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Insecticidal Activity of Five Essential Oils of Algerian Medicinal Plants on Peach-Potato Aphid, *Myzuspersicae (Homoptera: Aphididae)*

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ABSTRACT

Essential plant oils and their constituents have been previously proven to possess potential insecticidal and repellent activity against many types of insects. The interest in these essential oils is intensely increasing over time due to health and environmental concerns of synthetic insecticides. The present study was conducted to determine the insecticidal activity of essential oils from pine, *Pinussylvestris*; pennyroyal, *Menthapulegium*; rosemary, *Rosmarinusofficinalis*; lavender**,** *Lavandulastoechas*; and phoenician juniper**,** *Juniperusphoenicea* on the peach-potato aphid, *Myzuspersicae*. Each oil extract was used at three concentrations, 1000, 10,000 and 100,000 ppm. Oils were dissolved in 0.01 (v/v) dimethyl sulfoxide (DMSO) solution that was used as negative control. Actara® (Thiamethoxam) insecticide was used as a positive control. Sprays were conducted usingPotter Spray Tower (Burkard Scientific Ltd). Mortalities were recorded after 24, 48 ad 72hr of treatment. Results revealed that none of the used plant oil extracts at the three used concentrations was as toxic as Actara®. However, both *Juniperusphoenicea* and *Rosmarinusofficinalis* showed a mortality to aphids that exceeded 50 %. More research is required to improve the efficacy of these oils to be used as botanical insecticides.

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INTRODUCTION

Aphids are serious and most destructive insect pests on cultivated plants. They cause extensive damage to crops all over the world. Contamination of vegetables by aphids sometimes presents quarantine problems [26]. Aphids cause direct and indirect damage to infested plants because of their role in virus transmission, which can cause several losses especially in favorable condition [2].*Mysuspersicae*, which is known as peach-potato aphid is the most common aphid infesting about 100 plants species [10] and has also a secondary hosts in over 40 different plant families including many important agricultural plants [4, 19]. It has been identified as a major pest of vegetables and potatoes in Algeria and throughout the world due to its ability to transmit viruses. It has been considered as the most important aphid vector of potato viruses [3, 18, 22].

The conventional method used to combat the devastating effects of aphids and pests is the application of chemical insecticides. An alternative method to control aphids is the use of natural pesticides known as biopesticides based on plant extracts. Their usefulness in the control of aphids has been reported and elucidated [11, 20]. Essential oils are described as a complex mixture of natural substances. These high bioactive compounds can be used as effective insecticides [1, 24]. Essential oils showed good potential activity to control insects and having effectiveness by fumigation, topical application, antifeedant and repellent properties [9]. They are also safe to the user, environment friendly andcauselittle mammalian toxicity [14].

Recent investigations in several countries demonstrated how various essential oils were efficient against aphids [15, 21, 24] and can significantly reduce their reproduction potential [13]. The essential oil obtained from *Tagetesminuta* has reduced significantly the reproduction potential of *M.persicae*, *Acyrtosiphumpisum* and *Aulacorthumsolani* [27]. Hori [10, 12] reported that *M. persicae* was influenced by odors of rosemary oil and had effects on alighting behavior, and then it may be possible to control aphids with repellents and other ways.

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Also, Digilio *et al*. [6] showed aphidicial activity of vapors of essential oils extracted from several Mediterranean plants against *Acyrthosiphumpisum*and *M. persicae*.

Biopesticides based on essential oils have more characteristics of interest, being very little residual. The purpose of this study is therefore to evaluate the aphidicial activity of five essential oils extracted from Algerian medicinal plants against the most important aphid vector of plant viruses throughout the world, *M. persicae* [3].

MATERIAL AND METHODS

Aphid source:

The laboratory colonies of *M. persicae* were started with aphids collected from fresh leaves derived from a stock culture maintained at laboratory conditions; at 23 °C, photoperiod 11/13 hrs and 60% relative humidity.

Essential oil extraction:

Oils were extracted fromaerial parts of five medicinal plants: *Rosmarinusofficinalis, Lavandulastoechas, Menthapulegium, Juniperusphoenicea and Pinus sylvestris* by distillation using a Clevenger-type. Oils were stored in appropriate conditions. Those plants were reputed to perform important biological functions as conventional medicines, and then they become more widely available in the entire world for treating ailments (17, 8).

Experiments were carried at the laboratory of Plant Production and Protection Department at Al-Balqa, Applied University, Jordan, to evaluate the efficacy of those extracts against peach-potato aphid. Three concentrations (100, 1000, and 10000 ppm) of each extract were prepared by dissolving the oil extract in 0.01 (v/v) dimethyl sulfoxide (DMSO) solution.

DMSO and Actara® (Thiamethoxam) were used as negative and positive controls, respectively. Apterousvirginoparae were carefully placed on the lower surface of host plant leaves inside 9-cm petri dishes. Sprays made using with Potter Spray Tower (Burkard Scientific Ltd). Each treatment was replicated 5 times. Mortalities were recorded after 24 h, 48 h and72 hrs. Because mortality in the negative control treatment exceeded 20 % after 72 hrs, only data obtained after 24 and 48 hrs were considered.

Statistical analysis:

Arcsine-transformed percentage data were subjected to a one-way ANOVA, followed by a Least Significant Differences test at 95 % confidence level (SAS Institute, 2012).

Results:

Even though that the five used oils showed significant mortality to the aphid at a concentration of 1000 ppm compared with the negative control, DMSO solution, but none of them was as toxic as Actara insecticide did after 24 and 48 hr of treatment (Table 1). The extracted oil of *Rosmarinusofficinalis* resulted in a mortality above 50 % of the aphid that was (52.75) after 48 hr of treatment but it had no significant differences with *Pinussylvestris* (39.25) and *Juniperusphoenicea* (38.00).

When extracted oils used at a concentration of 10,000 ppm, both *Lavandulastoechas* and *Menthapulegium* showed no significant differences with control after 24hr of treatment (Table 2). But *Menthapulegium* showed significnt differences with control after 48 hr (Table 2). The extracted oil of both *Rosmarinusofficinalis* (55.50) and *Juniperusphoenicea* (57.50) resulted in a mortality above 50 % of the aphid after 48 hr of treatment but none of them was as toxic as Actara insecticide did(90.00).

Table 1: Percentage mortality of *Myzuspersicae* exposed to different plant oil extracts of Algerian medicinal plants at a concentrations of 1000 ppm.

Medicinal plant extract	% Mortality of *M. persicae*at a concentration of 1000 ppm±SE	
	After 24 hr	After 48 hr
Rosmarinusofficinalis	25.12^{b}± 6.58 (26.13)	52.75^{b}± 5.71 (46.38)
Pinussylvestris	15.87^{bc}± 2.97 (22.63)	39.25^{b}± 7.85 (38.25)
Lavandulastoechas	7.87^{c}± 3.22 (11.62)	16.87^{d}± 5.80 (19.12)
Menthapulegium	10.37^{bc}± 3.39 (15.75)	21.87^{cd}± 5.15 (25.63)
Juniperusphoenicea	17.12^{b}± 2.98 (24.13)	38.00^{bc}± 5.79 (37.88)
DMSO solution	10.12^{bc}± 2.66 (15.88)	16.50^{d}± 3.19 (22.25)
Actara	60.25^{a}± 7.22 (51.00)	90.62^{a}± 3.34 (76.25)

*Means within parentheses are angular transformed percents.
#Means within columns with the same letter are not significantlydifferent using LSD at 95% confidenceLevel.

Table 2: Percentage mortality of *Myzuspersicae* exposed to different plant oil extracts of Algerian medicinal plants at a concentrations of 10,000 ppm.

Medicinal plant extract	% Mortality of *M. persicae*at a concentration of 10,000 ppm±SE	
	After 24 hr	After 48 hr
Rosmarinusofficinalis	31.62^{b}± 6.87 (32.00)	55.50^{b} ± 9.26 (48.13)
Pinussylvestris	22.87^{bc}± 1.99 (28.38)	38.87^{bc}± 4.00 (38.50)
Lavandulastoechas	13.75^{cd}± 5.38 (16.88)	29.50^{cd}± 9.69 (29.88)
Menthapulegium	11.25^{cd}± 2.92 (17.00)	38.25^{bc}± 6.58 (37.63)
Juniperusphoenicea	32.37^{b}± 6.29 (34.00)	57.50^{b}± 9.01 (50.00)
DMSO solution	8.50^{d}± 2.79 (13.38)	17.00^{d}± 4.00 (21.38)
Actara	60.25^{a}± 7.22 (51.00)	90.62^{a}± 3.34 (76.25)

*Means within parentheses are angular transformed percents.
#Means within columns with the same letter are not significantlydifferent using LSD at 95% confidence level.

When the concentration of plant oils increased to 100,000 ppm, none of them showed to be as toxic as Actara insecticide after 24 and 48 hrs of treatment (Table 3). Both *Juniperusphoenicea (63.12)* and *Rosmarinusofficinalis (58.75)* resulted in mortalities above 50 % after 48 hrs of treatment.

Table 3: Percentage mortality of *Myzuspersicae* exposed to different plant oil extracts of Algerian medicinal plants at a concentrations of 100,000 ppm.

Medicinal plant extract	% Mortality of *M. persicae*at a concentration of 100,000 ppm±SE	
	After 24 hr	After 48 hr
Rosmarinusofficinalis	36.87^{ab}± 10.27 (36.32)	58.75^{b}± 12.12 (56.00)
Pinussylvestris	28.00^{bc}± 5.05 (29.88)	54.00^{b}± 9.06 (45.75)
Lavandulastoechas	12.62^{c}± 4.67 (17.38)	36.50^{bc}± 10.92 (38.00)
Menthapulegium	30.00^{b}± 10.56 (34.00)	44.37^{b}± 9.23 (43.50)
Juniperusphoenicea	32.12^{b}± 7.39 (33.50)	63.12^{b}± 8.65 (55.00)
DMSO solution	9.75^{c}± 2.07 (16.75)	17.00^{c}± 3.37 $(22.63^{)}$
Actara	60.25^{a}± 7.22 (51.00)	90.62^{a}± 3.34 (76.25)

*Means within parentheses are angular transformed percents.
#Means within columns with the same letter are not significantlydifferent using LSD at 95% confidence level.

Even both *Juniperusphoenicea and Rosmarinusofficinalis* showed mortalities more than 50 % to aphids, but increasing the concentration of *Juniperusphoenicea*from 1000 ppm to 100,000 ppm resulted in valuable increase in mortality of aphids (Fig. 1). On the other hand, *Rosmarinusofficinalis* showedmortality above 50% using the three concentrations but the percent of mortality did not more than 6% by increasing the concentration from 1000 ppm to 100,000 ppm (Fig. 1).

Discussion:

The toxicity of oil extracts of five Algerian plants known to have medicinal activity was investigated against the peach-potato aphid, *M. persicae* as botanical insecticides. These plants are pine, *Pinussylvestris*; pennyroyal, *Menthapulegium*; rosemary, *Rosmarinusofficinalis*; lavender**,** *Lavandulastoechas*; and phoenician juniper**,** *Juniperusphoenicea*.

None of the oils at the used concentrations was as toxic as Actara insecticide did in reducing the populations of beach-potato aphid. However, these oils showed variability in controlling the aphid. Both *Juniperusphoenicea*and *Rosmarinusofficinalis*resulted in mortalities to aphids that exceeded 50 % but they showed no significant differences with the other oils particularly after 48 hrs of their spray at the highest concentration. However, all used oils showed significant toxicity to aphids compared with the negative control after 48 hrs of spraying. These results concord with results of other researchers on these plant oils such as Hori [10, 11, 12] who reported that Rosemary oil exhibits a strong repellence and deterring gustatory and olfactory sense (Antifeeding activity, setting inhibitory and toxicity) of *M. persicae*. In addition, Santana *et al*. [25] demonstrated that *R.officinalis* oil caused a strong antifeedantactivity against *M.persicae*, while [5] results revealed that none of plant derived essential oils products (including Rosemary) provide sufficient control *of*

M.persicae. AlsoKatarzyna *et al*.[16] showed that Rosemary oil had a strongest deterrent effect on *Acyrthosiphumpisum* but not on *M. persicae*. On the other hand, Romuald and Michal [23] elucidated that Juniper oil mortality was very strong, amounted 100% on the aphid *Aulacorthumsolani*.

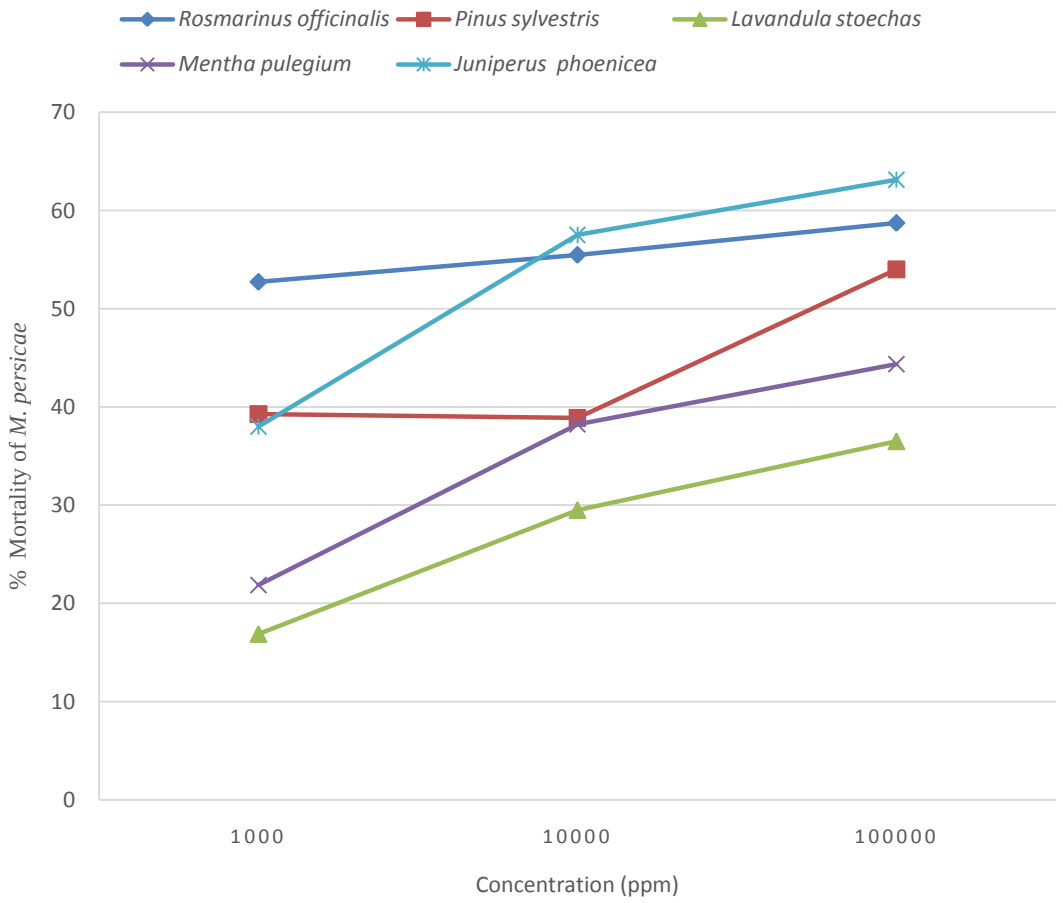

Fig. 1: Mortality of *M. persicae*exposed to different plant oil extracts of Algerian medicinal plants at three different concentrations.

An increase in the mortality was obtained by increasing the exposure time. However, data obtained after 72 hr of exposure were not considered as mortality in the negative control treatment was more than 20 %. Pine, Pennyroyal and Lavender oils showed low activity against *M.persicae*. The same results were reported by Cloyd [5] and Hiromi *et al*.[9] for Lavender at laboratory conditions. Pennyroyal oil reduced longevity and fecundity of *M.pessicae* [7].

The insecticidal activity of essential oils is varied and depends on the doses and exposure time. Perhaps, this variation is related to the penetration and detoxification mechanisms of plant-derived substances. It can be assumed that mortality was mainly due to the various active molecules containing in those oils and of a synergism of all compounds.

The use of essential oils from Rosemary and Phoenician juniper is proving to be an alternative approach for the protection of potatoes from aphids as biopesticide in pest management, especially for the green peach-potato aphid, which is considered to be the most important vector of plant viruses throughout the world [3].This study is a preliminary investigation in aphid control and more studies are needed to bioassy the activity of other concentrations and each identified compounds against aphid species and other pests.

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