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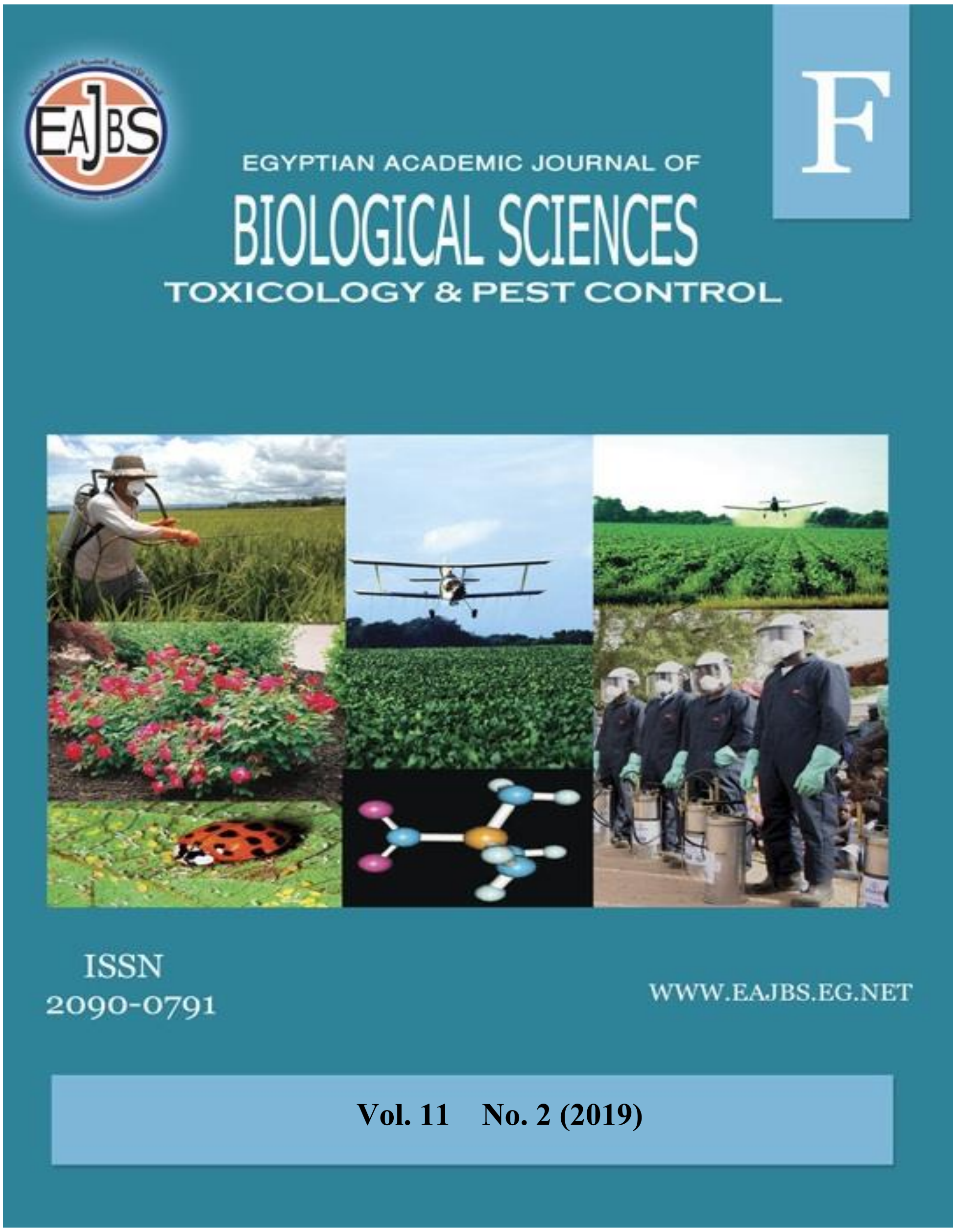

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The Toxic Effect of Magnetic and Non- Magnetic Cinnamic Essential Oil against the Cotton Leafworm, *Spodoptera littoralis*

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ABSTRACT

In lab-experiment to declare the effect of static magnetism on the essential cinnamic oil and comparing its effect with non- magnetic cinnamic essential oil and the insecticide, cymax 50% on 2nd instar larvae of the cotton leafworm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae). Due to the problems of chemical pesticides to all organisms and environment, natural control replaced pesticides. Results proved that magnetic cinnamic oil is the most effective material than the non- magnetic cinnamic essential oil and the insecticide cymax 50% with LC_{50} 926.57 ppm 4636.11 ppm for magnetic and non-magnetic cinnamic oil, respectively. Although LC_{50} for cymax 50% was 101.65 ppm, which was lowest than magnetic and non- magnetic cinnamic oil, but the highest concentration of this insecticide caused only 50% mortality for 2nd instar larvae of *S. littoralis*, in addition to its toxicity on plants, people and environment. So the magnetism which improved the properties of essential cinnamic oil proved its effectiveness on 2nd instar larvae of *S. littoralis*.

INTRODUCTION

Spodoptera 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). *S. littoralis* is widely distributed throughout the Middle East, East Asia, Oceania, and the Pacific Islander, and is found in climates ranging from tropical to temperate (Fu *et al*., 2015).

Chemical control is the most common method of *S. littoralis* management because of its ease of use and reliability (Zhou *et al*., 2011). However, *S. litura* is capable of developing resistance to various classes of insecticides (Su *et al*., 2012). The intensive use of insecticides for the control of this pest has resulted in high levels of resistance to almost all commercial insecticides available for its control worldwide (Rehan and Freed 2014; Babu *et al*. 2015). Therefore, the use of effective insecticides to control *S. littoralis* is a continuing need. Therefore, the use of botanical insecticides has been recommended as a suitable alternative of plant protection with minimum negative risk (Isman, 2007).

Cinnamon oil extracted from the cinnamon tree also is used widely (Rao & Gan 2014; Xing *et al*., 2014), although it is mostly known for its antimicrobial activity (Echegoyen & Nerin, 2015). For example, Al-Othman *et al*. (2013) found that cinnamon oil had respectable inhibitory effect on the fungi *Aspergillus flavus* Link (Trichocomaceae).

Magnetism and using magnetic field seems to be promising physical method in pest control (Hussein *et al*., 2014). Recently we have to focus some light on magnetism and the effect of electro-magnetic waves on the different biological aspects of insects. The aim of this study was to compare the toxicity of magnetic cinnamic oil, non- magnetic cinnamic oil and the insecticide, cymax 50% against *S. littoralis.*

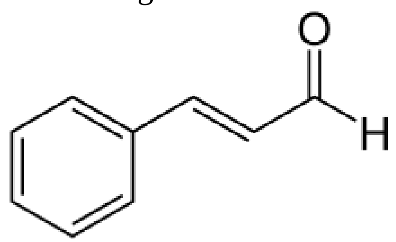
MATERIALS AND METHODS

Insects:

Rearing of *S. 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% R.H. 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 laying eggs.

Cinnamic oil was bought from Essential oil Extracts Center, National Research Center. Cinnamaldehyde, C_9H_8O is the active ingredient of cinnamic oil.



Cinnamaldehyde formula ***(Vogt, 2010)***

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The magnetic flux of cinnamic oil was measured with Magnetizing Battery apparatus which was 180 ml tesla.

The insecticide Cymax 50% SP, Cyromazine, is used for comparison, concentrations were 40, 60, 80 and 100 ppm.

Preparing the Stock Solution of the Tested Materials:

Concentrations of magnetic cinnamic oil, non- magnetic cinnamic oil, and the insecticide were prepared on basis of the tested plant weight and the volume of the distilled water (w/v). Tween 80 (0.1%) used as an emulsifier (in case of cinnamic essential oil). 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 essential oil and the insecticide were used to draw the LC-P Lines. Four replicates were used for each concentration.

Method of Application:

Leaf Dipping Method:

2nd instar larvae were used to determine the toxicity action of the tested materials. Castor bean 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 1000, 5000, 10000 and 15000 ppm (for magnetic and non- magnetic cinnamic oil), however, the concentrations were 40, 60, 80 and 100 ppm for cymax 50%. The same number of leaf discs per treatment was dipped into dis. water as an untreated check. Before and after treatment, larvae were maintained under

laboratory conditions (constant temperature 25 ±2 °C and 70± 5 % R.H. 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)

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

RESULTS AND DISCUSSION

Toxicity Effect:

Efficiency of Magnetic Cinnamic Oil, Non- Magnetic Cinnamic Oil and Cymax 50% against Larvae of *S. littoralis*:

The data in Table (1) demonstrated that, the insecticide Cymax 50% has no effect on 2nd instar larvae of *S. littoralis* with all concentrations 40, 60, 80 and 100 ppm, although, 100 ppm was the highest concentrations of Cymax, mortality rate was 50% only against 2nd instar larvae of *S. littoralis*. The non- magnetic cinnamic oil with concentrations 1000, 5000, 10000 and 15000 ppm recorded high mortality proportion against 2nd instar larvae of *S. littoralis* especially when the concentrations increased. However, magnetic cinnamic oil with the same concentrations of non- magnetic cinnamic oil recorded very high proportion of mortality against *S. littoralis*. Mortality rate in concentration 1000 ppm was 53.33 and 33.33 % with magnetic and non- magnetic cinnamic oil, respectively. Also, in concentration, 5000 ppm, mortality rate was 66.67 and 43.33% with magnetic and non- magnetic cinnamic oil, respectively. In concentration 10000 ppm, the mortality rate was 76.67 and 60 % with magnetic and non- magnetic cinnamic oil, respectively. While, in 15000 ppm concentration, the mortality rate was 86.67 and 70% with magnetic and non- magnetic cinnamic oil, respectively. The previous results proved that, the effect of magnetic field on cinnamic oil caused high mortality rate of 2nd instar larvae of *S. littoralis* comparing with the non- magnetic essential cinnamic oil and the insecticide Cymax 50%.The effectiveness of magnetism on improvement of materials was in agreement with Hussein *et al.*, (2017) which proved the effectiveness of magnetism on sea water in controlling *Tetranychus urticae*.

Table 1: Mortality % of 2nd instar larvae of *S. littoralis* treated with cinnamic oil, magnetic cinnamic oil and insecticide cymax 50% under laboratory conditions.

No.	Treatments	Conc. (ppm)	Mortality after treatments %				Total Mortality %
			One day	Three days	Five days	Seven days	
1	Magnetic cinnamic oil	1000	23.33	23.33	3.33	3.33	53.33
		5000	16.67	23.33	3.33	23.33	66.67
		10000	23.33	30	20	3.33	76.67
		15000	30	23.33	20	13.33	86.67
2	Non-magnetic cinnamic oil	1000	13.33	6.67	3.33	10	33.33
		5000	10	10	13.33	10	43.33
		10000	20	13.33	13.33	13.33	60
		15000	20	16.67	20	13.33	70
3	Cymax 50%	40	10	6.67	3.33	0	20
		60	20	10	3.33	0	33.33
		80	26.67	10	3.33	0	40
		100	30	16.67	3.33	0	50

However, the results in Table (2) and Fig. (1) demonstrated that, LC_{50} was 926.57 ppm and 4636.11 ppm for magnetic and non- magnetic cinnamic oil, respectively. LC_{50} was 101.65 ppm for the insecticide cymax 50%. LC_{90} was 42910.54 and 209751.68 ppm for magnetic and non- magnetic cinnamic oil, respectively. 50%. LC_{90} was 430.49 ppm for the insecticide cymax 50%. Although, LC_{50} and LC_{90} of the insecticide cymax 50% were lower than LC_{50} and LC_{90} of the magnetic and non- magnetic cinnamic oil, but the insecticide cymax 50% was not safety for plants, human and environment. Moreover, the insecticide cymax 50% is not effective in control of 2nd instar larvae of *S. littoralis*. The previous results proved that, magnetic cinnamic oil was very effective in controlling 2nd instar larvae of *S. littoralis.* Hussein *et al.* (2015 and 2017) proved the effectiveness of magnetism on controlling of many pests.

Table (2): Efficiency of cinnamic oil, magnetic cinnamic oil and cymax 50% against 2nd instar larvae of *S. littoralis*

Treatments	Conc.	Corrected mortality %	LC_{50}	LC_{90}	Slope± S.D.	Toxicity index LC_{50}	LC_{90}/ LC_{50}	R	P
Magnetic cinnamic oil	1000	53.33	926.57	42910.54	0.769 ± 0.148	10.97	46.31	0.949	0.249
	5000	66.67							
	10000	76.67							
	15000	86.67							
Non-magnetic cinnamic oil	1000	33.33	4636.11	209751.68	0.774± 0.145	2.19	45.24	0.942	0.153
	5000	43.33							
	10000	60							
	15000	70							
Cymax 50%	40	20	101.65	430.49	2.044± 0.452	100	4.24	0.995	0.901
	60	33.33							
	80	40							
	100	50							

R: Regression **P: Propability**

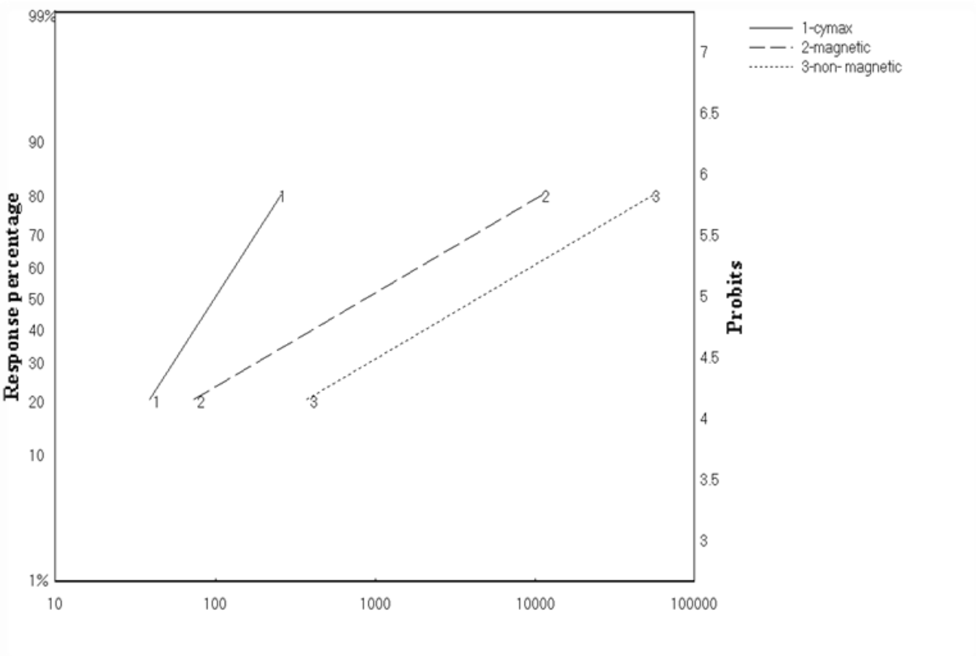

Fig. 1: LC-P line for cinnamic oil, magnetic cinnamic oil and insecticide cymax 50% against 2nd instar larvae of *S. littoralis*

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