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Efficiency of Labiateae plants essential oils against adults of cotton whitefly (*Bemisia tabaci*)

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ABSTRACT

The toxicity of essential oil vapours distilled from thyme (*Zataria multiflora* Boiss), rosemary (*Rosmarinus officinalis* L.), Savory (*Satureja hortensis* L.), Penny royal (*Mentha pulegium* L.) and spearmint (*Mentha viridis* L.) were tested against adults of cotton whitefly (*Bemisia tabaci* Gennadius). Insects were exposed at time 3, 6, 9, 12 and 24 hr and the amounts of the essential oils were 2, 4, 6 and 8 µl in each desiccator with 4l capacity, corresponding to 0.5, 1, 1.5 and 2 µl/l air. The essential oil vapours of all five species caused the highest mortality in 2 µl/l air doses and 24hr of exposure time in this species. In general, higher mortality was observed as the doses of essential oils and exposure period increased. The results showed that the essential oil of five aromatic plants have the potential to be used for management of *B. tabaci* in greenhouse conditions. *M. pulegium* and *M. viridis* essential oils caused the highest mortality of *B. tabaci* adults (78.75 and 78.19%), respectively. The mean mortality caused by essential oils of *Z. multiflora*, *R. officinalis* and *S. hortensis* were 69.02, 54.3 and 53.47% respectively.

Key words: *Bemisia tabaci*, Essential oil, *Mentha pulegium*, *Mentha viridis, Rosmarinus officinalis, Satureja hortensis, Zataria multiflora*

White fly (*Bemisia tabaci* Gennadius) is a pest species in tropics and sub-tropics on all inhabited continents of the world (Brown *et al*. 1995). As a widely polyphagous feeder, *B. tabaci* utilizes various crops, ornamentals, greenhouses plants and wild hosts. Current pest management includes the use of pesticides, combined or not with natural enemies. The use of heavy chemical pesticides against this pest is also recognized to be involved in many of the outbreaks of *B. tabaci* around the world, for different reasons: development of insecticide resistance, negative effects on natural enemies, alteration of behaviour and biology of the pest (Gonzalez-Zamora *et al*. 2004). Therefore, there is an urgent need to use safer and environmentally compatible pesticides to replace existing synthetic ones.

Some secondary plant metabolites such as *Azadirachta indica*, *Chrysanthemum cinerariaefolium* and *Carum carvi* which play an important role in plant-insect interaction, and are commonly responsible for plant resistance to insects and mites (Mann 1987, Kathuria and Kaushik 2006, Deka *et al*. 2011) have been receiving global attention for insecticidal properties. Other than these, the insecticidal effect of some of the essential oils of plants belonging to family Labiateae on *B. tabaci* was reported (Choi *et al*. 2003, Aslan *et al*. 2004, Calmasur *et al*. 2006, Kumar *et al*. 2011). The present study aimed to investigate the effect of vapours of essential oils of five aromatic plant species of family Labiateae against the adults of *Bemisia tabaci*, one of the important pests in greenhouses in Iran.

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MATERIALS AND METHODS

Adults of *B. tabaci* were collected from a cucumber field in the experimental farm of Ramin Agriculture and Natural Resources University, in Molasani, Ahvaz, Khoozestan province, Iran. The colony of *B. tabaci* was reared on 4–6 leaves cucumber plants maintained in wooden-framed rearing cages (120×120×60 cm) covered with white nylon mesh of 210 µm aperture. The cages were maintained in a laboratory at 20–25 °C, 40–50% R H and a 14:10 (L: D) photoperiod.

Leaves of *Z. multiflora*, *R. officinalis, S. hortensis*, *M. pulegium* and *M. viridis* were collected in 2009 and dried for 7 days at room temperature and ground to powder before being subjected to hydrodistillation using a modified Clevenger apparatus for 6 hr. Then oils collected were dried over anhydrous sodium sulphate and after filtration, stored at +4° C until tested.

To test the toxicity of essential oil vapours to adult stage

of *B. tabaci* desiccators with 4l capacity were used as exposure chambers. Adults of *B. tabaci* were exposed separately to essential oils of *Z. multiflora*, *R. officinalis, S. hortensis*, *M. pulegium* and *M. viridis.* The leaves infested with *B. tabaci* were transferred to exposure chambers. In order to maintain turgor of leaves in experimental period, the petiole of the leaves, were placed in a piece of wet cotton. Ten *B. tabaci* adults were used in each replicate. Three replicates were considered for each dose and exposure time combination. The essential oils were applied with an automatic pipette on filter paper discs (Whatman N°1) placed in the bottom of the desiccators. Initial experiments were carried out to determine the appropriate dose and exposure time ranges. The amounts of essential oil used were 2, 4, 6 and 8 µl in each desiccators, corresponding to 0.5, 1, 1.5 and 2 µl/l air. No material was applied to the control desiccators. Exposure periods were 3, 6, 9, 12 and 24 hr.

After exposure time, leaves with whiteflies were removed from the desiccators and whiteflies were prodded with a fine brush, if there was no movement in their legs or antennae, they were considered to be dead.

Cucumber plants were exposed to higher dose (2 µl/l air) and the longest exposure period (24 hr) of the five essential oils for phytotoxicity experiments. The above mentioned wooden-framed rearing cages were used in these tests. The differences in appearance such as wither of treated plants compared with healthy control were considered as the indication of phytotoxicity.

All the mortality data were corrected by using Abbott's formula (Abbott 1925). The effect of varying doses vs. different exposure period on mortality, for each essential oil, was analyzed with two-way analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Analysis of the toxicity data of the present study showed that the essential oil vapours of five aromatic plants tested exhibited a strong toxic action against the adult stages of *B. tabaci.* ANOVA indicated that the interactions of dose and exposure time in all essential oils were very significant at $P<0.01$ (Table 1). The mortality of *B. tabaci* adults increased with the increase in the dose of essential oil and exposure time (Table 2, Fig 1). At 24 hr exposure time, all *B. tabaci* adults died in 1µl/l of all essential oils (Table 2). 100% mortality was obtained after 24hr with all essential oils tested, this may be attributed to the stronger insecticidal effects of components of essential oils tested. The essential oils of *M. pulegium* and *M. arvensis* caused the highest mortality to *B. tabaci* (78.75 and 78.19%, respectively). Aroiee *et al*. (2005) showed the repellency effects of thyme and peppermint on *Trialeurodes vaporariorum* (Aroiee *et al*. 2005). Also ginger oil showed repellency effects to *B.argentifolii* (Zhang *et al*. 2004). Essential oils obtained from *S. hortensis*, *Thymus vulgaris* and *Ocimum basilicum* species efficiency killed adults and nymphs stages of

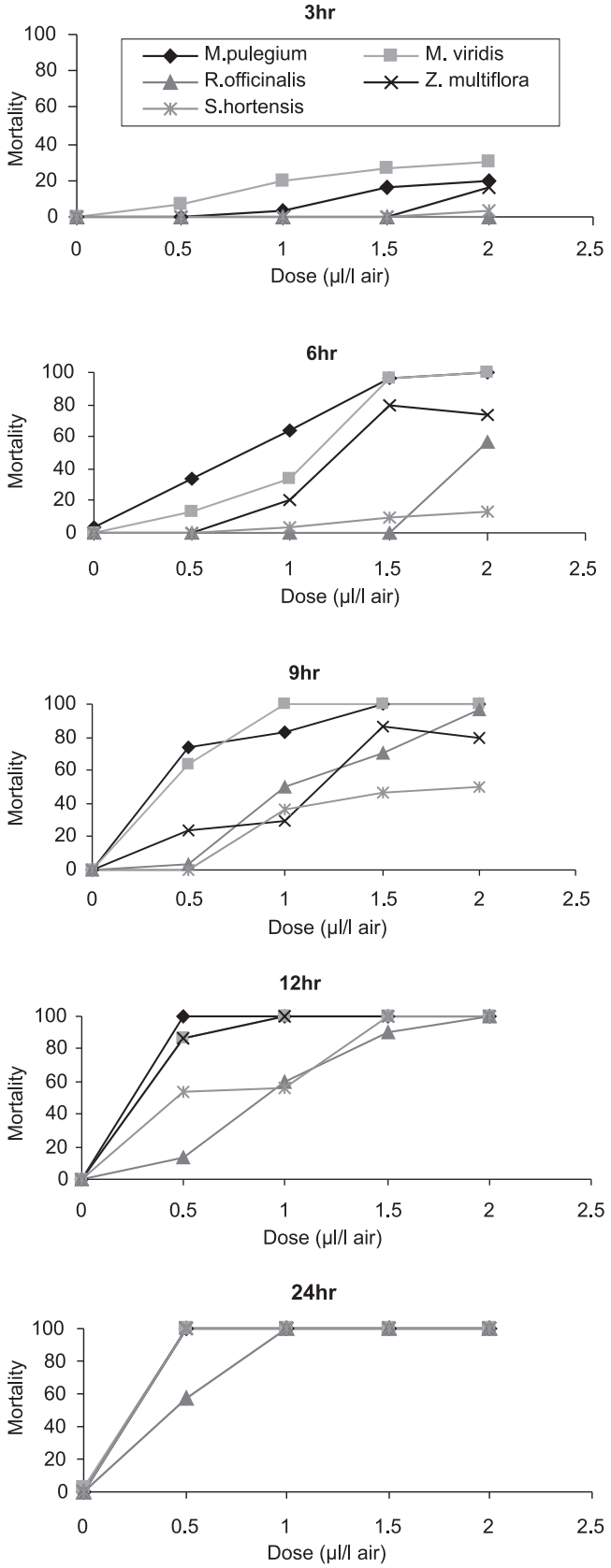

Fig 1 Percentage of mortality of *Bemisia tabaci* for all doses and times

Table 1 Results of ANOVA belonging to dose, time and their interactions with essential oils

Source	Df	Mean square	F
Essential oil	4	88.972222	129.57 **
Dose	4	885.138889	1289.04**
Time	5	649.138222	945.35 **
Essential oil* Dose	16	9.861111	14.36 **
Essential oil* Time	20	14.614889	21.28 **
Dose*Time	20	53.008222	77.20 **
Essential oil*Dose*Time	80	5.540444	8.07 **
Error	300	0.68	
Total	449		

** $P<0.01$

Tetranychus urticae and adults of *B. tabaci* (Aslan *et al*. 2004). Calmasur *et al*. (2006) obtained 100% mortality with 2µl/l vapours of *Micromeria fruticosa* L., *Nepeta racemosa* L. and *Origanum vulgare* L. (Labiateae) on *B. tabaci* by 120hr exposure time. Mahboubi and Haghi (2008) considered the chemical composition of *M. pulegium* essential oil. Their results showed that Piperitone and Piperitenone (38 and 33%, respectively) were common ingredients of *M. pulegium* essential oil. These researchers also, demonstrated the high antimicrobial (antifungal and antibacterial) effect of Piperitone. It seems that high insecticidal effect of *Mentha* spp in this study was related to Piperiton groups in these plants. The mean mortality caused by essential oils of *Z. multiflora, R. officinalis* and *S. hortensis* were 69.02, 54.3 and 53.47 %, respectively (Table 3).Results of phytotoxicity experiments indicated that plants essential oils had no toxic effects on plants in higher dose (2 µl/l air) and the longest exposure period (24 hr). This result demonstrates more suitability of essential oils for IPM. Plant essential oils act in

Table 2 Multiple comparison of exposure time and dose of essential oil (mean and standard error)

Time (hr)	Dose (µl/l air)	Essential oils					
		Z. multiflora	*R.officinalis*	*S. hortensis*	*M.pulegium*	*M. viridis*	Mean±S E
3	0.5	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	6.6±3.3	1.3±1.3
	1	0.0±0.0	0.0±0.0	0.0±0.0	3.3±3.3	20±5.7	4.7±2.2
	1.5	0.0±0.0	0.0±0.0	0.0±0.0	16.6±6.6	26.7±3.3	8.7±5.5
	2	16.7±3.3	0.0±0.0	3.3±3.3	20±5.7	30±5.5.7	14.0±6.3
	Cont.	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Mean±SE		3.34±1.8e	0.0±0.0e	0.6±0.6e	8.0±2.7e	16.66±3.4e	5.7±2.55
6	0.5	0±0	0.0±0.0	0.0±0.0	33.3±8.8	13.3±3.3	9.3±4.2
	1	20.0±10	0.0±0.0	3.3±3.3	63.3±13.3	33.3±3.3	24.0±11.5
	1.5	79.0±10	0.0±0.0	10±5.7	96.7±3.3	96.7±3.3	56.5±25.3
	2	80.0±3.3	56.7±8.8	13.3±8.8	100±0	100±0	70.0±16.3
	Cont.	0.0±0.0	0.0±0.0	0.0±0.0	3.3±3.3	0.0±0.0	0.7±0.7
Mean±SE		34.6±9.7d	11.3±6.2d	7.3±2.4d	59.3±10.3d	48.66±11.2d	32.3±10.1
9	0.5	23.3±3.3	3.3±3.3	3.3±3.3	73.3±6.6	63.3±14.5	33.3±14.83
	1	30.0±10.0	50.0±11.5	36.7±6.6	83.3±8.8	100.0±0.0	60.0±13.57
	1.5	86.7±3.3	70.0±15.3	46.7±14.5	100.0±0.0	100.0±0.0	80.7±10.1
	2	80.0±11.5	96.7±9.3	50±15.3	100.0±0.0	100.0±0.0	85.3±9.6
	Cont.	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Mean±SE		56.0±9.7c	44.0±10.3c	27.3±6.8c	71.3±10.1c	72.6±10.7c	54.3±8.5
12	0.5	86.7±6.6	13.3±6.6	53.3±6.6	100.0±0.0	86.6±0.0	68.0±15.7
	1	100.0±0.0	60±20.8	56.7±13.3	100.0±0.0	100.0±0.0	80.7±9.4
	1.5	100.0±0.0	96.7±3.3	96.6±3.3	100.0±0.0	100.0±0.0	98.7±0.8
	2	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0
	Cont.	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Mean±SE		77.3±10.4b	54.0±11.6b	61.3±10.1b	80.0±10.6b	77.3±10.7b	70.0±5.1
24	0.5	100.0±0.0	56.7±13.3	100.0±0.0	100.0±0.0	100.0±0.0	91.3±8.7
	1	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0
	1.5	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0
	2	100±0.0	100±0.0	100±0.0	100±0.0	100±0.0	100±0.0
	Cont.	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Mean±SE		80.0±10.6a	71.3±10.7a	80.0±10.6a	80.0±10.7a	80.67±10.3a	78.4±1.7

Means in each column followed by the different letters are significantly different at $P< 0.01$ by LSD test

many ways on several types of insects. They have useful effects to control stored product pests (Rajendran and Sriranjini 2008) and some greenhouse pests (Aslan *et al*. 2004, Choi *et al*. 2003, Calmasur *et al*. 2006, Isman 2000). Many essential oils are known to possess ovicidal, repellent and insecticidal activities against various insect species. Furthermore, some of these compounds can be highly effective against insecticidal resistance insect pests (Ahn *et al*. 1997).The present findings indicated that essential oils from all five plants, especially *M. pulegium* and *M. arvensis* have potential to be used in pest management programme in the greenhouse. However, further studies need to be conducted to evaluate the effects of these essential oils on natural enemies of *B. tabaci* and other economically important pests in greenhouse conditions.

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