ROSA DAMASCENA (ROSACEAE) CHARACTERS AND THEIR HERITABILITY ANALYSIS IN IRAN

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In order to determine phenotypic diversity, 40 *Rosa damascena* accessions were evaluated in a completely randomized block design with 3 replications at the experimental field of Research Institute of Forests and Rangelands, Tehran, Iran. Several traits including flower weight, flower diameter, peduncle length, number of petals, number of stamens, leaf area, leaf dry weight and thorns intensity were recorded and analyzed for two years (2005-2006). Correlation coefficients showed that flower yield correlated positively with number of petals and negatively with peduncle length, leaf area, leaf dry weight and thorn intensity. Because of high heritability obtained for flower weight, number of petals, number of stamens and thorn intensity, selection based on these characters is recommended. Cluster and principal components analyses showed no relationship between genetic divergence and geographical origins, indicating germplasm exchange between different areas of Iran.

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Key words. *Rosa damascena,* phenotype, diversity, heritability, Iran.

برخی خصوصیات گل محمدی و وراثت پذیری آنها در ایران

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به منظور ارزیابی تنوع فنوتیپی تعداد ٤٠ اکسشن گل محمدی (*Rosa damascena*) در یک طرح آزمایشی بلوکهای کامل تصادفی با سه تکرار در مزرعهٔ تحقیقاتی مؤسسهٔ تحقیقات جنگلها و مراتع کشورمورد ارزیابی قرار گرفت. صفات مختلفی شامل وزن گل، قطر گل، طول نهنج، تعداد گلبرگ، تعداد پرچم، سطح برگ، وزن خشک برگ و تراکم خار در سالهای زراعی١٣٨٤و١٣٨٥ مورد بررسی قرار گرفتند. براساس نتایج بدست آمده همبستگی عملکردگل با تعداد گلبرگ مثبت و با صفات طول نهنج، سطح برگ، وزن خشک برگ، و تراکم خار منفی بود. وراثت پذیری بالای وزن گل،تعداد گلبرگ و پرچم و تراکم خار نیز گزینش بر اساس این صفات را امکان‌پذیر می‌نماید. همچنین نتایج حاصل از تجزیه خوشه‌ای و تجزیه به مولفه‌های اصلی ارتباطی را میان تنوع ژنتیکی و مبدأ جغرافیایی نشان ندادند، که نشان‌دهنده تبادل ژرم‌پلاسم گل محمدی بین مناطق مختلف کشور می‌باشد.

Introduction

Roses have gained the title of the world's favorite flower in part due to their vast diversity in plant habit and floral characteristics (Cairns 2001). They have been bred and selected to serve a number of niches including flowering landscape shrubs, formal garden specimens, cut flowers, blooming potted plants, and sources of perfume and vitamin C (Zlesak 2006).

Despite the large number of cultivated rose varieties, only a few of them exhibit the marked fragrance that is sought by perfumeries in the world (Antonelli et al. 1997). There are mainly four species of roses for oil production. These are *Rosa damascena* Mill., *R. gallica* L., *R. moschata* Herrm. and *R. centifolia* L. (Tucker & Maciarello 1988). The main rose oil producers in the world are Turkey and Bulgaria and they obtain the rose oil from *R. damascena* (Baydar et al. 2004).

R. damascena can now be found growing wild in Morocco, Andalusia, Syria, and Caucasus. As Damask roses were originally introduced from the Middle East into Western Europe, it is thought that the origin and center of diversity of Damask roses can be found in this region. In Iran, cultivation and consumption of Damask roses has a long history. Crude distillation of roses was probably developed in Persia in the late 7th century A.D. (Saakov & Rieksta 1973; Chevallier 1996; Beales et al. 1998; Rusanov et al. 2005).

The aim of this paper is to study some characters and their heritability analysis of *R. damascena* in Iran.

Materials and Methods

Plant material

A total of 40 Damask rose accessions were collected from 28 provinces of Iran, in order to obtain a good geographical coverage of the country and a good coverage of the 13 different climatic regions that have been identified (Tabaei-Aghdaei et al. 2007). Samples were taken from commercial production fields. All accessions were grown from 1998 onwards in experimental field of the Research Institute of Forests and Rangelands (RIFR), Tehran, Iran.

Characters

Eight botanical characters were measured at flowering and harvesting times on three representative plants per plot. The investigated characters were flower weight (g), flower diameter (cm), peduncle length (cm), number of petals, number of stamens, leaf area (mm^2), leaf dry weight (g), thorn intensity (number of thorns per 10 cm of stem). These characters were evaluated on the base of means of nine randomly selected samples per plot.

Statistical analyses

For each character combined analysis using a randomized complete block design with three replications was performed and then the broad sense heritability of traits was calculated in order to identify the best descriptors for selection and breeding purposes. Degree of association among the characteristics was analyzed according to Pearson's coefficient. Following correlation analysis, stepwise regression was used to estimate the relationship between flower weight and other evaluated characters.

The recorded data were analyzed for numerical taxonomic techniques using the procedure of principal components and cluster analyses (Hair et al. 1992) using the 'SPSS' software. As the characters were recorded on different scales, the data were standardized to a mean of zero and a variance of unity prior to principal components and cluster analyses to eliminate scale differences (Sneath & Sokal 1973). The principal components analysis is a multivariate statistical technique for exploration and simplifying complex data sets and has been demonstrated by Everitt & Dunn (1992). Cluster analysis was performed using the unweighted pair-group method arithmetic average (UPGMA).

Results and discussion

The results of variance analysis indicated that there were significant differences between the genotypes for the recorded characters (Table 1). Broad sense heritability (H^2) showed values ranging from 0.35 to 0.89. Among evaluated characters the most heritable traits were flower weight (0.89), number of petals (0.88), number of stamens (0.82) and thorn intensity (0.86) (Table 1). These characters may be applied as useful traits in evaluating rose germplasm collections and for selection and ranking of the clones.

Simple correlation coefficient indicates the degree of association between two variables, which are considered to be independent (Sokal & Rohlf 1995). Correlation coefficients (Table 2) showed that flower yield correlated positively with number of petals and negatively with peduncle length, leaf area, leaf dry weight and thorn intensity. Positive correlations were also obtained between flower diameter and peduncle length (0.43) and also between leaf dry weight and peduncle length (0.32), leaf area (0.88) and thorn intensity (0.41). While, number of petals correlated negatively with flower diameter (-0.36), peduncle length (-0.57) and thorn intensity (-0.38). In a previous study Tabaei-Aghdaei et al. (2007) showed that number of petals positively correlated with flower weight, while its correlation with peduncle length was negative. Stepwise regression showed that number of petals,

Table 1. Analysis of variance and heritability of different characters on 40 *Rosa damascena* accessions (Y=Year; R=Replication; G=Genotype).

Source of variation	df	Flower Weight	Flower Diameter	Peduncle Length	Petal	Stamen	Leaf Area	Leaf Dry Weight	Thorn Intensity
Y	1	16.35**	877**	187	2226**	583	7.77	0.0024	104.3
R (Y)	4	0.102	20.82	66.4	25.5	261.9	32.20	0.0023	551.4
G	39	1.49**	55.27**	109.1**	1584**	4054**	478**	0.0243**	13729**
G*Y	39	0.146**	33.13**	32.19**	586**	2038**	5.38	0.0009	68.94
Error	156	0.027	6.72	7.91	21.91	71.24	28.84	0.0033	364
Heritability (%)		0.89	0.35	0.62	0.88	0.82	0.73	0.54	0.86

Table 2. Correlations between different characters of 40 *Rosa damascena* accessions (FW=Flower Weight; FD=Flower Diameter; PL=Peduncle Length; LA=Leaf Area; LD=Leaf Dry Weight; TI=Thorn Intensity).

Correlations

		FW	FD	PL	PETAL	STAMEN	LA	LD	TI
FW	Pearson Correlation	1.000	-.164	-.313*	.669**	-.138	-.481**	-.452**	-.625**
	Sig. (2-tailed)	.	.312	.050	.000	.397	.002	.003	.000
	N	40	40	40	40	40	40	40	40
FD	Pearson Correlation	-.164	1.000	.430**	-.360*	.295	-.102	.056	.115
	Sig. (2-tailed)	.312	.	.006	.022	.065	.531	.730	.482
	N	40	40	40	40	40	40	40	40
PL	Pearson Correlation	-.313*	.430**	1.000	-.570**	-.238	.187	.321*	.185
	Sig. (2-tailed)	.050	.006	.	.000	.139	.248	.043	.252
	N	40	40	40	40	40	40	40	40
PETAL	Pearson Correlation	.669**	-.360*	-.570**	1.000	.006	-.256	-.270	-.381*
	Sig. (2-tailed)	.000	.022	.000	.	.973	.111	.092	.015
	N	40	40	40	40	40	40	40	40
STAMEN	Pearson Correlation	-.138	.295	-.238	.006	1.000	-.129	-.174	.033
	Sig. (2-tailed)	.397	.065	.139	.973	.	.426	.283	.839
	N	40	40	40	40	40	40	40	40
LA	Pearson Correlation	-.481**	-.102	.187	-.256	-.129	1.000	.885**	.290
	Sig. (2-tailed)	.002	.531	.248	.111	.426	.	.000	.070
	N	40	40	40	40	40	40	40	40
LD	Pearson Correlation	-.452**	.056	.321*	-.270	-.174	.885**	1.000	.415**
	Sig. (2-tailed)	.003	.730	.043	.092	.283	.000	.	.008
	N	40	40	40	40	40	40	40	40
TI	Pearson Correlation	-.625**	.115	.185	-.381*	.033	.290	.415**	1.000
	Sig. (2-tailed)	.000	.482	.252	.015	.839	.070	.008	.
	N	40	40	40	40	40	40	40	40

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

thorn intensity and leaf area explain 44%, 16% and 6% of flower weight variation in 40 Damask rose accessions, respectively (Table 3).

Dendrogram created by UPGMA, using 40 accessions, showed 4 main groups (Fig. 1). Twenty eight of the 40 accessions were included in cluster I, 9 accessions in group II, while 1 and 2 accessions were presented in cluster groups III and IV, respectively. The result of cluster analysis showed that there was no relationship between genetic divergence and geographical origins, as accessions from the same origin entered different clusters and also genotypes from different origins entered the same cluster. It seems that these germplasms have been exchanged among different areas of Iran, so it is likely that *Rosa damascena* were conserved under combined effect of natural and human selective pressure.

Principal components analysis was carried out to determine the characters more strongly contributed to the principal components. Principal components analysis reduced the original 8 characters in experiment to 3 principal components. The first three principal components with eigenvalues >1 explained 75% of variation among 40 accessions (Table 4). Other PCs had eigenvalues <1 and have not been interpreted. The first PC, which is the most important component, explained 40% of total variation and was positively related to leaf area, leaf dry weight and thorn intensity and negatively related to flower weight, so PC1 is a weighted average of these four characters. PC2 accounted of 20% of the total variation and the

Table 3. Estimated equation for flower weight (dependent variable) based on stepwise regression (abbreviations as in table 2).

Step	Variable	R^2	Equation
1	Petal	0.44	FW= 1.05 + 0.02 Petal
2	TI	0.60	FW=1.8 + 0.01 Petal – 0.004 TI
3	LA	0.66	FW= 2.65 + 0.01 Petal – 0.03 TI – 0.01LA

Table 4. Principal components analysis for 8 characters in 40 *Rosa damascena* accessions.

	PC1	PC2	PC3
Eigen value	3.21	1.62	1.20
Proportion of σ^2	40	20	15
Cumulative σ^2	40	60	75
	Eigenvector		
FW	-.746	-.393	-.273
FD	-.108	.763	.284
PL	.164	.816	-.394
Petal	-.404	-.749	-0.037
Stamen	-0.03	0.017	.901
LA	.872	-0.078	-.243
LD	.855	0.064	-.276
TI	.662	.224	.262

characters with the greatest weight on this component were flower diameter, peduncle length and number of petals. While, PC3 was positively related to number of stamens.

The first two principal component scores were plotted to aid visualization of accessions grouping (Fig. 2). The derived cluster and subgroups are very similar to those identified from UPGMA analysis.

Identification and description of the genetic variability available in the germplasm of *Rosa damascena* are preliminary requirements for the exploitation of useful traits in plant breeding.

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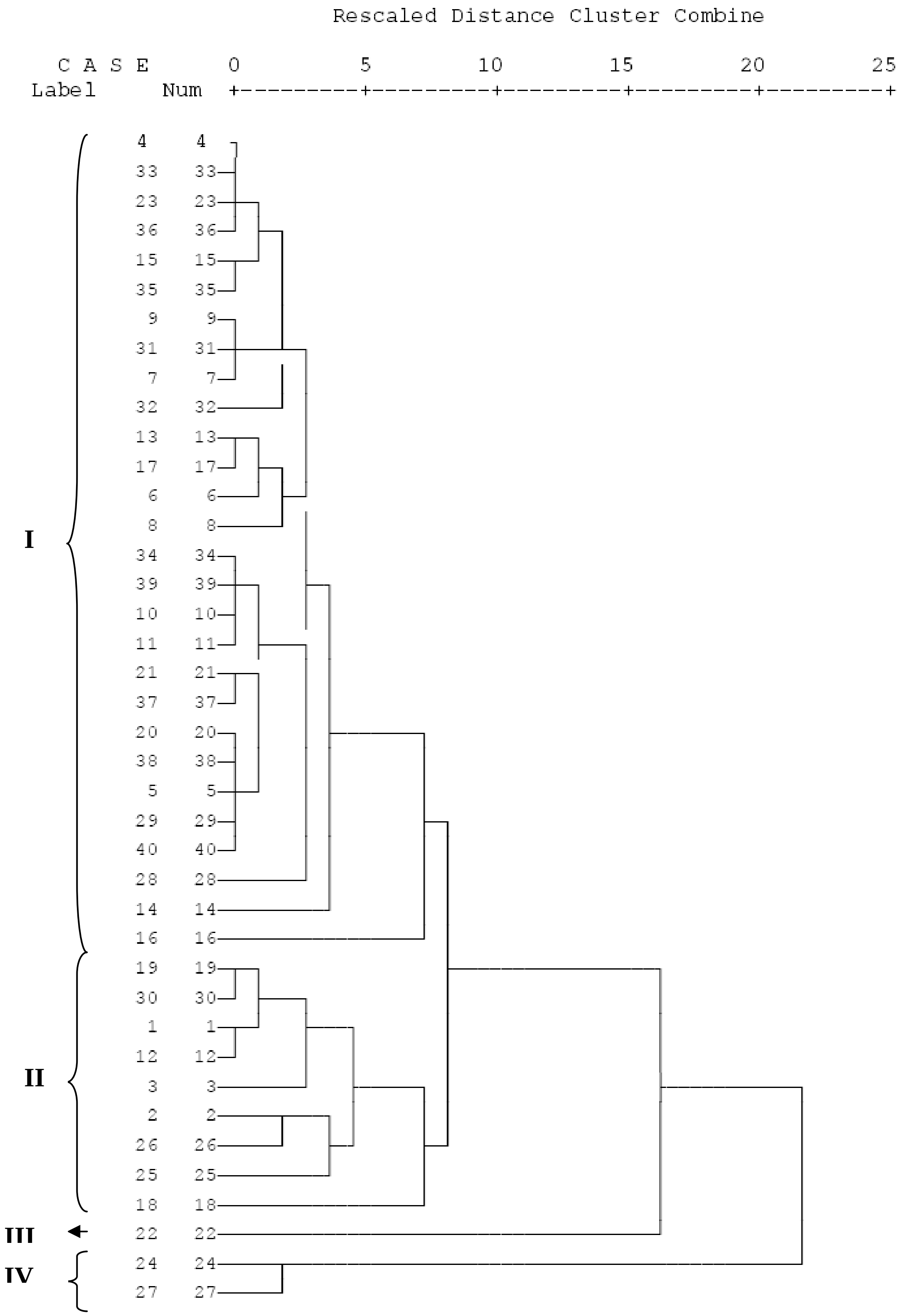

Fig. 1. Cluster analysis of 40 *Rosa damascena* accessions based on different characters using average linkage (between groups).

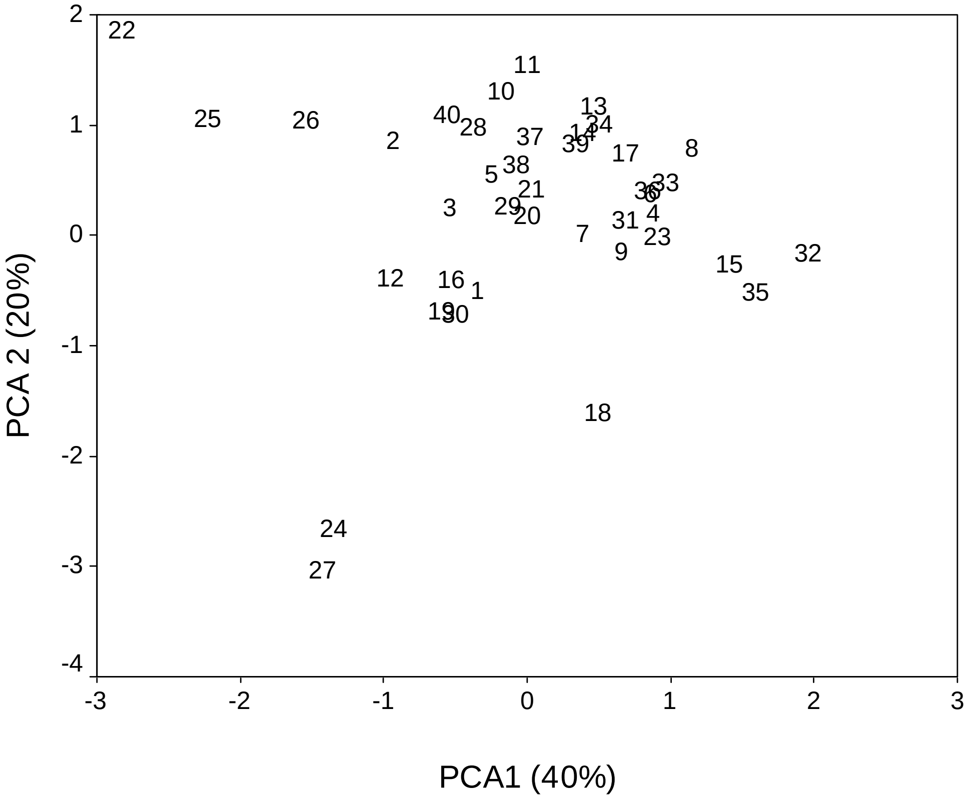

Fig. 2. Plot of principal components based on different characters of 40 *Rosa damascena* accessions**.**