowers, stems and especially fruits of tomato crops in both greenhouse and open field tomato (Desneux *et al*., 2010). *S. littoralis* (Lepidoptera: Noctuidae) is a polyphagous pest of many economically important crops such as cotton, groundnut, soybean tomato, sweet potato etc. (Senrung *et al*., 2014).

Chemical control tactics have been the primary method for managing infestation, but this strategy has become less effective due to development of insecticide resistant population (Siebert *et al.,* 2012). Occurring often slow acting crop protectants are usually safer to humans and the environment than conventional pesticides. Therefore, the use of botanical insecticides has been recommended ever more as a suitable alternative of plant protection with minimum negative risk (Isman *et al.*, 2007). Tomato is a good source of phenolic compounds, pigments, antioxidants and other nutrients, these compounds prevent oxidative changes in cell by reducing the level of free radicals (Norma *et al*., 2015). The aim of this study was to determine the toxicity of tomato leaves extract on *T. absoluta* and *S. littoralis.*

Materials and methods

1. Insects:

1.1. Rearing of *Tuta absoluta:*

Tomato leaves including *T. absoluta* were collected form the unsprayed farm of Agriculture College, Mansoura University (Dakahlia, Egypt). The larvae was reared for two generations before the beginning of the tests on leaves of unsprayed tomato which were provided daily, in laboratory under constant conditions of 25 ± 2°C, photoperiod of 14 h light and 10 h dark and 70±10 % RH. The adults were kept separately and mated on the third day of emergence in clean jars (4 lb.) adults were fed on 10% honey solution, fresh green leaves of unsprayed tomato were provided for egg laying (Bajonero and Parra, 2017).

1.2. Rearing of *Spodoptera littoralis*:

A laboratory strain of cotton leafworm, *S. littoralis* (Lepidoptera: Noctuidae) (maintained on above 30 generations) which was initiated from freshly collected egg-masses supplied from the division of cotton leafworm of Plant Protection Research Institute (PPRI), Dokki, Egypt. Larval stages were reared on castor leaves, which were provided daily, in laboratory under constant conditions of 27 ± 2°C, photoperiod of 14 h light and 10 h dark and 65 ± 5% RH. The adult were kept separately and mated on the third day of emergence in clean jars (4 lb.), adults were fed on 10% honey solution, fresh green leaves of tafla, *Nerium oleander* (L.) were provided for egg laying.

2. Preparation of plant sample and extraction:

Leaves of tomato plant, 961 sorts, were left to dry at room temperature for one month then the dried leaves were grinded into fine powder. Powder was soaked in a mixture of hexane, acetone and ethanol solvents of equal proportion (1:1:1) in a flask for about one week. Finally, the flask was shaked in a shaker and its contents were filtered. The solvents were evaporated under reduced pressure and the crude extract was weighted and kept in deep freezer until use.

2.1. Preparing the stock solution of the tested plant extract:

Convenient stock, concentrations of tomato extract, was prepared on basis of the tested plant weight and the volume of the distilled water (w/v) in the presence of tween 80 (0.1%) as emulsifier. The stock concentrations were kept in glass

stoppered bottles and stored under refrigeration. Such stock solutions were prepared periodically. Four diluted concentrations for the plant extract for each insect pest were used to draw the LC-P Lines. Four replicates were used for each concentration.

3. Method of application:

3.1. Spray method:

The 3rd instar larvae of the *T. absoluta* were used for application. Four concentrations were used as well as four replicates for each concentration. Ten individuals of larvae for each replicate were applied to estimate the mortality line. Different concentrations were sprayed directly on the leaves contains the larvae. The concentrations used were 250, 500, 1000 and 2000 ppm. The same number of leaf discs per treatment was dipped into distilled water water as an untreated check. The percentage of mortality was recorded after one, three, five and seven days and the data were corrected relatively to control mortality (Abbott, 1925). LC_{50} values were determined using probit analysis statistical method of (Finney, 1971).

3.2. Leaf dipping method:

The 2nd instar larvae were used to determine the toxicity action of the tomato leaves extract. Tomato leaf discs were cut and dipped into the treatments for 20 seconds, then left for air dryness, 10 larvae for each replicate were released to each leaf disc placed. Four concentrations and three replicates were used to estimate each concentration-mortality line. The concentrations used were 500, 1000, 2000 and 4000 ppm. The same number of leaf discs per treatment was dipped into distilled water water as an untreated check. Before and after treatment, larvae were maintained under laboratory conditions (constant temperature 25 ±2 °C and 70 ± 5 % RH. After 24 h of treatment.The percentage of mortality was recorded after one, three, five and seven days.The data were corrected relatively to control mortality (Abbott, 1925). LC_{50} values were determined using probit analysis statistical method of Finney (1971).

Equation: Sun, 1950 (to determine LC_{50} index**)**

Toxicity index for LC_{50} =

$$\frac{LC_{50} \text{ of the most effective compound}}{LC_{50} \text{ of the least effective compound}} \times 100$$

Results and discussion

The data in Table (1) demonstrated that, although the extract concentrations were low, the mortality rate of the larvae of *T. absoluta* was high and when the concentrations increased, the total mortality increased. Also, the mortality rate of 2nd instar larvae of S. littoralis was high especially with high concentations. The used concentrations in *T. absoluta* were 250, 500, 1000 and 2000 ppm. While, in *S. littoralis,* the used concentrations were 1000, 2000, 4000 and 8000 ppm. This means that, the cooperated concentrations between *T. absoluta* and *S. littoralis* were 1000 and 2000 ppm. The total mortality rates in concentration 1000 ppm were 66.67 and 46.66 % against *T. absoluta* and *S. littoralis*, respectively. Also, the total mortality rates in concentration 2000 ppm were 83.33 and 66.67 % against *T. absoluta* and *S. littoralis*, respectively. So, the effect of tomato leaves extract was more effective on larvae of *T. absoluta* than *S. littoralis*. The effectiveness of tomato leaves extract in controlling of pests was in agreement with Abd- Allah *et al.* (2017) which proved the effectiveness of tomato leaves extract on *Aphis gossypii*.

Table (1): Corrected mortality % of 3rd instar larvae of *Tuta absoluta* and 2nd instar larvae of *Spodoptera littoralis* treated with tomato leaves extract under laboratory conditions 27±2 ◦C and 65±5% RH.

Treatment	Conc. (ppm)	Mortality after treatments %				Total Mortality %
		One day	Three days	Five days	Seven days	
Tuta absoluta	250	3.33	3.33	10	6.67	23.33
	500	10	3.33	20	10	43.33
	1000	16.67	3.33	30	16.67	66.67
	2000	30	10	33.33	10	83.33
Spodoptera littoralis	1000	-----	3.33	20	23.33	46.66
	2000	-----	20	23.33	23.33	66.67
	4000	-----	20	26.67	26.67	73.34
	8000	6.67	26.67	30	30	93.34

Tuta absoluta* (Lepidoptera: Gelechiidae) and the cotton leafworm *Spodoptera littoralis

However, the results in Table (2) and Figure (1) demonstrated that, LC_{50} was 606.34 ppm and 1161.76 ppm for *T. absoluta* and *S. littoralis*, respectively. LC_{90} was 2888.98 and 7844.91 ppm for *T. absoluta* and *S. littoralis*, respectively. The toxicity index was 100% and 52.19 % for *T. absoluta* and *S. littoralis*, respectively. The previous results proved that, the extract of tomato leaves was very effective in controlling the most dangerous lepidopterous pests on tomato plants, but *T. absoluta* was more affected with tomato leaves extract than *S. littoralis.* Esther *et al.* (2008) proved a significant effect of tomato extract against lycopene level of tomato. Hussein *et al.* (2015) proved the more effectiveness of plant extracts against *T. absoluta* than the effectiveness of plant extracts against *S. littoralis* (Ankita and Sangeeta, 2017).

Table (2): Efficiency of tomato leaves extract against 3rd instar larvae of *Tuta absoluta* and 2nd instar larvae of *Spodoptera littoralis*

Treatment	Conc. (ppm)	Corrected mortality%	LC_{50}	LC_{90}	Slope± S.D.	Toxicity index LC_{50}	LC_{90}/LC_{50}	R	P
Tuta absoluta	250	23.33	606.34	2888.98	1.89±0.2	100	4.76	0.999	0.982
	500	43.33							
	1000	66.67							
	2000	83.33							
Spodoptera littoralis	1000	46.66	1161.76	7844.91	1.55±0.2	52.19	6.75	0.967	0.145
	2000	66.67							
	4000	73.34							
	8000	93.34							

R: Regression P: Propability

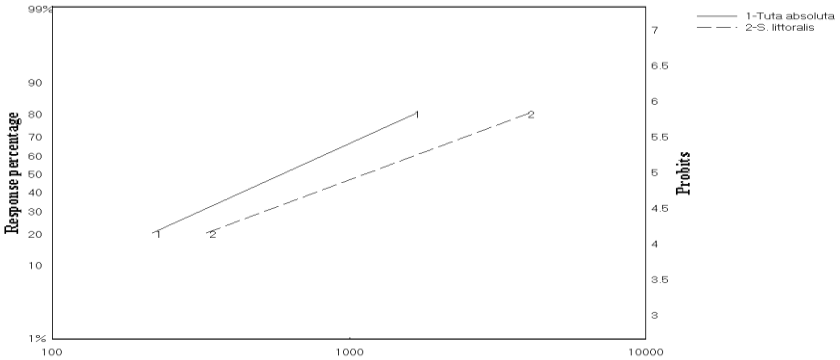

Figure (1): LC-P line for tomato leaves extract of *Tuta absoluta* and *Spodoptera littoralis.*

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