

Fumigant toxicity of some volatile oils belonging to Apiaceae plants against *Tetranychus urticae* Koch

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ABSTRACT

The fumigant toxicity of five volatile oils belonging to Apiaceae plants were investigated against red spider mite, *Tetranychus urticae* Koch as a suggested approach for controlling mites in greenhouses. Results showed that vapor of cumin (*Cuminum cyminum* Linn.) seeds oil revealed the most potent efficiency against all tested stages of mites, its LC₅₀ values were 3.4, 2.6 and 4.2 µl / l (oil / air), against adult females, protonymphs and eggs, respectively. Parsley (*Petroselinum sativum* L.) seed oil revealed poorest efficiency, its LC₅₀ values were 9.4, 7.0 and 12.6 µl / l, against adult females, protonymphs and eggs, respectively. On the other hand, coriander (*Coriandrum sativum* L.) seeds, parsley (*Petroselinum sativum* L.) herb and coriander herb oils came in between. It was also observed that protonymphs was the most susceptible stage while eggs was the most resistant stage. A significant reduction in oviposition period and number of deposited eggs was observed for the survived mites, after exposing protonymphs to LC₅₀ concentration of all tested oils.

Keywords: Fumigant toxicity, volatile oils, Apiaceae plants, *Tetranychus urticae*

INTRODUCTION

Red spider mite *Tetranychus urticae* Koch is a serious pest; it infects many economic plants causing reduction in plant productivity or even kills the host plants (Nachman and Zemek, 2002). It infects many greenhouse plantations causing a great problem. Using traditional pesticides should result in loss of the yield that is expected during the Pre Harvest Interval (PHI). Since greenhouses are usually planted with valuable crops, this loss is magnified. Besides, high-density plantation applied in greenhouses may complicate traditional application of pesticides. High-density plantation also provides shelters for pests which may prevent the pesticides to reach all the pest individuals. One of the alternative approaches, might be suitable for greenhouses, is using natural fumigants, because of safety and capability to reach every point in high density plantation. Fumigant toxicity of several

volatile oils was investigated against different pests (Stamopoulos, 1991; Regnault and Hamraoui 1994; Weaver et al., 1994; Don-Pedro, 1996; Reddy and Singh, 1998 and Sammataro *et al.*, 1998). Efficiency of volatile oils from family Apiaceae against different pests was investigated by many researchers; Su (1985) studied the effect of dill seeds extract on four species of stored product insects. Tunc and Sahinkaya (1998) proved the toxic effect of vapor of the essential oil of cumin, *C. cyminum* to *Tetranychus cinnabarinus* and *Aphis gossypii*; they also reported that greenhouse pests were much more sensitive to the vapors of essential oils than stored-product pests. Recently, Badawy *et al.* (2005) proved the acaricidal activity of coriander seeds, coriander herb, parsley seeds, parsley herb and cumin seeds oils against *T. urticae*. Current work was conducted in order to investigate the fumigant toxicity of five volatile oils belonging to Apiaceae plants against *Tetranychus urticae* Koch as one of the main greenhouse pests.

MATERIALS AND METHODS

1. Tested mites: The original colony of the red spider mite, *Tetranychus urticae* Koch was supplied from Acarology Laboratory in Plant Protection Research Institute. It was reared as a test mite as the following: Lima bean (*Phaseolus vulgaris*) seeds were planted in plastic jars (12 cm. diameter) at a rate of 6 - 7 seeds per jar, and incubated under muslin cage to prevent any infestation. Jars containing lima bean seedlings (15 cm long) were taken to the laboratory, then infested leaves of *T. urticae* were transferred to these plants and left to reproduce under laboratory condition at 25 ± 0.5 °C. This colony was supplied with fresh lima bean plants from time to time according to necessity.

2. Tested oils: Five essential oils belonging to family Apiaceae were obtained from Cato Aromatic Company, the plant origin of these oils are listed in Table (1). All of the oils were kept under freezing until used.

Table (1): The plant origin of the tested essential oils.

Scientific name	English name	Oil origin
<i>Coriandrum sativum</i> L.	Coriander	Seeds
		Herb
<i>Petroselinum sativum</i> L.	Parsley	Herb
		Seeds
<i>Cuminum cyminum</i> Linn.	Cumin	Seeds

3. Acaricidal activity of tested materials: The fumigant toxicity of the mentioned volatile oils was evaluated against adult females, protonymphs and eggs of *T. urticae*. The biological efficacy of LC₅₀ concentration was also investigated. Air tight jars (5 liters size) were used as a test chamber. To evaluate the acaricidal activity of tested materials on protonymphs and adult females, twenty newly emerged protonymphs or adult females were transferred to the lower surface of sweet potato disc (2.5 cm diameter) using fine brush. Discs were placed separately upside-down on moist cotton wool in small dishes. In order to reduce the evaporation of water in the test jars, dishes were chosen slightly larger than the disks. The dishes those contain mites were fixed on the bottom of the test jars. Series amounts of the essential oils were dropped in Petri dishes using micro applicator. Each Petri dish contains the certain amount of the oil was fixed also on the bottom of each test jar. Blank Petri dishes served as controls. The jars were closed and kept under constant temperature of 25 ± 0.5 °C for 24 hrs, then the mortality was counted.

To investigate the ovicidal activity of the above oils, ten adult females were placed on sweet potato leaf disc (2.5 cm) which was put on wet cotton wool in a Petri dish and incubated for 24 hrs to deposit eggs then adults were transferred from the leaf. Discs carrying the eggs were placed separately upside-down on moist cotton wool in small dishes and subjected to series concentrations of the oil vapor for 24 hrs, as described above. Treated eggs were incubated at 25 ± 0.5 °C and $60 \% \pm 5$ R.H. for six days till hatching and the percentage of hatchability was determined. Mortality was corrected by Abbott's formula (1925). LC₅₀, LC₉₀ and slope values were computed according to Finney (1971) using log-dose probit line software.

To study the effect of LC₅₀ concentration of the tested oils on the biological aspects of *T. urticae*, recently emerged protonymphs were collected and subjected to LC₅₀ concentration of each oil, for 24 hrs using the same procedure which described above. Survived protonymphs were placed individually each one on a sweet potato leaf disc, then discs were placed in Petri dishes on moist cotton wool. Leaf discs were changed when they wilt. Twenty replicates were used for each treatment. Treated protonymphs were incubated at 25 ± 0.5 °C to determine the periods of deutonymph, pre-oviposition, oviposition, post-oviposition, number of deposited eggs per female, mortality and egg hatchability. The following equation was used to determine % hatchability:

$$\% \text{ Hatchability} = \frac{\text{No. of hatched eggs}}{\text{No. of deposited eggs}} \times 100$$

RESULTS AND DISCUSSION

As shown in Table (2), vapor of cumin (*C. cyminum* Linn.) seeds oil revealed the most potent efficiency against mite adult females with LC₅₀ of 3.4 µl / l (oil / air) followed by coriander (*Coriandrum sativum* L.) seeds, parsley (*Petroselinum sativum* L.) herb, coriander herb and parsley seeds oils with LC₅₀ values of 4.0, 5.2, 5.4 and 9.4 µl / l, respectively. The corresponding LC₉₀ values were 7.2, 8.0, 12.6, 32.6 and 27.2 µl / l, respectively. Data in Table (3) showed that, mites protonymphs were more susceptible to tested oil vapors than adult females; vapor of cumin seeds oil kept its superiority against mites protonymphs followed by coriander seeds, parsley herb, coriander herb and parsley seeds with LC₅₀ values of 2.6, 3.0, 3.2, 3.4 and 7.0 µl / l, respectively. The corresponding LC₉₀ values were 5.8, 6.2, 7.2, 19.0 and 23.2 µl / l, respectively. Although, mites eggs exhibited higher resistance to oil vapors, a reduction in egg hatchability was obtained when eggs were exposed to oil vapors (Table 4). Also, vapors of cumin seeds revealed the highest ovicidal activity followed by parsley Herb, coriander seeds, coriander herb and parsley seeds oils with LC₅₀ values of 4.2, 6.2, 6.6, 7.0 and 12.6 µl / l, respectively. The corresponding LC₉₀ values were 7.2, 14.4, 14, 24.4 and 24.8 µl / l, respectively.

Table (2): Toxicity of certain volatile oil vapors against *T. urticae* adult females.

Oil origin	LC ₅₀ µl/ l (95 % C.L)*	Slope	LC ₉₀ µl/l
Cumin seeds	3.4 (3.2 - 3.8)	4.133	7.2
Coriander seeds	4.0 (3.6 - 4.4)	4.241	8.0
Parsley herb	5.2 (4.8 - 5.8)	3.323	12.6
Coriander herb	5.4 (4.2 - 7.0)	1.632	32.6
Parsley seeds	9.4 (8.4 - 10.8)	2.808	27.2

*C.L.: Confidence limits

Table (3): Toxicity of certain volatile oil vapors against *T. urticae* protonymphs.

Oil origin	LC ₅₀ µl/l (95%C.L)*	Slope	LC ₉₀ µl/l
Cumin seeds	2.6 (2.2 – 2.8)	3.477	5.8
Coriander seeds	3.0 (2.8 – 3.4)	4.162	6.2
Parsley Herb	3.2 (2.8- 3.6)	3.608	7.2
Coriander herb	3.4 (2.6 - 4.2)	1.692	19.0
Parsley Seeds	7.0 (3.0 - 13.2)	2.457	23.2

*C.L.: Confidence limits

Table (4): Toxicity of certain volatile oil vapors against *T. urticae* eggs.

Oil origin	LC ₅₀ ul/l (95%C.L)*	Slope	LC ₉₀ ul/l
Cumin seeds	4.2 (4.0 - 4.6)	5.591	7.2
Parsley Herb	6.2 (5.6 - 6.8)	3.484	14.4
Coriander seeds	6.6 (6.0 - 7.4)	4.018	14.0
Coriander herb	7.0 (5.8 - 8.2)	2.368	24.4
Parsley Seeds	12.6 (11.4 - 13.6)	4.33	24.8

*C.L.: Confidence limits

Results in Table (5) showed a significant shortage in oviposition period of the survived mites. The shortage, compared with the control, varied between 2.03 and 0.96 days, after the exposure to coriander seeds and cumin seeds oils, respectively. Also a significant reduction in deposited eggs was observed. This reduction varied between 16.34 and 5.97 eggs/female after the exposure to coriander seeds and cumin seeds oils, respectively.

Fumigant and contact acaricidal activity of coriander oil against *Dermanyssus gallinae* De Geer were reported by Kim Soon *et al.*, (2004).

Table (5): efficiency of LC₅₀ concentrations of certain oil on some biological aspects of *T. urticae*.

Tested oils	Duration (days)						Eggs / female	Hatchability %	Mortality %
	qp	D	qD	pre ov	ov	post ov			
Coriander herb	1.12	1.15	1.53*	1.39	5.55*	2.30	31.06*	90.62	23.82
Coriander seed	1.56*	1.20	0.93	1.74*	5.01*	2.33	28.19*	96.05	16.55
Cumin seed	1.13	1.01	1.33	1.42	6.08*	2.29	38.56*	95.16	17.96
Parstei herb	0.97	1.10	1.17	1.31	6.05*	1.64	35.57*	94.55	25.30
Parstei seed	1.27	1.12	1.13	1.40	5.39*	1.49*	32.79*	91.80	21.04
Control	1.21	1.17	1.20	1.32	7.04	2.03	44.53	94.61	20.74
Lsd	0.28	0.31	0.29	0.33	0.91	0.42	5.42	5.92	5.70

q: Quiescent p: protonymph D: Deutonymph ov: oviposition *: significant difference

It was proved by Saxena and Basit (1982) that volatiles of coriander inhibit the oviposition of leafhopper *Amrasca devastans* (Distant). Tunc and Sahinkaya (1998) stated the toxic efficiency of vapors of essential oils of cumin *C. cyminum* and anise, *Pimpinella anisum* (family Apiaceae) against greenhouse pests, *T. cinnabarinus* and *Aphis gossypii*.

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