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Toxicity of tomato and globe artichoke leaves extracts against cotton mealy bug
Phenacoccus solenopsis (Hemiptera: Pseudococcidae)

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Abstract

Phenacoccus solenopsis Tinsley (Hemiptera: Pseudococcidae) is a destructive pest for many crops. This study is concerned mainly with testing the toxicity of leaf extract of two main crops, tomato and globe artichoke. The fruits of the two crops are very useful for consumption and marking likewise, but their leaves were being burnt causing pollution to the environment. The leaf extract of tomato had high effect on *P. solenopsis* than the leaf extract of globe artichoke with LC₅₀ 134.86 ppm and 292.13 ppm, respectively. While LC₉₀ was 820.68 and 1312.75 ppm for tomato extract and globe artichoke extract, respectively. When LC₉₀ was applied to *P. solenopsis* in the field, tomato extract caused highly reduction with a percentage 91.5%, however the reduction for artichoke leaf extract was 90.1%.

Introduction

The cotton mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) is a serious polyphagous pest with many host ranges. *P. solenopsis* cause major damage to many crops such as cotton, okra and tomato. Being a polyphagous pest, *P. solenopsis* has been reported to feed on many cultivated crops including weeds (Patel *et al.*, 2009).

Dependence on synthetic chemicals for controlling pests has been given destruction of beneficial organisms, such as parasitoids and predators so that effects on food chain and biological diversity. Additionally, they affect health and environment causing pollution (Nas, 2004).

Botanical pesticides are biodegradable materials (Devlin and Zettel,

1999) and their use in plant protection is a practical alternative because it maintains the biological diversity of parasitoids and predators (Grange and Ahmed, 1988). They also reduce environmental contamination and hazards to human health. As soon as, botanicals are safe for greenhouses and home gardens.

The present study aims to study the toxicity of the unused parts of plants as tomato and globe artichoke leaves for controlling the cotton mealybug, *P. solenopsis*, and apply LC₉₀ on cotton crop that infected with *P. solenopsis*.

Materials and methods

1. Insect rearing:

P. solenopsis individuals were collected from infested cotton plants (*Gossypium barbadense* var. Giza 86) at the

field of Dekernes district, Dakahalia Governorate, Egypt. Then transferred to the laboratory, and sprouting potato tubers were used as a host plant for its rearing. Each of sprouted potato was infested with an adult female and then observed daily (Attia and Ebrahim, 2015). Additionally, newly hatched crawlers of *P. solenopsis* were put on each sprouted potato before being restricted in a carton cylindrical box of about 8 cm long and 12 cm diameter. The boxes were kept at 30 °C and 60 ± 5% RH.

2. Preparation of plant sample and stock solution:

Leaves of tomato and globe artichoke were left to dry at room temperature for about one month then these leaves were grinded into fine powder. The powder of each kind was soaked in a mixture of petroleum ether, acetone and ethanol solvents of equal proportion (1:1:1) in a flask for a week. Then, each flask was shaken in a shaker and the contents were filtered and the solvents were evaporated under reduced pressure; then the crude extracts were weighed and kept in deep freezer until use.

The concentration of each extract was prepared on the basis of tested plant weight and volume of distilled water in the presence of tween 80 as emulsifier. The stock concentrations were maintained in glass stoppered bottles and then stored under refrigeration. Four diluted concentrations of the plant extract were prepared and used to draw the LC-P lines. Three replicates for each concentration were used.

3. Laboratory experiment:

For testing each extract, thirty newly emerged adults of *P. solenopsis*, in each experiment, were placed on okra leaves in each petri dish and each extract had four concentrations. The concentrations for globe artichoke leaves extract were 250, 500, 1000 and 5000 ppm. However, concentrations for tomato leaves extract were 100, 250, 500 and 1000 ppm. The concentrations were sprayed

directly on the mealy bug individuals. Mortality was recorded for 7 days after treatment and the mortality percentages were estimated and corrected according to Abbott (1925). LC₅₀ values were determined using statistical method of Finney (1971).

Sun Equation (Sun, 1950) (To determine LC₅₀ index)

Toxicity index for

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

4. Field experiment:

After calculating LC₉₀ for each material, each LC₉₀ was sprayed in cotton field which is infected with *P. solenopsis* to detect the reduction in the mealybug infestation. This field is known as free of insecticides. The individuals were calculated before spraying and after 1, 3, 7, 10 and 14 days. Reduction percentage was calculated by Henderson and Tilton (1955) as follow:

$$\text{Reduction mortality \%} = \left[1 - \frac{(T_a \times C_b)}{T_b \times C_a} \right] \times 100$$

However:

C_b is the number of alive individuals in control before treatment.

C_a is the number of alive individuals in control after treatment.

T_a is the number of alive individuals after treatment.

T_b is the number of alive individuals before treatment.

Results and discussion

1. Laboratory experiments:

1.1. Efficiency of tomato and globe artichoke leaves extract on *Phenacoccus solenopsis*:

Data in Table (1) illustrated that, the mortality rates of the adults of *P. solenopsis* for globe artichoke extract at concentrations 250, 500, 1000 and 5000 ppm were 40, 70, 90 and 97.5%, respectively. While at concentrations of 100, 250, 500 and 1000 ppm, the mortality rates were 47.5, 60, 77.5 and 97.5%, respectively with tomato leaves extract. Ghada *et al.* (2017) proved the effectiveness of tomato leaves extract against *A. gossypii*. Abd-Allah and Youssef (2020) found that, *P. solenopsis* effected by different plant extracts.

Table (1): Corrected mortality % of the adults of cotton mealybug *Phenacoccus solenopsis* treated with tomato and globe artichoke leaves extract.

Treatments	Conc. (ppm)	Mortality after treatments %				Total Mortality %
		One day	Three days	Five days	Seven days	
Globe artichoke leaves extract	250	2.5	27.5	5	5	40
	500	5	30	25	10	70
	1000	10	35	40	5	90
	5000	42.5	20	35	----	97.5
Tomato leaves extract	100	----	7.5	30	10	47.5
	250	2.5	30	20	7.5	60
	500	2.5	40	35	----	77.5
	1000	25	32.5	37.5	2.5	97.5

Moreover, Table (2) and Figure (1) detected that, LC₅₀ was 134.86 ppm and 292.13 ppm for tomato extract and globe artichoke extract, respectively. While, LC₉₀ was 820.68 and 1312.75 ppm for tomato extract and globe artichoke extract, respectively. Slope values were 1.63 and 1.96 for tomato extract and globe artichoke extract, respectively. LC₉₀/LC₅₀ values were 6.09 and 4.49 for tomato extract and globe artichoke extract, respectively. So, the highest slope value or the lowest ratio LC₉₀/LC₅₀ means the steepest toxicity line.

Toxicity index at LC₅₀ was 100% and 46.47% for tomato extract and globe artichoke extract, respectively.

Ghada *et al.* (2019) demonstrated that, tomato leaves extract had the highest effect on *Spodoptera littoralis* (Boisduval) (Lepidoptera: Noctuidae) and *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). Additionally, Abd-Allah (2022) illustrated that, globe artichoke extract had the lowest effect on *P. solenopsis*.

Table (2): Efficiency of tomato and globe artichoke leaves extract against *Phenacoccus solenopsis*.

Treatments	Conc.	Corrected mortality %	LC ₅₀	LC ₉₀	Slope± S.D.	Toxicity index LC ₅₀	LC ₉₀ /LC ₅₀
Globe artichoke leaves extract	250	40	292.13	1312.75	1.96± 0.25	46.166	4.49
	500	70					
	1000	90					
	5000	97.5					
Tomato leaves extract	100	47.5	134.86	820.68	1.63± 0.20	100	6.09
	250	60					
	500	77.5					
	1000	97.5					

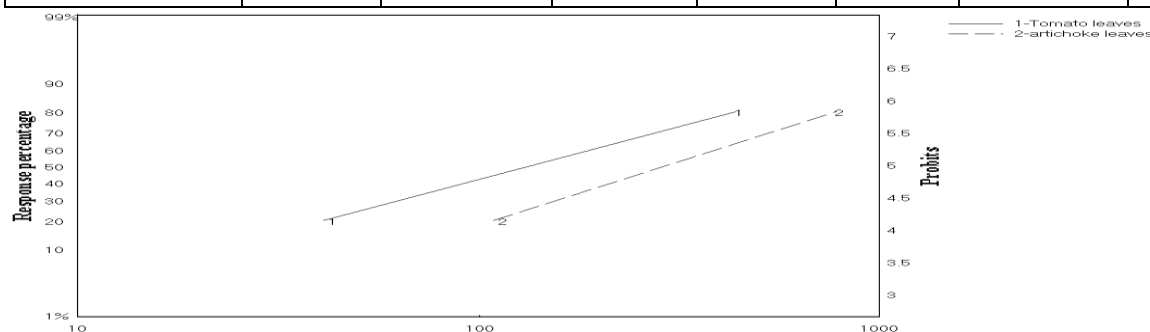


Figure (1): LC-P line for tomato and globe artichoke leaves extract of *Phenacoccus solenopsis*.

2. Field experiment:

Table (3) proved that, tomato leaves extract (TLE) had the highest effect than artichoke leaves extract (ALE) with reduction 71.7% and 67.1% after 24 hours, respectively; 94.1% and 92.8% after 3 days, respectively; 96.3% and 96.2% after 7 days, respectively;

97.5% and 97.3% after 10 days, respectively and then 98.1% and 96.8%, respectively. Ghada *et al.* (2019) proved the effectiveness of tomato leaves extract when applied to *T. absoluta* and *S. littoralis*.

Table (3): Reduction of *Phenacoccus solenopsis* treated with tomato and globe artichoke leaves extracts.

Treat.	1 st replicate		Red. %	2 nd replicate		Red. %	3 rd replicate		Red. %	4 th replicate		Red. %	Treatment efficiency		Total Red. %
	Pest number			Pest number			Pest number			Pest number			Pest number		
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	
After 24 hours															
T.L.E.	140	24	83.1	127	36	72.21	94	46	51.1	149	30	80.6	127.5	34	71.7
A.L.E.	127	30	76.7	240	51	79.2	176	48	72.73	69	43	39.9	153	43	67.1
Control	260	263		302	308		205	205		210	218				
After 3 days															
T.L.E.	140	11	91.9	127	10	92.6	94	5	97.3	149	9	94.5	127.5	8.8	94.1
A.L.E.	127	17	86.4	240	8	96.9	176	15	95.7	69	6	92.1	153	11.5	92.8
Control	260	255		302	321		205	410		210	230				
After 7 days															
T.L.E.	140	3	96.9	127	4	95.7	94	4	95.1	149	4	97.5	127.5	3.8	96.3
A.L.E.	127	4	95.6	240	6	96.6	176	5	96.7	69	3	95.9	153	4.5	96.2
Control	260	185		302	223		205	177		210	223				
After 10 days															
T.L.E.	140	3	98.1	127	4	97.4	94	4	97.2	149	4	97.2	127.5	3.8	97.5
A.L.E.	127	3	97.8	240	7	97.6	176	4	98.5	69	3	95.4	153	4.3	97.3
Control	260	281		302	372		205	314		210	198				
After 14 days															
T.L.E.	140	3	98.2	127	2	98.4	94	3	96.6	149	1	99.1	127.5	2.3	98.1
A.L.E.	127	3	98	240	6	97.4	176	4	97.6	69	3	94.1	153	4	96.8
Control	260	307		302	295		205	191		210	155				

Tomato leaves extract (TLE) Artichoke leaves extract (ALE)

Table (4) demonstrated that, the mean of total reduction of tomato leaves extract was higher than artichoke extract and reported 91.5% and 90.1%, respectively.

Abd-Allah (2022) illustrated that artichoke extract achieved 70% mortality with 20.000 ppm and its LC₅₀ 13.5 ppm when applied to *P. solenopsis* in laboratory.

Table (4): Mean of total reduction%.

Treatments	Red. after 1 day%	Red. after 3 days%	Red. after 7 days%	Red. after 10 days%	Red. after 14 days%	Mean of total reduction%
T.L.E.	71.7	94.1	96.3	97.5	98.1	91.5
A.L.E.	67.1	92.8	96.2	97.3	96.8	90.1

Tomato leaves extract (TLE) Artichoke leaves extract (ALE)

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