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Genetic variability and heritability in rose

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Abstract
Twenty-five varieties of Hybrid Tea rose were evaluated to determine genetic variability, heritability, genetic advance and genetic advance as per cent mean for significant variations were recorded for the various characters studied. Phenotypic co-efficient of variation was higher than genotypic co-efficient of variation for all the characters. Narrow differences between GCV and PCV were observed for all the characters excepting plant spread in East- West and North- South, number of cut flowers per plant, number of cut flowers per m2, stalk length and vase life, indicating minimal environmental influence on expression of these characters. High (>20%) genotypic and phenotypic co-efficient of variation were recorded for plant height, flower yield per plant, number of petals/flower, stalk length and vase life indicating the presence of maximum variability among the varieties studied. Heritability estimates ranged from 62.02% (plant spread in East- West) to 98.80% (flower bud diameter). High heritability, coupled with high genetic advance as per cent mean was recorded for flower bud diameter, flower yield per plant, individual leaf area, number of petals per flower, stem girth, days from bud initiation to full bloom stage, plant height, vase life, stalk length, number of cut flowers per m2 and number of cut flowers per plant. Therefore, these traits can be improved through selection and breeding.

Keywords: Genetic variability, heritability, rose

Introduction
The *Rosa* genus belongs to the family Rosaceae with chromosome number 2n = 4x = 28. The first modern roses were the Hybrid Tea roses, which were derived from crosses between Hybrid Perpetual and Tea roses (Marriott, 2003) [6] and thus contained genes from *R. damascena*, *R. moschata*, *R. chinenesis*, *R. gigantean*, and *R. gallica*. Hybrid Tea roses are grown specifically by commercial flower growers for the cut-flower market and they are also used for domestic and industrial landscaping. They have erect stems usually form plants that are 1-2 m tall.

Variation is the basic ground for evaluation of any species. The sources and success of any selection programme are based upon the extent of variability in the germplasm of a crop species with respect to important traits. Greater the genetic variability better would be the scope for selection. Higher the variability in the materials, greater the probability of producing recombinants. For effective and efficient utilization of a source population it is imperative to gather information on nature and extent of genetic variability for the manifestation of characters (Choudhary, 1987). The cultivation of rose is gaining importance in Karnataka due to its relative ease in cultivation, high returns, increasing market demand and high communication facilities. Considering the importance and popularity of rose flowers both in domestic as well as International markets, it is important to study extent of variability in Hybrid Tea group of rose varieties and also to test the new hybrids for their performance in eastern dry zone of Karnataka.

Material and Methods
The study was carried out at an experimental field of Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru, during the year 2017- 18 in Randomized Complete Block Design, with two replications. Experimental material comprised of 25 varieties, *viz*., Anika, Acapella, Auguste Renoir, Abhishek, A Modi Rose, Bora Bora, Chantre, Claire Chazal, Chitraranjini, Cherry Parfait, Double Delight, Eddy Mitchell, F. F. Rennaissance, Fragrant Plum, Eterna, Julio Iglesias, Mohana, Moonstone, Maurice Utrillo, Prescilla, Rose Rhapsody, Shi Un, Scandia, Tata Centenary and Temptress which were planted at a spacing of 60 cm x 60 cm on 20th of October 2017. Uniform cultural practices were imposed on all the varieties. Genotypic and phenotypic coefficients of variation were estimated according to Burton and Dewane (1953) [2] based on an estimate of genotypic and phenotypic variance. Broad sense heritability (h2) was estimated as per Weber and Moorthy (1952) [15]. Genetic advance as per cent mean was worked out as per Johnson *et al* (1955) [5].

Results and Discussion

Genetic variability

The basic information for improvement in a particular crop species is the extent of genetic variability and divergence present in the available germplasm. Large variability ensures better chances of producing new improved lines. Studies on genetic variability enable the breeder to select the population having desirable quality and diverse parents which can be used in hybridization. The presence of large amount of variation among the genotypes indicates that there is ample scope for improvement through selection for the characters like days taken to bud initiation, height of plant, spread of plant, days from bud initiation to tight bud stage, number of petals per flower, number of flowers per plant and vase life. These findings are in agreement with Lal *et al*. (1982), who also found wide variability for number of petals per flower, number of flowers per plant and plant height in rose.

Analysis of variance showed significant differences among varieties for all the traits studied. Extent of variability was measured in terms of variance, genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), along with per cent heritability (h2) and genetic advance as per cent mean (Table 1 and 2). Phenotypic co-efficient of variation was higher than genotypic co-efficient of variation for all the characters, which indicated greater genotype X environment interaction. The results were in agreement with the results of Verma *et al*. (2008) [14] in rose; Mishra and Gupta (2003) [6] in carnation; Verma *et al*. (2002) [13] in marigold, Sirohi and Behera (2000) [11] in chrysanthemum and Chobe *et al*. (2010) [3] in gerbera. This is because of the fact that variability at the phenotypic level includes genotypic and environmental variability. However, narrow differences between GCV and PCV were observed for all the characters excepting plant spread in East- West and North- South, number of cut flowers per plant, number of cut flowers per m2, stalk length and vase life, indicating minimal environmental influence on expression of these characters.

High genotypic and phenotypic co-efficient of variation were recorded for plant height, flower yield per plant, number of petals/flower, stalk length and vase life indicating the presence of maximum variability among the varieties studied. Similar high variability has been reported for thorn density, followed by length of shoot after one month of bud sprouting, number of flowers per plant and length of sprouted bud by Verma *et al*. (2008) [14] in Hybrid Tea rose varieties. This suggested that there is enough scope of selection based on these characters and the diverse genotypes can provide materials for breeding programme.

Moderate genotypic co-efficient and phenotypic co-efficient was recorded for stem girth, days from bud initiation to full bloom stage, number of cut flowers per plant, number of cut flowers per m2 and flower bud diameter. Low genotypic co-efficient of variation was recorded for plant spread in East-West and North- South, chlorophyll content, days to bud initiation, days from bud initiation to tight bud stage, flower diameter and stalk girth. Similar trend of low PCV and GCV was registered for bud diameter in rose by Verma *et al*. (2008) [14] and for days to bud appearance in dahlia by Dhane *et al*. (2002) [4]. These characters with low PCV and GCV values may have limited scope.

Plant height, leaf area, flower yield per plant, number of petals/ flower, stalk length and vase life, showed high genotypic coefficient of variation, coupled with a narrow difference between genotypic and phenotypic co-efficients of variation. Hence, these traits can prove to be effective in improving the crop through selection and breeding. Such a high genotypic co- efficient of variation, together with heritability estimates, would be useful in arriving at the amount of advancement to be achieved through selection (Burton, 1952) [1]. The similar results have also been advocated by Verma (2007) and Palai *et al*. (2003) in rose for plant height; Sriniwas and Gowda (1995) [12] in dahlia for number of florets; Patnaik and Mohanty (2002) [9] in marigold for number of flowers per plant and plant height.

Heritability and Genetic Advance

Magnitude of heritable variability is the most important aspect having a close bearing on response to selection (Panse, 1957) [8]. In the present experiment, heritability estimates ranged from 62.02% (plant spread in East- West) to 98.80% (flower bud diameter). Magnitude of heritability in broad sense was high for all the characters. Such high heritability estimates are helpful in making a selection for superior genotypes on the basis of phenotypic performance of these traits.

Heritability and genetic advance increase the efficiency of selection in a breeding programme by assessing the influence of environmental factors and the nature of gene action. Johnson *et al.* (1955) [5] suggested that heritability, along with genetic advance was more useful in predicting selection of the best individuals. In the present study, high heritability, coupled with high genetic advance as per cent mean was recorded for flower bud diameter, flower yield per plant, individual leaf area, number of petals per flower, stem girth, days from bud initiation to full bloom stage, plant height, vase life, stalk length, number of cut flowers per m2 and number of cut flowers per plant indicating, that, these traits are controlled by additive gene action. Therefore, these traits can be improved through pure-line selection and breeding. High heritability, associated with high genetic advance, is more useful for improvement of a character through selection. The results are in accordance with Lal *et al*. (1982), Palai *et al*. (2003) in rose, Mohapatra *et al*. (2000) in chrysanthemum, Sriniwas and Gowda (1995) [12] in dahlia and Barad (1992), Patnaik and Mohanty (2002) [9] and Singh (2004) [10] in marigold.

High heritability, with moderate genetic advance was recorded for days to bud initiation, days from bud initiation to tight bud stage, flower diameter, chlorophyll content, plant spread North-South and East-West, which are attributed to the presence of both additive and nonadditive gene effects indicating, that, these characters can be improved through hybridization and selection in later generations.

The present study revealed that traits like plant height, individual leaf area, flower yield per plant, stalk length, number of petals per flower and vase life, showed high genotypic coefficient of variation, heritability and genetic advance as per cent of mean, which may be attributed to additive gene effects. Thus, these characters can prove useful for selection and breeding in rose.

Table 1: Mean, range, variance, genotypic and phenotypic coefficient of variation, heritability and genetic advance for vegetative and flowering traits in Hybrid Tea rose

Character	Mean	Range	G.V.	P.V.	G.C.V. (%)	P.C.V. (%)	Heritability (%)	GA	GAM (%)
Plant height at 150 DAP (cm)	72.97	118.50-47.00	298.19	317.70	23.67	24.43	93.86	34.46	47.23
Plant spread in East- West at 150 DAP (cm)	32.16	36.50-21.75	5.78	9.32	7.83	9.94	62.02	3.90	12.71
Plant spread in North- South at 150 DAP (cm)	30.04	34.25-25.00	5.92	9.09	8.10	10.04	65.17	4.05	13.48
Stem girth (mm)	7.45	10.63-5.15	1.71	1.79	17.54	17.96	95.36	2.63	35.29
Chlorophyll content	49.16	58.90-41.24	12.58	19.22	7.21	8.92	65.44	5.91	12.02
Leaf area at 150 DAP (cm2)	15.72	25.07-6.77	26.94	27.63	33.03	33.44	97.52	10.56	67.19
Days to bud initiation	40.03	45.50-36.00	4.81	5.13	5.48	5.66	93.61	4.37	10.92
Days from bud initiation to tight bud stage	15.29	18.50-12.80	2.13	2.41	9.53	10.16	88.08	2.82	18.42
Days from bud initiation to full bloom stage	18.90	23.40-15.00	3.59	3.78	10.02	10.29	94.92	3.80	20.11

Table 2: Mean, range, variance, genotypic and phenotypic coefficient of variation, heritability and genetic advance for yield and quality traits in Hybrid Tea rose

Character	Mean	Range	G.V.	P.V.	G.C.V. (%)	P.C.V. (%)	Heritability (%)	GA	GAM (%)
Number of cut flowers per plant	13.89	2.00-11.25	4.18	5.57	14.71	17.00	74.96	3.65	26.24
Number of cut flowers per m2	56.04	83.00-45.00	74.70	95.55	15.42	17.44	78.18	15.74	28.09
Flower yield per plant (g)	134.47	243.43-83.40	2056.50	2082.71	33.72	33.94	98.74	92.83	69.04
Flower bud diameter (cm)	1.99	2.59-1.27	0.11	0.11	16.54	16.64	98.80	0.68	33.87
Flower diameter (cm)	8.45	9.40-6.06	0.66	0.86	9.63	10.98	76.88	1.47	17.39
Number of petals/ flower	36.79	71.20-20.60	159.35	164.62	34.32	34.88	96.80	25.58	69.55
Stalk length (cm)	31.80	55.40-20.20	49.72	58.45	22.18	24.04	85.07	13.40	42.13
Stalk girth (mm)	5.06	5.60-4.00	0.07	0.10	5.05	6.13	67.85	0.43	8.56
Vase life (days)	7.60	11.50-2.00	3.27	3.78	23.78	25.27	86.45	3.46	45.54

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