Egypt. J. Plant Prot. Res. Inst. (2019), 2 (1): 161-164

Egyptian Journal of Plant Protection Research Institute

www.ejppri.eg.net

Toxicity of cinnamon oil and its active ingredient against the carmine spider mite, *Tetranychus cinnabarinus* (Acari: Tetranychidae)

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ARTICLE INFO

Article History
Received: 11 /2 / 2019
Accepted: 28 /3 /2019

Keywords
The carmine spider mite, *Tetranychus cinnabarinus*, cinnamon oil, cinnamaldehyde, biocontrol agent and plant extracts.

Abstract:

The carmine spider mite, *Tetranychus cinnabarinus* (Boisduval) (Acari: Tetranychidae) is a worldwide polyphagous agricultural pest and it is an economically important pest that infests greenhouse and field crops. The toxicity of cinnamon oil (*Cinnamomum zeylanicum* Blume) and its active ingredient cinnamaldehyde were studied under laboratory conditions against adult female of carmine spider mite, *T. cinnabarinus.* LC_{50} of each treatment was established and the obtained results revealed that the active ingredient cinnamaldehyde was more effective than the cinnamon oil. LC_{50} was 2521.54 and 4516.61 ppm for cinnamaldehyde and cinnamon oil, respectively, for *T. cinnabarinus*. However, the LC_{90} was 27072.28 and 48576.69 ppm for cinnamaldehyde and cinnamon oil, respectively. It is concluded that cinnamon oil as a promising save control agent for controlling the carmine spider mite, *T. cinnabarinus*.

Introduction

The carmine spider mite, *Tetranychus cinnabarinus* (Boisduval) (Acari: Tetranychidae) is one of the most significant herbivores species of the genus *Tetranychus* which includes nowadays over 140 species (Wang *et al.*, 2004 and Sertkaya *et al., 2010*). This species infests greenhouse and field crops and has been documented to feed on more than 130 plant species of economic importance, including vegetables, fruit- trees and ornamentals (Guo *et al.*, 1998 and Sivira *et al.*, 2011). *T. cinnabarinus* can damage protective leaf surface, palisade layers and cause yellowing, crinkling, crumpling, curling and twisting of leaves (Jeppson *et al.*, 1975).

Commercially available synthetic acaricides are usually expensive and may be needed to be imported for use by farmers. They also tend to have detrimental effects on the environment and can be hazardous to humans. These negative effects have resulted in an increasing interest for natural plant-based pesticides which are assumed to be safer than the synthetic pesticides (Yanar *et al*., 2011). Natural plant extracts play an increasingly prominent role as alternatives to synthetic pesticides due to the increasing concern on health hazards, environmental pollution and negative effects on non target organisms (Sharma *et al*., 2006).

Cinnamon is a common spice used by different cultures around the world for several centuries. It is obtained from the inner bark of trees from the genus *Cinnamomum*, a tropical evergreen plant that has two main varieties; *Cinnamomum*

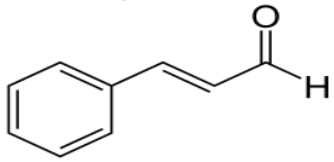
zeylanicum (CZ) and *Cinnamon cassia* (CC) (also known as *Cinnamomum aromaticum*/Chinese cinnamon) (Mazyad and Soliman, 2001). Almost every part of the cinnamon tree including the bark, leaves, flowers, fruits and roots, has some medicinal or culinary use. The volatile oils obtained from the bark, leaf and root barks vary significantly in chemical composition, which suggests that they might vary in their pharmacological effects as well (Shen *et al*., 2002). The present work was aimed to evaluate the toxicity of cinnamon oil and its active ingredient on *T. cinnabarinus*.

Materials and methods

1.Rearing the carmine spider mite, *Tetranychus cinnabarinus***:**

The carmine spider mite, *T. cinnabarinus* was collected from unsprayed castor bean plants and reared at 25± 2° C and 60± 5%RH. cinnamon oil and its active ingredient cinnamaldehyde were bought from Essential oil Extracts Center, National Research Center.

-Cinnamaldehyde, C_9H_8O.



Cinnamaldehyde formula (Vogt, 2010)

2.Preparing the stock solution of the tested materials:

Convenient stock concentrations of each material were prepared on basis of the tested material, (cinnamon oil or cinnamaldehyde powder), 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 each plant extract were used to draw the LD-P lines. Three replicates were used for each concentration.

3.Toxicity test:

The toxicity of cinnamon oil and cinnamaldehyde powder was evaluated against adult females of *T. cinnabarinus*. Thirty newly emerged adult females were transferred to the lower surface of castor leave discs (2.5 cm diameter) placed separately on moist cotton wool in petri dishes. Each petri dish contains three replicates, ten individuals in each replicate. Each acaricide had four concentrations, 1000, 5000, 7500 and 10000 ppm, which were sprayed on the individuals. Mortality was recorded for 7 days after treatment. The mortality percentage was estimated and corrected according to the Abbott's formula, 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

1.Efficiency of cinnamon oil and cinnamaldehyde on adult female of carmine spider mite *Tetranychus cinnabarinus*:

The data in Table (1) indicated that, the active ingredient, cinnamaldehyde, caused high mortality proportion on the carmine spider mite, *T. cinnabarinus* than the cinnamon oil. This is because cinnamon oil contains cinnamaldehyde (80– 90%) and other materials as eugenol, eugenol acetate, cinnamyl acetate, cinnamyl alcohol, methyl eugenol, benzaldehyde, benzyl benzoate, linalool, monoterpene, hydrocarbon, caryophyllene, safrole and others, such as pinene, phellandrene, cymene and cineol (Heath, 1978). While the active ingredient cinnamaldehyde is concentrate active ingredient powder. These results were in agreement with Tasnin and Khalequzzaman (2016).

However, Table (2) and Figure (1) demonstrated that the cinnamaldehyde was

more effective than the cinnamon oil, with LC_{50}: 2521.54 ppm and 4516.61ppm, respectively. LC_{90} value was 27072.28 ppm and 48576.69 ppm for cinnamaldehyde and cinnamon oil. The toxicity index was 100% for cinnamaldehyde while it was 55.83% for cinnamon oil. The slope values indicated that cinnamaldehyde and cinnamon oil had the same value which was 1.24. Also, LC_{90}/ LC_{50} values were 10.736 and 10.755 for cinnamaldehyde and cinnamon oil, respectively. The obtained results were in agreement with Mohammed and Hany (2013).

Table (1): Corrected mortality percent of the carmine spider mite ,*Tetranychus cinnabarinus* treated with cinnamon oil and cinnamaldehyde derivatives under laboratory conditions 25±2 ˚C and 60±5% RH.

No.	Treatments	Conc. (ppm)	Mortality after treatments %				Total Mortality %
			One day	Three days	Five days	Seven days	
1	Cinnamic oil	1000	13.33	3.33	3.33	3.33	23.32
		5000	10	16.67	13.33	3.33	43.33
		7500	10	20	16.67	13.33	60
		10000	20	20	16.67	16.67	73.34
2	Active ingredient	1000	6.67	3.33	10	13.33	33.33
		5000	16.67	26.67	10	3.33	56.67
		7500	16.67	10	26.67	16.67	71.01
		10000	20	40	13.33	10	83.33

Table (2): Efficiency of cinnamaldehyde and cinnamon oil against the carmine spider mite, *Tetranychus cinnabarinus*:

Treatments	Conc.	Corrected mortality%	LC_{50}	LC_{90}	Slope± S.D.	Toxicity index LC_{50}	LC_{90}/ LC_{50}	R	P
Cinnamic oil	1000	23.32	4516.61	48576.69	1.24± 0.178	55.83	10.755	0.952	0.061
	5000	43.33							
	7500	60							
	10000	73.34							
cinnamaldehyde	1000	33.33	2521.54	27072.28	1.24± 0.172	100	10.736	0.954	0.077
	5000	56.67							
	7500	71.01							
	10000	83.33							

R: Regression **P: Propability**

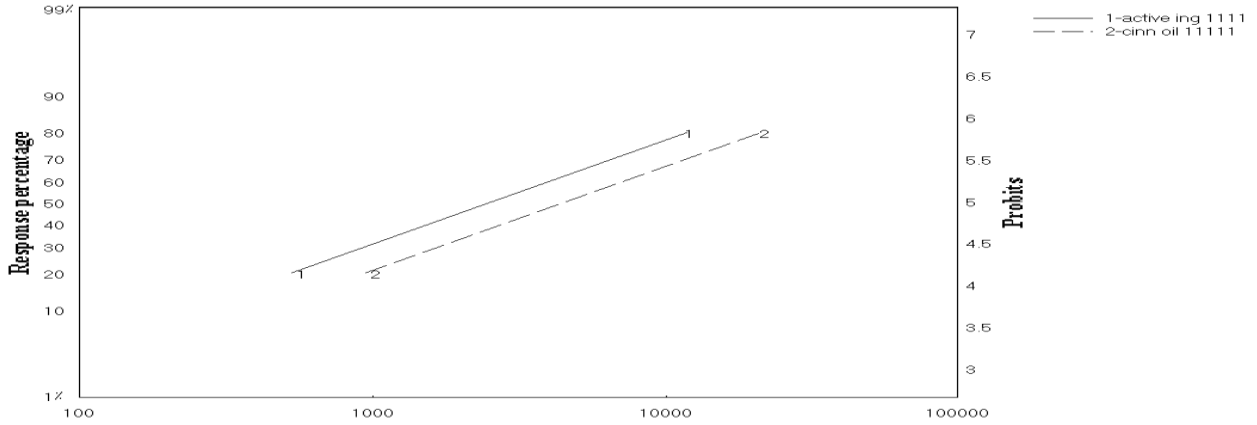


Figure (1): LD-P lines for cinnamic oil and cinnamldehyde against adult female of the carmine spider mite, *Tetranychus cinnabarinus*

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