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Evaluation of genetic variability in fragrant rose (*Rosa × hybrida*) cultivars under open field cultivations

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ABSTRACT

Twenty-six rose (*Rosa × hybrida* L.) cultivars grown for open field conditions were characterized using 16 vegetative and floral traits to obtain information on the nature and magnitude of existing genetic variability. The cultivars, Night Time, Christian Dior and Pusa Abhishek were early in flowering and Local Collection 3, Local Collection 4, Kashmir Velvet and Edouard had longer flowering duration; Christian Dior and Bonne Nuit had bigger flowers; Pusa Bahadur had long flower stalk; Local Collection 3, Local Collection 4, Edouard and Kashmir Velvet were having more number of flowers per plant and Pusa Bahadur, Night Time and Christian Dior were found with higher flower weight and shall help in further selection and hybridisation. The higher genotypic and phenotypic coefficients of variation were recorded for plant height, plant spread (E-W), plant spread (N-S), stem girth, number of shoots/ plant, number of petals/ flower, flower stalk length, number of flowers/ plant and 100-flower weight, indicating that genotypic variation contributed markedly towards total variability for the above traits. There is a greater scope for selection in improving flower yield. The high heritability with high expected genetic advance over mean (GAM) was observed for plant height, plant spread (E-W), plant spread (N-S), stem girth, number of shoots/ plant, flower bud length, flower diameter and flower stalk length. This also revealed the lesser influence of environment on these traits. Therefore, simple selection based on phenotypic values for these traits could be useful in their improvement for achieving higher flower yield. The trait specification identified genotypes could ideally be used as donor parents in rose breeding programme to develop desired genotypes for open field cultivation.

Key Words: Genetic characterization, Heritability, Morphological traits, Phenotypic value, Hybridization

Rose (*Rose hybrida* L.) is bred for higher productivity and better characteristics as garden rose, potted rose, loose flower and cut flowers. However, despite the high economic importance, very limited information is available about rose genetics. This might be due to the complex genetic nature of rose cultivars, including ploidy, low seed set, poor seed germination and a high degree of heterozygosity. The choice of selection strategy for effective crop improvement requires at least sound knowledge of inheritance of the major target traits (Debener, 2003). In rose, however, genetic knowledge is still limited and research certainly does not match its economic importance (Yan, 2005). Flower yield is a quantitative trait which is affected by many genetic factors as well as environmental fluctuations (Shivaprasad, 2016 and Swaroop, 2019). Since, variability studies provide useful information, study was undertaken to assess variability in rose cultivars.

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MATERIALS AND METHODS

The experiment was conducted during 2020-21 at ICAR-Directorate of Floricultural Research, Pune. Twenty-six rose cultivars were evaluated for 16 distinguishing traits. The experiment was conducted in a randomized complete block design with three replications. Each cultivar was represented by 5 random plants per replication, which was planted at 1 m × 1 m spacing. The cultivars were: Rose Sherbet, Pusa Gaurav, Abhisarika, Raktima, Lalima, Arka Parimala, Pusa Muskan, Jantar Mantar, Kashmiri Velvet, Accession 1, Edouard , Local Collection 3, Local Collection 4, Pusa Bahadur, Pusa Abhishek, Scentimental, Barkarole, Arka Sukanya, Pusa Arun, Night Time, Bonne Nuit, Double Delight, Montreal, Oklahoma, Blue Moon and Christian Dior. Observations on days to bud initiation, days to first flowering, days to 50% flowering, plant height (cm), plant spread (E-W) (cm), plant spread (N-S) (cm), stem girth (cm), number of shoots/ plant, flower

bud length (cm), flower bud diameter (cm), flower diameter (cm), number of petals/ flower, flower stalk length (cm), flower stalk girth (cm), number of flowers/ plant, and 100-flower weight (g). The standard package of practices was followed. All plant protection measures were applied.

The analysis of variance for different traits was carried out using the mean data in order to partition variability due to different sources by following Panse and Sukhatme (1961). The genetic parameters such as genotypic coefficient of variability (GCV%), phenotypic coefficient of variability (PCV%), heritability (h2), genetic advance (GA) and genetic advance as % mean (GAM) were estimated. Heritability in the broad sense was derived based on the formula given by Hansan *et al*. (1956). Genetic Advance was obtained as per Johnson *et al*. (1955). The method adopted by Burton and Devane (1953) was used to calculate phenotypic and genotypic coefficients of variation

RESULTS AND DISCUSSION

There was highly significant variation for all yield and yield related traits (Table 1), indicating sufficient variability in all traits. Relatively wide range of genetic variability was medium to high range for days to first bud initiation, days to first flowering, days to 50% flowering, plant height, plant spread (E-W), plant spread (N-S), number of shoots/ plant, flower diameter, number of petals/ flower, flower stalk length, number of flowers/ plant, and 100-flower weight. Low range of variability was observed for stem diameter, flower bud length, flower bud diameter and flower stalk diameter.

The cultivars Pusa Abhishek and Night Time were found with earliest flower bud initiation (32.5 days), whereas it was most delayed in Local Collection 3 (48.50 days). Cultivars Christian Dior and Night Time took significantly lesser number of days to first flowering (36.5), while Local Collection 4 (56.50 days) took maximum duration. The days to 50% flowering was 50.5 (Sentimental) to 75.50 (Local Collection 3 and Local Collection 4); for plant height 65.5 (Kashmir Velvet) to 165.5 cm (Pusa Arun); for plant spread (E-W) 67.0 (Double Delight) to 186.50 cm (Edouard); for plant spread (N-S) 62.5 (Double Delight) to 172.5 cm (Edouard); for stem girth 1.56 (Scentimental) to 3.65 cm (Lalima); for number of shoots/plant 8.5 (Rose Sherbet) to 33.0 (Local Collection 3); for flower bud length 1.65 (Kashmiri Velvet) to 2.82 cm (Barkarole), for flower bud diameter 1.03 (Double Delight) to 2.23 cm (Christian Dior), for flower diameter 5.6 (local collection 3) to 10.32 cm (Bonne Nuit), for number of petals/ flower 20.33 (Kashmir Velvet) to 60.33 (Local Collection 3), for flower stalk length 2.03 (Kashmir Velvet) to 31.20 cm (Pusa Bahadur); for flower stalk girth 0.5 (Lalima) to 1.08 cm (Pusa Bahadur); for number of flowers/ plant 11.5 (Montreal) to 167.5 (Local Collection 4) and for 100-flower weight is 139.45 (Barkarole) to 729.45 g (Christian Dior) (Tables 2 and 3).

Based on the data for different genetic parameters, the selection would prove promising in Night Time, Christian Dior and Pusa Abhishek for early flowering, Local Collection 3, Local Collection 4, Kashmir Velvet and Edouard for early flowering duration, Christian Dior and Bonne Nuit for bigger flowers, Pusa Bahadur for longer flower stalk, Local Collection 3, Local Collection 4, Edouard and Kashmir Velvet for high number of flowers and Pusa Bahadur, Night Time and Christian Dior for high flower weight (Table 2). These results are in agreement with the findings of Mantur *et al.* (2005), Prashanth (2010) and Shivaprasad *et al.* (2016) for variation in different traits among cultivars.

Phenotypic coefficient of variation (PCV) was found higher than genotypic coefficient of variation (GCV) for different traits, indicating higher influence of environment on the traits (Table 3). The similar results were reported by Panwar *et al*. (2012) and Verma *et al*. (2008) in rose. However, difference between phenotypic and genotypic coefficient of variation values, which reflects environmental coefficient of variance, was higher for some of the traits (days to first flowering, days to 50% flowering, stem girth, number of shoots/ plant, flower bud diameter, flower stalk diameter, number of flowers/ plant and 100-flower weight) and less in other traits (days to first bud initiation, plant height, plant spread (E-W), plant spread (N-S), flower bud length, flower diameter, number of petals/ flower).

The magnitude of difference between phenotypic and genotypic coefficients of variation for days to first flower bud initiation, plant height, plant spread (E-W), plant spread (N-S), flower bud length, flower diameter, number of petals /flower, and flower stalk diameter was found to be less indicating that these traits are least affected by environment and reflects the reliability of selection based on phenotypic performance (Table 3). Similar results were reported

Table 1. Mean sum of square for different traits in rose cultivars

Source	Df	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
Replication MSS	1	15.08	3.77	4.33	62.70	3.77	15.08	0.01	8.48	0.05	0.19	0.04	0.48	5.17	0.04	60.31	26668.11
Treatment MSS	25	35.83**	50.40**	103.06**	1062.24**	1247.59**	1396.78**	0.79**	80.62**	0.20**	0.16**	3.75**	169.45**	96.21**	0.03**	2612.16**	48534.94**
Error MSS	25	3.04	4.89	9.41	27.68	22.65	14.60	0.11	4.64	0.01	0.04	0.07	3.27	0.57	0.01	11.31	696.36
Treatment cal F value		11.80	10.31	10.96	38.37	55.08	95.69	7.33	17.37	17.04	3.62	53.37	51.86	168.88	4.12	231.01	69.70
S. Em. ±		1.23	1.56	2.17	3.72	3.37	2.70	0.23	1.52	0.08	0.15	0.19	1.28	0.53	0.06	2.38	18.66
CD (5 %)		3.59	4.55	6.32	10.84	9.80	7.87	0.68	4.44	0.22	0.43	0.55	3.72	1.55	0.18	6.93	54.35
CD (1 %)		4.86	6.16	8.55	14.67	13.27	10.65	0.92	6.00	0.30	0.58	0.74	5.04	2.10	0.25	9.37	73.56
CV (%)		4.64	5.26	5.19	4.68	4.71	4.24	12.42	10.97	4.96	12.76	3.47	5.31	9.28	12.50	7.26	8.43

X1: days to first bud initiation (days), X2: days to first flowering (days), X3: days to 50% flowering (days) X4: plant height (cm), X5: plant spread E-W (cm), X6: plant spread N-S (cm), X7: stem girth (cm), X8: number of shoots/ plant, X9: flower bud length (cm), X10: flower bud diameter (cm), X11: flower diameter (cm), X12: number of petals /flower, X13: flower stalk length (cm), X14: flower stalk girth(cm), X15: number of flowers/plant, X16: 100 flower weight (g)

Table 2. Performance of loose flower cultivars for morphological traits

Cultivar	Days to first bud initiation (days)	Days to first flowering (days)	Days to 50% flowering (days)	Flower dia. (cm)	No. of petals / flower	Flower stalk length (cm)	No. of flowers/ plant	100-flower weight (g)
Rose Sherbet	43.0	45.5	55.0	6.78	41.00	3.50	32.5	206.30
Pusa Gaurav	36.5	40.5	51.0	7.13	39.83	4.32	60.5	333.45
Abhisarika	38.5	43.5	58.5	9.12	32.50	4.20	35.0	255.25
Raktima	37.5	41.5	54.5	8.42	21.83	10.58	25.5	264.35
Lalima	33.5	39.0	58.5	8.25	31.67	6.70	21.5	240.60
Arka Parimala	36.0	38.5	55.0	8.15	27.50	5.48	21.0	270.75
Pusa Muskan	35.5	38.0	58.5	7.18	25.50	5.87	23.5	164.50
Jantar Mantar	33.5	38.5	60.5	7.60	27.00	6.90	18.5	311.35
Kashmiri Velvet	37.0	41.0	72.0	6.77	20.33	2.03	60.5	199.95
Accession 1	41.0	45.5	65.0	6.03	47.00	3.17	41.0	215.55
Edourd	43.0	48.0	71.0	5.90	41.33	3.62	103.5	217.80
Local Collection3	48.5	55.0	75.5	6.85	60.33	2.82	132.0	335.60
Local Collection 4	46.5	55.5	75.0	5.60	28.67	5.12	167.5	163.70
Pusa Bahadur	35.0	42.0	54.0	8.30	37.50	31.20	50.0	723.60
Pusa Abhisek	32.5	38.5	54.5	7.77	30.67	16.25	45.0	243.45
Scentimental	39.5	42.5	50.5	5.93	25.50	3.80	17.5	200.40
Barklore	38.5	41.5	51.5	5.87	25.17	12.75	36.5	139.45
Arka Sukanya	36.0	39.0	54.0	8.18	30.33	8.30	40.5	394.35
Pusa Arun	36.5	37.5	50.0	9.08	27.17	4.03	41.5	401.45
Night Time	32.5	36.0	61.0	6.38	39.33	9.12	52.0	546.45
Bonne Nuit	35.5	39.0	59.0	10.32	27.83	4.42	34.5	244.55
Double Delight	36.0	40.5	55.5	8.98	41.33	5.62	13.5	365.60
Montreal	39.0	45.5	60.0	6.62	44.17	12.50	11.5	453.50
Oklahoma	33.0	37.5	56.0	10.13	29.67	7.40	37.5	343.50
Blue Moon	32.5	43.0	58.0	7.67	40.67	6.02	37.5	174.30
Christian Dior	34.0	36.5	59.0	9.73	42.00	25.73	44.0	729.45

by Roychowdhury and Tah (2011) in carnation. Kumari *et al*. (2011) and Kumar *et al*. (2012) who also reported higher PCV than GCV for different traits in gerbera.

The PCV and GCV values revealed that there was significant variability present at both levels (Table 3). The higher GCV was recorded for plant height, plant spread (E-W), plant spread (N-S), stem girth, number of shoots/ plant, number of petals/flower, flower stalk length, number of flowers/ plant and 100-flower weight, indicating that variation in genotypes contributed for total variability. The higher PCV was recorded for plant height, plant spread (E-W), plant spread (N-S), stem girth, number of shoots/ plant, number of petals/ flower, flower stalk length, number of flowers/ plant and 100-flower weight. Higher PCV and GCV values were recorded for flower stalk length (85.55 and 85.04%), number of flowers/plant (78.21 and 71.87%) and flower wright (50.12 and 47.40%, respectively). Therefore, for higher GCV and PCV traits, there is a greater scope for selection to improve these traits.

Similar results were reported by Panwar *et al*. (2012) for number of flower and flower weight. The sufficient variation available for these traits can be exploited by direct selection among cultivars

and could be used as selection indices for yield improvement. Further, traits or recombination of traits can be improved by involving carefully chosen parents in hybridization. There was less genetic variability for days to first flower bud initiation, days to first flowering, days to 50% flowering, flower bud diameter, flower bud length, flower diameter and flower stalk girth (Table 3). These traits had moderate GCV to low GCV values. Therefore, it is necessary to create variability through hybridization or mutagenesis. Similar results were reported by Kumar (2013).

The heritability provides upper limit possible for estimate of heritability in narrow sense. The extent of response to any selection depends on magnitude of heritability and variability available. It is possible to predict the response for given level of selection intensity if these parameters are known. High heritability was observed for days to bud initiation, days to first flowering, days to 50% flowering, plant height, plant spread E-W, plant spread N-S, stem girth, number of shoots/plant, flower bud length, flower diameter, flower stalk length. Similar results of high heritability was recorded by Panwar *et al.* (2012) for plant height, flower diameter, flower stalk length. Thus, lesser magnitude of non-genetic (environmental) variability indicates ease with which above characters can be handled for further improvement (Table 3).

The genetic advance over mean (GAM) facilitates the comparison for predicted selection response shown by different characters. The high heritability with high expected GAM was observed for plant height, plant spread E-W, plant spread N-S, stem girth, number of shoots/plant, flower bud length, flower diameter, and flower stalk length. These findings are in accordance with those of Singh (2019). This indicates the less effect of environment on these traits. Therefore, simple selection based on phenotypic values for these traits could be useful in improving these characters because of presence of additive gene action (Table 3). Moderate to high heritability with moderate to high GAM was observed for days to first budding, days to first flowering, days to 50% flowering, number of petals/ flower, flower stalk girth and number of flowers/ plant, indicating moderate role of environment on selection of these traits. Moderate heritability and GAM were observed in flower bud diameter and 100-flower weight. It is

Table 3. Estimates of Mean, range and different genetic parameters for different traits in rose.

Trait	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
Mean	37.54	42.04	59.13	112.40	100.96	90.08	2.66	19.63	2.18	1.64	7.64	34.07	8.13	0.71	46.31	313.05
	32.5-	36.5-	50.5-	65.5-	67-	62.5-	1.56-	8.5-33	1.65-	1.03-	5.6-	20.33-	2.03-	0.5-	11.5-	139.45-
Range	48.50	56.50	75.50	165.5	186.50	172.50	3.65		2.82	2.23	10.32	60.33	31.20	1.08	167.50	729.45
PCV (%)	11.74	12.51	12.68	20.77	24.96	29.49	25.35	33.25	14.88	19.40	18.08	27.28	85.55	20.01	78.21	50.12
GCV (%)	10.79	11.35	11.57	20.23	24.51	29.18	22.09	31.39	14.03	14.60	17.74	26.75	85.04	15.62	71.87	47.40
h^2bs (%)	74.38	72.31	73.27	84.92	86.43	87.93	65.98	79.11	78.91	46.69	86.32	56.22	88.82	60.97	59.14	57.17
GA	7.66	7.92	11.86	35.65	40.06	43.59	0.94	9.99	0.60	0.27	2.74	12.42	6.16	0.18	24.97	34.06
GAM (%)	20.41	18.83	20.06	31.71	39.68	48.39	35.35	50.86	27.26	16.56	35.87	36.45	75.77	25.13	53.91	10.88

X1: days to first bud initiation (days), X2: days to first flowering (days), X3: days to 50% flowering (days) X4: plant height (cm), X5: plant spread E-W (cm), X6: plant spread N-S (cm), X7: stem girth (cm), X8: number of shoots/ plant, X9: flower bud length (cm), X10: flower bud diameter(cm), X11: flower diameter (cm), X12: number of petals /flower, X13: flower stalk length (cm), X14: flower stalk girth(cm), X15: number of flowers/plant, X16: 100 flower weight (g)

evident, that these traits fluctuate according to the environment influence. Selection for these traits should be carefully done and monitored for better results (Table 3).

Selection shall prove promising for early flowering in Night Time, Christian Dior and Pusa Abhishek; for duration of flowering in Local Collection 3, Local Collection 4, Kashmir Velvet and Edouard, for bigger flowers in Christian Dior and Bonne Nuit, for longer flower stalks in Pusa Bahadur; for higher number of flowers in Local Collection 3, Local Collection 4, Edouard and Kashmir Velvet and higher flower weight in Pusa Bahadur, Night Time and Christian Dior. The PCV and GCV values revealed ample variability at both these levels. The higher GCV and PCV were recorded for plant height, plant spread (E-W), Plant spread (N-S), stem girth, number of shoots/ plant, number of petals flower, flower stalk length, number of flowers/ plant and 100-flower weight, indicating that variation was significant. There is a greater scope for selection to improve for these traits. The sufficient variation available for these traits can be exploited by direct selection among cultivars and could be used as selection indices for flower yield improvement. Further, these traits or recombination of traits can be improved by involving carefully chosen parents in hybridization. High heritability was observed for days to bud initiation, days to first flowering, days to 50% flowering, plant height, plant spread (E-W), plant spread (N-S), stem girth, number of shoots/plant, flower bud length, flower diameter, flower stalk length. Indicating these traits are more heritable in progenies and can be handled easily compared to other traits, while improving these traits.

REFERENCES

Baskaran V, Janakiram T and Jayanthi R. 2004. Correlation and path coefficient analysis studies in chrysanthemum. *J. Orn. Hort*. **7**: 37–44.

Burton G W and De Vane G M. 1953. Estimating heritability in tall fescue (*Festuca arundinaceae*) from replicated clonal material. *Agron. J*. **45**: 478-71.

Debener T. 2003. Genetics: Inheritance of characteristics.*In*: *Encyclopedia of Rose Science*. Andrew, V. Roberts (Ed.). Oxford, Elsevier, pp. 286-92.

Gudin, S., 2000. Rose: Genetics and breeding. *Plant Breed Rev* **17**:159-89.

Hanson G H, Robinson H F and Comstock R E. 1956. Biometrical studies of yield in segregating populations of Korean Lespedeza. *Agron. J*. **48**: 267-82.

Johnson H W, Robinson H F and Comstock H F. 1955. Estimates of genetic and environmental variability in soybeans. *Agron. J.* **47**: 314-18.

Kumar R. 2013. Studies on genetic variability in gerbera (*Gerbera jamesonii* Bolus ex. Hooker F.) *J. Hort. Sci.* **8**:111-13.

Kumar R, Deka B C and Venugopalan R. 2012. Genetic variability and trait association studies in gerbera (*Gerbera jamesonii*) for quantitative traits. *Indian J. Agric. Sci.* **82**: 615–-19

Kumari A, Patel K S and Choudhary M. 2011. Genetic variability studies in gerbera. *Res. Pl. Biol*. **1**: 1-4.

Mantur S M, Bagali A N and Patil S R. 2005. Influence of bending and pruning on different varieties of roses under naturally ventilated polyhouse. *Karnataka J. Agri. Sci*. **18**: 474-77.

Mishra H N, Das J N and Palai S K. 2006. Character association and path coefficient analysis in spray type chrysanthemum. *Orissa J. Hort.* **34** : 32-33.

Panse V G. and Sukhatme P M. 1961. Statistical Methods for Agricultural Workers, Indian Council of Agricultural Research, New Delhi, 359 p.

Panwar S, Singh K P and Namita. 2012. Assessment of variability, heritable components and grouping of Indian rose (*Rosa* × *hybrida*) genotypes based on DUS guidelines. *Indian J. Agric. Sci.* **82**: 875-80.

Prashanth P. 2010. Performace of Dutch roses under polyhouse. M.Sc. (Horti) thesis, Univ. Agric. Sci., Dharwad, Karnataka.

Roychowdhury R and Tah J. 2011a. Evaluation of genetic parameters for agro-metrical characters in carnation genotypes. *African Crop Sci. J.* **19**: 183–88.

Shivaprasad S G, Nataraj S K, Latha S, Ravi C H and Suryakiran K V. 2016. Evaluation and correlation studies of rose cultivars under naturally ventilated polyhouse. *Res. Environ. Life Sci*. **9**: 1097-99.

Singh J, Singh R and Grewal H S. 2019. Assessment of genetic variability in open cultivated hybrid tea roses (Rosa hybrida L.). *Agric. Res.J.* **56**: 329-31.

Swaroop K, Singh Kanwar P and Kumar P. (2019) Evaluation of gladiolus (*Gladiolus grandiflora*) genotypes for morphological diversity and corm yield. *Current Horticulture* **7**(2): 48–51.

Verma S, Kumar S and Singh D. 2008. Studies on variability for various quantitative traits in rose (Rosa spp.). *J. Orn. Hort*. **11**: 27-31.

Yan Z F, Dolstra O, Hendriks T, Prins T W, Stam P and Visser P B. 2005. Vigour evaluation for genetics and breeding in rose. *Euphytica* **145**: 339-47.