Effects of some natural products on population of *Metopolophium dirhodum* (Walker) (Hemiptera: Aphididae) on rose plants

Özge HELVACIOĞLU [1], Tülin AKŞİT [*2]

[1]*Directorate of Plant Protection Research Institute, 35040 Bornova-İzmir*
[2]*Department of Plant Protection, Faculty of Agriculture, University of Aydın Adnan Menderes, 09100 Aydın*

Abstract: Four products allowed in organic farming (kaolin, insecticidal soap, neem oil soap, spinosad) as alternatives to chemical insecticides, were evaluated for the control of *Metopolophium dirhodum* (Walker, 1849) (Hem.: Aphididae). In addition, number of the newborn nymph and host selection for the treated and untreated rose (*Rosa hybrida* L. cv. First Red) leaves were examined. The toxicities of used natural products were compared with the diazinon and control (water). Rose saplings were used as experimental material. The application was repeated twice in the same greenhouse. Evaluations in populations were done on 1, 3, 5, 7, 10 and 14 days after applications. Insecticidal soap showed toxicity between 50.45 % and 74.0 % until fifth day and its toxicity decreased in the following days. Neem oil soap was non-toxic (15.09%–19.71%) at first application but, in the second application, its toxicity was increased (36.96%-72.27%). Repeated kaolin application ended with a positive result of 66.87% control. Spinosad had no effect on aphid. It was observed that *M. dirhodum* population was decreased by repeated (twice) applications of kaolin, insecticidal soap and neem oil soap. However, they could not control the aphid populations completely. In choice tests, the numbers of living aphids and newborn nymphs on rose leaflets treated with kaolin, neem oil soap, and insecticide soap were lower than those not treated. These three products were found to be repellent for *M. dirhodum*.

Keywords: Rose-Grain aphid, kaolin, insecticidal soap, neem oil soap, spinosad

Gül Üzerinde *Metopolophium dirhodum* (Walker) (Hemiptera: Aphididae)'un Kontrolunda Bazı Doğal Ürünlerin Etkileri

Öz: *Organik tarımda kimyasal insektisitlere alternatif olarak kullanılmasına izin verilen dört ürünün (kaolin, insektisit etkili sabun, neem yağı sabunu, spinosad) Metopolophium dirhodum (Walker, 1849) (Hem.: Aphididae) 'a etkileri değerlendirilmiştir. Ayrıca, uygulama yapılan ve yapılmayan gül yapraklarını tercihi ile bunların üzerinde yeni doğan nimf sayıları belirlenmiştir. Kullanılan doğal ürünlerin etkileri diazinon ve kontrol (su) ile karşılaştırılmıştır. Denemelerde gül fidanları (Rosa hybrida L. cv. First Red) kullanılmıştır. Uygulama aynı serada iki kez tekrarlanmış, değerlendirmeler uygulamalardan 1, 3, 5, 7, 10 ve 14 gün sonra yapılmıştır. İnsektisit etkili sabun beşinci güne kadar %50.45 ile %74.00 arasında etki göstermiş olmasına karşın sonraki günlerde etkisi azalmıştır. Neem yağı sabunu ilk uygulamada etkisiz (%15.09-%19.71) olmuş, ikinci uygulamada etkisi (%36.96-%72.27) artmıştır. Tekrarlanan kaolin uygulaması %66.87 oranında pozitif sonuç vermiştir. Spinosad yaprak bitine etkisiz bulunmuştur. Tekrarlanan kaolin, insektisit etkili sabun ve neem yağı sabunu uygulamalarının M. dirhodum popülasyonlarını azalttıkları ancak, tamamen kontrol edemedikleri görülmüştür. Tercih denemelerinde kaolin, neem yağı sabunu ve insektisit etkili sabun uygulanmış yapraklar üzerindeki canlı yaprakbiti ve yeni doğan nimflerin sayıları, kontrolden düşük bulunmuştur. Bu üç ürünün M. dirhodum'a repellent etki gösterdiği saptanmıştır.*

Anahtar Kelimeler: *Gül–Ekin yaprakbiti, kaolin, insektist etkilil sabun, neem yağı sabunu, spinosad*

INTRODUCTION

Rose (*Rosa damascena* Mill.) is one of the important cultivated ornamentals plants in Turkey. The rose oil as one of the important raw materials used in cosmetic industry is manufactured in Isparta province of Turkey. In Turkey, in the year 2018, 9 500 tons of rose oils were obtained from 3500 ha area (Anonymous, 2019a) and 97 587 112 pieces of cut roses were produced from 2 067 547 m^2 (Anonymous, 2019b). Insect pests are one of the important problems in rose cultivation. Aphids have an important place among the pests. Aphids cause direct damage to plants by feeding on plant sap and distorting their growth. The honeydew produced is accumulated on the plants and encourages the growth of sooty moulds which restrict photosynthesis. *Metopolophium dirhodum* (Walker) (Hem.: Aphididae) is one of the three most important cereal aphid species in Europe (Ma et al., 2004). It is known that it was fed on wheat and rose plants in Turkey and Europe (Elmalı and Toros, 1996; Bilgin, 2006; Honek et al., 2018). It transmits a number of virus diseases such as Barley yellow dwarf, Potato virus Y and A (Waterhouse and Helms 1985; Fox et al., 2017). In Germany and Poland, the biology, natural enemies and population fluctuations of rose-grain aphid on wheat were studied, and it was determined that it caused loss in the wheat grain quality (Gruppe, 1985; Jaśkiewicz, 1995). In general, *M. dirhodum* is controlled using non-selective and synthetic insecticides. These insecticides

Sorumlu Yazar: *taksit@adu.edu.tr* *Bu çalışma yüksek lisans tez ürünüdür ve Aydın Adnan Menderes Üniversitesi Bilimsel Araştırma Projeleri Birimi tarafından desteklenmiştir (Proje No: ZRF-11036).*
Geliş Tarihi: *3 Mart 2019*
Kabul Tarihi: *6 Mart 2020*

cause environmental problems and insects can evolve a resistance against them.

Many pesticides are toxic to people, they can easily be absorbed through skin contact, and florists who handle the flowers can potentially be exposed to residual deposits of pesticides, which will put their health to danger. In Belgium, among the cut flowers, the most insecticide residue was found in the roses (Khaoula et al., 2016). Likewise, Kumar et al. (2004) reported that pesticide residues were detected in commercial products of the scented rose plants in India and this caused problems in export of the products.

Nowadays, it is important that organic materials having no negative effect to environment should be used as alternative to synthetic chemicals in the control of pests including aphids. The toxicity of biopesticides on aphids has been studied in some experiments; Imai et al., 1995; Fournier and Brodeur, 2000; Cottrell et al., 2002; Karagounis et al., 2006; Alavo et al., 2011; Chopa et al., 2012; Nateghi et al., 2013; Alins et al., 2017).

There is no information about the effectiveness of insecticidal soap, kaolin and neem oil soap on *M. dirhodum*. Therefore, this study was conducted to determine the effects of kaolin, insecticide soap, neem oil soap and spinosad on *M. dirhodum* in laboratory and greenhouse conditions.

MATERIAL AND METHODS

Four natural products were selected for experiments because of their widespread use in organic agriculture. The used materials were kaolin (Surround WP, BASF; Surround contains 95% kaolin and 5% other ingredients), insecticidal soap (Savona, Koppert), neem oil soap (Neem oil soap concentrate, Organica), spinosad (Laser, Dow AgroScience). Diazinon (Basotim 20 EM, Agrofarm) was used for comparison. Application concentration of kaolin was determined according to literature (kaolin 60 g-100 L) (Cottrell et al., 2002) and the other products were applied according to label information (diazinon 200 ml-100 L, spinosad 30 ml-100 L, neem oil soap 500 ml -100 L, insecticidal soap 1000 ml-100 L).

Plant and insect rearing

The study was conducted in laboratory and glass greenhouse (24 m^2) conditions in Aydın, Turkey. Rose-grain aphid, *Metopolophium dirhodum* (Walker) (Hem.: Aphididae) and one-year-old *Rosa hybrida* L. cv. 'First red' saplings were used. The one-year-old rose saplings were planted as one sapling in each of the 5-litre plastic pots. Nitrogen fertilizer (46%) was given once every two weeks. The plants were watered when needed.

Metopolophium dirhodum used in this study were obtained from infested roses in a greenhouse in Aydın Adnan Menderes University, Agricultural Faculty in Aydın province. The samples were identified by Dr. Işıl Özdemir (Directorate of Plant Protection Central Research Institute, Ankara). Aphids were grown on rose saplings in cages (90 × 60 × 60 cm) in climate chamber (16:8 h light:dark photoperiod, 22 ± 1 ºC, 60-70% RH).

Greenhouse experiments

The experiments were conducted on one-year-old rose saplings in glass greenhouse between April-June. Rose shoots were infected with *M. dirhodum* and the aphid population was waited to reach the economic damage threshold level (10 aphid individuals/leaf) for application (Anonymous, 2010).

The experiments consisted of a randomized complete block design with four replications and six treatments. There were three saplings at each replicate. The effects of Kaolin, neem oil soap, insecticidal soap and spinosad were compared with those of control (water) and diazinon. Products were sprayed to the rose saplings by using a 5-litre hand sprayer with 3-bar pressure. Live aphids were counted on five previously marked compound leaves per sapling using a hand lens (10x). The first evaluation was made one hour before spraying. Other evaluations were made at 1, 3, 5, 7, 10, and 14 days after the application.

The second treatments carried out on the same plants with the same products 20 days after the first application. And then the live aphids on the same marked leaves were counted. The mortality of aphids was explained according to Hassan et al. (1985); non-toxic (<25% mortality), slightly toxic (25–50% mortality), moderately toxic (51–75% mortality), highly toxic (>75% mortality).

During the first (April 19-May 03) and second (May 09-May 23) applications in glass greenhouse, mean temperatures and relative moistures were recorded as 19.8 ºC (min.17.1 ºC, max. 21.6 ºC), 49.4% (min. 43.0%, max. 68.8%) RH; 22.2 ºC (min.17.0 ºC, max. 25.8ºC) and 47.1% (32.6%-74.6%) RH, respectively.

Choice tests

The choice tests (settling preference) were carried out at 22±1ºC, 16:8 h light: dark, 60±5% RH in climate chamber. The effects of kaolin, neem oil soap and insecticidal soap to *M. dirhodum* were determined. In the tests, a leaflet of compound rose leaf was used. The apical half of the leaflet was dipped in the insecticide solution and left for 5 seconds until both surfaces were wetted, and no action was taken to the other half of the leaflet. They were placed on a plastic tray and allowed to dry before use. Then leaflets were placed in plastic petri dishes (9 cm diameter) coated with filter paper. Petioles of leaflets were wrapped with moisturized cotton and 5 apterous adults were left to each petri dish. Petri dishes were wrapped with stretch film.

According to the method of Showler (2003), positions of aphid adults and newborn nymphs relative to treated and untreated halves of leaflets were recorded at 2, 4, and 24 h. Each group comprised of 10 replicates x 5 petri dishes. The experiment was repeated twice.

Statistical analysis

Aphid infestation data were analysed by multivariate ANOVA using GLM procedure in SPSS version 10 (SPSS Inc., 1999). The numbers of aphids that were not normally distributed were transformed according to equation $\log_{10}(x+1)$. The means were separated using the Tukey's test. Percentage efficacy of the chemicals was found according to Henderson-Tilton formula (HTE): Effect %=(Population in control plot before treatment × Population in treated plot after treatment)/Population in control plot after treatment × Population in treated plot before treatment) × 100). T-test was applied to choice test results (Karman, 1971).

RESULTS

Greenhouse experiments

The mean aphid infestation scores (±SE) and Henderson-Tilton's efficacy (HTE) values are presented in Table 1 and 2. In the first experiment, the toxicity of insecticidal soap varied between 60.76% and 20.45% on the first and seventh days, respectively. Insecticidal soap and neem oil soap were non-toxic between seventh and fourteenth days. It was determined that the number of aphids gradually decreased after the third day until the fourteenth day by effect of Kaolin (10.87%-33.25%) (Table 1). The toxicity of neem oil soap was low on the third (19.71%) and fifth (15.09%) days, it was completely ineffective on other days. Except diazinon, other products are listed from the highest to the lowest according to their toxicities; on the 1st day insecticidal soap 60.76%; on the 3rd day insecticidal soap 51.95%, neem oil soap 19.71%, kaolin 10.87%; on the 5th day insecticidal soap 50.45%, kaolin 15.39%, neem oil soap 15.09%; on the 7th day insecticidal soap 20.45%, kaolin 18.72%; on the 10th day kaolin 18.25% and 14th day 33.25%. At 10th and 14th days, only kaolin was effective. Diazinon was highly toxic but, spinosad was completely ineffective to *M. dirhodum* ($P<0.05$) (Table 1).

In the second application; different results were found from the first application. The effect (66.87%) of kaolin was higher than first application (33.25%), and the highest effective was determined on the 10th day (Table 2). The highest effectives of insecticidal soap (74.0%) and neem oil soap (72.27%) was determined on the third day (Table 2). The toxicities of kaolin, insecticidal soap and neem oil soap increased in the second application. Although spinosad was non-toxic in the first application, it showed effect slightly toxic (27.37%) on the third day in the second application.

Diazinon was highly toxic. Except diazinon, other products are listed from the highest to the lowest according to their efficacy; on the 1st day insecticidal soap 61.10%, neem oil soap 60.84%, spinosad 22.93%, kaolin 16.28%; on the 3rd day insecticidal soap 74.0%, neem oil soap 72.27%, kaolin 42.17%, spinosad 27.37%; on the 5th day insecticidal soap

Table 1. Mean aphid infestation score (±SE) per rose leaflet and Henderson-Tilton's efficacies (HTE) of products in the first experiment

Treatments		1h pre-Application	Post-application					
			1 day	3 day	5 day	7 day	10 day	14 day
Kaolin	Mean	2.4	2.4 ^{c}	2.4 ^{bc}	2.3 ^{bc}	2.2 ^{b}	2.3 ^{b}	2.3 ^{ab}
	± SE	0.07	0.10	0.09	0.10	0.10	0.09	0.09
	HTE (%)		0.00	10.87	15.39	18.72	18.25	33.25
Insecticidal soap	Mean	2.5	1.8 ^{b}	2.1 ^{b}	2.0 ^{b}	2.1 ^{b}	2.3 ^{b}	2.7 ^{b}
	± SE	0.07	0.10	0.09	0.10	0.10	0.09	0.09
	HTE (%)		60.76	51.95	50.45	20.45	0.00	0.00
Neem oil soap	Mean	2.5	2.4 ^{c}	2.4 ^{bc}	2.4 ^{bc}	2.4 ^{b}	2.4 ^{b}	2.6 ^{b}
	± SE	0.08	0.11	0.09	0.10	0.10	0.10	0.09
	HTE (%)		0.00	19.71	15.09	0.00	0.00	0.00
Spinosad	Mean	2.5	2.5 ^{c}	2.5 ^{c}	2.6 ^{c}	2.4 ^{b}	2.5 ^{b}	2.6 ^{b}
	± SE	0.08	0.11	0.10	0.11	0.11	0.10	0.10
	HTE (%)		0.00	0.00	0.00	0.00	0.00	0.00
Diazinon	Mean	2.4	0.7 ^{a}	0.9 ^{a}	1.5 ^{a}	1.6 ^{a}	1.9 ^{a}	2.2 ^{a}
	± SE	0.08	0.11	0.09	0.10	0.10	0.10	0.09
	HTE (%)		97.15	96.81	86.83	71.69	58.42	30.40
Control	Mean	2.6	2.4 ^{c}	2.5 ^{c}	2.5 ^{c}	2.5 ^{b}	2.5 ^{b}	2.6 ^{b}
	± SE	0.08	0.11	0.09	0.10	0.10	0.10	0.09

$^{a-c}$Means in a column with different superscripts are significantly different ($P < 0.05$)

Table 2. Mean aphid infestation score (±SE) per rose leaflet and Henderson-Tilton's efficacies (HTE) of products in the second experiment

Treatments		1h pre-Application	Post-application					
			1 day	3 day	5 day	7 day	10 day	14 day
Kaolin	Mean	2.5	2.9 ^{bc}	2.4 ^{bc}	2.3 ^{b}	2.9 ^{b}	2.2 ^{b}	2.5 ^{ab}
	± SE	0.09	0.10	0.10	0.11	0.11	0.13	0.16
	HTE (%)		16.28	42.17	56.57	64.14	66.87	34.98
Insecticidal soap	Mean	27	2.3 ^{b}	2.2 ^{b}	2.4 ^{b}	2.6 ^{bc}	2.9 ^{c}	3.0 ^{b}
	± SE	0.09	0.09	0.09	0.10	0.10	0.13	0.16
	HTE(%)		61.10	74.0	61.81	48.88	20.70	9.24
Neem oil soap	Mean	2.7	2.5 ^{bc}	2.3 ^{b}	2.5 ^{bc}	2.6 ^{bc}	2.7 ^{bc}	25 ^{ab}
	± SE	0.09	0.09	0.09	0.10	0.10	0.13	0.16
	HTE (%)		60.84	72.27	61.10	54.66	37.90	36.96
Spinosad	Mean	2.7	2.7 ^{c}	2.7 ^{cd}	3.1 ^{d}	3.0 ^{d}	3.0 ^{c}	3.0 ^{b}
	± SE	0.09	0.09	0.09	0.10	0.10	0.13	0.16
	HTE (%)		22.93	27.37	9.76	0.00	0.00	0.00
Diazinon	Mean	2.5	0.3^{a}	0.9 ^{a}	1.1 ^{a}	1.3 ^{a}	1.5 ^{a}	1.9 ^{a}
	± SE	0.08	0.09	0.08	0.10	0.10	0.12	0.15
	HTE (%)		99.57	98.72	98.17	96.12	92.59	81.81
Control	Mean	2.6	2.7 ^{c}	2.8 ^{d}	2.8 ^{cd}	2.8 ^{cd}	2.8 ^{c}	2.8 ^{b}
	± SE	0.08	0.09	0.08	0.10	0.10	0.12	0.16

$^{a-c}$Means in a column with different superscripts are significantly different (P < 0.05)

61.81%, neem oil soap 61.10%, kaolin 56.57%, spinosad 9.76%; on the 7th day kaolin 64.14%, neem oil soap 54.66%, insecticidal soap 48.88%; on the 10th day kaolin 66.87%, neem oil soap 37.9%, insecticidal soap 20.7%; on the 14th day neem oil soap 36.96%, kaolin 34.98% and insecticidal soap 9.24% (Table 2).

Choice Tests: In the choice tests, more aphids were located on the control half of leaflets than on the treated parts at 2, 4, and 24 h in the first and second experiments (Table 3). Aphid numbers at 2, 4, and 24 hours in first and second experiments were t2=-6.82, t4=-6.26, t24=-4.47, t2=-7.69, t4=-7.92, t24=-9.09 (P<0.05) for kaolin; t2=-8.52, t4=-8.61, t24=-8.53 (P<0.05) for neem oil soap, t2=-4.69, t4=-4.64, t24=-7.88 (P<0.05), t2=-10.78, t4=-11.00, t24=-7.83, t2=-7.96, t4=-7.60, t24=-10.57(P<0.05) for insecticidal soap, respectively. The measures analysis showed that the treatments had a significant effect on aphid preference. Alike, newborn nymphs numbers were more on the control parts of leaf than on the treated parts (Table 3).

DISCUSSION AND CONCLUSIONS

In this study, alternative products that can be used in control of *M. dirhodum* were investigated. The experiments showed that synthetic insecticide diazinon was highly toxic to aphid. However, its use in Turkey has been banned. Kaolin, insecticide soap and neem oil soap were slightly toxic or moderately toxic to *M. dirhodum*. The aphid population was reduced when compared to the control plants. However, they could not control the aphid populations completely. It was determined that the toxicity changed depending on the time elapsed after the application. The insecticidal soap had similar effect on *M. dirhodum* in both the experiments. It was slightly toxic or moderately toxic during the first five days (between 50.45%-74.00%), but its toxicity decreased in the following days. Results of the present studies were similar to Raudonis (2009), who detected the effect of insecticidal soap on A*phis pomi* DeGeer (Hem.:Aphididae) between 64.9%-84.8%. Similar results have been reported by others; Tremblay et al. (2009) and Karagounis et al. (2006) reported that insecticidal soap was effective on *Myzus persicae* (Sulzer) (Hem.:Aphididae). In contrast, Kourdoumbalos et al. (2006) reported that *M. persicae* could not be controlled in peach trees when insecticidal soap was applied only once. *Dysaphis plantaginea* (Pass.) (Hem.:Aphididae) population in apple trees was reduced by the application of potassium soap, but this was not sufficient to provide control (Alins et al., 2017). In present study, it was determined that the insecticide soap had an effect on *M. dirhodum* but did not completely control.

Kaolin is not fatal to insects, but feeding and ovipositional behaviors may be affected. The direct application to *M. persicae* and the pear psylla indicated that the kaolin had no contact toxicity (Glenn et al., 1999; Glenn and Puterka, 2005; Kourdoumbalos et al., 2006).

Twice kaolin application reduced the population of *M. dirhodum*, but this was not enough. Previous studies with other species of aphids, psyllids indicate that kaolin applications may reduce the performance of sap-feeding insects (Glenn et al., 1999; Fournier and Brodeur, 2000; Cotrell et al., 2002; Glenn and Puterka, 2005; Baniameri, 2008). It was reported that this negative effect was increased with repeated kaolin applications because a

Table 3. Mean numbers (±SE) of adult and newborn nymph aphids on a rose leaflet treated and untreated with products

Applications	First experiment results Number of aphids settled				Second experiment results Number of aphids settled			
	2nd h	4th h	24th h	Total nymph	2nd h	4th h	24th h	Total nymph
Kaolin	0.31 ± 0.03	0.33 ± 0.03	0.21 ± 0.03	94	0.32 ± 0.03	0.31 ± 0.03	0.22 ± 0.03	104
No treatment	0.58 ± 0.02	0.57 ± 0.02	0.42 ± 0.04	227	0.63 ± 0.02	0.63 ± 0.02	0.58 ± 0.02	342
T	-6.82	-6.26	-4.47	-3.47	-7.69	-7.92	-9.09	-7.25
P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	7.26	5.63	0.63	12.78	12.45	12.83	14.83	10.26
Neem oil soap	0.27 ± 0.03	0.28 ± 0.03	0.24 ± 0.03	106	0.38 ± 0.03	0.36 ± 0.03	0.21 ± 0.03	85
No treatment	0.61 ± 0.03	0.63 ± 0.02	0.60 ± 0.03	319	0.56 ± 0.02	0.54 ± 0.03	0.51 ± 0.02	165
T	-8.60	-8.61	-8.53	-6.87	-4.69	-4.64	-7.88	-4.11
P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020
F	1.12	7.48	2.15	10.47	6.59	4.02	9.58	5.35
Insecticidal soap	0.32 ± 0.03	0.32 ± 0.03	0.29 ± 0.03	153	0.35 ± 0.03	0.33 ± 0.03	0.21 ± 0.03	104
No treatment	0.64 ± 0.01	0.64 ± 0.01	0.59 ± 0.0	358	0.60 ± 0.02	0.60 ± 0.02	0.59 ± 0.02	290
T	- 10.78	- 11.00	-7.83	-6.19	-7.96	-7.65	-10.57	-6.41
P	0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.000
F	7.11	4.77	1.78	4.61	8.13	6.99	18.02	8.41

single kaolin treatment was not sufficient for controlling the aphid population (Bürgel et al., 2005; Andreev et al., 2012). In contrast, Alavo and Abagli (2011) reported that the *Lipaphis erysimi (*Kalt.) (Hem.:Aphididae) population could be reduced by kaolin application, but the effect could not be increased with repeated applications. Another positive result related to kaolin was obtained in cotton for controlling *Aphis gossypii* Glov. (Hem.:Aphididae) in West Africa and it was recommended as integrated pest management component (Alavo et al., 2011). The same researchers stated that high kaolin concentrations left more residues on cotton leaves and the residue could be a handicap for chlorophyll synthesis and plant growth. On the contrary, Showler and Armstrong (2007) found that *A. gossypii* population on cotton plants increased by the kaolin treatment. The kaolin treatment suppressed the *A. pomi* population, did not affect *Dysaphis devecta* (Walk.) (Hem.:Aphididae) and even increased *D. plantaginea*, a species that lives in curled leaves (Markó et al., 2008).

However, in present study, we detected that repeated (twice) applications of kaolin produced a white residue layer on rose leaves and flower buds and this residue layer could not be removed from the plants. Therefore, kaolin residues can create problems that will cause visual pollution on ornamental plants. Thus, it is thought that it would be more suitable to apply kaolin to the oil roses grown to obtain rose oil.

In choice tests, it was found that numbers of adult and newborn nymphs of *M. dirhodum* on kaolin treated parts of leaflets were lower than control parts. These findings are in agreement with results from Cottrell et al., (2002). They observed that kaolin significantly affects number of *Melanocallis caryaefoliae* (Davis) (Hem.:Aphididae) through interfering with host finding, and decreasing production of progeny.

Neem oil soap had the repellent and growth regulatory effects on *M. dirhodum*. These effects increased in the second application. Because neem oil soap has the property of insect growth regulator, its effect may be seen late. In some studies, neem products are reported to be effective on some aphid species (Hummel and Kleeberg, 1997; Tang et al., 2002; Raudonis et al., 2009; Andreev et al., 2012). In our study, it was determined that the number of adult aphids and newborn nymphs on the neem oil soap applied leaflets were lower than that of non-applied parts. Koul (1999) found that neem seed extracts had the deterrent and growth regulatory effects on *Macrosiphum rosae* (L.) and *Macrosiphoniella sanborni* (Gillette) (Hem.:Aphididae). On the contrary, it was ineffective on *Aphis spiraecola* Patch. (Hem.:Aphididae) (Andreev et al., 2012).

M. dirhodum were given a choice between product-treated and untreated leaflet areas, both adults and nymphs exhibited a significant preference for untreated host leaves. Insecticidal soap had the repellent and lethal effects on *M. dirhodum.* The number of aphid on the soap applied leaflet part was determined to be less than on the untreated part. Similarly, for insecticidal soap (Savona), Kourdoumbalos et al. (2006) and Alins et al. (2017) suggested that applications should be repeated in the early stages of aphid infestation to obtain satisfactory results. In the present study, spinosad was non-toxic or slightly toxic to *M. dirhodum* (max. 27.37%). In similar away, it was reported that spinosad

reduced the *M. persicae* population (11.26%), but was not sufficient (Akbar et al., 2010). However, it had no effect on *Brevicoryne brassicae* (L.) (Hem.:Aphididae) (Ester et al., 2003).

In conclusion, the results of this study show that kaolin, insecticidal soap, and neem oil soap are from moderately toxic to toxic on *M. dirhodum* population. However, they could not control the aphid populations completely. It was concluded that intermittent administration of these products may reduce the population of *M. dirhodum*.

ACKNOWLEDGEMENTS

We thank to Aydın Adnan Menderes University, Scientific Research Projects (ZRF-11036) supporting this Project and Dr. Işıl Özdemir (Directorate of Plant Protection Central Research Institute, Ankara) who identified *M. dirhodum*.

REFERENCES

Akbar MF, Haq MA, Parveen F, Yasmin N, Khan MFU (2010) Comparative management of cabbage aphid (*Myzus persicae* (Sulzer) Aphididae:Hemiptera) through bio and synthetic insecticides. Pakistan Entomologist 32:12-17.

Alavo TBC, Abagli AZ (2011) Effect of kaolin particle film formulation against populations of the aphid *Lipaphis erysimi* Kalt. (Homoptera:Aphididae) in cabbage. The Open Entomology Journal 5: 49-53.

Alavo TBC, Abagli AZ, Tégbéssou KJC, Dunphy GB (2011) Kaolin potential for the integrated management of *Aphis gossypii* Glov. (Homoptera: Aphididae) on cotton. Archives of Phytopathology and Plant Protection 44(8):764-770.

Alins G, Alegre S, Avilla J, (2017) Alternative to azadirachtin to control *Dysaphis plantaginea* Passerini (Hemiptera: Aphidae) in organic apple production. Biological Agriculture and Horticulture DOI: 10.1080/01448765.2017.1333454

Andreev R , Kutinkova H, Rasheva D (2012) Non-chemical control of *Aphis spiraecola* Patch. and *Dysaphis plantaginea* Pass. on apple. Journal of Biopesticides 5 (Supplementary): 239– 242.

Anonymous (2010) Bitki Zararlıları Standart İlaç Deneme Metodları, Endüstri ve Süs Bitkileri Zararlıları Standart İlaç Deneme Metodları. *[http://www.tagem.gov.tr/yayin/standart_ilac/6.pdf], Erişim Tarihi: 15.02.2010.

Anonymous (2019a) 2018 Yılı Gül Çiçeği Raporu .T.C. Ticaret Bakanlığı Esnaf, Sanatkârlar ve Kooperatifçilik Genel Müdürlüğü.

Anonymous (2019b) Bitkisel Ürün İstatistikleri, Süs Bitkileri 2011-2018. http://www.tuik.gov.tr/PreTablo.do?alt_id=1001(Erişim Tarihi:12.12.201)

Baniameri V (2008) Study of the efficacy of different concentrations of insecticidal soap, in comparison oxydemeton-methyl to control *Aphis gossypii* in greenhouse cucumber. IOBC/WPRS Bulletin 32:13-16.

Bilgin GM (2006) Kahramanmaraş ilinde Buğday Tarlalarında Görülen Yaprakbitlerinin Populasyon Yoğunlukları ve Doğal Düşmanları. (Yüksek Lisans Tezi), Kahramanmaraş Sütçü İmam Üniversitesi Fen Bilimleri Enstitüsü, Kahramanmaraş.

Bürgel K, Daniel C, Wyss E (2005) Effects of autumn kaolin treatments on the Rosy apple aphid, *Dysaphis plantaginea* (Pass.) and possible modes of action. Journal of Applied Entomology 129: 311-314.

Cottrell TE, Wood BW, Reilly CC (2002) Particle film affects Black pecan aphid (Homoptera: Aphididae) on pecan. Journal of Economic Entomology 95(4): 782-788.

Chopa CS, Descamps LR (2012) Composition and biological activity of essential oils against *Metopolophium dirhodum* (Hemiptera:Aphididae) cereal crop pest. Pest Management Science 68(11):1492-500.

Elmalı M, Toros S (1996) Konya ilinde buğdaylarda Aphidoidae türleri ve bulunuş oranları. Ankara Üniversitesi, Ziraat Fakültesi, Yayın no:1454, Bilimsel Araştırma ve İncelemeler: 802.

Ester A, de Putter H, van Bilsen JGPM (2003) Filmcoating the seed of cabbage (*Brassica oleracea* L. convar. *capitata* L.) and cauliflower (*Brassica oleracea* L. var. *botrytis* L.) with imidacloprid and spinosad to control insect pests. Crop Protection **22**: 761-768.

Fournier V, Brodeur J (2000) Dose-response susceptibility of pest aphids (Homoptera: Aphididae) and their control on hydroponically grown lettuce with the entomopatogenic fungus, *Verticillium lecanii*, azadirachtin and insecticidal soap. Environmental Entomology 29: 568-578.

Fox L E, Collins R, Macarthur L, Blackburn F, Northing P (2017) New aphid vectors and efficiency of transmission of Potato virus A and strains of Potato virus Y in the UKA. Plant Pathology 66:325–335.

Glenn D M, Puterka G, Vanderzwet T, Byers R E, Feldhake C (1999) Hydrophobic particle films: a new paradigm for suppression of arthropod pests and plant diseases. Journal of Economic Entomology 92:759-771.

Glenn, D M, Puterka G J (2005) Particle films: A new technology for agriculture. Horticultural Reviews 31:1–44.

Gruppe A (1985) Observation on the development of populations of *Metopolophium dirhodum* (Walk.) on the primary host in spring. Anzeiger Fur Schadlingskunde Pflanzenschutz Umweltschutz 58: 51-55.

Hassan E, Oomen P A, Overmeer W P, Plevoets J P, Reboulet J N, Rieckmann W, Samsoe-Petersen L, Shires S W, Staubli A, Stevensen J, Tuset J J, Vanwetswinkel G, Zon A Q (1985) Standard methods to the test of side-effects of pesticides on natural enemies of insects and mites developed by the IOBC/WPRS Working Group “Pesticides and Beneficial Organisms”, OEPP/ EPPO Bulletin 15: 214–255.

Hummel E, Kleeberg H (1997) New results on the practical application of NeemAzal-formulations. In Mitteilungen der Deutschen Gesellschaft fuer

Allgemeine und Angewandte Entomologie, (Hoffmann, K.H., Volkl, W. Eds.), pp. 331-336. Bremen, Germany.

Honek A, Martinkova Z, Saska P, Dixon AFG (2018) Aphids (Homoptera: Aphididae) on Winter Wheat: Predicting Maximum Abundance of *Metopolophium dirhodum* Journal of Economic Entomology 111(4): 1751–1759.

Imai T, Tsuchiya S, Fujimori T (1995) Humidity effects on activity of insecticidal soap for the green peach aphid, *Myzus persicae* (Sulzer) (Hemiptera, Aphididae). Applied Entomology and Zoology 30: 185-188.

Jaśkiewicz B (1995) The association of aphids feeding on shrubs of *Rosa rugosa* Thunb. in the Academiy Park in Lublin. Annales Universitatis Mariae, Curie, Skodowska. Sectio, EEE, Horticultura (3): 159-171.

Karagounis C, Kourdoumbalos AK, Margaritopoulos JT, Nanos GD, Tsitsipis JA (2006) Organic farming-compatible insecticides against the aphid *Myzus persicae* (Sulzer) in peach orchards. Journal and Applied Entomology 130: 150-154.

Karman M (1971) Bitki Koruma Araştırmalarında Genel Bilgiler, Denemelerin Kuruluşu ve Değerlendirme Esasları. T.C. Tarım Bakanlığı Zirai Mücadele ve Zirai Karantina Genel Müdürlüğü Yayınları, İzmir.

Khaoula T, Vleminck C, van Loco J, Schiffers B, (2016) Pesticide Residues on Three Cut Flower Species and Potential Exposure of Florists in Belgium. International Journal of Environmental Research and Public Healty 13(10): 943.

Kourdoumbalos AK, Margaritopoulos JT, Nanos GD, Tsitsipis JA (2006) Alternative aphid control methods for peach production. Journal of Fruit and Ornamental Plant Research 14: 181-189.

Koul O (1999) Insect growth regulating and antifeedant effects of neem extracts and azadirachtin on two aphid species of ornamental plants. Journal of Biosciences 24(1):85-90.

Kumar A, Nadda G, Shanker A (2004) Determination of chlorpyrifos 20%EC (Dursban 20 EC) in scented rose and its products. Journal of Chromotography A.1050: 193-199.

Ma C-S, Hau B, Poehling H-M (2004) The effect of heat stress on the survival of the Rose grain aphid, *Metopolophium dirhodum* (Hemiptera: Aphididae). European Journal of Entomology 101(2):327-331.

Markó V, Blommers L H M,. Bogya S, Helsen H (2008) Kaolin particle films suppress many apple pests, disrupt natural enemies and promote woolly apple aphid. Journal of Applied Entomology 132:26-35.

Nateghi M, Paknejad F, Moarefi M (2013) Effect of concentrations and time of kaolin spraying on wheat aphid. Journal of Biological Environmental Sciences 7(21):163-168.

Raudonis L,Valiuškaitė A, Duchovskienė L, Survilienė E (2009) Toxicity of biopesticides to green apple aphid in apple-tree. Sodınınkystė Ir Daržınınkystė. Mokslo Darbaı 28(3):173-179.

Showler AT (2003) Effects of kaolin particle film on beet armyworm, *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae), oviposition and larval feeding and development on cotton, *Gossypium hirsutum* L. Agriculture, Ecosystems and Environment 95: 265-271.

Showler AT, Armstrong JS (2007) Kaolin particle film associated with increased cotton aphid infestation in cotton. Entomologia Experimentalis et Applicata 124: 55-60.

Tang YQ, Weathersbee AA, Mayer RT (2002) Effect of neem seed extract on the brown citrus aphid (Homoptera: Aphididae) and its parasitoid *Lysiphlebus testaceipes* (Hymenoptera: Aphidiidae). Biological Control 31: 172-176.

Tremblay E, Belanger A, Brosseau M, Boivin G (2009) Toxicity effects of an insecticidal soap on the gren peach aphid (Homoptera: Aphidiidae). Phytoprotection 90: 35-39.

Waterhouse, PM., Helms K (1985) *Metopolophium dirhodum* (Walker): a newly arrived vector of barley yellow dwarf virus in Australia. Australasian Plant Pathology 14:64–66.