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Studying the essential oil of some damask rose genotypes under dry farming and irrigated conditions

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ABSTRACT

Damask rose (Rosa damascena Mill.) has high genetic varieties in Iran; however, drought is a limiting factor it's production. In most regions of Iran, water deficit always limits production in irrigated and dry farming systems. This experiment was conducted to study the Rosa damascena genotypes tolerance and essential oil yield under dry farming conditions with using plastic mulch. In this experiment, 12 damask rose genotypes from different regions of Iran were planted in Homand Research Station, which is located in east of Tehran. Damask rose plantlets were planted under the three conditions (irrigated, non irrigated and non irrigated with using the plastic mulch) under randomized complete blocks design with three replications. The results showed a significant difference among the percentage of essential oil in damask rose genotypes. The essential oil during 2008 and 2009 presented that in non irrigation conditions, the most amount of essential oil (0.54%) was related to Fars1 genotype and the least (0.10%) was related to Tehran1 genotype. Kerman1 genotype did not bloom under the non irrigated condition. In the irrigated condition, the most amount of essential oil was related to Kerman1 genotype. Under the non irrigated condition with using mulch, the most amount of essential oil (1.710%) was related to Ilam1 genotype and the least (0.57%) was related to Kerman 1 genotype. All genotypes had significant amount of essential oil under the non irrigated condition with using mulch because of gathering the rainfall during the growth season. The Fars 1 genotype produced the highest essential oil yield in the three conditions of this experiment.

Keywords: essential oil, medicinal plant, *Rosa damascene*.

INTRODUCTION

Rosa damascene Mill has high genetic diversity in Iran and is important with respect to ornamental and export aspects. It consisted of two species including *R. galica* and *R. moscatag*. Essential oil of *Rosa damascene* Mill is located at the top of petal and inside the cells with projected appearance. This essential oil is collated at the bottom section of petal and where the inner petal is covered by the outer petal. *Rosa damascene* Mill essential oil is regarded as one of the most famous perfume that has many application at pharmaceutics, aromatherapy, perfume production, cosmetic products (dental powder and types of ointments as odor material. Although essential oil of *Rosa damascene* Mill is complicated mixture of more than 10 compounds, more compound that is obtained from blossoms of this flower are phenyl ethyl alcohol and other principal compounds are jeraniol, citronella and nerol. Jeraniol, citronellol and nerol are the most important volatile materials that have several application in perfume production, cosmetic and soap.

In order to produce each pharmaceutical plant and extracting its essential oil, it is required to use a suitable irrigation. One of the limitations of gardening is drought that is generally harmful for growth of plant. Studying drought stress in lands that are faced with shortage of water for agriculture and also lands that are dependant to rain

water is necessary [8, 11]. By increasing demand for pharmaceutical plants and with respect to damaging natural environment, they may not satisfy human needs. Whereas identifying commercial and resistant species against drought is very important, it is required to study ratio of available essential oil at pharmaceutical plant and shortage of water. Meanwhile, little information is available in relation to ratio of water and secondary metabolite content of pharmaceutical plant. Not only producing essential oil in plant depends on metabolic mode of resource tissue, but also it may influence stress factors [12]. Abdolshah [13] in the a study in relation to compound essential oil of German chamomile as a plant resistant to drought to determine threshold of resistance against drought and its effect on farming and pharmaceutical properties of German chamomile within test under four levels of irrigation based on capacity of farm showed that, the highest percentage of performance and also essential oil performance is related to 85% treatment for capacity of farm which had no significant difference with 70% irrigation. The lowest percentage of essential oil is obtained when plant is irrigated with 100% and 55% irrigation capacity of farm. Lebaschi et al. [10] studied growth indices of some pharmaceutical plant species under several tension conditions as a result of drought. Plant species were separately gone under treatment of complete irrigation as capacity of farm and drought tension of 75%, 50% and 25% capacity of farm at test units. Different plant species gone under complete irrigation and drought tension treatment showed different reactions. All species under different treatments of tension and irrigation showed significant difference at 1% performance. Results showed that plants are not drought in spite of going under severe tension condition and being withered and completed their growth period under severe tension conditions.

A study in relation to performance of essential oil for genotype of *Rosa damascene* Mill at central provinces of Iran [16] showed that, samples of Yazd 1 (0,020%) and Isfahan 1 (0,019%) had highest percentage of essential oil. In addition, the highest average for performance of essential oil (632,33 g/ha) was obtained in Yazd. Result of this study is compatible with report of Tabaei-Aghdaei and Babaei [15] in relation to diversity of essential oil at genotype of *Rosa damascene* Mill. Results of this study prepare some considerations in relation to abilities of genetic reserves of *Rosa damascene* Mill in Iran. In study of Salehi Arjomand [7] on the effect of environmental tension on increasing secondary metabolite in plant showed that whereas defense role of secondary metabolite is generally accepted, studying mechanisms related to effect of environmental stress on production of *Rosa damascene* Mill has created complicated and ambiguous concept. Many evidences show that under tension condition, it is possible to increase production of these compounds even several times; however, there are many reasons which show that this effect is not permanent and all inclusive [3]. Under many cases it is observed that level of secondary metabolite is decrease under tension condition [3]. On the other hand, the effect of environmental tension on all of these compounds is not equal; therefore, quality of materials is under influence of tension and also influence of tension on total biomass is generally negative [3, 14]. In spite of these tensions, it seems that having more study in relation to this topic may create new opportunity to utilize tension condition in Iran. So, the objective of this experiment was to compare the yield of 12 *Rosa damascene* genotypes under irrigation and dry farming conditions.

MATERIALS AND METHODS

This experiment was conducted at Homand Absard research station located at Damavand- Firouzkouh road, Iran (35^o 49' N, 52^o 15' E, 1960 above the sea level). According to the studies by using Amberjet method, the climate of this station is semi step cold. Structure of soil is clay loam, its pH is 7.1 and annual precipitation is 338 mm. Flowers of *Rosa damascene* Mill at Kermanshah, Chaharmahal Bakhtiyari, Tehran, Arak, Isfahan, Ardebil, Ilam, Fars, Hormozgan and Kerman under three conditions including: irrigation, dry farming and dry farming with plastic mulch in the form of a randomized complete block design with three replications were studied during 2008 and 2009. Distance between bushes was 2.5 m. Irrigation treatment was performed by drip method. Under dry farming method the bushes of *Rosa damascene* Mill did not go under special treatment and under dry farming with mulch plastic in order to direct rain water to bushes of flower and also prevention from growth of weeds, it is used from mulch plastic. In spite of cool weather at Damavand; the samples were collected since middle of May. During flowering, on early morning the flowers were picked up and after separating petal and extracting its essential oil with Clevenger, the performance of essential oil during year 2008 and 2009 was measured and calculated. Data related to different properties were analyzed and compared using Excel, Mini Tab and SAS software.

RESULTS

Analysis of the variances for essential oil percentage under three conditions of irrigation, dry farming and dry farming with mulch in 2008 showed that there is no significant difference between essential oil of genotypes of *Rosa damascene* Mill under irrigation condition ($P \geq 0.05$). Index for essential oil percentage at the second year of genotypes was significant ($P \leq 0.01$). Percentage of essential oil for different genotypes under dry farming condition in the first year was significant ($P \leq 0.01$). Under dry farming with mulch, the efficiency of genotypes in different

years of test was not significant (P≥0.05). Results of analysis of the variances for average percentage of essential oil of *Rosa damascene* Mill in different years and irrigation, dry farming and dry farming with mulch plastic shows their significant difference (P≤0.01). Analyzing average compound of genotypes and different years for percentage of essential oil of to *Rosa damascene* Mill showed that there is no significant difference for properties under this condition ((P≥0.05).

Mean comparison of average percentage of essential oil of *Rosa damascene* Mill under irrigation, dry farming and dry farming with mulch plastic during different years are presented in Table 1. In the first year and under irrigation condition, the highest percentage of essential oil (0,059) was related to Kerman 1 genotype that was in the same statistical group with other genotypes except for Fars 1, and the lowest percentage of essential oil (0,024) was related to Fars 1. Under dry farming condition, the highest percentage of essential oil (0,050) was related to Chaharmahal Bakhtiyari 1 which did not have significant difference with Ardebil 1, Fars 1, Kermanshah 1, Arak 1, Hormozgan 1, Isfahan 3 and Isfahan 8. Under dry farming with mulch, the highest percentage of essential oil (0,046) was related to Hormozgan 1 and Isfahan 6 that were in the same statistical group except for Kermanshah genotype. The lowest amount of essential oil (0,019) under dry farming with mulch plastic was related to genotype of Kermanshah 1. In the second year of test and under irrigation condition, the highest percentage of essential oil (0,063) was related to genotype of Tehran that fall with same statistical group with genotype of Hormozgan 1 and Isfahan 3. The lowest percentage of essential oil (0,007) was related to genotype of Fars 1 that fall within same statistical group with most of genotypes. Under condition of dry farming the highest percentage of essential oil (0,050) was related to genotype of Tehran 1 that had no significant difference with genotype of Chaharmahal Bakhtiari 1, Kermanshah 1, Arak 1, Hormozgan 1 and Isfahan 6. The lowest percentage of essential oil after Kerman as 0 was observed at Isfahan as 8 (0,012). Under dry farming with higher amount of mulch the highest percentage of essential oil (0,078) was related to genotype of Chaharmahal Bakhtiari 1 that fall within same statistical group except genotype of Isfahan 6. The lowest percentage of essential oil (0,011) was related to genotype of Isfahan 6.

Table 1: Comparing percentage of essential oil for genotype in year 2008 and 2009.

Genotypes	average Percentage of essential oil (%)											
	Irrigation				Dry farming				Dry farming with mulch			
	2008		2009		2008		2009		2008		2009	
Ardebil1	0.036	ab	0.013	c	0.036	abc	0.025	cde	0.038	ab	0.017	ab
Ilam1	0.036	ab	0.012	c	0.027	bc	0.024	cde	0.035	ab	0.029	ab
Tehran1	0.036	ab	0.063	a	0.023	c	0.059	a	0.038	ab	0.021	ab
Chaharmahal Bakhtiyari 1	0.041	ab	0.008	c	0.050	a	0.039	a…d	0.040	ab	0.078	a
Fars1	0.024	b	0.007	c	0.033	abc	0.028	bcd	0.031	ab	0.019	ab
Kerman1	0.059	a	0.009	c	0	d	0	f	0.041	ab	0.029	ab
Kermanshah1	0.034	ab	0.012	c	0.038	abc	0.045	abc	0.019	b	0.017	ab
Arak1	0.034	ab	0.019	bc	0.028	abc	0.040	a…d	0.040	ab	0.018	ab
Hormozgan1	0.033	ab	0.047	ab	0.048	ab	0.041	a…d	0.046	a	0.020	ab
Isfahan3	0.037	ab	0.040	abc	0.040	abc	0.019	de	0.033	ab	0.020	ab
Isfahan6	0.034	ab	0.018	bc	0.025	c	0.050	ab	0.046	a	0.011	b
Isfahan8	0.044	ab	0.018	bc	0.045	abc	0.012	e	0.028	ab	0.018	ab

Means in a column followed by the same letter are not significantly different at P≤0.05.

Mean comparison of the percentage of essential oil for *Rosa damascene* Mill in different years of test under irrigation, dry farming and dry farming with mulch plastic are presented in Table 2. Under irrigation condition, the average of 2 years and the highest percentage of essential oil (0,050) was related to Tehran 1 genotype, that was significant difference with Kerman 1, Hormogzan 1, Isfahan 3 and Isfahan 8. Under dry farming, the highest percentage of essential oil (0,045) was related to Hormozgan 1. Under dry farming with mulch plastic, the highest percentage of essential oil (0,059) was related to Chaharmahal Bakhtiari 1.

In a separate study for 2 year test as indicated in Table 3, in the first year (2008) under irrigation condition, the highest amount of essential oil was related to Fars 1 (1,6 kg/ha) and in the second year (2009) was related to Hormozgan (0,603 kg/ha). Under dry farming, the highest amount of essential oil in the first year was related to Isfahan 8 (0,38 kg/ha) and in the second year the highest amount of essential oil was related to genotype Fars 1 (0,706 kg/ha). Under dry farming with mulch in the first year, the highest percentage of essential oil was related to Arak 1 (1,83 kg/ha) and in the second year the highest percentage of essential oil was related to Fars 1 (2,14 kg/ha).

Table 2: Comparing genotypes based on average of 3 conditions (irrigation, dry farming and dry farming with mulch) for percentage of essential oil in year 2008 and 2009

Year	Percentage of Essential oil (irrigation) (%)	Percentage of Essential oil (dry farming) (%)	Percentage of Essential oil (dry farming with mulch) (%)	Conditions	
2008	0.037a	0.033a	0.036a	irrigation	0.0377a
				Dry farming	0.0330a
2009	0.022b	0.032a	0.025b	dry farming with mulch	0.0367a
Genotype				Percentage of Essential oil (%)	
Ardebil1	0.024bc	0.030abc	0.028ab	0.037a	
Ilam1	0.024bc	0.025c	0.032ab	0.033a	
Tehran1	0.050a	0.041abc	0.030ab	0.032a	
Chaharmahal Bakhtiyari 1	0.024bc	0.044ab	0.059a	0.043a	
Fars1	0.016c	0.030abc	0.025ab	0.029a	
Kerman1	0.034abc	-	0.035ab	0.033a	
Kermanshah1	0.023bc	0.041abc	0.018b	0.031a	
Arak1	0.026bc	0.034abc	0.029ab	0.034a	
Hormozgan1	0.040ab	0.045a	0.033ab	0.042a	
Isfahan3	0.039ab	0.030abc	0.026ab	0.037a	
Isfahan6	0.026bc	0.037abc	0.028ab	0.035a	
Isfahan8	0.031abc	0.028bc	0.023b	0.039a	

Means in a column followed by the same letter are not significantly different at P≤0.05.

Table 3: Comparing yield of essential oil for genotype in year 2008 and 2009

Genotype	Amount of essential oil (kg/ha)											
	Irrigation				Dry farming				Dry farming with mulch			
	2008		2009		2008		2009		2008		2009	
Ardebil1	0.673	bc	0.546	a	0.336	a	0.21	bc	0.963	cd	0.87	bcd
Ilam1	1.49	a	0.15	bc	0.23	ab	0.23	bc	1.343	abc	2.076	a
Tehran1	0.7	bc	0.576	a	0.06	b	0.143	bc	0.703	cd	0.606	cd
Chaharmahal Bakhtiyari 1	0.956	b	0.196	bc	0.136	b	0.273	bc	1.12	a…d	1.173	bc
Fars1	1.6	a	0.356	abc	0.366	a	0.706	a	1.22	abc	2.14	a
Kerman1	0.316	c	0.086	c	-	-	-	-	0.436	d	0.576	cd
Kermanshah1	0.44	c	0.186	bc	0.1	b	0.133	bc	0.433	d	0.676	cd
Arak1	0.726	bc	0.456	ab	0.333	a	0.405	abc	1.833	a	1.556	ab
Hormozgan1	0.983	b	0.603	a	0.363	a	0.403	abc	1.713	ab	1.45	ab
Isfahan3	0.633	bc	0.0533	a	0.18	ab	0.07	c	0.943	cd	1.053	bc
Isfahan6	0.713	bc	0.463	ab	0.967	b	0.433	ab	0.803	cd	0.2767	d
Isfahan8	1.033	b	0.583	a	0.38	a	0.23	bc	1.1	bcd	1.09	bc

Means in a column followed by the same letter are not significantly different at P≤0.05.

Table 4: Comparing genotypes based on average of 3 conditions (irrigation, dry farming and dry farming with mulch) for yield of essential oil in year 2008 and 2009

Genotypes	Essential oil (average of 3 conditions) (kg/ha)		Essential oil (dry farming) (kg/ha)		Essential oil (irrigation) (kg/ha)		Essential oil (dry farming with mulch) (kg/ha)	
Ardebil1	0.60	cde	0.27	bcd	0.61	b	0.917	cd
Ilam1	0.92	ab	0.23	c-f	0.82	ab	1.710	a
Tehran1	0.47	def	0.10	f	0.64	b	0.655	cd
Chaharmahal Bakhtiyari 1	0.64	cd	0.21	def	0.58	b	1.147	bc
Fars1	1.07	a	0.54	a	0.98	a	1.680	a
Kerman1	0.35	ef	-	-	0.20	c	0.507	d
Kermanshah1	0.33	f	0.12	f	0.31	c	0.555	d
Arak1	0.91	ab	0.36	bc	0.59	b	1.695	a
Hormozgan1	0.92	ab	0.38	b	0.79	ab	1.582	ab
Isfahan3	0.57	c-f	0.13	ef	0.58	b	0.998	cd
Isfahan6	0.46	def	0.27	b-e	0.59	b	0.540	d
Isfahan8	0.74	bc	0.31	bcd	0.81	ab	1.095	bc

Means in a column followed by the same letter are not significantly different at P≤0.05.

According to results presented in Table 4, the highest amount of essential oil was related to Fars 1 genotype (1, 07 kg/ha). Under irrigation condition, the highest amount of essential oil was related to Fars 1 (0,98 kg/ha). In dry

framing with mulch treatment, the highest amount of essential oil was related to Ilam (1,710 kg/ha) that was in the same statistical group with Fars 1 genotype (1,68 kg/ha) and Arak 1 (1,69 kg/ha).

DISCUSSION

According to the status of spring rain during the years of test (13 mm and 130 mm in the first and second year respectively), it seems that under irrigation, dry farming and dry farming with mulch plastic conditions, the rate of rain in year 2008 not only did not have negative effect on production of essential oil but also resulted in the enhancement of essential oil percentage. On the other hand, severe cold during winter of 2007 did not have negative effect on production of essential oil at bush of *Rosa damascene* Mill and possibly high amount of snow in 2007 could prepare suitable soil water reserve for 2008. According to the analysis of the variances for percentage of essential oil under irrigation, dry farming and dry farming with mulch plastic in 2008 and 2009, in the second year of test (2008), there is significant difference ($P<0,01$) between percentage of genotypes. Under dry farming condition ($P<0,01$) there is significant difference between percentage of essential oil at both years of test which is due to difference in climatic conditions and rain during these years. Whereas under dry farming condition there is no irrigation and flowers supply their required water through the rain, it is natural that there is significant difference under this condition.

Through comparing average percentage for essential oil of flower in first and second year of test and under irrigation condition, the highest average for percentage of essential oil was related to Tehran 1 genotype (0,050) that was distinguished with irrigation condition for other genotypes and there was significant difference with most of the genotypes. This genotype under dry farming and dry farming with mulch plastic was regarded as the best genotype. Tehran 1 has buds that are opened very late and give flower later than other genotypes. Consequently, buds and flowers are opened during hot days of spring and summer and in case of not receiving enough water, they may wilt. The lowest percentage of essential oil is related to Fars 1 (0,016). Average genotype of Tehran 1 is regarded as best genotype for producing essential oil under irrigation condition. Although Tehran 1 did not have suitable performance, it has considerable percentage of essential oil and therefore it is possible to conclude that performance of flower does not have direct relationship with percentage of essential oil.

Under condition of dry farming, the highest percentage of essential oil is related to Hormozgan 1 genotype (0,045) that was equal to Chaharmahal Bakhtiari 1 (0,044) and it is possible to say that these genotypes have high percentage of essential oil and are regarded as drought genotypes for producing essential oil. Genotypes of Hormozgan 1, Chaharmahal Bakhtiari 1 and Fars 1 under condition of dry farming considerably increased their level of essential oil content that this result is in agreement with results of Salehi Arjomand [7] which refers that drought is the most important factor of stress in Iran. According to tests of Aliabadi et al. [4] drought stress results in decreasing biomass. Results of study by Aliabadi et al. [4] showed that drought stress at coriander results in increasing percentage of essential oil, performance of essential oil and length of internodes. Aliabadi et al. [5] reported that the highest performance in Balm (*Melissa Officinalis* L.) is obtained at 100% FC and the highest performance of essential oil at 60% FC and the highest percentage of essential oil at 20% FC. Therefore, amount of essential oil in this plant is decreased under drought condition; however, percentage of essential oil under drought stress is increased. Gholizadeh et al. [1] showed that shortage of water at Moldavian Balm plant has significant effect on level of essential oil, so that content of essential oil is decreased upon increase at water depletion from 1.7 to 0.9. Another study show that upon decreasing level of irrigation water the percentage of essential oil in lemon balm is increased and the highest level of essential oil was obtain at 50% FC [2]. Therefore, in case of being able to use this factor to increase effective materials, we may obtain great advantage.

Increasing some secondary metabolites under drought condition may be in the way of mechanism of arranging plant osmosis [6, 9]. Some alkaloids and essential oils may also increase without such effect that may influence on mechanism of plant [3]. Plants rich in essential oil are more abundant at arid areas in comparison to humid areas [3]. Level of essential oil in plants including absinthium, chamomile, spike, lavender and eucalyptus is increased under drought condition. It is possible that essential oil may be effective on mechanism of resistance against drought through decreasing perspiration [3].

The lowest percentage of essential oil under dry farming condition is related to Ilam 1 genotype (0,025) that is similar to Isfahan 8 (0,028) and Ilam 1 under irrigation condition has the same level of essential oil and under dry farming with mulch plastic results in increasing percentage of essential oil in genotype; which show that level of water is not enough for increasing percentage of essential oil. In order to obtain percentage of essential oil, it is possible to use other advantages of mulch. Under dry farming with mulch, the highest percentage of essential oil is related to Chaharmahal Bakhtiari 1 genotype (0,059); in which, under dry farming condition, this genotype has the

highest percentage of essential oil and it is possible to say that this genotype under dry farming condition and dry farming with mulch results in higher essential oil in comparison to irrigation condition. The lowest percentage of essential oil under dry farming with mulch is related to Kermanshah 1 genotype (0,018) in which under dry farming condition, this essential oil is 0,041 and there is considerable decrease at percentage of essential oil at this genotype with dry farming with mulch and it is possible to say that this genotype with respect to producing essential oil may tolerate drought.

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