

Romuald GÓRSKI^{1*} and Michał TOMCZAK¹

**USEFULNESS OF NATURAL ESSENTIAL OILS
IN THE CONTROL OF FOXGLOVE APHID
(*Aulacorthum solani* Kalt.) OCCURRING ON EGGPLANT
(*Solanum melongena* L.)**

**PRZYDATNOŚĆ NATURALNYCH OLEJKÓW ETERYCZNYCH
W ZWALCZANIU MSZYCY ZIEMNIACZANEJ (*Aulacorthum solani* Kalt.)
WYSTĘPUJĄCEJ NA OBERŻYNIĘ (*Solanum melongena* L.)**

Abstract: The purpose of the study was to determine the efficacy of natural essential oils, such as basil oil, citronella oil, eucalyptus oil, juniper oil and patchouli oil, in the control of foxglove aphid (*Aulacorthum solani* Kalt.) occurring on eggplant. The above-mentioned oils were used at concentrations of 0.02, 0.05 and 0.10%. The mortality of pest was evaluated 24, 48 and 72 hours after treatment. After application of citronella oil and patchouli oil at a concentration of 0.05 and 0.10% and juniper oil at 0.10%, 100% mortality of *A. solani* was observed. In the remaining combinations with the use of tested essential oils mortality amounted to 24.63÷89.40% (72 hours after treatment).

Keywords: natural essential oils, eggplant, *Aulacorthum solani*, control

Increasing problems have been observed in recent years in the control of pests found on crops, including aphids. These results first of all from the generation of pest biotypes resistant to applied chemical preparations. At the same time the range of admissible plant protection agents has been considerably reduced. In view of the Directive of the European Union many active substances of these preparations have been withdrawn from use in plant protection due to their being a hazard for human health and for the natural environment (Directive of the EEC Council of 15.07.1991, consolidated version of 01.08.2006, on the marketing of plant protection products - 91/414/EEC) [1]. Thus it is necessary to search for new, alternative methods of pest control. At present in plant protection we may observe increasing interest in the applicability of natural origin preparations, based on essential oils produced from different plant species. Essential oils are characterized by a complex chemical composition (Table 1) and many compounds they contain exhibit toxic or repellent action against pests.

¹ Department of Plant Protection Methods, Poznan University of Life Sciences, ul. Zgorzelecka 4, 60-198 Poznań, Poland

* Corresponding author: rgorski@up.poznan.pl

Table 1

A list of the most important chemical compounds found in natural essential oils used in the study and their contents [%] [2-6]

Essential oil	Monoterpenes	Monoterpenols	Sesquiterpenes	Sesquiterpenols	Esters	Ethers	Phenols	Aldehydes	Oxides
Basil oil	Ocimene 1-3 Limonene 1-2 Myrcene 0.1-2 Alpha-pinene 0.5-1 Beta-pinene <1	Linalool 35-54 Citronellol 2-4 Terpinen-4-ol 2-4	-	-	Methyl cinnamate 4 Geranyl acetate 1-2	Methyl chavicol 0-5	Eugenol 5-6	-	-
Citronella oil	Limonene 1-5	Geraniol 20-25 Citronellol 9-15	-	-	-	-	-	Citronellal 30-45 Geraniol <2 Neral <2	-
Eucalyptus oil	Pinenes 3-30 Limonene 0-4 Alpha-pinene 33-45	-	-	-	-	-	-	-	1,8 cineole 40-85
Juniper oil	Myrcene 11-20 Beta-farnesene 10 Camphene 3-4 Carene 1-2 Limonene 1-2 Sabinene 3	-	-	-	-	-	-	-	-
Patchouli oil	-	-	Alpha patchoulene 22 Beta caryophyllene 20 Beta patchoulene 13	Patchoulol 30-40 Bulnesol 1-3 Pogostol 1-3	-	-	-	-	-

The aim of the study was to determine the efficacy of selected natural essential oils in the control of foxglove aphid (*Aulacorthum solani* Kalt.) occurring on eggplant (*Solanum melongena* L.).

Materials and methods

Experiments on the efficacy of natural essential oils in the control of foxglove aphid (*A. solani*) occurring on eggplant were conducted in 2009. The following essential oils were tested: basil (*Ocimum basilicum*), citronella (*Cymbopogon winterianus* Jowitt), eucalyptus (*Eucalyptus globulus*), juniper (*Juniperus communis*) and patchouli (*Pogostemon patchouli*) oils, which were applied at a concentration of 0.02, 0.05 and 0.10%. The above-mentioned aroma substances were produced by Pollena-Aroma Sp. z o.o., Warsaw, Poland. Leaves of eggplant cv. "Epic" infested by the pest were removed from plants and immersed for 3 s in the prepared solution (water emulsion) containing different combinations of essential oils at appropriate concentrations. After leaves were removed from the solution they were placed for several seconds in the vertical position for excess liquid to drip down. In order to obtain a homogenous emulsion an emulsifier, RO-1, was added to solutions of tested oils at a concentration of 0.0125%. In the conducted experiments the effect of the emulsifier RO-1 on mortality of foxglove aphid was also tested by treating the pest with its solution at the applied concentration. In the control combination no essential oils were applied and eggplant leaves infested by the bug were immersed in water with no addition of aroma substances. Each combination was performed in 10 replications. After the oils were spread, leaves were placed on glass dishes lined with moistened filter paper and next plastic plates with holes of 35 mm in diameter were placed on leaf surface. The number of pests was counted in the location of holes in these plates. After counting was completed plates with holes were covered with glass plates, constituting a physical barrier preventing migration of bugs. Filter paper was moistened with water daily in order to maintain leaf turgor.

The efficacy of tested essential oils was determined after 24, 48 and 72 h. Results were analyzed statistically using the Newman-Kels test at the significance level $p = 0.05$.

Results and discussion

In the conducted experiments high efficacy of natural essential oils was recorded in the control of foxglove aphid (*A. solani*). After the application of citronella and patchouli oils at a concentration of 0.05 and 0.10%, as well as juniper oil at 0.10% a 100% mortality of the examined pest was recorded at 72 h after treatment. In the other combinations of tested essential oils mortality of the bug on the last day of observations was 24.63–89.40% (Table 2).

At the same time no effect on survival rates of foxglove aphids was found for the emulsifier RO-1 applied at a concentration of 0.0125%. No significant differences were found in terms of mortality between pests treated with an emulsifier solution and the control.

Literature contains information on the suitability of natural essential oils in the control of different pest species, although data concerning aphids are relatively scarce. Digilio et al [7] found high mortality of pea aphid (*Acyrtosiphon pisum* Harris) and green peach aphid (*Myzus persicae* Sulzer) following the application of oils produced from anise (*Pimpinella*

anisum L.), basil (*Ocimum basilicum* L.) and fennel (*Foeniculum officinale* All.). Satisfactory results in the control of peach aphid were recorded by Chiasson et al [8] when applying oil from wormseed goosefoot (*Chenopodium ambrosioides* L.). In turn, Masotoshi [9] showed a strongly toxic action against peach aphid for oils from penny-royal (*Mentha pulegium* L.) and garden thyme (*Thymus vulgaris* L.). Usability of different essential oils, including thyme oil, in the control of cabbage aphid (*Brevicoryne brassicae* L.) was determined by Görür et al [10]. Thyme oil exhibited the strongest action, mainly due to the content of such compounds as carvacrol and thymol. High mortality of pests was also reported after the application of oil produced from drug speedwell (*Veronica officinalis* L.) and agrimony (*Agrimonia eupatoria* L.). Essential oils used in the control of cabbage aphid when applied at lower doses caused reduced fertility of the pest. As it was reported by Soliman [11], high efficacy in the control of cotton aphid (*Aphis gossypii* Glover) was observed for essential oils produced from two wormwood species, ie *Artemisia herba-alba* (Asso) and *Artemisia monosperma* (Delile), with the former exhibiting higher effectiveness.

Table 2

Average mortality of foxglove aphid (*Aulacorthum solani* Kalt.) occurring on eggplant after application of natural essential oils

Essential oil	Concentration [%]	No. of hours after treatment		
		24	48	72
		mortality [%]		
Patchouli oil	0.02	31.38 ab*	35.50 ab	36.03 a
	0.05	91.04 d	100.00 d	100.00 c
	0.10	96.40 d	100.00 d	100.00 c
Citronella oil	0.02	35.29 ab	53.96 bc	58.90 ab
	0.05	59.66 bc	96.44 cd	100.00 c
	0.10	96.57 d	100.00 d	100.00 c
Juniper oil	0.02	22.28 a	34.47 a	39.22 a
	0.05	26.71 ab	54.01 bc	71.60 ab
	0.10	92.18 d	100.00 d	100.00 c
Basil oil	0.02	21.33 a	46.56 bc	49.84 a
	0.05	39.68 ab	59.08 bc	84.24 b
	0.10	69.11 c	85.00 cd	89.40 b
Eucalyptus oil	0.02	16.55 a	20.07 a	24.63 a
	0.05	17.69 a	44.26 ab	67.53 ab
	0.10	37.54 ab	61.00 bc	68.69 ab
Emulsifier RO-1	0.0125	21.55 a	24.45 a	28.05 a
Control	–	21.43 a	24.56 a	28.71 a

* Means in columns denoted with identical letters do not differ significantly ($p = 0.05$) according to Newman-Keuls' test

Natural essential oils not only exhibit toxic action against aphids, but also may have a repellent activity. Masotoshi [12, 13] reported that such properties in relation to peach aphid (*M. persicae*) are shown by ginger (*Zingiber* spp.), lavender (*Lavandula officinalis* Chaix), peppermint (*Mentha piperita* L.), spear-mint (*M. spicata* L.), thyme (*Thymus vulgaris* L.) and rosemary (*Rosmarinus officinalis*) oils. At the same time that author found that among the 13 tested chemical compounds contained in rosemary oil a repellent action in relation to *M. persicae* is exhibited by such compounds as linalool, d,1-camphor and

terpineol. According to Masatoshi [12] rosemary oil also shows repellent action in relation to cotton aphid (*A. gossypii* Glover) and potato aphid (*Macrosiphum euphorbiae* Thomas), also repelled by ginger oil.

Conclusions

1. Natural essential oils such as citronella oil, juniper oil and patchouli oil may be useful in the control of foxglove aphid (*Aulacorthum solani* Kalt.). After application of these oils 100% mortality of the pest was recorded.
2. A lower efficacy in the control of *A. solani* was found for the other tested natural essential oils, which exhibited 24.63÷89.40% efficacy (72 hours after treatment).

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Katedra Metod Ochrony Roślin, Uniwersytet Przyrodniczy w Poznaniu

Abstrakt: Celem badań było określenie skuteczności naturalnych olejków eterycznych, takich jak: bazyliowy, cytronelowy, eukaliptusowy, jałowcowy i paczulowy w zwalczaniu mszyicy ziemniaczanej (*Aulacorthum solani* Kalt.), występującej na oberżynie. Wyżej wymienione olejki stosowano w stężeniach 0,02; 0,05 i 0,10%. Śmiertelność szkodnika określono po 24; 48 i 72 godzinach po zabiegu. Po zastosowaniu olejków: cytronelowego i paczulowego o stężeniach 0,05 i 0,10% oraz jałowcowego - 0,10% zanotowano 100% śmiertelność *A. solani*. W pozostałych kombinacjach z użyciem testowanych olejków śmiertelność wynosiła 24,63÷89,40% (72 godziny po zabiegu).

Słowa kluczowe: naturalne olejki eteryczne, oberżyna, *Aulacorthum solani*, zwalczanie