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Research Article

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Insecticidal Effect of Some Plant Essential Oils against Green Peach Aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae) Under Laboratory Conditions

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Abstract The green peach aphid, *Myzus persicae* Sulzer (Hemiptera: Aphididae), is a polyphagous species, that causes economic damage to many crops. The purpose of the current study was to investigate the insecticidal effect of black cumin (*Nigella sativa* L.), thyme (*Tyhmus vulgaris* L.), chamomile (*Matricaria chamomilla* L.) and fennel (*Foeniculum vulgare* Mill.) plant essential oils (PEOs) on the second stage nymphs of *M. persicae* under laboratory conditions. Doses of 1%, 2, 4 and 8 µL mL^{-1} of PEOs were applied by spraying method, and sterile distilled water was used in the control treatment. Dead-live individuals were counted on the 1st, 3rd, 5th and 7th days after the applications. The experiments were carried out in growth chambers (25±1ºC temperature, 60±5% RH, and (16:8) L:D) in a randomized plot design with five replications. According to the results, a 100% mortality rate was detected in all doses of thyme and chamomile PEOs applied on the 5th day of the experiment. A 100% mortality rate for all supplied doses and PEOs was noted on the seventh day of the experiment. Even at low dosage levels, the applied PEOs demonstrated a strong insecticidal effect on *M. persicae* nymphs. These PEOs can be preferred to control the green peach aphid because of high mortality rates, vegetable origin, and eco-friendly. Meanwhile, field studies need to be carried out with the four PEOs found effective in the study.

Keywords *Myzus persicae*, Plant essential oils, Bioinsecticide, Toxic effect, Mortality

1. Introduction

The green peach aphid *Myzus persicae* (Sulzer) (Hemiptera: Aphididae) is a polyphagous species worldwide. This pest causes economic damage to many crops such as peach, apricot, cherry, plum, almond, citrus, tobacco, sugar beet, spinach, pepper, eggplant, tomato and cucumber, as well as forest and ornamental plants [1]. *M. persicae* damages plants by sucking on their young shoots and leave. It also secretes subtances that produce fumagin in the plant [2]. Similar to other aphids, it is a major source of injury as it can transmit viruses. According to the studies, it causes indirect damage to the plant by carrying more than 86 viral diseases [3]. According to Velioğlu and Toros [4] the green peach aphid is a common pest that requires frequent application of pesticides to control due to its high reproduction rate, feeding on the lower leaf surface, and many hosts. As a result, the pest becomes more resistant to these treatments.

Chemical pesticides are very effective against species of hemiptera insects [5]. These synthetic chemicals have become an important environmental problem because they create toxic effects for humans and many non-target organisms [6]. Safe, cheap, and eco-friendly alternative methods are required to stop these problems. In several studies, it has been reported that PEOs obtained from plants and considered biopesticides can be used in the IPM program to control pests by minimizing the use of pesticides [7-10]. PEOs are biosynthesized from many plant

organs as secondary metabolites [11]. Important families containing PEOs are reported as Asteraceae, Apiaceae, Brassicaeae, Compositaceae, Chenopodiaceae, Cupressaceae, Lauraceae, Lamiaceae, Myrtaceae, Ridaceae, Rutaceae, Rosaceae, Pineaceae, Poaceae, and Zingiberaceae [12]. PEOs extracted from plants contain various volatile molecules such as monoterpenoids, aromatic, phenolic, and aliphatic compounds [13]. Monoterpenoids are volatile, easily penetrate the insect's body and affect physiological functions by replacing lipophilic compounds [14]. PEOs have a lethal effect on eggs and larvae and also have an insect repellent effect [15].

In the previous studies; *Tagetes minuta* L. [16], thymus, veronica and agrimonia [17], anise, fennel and basil [18], *Juniperus excelsa* M. Bieb., *Juniperus oxycedrus* L., *Foeniculum vulgare* Miller, *Pimpinella anisum* L., *Rosmarinus officinalis* L., *Juglans regia* L. and *Laurus nobilis* L. [19]; *Mentha piperita*, *M. pulegium*, *Ocimum basilicum*, and *Pimpinella anisum* [20]; *Thymus vulgaris* L. [18]. PEOs have been reported to be effective on different aphids. In this study, the insecticidal effect of *Nigella sativa* L. (Ranunculaceae), *Tyhmus vulgaris* L. (Lamiaceae), *Matricaria chamomilla* L. (Asteraceae), and *Foeniculum vulgare* Mill. (Apiaceae) PEOs against second stage nymphs of *M. persicae* was investigated under laboratory conditions.

2. Materials and Methods

2.1. Plant essential oils

In the study, four PEOs including black cumin, tyhme, camomile and fennel were selected based on their plant family (Table 1). Black cumin, tyhme and camomile PEOs were produced by Arifoğlu Company (İstanbul, Türkiye), fennel PEO was produced by Beyazlar Company (Kocaeli, Türkiye) by steam distillation method. PEOs were stored at 4°C in a sealed vial until used.

Table 1: General information of PEOs used in the present study

English name	Scientific name	Family
Black cumin	*Nigella sativa* L.	Ranunculaceae
Tyhme	*Tyhmus vulgaris* L.	Lamiaceae
Camomile	*Matricaria chamomilla L.*	Asteraceae
Fennel	*Foeniculum vulgare* Mill.	Apiaceae

2.2. Insect rearing

The green peach aphid, *M. persicae* individuals were collected from a rearing on young seedlings pepper (*Capsicum annuum* L. Fam. Solanaceae) in the farmer's greenhouse in Kumluca district of Antalya province, Türkiye and transferred in laboratory. Mostar green pepper variety (*Capsicum annuum* L.), obtained from the private sector, was used as the host plant in the experiments. Pepper seedlings were transplanted into plastic pots (20 cm diameter) containing a mixture of soil, perlite and peat (1:1:1), and these pots were kept in the growth chamber. The seedlings were grown without the use of fertilizer or insecticides. After reaching the necessary height and leaf count, adult *M. persicae* individuals were transplanted and propagated on pepper seedlings. The production of *M. persicae* individuals and pepper plants used in the experiment was carried out in the growth chambers [25±1°C, 60±5% RH and photoperiod 16:8 h (L:D)] in the Entomology laboratory within the Department of Organic Farming Business Management, Faculty of Applied Sciences, Pamukkale University.

2.3. Insecticidal effect of PEOs against *M. persicae*

Ten second stage nymphs of *M. persicae* were selected from aphid-infested pepper leaves using a sable brush. Pepper leaves containing 10 second instar nymphs were placed in petri dishes (90 mm) containing drying paper moistened with pure water. Doses of 1%, 2, 4 and 8 µL mL^{-1} of black cumin, thyme, chamomile, and fennel PEOs were applied to each petri dish by spraying using a hand sprayer. Only pure water was used as a control. On the first, third, fifth, and seventh days following the applications, the number of living and dead individuals was counted. The experiments were carried out in a randomized plot design with 5 replications in the growth chamber.

2.5. Statistical analysis

The number of individuals surviving as a result of the applications was recorded. Using these data, mortality percentages were corrected using Abbott's formula [21]. One-way analysis of variance (One-Way ANOVA) was applied to the data obtained after angle transformation. The differences between the means were determined by

the Tukey's multiple comparison test at the P≤0.05 significance level [22]. All statistical analysis were performed using the SPSS® (Version 20.0, August 2011, SPSS Inc., Chicago, Illinois, USA) software.

3. Results and Discussion

All PEOs were statistically in the same group in the first day counts after the application of a 1% µL mL^{-1} dose. Thyme PEO had the highest mortality rate (60%) on the third day of counting, and it was statistically different from the other PEOs. Thyme and chamomile PEOs showed a 100% mortality rate on the fifth day of counting, whereas fennel PEO showed a 90% mortality rate. These PEOs were statistically in the same group. A 100% mortality rate for all applied PEOs was found on the seventh day of counting (Figure 1).

All PEOs were statistically in the same group in the first day counts after applying the 2% µL mL^{-1} dose. After three days of counting, chamomile PEO had the highest mortality rate (80%), and it was statistically separated from the other PEOs. Black cumin, thyme, and chamomile PEOs had 100% mortality rates on the fifth day of counting, whereas fennel PEO had a 90% mortality rate and all PEOs were statistically in the same group. All PEOs applications had a 100% mortality rate on the seventh day of counting, and there was no statistically significant difference between the PEOs (Figure 1).

No statistically significant difference was seen between any of the PEOs when applied at a dose of 4% µL mL^{-1} in the first day counts. Black cumin, thyme, and fennel PEOs were all in the same statistical group on the third day of counting, and thyme PEO had the highest recorded mortality rate (68%). All PEOs were statistically in the same group on the fifth day of counting, with thyme, chamomile, and fennel PEOs recording 100% mortality rates and black cumin PEO recording 90%. All PEOs treatments showed a 100% mortality rate by the seventh day (Figure 3).

All PEOs were in the same group in the first day counts after applying a dose of 8% µL mL^{-1}, and thyme PEO had the greatest mortality rate (30%). Thyme, chamomile, and fennel PEOs were in the same statistical group on the third day of counting, and thyme PEO had the highest recorded mortality rate (77%). All PEOs were statistically in the same group on the fifth day of counting, and thyme and chamomile PEOs had a 100% mortality rate. All PEOs applications had a 100% mortality rate by the seventh day of counting, and all PEOs were statistically all in the same group (Figure 4).

A 100% mortality rate was recorded for all doses of thyme and chamomile PEOs on the 5th day of the experiment. A 100% mortality rate was seen in the 7th day counts for all dosages of all PEOs. All applied PEOs showed a high insecticidal effect on *M. persicae* nymphs even at low dose levels. Although the application doses (1, 2, 4, and 8 µL mL^{-1}) increased death rates, it was found that the time increase was more significant than the dose. Researcher found that when adult *Aphis gossypii* Glover (Hemiptera: Aphididae) were treated with the active constituents of thyme and fennel PEOs, the mortality rate increased with the length of time (24, 48, and 96 hours) [23]. According to Isman's [24] laboratory experiment, when thyme PEO was applied to *M. persicae* (Sulz.) nymphs, the mortality rate increased from 22% to 60% in 24 hours. In another study, mortality rates against *M. persicae* were reported as 46.67% when thyme PEO was applied at 10 µl L^{-1} air dose, 66.67% when lavender PEO was applied at 20 µl L^{-1} air dose, and 86.67% when anise and lavender PEOs were applied at 30 µl L^{-1} air dose [25]. Mortality rates of 77.24–88.13% were found when *Myrtus communis* (Myrtaceae) and *Foeniculum vulgare* (Apiaceae), two PEOs from different families, were treated to *Ropalosiphum maidis* (Fitch, 1856) (Hemiptera: Aphididae) [26]. Mortality rates of 78.3% were determined for *Thymus vulgaris* PEO, 54.7% for *Lavandula dentata* PEO, and 56.7% for *Rosmarinus officinalis* var. *prostratus* PEO applied against another aphid species *Rhopalosiphum padi* L. (Hemiptera: Aphididae) [27]. Dancewicz et al. [28] found that *Carum carvi* L., *Origanum vulgare* L., *Rosmarinus officinalis* L., and *Satureja hortensis* L PEOs were effective against another aphid species, *Acyrthosiphon pisum* (Harris) (Hemiptera: Aphididae). The same study reported that *Thymus vulgaris* L. and *Pimpinella anisum* L. PEOs were effective against *M. persicae*. A study conducted under field conditions with the *F. vulgare* PEO used in the study reported that this PEO could be used as an insect control agent [29].

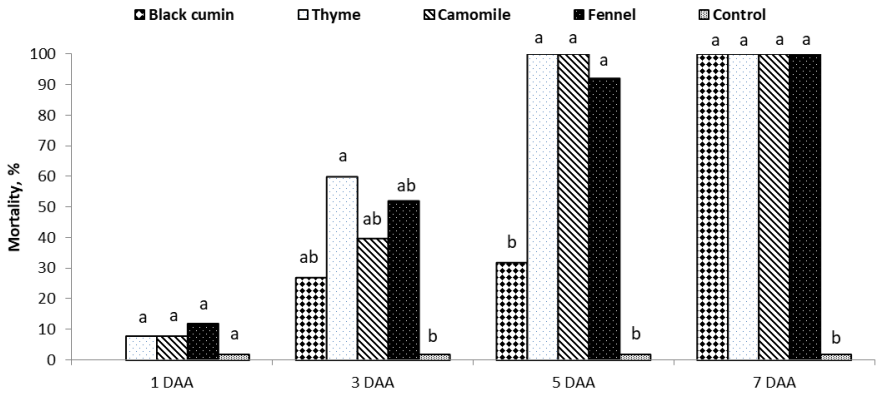

Figure 1: Average mortality percentage of 1% µL mL-1 dose of four PEOs on M. persicae
Different lowercase letters represent statistically significant differences among mortality, between treatments according to Tukey's HSD test (P ≤ 0.05). DAA= days after application

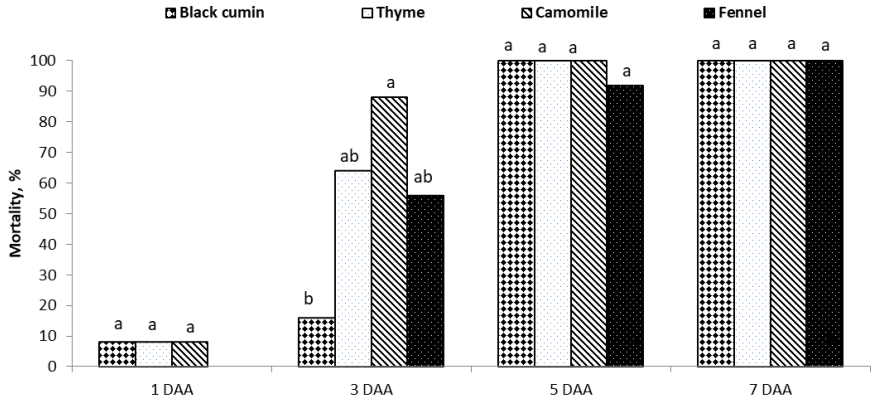

Figure 2: Average mortality percentage of 2% µL mL^{-1} dose of four PEOs on M. persicae
Different lowercase letters represent statistically significant differences among mortality, between treatments according to Tukey's HSD test (P ≤ 0.05). DAA= days after application

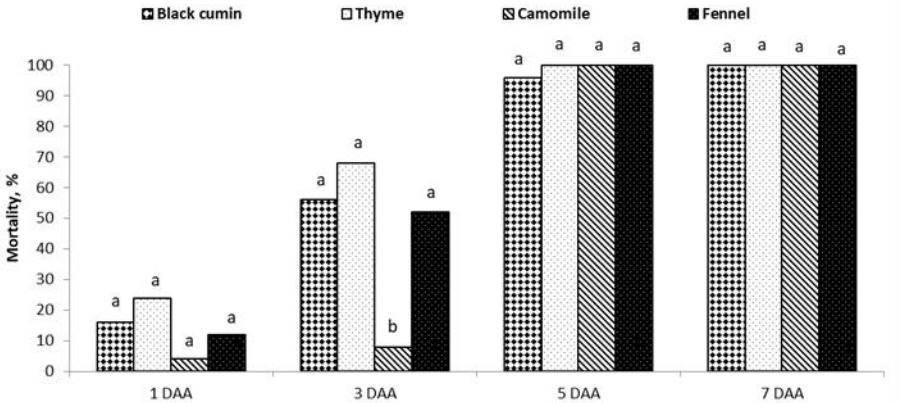

Figure 3. Average mortality percentage of 4% µL mL^{-1} dose of four PEOs on M. persicae
Different lowercase letters represent statistically significant differences among mortality, between treatments according to Tukey's HSD test (P ≤ 0.05). DAA= days after application

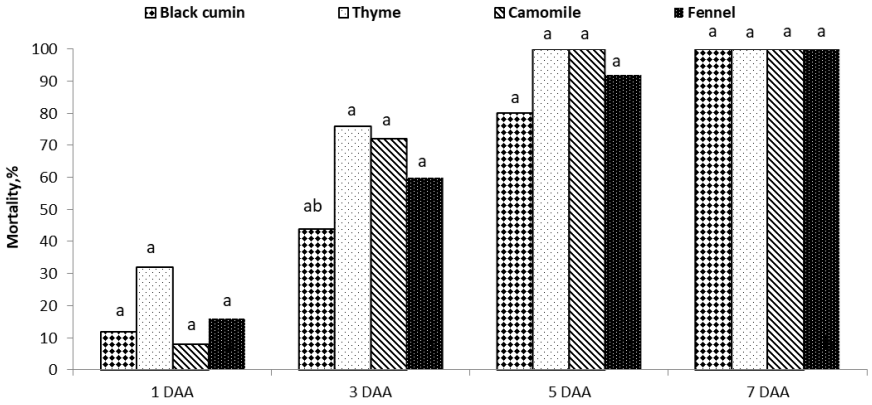

Figure 4. Average mortality percentage of 8% µL mL^{-1} dose of four PEOs on M. persicae
Different lowercase letters represent statistically significant differences among mortality, between treatments according to Tukey's HSD test ($P \leq 0.05$). DAA= days after application

4. Conclusions

M. persicae is a pest that causes economic losses in many agricultural crops. Chemical control is generally preferred in the control against this pest. In the laboratory study conducted to determine the effect of PEOs from different families and their different doses against *M. persicae*, all PEOs (black cumin, thyme, chamomile, and fennel) showed a high insecticidal effect. Unlike chemical-based insecticides, these PEOs are less harmful to plants and can successfully control pests. Additional studies need to be conducted to unravel the direct or indirect mechanism of action of black cumin, thyme, chamomile and fennel PEOs. The results obtained from the study will shed light on future studies and will support studies on the use of black cumin, thyme, chamomile and fennel PEOs within the scope of IPM against *M. persicae*.

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