Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2763

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (2):** 923-930 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Genetic Diversity of Rose Germplasm as Determined by Morphological Traits

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Received: 28.03.2017 | Revised: 10.0.2017 | Accepted: 11.04.2017

ABSTRACT

The extent of genetic diversity for yield and its attributing traits in 25 genotypes each of Hybrid Tea and Floribunda groups were studied. On the basis of Mahalanobis[6] D^2 statistics grouping of these genotypes was done grouped. Ten clusters in Hybrid Tea and nine clusters in Floribunda resulted. In Hybrid Tea, the inter cluster distance varied from 349.30 (between cluster IX and VII) to 8159.59 (between cluster X and V). In Floribunda roses, the inter cluster distance ranged from 387.40 (between clusters IV and II) to 2647.54 (between clusters VIII and III). The clusters were highly divergent suggesting the presence of wide genetic diversity in the material. Genotypes from divergent clusters can be selected for hybridization programme to get desirable recombinants. The characters number of leaves at first flower and number of days to first flower contributed maximum towards genetic divergence followed by number of petals per flower and flower size.

Key words: *Hybrid Tea, Floribunda, Roses, diversity, variability, clusters and genotypes.*

INTRODUCTION

Roses have gained the title of the 'Queen of flowers' and it is the most popular ornamental plant that has been cultivated systematically. Roses are mainly used for showy purposes and for essential oil. They are a rich source of Vitamin C are and hence used in the making of medicinal stuff. A very ancient breeding history has led to breeding of rose varieties with attractive flower colour, form, fragrance, proliferousness, disease & pest resistance, and suitability for growing under tropical & subtropical conditions[11]' Today, there are over 30,000 varieties of roses and it has the most complicated family tree of any known flower species.

The genetic diversity available within *Rosa* species is huge. The potential for its utilization in rose improvement depends on the systematic characterization of the genetic resources and on the study of possible hybridization mechanisms. Morphological markers are the phenotypic traits of any organism and are the earliest markers used to describe the observable characters of an organism.

Cite this article: Brunda, S.M., Rani, C.L. and Revi, S., Genetic Diversity of Rose Germplasm as Determined by Morphological Traits, *Int. J. Pure App. Biosci.* **5(2):** 923-930 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2763

Each species of the genus *Rosa* has a wide and overlapping range of morphological variations that are influenced by environmental conditions. India has a very diverse climate, which ranges from subtropical to temperate and allows the cultivation of almost all kinds of plants. Therefore, we cannot negate the possibility of a large diversity in roses grown in India. Hence the present study was carried out for the systematic characterization of the rose germplasm with the help of morphological characters.

MATERIALS AND METHODS

In the present study 25 cultivars each coming under the Hybrid Tea (a) and Floribunda (b) groups were evaluated separately with respect to morphological characters. (Table 1). Rose germplasm was characterized for nine different morphological characters viz. number of leaves at first flower, number of days to first flower, prickle density, flower size, flower weight, pedicel length, number of petals per flower, size of petals and number of flowers per plant/bunch. The germplasm maintained in the Rose garden Regional Agricultural Research Station Ambalavayal, Kerala Agricultural University, was used for the study. The data were recorded from ten representative plants from each replication of the experiment. The data were analyzed using cluster analysis with the help of Mahalanobis[6] D^2 statistic tool to determine genetic diversity and relationship of rose varieties.

RESULTS AND DISCUSSION

The genetic divergence estimated in both Hybrid Tea and Floribunda group of roses has been discussed below.

Genetic divergence studies

Divergence analysis is performed to identify the most diverse cultivars. Mahalanobis[6] generalized distance estimated by D^2 statistic has been used as an efficient tool in the quantitative estimation of genetic diversity for a rational choice of potential parents for breeding programme. It was observed that the 25 genotypes of both Hybrid Tea and Floribunda are from different regions representing diverse agro climatic conditions and hence distributed at random among the clusters formed based on their genetic distance.

Genetic diversity in different groups

Based on D^2 values, 25 genotypes of both Hybrid Tea and Floribunda were grouped as presented below (Table 3 and 4).In Hybrid Tea, among the ten clusters formed, Cluster I and II were the biggest clusters consisting of five cultivars each followed by cluster III and IV comprising of 3 cultivars each. Cultivars Madame George Delbard, Chirst of Colomb, Pink Panther, Priority Pride and Prince Jardiner, were grouped in Cluster I. Cluster II included Roughe Miland, Shrewsbury Show, A Tago, Demestra and Lois Wilson and cluster III contained Aishwarya, Lincoln Cathedral and Mary Jean. Cluster IV comprised of Silver Star, Toplesse and Cel b Lau. Cluster V contained Alaine Souchen and Fryat. Cluster VI included Perfume Perfect and Majestic . Cluster VII contained Mom's Rose and Alabama. Cluster VIII, IX and X had solitary entries cultivars *viz.* Amara, Golden Fairy Sport, and Josepha respectively.

In Floribunda, Cluster I was the biggest cluster consisting of ten cultivars viz., Tickled Pink, Rose Mary Gandhi, Princess de Monaco, Ochi di Fita, The McCartney Rose, Cheshire, Messara, Home e Garden, Plantein on Blumen and Prosperity. Cluster II included Rosarale de Chateau, Carry Free Beauty, City of Glasgow and Michel Fish. Cluster III was made up of Versailles, Lisa and Schloss Eutin. Cluster IV consisted of Sterntaler, Orange N Lemon and Plantein on Blumen. Cluster V, VI, VII, VIII and IX contained solitary cultivars *viz.* Monnalisa, Carolanne, Mini Pink, Lasting Piece and Golden Fairy respectively. These results were in good agreement with the findings of Desh raj and Mishra[2] in gladiolus, Nimbalkar *et al*[9]., in Dahlia and Manjunath *et al*[7]., in Anthurium. Wide range of diversity was observed among the Rose cultivars. Cultivars falling in the highly divergent groups will help in broadening the existing genetic base and may produce new cultivars.

The intra and inter cluster D^2 and D values among the ten clusters of Hybrid Tea are given in the Table 5 and 6. The intra cluster D^2 values indicated that cluster II (D^2 = 324.20) had the maximum genetic diversity within the genotypes of that group followed by cluster I (D^2 = 278.58) and cluster VI (D^2 = 271.20) .The inter cluster D^2 values of the ten clusters revealed that the highest inter cluster generalized distance (D^2 = 8159.59) was between cluster X and cluster V while, the lowest (D^2 = 349.30was between clusters IX and VII.

The intra and inter cluster D^2 and D values among the ten clusters of Floribunda are given in the Table. The intra cluster D^2 values indicated that, cluster II (D^2 = 364.94) had the maximum genetic diversity within the genotypes of that group followed by cluster I (D^2 = 338.29) and cluster VI (D^2 = 203.25) .The inter cluster D^2 values of the ten clusters revealed the highest inter cluster generalized distance (D^2 = 2647.54) was between cluster VIII and cluster III while the lowest (D^2 = 387.40) was between clusters IV and II.

Thus it can be concluded that considerable diversity existed among the genotypes. This could be the result of selection in different directions by nature and human forces. Crossing of genotypes within the cluster is not expected to yield desirable recombinants. However, theoretically a general notion exists that the larger the divergence between genotypes, the higher will be the heterosis. Therefore, it would be desirable to attempt crosses between genotypes belonging to distant clusters to obtain genetically divergent genotypes as reported by Lauric and Ries[5] In this context, inter cluster distances were worked out considering nine characters and the inter cluster distances varied significantly in both the groups of roses. These results suggest the presence of wide diversity between the genotypes. Hence, genotypes from these clusters may be selected for hybridization programme to obtain desirable recombinants.

As considerable diversity was observed between the cultivars within the clusters, the cultivars from individual clusters can be utilized in breeding of rose varieties/ hybrids for desirable traits. Thus, genetic divergence can also be used as an indirect parameter in selecting parents to produce heterotic high yielding progenies. Cluster analysis studies were done in gladiolus by Sheikh and Mushtaq[12] with the same objective.

Contribution of character towards genetic divergence

Contribution of each character towards genetic divergence has been estimated from the number of times that each character scored the first rank. It is presented in Table 2. In Hybrid Tea, it has been observed that number of days to first flower, number of leaves at first flower, number of petals per flower, size of petals and flower size in that order are contributing towards divergence. In Floribunda, It has been observed that number of leaves at first flower, number of days to first flower, number of petals per flower, size of petals and flower size contributed maximum towards the genetic divergence indicating the major role of these characters in building up diversity and differentiating of inter cluster levels.

The results of the study imply that in order to select genetically diverse genotypes for hybridization, emphasis must be placed on important traits such as number of days to first flower, flower size and number of flowers per plant.

Analysis of cluster means

The cluster means reveal the best cluster for various characters. Depending upon the aim of breeding, potential lines can be selected from different clusters as parents in a hybridization programme. In Hybrid Tea roses, if a breeding programme is aimed at more number of flowers per plant, cluster IX showing highest mean number of flowers per plant can be selected. If a breeding programme is aimed at improving flower weight, cluster V showing highest mean flower weight along with highest values for number of petals per flower can be selected. Cluster VIII comprised of cultivars exhibiting highest values for number of days to first flower, flower size, flower weight and pedicel length, while characters such as leaves

at first flower, prickle density, size of petals and number of flowers per plant had moderate expression. Cluster VIII can be selected for improving most of the desirable traits considered in the present study. It has been presented in the (Table 7 and 8).

In Floribunda roses, if a breeding programme is aimed at more number of flowers per plant, cluster IV showing highest mean number of flowers per plant can be selected. If a breeding programme is aimed at highest flower weight, cluster V showing highest mean for flower weight along with highest values for number of petals per flower can be selected. Cluster VIII consisted of cultivars exhibiting highest values for prickle density, pedicel length and size of petals, whereas characters such as flower size and number of petals per plant had moderate expression.

Hence, it is worthy to note that in calculating cluster means, the superiority of particular genotypes in respect to a given character is diluted by other genotypes that are related and grouped in the same cluster but which are inferior or intermediary for the character in question. Hence, apart from selecting genotypes from the clusters which have high inter cluster distance and high mean values for hybridization, one can also think of selecting genotypes based on the extent of genetic divergence with respect to a particular character of interest. This means that in order to improve the character of interest, highly divergent genotypes for traits may be selected.

Table 1: List of Rose genotypes used for characterisation

Sl. No	Code	Name of the genotype	Sl. No	Code	Name of the genotype
1	M 185	Madame george Delbard	1	1783	Versailles
2	A 9	Aishwarya	2	1696	Tickled Pink
3	H 107	Chirst of Colomb	3	1490	Rosarale de Chateau
4	M 242	Pink Panther	4	1857	Rose Mary Gandhi
5	R 78	Roughe Miland	5	1598	Princess de Monaco
6	S 170	Shrewsbury Show	6	1624	Ochi di Fita
7	A 172	Alaine Souchen	7	1627	Carry Free Beauty
8	A 83	Amara	8	S280	Sterntaler
9	B 158	Fryat	9	1324	Orange N Lemon
10	S 262	Perfume Perfect	10	1682	Lisa
11	L 89	Silver Star	11	T77	The McCartney Rose
12	A 129	Lincoln Cathedral	12	C 258	Chesire
13	M 48	A Tago	13	1740	Monnalisa
14	S 280	Demestra	14	1589	Carolanne
15	M 184	Golden Fairy Sport	15	1650	City of Glasgow
16	T 85	Mary Jean	16	1489	Messara
17	P 124	Toplesse	17	1684	Michel Fish
18	M 228	Priority Pride	18	1609	Mini Pink
19	P 194	Majestic	19	1593	Sans Souci
20	C 168	Prince Jardiner	20	S 292	Schloss Eutin
21	L 123	Cel b Lau	21	L 122	Lasting Piece
22	M219	Lois Wilson	22	1790	Plantein on Blumen
23	A 71	Mom's Rose	23	W 60	Winchester Cathedral
24		Alabama	24	1581	Golden Fairy
25		Josepha	25		Prosperity

Table 2: Contribution of 9 characters towards divergence in 25 varieties of Hybrid Tea and Floribunda Roses

Sl. No.	Characters	Hybrid Tea Roses (%contribution)	Floribunda Roses (%contribution)
1	Number of leaves at first flower	22	34
2	Number of days to first flower	39	32
3	Prickle density/5 cm	0	0
4	Flower size (cm)	12	8
5	Flower weight(g)	0	2
6	Pedicel length(cm)	0	2
7	Number of petals per flower	14	11
8	Size of petals (cm)	12	10
9	Number of flowers per plant/bunch	1	1

Table 3: Clustering of 25 varieties of Hybrid Tea Roses

Cluster	Name of the varieties	No of varieties
I	Madame George Delbard, Chirst of Colomb, Pink Panther, Priority Pride and Prince Jardiner	5
II	Roughe Miland, Shrewsbury Show, A Tago, Demestra and Lois Wilson	5
III	Aishwarya, Lincoln Cathedral and Mary Jean	3
IV	Silver Star, Toplesse and Cel b Lau	3
V	Alaine Souchen and Fryat	2
VI	Perfume Perfect and Majestic	2
VII	Mom's Rose and Alabama	2
VIII	Amara	1
IX	Golden Fairy Sport	1
X	Josepha	1

Table 4: Clustering of 25 varieties of Floribunda Roses

Clusters	Name of the varieties	No of varieties
I	Tickled Pink,Rose Mary Gandhi, Princess de Monaco, Ochi di Fita, The McCartney Rose, Chesire, Messara , Home e Garden, Plantein on Blumen and Prosperity	10
II	Rosarale de Chateau, Carry Free Beauty, City of Glasgow and Michel Fish	4
III	Versailles, Lisa and Schloss Eutin	3
IV	Sterntaler, Orange N Lemon and Plantein on Blumen	3
V	Monnalisa	1
VI	Carolanne	1
VII	Mini Pink	1
VIII	Lasting piece	1
IX	Golden Fairy	1

Table 5: Average intra and inter cluster distance values of 25 varieties of Hybrid Tea Roses

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X
I	278.58	506.47	480.99	750.24	480.99	927.58	969.22	1151.15	1107.36	5895.32
II		324.2	999.14	554.8	465.24	1127.45	1630.2	792.1	1693.21	7432.01
III			195.47	815.08	940.19	974.64	481.35	774.9	1041.97	4650.33
IV				256.32	1108.09	664.87	866.14	500.79	965.98	5095.53
V					1.07	1452.47	1760.39	1344.9	2013.32	8159.59
VI						271.2	613.74	1656.31	540.11	3430.09
VII							71.41	1219.41	349.3	2652.81
VIII								0	1489.01	6520.64
IX									0	2975.2
X										0

Table 6: Average intra and inter cluster distance values of 25 varieties of Floribunda Roses

Clusters	I	II	III	IV	V	VI	VII	VIII	IX
I	338.29	840.06	585.3	523.31	556.07	529.81	1610.47	1645.49	1023.73
II		364.94	832.76	387.4	910.33	968.47	1041.18	2279.14	1378.19
III			170.04	539.14	562.77	712.74	834.28	2647.54	881.52
IV				203.25	701.36	629.48	797.97	1742.18	1004.15
V					0	726.36	706.4	2397.25	1459.17
VI						0	1170.8	1211.78	500.98
VII							0	2457.28	771.08
VIII								0	955.48
IX									0

Table 7: Cluster means of various characters of 25 varieties of Hybrid Tea Roses

Clusters	Number of leaves at first flower	Number of days to first flower	Prickle density/5 cm	Flower size (cm)	Flower weight (g)	Pedicel length (cm)	Number of petals per flower	Size of petals (cm)	Number of flowers per plant/ bunch
I	25.37	46.5	4.4	7.07	5.14	5.89	22.43	3.53	1.63
II	50.77	63.47	3.7	7.41	5.71	6.04	40.37	2.79	1.63
III	32.78	45.5	5.67	8.68	4.92	5.18	21.5	5.1	1.72
IV	66.67	53.72	5.61	7.84	4.97	6.42	24.78	3.97	2
V	24.83	63.17	6.33	7.35	6.07	5.93	45.17	2.97	1.58
VI	60.17	29.08	4.83	6.79	5.04	5.78	38.58	3.49	1.67
VII	39	26.17	4.17	9.65	5.52	5.71	24.5	4.4	1.17
VIII	59.67	67.5	3.5	10.3	7.17	7.3	17.33	3.65	2
IX	46.00	46.50	4.00	9.13	1.76	4.12	18.17	1.69	2.83
X	65.67	63.47	3.83	9.20	5.83	5.98	14.67	5.95	1.33

Table 8: Cluster means of various characters values of 25 varieties of Floribunda Roses

Clusters	Number of leaves at first flower	Number of days to first flower	Prickle density/5 cm	Flower size (cm)	Flower weight(g)	Pedicel length (cm)	Number of petals per flower	Size of petals (cm)	Number of flowers per plant/ bunch
I	41.72	60.05	6.67	6.08	3.71	4.54	23.27	3.12	1.82
II	45.71	31.38	3.29	6.67	3.7	3.71	30.04	3.18	1.88
III	79.44	57.83	4.28	6.51	3.19	4.24	27.5	2.93	2.17
IV	48.44	39.06	9.5	6.55	5.58	6.13	25.78	3.17	2.61
V	52.67	63.5	3.17	7.14	6.5	4.35	54.67	2.72	2.17
VI	45.83	56.33	2.33	8.66	5.49	4.38	14.67	3.17	2.5
VII	22.83	53.5	3	6.91	4.43	3.6	25.17	3.18	1.67
VIII	17.17	46	11.5	8.11	5.58	6.78	16.17	5.44	1.67
IX	74.83	51.17	2.67	8.21	3.2	3.8	12.17	4.88	2

CONCLUSION

Based on D^2 values in Hybrid Tea roses 25 genotypes were grouped into10 clusters. Cluster I and II contained 5 genotypes each, while cluster III and IV had 3 genotypes each. Two genotypes were present in clusters V, VI and VII whereas clusters VIII, IX and X had one genotype each. Twenty five genotypes of Floribunda were grouped into 9 clusters. Cluster I contained 10 genotypes, 4 genotypes belonged to cluster II, while clusters III and IV had 3 genotypes each. Clusters V,VI, VII, VIII and IX had one genotype each. It would be desirable to attempt hybridisation between genotypes belonging to distant clusters to obtain highly heterotic crosses. Similar conclusions were drawn by Kavitha and Anburni[4] in African marigold and Rakesh Kumar *et al*[10]., in Snapdragon. For this purpose in Hybrid Tea, inter cluster distances were worked out considering the 9 characters. The inter cluster distance varied from 349.30 (between cluster IX and VII) to 8159.59 (between cluster X and V). In Floribunda roses, the inter cluster distance ranged from 387.40 (between clusters IV and II) to 2647.54 (between clusters VIII and III). These results suggest the presence of wide diversity between these clusters. Therefore, genotypes from these clusters can be selected for hybridization programme to get desirable recombinants.

In Hybrid Tea, the intra cluster distances indicated that cluster II had the maximum intra cluster distance followed by cluster I. The maximum inter cluster distance was found between clusters X and V. Among Floribunda genotypes, cluster II had the maximum intra cluster distance followed by cluster I. The maximum inter cluster distance was found between clusters VIII and III. This indicates the presence of considerable wide genetic diversity among the genotypes studied. In both the groups of roses it has been observed that per cent contribution of number of days to first flower and number of leaves at first flower was maximum towards the genetic divergence followed by number of petals per flower and flower size indicating the major role of these characters in determining the genetic diversity among genotypes.

Based on overall performance of rose varieties, it can be concluded that morphological data can give a better estimate of genetic differences in rose varieties. There exists significant diversity between different varieties of rose characterized in the present study, which will form an important basis for selection of variability to be used in future rose improvement. Therefore, diversity of morphological-based markers for genetic diversity of wild *Rosa* species and interaction of environment are expected to be quite high and this can efficiently used for future breeding programmes as reported by Debener *et al*[1]., Joublan *et al*[3]., Mohapatra and Rout[8], and Yan *et al*[13].

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