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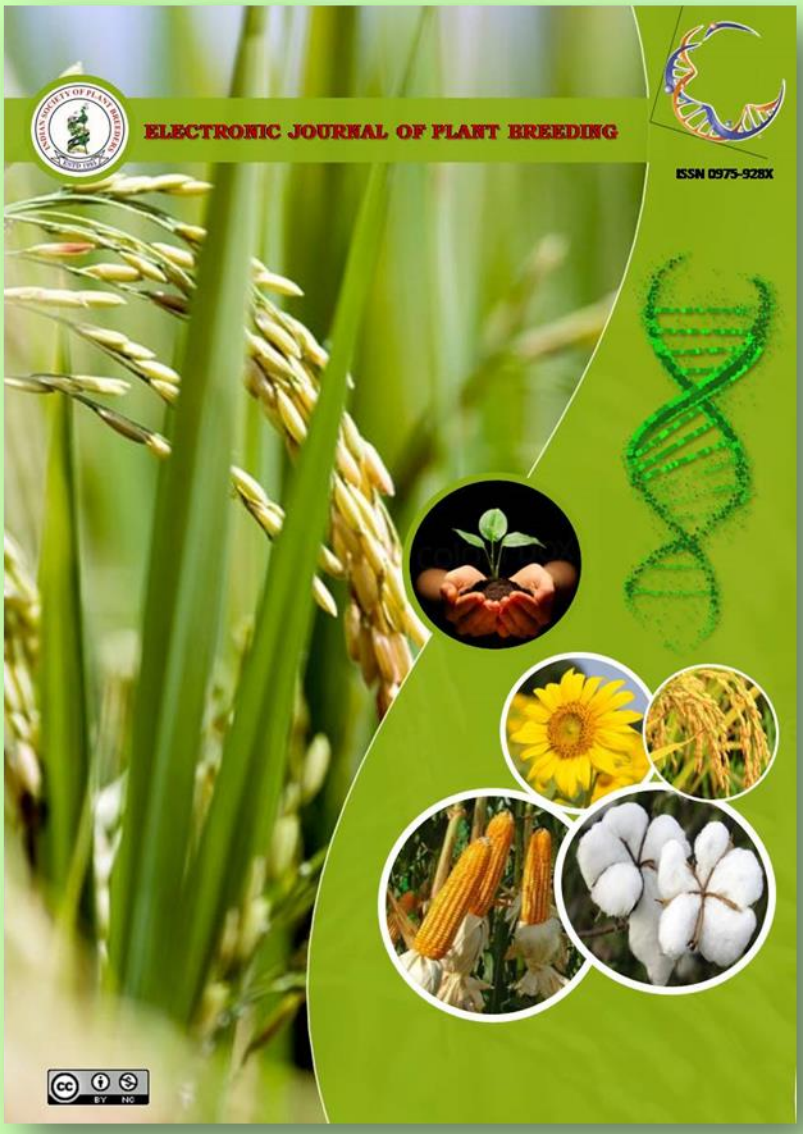

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Research Article

Genetic variability, heritability and genetic advance studies in marigold (*Tagetes spp*.) under the South Gujarat region

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Abstract
The success of crop improvement programme depends on the extent of genetic variability existing in the population of germplasm. The improvement and development of new varieties depends to a great extent upon the magnitude of genetic variability. The present investigation was carried out at three different locations during *Rabi* season (November 2014- April 2015) to evaluate 26 genotypes of marigold. The analysis of variance for all the traits revealed presence of considerable genetic variability in the material studied. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits studied, which indicated appreciable influence of environment. The high magnitude for genotypic and phenotypic coefficient of variation as well as high magnitude of broad sense heritability coupled with genetic gain was observed for plant height, number of secondary branches per plant, leaf area, leaf biomass, photosynthetic rate, flower weight, number of flower per plant, flower yield per plant, seed yield per plant and carotenoid content, which indicated additive gene effects. Hence, these characters were less influenced by environment and direct selection for these traits would be effective for further improvement.

Key words
Marigold, variability, heritability, genetic advance

Introduction

Marigold (*Tagetes* spp.) is one of the most important species grown commercially for loose flowers in different parts of India, especially tropical and subtropical regions. It is also grown for landscaping and occupies an ever increasing demand in medicinal and industrial sector. It is widely grown for its loose flowers used for religious offerings and making garlands during social functions and as a bedding plant in landscape gardening. The extraction of carotenoides from petals for industrial uses raised the importance of this crop and increased the area under its cultivation. The carotenoides are mixed with poultry feed to intensify yellow colour of egg yolk, source of pigments for colouring food stuffs in place of synthetic colours and also having medicinal properties and used in the preparation of lotion, creams and tablets intended for the treatment of eye ailments. Hence, the present study was aimed to study variability, heritability and genetic advance in order to identify the best genotypes in marigold, which can be further exploited for crop improvement.

Materials and Methods

The present study was carried out during *Rabi* season (November 2014 - April 2015) at three different locations *viz.*, Floriculture Research Farm, Navsari (Dist- Navsari), Regional Rice Research Station, Vyara (Dist- Tapi), Hill Millet Research Station, Waghai (Dist- The Dangs) of Navsari Agricultural University. Twenty six (26) genotypes collected from diverse source were grown in a randomized block design (RBD) with three replications. The 26 genotypes of marigold comprised four F_1 hybrids (Inca Gold, Inca Yellow, F_1 White Dwarf and Sonata Orange); fifteen local genotypes (Local Sel. 1, Local Sel. 2, Local Sel. 3, Local Sel. 4, Local Sel. 5, Local Sel. 6, Local Sel. 7, Local Sel. 8, Local Sel. 9, Local Sel. 10, Local Sel. 11, Local Sel. 12, Local Sel. 13, Local Sel. 14 and Local Sel. 15) as well as seven open pollinated varieties (Pusa Narangi Gainda, Summer Sugat, Namdhari African Orange, Hawaii orange, Swati Orange, Indus Orange Bunch and Suvarna Orange).

Seeds of all the genotypes were sown on the raised beds in the month of November to raise seedlings. Transplanting of seedlings was done when they attain three to four true leaves stage. The genotypes were planted in a single-row of 20 plants under each replication with a spacing of 60 x 40 cm. All the agronomical practices and plant protection

measures were followed as and when required to raise a good crop of marigold. The observations were recorded on five randomly tagged plants from each genotype of each replication. The data recorded for all the characters were subjected to pooled analysis of variance with the formula suggested by Panse and Sukhatme (1978). The coefficient of phenotypic and genotypic variations was calculated by the formula suggested by Burton (1952). Heritability in broad sense was computed to know the extent of variation due to genotype in the phenotypic variance expressed in percentage (Hanson *et al*., 1956). Genetic advance was calculated by using the methodology suggested by Allard (1960). The expected genetic advance as expressed in per cent of mean was calculated by the method suggested by Johnson *et al*. (1955).

Results and Discussion

It is evident from Table 1 that mean square differences due to genotypes were highly significant for all the characters indicating considerable variability among the genotypes tested in the investigation. This clearly indicated that the existence of wide range of variability for different traits which revealed the considerable improvement can be made in marigold.

The data depicted in Table 2 indicated that highest range of variation was reported with plant height (28.07 - 76.58 cm.), leaf area (9.75 - 47.74 cm.^{2}), leaf biomass (35.72 - 150.16 g.), duration of flowering (47.69 - 110.51 days), flower diameter (41.56 - 81.63 mm.), flower yield per plant (115.53 - 575.41 g.), seed yield per plant (26.60 - 171.55 g.) and carotenoid content (38.18 - 436.03 mg/100g.). The data revealed that different genotypes performed differently for different quantitative traits; hence these diverse genotypes with superior traits could be involved in the hybridization programme for assembling of desirable traits in single genotypes. Similar results were also reported by Namita *et al.* (2008) and Sapna *et al.* (2013) for various vegetative and flowering traits in marigold.

In the present investigation, the phenotypic variance was higher than genotypic variance and both were greater than environmental variance for all the characters. This implied that phenotypic variance may be considered as a reliable measure for genotypic variability. The phenotypic and genotypic variance were greater than environmental variance for all the characters under study, which directed that influences of environment on expression of traits was lower or negligible, the true selection could be effective. Similar results were obtained by Verma *et al.* (2002), Singh and Singh (2010) and Anuja and Jahnvi (2012). The phenotypic and genotypic coefficient of variation measure the extent of variation present in the population in the particular characters. In the present investigation, phenotypic coefficient variation (PCV) was higher than those of genotypic coefficient of variation (GCV) for all the characters under study denoting the environmental factors influenced their expression to some degree which is in accordance with findings of Anuja and Jahanvi (2012), Kumar *et al.* (2014), Namita *et al.* (2008), Sapna *et al.* (2013), Singh and Singh (2010), Singh *et al.* (2014) as well as Yuvraj and Dhatt (2014) in marigold.

The high magnitude for genotypic and phenotypic coefficient of variation (per cent) was observed for most of the characters *viz.*, plant height (GCV= 21.85, PCV =25.05) , number of secondary branches per plant (GCV= 20.73, PCV =21.96), leaf area (GCV= 39.35, PCV =40.66), leaf biomass (GCV= 38.71, PCV =41.10), photosynthetic rate (GCV= 27.48, PCV =28.45), flower weight (GCV= 21.07, PCV =23.08), number of flowers per plant (GCV= 20.10, PCV =21.63), flower yield per plant (GCV= 31.52, PCV =34.64), seed yield per plant (GCV= 32.68, PCV =36.57) and carotenoid content (GCV= 38.05, PCV =38.08), which indicated wide diversity for these characters and the selection for these traits would be effective as well as high scope for improvement. These results are in line with the findings of Anuja and Jahanvi (2012), Kumar *et al*. (2014), Sapna *et al*. (2013), Singh and Singh (2010) and Yuvraj and Dhatt (2014) in marigold.

Heritability is an important genotypic parameter, which serves as an index of transmissibility of the characters in the next generation. The higher estimate of broad sense heritability (more than 60%) was observed for most of the characters *viz.*, plant height (75.91), plant spread (87.01), number of primary branches per plant (64.66), number of secondary branches per plant (89.13), stem diameter (74.56), leaf area (93.68), leaf biomass (88.72), photosynthetic rate (93.27), days to first flowering (68.23), duration of flowering (88.56), flower diameter (71.92), flower weight (83.60), number of flowers per plant (86.35), flower yield per plant (82.81), flower longevity (81.02), 1000-seed weight (80.93), seed yield per plant (79.84) and carotenoid content (99.28). Similar results were also reported by Anuja and Jahnvi (2012), Namita *et al.* (2008), Sapna *et al.* (2013) and Singh *et al.* (2014) in marigold.

High genetic advance as percentage of mean (20% and above) was observed for characters *viz.*, plant height (75.91), plant spread (87.01), number of secondary branches per plant (89.13), leaf area (93.68), leaf biomass (88.72), photosynthetic rate (93.27), duration of flowering (88.56), flower diameter (71.92), flower weight (83.60), number of flower per plants (86.35), flower yield per plant (82.81), flower longevity (81.02), 1000-seed weight (80.93), seed yield per plant(79.84), and carotenoid content (990.28). These findings are in accordance with the findings of Anuja and Jahanvi (2012), Namita *et al.* (2008), Sapna *et al.* (2013), Singh and Singh (2010), Singh *et al.* (2014) as well as Yuvraj and Dhatt (2014) in marigold.

In the present study, the highest estimates of broad sense heritability (more than 60%) coupled with high genetic advance as percentage of mean (more than 20%) was observed for carotenoid content (h^2=99.28, GA=78.09) followed by leaf area (h^2=93.68, GA=78.46) , photosynthetic rate (h^2=93.27, GA=54.67), number of secondary branches per plant (h^2=89.13, GA=40.32), leaf biomass (h^2=88.72, GA=75.12), duration of flowering (h^2= 88.56, GA=37.90), plant spread (h^2=87.01, GA=35.46), number of flowers per plant (h^2=86.35, GA=38.48), flower weight (h^2=83.60, GA=39.68), flower yield per plant (h^2=82.81, GA=59.08), flower longevity (h^2=81.02, GA=59.08), 1000-seed weight (h^2=80.93, GA=25.04), seed yield per plant (h^2=79.84, GA=60.15), plant height (h^2= 75.91, GA=39.22) and flower diameter (h^2=71.92, GA=28.21). Similarly, Anuja and Jahanvi (2012), Sapna *et al.* (2013), Singh and Singh (2010) and Yuvraj and Dhatt (2014) also observed broad sense heritability coupled with high genetic advance for various vegetative and flowering parameters in marigold.

References

Allard, R.W. 1960. *Principles of Plant Breeding*. John Willey and Sons, Inc., New York.

Anuja, S. and Jahnavi, K. 2012. Variability, heritability and genetic advance studies in French marigold (*Tagetes patula* L.). *Asian J. Hort*., **7**(2): 362-64.

Burton, G.W. 1952. Quantitative inheritance in grasses. *Proceeding of the International Grassland Congress*, **6**: 277-83.

Hanson, C.H., Robinson, H.F. and Comstock, R.E. 1956. Biometrical studies of yield in segregating population of Korean *Lespedeza*. *Agron. J.*, **48**: 268-72.

Johnson, H.W., Robinson, H.F. and Constock, R.E. 1955. Estimate of genetic and environmental variability in soyabeans. *Agron. J.*, **47**:314-18.

Kumar, A., Pratap, K. and Karma B. 2014. Studies on genetic variability and character association in French marigold (*Tagetes patula* L.). *Trends in Bioscience*, **7**(2):122-24.

Namita, Singh K.P., Raju, D.V.S. and Bharadwaj, K.V. 2008. Studies on genetic variability, heritability and genetic advance in French marigold (*Tagetes patula* L.) genotypes. *J. Ornam. Hort.*, **12** (1): 30-34.

Panse, V.G. and Shukhatme, P.V. 1978. *"Statistical Methods For Agricultural Workers"*(3rd end.). Indian Council of Agricultural Research, New Delhi, India, pp: 152-61.

Sapna P., Singh, K.P., Janakiram, T. and Namita. 2013. Genetic variability, heritability and genetic advance in African marigold (*Tagetes erecta* L.) genotypes. *Prog. Hort.*, **45** (1):135-40.

Singh, A.K. and Singh, D. 2010. Genetic variability, heritability and genetic advance in marigold. *Indian J. Hort*., **67**(1): 132-36.

Singh, K.P., Raju, D.V.S., Namita and Janakiram, T. 2014. Determination of genetic variation for vegetative and floral traits in African marigold (*Tagetes erecta* L.). *Indian J. Agril. Sci.*, **84**(9): 1057-62.

Verma, S.K., Singh R.K., Arya R.R., Misra R.L. and Misra, S. 2002. Genotypic and phenotypic variability in marigold. Floriculture Research Trend in India. *Proc. National Symposium on Indian Floriculture in New Millennium*. pp. 330-31.

Yuvraj and Dhatt, K.K. 2014. Studies on genetic variability, heritability and genetic advance in marigold. *Indian J. Hort*., **71** (4): 592-94.

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Table 1. Analysis of variance showing mean square for twenty characters in marigold (pooled)

		CHARACTERS									
Source	**d.f.**	**Plant height (cm)**	**Plant spread (cm)**	**Number of primary branches per plant**	**Number of secondary branches per plant**	**Stem diameter (mm)**	**Leaf area (cm^2)**	**Leaf biomass (g)**	**Photosynthetic rate ($\mu mol/m^2/sec$)**	**Days to first flowering**	**Duration of flowering (days)**
Location	2	31461.97**	4074.97**	97.53**	12671.73**	107.66**	533.19**	33562.22**	343.80**	786.94**	6656.06**
Replication(Location)	6	44.95**	8.02**	0.64	195.94**	0.32	1.01	112.08**	0.70	1.66	20.69**
Genotypes (G)	25	1894.92**	570.97**	12.83**	396.62**	13.54**	698.42**	9861.22**	301.08**	396.51**	2216.04**
Interactions (G x E)	50	299.58**	64.05**	2.31**	70.86**	3.15**	34.23**	506.09**	9.31**	90.61**	202.34**
Error	150	56.25	8.41	0.64	4.41	0.39	4.98	132.12	2.34	15.82	28.91
C.D. at 5%		6.93	2.68	0.74	1.94	0.58	2.06	10.62	1.41	3.68	4.97
S.Em. ±		2.50	0.97	0.27	0.70	0.21	0.74	3.83	0.51	1.33	1.79
C. V. %		12.31	7.13	7.77	7.24	6.02	10.22	13.80	7.38	7.03	7.03
		CHARACTERS									
Source	**d.f.**	**Flower diameter (mm)**	**Flower weight (g)**	**Number of flowers / plant**	**Flower yield / plant (g)**	**Flower longevity (days)**	**Shelf life of flower (days)**	**1000 seed weight (g)**	**Seed yield /plant (g)**	**Harvest index (%)**	**Carotenoid content (mg/100g)**
Location	2	8976.13**	310.43**	13952.11**	2808726.00**	688.98**	11.43**	13.24**	13250.75**	1356.06**	661.00**
Replication(Location)	6	28.70**	1.26	4.17**	1446.33**	3.90**	0.03	0.03	335.83**	37.09**	17.33**
Genotypes (G)	25	957.56**	45.83**	604.18**	145789.27**	379.53**	1.76**	1.81**	14595.26**	245.92**	110604.60**
Interactions (G x E)	50	86.67**	11.58**	176.52**	52597.91**	53.12**	0.61	0.16	3244.61**	47.72**	83.62**
Error	150	37.79	0.75	7.51	2149.82	8.50	0.09	0.04	318.43	30.90	89.28
C.D. at 5%		5.68	0.80	2.53	42.84	2.69	0.28	0.19	16.49	5.14	8.73
S.Em. ±		2.05	0.29	0.91	15.46	0.97	0.10	0.07	5.95	1.85	3.15
C. V. %		10.09	9.33	7.99	14.36	6.23	7.12	6.56	16.42	10.96	3.24

*, ** Significant at 5 % and 1 % level, respectively against pooled error

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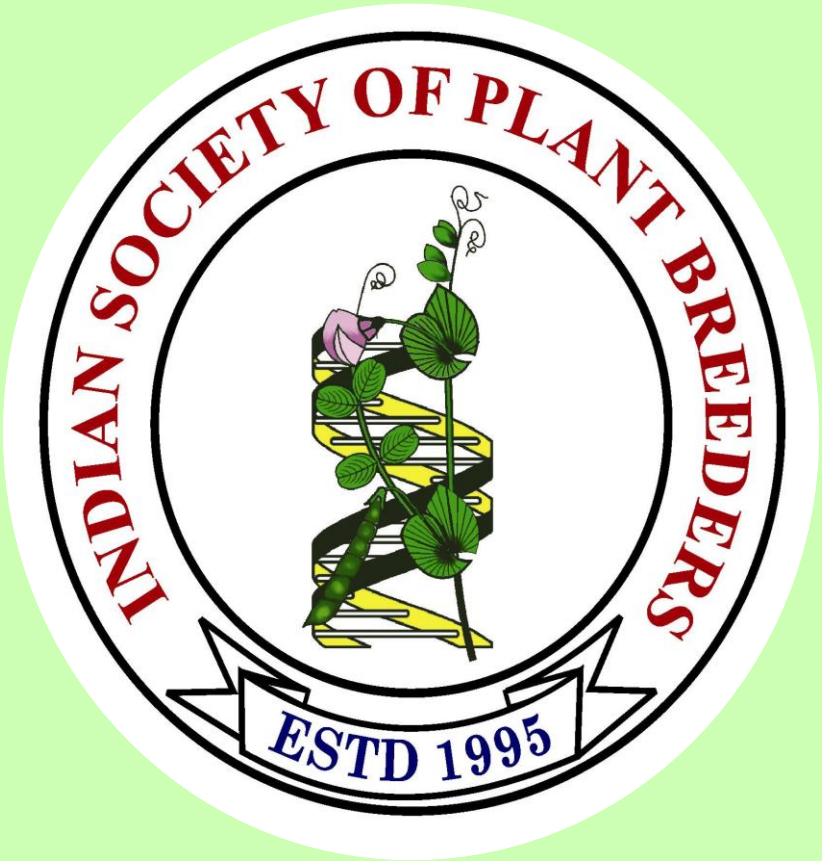
Table 2. General mean, phenotypic range, variance components, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance (% of mean) of twenty six marigold genotypes (pooled)

Character	General mean	Range (phenotypic)	Genotypic variance	Phenotypic variance	Environmental variance	GCV (%)	PCV (%)	H^2 (b)	G. A as % of mean
Plant height (cm)	60.93	28.07 - 76.58	177.26	233.51	56.25	21.85	25.08	75.91	39.22
Plant spread (cm)	40.67	22.18 - 50.23	56.32	64.73	8.41	18.45	19.78	87.01	35.46
Number of primary branches per plant	10.28	7.93-13.16	1.17	1.81	0.64	10.51	13.08	64.66	17.42
Number of secondary branches per plant	29.02	14.82 - 37.22	36.20	40.61	4.41	20.73	21.96	89.13	40.32
Stem diameter (mm)	10.43	6.40 - 12.09	1.15	1.55	0.39	10.30	11.93	74.56	18.32
Leaf area (cm^2)	21.83	9.75 - 47.74	73.80	78.78	4.98	39.35	40.66	93.68	78.46
Leaf biomass (g)	83.28	35.72 - 150.16	1039.46	1171.58	132.12	38.71	41.10	88.72	75.12
Photosynthetic rate (µmol/m^2/sec)	20.72	7.91 - 28.61	32.42	34.76	2.34	27.48	28.45	93.27	54.67
Days to first flowering	56.56	43.36 - 75.47	33.99	49.81	15.82	10.31	12.48	68.23	17.54
Duration of flowering (days)	76.51	47.69 - 110.51	223.74	252.66	28.91	19.55	20.78	88.56	37.90
Flower diameter (mm)	63.91	41.56 - 81.63	96.77	134.55	37.79	15.39	18.15	71.92	28.21
Flower weight (g)	9.26	5.58 - 12.82	3.81	4.55	0.75	21.07	23.04	83.60	39.68
Number of flowers / plant	34.29	19.22 - 50.67	47.52	55.03	7.51	20.10	21.63	86.35	38.48
Flower yield / plant (g)	322.86	115.53 - 575.41	10354.60	12504.42	2149.82	31.52	34.64	82.81	59.08
Flower longevity (days)	46.78	34.58 - 59.11	36.27	44.77	8.50	12.87	14.30	81.02	23.87
Shelf life of flower (days)	4.24	3.09 - 4.89	0.13	0.22	0.09	8.43	11.04	58.34	13.27
1000 seed weight (g)	3.17	2.43 - 4.34	0.18	0.23	0.04	13.51	15.02	80.93	25.04
Seed yield /plant (g)	108.67	26.60 - 171.55	1261.18	1579.62	318.43	32.68	36.57	79.84	60.15
Harvest index (%)	50.71	42.06 - 62.45	22.02	52.92	30.90	9.25	14.35	41.62	12.30
Carotenoid content (mg/100g)	291.27	38.18 - 436.03	12280.11	12369.39	89.28	38.05	38.18	99.28	78.09



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