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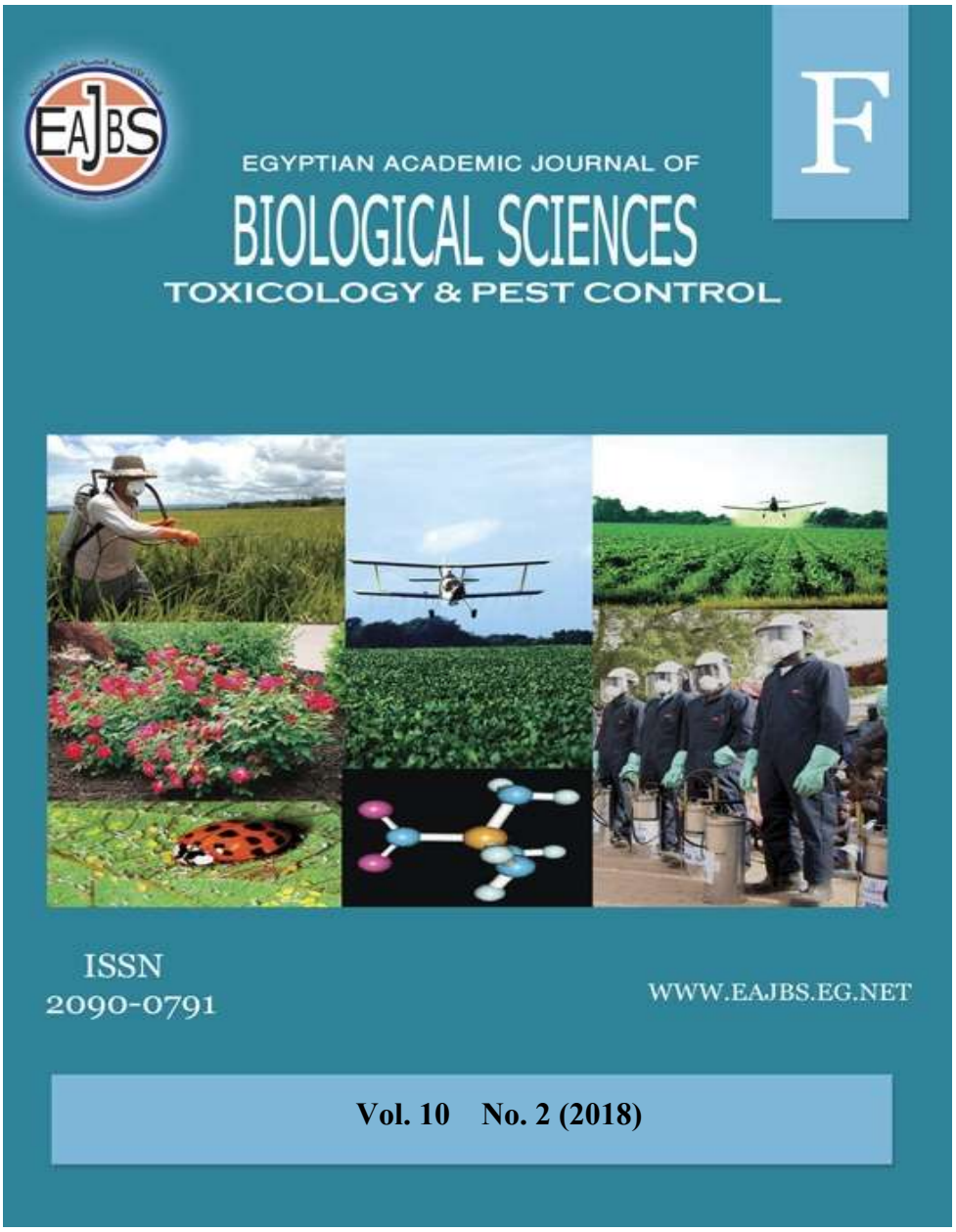

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Effect of some Essential Oils Against Green Leafhopper, *Empoasca decipiens* Paoli (Hemiptera: Cicadellidae)

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Empoasca decipiens, camphor oil, menthol oil, essential oil mixtures.

ABSTRACT

This study aimed to evaluate the effect of menthol oil, camphor oil and their mixture against the green leafhopper, *Empoasca decipiens* Paoli (Hemiptera: Cicadellidae) in laboratory and estimation of LC_{90} to apply it under semi-field condition. The results showed that the mixture of the two oils was more effective than each essential plant oil alone where LC_{50} was 37.86 ppm while it was 182.34 ppm and 242.80 ppm for menthol oil and camphor oil, respectively. LC_{90} values were 463.12 ppm, 962.36 ppm and 1128.05 ppm for the mixture, menthol oil, and camphor oil, respectively. When LC_{90} was applied in the semi-field experiment, also the mixture of camphor and menthol oil was the most effective than each plant oil alone which recorded 50% mortality while menthol oil recorded 41.03 % and camphor oil recorded 35.90%.

INTRODUCTION

The green leafhopper, *E. decipiens* is one of the most important economic hemipterans pests infest a wide range host of plants caused serious damage whether directly or indirectly. They feed by piercing plant tissue and penetrating the phloem with needle-like mouthparts. Both nymphs and adults of *E. decipiens* cause damage by removing sap from vital cells and plant tissues, which adversely affect to leaves and stems beside damage caused by egg punctures of the larger spots where, *E. decipiens* females lay their eggs within the host plant tissue (Raupach *et al.*, 2002; Backus *et al*., 2005 and Abou-Yousef *et al.*, 2010) and they are not visible to the naked eye (Schöpke, 1996). The insect injects toxic substances in plant tissues, that interfere with plant physiology (Sakthivel *et al.*, 2011). This species is an efficient vector of several important virus diseases. Several investigators recorded the role of some leafhopper species in transmitting the pathogens of plant diseases (Nielson, 1968). The fauna of this species was studied in Egypt in the field of vegetable crops and fruit trees (Awadalla *et al*., 2011; Shalaby *et al.*, 2012; Awadalla *et al.*, 2013 and 2014).

Controlling the insect pests using chemical pesticides has resulted in several problems to the environment and human health. Thus, it has been crucial to avoid or reduce the applications of these chemicals. Shaaya *et al*. (1997) recommended using plant bioactive chemicals to avoid environmental pollution and not damage populations of natural enemies where plants offer an alternative source for insect control because many plants contain a wide range of bioactive chemicals, many of which are selective and less harmful on non-target organisms and environment**.** In

the same direction, Pavela (2005) reported that botanical insecticides may represent attractive alternatives to currently used synthetic chemical insecticides for pest management.

Ben Jemaa (2014) evaluated essential oils as a source of bioactive constituents for the control of some important insect pests. Some species of camphor, Eucalyptus have a vast range of insecticidal activities including fumigant contact and repellent effects, the most important active ingredients are 1.8 cineole and α- pinene. Camphor oil is a natural product derived from the wood of the camphor laurel (*Cinnamomum camphora* L.) trees through steam distillation and purification by sublimination; the trees used should be at least 50 years old (Bin Jantan, 2006). Menthol oil a natural product derived from the Mint plants were grown in a greenhouse in pots (*Mentha piperita* L.) (Scavroni *et al*, 2005). Khan *et al*. (2017) indicated that some oil extracts obtained from plants in family Lamiaceae could be exploited and further developed as potential plant-based insecticides against some sucking insect pests.

The aim of this study was to determine the effect of menthol oil, camphor oil and their mixture against the green leafhopper, *E. decipiens* in the laboratory and application of LC_{90} on it under semi-field conditions.

MATERIALS AND METHODS

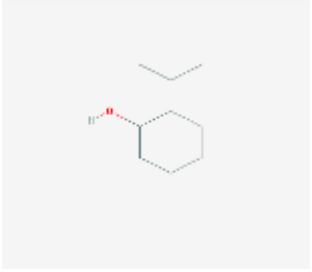
E. decipiens Culture:

Individuals of green leafhoppers were collected from infested cowpea plants at the unsprayed experimental farm of Faculty of Agriculture, Mansoura University and transported to the laboratory in paper bags. Nymphs were transferred for rearing on leaves and kept in jars covered with muslin at 27±2^{O}C and 65±5% RH for development to adults. Fresh leaves were provided to nymphs every two days. Then, newly emerged adults were collected to start the experiments.

The Plant Oils:

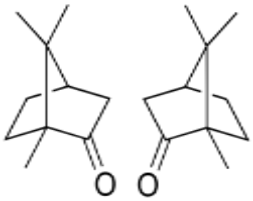
Both menthol and camphor oil extracts were bought from Essential oil Extracts Center, National Research Center.

- Menthol oil is extracted from leaves of *Mentha piperita* L. (Family: Lamiaceae) and the chemical formula is $C_{10}H_{20}O$.



(O'Neil, 2013)

- Camphor oil, the chemical formula is $C_{10}H_{16}O$ and it is found in the wood of the camphor laurel, *Cinnamomum camphora* L. (Family: Lauraceae).



Camphor formula (Lincoln and Lawrence, 1984).

A Mixture of both oils made by adding a proportion of 1:1 of each oil.

Convenient stock concentrations of each oil were prepared on the basis of the tested plant oil weight and the volume of the distilled water (w/v) in the presence of tween 80 (0.1%) as the emulsifier. Then, concentrations were prepared according to Abd-Allah and Marouf (2015) and kept in glass-stoppered bottles under refrigeration. Such stock solutions were prepared periodically.

Laboratory Experiments:

Three treatments (menthol oil, camphor oil and their mixture) were examined to evaluate their toxicity on the adults of *E. decipiens*. Five concentrations (100, 200, 300, 400 and 500 ppm) of each plant oil and their mixture were made to be tested against the target insect pest. The five diluted concentrations were used to draw the LC-P lines. Four replicates were used for each treatment concentration and the same for the untreated.

Twenty individuals of the green leafhoppers for each replicate were introduced into plastic units (9 cm in diameter and 5 cm high) and applied with the different current treatments concentrations which were sprayed directly on the target insect pest to estimate the mortality line, as well as twenty adults of *E. decipiens* in the untreated which was sprayed only by distilled water and tween.

The mortality percentage was estimated and corrected according to **Abbott's** formula, 1925. LC_{50} values were determined by using probit statistical analysis method (Finney, 1971).

$$\text{Toxicity index for } LC_{50}(\textbf{Sun, 1950}) = \frac{LC_{50} \text{ of the most effective compound}}{LC_{50} \text{ of the other tested compound}} \times 100$$

Semi-field Experiments:

Sixteen pots were planted by cowpea which is one of the important plants which infested by leafhopper (Ebadah, 2002; El-Kady *et al.*, 2016 and El-Khayat *et al*., 2017). The experiment was carried out in cages covering the plants where each plant was covered by special cylinder cage (14 cm in diameter and 30 cm high) which was coated by muslin. After approximately two weeks of the plantation, twenty individuals of the green leafhopper were transferred on the cowpea plants under cages in each pot. Four replicates were used for each essential plant oil treatment and also the untreated.

The LC_{90} of all treatments was sprayed while untreated was sprayed by distilled water and tween. Death corrected ratio was computed one, three, five and seven days after treatment according to Abbott's formula (1925):

$$\text{Death correctedratio\%} = \left(1 - \frac{\text{n in T. after treatment}}{\text{n in Co. after treatment}} \times 100\right)$$

Where :

n in T. : Number of living individuals after spraying with different essential oil concentrations.

n in Co. : Number of living individuals after spraying with distilled water and tween

RESULTS AND DISCUSSION

Laboratory Experiment:

Data in Table (1) showed the efficiency of treated essential plant oils against *E. decipiens* adults. It demonstrated that all concentrations of the mixture of menthol and camphor oils were highly effective and more toxic to the insect pest than either oil alone. This result was in agreement with Abd-Allah and Marouf (2015) who proved that the effectiveness of the mixture of menthol and camphor oils was higher

than each oil alone against the pupae of cotton leafworm, *Spodoptera littoralis* (Boisd.).

Table (1) Corrected mortality percentages of the adults of green leafhopper, *E. decipiens* treated with essential plant oils under laboratory conditions (27±2^{O}C and 65±5% RH).

Treatments	Conc. (ppm)	Mortality after treatments %				Total mortality%
		One day	Three days	Five days	Seven days	
Menthol oil	100	7.5	17.5	10	2.5	37.5
	200	8.8	17.5	16.3	5	47.6
	300	10	17.5	20	7.5	55
	400	15	27.5	23.8	11.3	77.6
	500	25	30	23.8	3.8	82.6
Camphor oil	100	5	6.3	10	5	26.3
	200	6.3	12.5	15	6.3	40.1
	300	7.5	16.3	20	6.3	50.1
	400	11.3	22.5	26.3	10	70.1
	500	16.3	26.5	25	7.5	75.3
Mixture of Menthol and Camphor oils	100	10	27.5	22.5	11.3	71.3
	200	18.8	28.8	20	7.5	75.1
	300	21.3	33.8	25	7.5	87.6
	400	21.3	33.8	20	13.9	89
	500	23.3	35.2	25	7.5	91

Results in Table (2) revealed that LC_{50} and LC_{90} values of the mixture of both essential oils were lowest (37.86 ppm and 463.12 ppm) compared with each menthol oil (182.34 ppm and 962.36 ppm) and camphor oil (242.80 ppm and 1128.05 ppm) alone. This means that the mixture of both oils was more effective on *E. decipiens* control than either oil.

Table (2) Efficiency of some plant essential oils against green leafhopper, *E. decipiens.*

Treatments	Conc.	Corrected mortality %	LC_{50}	LC_{90}	Slope± S.D.	Toxicity index LC_{50}	LC_{50}/ LC_{90}	R	P
Menthol oil	100	37.5	182.34	962.36	1.7± 0.2	20.76	5.28	0.932	0.028
	200	47.6							
	300	55							
	400	77.6							
	500	82.6							
Camphor oil	100	26.3	242.80	1128.05	1.92± 0.2	15.59	4.65	0.971	0.249
	200	40.1							
	300	50.1							
	400	70.1							
	500	75.3							
Mixture of Menthol and Camphor oils	100	71.3	37.86	463.12	1.18± 0.27	100	12.23	0.956	0.533
	200	75.1							
	300	87.6							
	400	89							
	500	91							

P: Probability **R: Regression**

The slope values in Fig. (1) indicated that the mixture of both ingredients had the lowest value 1.18 followed by 1.7 and 1.92 for menthol oil and camphor oil, respectively. The red flour beetle, *Tribolium castaneum* Herbst could be managed using oil extract of mint, *M. longifolia* (Khani and Asghari 2012). Osman *et al.* (2012) proved that camphor oil extract had a significant effect on larval mortality of cotton leaf worm. Abd-Allah and Marouf (2015) proved the effectiveness of camphor and menthol mixture on pupae of cotton leafworm. Mohamed *et al.* (2018) and Kwadwo *et al.* (2018) obtained similar results concerning the effectiveness of plant extracts against leafhoppers.

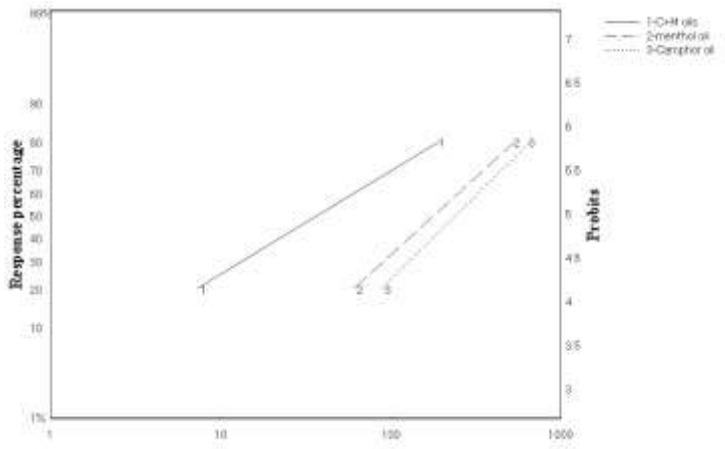


Fig. (1) LC-P lines for some plant essential oils against green leafhopper, *E. decipiens*.

Semi-field Experiment:

Results in Table (3) showed that LC_{90} of the mixture of menthol and camphor oils was more effective in controlling green leafhopper, *E. decipiens* than each oil alone. Where, the mortality percentage of the target insect pest was 50% compared with 41.03% and 35.90% mortality for menthol and camphor oils, respectively. This result is in agreement with the result of Kwadwo *et al*. (2018).

From the current results, it could be concluded that applying oil extracts of menthol, camphor and their mixture could be effective in controlling the green leafhopper, *E. decipiens.*

Table (3) Corrected mortality percentages of *E. decipiens* sprayed by LC_{90} of menthol, camphor oils and their mixture under semi-field conditions.

Treatments	Total living individuals	Corrected mortality %
Menthol oil	46	41.03
Camphor oil	50	35.90
Mixture of camphor and menthol oils	39	50
untreated	78	

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ARABIC SUMMARY

تأثير بعض الزيوت الطبيعية ضد آفة نطاط الأوراق الأخضر *E. decipiens*

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معهد بحوث وقاية النباتات- الدقى- الجيزة- جمهورية مصر العربية

تم دراسة تأثير كلاً من زيت النعناع و زيت الكافور على حدة وخليطهما على نطاط الأوراق الأخضر *E. decipiens* معملياً الى جانب تحديد التركيز المميت ٩٠ و تطبيقه فى تجربة نصف حقلية. وقد أوضحت النتائج أن خليط من كلا الزيتين كان له التأثير الأعلى من كل زيت على حدة حيث أن التركيز النصف مميت ٣٧,٨٦ جزء فى المليون للخليط، ١٨٢,٣٤ جزء فى المليون و ٢٤٢,٨٠ جزء فى المليون لكل من زيت النعناع وزيت الكافورعلى التوالى. كذلك فإن التركيز المميت٩٠ كان ٤٦٣,١٢ جزء فى المليون، ٩٦٢,٣٦ جزء فى المليون و ١١٢٨,٠٥ جزء فى المليون لكل من الخليط، زيت النعناع و زيت الكافور على التوالى. كما أوضحت النتائج بعد تطبيق التركيز المميت ٩٠ على الآفة بكل من الخليط وكل زيت على حدة فى التجربة النصف حقلية أن التأثير الأعلى كان للخليط حيث كانت نسبة الموت ٥٠٪ بينما كانت ٤١,٠٣٪ و ٣٥,٩٠٪ على التوالى لكل من زيت النعناع وزيت الكافور على حدة.