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Research Article

Effects of Thyme and Rosemary essential oils on population growth parameters of *Macrosiphum rosae* (Hemiptera: Aphididae) on cut flower rose

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Abstract: The effect of thyme *Thymus vulgaris* L. and rosemary *Rosmarinus officinalis* (L.) essential oils on life table parameters of red rose aphid *Macrosiphum rosae* (L.) on cut flower rose *Rosa hybrida* L. were investigated in laboratory conditions (27 ± 2 ºC, 70 ± 5% humidity and a photoperiod of 16L:8Dh), during 2014-2015. The results on the basis of LC_{50} values showed that the *M. rosae* was significantly more sensitive to the oil of *T. vulgaris* (LC_{50} = 36621 ppm) than *R. officinalis* (LC_{50} = 57565 ppm). Also, Investigation of the thyme essential oil on life table parameters of *M. rosae* showed that the net reproductive rate (R_0) values changed from 16.62 ± 2.31 to 29.10 ± 1.97 female offspring, the intrinsic rate of increase (r) values ranged from 0.177 ± 0.01 to 0.229 ± 0.13 day^{-1}, the mean generation time (T) was 13.92 ± 0.22 to 15.88 ± 0.19 days, the *DT* values ranged from 3.01 ± 0.05 to 3.90 ± 0.007 days and the finite rate of increase (λ) values was 1.19 ± 0.003 to 1.26 ± 0.06 day^{-1}. Also, the rosemary essential oil on life table parameters of red rose aphid revealed that the R_0 values ranged from 17.87 ± 1.97 to 31.97 ± 1.98 female offspring, the r values ranged from 0.185 ± 0.02 to 0.237 ± 0.001 day^{-1}, the mean generation time (T) was 14.45 ± 0.23 to 15.99 ± 0.21 days, the *DT* ranged from 2.85 ± 0.14 to 3.71 ± 0.14 days and the λ values was 1.20 ± 0.01 to 1.27 ± 0.02 day^{-1}. The results revealed that the essential oils of rosemary and thyme used in this research had a significant difference on population parameters of rose aphid. The maximum mortality percent of *M. rosae* population registered 86.12 ± 1.02% and 90.21 ± 1.12% for rosemary and thyme essential oils, respectively. Hence, *T. vulgaris* had higher insecticidal effect than *R. officinalis* essential oil on rose aphid population.

Keywords: Life table, *Macrosiphum rosae*, Population growth parameters, *Rosmarinus officinalis*, *Thymus vulgaris*

Introduction

The high commercial value and widespread cultivation of rose make it the most important ornamental crop. *Rosa hybrida* L. (rose) is not a species in the botanical sense, but is a description used for most cultivated rose cultivars of the Hybrid tea or Floribunda types or classes. These cultivated roses have been derived over centuries through complex crosses involving a number of species of the genus *Rosa* (Phillips and Rix, 1988). *Rosa hybrida* is

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the most economically important cut-flower plant. The first rose was introduced in 1867 in the Netherlands and since then more than 10,000 varieties have been released. The *Rosa* genus belongs to the family Rosaceae and is closely related to apple, pear, quince, plum, cherry, blackberry, and strawberry (Zielinski *et al.,* 2004).

The common thyme *Thymus vulgaris* L. is a species of flowering plant in the mint family Lamiaceae, native to southern Europe from the western Mediterranean to southern Italy which its insecticidal activity has been demonstrated against some insect pests (Shalaby *et al.,* 1998; Isman *et al.,* 2001; Pavela, 2005).

The rose aphid, *Macrosiphum rosae* (L.) (Hemiptera: Aphididae), is the most common insect pest of roses in Iran. The rose aphid is monophagous and generally found only on cultivated and wild roses. This aphid feeds mostly on Roseaceous plants, but it is known to feed on species in 15 other plant families (Ferran *et al.,* 1996). Aphids damage plants by sucking sap from plant tissues using highly specialized sucking mouth parts. The usual symptoms of damage are distortion of new leaves and flowers. Aphids particularly like newly-forming flower buds, and damage done at this stage has more serious consequences than if the buds are attacked later (Blackman and Eastop, 2000). Aphids also excrete large amounts of honeydew, which can cover the plant. Honeydew is a food source for sooty molds, which form a black covering over affected areas, severely reducing photosynthesis and aesthetic appeal. Severe aphid infestations can result in defoliation of the plant and loss of the flower crop. Aphids can breed very rapidly and build up vast numbers, especially in warm, humid weather (Voegtlin *et al.,* 2003).

Unfortunately, members of this family have been found to be resistant against synthetic chemical insecticides. The reasons for this may be their short developmental period and high fecundity enforced by life-history characteristics to produce successive generations. Hence, there is a real need to find other effective and safer approaches like natural products. Natural products are excellent alternative to synthetic pesticides, as a mean to reduce negative impacts to human health and the environment. They are more compatible with the environmental components than synthetic pesticides and so. The plant derived essential oils are attracting interests of the scientists (Isman and Machial, 2006). Many plant-derived essential oils like rosemary, lavandula, thyme and ziziphora have insecticidal properties, with a broad-spectrum of activity against many different types of soft-bodied arthropod pests (Alexenizer and Dorn, 2007). This is mainly due to multiple modes of action, including antifeedant and repellent activity, molting, and respiration inhibition, growth, and fecundity reduction, cuticle disruption, and activity on the octopamine pathway in the central nervous system (Chaubey, 2007a). In order to reduce insecticide use and encourage the use of plant compounds for pest control, this work aimed to study the efficacy of *T. vulgaris* and *R. officinalis* essential oils on life table parameters of *M. rosae* on *R. hybrida*.

Materials and Methods

Rose plant

The cut-flower roses group var. Vendetta was selected as test crop for the experiments. This variety was prepared from Flowers and Ornamental Plants Research Institute of Mahallat-Iran (The entomology research laboratory, department of plant protection and research greenhouses). Greenhouse experiments were conducted during 2014-2015. Rose plants were grown under both organic (chicken manure vermicompost) and chemical (Biozar, 20-20-20 NPK, Fannavar-Nano products Company, Biozar, Khomein, Iran) fertilization at a rate of 25kg N ha^{-1}. Plants were grown in plastic pots (20cm diameter and 25cm height). One rose cutting was sown in each pot. The plants were allowed to grow in the greenhouse conditions (25 ± 2 °C; 40 ± 5% R. H. and 16L: 8D photoperiod).

Rose aphid colony

The adults of rose aphid *M. rosae* were originally collected from common rose greenhouses of the Mahallat-Iran in December 2014. These aphids were reared on rose var. Vendetta grown in plastic pots (20 cm diameter 25 cm height) in a growth chamber (25 ± 2 ºC, 40 ± 5% R. H. and a photoperiod of 16:8 L: D) for at least two months (several generations) before conducting the experiments. All experiments were performed under the above mentioned conditions in growth chambers.

Plant materials and preparation of essential oils

The rosemary and thyme leaves were collected from the Medicinal Plants Research Station of Arak, Markazi province-Iran during 2014-2015. The whole plants (herbs) were dried at room temperature (20-25 ºC) for a week and then were stored in cloth bags. The plant leaves were chopped into small pieces using a mill with rotary knives. The essential oils were extracted by hydrodistillation of dried plant material (100 g of each sample in 500 ml of distilled water) using a modified Clevenger-type apparatus for 4 h (Papachristos and Stamopoulos, 2004). The distilled essential oils were stored in a refrigerator at 4 °C until being used in the treatments.

Treatments and leaf samples

First, preliminary bioassay was conducted to determine the effective concentrations of botanical compounds (rosemary and thyme) that caused between 10-90% mortality on population of rose aphid. Then six concentrations with logarithmic distance was tested based on Robertson and Preisler (1992) method. The experiment was performed based on soaking leaf method for each concentration. Rose leaves were soaked in each concentration of rosemary and thyme essential oils and rose aphids were placed on leaves.

To perform the experiments, the leaf sample method was used (Pedigo and Buntin 1994; Naher *et al.*, 2006). The rose leaves with five-leaflets were selected randomly and placed inside water-saturated cotton wools in plastic Petri dishes (4cm diameter and 8cm height). When the leaflets were expanded, a fully expanded young leaf was used for running the experiment. Finally, each rose aphid was transferred on leaf sample in Petri dish and the rosemary and thyme essential oils effect on life table of rose aphid was studied.

Experiments

Insecticidal activity

Insecticidal activity of *T. vulgaris* and *R. officinalis* essential oils were determined against *M. rosae* by indirect spray methods based on Pascual-Villalobos and Robledo (1998). Briefly, glass Petri plates (90 ×10 mm) were used as a chamber for the determination of test materials on the insect. To test essential oil toxicity, ten adults of the same age (1-48 hour of age) from the stock colonies were transferred onto excised leaves (2cm diam.), placed with dorsal side on four layers of wet (saturated with distilled water) filter paper in a Petri dish, using a soft paint brush. The aphids were allowed to settle for half an hour before being exposed to the essential oils. The applications of the essential oils were based on Soylu *et al.*, (2006). To prevent a direct contact between the aphids and oils, the desired oil quantities were applied on filter paper (5 × 2cm) fixed on the inner surface of the Petri dish lid. Preliminary tests were done to choose the right doses. Plates were then sealed with parafilm to prevent any loss of essential oils. Each concentration was replicated five times with each replicate consisting of 10 adult insect. The control consisted of a similar setup but without essential oils. Mortality was recorded after 24 h of the treatment and the LC50 values were calculated. Aphids incapable of moving after a slight touch with a fine brush were considered as dead.

Life table parameters

The life table parameters of *M. rosae* were determined on rose plants in laboratory conditions at 27 ± 2 ºC, 70 ± 5% humidity and a photoperiod of 16: 8 L: D h. The study was initiated with 60 nymphs of the rose aphid as cohort for each treatment. In this regards, 10 adult aphids of *M. rosae* (reared on each treatment), were transferred onto new leaf sample of the same treatment. Twelve hours later, the new nymphs were collected from these leaf samples and individually transferred with a fine camel hair brush onto a new leaf sample. Thereafter, the mortality, development and number of offspring were recorded daily up to the death of the last individual.

Data Analysis

Insecticidal activity

Mortality of the rose aphid *M. rosae* was calculated by using Abbott's formula (Abbott, 1925) and the lethal concentration (LC_{50}) was obtained using probit analysis (Robertson *et al.*, 2007) and Polo Pc software (LeOra software, 1987). Percentage of mortality values for different doses were subjected to analysis of variance by one way ANOVA followed by LSD test when significant differences were shown at $\alpha = 0.05$ (SAS Institute, 1997).

Life table parameters

The age-specific fecundity (m_x) and age-specific survival (l_x) of aphid on various concentrations of rosemary and thyme essential oils were calculated according Birch (1948) and the life table parameters estimated based on suggested formula by Carey (1993). The life table parameters included: net reproductive rate (R_0), intrinsic rate of natural increase (r), finite rate of increase (λ), mean generation time (T), doubling time (DT) and life expectancy (e_x). Data on immature developmental period and adult longevity of rose aphid were analyzed with one-way analyses of variance (ANOVA). When the variation among treatments was significant, means comparison were done based on Duncan's multiple range test ($P < 0.05$). The statistical differences of life table parameters among various treatments were detected using the jackknife procedure (Meyer *et al.*, 1986; Maia *et al.*, 2000). In this procedure, jackknife pseudo values of each life table parameter were calculated for n aphids by the following equation:

$$A_{(j)} = n \times A_{(all)} - (n - 1) \times A_{(i)}$$

Where $A_{(j)}$ is the jackknife pseudo value, n is the number of aphids, $A_{(all)}$ is the calculated life table parameters for all aphids and $A_{(i)}$ is the calculated parameters for (n–1) aphids. All statistical analyses were carried out using the Minitab statistical software (MINITAB, 2000) and SPSS statistical packages (SPSS, 2004).

Results

Logarithmic concentrations and insecticidal activity

Logarithmic concentrations and mortality percent (%Mortality ± SE) of the botanical compounds (*R. officinalis* and *T. vulgaris*) on *M. rosae* in laboratory conditions, are shown in Table 1. Variance analysis revealed that the essential oils of rosemary and thyme had a significant difference on population parameters of rose aphid ($F_{5, 500} = 54.32$; $P < 0.01$). The means were further separated by Duncan test (one-way ANOVA) at 1% level of significance. The maximum mortality percent of *M. rosae* population for treatments with *R. officinalis* and *T. vulgaris* essential oils were 89.79 ± 1.28% and 93.87 ± 1.41%, respectively.

Table 1 Logarithmic concentrations and mortality of all compounds on *Macrosiphum rosae* in laboratory conditions.

Concentrations (ppm)		Mortality ± SE (%)[1]	
R. officinalis	*T. vulgaris*	*R. officinalis*	*T. vulgaris*
16000	7000	11.75 ± 0.98 f	14.88 ± 0.84 f
23442	11876	18.96 ± 1.04 e	18.96 ± 1.23 e
34435	20091	25.48 ± 1.85 d	28.47 ± 1.69 d
50466	34041	31.58 ± 1.71 c	32.96 ± 1.27 c
74131	57677	42.36 ± 1.97 b	44.85 ± 1.82 b
109000	98000	86.12 ± 1.02 a	90.21 ± 1.12 a

[1] Means with the same letters in each column are not significantly different (Duncan's multiple range test, $P < 0.05$).

Data on toxicity of essential oils against *M. rosae* are given in Table 2. On the basis of LC50 values, *M. rosae* was significantly more sensitive to the oil of *T. vulgaris* than to the *R. officinalis*. Hence, *T. vulgaris* essential oil had higher insecticidal effect (LC50 = 36621 ppm) than *R. officinalis* essential oil (LC_{50} = 57565 ppm) on rose aphid.

Table 2 LC_{10}, LC_{50} and LC_{90} of six essential oils of *Thymus vulgaris* and *Rosmarinus officinalis* against *Macrosiphum rosae.*

Essential oils	n	LC (95% FL) (ppm)			Slope ± SE	χ^2
		LC_{10}	LC_{50}	LC_{90}		
R. officinalis	200	15702 (1141-27382)	57565 (36595-142560)	211034 (103242-8440830)	2.275 ± 0.574	15.655
T. vulgaris	200	6251 (358-14338)	36621 (17390-156327)	214546 (78532-183068790)	1.669 ± 0.461	13.119

LC: lethal concentration (ppm); FL: fiducial limits; χ2: chi square.

Life table parameters of *Macrosiphum rosae*

The life expectancy (e_x) at adult emergence time of *M. rosae* exposed to rosemary and thyme essential oils are given in Figure 1.

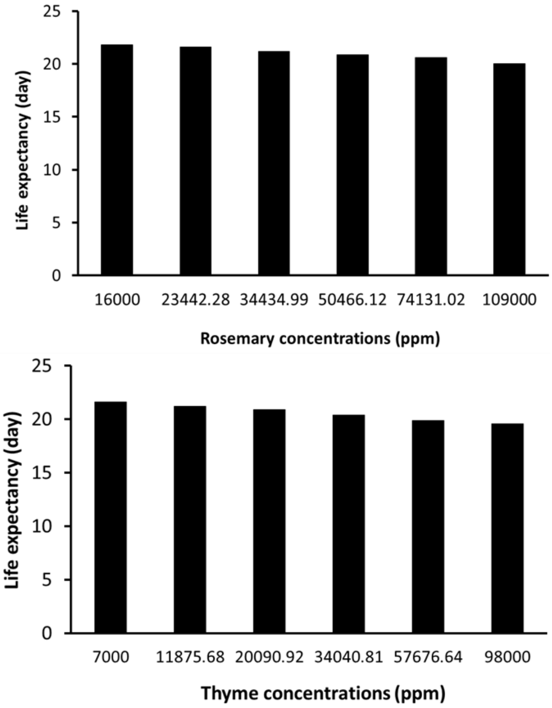

Figure 1 The life expectancy (e_x) at adult emergence time of *Macrosiphum rosae* on rosemary and thyme essential oils.

There were no significant differences in this parameter of *M. rosae* treated with different concentrations of rosemary ($F_{5,\ 328}$ = 2.39; P < 0.01) and thyme ($F_{5,\ 322}$ = 3.14; P < 0.01) essential oil. The life expectancy on different concentrations (1st to 6th concentration) of rosemary essential oil was 21.8, 21.6, 21.2, 20.9, 20.6 and 20.01 days and on different concentrations (1st to 6th concentration) of thyme essential oil was 21.6, 21.2, 20.9, 20.4, 19.9 and 19.6 days, respectively.

The process of changes in age-specific survival (l_x) and age-specific fecundity (m_x) of *M. rosae* on various rosemary and thyme essential oil concentrations are shown in Figures 2 and 3. As can be seen, the first nymphiposition and the deaths of all examined aphids were occurred on the 10th and 30th days on various treatments, respectively. The nymphiposition period on different concentrations (1st to 6th concentration) of rosemary essential oil had lasted 17, 17, 16, 16, 15.5 and 15 days (Fig. 2) and of thyme essential oil had lasted 15, 15, 16, 16, 17 and 17 days (Fig. 3), respectively. Also, the number of nymphs at the peak of nymphiposition of females was determined to be 3.5, 3.5, 3, 2.8, 2 and 1.5 nymphs on various thyme essential oil concentrations (1st to 6th concentration) and on various rosemary essential oil concentrations was determined to be 4, 3.8, 3, 3, 2.2 and 1.8 nymphs, respectively. Hence, in all thyme concentrations the number of born nymphs of *M. rosae* was lower than the number of born nymphs in various rosemary concentrations.

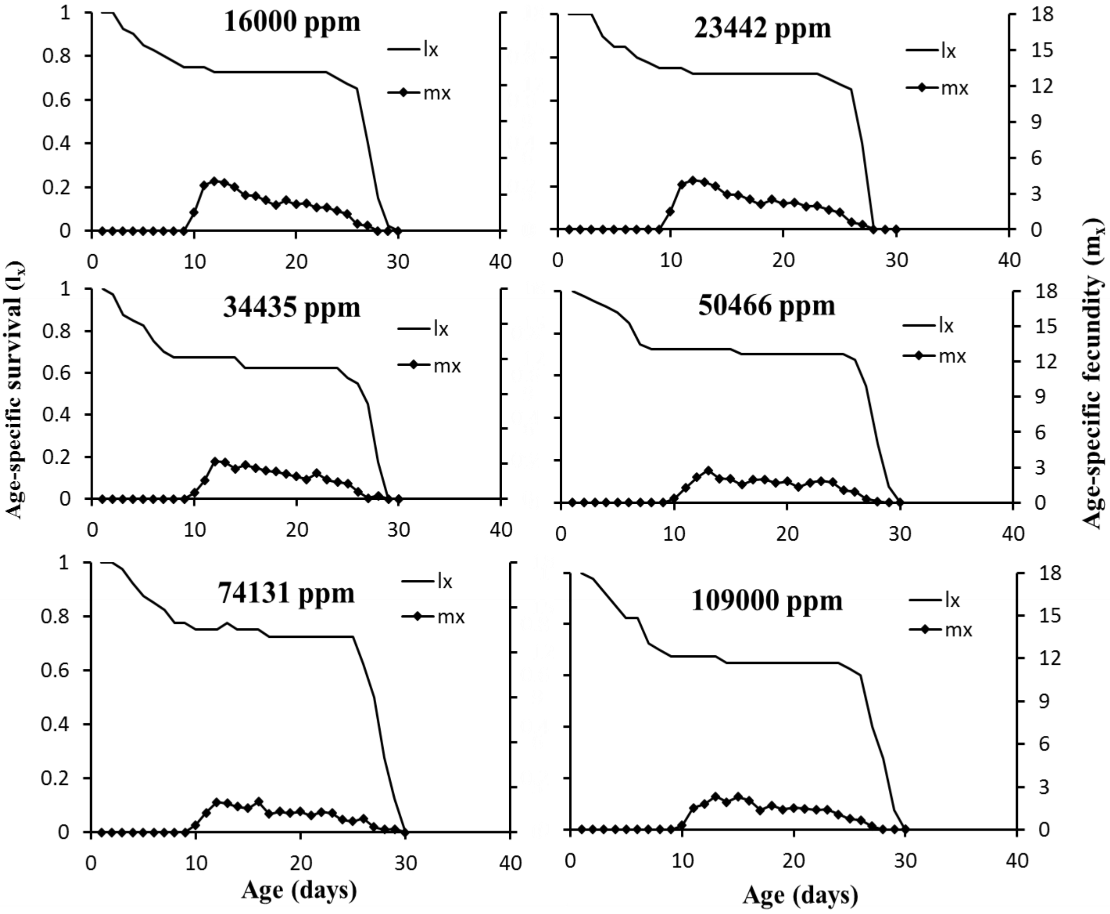

Figure 2 Age-specific survival (l_x) and age-specific fecundity (m_x) of *Macrosiphum rosae* on various rosemary essential oil concentrations.

There were significant differences among the life table parameters of *M. rosae* on different rosemary and thyme essential oil concentrations (Tables 3 and 4). The life table parameters of *M. rosae* on various rosemary essential oil concentrations (1st to 6th concentration) are as follows (Table 3): The highest and lowest of net reproductive rates (R_0) ($F_{5, 40} = 6.12$; $P < 0.01$) were obtained on 1st concentration (31.97 ± 1.98 female offspring) and 6th concentration of rosemary essential oil (17.87 ± 1.97 female offspring), respectively. Also, the intrinsic rates of natural increase (*r)* ($F_{5, 40} = 9.09$; $P < 0.01$) for 1st to 6th concentration ranged from 0.237 ± 0.001 to 0.185 ± 0.02 day^{-1}, the mean generation time (*T*) ($F_{5, 40} = 7.40$; $P < 0.01$) was 14.45 ± 0.23 to 15.99 ± 0.21 days, the doubling time (*DT*) ($F_{5, 40} = 7.35$; $P < 0.01$) ranged from 2.85 ± 0.14 to 3.71 ± 0.14 days and the finite rate of increase (λ) ($F_{5, 40} = 9.21$; $P < 0.01$) was 1.27 ± 0.02 to1.20 ± 0.01 day^{-1} (Table 3). The life table parameters of *M. rosae* on various thyme essential oil concentrations (1st to 6th concentration) are as follows (Table 4): The R_0 values ($F_{5, 40} = 5.10$; $P < 0.01$) changed from 29.10 ± 1.97 to 16.62 ± 2.31female offspring. The *r* values ($F_{5, 40} = 8.07$; $P < 0.01$) ranged from 0.229 ± 0.13to 0.177 ± 0.01 day^{-1}, the mean generation time (*T*) ($F_{5, 40} = 6.38$; $P < 0.01$) was 13.92 ± 0.22 to 15.88 ± 0.19 days, the *DT* values ($F_{5, 40} = 6.33$; $P < 0.01$) ranged from3.01 ± 0.05 to 3.90 ± 0.007 days and the λ values ($F_{5, 40} = 8.19$; $P < 0.01$) were 1.26 ± 0.06 to1.19 ± 0.003 day^{-1} (Table 4).

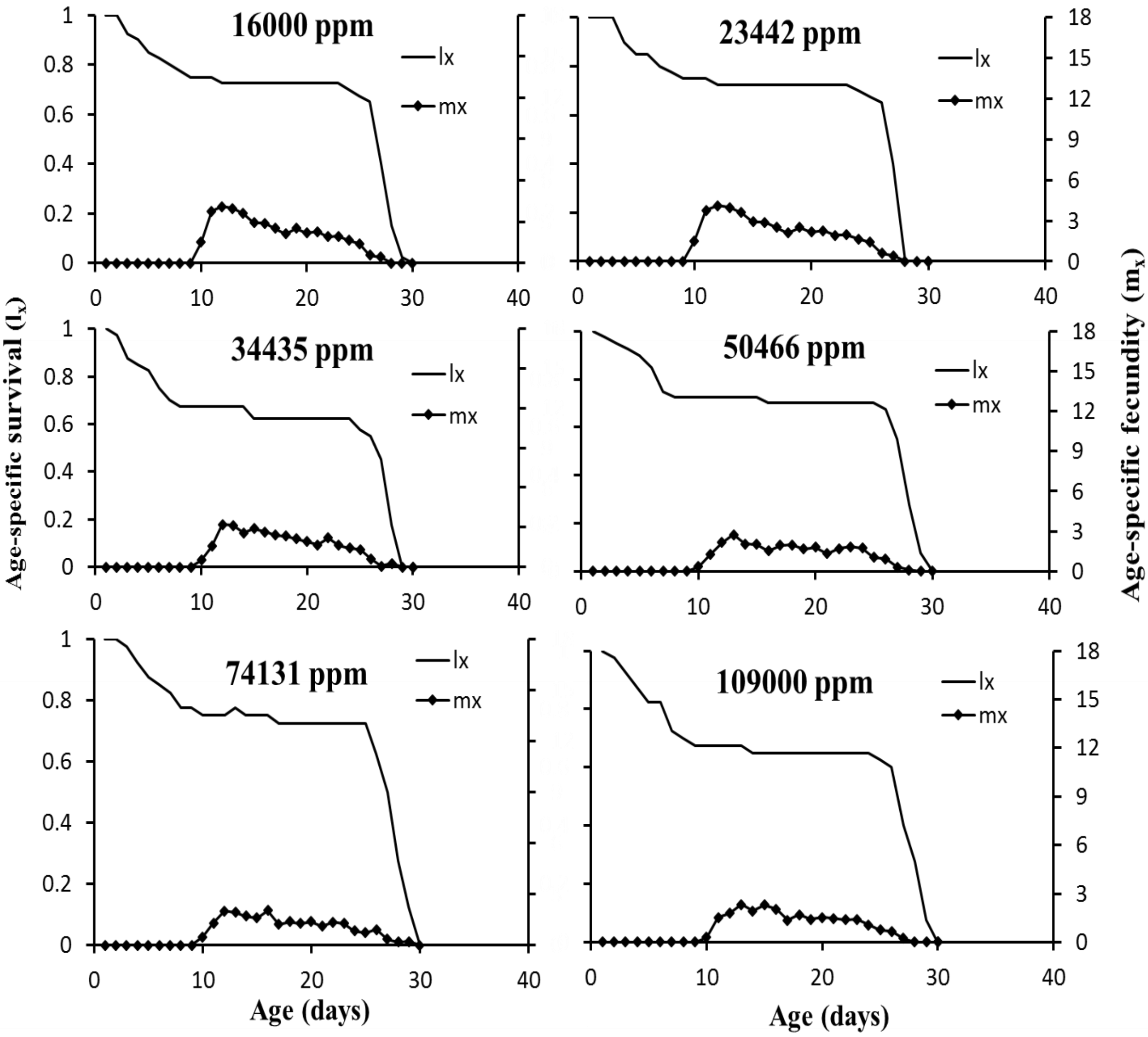

Figure 3 Age-specific survival (l_x) and age-specific fecundity (m_x) of *Macrosiphum rosae* on various thyme essential oil concentrations.

Table 3 Life table parameters of *Macrosiphum rosae* on various Rosemary essential oil concentrations.

Parameters	Rosemary concentrations (ppm)					
	16000	23442	34435	50466	74131	109000
r (day^{-1})	0.237 ± 0.001a	0.235 ± 0.011a	0.203 ± 0.017b	0.189 ± 0.104c	0.187 ± 0.045c	0.185 ± 0.022d
R_0 (female offspring)	31.97 ± 1.98a	32.30 ± 2.06a	23.49 ± 1.43b	20.74 ± 2.32c	18.02 ± 2.12d	17.87 ± 1.97d
T (day)	14.45 ± 0.238c	14.76 ± 0.187c	15.54 ± 0.214b	15.48 ± 0.197b	15.57 ± 0.165b	15.99 ± 0.213a
λ (day^{-1})	1.27 ± 0.024a	1.26 ± 0.017a	1.22 ± 0.113b	1.20 ± 0.107c	1.20 ± 0.102c	1.20 ± 0.011c
DT (day)	2.85 ± 0.141e	2.93 ± 0.203e	3.39 ± 0.124d	3.64 ± 0.112c	3.68 ± 0.285ab	3.71 ± 0.147a

Means with the same letters in each row are not significantly different (Duncan's multiple range test, $P < 0.05$).

Table 4 Life table parameters of *Macrosiphum rosae* on various thyme essential oil concentrations.

Parameters	Thyme concentrations (ppm)					
	7000	11876	20091	34041	57677	98000
r (day^{-1})	0.229 ± 0.134a	0.226 ± 0.147ab	0.205 ± 0.011c	0.186 ± 0.117d	0.177 ± 0.125e	0.177 ± 0.014e
R_0 (female offspring)	29.10 ± 1.97a	28.07 ± 2.24ab	24.52 ± 1.89c	19.24 ± 2.01d	16.57 ± 2.02e	16.62 ± 2.31e
T (day)	13.92 ± 0.222d	14.77 ± 0.174c	15.56 ± 0.214ab	15.85 ± 0.201a	15.84 ± 0.162a	15.88 ± 0.198a
λ (day^{-1})	1.26 ± 0.063a	1.25 ± 0.045b	1.22 ± 0.354c	1.20 ± 0.248d	1.19 ± 0.011e	1.19 ± 0.003e
DT (day)	3.01 ± 0.054c	3.06 ± 0.035c	3.36 ± 0.025b	3.70 ± 0.017ab	3.89 ± 0.014a	3.90 ± 0.007a

Means with the same letters in each row are not significantly different (Duncan's multiple range test, $P < 0.05$).

Discussion

Essential oils as a natural alternative to synthetic insecticides, have a good potential for safe insect control on diverse array of agricultural products. Over 120 plants and plant products have been identified to have insecticidal or deterrent activity against different insect pests (Dales, 1996) and many producers in parts of Asia and Africa use these botanicals against insect pests to protect agricultural products (Dharmasena *et al.*, 1998; Singh, 1990). These compounds are usually extracted from a wide range of species belonging to the Apiaceae and Lamiaceae (Chaubey, 2007a, b; Kim and Ahn, 2001; Taghizadeh-Saroukolai *et al.*, 2010) and in addition to insect pests, they have the high potential to be used against fungi and bacteria as well (Chaubey, 2007a, b; Kim and Ahn, 2001; Taghizadeh-Saroukolai *et al.*, 2010).

Natural organic compounds produced by plants include repellents, growth inhibitors and toxins that form an extensive chemical defense against plant pests (Viegas, 2003). The plant essential oils have insecticidal activity due to the presence of terpenoids (Isman and Machiad, 2006). Tewary *et al*. (2005) believed that the various terpenoids found in the plant essential oils exert toxicity against aphids such as deterring the aphid penetration and reducing feeding and also reducing reproduction and inhibiting oviposition.

In the current study, the effect of essential oils from two plant species *T. vulgaris* and *R. officinalis* were evaluated on rose aphid *M. rosae*. Our tests showed that both essential oils had contact toxicity toward the rose aphid but with varying degrees. On the basis of our results, *T. vulgaris* essential oil had higher insecticidal effect (LC50 = 36621 ppm) than *R. officinalis* essential oil (LC50 = 57565 ppm) on rose aphid. In confirming this result, Hori (1998) investigated essential oils of five plants (rosemary, thyme, peppermint, lavender and spearmint) against *Myzus persicae* and concluded that the rosemary oil at a dose of 10 µl and the thyme oil at a dose of 1 µl, caused 70% mortality in the population of the aphid, indicating that the *T. vulgaris* oil was more effective against *M. persicae* than *R. officinalis* oil. Gorur *et al.* (2008) studied on essential oil effect of three plants *T. vulgaris, Veronica officinalis* and *Agrimonia eupatoria* on cabbage aphid *Brevicoryne brassicae* L. under laboratory conditions. They found that of the three tested essential oils, *T. vulgaris* oil had the highest percentage of the monoterpene phenols of which Thymol and Carvacrol have had a great potential on cabbage aphid population control.

Our results on the effect of thyme and rosemary essential oils on life table parameters of red rose aphid on cut flower rose in laboratory conditions showed that both of these essential oils were able to cause mortality in *M. rosae* and influence its demographic parameters severely. These findings are consistent with other studies as to the high performance of thyme and rosemary essential oils against insect pests (Hori, 1998; Gorur *et al.*, 2008). The relative efficacy of essential oils extracted from *Thymus persicus* Ronniger ex Rech. (Taghizadeh-Saroukolai *et al.*, 2010), *Ziziphora clinopodioides* Boiss. (Lorestani and Shayesteh, 2009), *Hyptis spicigera* L. (Ngamo *et al.*, 2007), *Trachyspermum ammi* L., *Anethum graveolens* L. and *Cuminum cyminum* L. (Chaubey, 2007a, b) against several stored product pests has also been reported.

The two essential oils in our study also had different influence on population parameters of *M. rosae*. The maximum mortality percent of *M. rosae* population for treatments *R. officinalis* and *T. vulgaris* essential oils were 89.79 ± 1.28% and 93.87 ± 1.41%, respectively. Hence, *T. vulgaris* essential oil had higher insecticidal effect than *R. officinalis* essential oil on rose aphid. Since plants with insecticidal properties may be different in percent of their efficient components, this attribute may affect their insecticidal efficiency. For example, it has been shown that *T. vulgaris* containing EO composed of o-Cymene (5.04%), γ-Terpinen (1.84%), Linalool (27.25%), 4-Terpineol (2.68%), β-Fenchyl alcohol (1.19%), Thymol (36.26%), Carvacrol (1.50%), and the sesquiterpenes Caryophyllene (0.61%) is more efficient than that plants containing lower percent of these components or lacking some of them (see Gorur *et al.*, 2008). Furthermore, in a same species, each of these components may have different insecticidal activity (see Szczepanik *et al.*, 2012). Insecticidal activity of thyme has been demonstrated by several researchers. Tomova *et al.* (2005) demonstrated significant effects of the *Thymus minuta* essential oil on three species of aphid *Acyrthosiphon pisum*, *M. persicae* and *Aulacorthum solani*. Their results showed that the essential oil of *T. minuta* had the most effect on *M. persicae* and the mortality percent on *A. pisum*, *M. persicae* and *A. solani* was 68, 80 and 63%, respectively. Gorur *et al.* (2008) reported similar effects of *T. vulgaris*, *Veronica officinalis* and *Agrimonia eupatoria* essential oils on cabbage aphid *Brevicoryne brassicae*. They reported that the essential oil of *T. vulgaris* caused 80% mortality in the cabbage aphid population.

In addition, thyme essential oil reduced more *r* value than rosemary. As is known among the life table parameters, the intrinsic rate of increase (*r*) is the best parameter for evaluating the host plant species or treatment efficacy, because it reflects the overall effects on both survivorship and fecundity (Soufbaf *et al.*, 2010). On the whole our results show that thyme essential oil is more efficient botanical compound against *M. rosae* than rosemary. Although rosemary essential oil was rather less efficient than thyme in the current study, but it caused high mortality in *M. rosae* and highly affected its population parameters (Table 1). The insecticidal and acaricidal effects of rosemary oil have been shown by various researchers. Miresmailli and Isman (2006) and Miresmailli *et al.* (2006) clearly indicated that rosemary oil can be considered as an important acaricide against two spotted spider mite *Tetranychus urticae*, causing complete mortality in the laboratory at concentrations that cause no phytotoxicity to host plants and can affect oviposition behaviour. The insecticidal and acaricidal effects of rosemary can be related to its specific chemical composition, containing a mixture of different terpenoids (Miresmailli, 2001).

In the current study we also found that there was a reverse correlation between increased essential oil concentration and population parameter values of *M. rosae* so that by increasing the concentrations of the essential oil, population parameter values of *M. rosae* reduced significantly (Tables 3, 4).

The effect of seven plant essential oils *Polyscias crispate*, *P. scutellaria*, *Vibernum suspensum*, *Citrus paradisi*, *C. jambhiri*, *C. sinensis*, *Murraya paniculata* was investigated on life table parameters of the spirea aphid *Aphis spiraecola* Patch by Tsai and Wang (2001). Their results showed that the spirea aphid failed to survive on *M. paniculata*. Also, the intrinsic rate of increase (*r*) for spirea aphid on *P. crispata* was highest. Jackknife estimates of *r* varied from 0.308 on *P. crispata* to 0.177 on *C. sinensis*. The mean population generation time on these hosts ranged from 11.6 to 13.2 days.

Study by Modarres Najafabadi *et al.* (2014), indicated significant differences among life table parameters of *T. urticae* treated by thymol compared to control. R_0, *r*, *T*, *DT* and λ values (life table parameters) of *T. urticae*, in the vicinity of thymol essential oil were 53.73 female offspring, 0.237 day^{-1}, 16.78 days, 2.96 days and 1.26 day^{-1}, respectively. Kassimi and Lahcen (2012) studied the insecticidal effect of EO extracts from six plants (Kanuka, Ravintsara, Tea tree, Thyme, Oregano and Neem) on the aphids in alfalfa green. A comparison between the results obtained showed that the oregano, neem and thyme extracts had more effects on the alfalfa aphids.

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تأثیر اسانس گیاهان آویشن و رزماری روی پارامترهای رشدی جمعیت شته قرمز رز *Macrosiphum rosae* L. (Hemiptera: Aphididae) روی گل‌های رز شاخه بریده

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چکیده: در این تحقیق تأثیر اسانس گیاهان آویشن و رزماری روی پارامترهای رشدی جمعیت شته قرمز رز *Macrosiphum rosae* L. (Hemiptera: Aphididae) روی گل‌های رز شاخه بریده (*Rosa hybrid* L.) در شرایط آزمایشگاهی (دمای ۲ ± ۲۷ درجه سلسیوس، رطوبت ۵ ± ۷۰ درصد و شرایط نوری ۱۶ ساعت روشنایی و ۸ ساعت تاریکی) طی سال‌های ۱۳۹۴-۱۳۹۳ مورد بررسی قرار گرفت. نتایج حاصل نشان داد که شته قرمز رز نسبت به اسانس آویشن حساسیت بیش‌تری از خود نشان داده است به‌طوری که مقادیر LC_{50} محاسبه شده برای اسانس آویشن و اسانس رزماری به‌ترتیب ۳۶۶۲۱ و ۵۷۵۶۵ پی‌پی‌ام بود. هم‌چنین نتیجه بررسی‌ها روی جدول زندگی شته قرمز رز نشان داد که در برابر اسانس آویشن میزان نرخ خالص تولید مثل (R_0) از ۲/۳۱ ± ۱۶/۶۲ تا ۱/۹۷ ± ۲۹/۱۰ و میزان نرخ ذاتی افزایش جمعیت (r) از ۰/۰۱ ± ۰/۱۷۷ تا ۰/۱۳ ± ۰/۲۲۹ و میزان میانگین زمان نسل (T) از ۰/۲۲ ± ۱۳/۹۲ تا ۰/۱۹ ± ۱۵/۸۸ و میزان مدت زمان دو برابر شدن جمعیت (DT) از ۰/۰۵ ± ۳/۰۱ تا ۰/۰۰۷ ± ۳/۹۰ و میزان نرخ متناهی افزایش جمعیت (λ) از ۰/۰۰۳ ± ۱/۱۹ تا ۰/۰۶ ± ۱/۲۶متغیر می‌باشد این درحالی است که در برابر اسانس رزماری میزان R_0 از ۱/۹۷ ± ۱۷/۸۷ تا ۱/۹۸ ± ۳۱/۹۷ و میزان r از ۰/۰۲ ± ۰/۱۸۵ تا ۰/۰۰۱ ± ۰/۲۳۷ و میزان T از ۰/۲۳ ± ۱۴/۴۵ تا ۰/۲۱ ± ۱۵/۹۹ و میزان DT از ۰/۱۴ ± ۲/۸۵ تا ۰/۱۴ ± ۳/۷۱ و میزان λ از ۰/۰۱ ± ۱/۲۰ تا ۰/۰۲ ± ۱/۲۷متغیر می‌باشد. نتیجه نهایی نشان داد که اسانس آویشن با ایجاد ۱/۱۲ ± ۹۰/۲۱ درصد مرگ‌ومیر در جمعیت شته قرمز رز، نسبت به اسانس رزماری با ایجاد ۱/۰۲ ± ۸۶/۱۲ درصد مرگ‌ومیر، تأثیر بیش‌تری دارد.

واژگان کلیدی: جدول زندگی، شته قرمز رز، پارامترهای رشدی جمعیت، رزماری، آویشن