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Evaluation of Genetic Diversity of Some Damask Rose (*Rosa damascena* Mill.) Genotypes of Kurdistan Province Using Morphological Traits

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Abstract

This study was conducted to assess the genetic variety of 12 damask rose genotypes of Kurdistan using morphological traits in Zaleh Research Farm affiliated to Kurdistan Province Agriculture Research Center. The experiment was carried out as a randomized complete block design with three replications and each replication included three stocks in each genotype. Results of analysis of variance showed significant differences among the studied genotypes at the probability level of 1%. Results of mean comparison showed a wide variety for studied traits in different genotypes. Relationship between traits showed that the number of flowers, plant height, average width, average length, average number of leaves, mean flower diameter, and petal to flower weight ratio per stem had positive and significant correlation at 1% probability level. Based on cluster analysis, 12 genotypes of damask rose were divided into four distinct groups according to different traits. Thus, according the results, genotypes Kurdistan 3 and Kurdistan 2 can be introduced as superior genotypes. Kurdistan 3 had high yield in flower per hectare and the number of flowers in per bush, and Kurdistan 2 had the highest flower diameter.

Keywords: Flower diameter, Genotype, Morphologic traits, Number of flower.

INTRODUCTION

Rose is the most ancient ornamental species. There is evidence that roses were cultivated 5,000 years ago in China, Western Asia, and Northern Africa (Gudin, 2001). Damask rose is one of the most aromatic species of the rose genus that are of great food and pharmaceutical applications. Inflorescence is the most valuable part of the plant that is used for different products such as rose water, jam and dried flowers used in human foods. The essential oil of the plant is used in aromatherapy and cosmetic industry and perfumery (Chevallier, 1996; Tabaei-Aghdaei *et al.*, 2005; Kumar *et al.*, 2013). Damask rose is one of several plants that have beautiful flowers in different colors (mostly red and pink) and can be used in landscape and gardens as beautiful and fragrant plant. Flower size and growth rate has a great effect on its beauty (Rahmani *et al.*, 2011). Process and evolution of damask rose is not well understood, although according to one of the pioneers of systematic study of the rose (Lindley, 1979) an extraordinary attention is paid especially to the European roses. The plant grows for wild in some parts of the world including in Syria, Morocco and Australia. Create new cultivars of damask rose have been selected during a long period and also it has been crossed with local species. For instance, in Anatolia which is one of *Rosa damascena* culture centers, about 30 to 40 species of the genus rosa is available, but has not been collected from the wild damask rose (Nilson, 1972). Damask rose that is used in mass culture and commercial operation is a perennial shrub with a lot of thorny branches and multiple large and very fragrant flowers. Plant height is usually 1 to 2 meters (Carins, 2003). Iran represents a center of genetic diversity of the damask roses (Babaei *et al*., 2007; Tabaei-Aghdaei *et al*., 2007; Kiani *et al.*, 2008, Nasri *et al.*, 2015).

This research aims to implement the general plan on the genetic study of various rose genotypes in Kurdistan province so as to assess the genetic diversity and favorable characteristics of different genotypes in different geographical locations. Also, the information needed for the selection and breeding, cultivation and mass production of the plant are provided.

MATERIALS AND METHODS

Damask rose germplasm used in this study consisted of 12 different genotypes (Kurdistan 1 to 12) collected from different regions of Kurdistan Province. Genotypes used were provided by the Institute of Agricultural Research Center of Kurdistan. Damask rose collection was created in March 2010 and was assessed in the spring of 2015. The experimental farm of the research station is located at an altitude of about 1,373 meters above sea level, over the geographical longitude of 47° east and latitude of 35.20° north to the west of Iran. The study is a randomized complete block design with three replications and each replication had three stocks in each genotype in that the genotypes were planted as suckers and then were studied. In each replication of uniform healthy stocks which were free of any pests and diseases were sown (in March) in holes with a diameter and depth of 1 meter with inter-hole spacing of 3 meters on a substrate of a mixture of soil and manure. Then, they were irrigated by drip method. At the start of vegetative growth and flowering, the recorded traits included plant height (cm), number of leaves at the base, average leaf length (cm) and average leaf width (cm), number of flowers at the base, performance of flowers at the base (g), average weight of the flowers (g), flower dry weight (g), average fresh and dry weight of petals (g), average flower diameter (cm) including average diameter of 30 flowers from each plant and weight ratio of petal to flower were evaluated.

To determine the genetic variation among studied genotypes, analysis of variance was performed and the means of the traits were compared using Duncan's multiple range test by SAS software. SPSS software was used to determine the coefficients correlations among traits and to group the genotypes through cluster analysis (by Ward method) using Euclidean squared distance.

RESULTS AND DISCUSSION

According to the analysis results of the studied genotypes of the damask rose, plant height, average of leaf length, average of leaf width, number of flowers at the base, yield flowers at the base, average diameter of the flower, average weight of flowers, flower dry weight, and average

Table 1. Analysis of variance the parameters measured.

S.o.V.	df	Plant height	Leaf number	Leaf length	Leaf width	Number of flowers	Flower yield	Diameter of flower	F.W	D.W.F	P.W	D.W.P
Block	2	2575.2^{ns}	43789368 ^{ns}	0.55^{ns}	0.32 ^{ns}	273648^{ns}	1694622^{ns}	1.67 ^{ns}	0.01 ^{ns}	0.16 ^{ns}	0.18 ^{ns}	0.36*
Genotype	11	17334.1**	181082527**	1.71**	0.75**	643456**	269085**	4.05**	9.13**	1.94**	4.80**	0.72**
Error	22	1111.7	43676730	0.43	0.27	109505	549480	1.11	0.02	0.09	0.05	0.07

**: Significant at = 1%, *: Significant at = 5%, ns= Not significant.

dry weight of petal showed significant differences at the 1% probability level (Table 1).

Comparison of the average evaluated traits using the Duncan's test showed significant differences among genotypes at probability level of 0.05 (Table 2). Kurdistan 3 and Kurdistan 12 had

Table 2. Comparison of the measured traits of *Rosa damascena* Mill. genotypes.

Genotype	Height (cm)	Leaf no. per plant	Leaf length (cm)	Leaf width (cm)	Number of flowers at the base	Flower yield per plant	Flower diameter mean (cm)
Kurdistan 1	111.1 ^{cd}	2697.1 ^{f}	6.34 ^{bcd}	5.27 ^{abc}	307.56 ^{bcde}	745.74 ^{bcd}	5.57 ^{cd}
Kurdistan 2	152.38 ^{a}	7279.1 ^{b}	6.29 ^{bcd}	5.23 ^{abc}	440.67 ^{bcd}	1193.78 ^{abc}	6.93 ^{a}
Kurdistan 3	161.2 ^{a}	11603.7 ^{a}	6.31 ^{bcd}	5.26 ^{abc}	784.39 ^{a}	1518.35 ^{a}	6.05 ^{bcd}
Kurdistan 4	103.21 ^{cde}	2418.6 ^{f}	6.12 ^{cd}	5.11 ^{bc}	312.33 ^{bcde}	1262.88 ^{abc}	6.85 ^{a}
Kurdistan 5	137.78 ^{ab}	6289.6 ^{c}	6.31^{bcd}	5.26 ^{abc}	500.56 ^{bc}	1017.74 ^{abc}	6.32 ^{abc}
Kurdistan 6	73.63 ^{fg}	2013.8 ^{g}	5.88 ^{d}	4.97 ^{c}	189.72 ^{de}	692.17 ^{cd}	6.57 ^{ab}
Kurdistan 7	84.73 ^{ef}	342 ^{h}	5.86 ^{d}	5 ^{c}	123.56 ^{e}	423.99 ^{d}	5.40 ^{d}
Kurdistan 8	99.36 ^{de}	3277.8 ^{e}	6.34 ^{bcd}	5.3 ^{abc}	262.22 ^{cde}	702.05 ^{cd}	5.85 ^{bcd}
Kurdistan 9	127.37 ^{bc}	3166.9 ^{e}	6.89 ^{a}	5.62 ^{a}	426.33 ^{bcd}	1316.43 ^{ab}	5.97 ^{bcd}
Kurdistan 10	104.33 ^{cde}	4561.16 ^{d}	6.66 ^{ab}	5.46 ^{ab}	286.22 ^{bcde}	1071.22 ^{abc}	5.88 ^{bcd}
Kurdistan 11	125.89 ^{bc}	339.4 ^{e}	6.41 ^{bc}	5.32 ^{abc}	545.44 ^{b}	1334.91 ^{a}	5.89 ^{bcd}
Kurdistan 12	57.80 ^{g}	340.4 ^{h}	5.9 ^{cd}	4.91 ^{c}	152.28 ^{e}	302.89 ^{d}	5.95 ^{bcd}

* In each column, means with the similar letter(s) are not significantly different at 5% level of probability using LSD test.

Continue of Table 2. Comparison of the measured traits of *Rosa damascena* Mill. genotypes.

Genotype	Flower fresh weigh (g)	Flower dry weight (g)	Petals weight (g)	Petals dry weight (g)	Petals weight/ flower weight
Kurdistan 1	2.49 ^{fg}	1.99 ^{cde}	1.91 ^{de}	1.73 ^{d}	0.77 ^{ab}
Kurdistan 2	2.7 ^{e}	2.08 ^{bcd}	2.08 ^{d}	1.72 ^{d}	0.78 ^{ab}
Kurdistan 3	1.97 ^{h}	1.69 ^{f}	1.58 ^{f}	1.64 ^{d}	0.8 ^{a}
Kurdistan 4	4.04 ^{a}	2.72 ^{a}	3.05 ^{a}	2.12 ^{b}	0.75 ^{abc}
Kurdistan 5	2.08 ^{h}	1.78 ^{ef}	1.64 ^{f}	1.85 ^{cd}	0.8 ^{a}
Kurdistan 6	3.62 ^{b}	2.29 ^{b}	2.73 ^{b}	1.98 ^{bc}	0.76 ^{abc}
Kurdistan 7	3.36 ^{c}	2.08 ^{bcd}	1.88 ^{e}	1.83 ^{cd}	0.56 ^{d}
Kurdistan 8	2.59 ^{ef}	2 ^{cde}	1.87 ^{e}	1.68 ^{d}	0.73 ^{bc}
Kurdistan 9	3.14 ^{d}	2.21 ^{bc}	2.34 ^{c}	1.79 ^{cd}	0.75 ^{abc}
Kurdistan 10	3.71 ^{b}	2.56 ^{a}	2.77 ^{b}	2.83 ^{a}	0.75 ^{abc}
Kurdistan 11	2.44 ^{g}	1.94 ^{de}	2.03 ^{de}	2.13 ^{b}	0.8 ^{a}
Kurdistan 12	1.99 ^{h}	1.61 ^{f}	1.39 ^{g}	1.43 ^{e}	0.7 ^{c}

* In each column, means with the similar letter(s) are not significantly different at 5% level of probability using LSD test.

the highest and lowest plant height, number of leaves at the base, and flower yield, respectively. In the studied trait of petal weight ratio to flower, Kurdistan 3 had the highest and Kurdistan 2 had the lowest rate. The number of flowers at the base of Kurdistan 3 had the greatest number and Kurdistan 3 had the lowest number. In terms of the average length of leaf, the highest and lowest rate was observed in Kurdistan 9 and Kurdistan 7, respectively. In terms of leaf width, the highest and lowest rate was observed in Kurdistan 9 and Kurdistan 2, respectively. In two traits of mean flower dry weight and average weight of petals, Kurdistan 4 had the highest and Kurdistan 12 had the lowest rates. In terms of dry weight of petals, Kurdistan 10 had the highest and Kurdistan 12 had the lowest and in the trait of the diameter of flower, Kurdistan 2 had the highest and Kurdistan 7 had the lowest amount. In a study to assess the relationship between performance and components of damask rose genotypes in different parts of Iran, it has been reported that genotypes have shown significant differences in traits such as flower yield per plant, number of flowers per plant, plant height, leaves length, leaf width, and leaf and flower area (Haghi Kashani *et al.*, 2012). The results of means comparison of present study are consistent with the results of this study.

Results of the correlation coefficients between the measured traits (Table 3) show high correlation between traits in most cases. Plant height has a positive and significant correlation with the average number of leaves at the base, average leaf length, average leaf width, number of flowers at the base, performance of flowers at the base, average flower weight, and the weight ratio of petal to flower at the probability level of 1 %. Also, mean diameter of the flower has a positive and significant correlation with the petals weight at the probability level of 5 %. So, in order to improve genotypes' to enhance performance and increase the number of flowers at the base of the flowers, taller genotypes can be used. The average number of leaves at the base has a positive, significant correlation with the plant height, number of flowers at the base, performance flower at the base, average weight of the flowers, and the weight ratio of petal to flower at the probability level of 1 %, as well as with the average leaf length, the average leaf width, average flower diameters and the average petal weight at the probability level of 5 %. The average leaf length was significantly and positively correlated with plant height, the average leaf width, number of flowers at

Table 3. Correlation between the traits.

Traits	Plant height	Leaf number	Leaf length	Leaf width	Number of flowers at the base	Flower yield	Mean diameter of the flower	F.W	D.W.F	P.W	D.W.P	etal weight / flower weight
Plant height	1											
Leaf number	0.499**	1										
Leaf length	0.305**	0.142*	1									
Leaf width	0.292**	0.136*	0.957**	1								
Number of flowers at the base	0.725**	0.473**	0.217**	0.205**	1							
Flower yield	0.664**	0.378**	0.287**	0.262**	0.879**	1						
Mean diameter of the flower	0.124*	0.127*	0.014 ns	0.046 ns	0.155*	0.266**	1					
F.W.	0.256**	0.215**	0.033 ns	0.024 ns	0.365**	0.043 ns	0.160*	1				
D.W.F.	0.086 ns	0.065 ns	0.092 ns	0.056 ns	0.210**	0.165*	0.234**	0.825**	1			
P.W.	0.130*	0.106*	0.083 ns	0.083 ns	0.183*	0.186*	0.275**	0.850**	0.853**	1		
D.W.P.	0.074 ns	0.020 ns	0.050 ns	0.050 ns	0.037 ns	0.165*	0.151*	0.484**	0.546**	0.561**	1	
Petal weight to flower weight	0.297**	0.236**	0.099 ns	0.112*	0.400**	0.269**	0.154*	0.364**	0.022 ns	0.165*	0.102*	1

**: Significant at = 1%, *: Significant at = 5%, ns= Not significant.

the base and flower performance at the base at the probability level of 1 %. The average leaf width has a positive, significant correlation with the plant height, the average leaf length, number of flowers at the base, flower performance at the base, and the weight ratio of petal to flower at the probability level of 1 %. The number of flowers at the base has a positive and significant correlation with the plant height, leaf number at the base, the average leaf length, the average leaf width, performance flower at the base, the average weight of flower, flower dry weight, and the weight ratio of petal to flower at the probability level of 1 % and also with the average diameter of the flower and petal weight at the probability level of 5 %. Performance of flower at the base was positively and significantly correlated with the number of flowers at the base, plant height, average leaf width, average leaf length, average number of leaves at the base, average diameter of the flower, and the weight ratio of the petal to flower at the probability level of 1 % and with dry weight of flower, average flower weight, and the average weight of dried flower and petal at the level of 5 %. The average diameter of the flower showed a positive, significant correlation with the flower yield at the base, the number of flowers at the base, the average number of leaves at the base, average flower dry weight, and the average weight of the flowers at the level of 1% and with the plant height, average weight petals, average dry weight ratio of petal at the level of 5 %. The average weight of flowers exhibited a positive, significant correlation with the flower yield at the base, plant height, leaf number at the base, the average diameter of the flower, flower number at the base, average dry weight of flowers, petals weight, and dry weight ratio of petals at the 1% level.

Flower dry weight had a positive, significant correlation with the average weight of flowers, average flower diameter, number of flowers at the base, average weight of petal, and average dry weight of petal at the level of 1%. Average weight of petal indicated a significant, positive correlation with the flower dry weight, average weight of flower, plant height, and average dry weight of petal at 1% and with the weight ratio of petal to flower, the average diameter of the of flowers, number of flower at the base, and the average number of the leaf at the base at the level of 5 %. The average weight of petals was significantly and positively correlated with the average weight of petals, flower dry weight, the average weight of flowers, and the number of flowers at the base at the level of 1% and with the average diameter of flowers and petal weight ratio at the level of 5 %. Weight ratio of petal to flower had significant, positive correlation with average weight of flower, flower yield at the base, leaf number at the base and plant height at the 1% level and with average petal dry weight and average flower diameter at the level of 5 %. Results of correlation study between the components of flowers of genotypes of *Rosa damascena* Mill. in Isfahan province showed that the number of flowers per plant, flower weight, and plant yield per branch had the strongest direct effect on the performance of the flowers (Zeinali *et al*., 2007). So, they suggested that the number of flowers per plant, and the weight and number of flowers per branch can be criteria and good choices to improve the performance of flower in the rose genotypes (Zeinali *et al*., 2007; Dewyer *et al.*, 1994) which correspond to the results of the present experiment.

Cluster analysis

The aim of many research activities is to find out the similarities and differences of the material contained in a collection. For this purpose, the best method is the use of cluster analysis. The objective of the cluster analysis is to find the real peoples and then reduce the number of data. In other words, it is aimed at identifying a smaller number of groups so that groups with more similarities are placed together in one group (Farshadfar, 1998). According to the cluster analysis, 12 genotypes of damask rose were divided into four groups in terms of 12 traits. The study for grouping of the genotypes and cluster analysis was carried out by Ward's method (Fig. 1). The first group included Kurdistan 1, Kurdistan 2, Kurdistan 11, Kurdistan 5 and Kurdistan 3. The second group included Kurdistan 4, Kurdistan 10 and Kurdistan 9. The third group consisted of Kurdistan 6. The fourth group included Kurdistan 7, Kurdistan 8, and Kurdistan 12. Based on cluster analysis, it can be stated that the highest heterosis in the genotype is the result of crosses of Kurdistan 1,

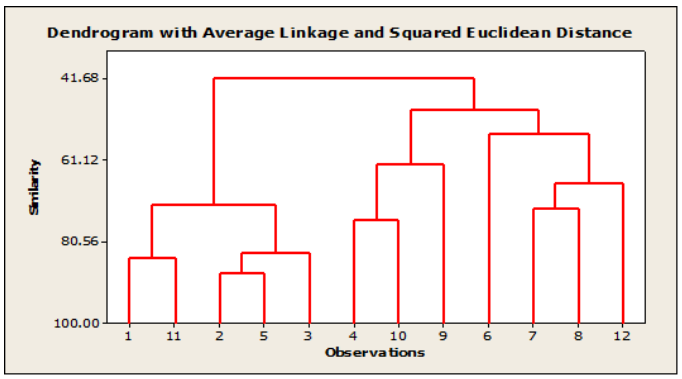

Fig. 1. Cluster analysis based on the traits of *Rosa damascena* Mill. genotypes

Kurdistan 2, Kurdistan 3, Kurdish 5 and Kurdistan 11 with Kurdistan 7, Kurdistan 8 and Kurdistan 12. So, the population of damask rose genotypes studied in this experiment has a very rich genetic diversity in terms of all studied traits and also they are a good treasure for taking corrective measures on damask rose. To evaluate the morphological traits of damask rose, a research was conducted using multivariate statistical method. Based on the results of this study, cluster analysis divided the genotypes into three groups. The highest genetic distance was reported between the genotypes of Azerbaijan and Ilam. Based on this grouping, the first cluster had the highest diversity with the third group in terms of traits (Tabaei-Aghdaei *et al*., 2004), which corresponded with the results of the present experiment.

CONCLUSION

The results of data analysis showed that the most significant differences between the studied genotypes of damask rose were observed at the probability level of 1 %. Means comparison represents a wide diversity of traits among different genotypes. As well, most traits of the studied genotypes showed significant differences. In this study, 12 genotypes were divided into four groups based on different attributes, which can be used in breeding programs. So, according to the present results, Kurdistan 2 and Kurdistan 3 can be introduced as the superior genotypes. Kurdistan 3 has a high performance of the flower in hectares and has a high number of flowers per plant. The flowers of Kurdistan 2 have the highest diameter. So, with regard to targets for production, it seems logical to cross in order to create a new population.

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