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Effect of Some Aromatic Plant Extracts, Silica Nanoparticles and Imidacloprid on the Cotton Whitefly, *Bemisia tabaci* (Genn.) and its Associated Parasitoid, *Eretmocerus mundus* Mercet on Tomato

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ABSTRACT

This study was conducted at the Experimental Farm belonging to Sakha Agricultural Research Station, Kafr El-Sheikh, ARC, during 2016 and 2017 seasons to investigate the role of aqueous extracts of nine aromatic plants, silica nanoparticle, and the insecticide Imidacloprid (admire) on *Bemisia tabaci* (Genn.) infesting tomato plants . Results showed that the highest value of unhatched *B. tabaci* eggs was 84.40 and 84.60 %respectively on tomato plants treated with the highest concentration of geranium extract, which was significantly different from the other treatments. Silica nano particles killed 90.99 and 91.00 %resp. of early nymphal stage , which was not significantly different from mortality caused by admire **.** Silica nano particles, spurge and geranium extracts prevented adult development and killed adults at levels that were not significantly different from admire . However, the extracts of four plants; geranium, peppermint, spurge and rosemary had high repellent effect against whitefly adults . The highest parasitism percentage (93.88 and 93.63% respectively) was recorded on tomato plants treated with the highest concentration of hot pepper extract, followed by 86.23 and 86.04%resp. on tomato plants sprayed with the highest concentration of sweet basil extract. While the lowest parasitism percentage (16.53 %in both the two seasons) was obtained on tomato plants treated with imidacloprid.

Keywords: *Bemisia tabaci*, silica nanoparticles, tomato, aromatic plants, *Eretmocerus mundus*

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INTRODUCTION

Tomato, *Lycopersicon esculentum* Mill of Family Solanaceae is one of the most consumed vegetables in the world, and global production is estimated at around 136 billion ton per year (FAOSTAT 2009). It is the third most economical important vegetable crop after potato and onion. Tomato is a dietary source of vitamins, especially A and C minerals and fibers which are important for human nutrition and health. Also, tomato is rich in lycopene, a phytochemical that protects cells from oxidants linked to human cancer (Giovannuci 1999 and Mutanen *et al.* 2011). It is also rich in flavonoids and phenolic acid.

The cotton whitefly, *Bemisia tabaci* (Genn.) (Homoptera: Aleurodidae) is a key pest of vegetables (Al-Musa *et al* 1987). It is also a serious economic pest of agronomic, horticultural and ornamental crops throughout warm regions of the world (Byrne *et al.* 1990 and Brown 1994). *B. tabaci* can develop and reproduce on over 500 plant species, distributed in 74 families (Greathed 1986), and affect some 30 cash and staple crops worldwide, such as tomato, pepper, melon, watermelon, soybean, cotton, beans and cassava. Crop damage may occur directly through excessive sap removal, or indirectly by promoting the growth of sooty mold, inducing syndromes through feeding, or by vectoring plant viruses (Schuster *et al.* 1996). Estimated economic losses amount to several hundreds or even thousands of millions of dollars a year, worldwide (Oliveira *et al.* 2001). Begomoviruses are the most numerous of *B. tabaci* transmitted viruses and can cause crop yield losses between 20 and 100 % (Brown & Bird 1992). *B. tabaci* is capable of transmitting more than100 different virus species of which the majority belong to the genus geminovirus, such as Tomato Yellow Leaf Curl Virus, Tomato Mottle Virus (Jones 2003) and African Cassava Mosaic Virus (Maruthi *et al.* 2001). In addition , it has been documented that the action threshold is very low (0.3 adults/plant) in Costa Rica (Hilje 2001).

Plants may provide an alternation to currently used pesticides for control of plant pests, as they constitute a rich source of bioactive chemicals (Kim *et al.* 2005 and Daoubi *et al.* 2005). Recent studies have demonstrated the insecticidal properties of chemicals derived from plants that are active against specific target species, biodegradable to nontoxic products and potentially suitable for use in integrated management programs (Tare *et al.* 2004).

The demand for alternative pest control strategies is increasing. In order to further development, the utilization of semi chemicals or mixing planting strategies is reinvestigated in pest management in polycultures .Volatile chemical compounds emitted from plant tissues are most likely originated to repel the attacking pests, and also serve as a secondary function as it attracts the parasitoids and predators in search of insect pests (Mauchline *et al.*2005*)*.

In the present study, the toxicity of crude extracts of nine aromatic plant species known to have medicinal activity, and silica nanoparticles compared to imidacloprid (Admire) insecticide were investigated against the sweet potato whitefly, *Bemisia. tabaci* and its parasitoid *Eretmocerus mundus* Mercet under semi natural conditions on tomato plants (in wooden frame cage at open field) .

MATERIALS AND METHODS

Insect materials:

Adults and immature stages of *Bemisia tabaci* (Genn.) were reproduced on tomato plants for two years .The adults of the parasitoid (*Eretmocerus mundus* Merecet) were collected from different vegetable plants parasitized immature stages of *B. tabaci* . This was practiced by introducing the immature stages of *B. tabaci* in glass- tube cages, till the emergence of the parasitoid or emergence of whitefly adults.

Plant materials:

Tomato (*Lycopersicon esculentum* Mill),Giza 186 variety, was cultivated in pots and the aromatic plants (Table 1) were collected from the local market .

Preparation of the aqueous extracts

The aqueous extracts were prepared by boiling air – dried plant parts in sterile distilled water (10 % wt/wt) for 10 minutes, and then cooled to room temperature overnight . The aqueous extracts were filtered using a Millipore filters (Millipore 0.2 mm, www. Waters. Com) to remove particulate matter. The final volume of each filtrate was completed to 100 ml with distilled water with 0.2% Tween 80 to account for the evaporated water during boiling. The aqueous extracts were prepared shortly before application . Negative controls were represented by the distilled water that contained the emulsifier Tween 80.

Table 1. Common name, family, scientific name, Arabic name and part used of the aromatic plants collected from the local market

Common Name	Scientific name	Plant family	Plant part
Geranium	*Pelargonium graveolens* L.	Geraniaceae	Leaves
Spearmint	*Mentha viridis* L .	Lamiaceae	Leaves
Peppermint	*Mentha piperita* L .	Lamiaceae	Leaves
Hot-pepper	*Capsicum annum* L .	Solanaceae	Leaves
Sweet basil	*Ocimum basilicum* L	Lamiaceae	Leaves
Christ's	*Ramnus diffusa* L.	Rhamnaceae	Leaves
Rosemary	*Rosmarinus officinalis*	Lamiaceae	Leaves
Mooring	*Lagopus scoticus* L.	Phasianidae	Leaves
Spurge	*Euphorbia hierosolymitana Boiss*	Euphorbiaceae	Stems

Treatments:

Crude extracts of the nine aromatic plants were each applied at the rates of 50, 100 and 150 ml /100 liter of water

Silica nanoparticles: The silica nanoparticles were obtained from Egypt Nanotech Company Limited , Cairo, Egypt. The size of silica nanoparticles was 100 nm with a purity of 99.99 % .It is was applied at the rates of 100, 200 and 300 ppm /100 liter of water

Insecticide: The tested insecticide used in this study was imidacloprid (35% SC) produced by Shreeji Pesticides at the rate of 300 ml/ Feddan. This insecticide is recommended for control *B. tabaci* in vegetable crops (Walaa,2013)

Equipment:

Stereomicroscope: to examine insect stages and their parasitoids.

Aspirators: for collecting and transferring adult insects and parasitoids.

Solo motor, 2.5 Liters volume, a sprayer used in applying the crude extracts of the nine aromatic plant species, silica nanoparticle and Admire insecticide.

A blender, V 2.5 liters for preparing the crude extracts of the aromatic plants .

Paper bags for transferring the plant samples to the laboratory

Cages:

Glass- tube cages: (3 cm in diameter and 20 cm long), for transferring adults of *B. tabaci* to infest tomato plants and to release the parasitoid *E. mundus* Mercet on *B. tabaci* nymphs.

Chimney – glass cages: (No. 7) for biological experiments to infest tomato plants with *B. tabaci* adults and to release the parasitoid .

Wooden frame cages (250 × 250 × 200 cm), covered with double layers of muslin on two sides and glass on the top and both front and back sides . The insect – free plants were selected to be infested with *B. tabaci* adults and release the parasitoid .

A Blackman box (Blackman 1971).

Plastic jar (20 cm diameter, 30 cm high).

Curative effect of crude extracts of nine aromatic plants, silica nanoparticles and insecticide (Admire) on *Bemisia tabaci* :

This experiment was carried out under semi natural conditions (in wooden frame cage at open field) of Sakha Agricultural Research Station (SARC), at kafr El- Sheikh during September, October and November, 2016 and 2017 . Crude extracts of the nine aromatic plant species at three concentrations (50, 100 and 150 cm) compared to silica nanoparticles, at three concentrations (100, 200 and 300 ppm) and Admire insecticide were evaluated against *B. tabaci* stages on tomato plants. Seeds of tomato were germinated in tray .The seedlings were transplanted in pots when aged five leaves (one seedling/pot). Each plant was placed under chimney glass cage (No. 7). Recently emerging *B. tabaci* adults were released (3 pairs /leaf) on tomato plants (5 plants) with five replicates of each treatment, for about 24 hours . Adults of *B. tabaci* were aspirated from the plants and the plants were placed in separate wooden cages. The synchronously- developing, uniformly- aged whitefly population were then held until they developed to the appropriate stage

Unhatching egg percentage :

Immediately, after the adult whiteflies were aspirated from the plants, the plants were sprayed with abovementioned treatments. Initial number of eggs prior to application ranged from 300 to 350 per plant. There were five replicates (5 Plants/ replicate) per treatment. Four days after treatment, the unhatching eggs and newly emerging nymphs were counted and the hatchability was calculated.

Early stages mortality percentage:

Five days, after infestation, when first nymphal instar emerged and attached to the leaf, the plants were sprayed as before . There were five replicates (5 Plants/ replicate) per treatment. Four days after treatment, the number of dead nymphs were counted under dissecting microscope. A nymph was considered dead if it was shrunken or its color changed. Normally developed nymphs to adult stage were also counted and their percentages were calculated .

Late pupal stage mortality percentage:

Eight days after infestation, when most nymphs were in the red-eye stage, the plants were sprayed as before. There were five replicates (5 plants/ replicated). Seven days after treatment, when most of the pupae emerged from control plants, the number of empty pupae cases and pupae that failed to emerge were counted and percentage of adult emergence was calculated.

Adult mortality percentage :

A fully expanded leaf was placed in wet moss inside a Blackman box (Blackman 1971). The leaf was dipped into the solution of crude extract treatments and left overnight. About 30 adults were then introduced inside each box. Distilled water was used as a negative treatment and imidacloprid was used as a positive one . The number of dead whitefly adults was recorded after 48 hr. A whitefly adult was considered dead if it was motionless after probing with a camel hair brush. Five replicates were made for each treatment.

Repellency test :

Two fully expanded leaves of tomato were placed individually in vials containing water . One leaf was dipped in one of test materials and the other one was dipped in distilled water . The vials were placed in a plastic jar (20 cm diameter, 30 cm high) covered with fine netting material . About 50 mobilized adults were placed between the two vials .Numbers of adults attracted to each leaf was recorded after 3hr and 24hr . Five replicates were made for each treatment .

Effect of tested materials on the parasitoid *Eretmocerus mundus* under semi- natural conditions:

The experiment was carried out under semi-natural conditions (in wooden frame cage at open field) during September, October and November 2016 and 2017 seasons, in order to evaluate the efficacy of the nine crude extracts, silica nanoparticles and insecticide at commercial dose on the parasitoid (*E. mundus)* of *B. tabaci* on tomato plants. Tomato plants were prepared as previously mentioned . These plants were divided into 32 groups; each group consisted of five plants in four replicates. These tomato plants were placed under chimney-glass cages as one plant/ cage, and recently emerging *B. tabaci* adults were released as three pairs / leaf, and left for 24 hours. *B. tabaci* adults were discarded by aspirator. Eight days later, to get the 2^{nd} nymphal instar and preferred the parasitoid according to Jones and Greenberg, 1998 respectively.

Emerged and mated females of *E. mundus* were released (one female/ plant). After four days, from release of *E. mundus* on tomato plants of 32 groups the plants were sprayed by the treatments . Then, *B. Tabaci* nymphs infested (tomato plants leaves) of each treatment were counted by stereomicroscope, then put in a glass tube and observed daily for the emergence of parasitoid adults. The number of parasitoid adults and date were scored , counted and parasitism % was calculated .

Data were subjected to analysis of variance and differences among means were significantly compared according to Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Curative effect of crude extracts of nine aromatic plants, silica nanoparticles and insecticide (Admire) on *Bemisia tabaci* :

Unhatching egg percentage :

The obtained results arranged in Table (2) during 2016 season, percentage of unhatched *B. tabaci* eggs was influenced by different concentrations of different treatments compared to untreated tomato plants (Table 2). The highest *B. tabaci* unhatched eggs was 84.40 % on tomato plants treated by the highest concentration of geranium extract, followed by 75.20 % in tomato plants sprayed by the highest concentrations of peppermint plant extract compared with tomato plants untreated and other treatments. However, the lowest unhatched *B. tabaci* eggs was 8.00 % in tomato plants treated with low concentration of sweet basil extract compared with the other treatments (Table 2) . percentage of unhatched *B. tabaci* eggs during 2017 season was similar to that of 2016 season (Table 2).

Table 2. The average percentage of unhatched eggs of *Bemisia tabaci* exposed to aromatic plant extracts , silica nanoparticles and Imidacloprid on tomato plants under semi natural conditions during 2016and 2017 seasons

Treatment	Rate ml / 100 l. water	Average percentage of unhatched eggs	
		Season 2016	Season 2017
Geranium	50	41.00 e	41.25 e
	100	60.00 c	60.50 c
	150	84.40 a	84.60 a
Peppermint	50	28.00f	28.25 f
	100	49.80 d	50.00 d
	150	75.20 b	75.25 b
Spearmint	50	15.40 h	15.66 h
	100	23.80 g	24.00 g
	150	42.20 e	42.25 e
Sweet basil	50	8.00i	8.20 i
	100	10.40 i	10.50 i
	150	15.20h	15.25 h
Hot pepper	50	10.00 i	10.25 i
	100	15.40h	15.50 h
	150	28.80f	29.00 f
Chris's	50	19.20g	19.25 g
	100	42.00e	42.20 e
	150	64.40c	64.50 c
Rosemary	50	19.40g	19.55 g
	100	24.80 g	24.90 g
	150	29.20 f	29.25 f
Spurge	50	22.20 g	22.25 g
	100	51.40 d	51.44 d
	150	70.80 c	70.90 c
Moringa	50	10.40 i	10.55 i
	100	14.20 h	14.30 h
	150	23.80 g	24.00 g
Silica nanoparticles	100 ppm	9.40I i	9.60 i
	200 ppm	21.20 g	21.32 g
	300 ppm	39.80 e	39.88 e
Imidacloprid	25	19.40g	19.55g
Control	-	5.20k	5.25k

Means followed by the same letters are not significantly different at the 5% level by DMRT

Early stages mortality percentage:

Data represented in Table (3) showed that, during 2016 season, the curative effect of the nine extracts of aromatic plant species on *B. tabaci* early nymphs infesting tomato plants is presented in Table (3) . Mortality of *B. tabaci* early nymphs was influenced by different treatments and different concentrations compared with control (untreated tomato plant).The highest mortality of *B tabaci* early nymphs was 91.55 % in tomato plants treated with the insecticide, followed by 90.99 and 88.17 % on tomato plants sprayed with the highest concentration of silica nanoparticles and Spurge extract, respectively. However, the lowest mortality of *B. tabaci* early nymphs was 18.21 % on tomato plants treated with the lowest concentration of sweet basil extract followed by 24.76 % in tomato plants sprayed with the lowest concentration of hot- pepper extract (Table 3). Mortality of *B. tabaci* early nymphs during 2017 season was similar to that of 2016 season (Table 3).

The late pupal stage mortality percentage:

Data in Table (4) showed that the effect of nine aromatic plant extracts, Silica nanoparticles and admire insecticide on *B. tabaci* adults stage was influenced by different treatments and different concentration of treatments

Table 3.The mortality average percentage of early stages of *Bemisia tabaci* after exposure to medicinal plant extracts, silica nanoparticles and Imidacloprid under semi natural conditions during 2016 and 2017 seasons

Treatment	Rate ml/100 l.water	Mortality average percentage of nymphal stage	
		Season 2016	Season 2017
	50	61.20 f	61.75 f
Geranium	100	70.40 e	70.60 e
	150	85.80 b	90.00 b
	50	59.00 f	59.25 f
Peppermint	100	67.20 e	67.20 e
	150	79.80 c	80.00 c
	50	50.00 h	50.00 h
Spearmint	100	61.20 f	61.50 f
	15	68.40 e	68.75 e
	50	18.21 k	18.50 k
Sweet basil	100	41.00 i	41.25 i
	150	55.40 g	55.75 g
	50	24.76 j	25.00 j
Hot pepper	100	51.40h	51.50 h
	150	69.40e	69.70 e
	50	54.80g	55.00 g
Christ's	100	62.40 f	62.75 f
	150	75.60d	75.75 d
	50	51.40h	51.75 h
Rosemary	100	68.60e	68.66 e
	150	79.20c	79.25 c
	50	61.60 f	61.70
Spurge	100	80.80 c	81.20 c
	150	88.17a	88.25 a
	50	51.20 h	51.50 h
Mooring	100	60.80 f	61.00 f
	150	70.40 e	70.55 e
Silica nanoparticles	100ppm	76.20 d	76.60 d
	200ppm	88.40 a	88.70 a
	300ppm	90.99 a	91.00 a
Imidacloprid	25	91.55 a	91.50 a
Control	-	2.20 l	2.19 l

Means followed by the same letters are not significantly different at the 5% level by DMRT

Table 4. The percentage of *Bemisia tabaci* adult emergence failure after exposure of pupae to number of plant extracts, silica nanoparticles and insecticide under semi natural conditions during 2016 and 2017seasons

Treatment	Rate ml / 100 l.water	% of *Bemisia tabaci* adults emergence failure	
		Season 2016	Season 2017
	50	68.77 d	69.20 d
Geranium	100	79.75 b	79.77 b
	150	86.39 a	87.00 a
	50	58.67 e	58.75 e
Peppermint	100	69.75 d	70.00 d
	150	79.78 b	80.20 b
	50	49.75 g	50.20 g
Spearmint	100	56.77 f	57.00 f
	150	62.25 e	62.75 e
	50	13.67 l	14.00 l
Sweet basil	100	25.75 j	26.25 j
	150	38.75 i	39.40 i
	50	19.25 k	19.70 k
Hot pepper	100	33.75 i	34.25 i
	150	44.75 h	45.50 h
	50	48.75 g	49.00 g
Christ's	100	69.50 d	70.25 d
	150	84.67 a	85.70 a
	50	25.00 j	25.25 j
Rosemary	100	47.75 g	48.75 g
	150	69.75 d	70.60 d
	50	73.75 c	74.25 c
Spurge	100	81.50 b	81.75 b
	150	87.01 a	87.66 a
	50	34.25 I	34.50 l
Mooring	100	43.75 h	44.25 h
	150	62.5 e	62.75 e
Silica nanoparticales	100ppm	69.50 d	70.00 d
	200ppm	81.75 b	82.25 b
	300ppm	87.25 a	87.75 a
Imidacloprid	25	88.50 a	88.25 a
C0ntrol	-	0.75 m	0.77 m

Means followed by the same letters are not significantly different at the 5% level by DMRT

During 2016 season, the pupal mortality was influenced by different treatments and different concentrations compared to tomato plants untreated . The highest adult emergence failures were 88.50, 87.10, 86.39 and 84.67 % in tomato plants treated with the insecticide, the highest concentration of silica nanoparticles, geranium and spurge extract, respectively (Table 4). However, the lowest of % adult emergence failure was 13.67 % in tomato plants treated with the highest concentration of sweet basil extract (Table 4). Moreover,the pupal mortality of *B. tabaci* during 2017 season was similar to that of 2016 season (Table 4).

Adult mortality percentage :

Results in Table (5) showed that the highest adult mortality of *B. Tabaci* was 80.66 % in tomato plants treated with the highest concentration of silica nanoparticle . However, the lowest *B. tabaci* adult mortality was 5.00 % in tomato planted treated with the lowest concentration of sweet basil crude extract during 2016 season (Table 5) . The pupal mortality of *B. tabaci* during 2017 season was similar to that of 2016 season (Table 5).

Table 5. Mortality percentage of *Bemisia tabaci* adults stage exposure to plant extracts, silica nanoparticle and imidacloprid on tomato under semi natural conditions during 2016 and 2017 seasons

Treatment	Rate ml/ 100 l.water	Adult mortality percentage	
		Season 2016	Season 2017
	50	30.33 i	30.50 i
Geranium	100	60.00 d	60.25 d
	150	75.33 b	75.60 b
	50	21.67 j	22.00 j
Peppermint	100	50.67 f	50.90 f
	150	75.00 b	75.20 b
	50	23.33 j	23.60 j
Spearmint	100	33.33 i	33.50 i
	150	55.33 e	55.40 e
	50	5.00 l	5.25 l
Sweet basil	100	10.33 k	10.50 k
	150	18.33 j	18.60 j
	50	19.33 j	19.51 j
Hot pepper	100	33.33 i	33.41 i
	150	45.00 g	45.20 g
	50	30.00 i	30.25 i
Christ's	100	51.33 e	51.42 e
	150	76.67 b	79.91 b
	50	18.67 j	18.85 j
Rosemary	100	30.00 i	30.11 i
	150	69.33 c	69.55 c
	50	40.67 h	40.77 h
Spurge	100	60.75 d	60.85 d
	150	76.25 b	76.33 b
	50	20.00 j	20.22 j
Mooring	100	39.67 h	39.91 h
	150	45.33 g	45.49 g
Silica nanoparticles	100 ppm	45.00 g	45.22 g
	200 ppm	73.33 b	73.66 b
	300 ppm	80.66 a	80.90 a
Imidacloprid	- 25 ml	77.25 a	77.35 a
Control	25 ml.-	1.25 l	1.33 l

Means followed by the same letters are not significantly different at the 5% level by DMRT

Repellency tests:

Results presented in Table (6) recorded that, the extracts of geranium, peppermint, christ's and rosemary showed repellency effects against adults of *B. tabaci* compared with untreated plants. The leaves treated with silica nanoparticles were more attractive to *B. tabaci* than untreated leaves during 2016 season. On the other hand, the repellency effect of plant extracts, silica nanoparticle and Imidacloprid against *B. tabaci* during the season 2017 was similar to that of 2016 season.

Table 6. Repellency effect of plant extracts, silica nanoparticle and Imidacloprid against *Bemisia tabaci* adults during 2016 and 2017 seasons

Treatment	Rate ml / 100 l. water	Whiteflies 3 hr. post application				Whiteflies 24 hr. post application			
		Season 2016		season 2017		Season 2016		Season 2017	
		Un treated	Treated	Un treated	Treated	Un treated	Treated	Un treated	Treated
	50	50.00	0.00a	50.00	0.00a	50.00	0.00 a	50.00	0.00 a
Geranium	100	50.00	0.00a	50.00	0.00a	50.00	0.00 a	50.00	0.00 a
	150	50.00	0.00a	50.00	0.00a	50.00	0.00 a	50.00	0.00 a
	50	49.00	1.00a	48.80	1.20a	48.20	1.80 a	48.20	1.80 a
Peppermint	100	50.00	0.00a	50.00	0.00a	50.00	0.00 a	50.00	0.00 a
	150	50.00	0.00a	50.00	0.00a	50.00	0.00 a	50.00	0.00 a
	50	44.80	5.20b	44.60	5.40b	43.60	6.40 b	43.60	6.40 b
Spearmint	100	47.40	2.60a	47.20	2.80a	48.80	1.20 a	48.80	1.20 a
	150	49.40	0.60a	49.00	1.00a	49.40	0.60 a	49.40	0.60 a
	50	26.60	23.40f	26.20	23.80f	24.80	25.20 d	24.80	25.20d
Sweet basil	100	35.80	14.20e	35.40	35.40e	34.60	15.40 c	34.60	15.40 c
	150	40.00	10.00d	39.60	10.40d	40.00	10.00 b	40.00	10.00b
	50	35.40	14.60e	35.00	15.00e	34.20	15.80 c	34.20	15.80 c
Hot pepper	100	39.60	10.40d	39.20	10.80d	37.80	12.20 c	37.80	12.20 c
	150	41.40	8.60c	41.20	8.80c	41.8	8.20 b	41.8	8.20 b
	50	47.20	2.80a	47.00	3.00a	48.80	1.2 a	48.80	1.2 a
Christ's	100	50.00	0.00a	50.00	0.00a	50.00	0.00 a	50.00	0.00 a
	150	50.00	0.00a	50.00	0.00a	50.00	o.00 a	50.00	o.00 a
	50	42.20	7.80c	42.00	8.00c	41.80	8.20 b	41.80	8.20 b
Rosemary	100	46.20	3.80a	46.00	4.00a	46.00	4.00 a	46.00	4.00 a
	150	49.80	0.20a	49.00	1.00a	48.20	1.80 a	48.20	1.80 a
	50	46.20	3.80b	46.50	3.50b	47.20	2.80 a	47.20	2.80 a
Spurge	100	48.60	1.40a	49.00	1.00a	49.20	0.80 a	49.20	0.80 a
	150	49.8	0.20a	50.00	0.00a	50.00	0.00 a	50.00	0.00 a
	50	39.40	10.60d	40.00	10.00d	37.80	12.20 c	37.80	12.20 c
Mooring	100	42.40	7.60c	42.80	7.20c	41.20	8.80 b	41.20	8.80 b
	150	47.00	3.800ba	47.50	2.50a	48.40	1.60 a	48.40	1.60 a
	100	7.00	43.00h	7.60	4.40 h	15.00	35.00 f	15.00	35.00 f
Silica nanoparticles	200	21.00	29.00g	21.80	29.25g	25.60	24.40 d	25.60	24.40d
	300	30.60	19.40f	31.00	19.33f	37.00	13.00 c	37.00	13.00 c
Imidacloprid	25 ml	12.80	37.20h	12.50	37.50h	13.20	36.80h	13.20	36.80h

Means followed by the same letters are not significantly different at the 5% level by DMRT

Effect of crude extracts of nine aromatic plant species, silica nanoparticle and Imidacloprid on the parasitism percentages of *Eretmocerus mundus* under semi-natural condition

Results illustrated in Table (7) revealed that the highest parasitism (93.88 %) was recorded in tomato plants treated with the highest concentration of hot pepper extract, followed by 86.23 % on that sprayed by the highest concentration of sweet basil extract. However, the lowest parasitism 16.53 % was obtained in tomato plants treated with admire. The date indicated generally that spraying crude extracts of these aromatic plant species augmented the parasitism percentage of *E. mundus* than tomato plants treated with the insecticide during 2016 season. These results reveled that hot-pepper extract induced the highest parasitism. However, tomato plant sprayed with spurge extract had the lowest parasitism during 2016 season (Table 7 & 8) .

Effect of crude extracts of aromatic plants silica nanoparticles on the parasitism percentages of *Eretmocerus. mundus* under semi natural condition during 2017 season was similar to that of 2016 season (Table 7 & 8).

Table 7. ffect of crude extracts of aromatic plants, silica nanoparticles and imidacloprid on the parasitism percentages of *Eretmocerus. mundus* under semi natural condition during 2016 season .

Treatments	Rate ml / 100 l water	Total no. of *B.tabaci* nymphs	Total no. of *E. mundus*	Parasitism %	Emergency (day)
Hot-pepper extract	150	245	230	93.88 a	4 - 8
	100	250	200	80.00 b	4 - 10
	50	268	203	75.75 b	6 - 13
Sweet basil extract	150	247	215	87.04 a	4 - 9
	100	271	213	79.17 b	7- 11
	50	253	190	75.10 b	8 - 12
Geranium extract	150	265	210	79.25 b	5 - 12
	100	250	200	76.92 b	5- 14
	50	255	181	70.98 d	7-15
Peppermint extract	150	249	185	74.30 c	9 -13
	100	250	175	69.79 d	10 - 14
	50	256	160	62.50 e	12 - 16
Spearmint extract	150	253	199	78.66 b	8 - 12
	100	248	182	73.38 c	9 - 15
	50	244	155	63.52 e	11 – 16
Christ's extract	150	242	181	74.79 c	9 – 13
	100	248	175	70.56 d	10 – 15
	50	244	150	61.48 e	10 – 17
Mooring extract	150	245	196	80.00 b	6 – 13
	100	240	178	74.17 c	7 – 15
	50	243	165	67.90 d	9 – 18
Rosemary extract	150	241	164	68.05 d	6 – 11
	100	245	152	62.04 e	8 – 15
	50	245	141	57.55 f	10 – 17
Spurge extract	150	242	122	50.41 g	13 – 18
	100	246	136	55.28 h	15 – 20
	50	242	152	62.81 e	17 – 22
Silica nanoparticles	300ppm	249	105	42.17 i	13 – 23
	200ppm	243	125	51.44 g	11 – 21
	100ppm	243	145	59.67 e	10 – 20
Imidacloprid	25	242	40	16.53 j	12 – 19
Control	-	251	130	51.79 g	8 - 17

Means followed by the same letters are not significantly different at the 5% level by DMRT

Table 8. Effect of crude extracts of aromatic plants, silica nanoparticles and imidacloprid on the parasitism percentages of *Eretmocerus. mundus* under semi natural condition during 2017 season .

Treatments	Rate ml / 100 l. water	Total no. of *B.tabaci* nymphs	Total no. of *E. mundus*	Parasitism %	Emergency day
Hot-pepper	150	251	235	93.63 a	4 - 8
	100	255	205	80.39 b	4 - 10
	50	273	209	76.56 b	6 - 13
Sweet basil	150	250	216	86.04 a	4 - 9
	100	253	200	79.05 b	7- 11
	50	259	195	75.29 b	8 - 12
Geranium	150	268	214	79.85 b	5 - 12
	100	266	204	76.79 b	5- 14
	50	257	182	70.82 d	7-15
Peppermint	150	250	186	74.40 c	9 -13
	100	249	174	69.88 d	10 - 14
	50	256	160	62.50 e	12 - 16
Spearmint	150	253	199	78.66 b	8 - 12
	100	249	183	73.49 c	9 - 15
	50	244	155	63.52 e	11 – 16
Christ's	150	243	182	74.90 c	9 – 13
	100	250	176	70.40 d	10 – 15
	50	248	152	61.29 e	10 – 17
Mooring	150	246	197	80.08 b	6 – 13
	100	241	179	74.27 c	7 – 15
	50	245	166	67.76 d	9 – 18
Rosemary	150	241	164	68.05 d	6 – 11
	100	247	154	62.04 e	8 – 15
	50	245	141	57.55 f	10 – 17
Spurge	150	244	124	50.41 g	13 – 18
	100	247	137	55.28 h	15 – 20
	50	244	154	62.81 e	17 – 22
Silica nanoparticles	300ppm	250	106	42.17 i	13 – 23
	200ppm	244	126	51.44 g	11 – 21
	100ppm	247	146	59.67 e	10 – 20
Imidacloprid	25	245	42	16.53 j	12 – 19
Control		254	132	51.79 g	8 - 17

Means followed by the same letters are not significantly different at the 5% level by DMRT

Whitefly management has traditionally depended on the use of synthetic insecticides. However, the increasing resistance of *Bemisia* species to insecticides provides an impetus to integrated pest control measures , including bio pesticides and biological control combat this pest. Biopesticides are based on natural products and synthetic analogs of naturally occurring biochemical and are more acceptable than congenital pesticides because of their reputation for being less hazardous to humans and other non – target organisms (McClosky *et al.* 2000) . Among the bio pesticides are chemicals derived from a variety of plant families . The biological activity of plant extracts, bacteria, fungi, viruses and insects has been reported (Bazsik 1996; Macedo *et al.* 1997; Unicini Manganelli *et al.* 2005) . In the present work, the crude extracts had toxicity and repellent effects of mooring, geranium, peppermint and spearmint extracts on *Bemisia tabaci* stages . However, the toxicity effects of hot- pepper, sweet basil, rosemary, spurge extracts , nano silica and the insecticide were tested against *B. tabaci* stages . The extracts of nine aromatic plants can be used as natural control agents . Most of these plants are widely distributed and easy grown . Furthermore, the extraction method is simple and cost-effective and the application techniques could be relatively easily designed for non–form use. Since *B. tabaci* transmits tomato leaf curl virus, developing new methods of control is obviously important. Many essential plant oils show a broad spectrum of activity against pest insects and growth regulatory and antivector activities (Opender *et al.* 2008). The essential oils of peppermint (*Mentha piperita* L.) and rosemary (*Rosmarinus officinalis* L.) have been reported for its insecticidal activities against greenhouse whitefly (*Trialeurodes vaporariorum*) (Aroiee et al. , 2005) . Rosemary oil is significantly repellent to the two- spotted spider mite (Miremallis and Isman 2006).

Therefore, recent efforts have expanded research and utilization of habitat management techniques for conservative biological control of arthropods in various systems (Landis et al.2000). Parasitoids are known to be attracted to plant extracts or volatiles (Vinson, 1975).

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تأثير مستخلصات بعض النباتات العطرية, والسليكآ النانو مترية والمبيد الحشرى (اميداكلوبرايد) على ذبابة القطن البيضاء والطفيل *Eretmocerus mundus* المرتبط بها

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أجريت هذه التجربة في المزرعة البحثية لمحطة بحوث سخا – مركز البحوث الزراعية خلال موسمي ٢٠١٦- ١٠١٧، لدراسة تأثير المستخلصات المائية لتسعة من النباتات العطرية وهى العتر، النعناع الفلفلي، النعناع البلدي، الريحان ،الفلفل الحار, حصان البان، المور ينجا، النبق وكذا السيليكا النانومترية مقارنة بالمبيد الحشري اميداكلوبرايد على الأطور المختلفة للذبابة البيضاء على الطماطم . أظهرت النتائج أن أعلى نسبة للبيض الغير فاقس كانت ٨٤,٤٠ و ٨٤٫٦٠% على نباتات الطماطم التي تمت معاملتها بالتركز الأعلى لمستخلص العتر, مع وجود فروق معنوية بين المعاملات الأخرى .أحدثت السيليكا النانو مترية اعلى نسبة موت٩٠,٩٩ و ٩٠٫٠٠% للعمر الحوري الأول مع عدم وجود فرق منوى مع المبيد الكيماوي .أدت السليكا النانو مترية والمستخلص المائي لكل من العتر نبات و ام البن ادى إلى إعاقة تطور عذراء الذبابة البيضاء الى الحشرة الكاملة . كما كان للمستخلصات المائية لنباتات العتر , النعناع الفلفلي, ام البان وحصى البان تأثير طارد على الحشرات الكاملة للذبابة البيضاء . أظهرت النتائج ان اعلى نسبة تطفل (٩٣,٨٨ و٩٣٫٦٣%) لطفيل *E. mundus* كانت على نباتات الطماطم التي تمت معاملتها بأعلى تركيز لمستخلص الفلفل الحار يليها النباتات المعاملة بمستخلص الريحان وكانت نسبة التطفل ٨٦٫٢٣ و ٨٦٫٠٤% على الترتيب. بينما كانت أقل نسبة للتطفل ١٦,٥٣% على نباتات الطماطم المعاملة بالمبيد الحشري خلال موسمي الدراسة.