Short Communication

Morphological and phytochemical variations among 41 genotypes of Damask rose

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Abstract

To evaluate the genetic potential for flower yield and oil production in *Rosa damascene* Mill. an experiment was conducted using a complete block design with three replications. Forty-one (41) genotypes of *Rosa damascene* Mill. were collected from 33 areas in 28 provinces of Iran, and cultivated in 2005-2007 at the experimental field of Ali Abad Medicinal Plants Research Station in Arak, Iran. The data were evaluated for different traits, including flower yield per hectare, number of flowers, single flower weight, percent of flower dry weight, and oil contents and percent. Findings suggested significant differences among the genotypes under study. The highest and lowest flower yields were recorded with West Azerbaijan and Fars$_2$ genotypes, respectively. The highest amount of essential oil percentages (0.0055%) was also obtained in the Yazd$_2$ genotype. Baluchistan genotype with 18.5% citronellol and Kohgiluye and Booyer Ahmad with 4% citronellol showed the best quality of essential oils. Based on the findings of the study it is concluded that flower yield and quality especially essential oil yield are necessary traits to consider for breeding programs and selection of commercial *R. damascene* genotypes.

Keywords: diversity, genetic potential, oil content, oil percent, oil yield, *Rosa damascena* Mill

Latifi, M., Sh. Khaghani, M. Gomarian, M. Changizi, G. R. Goodarzi. 2025. 'Morphological and phytochemical variations among 41 genotypes of Damask rose'. *Iranian Journal of Plant Physiology 15* (3), 5541-5545.

Introduction

Rosa damascena, commonly known as the Damask rose, is a highly aromatic and cherished rose species widely cultivated for its fragrant flowers. Significant genetic variation within the *Rosa damascena* species has led to the development of different cultivars with distinct characteristics (Omidi et al., 2022). The genetic variation in Damask rose is mainly attributed to natural selection, hybridization, and human intervention through selective breeding. Different cultivars of *Rosa damascena* have been developed over the years to enhance specific traits such as flower color, fragrance intensity, and disease resistance (Venkatesha et al., 2022). Genetic studies have shown that Damask rose has a complex genetic makeup, with multiple genes responsible for traits such as flower color and fragrance. This genetic diversity has allowed for

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Received: May, 2025
Accepted: June, 2025

the development of a wide range of cultivars that cater to different preferences and market demands (Liu et al., 2023). Overall, the genetic variation within *Rosa damascena* has played a crucial role in the cultivation and breeding of this species, leading to the creation of diverse and unique cultivars that are highly valued for their beauty and fragrance (Ziogou et al., 2023).

Rosa damascena is renowned for its rich phytochemical composition, which contributes to its aromatic fragrance and potential health benefits (Ahadi et al., 2023). The phytochemical composition of Damask rose can vary depending on factors such as cultivar, growing conditions, and extraction methods (Trendafilova et al., 2023). The essential oil extracted from *Rosa damascena* flowers is highly valued for its complex aroma, which is characterized by floral, sweet, and slightly spicy notes. The main components of rose essential oil include citronellol, geraniol, nerol, and various other terpenes and alcohols (Dobreva and Nedeltcheva-Antonova, 2023). Also, *Rosa damascena* contains a variety of phenolic compounds, such as flavonoids, tannins, and phenolic acids. These compounds have antioxidant properties and may help protect against oxidative stress and inflammation (Osman et al., 2023). Terpenes are another class of phytochemicals found in Damask rose, which contribute to the plant's fragrance and may have therapeutic effects. Some of the terpenes present in *Rosa damascena* include linalool, limonene, and myrcene (Majedi et al., 2024). Carotenoids are pigments that give plants their vibrant colors and have antioxidant properties. *Rosa damascena* contains carotenoids such as beta-carotene, lycopene, and lutein, which contribute to the plant's pink and red flower colors (Guantario et al., 2023). Overall, the phytochemical variation in *Rosa damascena* contributes to its therapeutic properties and makes it a valuable plant for both perfumery and traditional medicine. This study aimed to evaluate morphological and phytochemical variations among 41 Genotypes of Damask rose.

Material and Methods

This research was conducted at Ali Abad Medicinal Plants Research Station, Arak, Iran. A total of 41 genotypes of *Rosa damascene* Mill. were obtained from 33 areas in 28 provinces of Iran and planted in holes with the diameter and depth of one meter during 2005-2007. The experimental set up was arranged in a randomized complete block design with 3 replications. The distance between the seedlings was 3 x 3 meters. The planting beds were covered with a mixture of soil, animal manure, and sand, and the drip method was used for irrigation.

Morphological and yield parameters assayed in the study included flower yield per hectare, number of flowers per hectare, single flower weight, and flower dry matter percentage. Thermo-UFM gas chromatograph and gas chromatograph connected to a mass spectrometer with Saturn II software were used to measure photochemical traits.

The composition of essential oil was analyzed by GC-MS using an Agilent 6890 gas chromatograph mass spectrometer. The operating conditions were as follows: carrier gas, helium with a flow rate of 0.8 ml/min; column temperature, 5 min at 50, 240 °C at 15 °C/ min, and finally 3 min at 300 °C, injector temperature, 290 °C, and detector temperature of 220 °C. The identification of the GC peaks corresponding to the essential oil components was based on a direct comparison of the retention times (RT) and mass spectral data with those for standard compounds. Data were subjected to analysis of variance (ANOVA) using a statistical analysis system, and then Duncan's multiple range tests was used, and the terms were considered significant at $p<0.05$ by SPSS software.

Results

Yield and yield components

According to the analysis of variances, it was found that year, genotype, and their interaction had significant effects on studied traits (Table 1). The highest flower yield was obtained with West Azarbaijan while and $Fars_2$ recorded the lowest flower yield, 1650 and 347 kg/ha, respectively. The maximum and minimum number of flowers per ha were observed in $Esfahan_8$ (537) and $Fars_2$ (136), respectively. Also, there were variations in flower

Table 1
year, genotype, and their interaction on mean yield and yield components of Damask rose flower

Source of variation	Flower Yield	Flower Number	Flower Weight	Flower Dry Matter
block	287649.62 ^{ns}	53142.63*	0.009 ^{ns}	2.54*
Year	11163012.37 **	1777377.5**	0.15**	49.83**
Genotypes	683138.38**	106833.72**	3.55**	670.83**
Year*Genotypes	370246.26**	50162.03**	0.058**	17.42**

ns, *, and ** show nonsignificant and significant at 5% and 1% probability levels, respectively.

Table 2
Mean comparison of yield and yield components of flower in *Rosa damascene* Mill. Genotypes under study

	Flower Yield/Ha	Flower Number/Ha	Flower Weight (g)	Flower Dry Matter %
East Azarbaijan	717.5^{ghijk}	$291.67^{fghijkl}$	$2,46^{hi}$	30.48^{k}
West Azarbaijan	1650.5^{a}	452.22^{abcde}	3.61^{c}	14.76^{u}
Ardabil	683.4^{hijkl}	$285.78^{fghijkl}$	2.41^{ij}	22.13^{pq}
Esfahan9	$1189.4^{bcd/}$	492.44^{abc}	2.36^{jk}	32.02^{j}
Esfahan 10	610.8^{ijkl}	424.33^{abcdef}	1.43^{s}	55.77^{a}
Tehran	731.5^{fghijk}	$330.56^{defghij}$	2.2^{m}	33.09^{i}
Chahar Mahal Bakhtiari	1072.8^{cdefg}	421.22^{abcde}	2.52^{gh}	29.38^{l}
Ghom	$826.6^{defghij}$	$462/22^{abcd}$	1.78^{qr}	41.54^{d}
Khuzestan	755.4^{efghij}	$334.11^{defghij}$	2.25^{lm}	$30/58^{k}$
Zanjan	$878.4^{defghij}$	$357.11^{cdefghi}$	2.42^{ij}	34.2^{h}
Semnan1	939.8^{defghi}	$378.44^{bcdefghi}$	2.45^{hi}	32.01^{j}
Semnan2	597.8^{ijkl}	266.89^{hijklm}	2.3^{kl}	35.5^{g}
Baloochestan	$896.8^{defghij}$	$F293.33^{ghijkl}$	2.63^{f}	23.43^{o}
Fars1	1331.4^{bc}	428.11^{abc}	2.7^{e}	27.1^{n}
Fars2	346.9^{l}	136.78^{m}	2.55^{g}	26.8^{n}
Ghazvin	538.7^{jkl}	181.89^{klm}	d۲/۹۳	17.3^{s}
Kordestan	654.3^{hijkl}	180.22^{klm}	3.62^{c}	20.4^{r}
Kerman	569^{ijkl}	$318.33^{efghijk}$	$1/71^{r}$	45.99^{b}
Kermanshah	738^{efghij}	$410.89^{abcdefg}$	1.96^{op}	40.8^{d}
Kohgiluye and Booyer Ahmad	779.7^{efghij}	187^{klm}	4.18^{b}	$21/56^{q}$
Khorasan2	$830.7^{defghij}$	$332.67^{defghij}$	2.48^{ghi}	22.42^{p}
Gilan	718.4^{ghijk}	$168.78l^{m}$	4.47^{a}	26.44^{t}
Lorestan	383.3^{kl}	198.67^{jklm}	1.95^{p}	43.09^{c}
Markazi1	727.5^{ijkl}	250.67^{ijklm}	2.45^{hi}	32.3^{ij}
Hormozgan	$911.9^{defghij}$	$367.44^{cdefghi}$	2.52^{gh}	28.02^{m}
Hamadan	637^{ijkl}	$269.44^{ghijklm}$	2.36^{jk}	30.34^{k}
Yazd1	1094.7^{cdef}	$479.44^{bcdefghi}$	2.88^{d}	28.07^{m}
Yazd2	$831.5^{defghij}$	$376.67^{cdefghi}$	2.23^{lm}	35.74^{g}
Esfahan1	939.6^{defghi}	517.67^{ab}	1.81^{q}	37.86^{f}
Esfahan2	1020.7^{cdefgh}	$440/44^{abcde}$	2.32^{k}	38.72^{e}
Esfahan3	585.2^{ijkl}	276^{ghijkl}	2.1^{n}	42.81^{c}
Esfahan4	1108.9^{cde}	486^{abc}	2.29^{kl}	32.06^{j}
Esfahan5	1466.6^{ab}	523.11^{a}	2.91^{d}	28.2^{m}
Esfahan6	$836.1^{defghij}$	$376^{cdefghi}$	2.23^{lm}	36.13^{g}
Esfahan7	$D869^{efghij}$	$398.89^{abcdefgh}$	$2.17^{m}n$	32.3^{ij}
Esfahan8	1096^{cdef}	537.89^{a}	2.02^{o}	$35/78^{g}$
Markazi2	759.3^{efghij}	$326.44^{cdefghi}$	$2/1^{n}$	34.16^{h}

In each Column, the means with the common alphabet show no significant differences.

weight between genotypes, so that the highest and lowest means were recorded with Gilan (4.47 g) and $Esfahan_{10}$ (1.2 g) genotypes, respectively. Finally, the maximum and minimum flower's dry matter were obtained in $Esfahan_{10}$ genotype (55%)

and West Azerbaijan genotype (14.8%), respectively.

Furthermore, significant positive correlations were found between plant height and number of flowers on the one hand and yield per plant.

Efficiency and chemical composition of essential oil

The main compounds of rose essential oil were n-nonadecane, n-heneicosane, n-hexadecanol, n-citronellol, and n-tricosane. The highest percentages of citronellol were recorded with Baluchistan (18.5%), Qom (7.1%), Kohgiluye and Booyer Ahmad (6.9%), East Azerbaijan (6.1%) and Semnan$_1$ genotype (5.4%), in that order. Moreover, the highest percentages of geraniol were recorded in Kohgiluye and Booyer Ahmad (4%), East Azerbaijan (3.5%), Isfahan$_{10}$ (3.3%), and Semnan$_1$ (2.9%) in that order. Also, the highest percentages of hexadecanol were found in Isfahan$_8$ (13.1%), Gilan (12.8%), Fars$_1$ (10.9%), and Golestan (10.4%), in that order. Furthermore, the highest percentages of n-nonadecane were recorded in Isfahan$_1$ (44.9%), Markazi$_2$ (44.2%), Lorestan (44.1%), and Khorasan$_1$ (43.1%) in that order. In addition, the highest percentages of essential oil contents were observed in Yazd$_2$ (0.0055%), Chahar Mahal Bakhtiari (0.0054%), and Isfahan$_3$ and Isfahan$_{10}$ genotypes (0.0051%) in that order while and the lowest mean was obtained in Mazandaran and Isfahan$_8$ genotypes (0.0010%).

Discussion

Significant differences were found among the genotypes under study in terms of flower yield, weight, and dry weight. Nazarolmolk et al (2017)evaluated the flower performance and its components in terms of morphological traits, among 10 genotypes of Damask rose. They reported that for yield per plant, Yazd$_2$ and Khuzestan genotypes had the highest and lowest values, respectively. They also found that Esfahan$_4$ was the superior genotype for oil yield per ha. Significant correlations were observed between the characteristics.

Due to the high genetic diversity of damask rose in the World, it is essential to carry out comprehensive phytochemical studies to introduce high-yielding genotypes for further use in breeding programs and commercial exploitations (Ahadi et al., 2023). As Khaleghi and Khadivi (2020)argued the genotypes collected from 327 accessions of wild Damask rose from 21 geographically distinct regions of Iran will be useful for ex-situ conservation and utilization in breeding programs of Damask rose.

The present results showed that there was a significant metabolic diversity among the studied *R. damascena* genotypes in Iran, especially in terms of essential oil, component, and yield. The studied genotypes have been cultivated and evaluated in the same area, so their differences may be mostly attributed to genetic factors.

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