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Evaluation of Abamectin and Peppermint oil Against the *Thrips tabaci* on strawberry plant and its effect on vegetative characteristics

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Abstract

A field study was conducted to evaluate the efficacy of unconventional insecticides, Vertimec 1.8% EC (Abamectin) and Peppermint oil (*Mentha piperita*) (family Lamiaceae) against *Thrips tabaci* (Lindeman) on Strawberry plant crop during two successive seasons 2020 and 2021, at a private farm in Meet Al-Kenana Toukh, Qalyubia governorate in Egypt. All the treatments showed a significant difference two insecticidal applications, regarding their effectiveness. The efficacy of insecticide Vertimec 1.8% EC (Abamectin) and Peppermint oil increased gradually to reach their highest efficacy after 10 days of spray and more efficient to combat *T. tabaci*, were 81.55% and 79.11%, respectively. Peppermint oil was closed to terminal in of the chemical analysis to estimate the chlorophyll content in the leaves, it turned out that the untreated area recorded the highest percentage, followed by Vertimec 1.8% EC (Abamectin).

Key words: Strawberry plant, *Thrips tabaci*, abamectin, peppermint oil, vegetative characteristics

Introduction

Strawberry (*Fragaria x ananassa* Duch) is an important member of the Rosaceae family. It has become one of Egypt's most economically successful vegetable crops, serving as the primary cash crop for strawberry growers in the governorates of Qalyubia, Ismailia, Sharkia, and Beheira **(Ferla *et al.*, 2007).** Strawberry fruits having high in vitamins C, A, and B, potassium, calcium, and magnesium, and have medicinal characteristics for avoiding cardiovascular, neurological, and other human disorders such as ageing, obesity, and cancer **(Zhang *et al.*, 2008 and Saber *et al.*, 2016).**

Strawberries are attacked by a number of pests in Egypt, which cause in significant quantitative and qualitative losses in fruit supply. It is proper to focus on the more significant insects and other pests that harm strawberry plants. These pests may result in a significant financial loss (**Rings and Neiswander, 1966**), such as the cotton leaf-worm (Boisd.) (Lepidoptera: Noctuidae) (**Abd El-Razik and Mostafa, 2013 and EPPO, 2014**), *Anthonomus rubi* Herbst, (Coleoptera: Curculionidae), *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) (**Shakya *et al.*, 2010**), the whitefly *Bemisia tabaci* (Hemiptera: Aleyrodidae) (**Abou El-Naga *et al.*, 2009**), one of the most significant insects affecting strawberry plants is the green peach aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae) **(Bernardi *et al.*, 2013**) *Tetranychus urticae* (Koch) (Prostigmata: Tetranychidae) **(MD Salas-Araiza *et al.*, 2020 and Rosa *et al.*, 1993)** plant-parasitic nematodes (**Abdet-Sattar *et al.*, 2008** and **El-Habashy 2010).**

Abamectin is a one of the family of insecticides known as avermectins, which are created by the soil bacterium *Streptomyces avermitilis* **(Burg *et al.*, 1979).** Abamectin works as an agonist for the GABA receptors in the nervous system of arthropods, exhibiting both insecticidal and acaricidal properties **(White *et al.*, 1997).** When it was applied to crops, abamectin residues decompose into a variety of compounds through oxidative and photochemical activity. However, only avermectin B1 and its metabolite, 8,9-Z-avermectin B1, are toxicologically significant residues **(FAO/OMS, 1992).** MRLs (maximum residue limits) are therefore calculated as the sum of avermectin B1a, B1b, and 8,9-Z-avermectin B1. MRLs of 0.01 to 0.02 mg/kg for fruits and tomatoes have been established by the Codex Committee on Pesticide Residues under the Joint

FAO/WHO Food Standards Programme **(FAO/WHO, 1997; Diserens and Henzelin, 1999).**

Considering the long-term harm that pesticide use causes to the economy, natural systems, and public health **(Biziuk and Stocka, 2015).** Essential oil substances and their derivatives are believed to be effective in controlling a number of harmful insects, and the quick environmental degradation of these substances has enhanced their specificity in favour of beneficial insects **(Pillmoor *et al.*, 1993).** Its larvicidal and antifeedant activities have been demonstrated by research in recent years **(Gbolade, 2001; Adebayo *et al.*, 1999; and Larocque *et al.*, 1999).** Plant essential oils recently have been used as a biological control for insects and pests **(Elshafie and Camele, 2017 ; Lins *et al.*, 2019) .** Regarding their important characteristics, essential oils are considered safer and more eco-friendly than synthetic pesticides and insecticides; additionally, essential oils are with a lower toxicity for mammalians **(Mossa, 2016)** Also, essential oils help plants defend themselves against diseases, viruses, fungus, insects, and other pests.

Mentha piperita L. essential oil has stood out among essential oils from various plants due to its antibacterial, antifungal, and antioxidant **characteristics (Iscan *et al.*, 2002; Arslan and Dervis 2010; Hussain *et al.*, 2010; Soltani & Aliabadi 2013; Beyki *et al.*, 2014; Sun *et al.*, 2014)**.

Pesticides can disrupt crop physiology in a number of ways, including by affecting how reproductive organs develop, reducing growth, and changing how carbon and/or nitrogen are metabolised, which reduces the amount of nutrients available for plant growth **(Petit *et al.*, 2012; Giménez *et al.*, 2020).** Pesticides can either control or kill plants in a number of ways, such as by preventing biological processes like photosynthesis, mitosis, cell division, enzyme activity, root development, or leaf formation; by interfering with the production of pigments, proteins, or DNA; by destroying cell membranes; or by encouraging unchecked growth **(William *et al.*, 1995; Parween *et al.*, 2016) .**

Is to. aim to the present investigation is to determine effects of the Abamectin and Peppermint oil against *Thrips tabaci* on strawberry plant during two successive seasons 2020 and 2021,and its effect on Vegetative measurements and concentration of Chlorophyll in content of strawberry plant

Materials And Methods

The present study was conducted during two successive seasons 2020 and 2021 to evaluate the efficacy of two chemical materials, namely abamectin (biopesticide) and peppermint oil (essential oil) against thrips and their effect on the botanical properties of strawberry.

Experimental design:

The experiments were carried out in the Meet Al-Kenana Toukh region of Al Qalyubia Governorate. An area of 88 m^2 was selected to be sown in the first week of October 2020 and 2021 with strawberry seedlings for the Strawberry Festival. The area of treatment was divided into three plots for each treatments, the same in control. The experiment was laid out in plots that were arranged in a randomized design. All agricultural practices were conducted as usual throughout the strawberry growing seasons. Spray tested materials by on the 14^{th} and 25^{th} of November, 2020 and 2021, respectively, at recommended rates of application and applied once. Spray of the final solution was sprayed using a dorsal solo motor (2 liters).

Sampling of *thrips tabaci* adults and larvae was repeated eight times in two months November and December 2020 (sampling dates: 6 , 13, 20 and 27 November while in December were 4,11,18 and 25 respectively, Sampling was repeated nine times in the second season 2021 in November, December and January (sampling dates: 19,26 November , 3,10,17,24 and 31 December,7,14 January, the upper and lower surfaces of the randomly chosen leaves from each plant level were carefully examined using a hand lens. The insect numbers were recorded on the day before application and after 1, 3, 5, 7, and 10 days from application post treatment to determine the numbers of *thrips tabaci* on 10 plants from each plot. The degree of infestation was estimated by counting the number of living insects (immature and adult stages). The percentages of infestation reduction were calculated according to **Henderson and Tilton's equation (1955),** as follows:

Reduction percentage **= 100 [1-(Cb / Ca X Ta / Tb)]**

Where:

Cb = counts of insects in control before application

Ca = counts of insects in control after application.

Ta = counts of insects in treatment before application.

Tb = counts of insects in treatment after application .

Chemicals Material:

Bio-pesticide: Vertimec 1.8%EC At a rate of 60 cm 3 / 100 liters of water .(Avermectin Group) produced by (Syngenta Agro Egypt).

Essential oil: Menthol Oil At the rate of liter / acre was purchased from (Pure Life Company) / Giza / Egypt.

Growth vegetative parameters:

Vegetative measurements of 9 plants for treatment of strawberry were recorded on day 128 after planting:

1-Number of leaves per plant(cm)

2- Stem length and stem diameter (cm)

3- Dry weight recorded (g) (**EL-SAWY *et al.*, 2012)**.

4- Analysis of the total chlorophyll percentage of leaves.

Plant chemical analysis

Determination of chemical constituents of chlorophyll content:

The levels of chlorophyll a, b, and total carotenoids in the leaves were determined using the method described by **(Saric *et al.*, 1967).** Fresh samples (0.2g) were homogenized with acetone (85%v/v) in the presence of a trace of Na2Co3 and silica quartz before being filtered through a central glass funnel (G4). The residue was washed with acetone many times until the washings became colorless. The mixed extract was finished to a predetermined volume (250ml.). A sufficient volume was obtained for colorimetric measurement of chlorophyll a, b, and carotenoids at 660,640, and 440 nm, respectively. The test was carried out with acetone (80%v/v) as a blank.

Statistical analysis:

The statistical analysis was carried out using two-way ANOVA using SPSS, ver. 25 **(IBM Corp. Released 2013)**. Data were treated as a complete randomization design according to **Steel *et al.*, (1997)**. Multiple comparisons were carried out applying **Duncun test.** The significance level was set at < 0.05.

Results And Discussion

Effect of the Abamectin and Peppermint oil against *Thrips tabaci* on strawberry plant during two successive seasons 2020 and 2021

First season 2020:

The effectiveness of different chemical compounds included Vertimec 1.8% E.C and Peppermint oil in reducing the population densities of *Thrips tabaci* on strawberry plants were assayed after receiving one spray of each compound during the experimental period, the results of these field experiments are tabulated in Table (1)

Data in Table (1) showed general mean percentage of reduction in population of *Thrips tabaci*, the effectiveness of Vertimec and Peppermint oil against *Thrips tabaci* on strawberry plants was increased with increasing the periods after insecticidal application. The population of *Thrips tabaci* in the pre-treatment sampling was high in all treatments recorded (6.33 ±0 .88 , 5 ±0 .88 , and5.66 ±0 .67) insects / 10 plants for (control, Peppermint oil and Vertimec 1.8% EC), respectively. On the other hand, population was significantly decreased in all the treated plots, one day from spraying, results revealed in Table (1) that Vertimec was found superior to Peppermint oil after the first day of treatment resulting 13.14 % reduction to insects. Compared in peppermint oil was 8.64% reduction to insects. The reduction percentage of population of *Thrips tabaci* was significantly increased for both tested the Vertimec and the peppermint oil sequentially during the duration days from spraying were 23.20%, 20.90% (3^{rd} days) , 66.42% , 49.44% on (7^{th} days) and the highest reduction in *Thrips tabaci* population was recorded after 10^{th} days after spraying reached 81.55%, 79.11% , respectively.

Second season 2021:

The average number of *Thrips tabaci* and percent of reduction in infestation are presented in table(1). The results showed that Vertimec 1.8% EC and Peppermint oil were able to suppress the levels of infestation to different degrees in comparison to that of untreated control. In the 1^{st} day after spraying, where all the plots were treated once, the reduction percentages of the Peppermint oil and Vertimec 1.8% EC were 11.17% and 18.45%, respectively. Meanwhile, this percentages increased gradually during the examination days (after 3^{rd} , 5^{th} ,7^{th} and 10^{th} days) was (24.91%,37.84%,55.58% and 64.69%)for peppermint oil, respectively. While the insecticide, Vertimec 1.8% EC, more effective than peppermint oil , the reduction percentage after(3^{rd} , 5^{th} ,7^{th} and 10^{th} days) were (34.76%, 43.44%, 64.60% and 81.28%), respectively. Our results agree with **Fakeer and Ahmed , 2022** reported that, abamectin was highly toxic to thrips . Also, **Mahmoud, 2017** found that the abamectin appeared highly effect of in cntrolling the larvae of cotton leaf worm . According to **Jacobson, 1989,** the lipophilic structure of plant essential oils allows them to interfere with basic metabolic, biochemical, physiological, and behavioral activities of insects. Furthermore, **Kumar *et al.*, 2011 reported that** Mentha has a historical value as a medicinal and insecticidal herb in the traditional knowledge system. *Mentha piperita* L. essential oil has been recognised for its antibacterial, antifungal, and antioxidant effects. also was registered by **Iscan *et al.*, 2002, Arslan and Dervis 2010, Hussain *et al.*, 2010, Soltani and Aliabadi 2012, Beyki *et al.*, 2014, Sun *et al.*, 2014.** Regarding use in pest management, *Mentha piperita* Essential oil has an insecticide effect against stored grain pests **Halit *et al.*, 2012, Mishra *et al.*, 2014, Rajkumar *et al.*, 2019. SOUZA *et a.l*, 2022 reported that** *Mentha piperita* is also effective against the two-spotted spider mite. Because of the fatal effect and reproductive performance of these EO and its main constituent menthol against *Tetranychus urticae* adult females.

Table (1): Effect of Chemical compounds on population of *Thrips tabaci* on strawbarry plant , under field conditions during seasons 2020,2021 .

Treatments	Pre-spray	season`2020									
		1		3		5		7		10	
		M.	Red.%	M.	Red.%	M.	Red.%	M.	Red.%	M.	Red.%
Peppermint oil	5 ±0 .88	4.33 ±0 .67	8.64	3.33 ±0 .67	20.90	2.33 ±0 .00	31.88	1.33 ±0 .00	49.44	0.33 ±0 .33	79.11
Vertimec 1.8% EC	5.66 ±0 .67	4.66 ±0 .88	13.14	3.33 ±0 .58	23.20	2 ±0 .33	48.34	1 ±0 .00	66.42	0.33 SE±0 .33	81.55
Control	6.33 ±0 .88	6 ±0 .88		5.33 ±0 .58		4.33 ±0 .00		3.33 ±0 .00		2 ±0 .33	

M. mean
Red.% : reduction

Treatments	Pre-spray	season`2021									
		1		3		5		7		10	
		M.	Red.%	M.	Red.%	M.	Red.%	M.	Red.%	M.	Red.%
Peppermint oil	6 ±0 .58	5 ±0 .58	11.17	3.66 ±0 .67	24.91	2.33 ±0 .33	37.84	1.33 ±0 .33	55.58	0.66 ±0 .33	64.69
Vertimec 1.8% EC	5.66 ±1 .67	4.33 ±1 .33	18.45	3 ±1 .00	34.76	2 ±0 .58	43.44	1 ±0 .58	64.60	0.33 ±0 .33	81.28
control	5.33 ±0 .33	5 ±0 .58		4.33 ±0 .33		3.33 ±0 .33		2.66 ±0 .33		1.66 ±0 .33	

Vegetative growth at 128 days after transplanting:
Vegetative characteristics:
First season 2020:

Data presented in Table (2) clearly indicated that, the vegetative, growth parameters of strawberry plants expressed as leaves number , Stem length, Stem diameter Shoots Dry weight had significantly effect by chemical and plant extract pesticides treatments. As shown in Table (2) Register properties (i.e., Leaf number ,Stem length, stem diameter and The dry weight of the shoot) The number of leaves increased in the treatment of peppermint oil achieved mean (24.00 ± 0.58a) followed by Vertimec 1.8% E.C at mean (19.67 ± 0.67b) among the untreated strawberry plants, the leaves number (18.67 ± 0.88bc) leaves as mean plant (after 128 days of transplanting).As for stem length, its high significant increase existed with Peppermint oil rate (13.27±0.12a) but Vertimec slightly increased rate (11.97±0.50b) Where the control scored(11.17±0.18bc).With regard to the Stem diameter, it was highly significantly with Peppermint oil achieved mean (4.30±0.12a) and Vertimec , 4.10±0.12a), but slightly decreased in the control rate (3.23±0.09b).

Furthermore, high significant increases existed in Shoots Dry weight with Peppermint oil gave mean (7.80±0.11a) significant increase. Also, it could be noticed that Vertimec gave mean(5.78±0.36b) but found a slight decrease with control values who scored mean(5.75±0.56b).

Second season 2021:

Register properties Table (2) in 2021 season that The number of leaves increased in the treatment of peppermint oil achieved mean (24.33±0.88a) followed by Vertimec 1.8% E.C at mean (19.33±0.88b) among the untreated strawberry plants, the leaves number (18.67±0.88bc) leaves as mean plant (after 128 days of transplanting).

As for stem length, its high significant increase existed with Peppermint oil rate (13.33±0.12a) but Vertimec slightly increased rate (11.90±0.53b) Where the control scored(11.87±0.28b).

With regard to the Stem diameter, it was highly significantly with Peppermint oil achieved mean (4.50±0.17a) and Vertimec , 4.30±0.12a), but slightly decreased in the control rate (3.40±0.06b).

In addition , high significant increases existed in Shoots Dry weight with Peppermint oil gave mean (7.72±0.31a) significant increase. Also, it could be noticed that Vertimec gave mean(6.26±0.66b) but found a slight decrease with control values who scored mean(6.02±0.05b).

Eisa and Behnam, 2015 , The results of research have demonstrated that treatment of peppermint can be used as a proper method to improve the qualification of strawberry And **EL Sayed and Elshawa, 2016** proved that spraying with Peppermint oil He gave the highest values in vase life and fresh weight . **El-Aziz and El-khouly, 2022** found that abamectin were increase the fresh weight of tomato plants and increased the root length .

Table 2. Effect of Abamectin and Peppermint oil on some morphological characteristics and concentration of Chlorophyll in content of strawberry plant at 128 Days after transplanting (mean±SE).

Growth character	Leaf number		Stem length		Stem diameter		Shoots Dry weight		Chlorophyll			
	Seasons study											
Treatments	2020	2021	2020	2021	2020	2021	2020	2021	season`2020		season`2021	
									A	B	A	B
Control	18.67±0.88bc	18.67±0.88bc	11.17±0.18bc	11.87±0.28b	3.23±0.09b	3.40±0.06b	5.75±0.56b	6.02±0.05b	0.075	0.58	0.082	0.63
Peppermint oil	24.00±0.58a	24.33±0.88a	13.27±0.12a	13.33±0.12a	4.30±0.12a	4.50±0.17a	7.80±0.11a	7.72±0.31a	0.042	0.34	0.047	0.42
Vertimec 1.8% EC	19.67±0.67b	19.33±0.88b	11.97±0.50b	11.90±0.53b	4.10±0.12a	4.30±0.12a	5.78±0.36b	6.26±0.66b	0.015	0.71	0.019	0.78

a, b & c: There is no significant difference (P>0.05) between any two means for each attribute, within the same column have the same superscript letter; chemical composition Chlorophyll concentration at 128 days after transplanting .

First season 2020:

As shown in Tables (2) it could be clearly noticed that total Chlorophyll in leaves were increased with untreated plants followed by Vertimec 1.8% EC treatment , but Peppermint oil recorded the lowest total chlorophyll readings .

Second season 2021:

As shown in Tables (2) it could be clearly noticed that total Chlorophyll in leaves were increased with untreated plants followed by Vertimec 1.8% EC treatment , but Peppermint oil recorded the lowest total chlorophyll readings ,The results of this analysis agreed with the first season 2020.

Belmekki and Bendimerad, 2012 reported that the Lamiaceae family includes rich source of polyphenol compounds and therefore, it has antioxidant and biological properties. **Mahdavikia and Saharkhiz, 2015.**showed the EO of peppermint had the maximum

inhibitory effect on germination and growth factors of field bindweed, purslane and radish .

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تقييم فعالية مبيد الابامكتين وزيت النعناع علي حشرة التربس علي نباتات الفراولة وتأثير ذلك علي الصفات الخضرية للنباتات.

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أجريت دراسة ميدانية لتقييم فاعلية المبيد الحشري الفرتيميك 1.8% EC (الابامكتين) وزيت النعناع (*Mentha piperita*) (عائلة Lamiaceae) ضد (*Thrips tabaci* Lindeman) على محصول نبات الفراولة خلال موسمين متتاليين 2020 و 2021 على انفراد. في مزرعة بميت الكنانة طوخ بمحافظة القليوبية في مصر. أظهرت جميع العلاجات اختلافًا كبيرًا مع بعضها البعض فيما يتعلق بفعاليتها. أظهر استخدام المبيد الحشري الفرتيميك 1.8% EC (الابامكتين) وزيت النعناع أعلى فاعلية لهما بعد 10 أيام من الرش وأكثر فاعلية لمكافحة التربس كانت 81.55٪ و 79.11٪ على التوالي. كان زيت النعناع قريبًا من نهايته في التحليل الكيميائي لتقدير محتوى الكلوروفيل في الأوراق ، واتضح أن المنطقة غير المعالجة سجلت أعلى نسبة ، تليها الفرتيميك 1.8% EC (الابامكتين).