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STUDIES ON GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN AFRICAN MARIGOLD (*Tagetes erecta* L.)

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ABSTRACT
The present investigation on variability, heritability and genetic advance in seventeen African marigold genotypes was carried out for plant growth and flower yield. The vegetative and flowering characters varied significantly among the genotypes. The highest value of GCV and PCV was observed for dry flower weight per plant (37.0% and 37.46%, respectively). High heritability was observed for xanthophyll content (99.9%), followed by dry flower weight per plant (97.53%). Plant height (95.0%), number of leaves per plant (94.8%).The estimates of genetic advance were comparatively maximum for number of leaves per plant (80.71%) followed by plant height (39.67%). For all the parameters, the estimates of phenotypic coefficient of variance (PCV) was higher as compared to genotypic coefficient variance (GCV), indicating the role of environmental factors for the expression of these characters. This suggests the presence of sufficient genetic variability can be exploited by practicing pure line selection.

INTRODUCTION

Marigold (*Tageteserecta*L.) is one of the important commercial annual flower crop belonging to the family Asteraceae. African marigold is popular throughout the world because of wide spectrum of attractive colours, shape and good keeping quality has attracted the attention of flower growers. They are extensively used as loose flower, potted plant and also as a bedding plant. It has gained popularity in India on account of its easy cultivation, wide adaptability and production throughout the year.The sources of any breedingProgramme for developing suitable varieties dependslargely on the availability of genetic variability in a givenSpecies. Heritability estimates give a measure ofTransmission of characters from one generation to theother as consistency in the performance of the selectiondepends on the heritable portion of the variability.(Kavitha*et al*.2010).According to Karuppaiah*et al*.(2011) Before embarking on any selectionprogramme, it is imperative to have knowledgeon the magnitude of variability and the extentof heritable variation present in the materialfor the desired characters. Since the varianceinvolves units, the estimates like phenotypiccoefficient of variation (PCV) and genotypiccoefficient of variation (GCV), which are devoidof measurements, are essential for validcomparison of different characters.Success of crop improvement programme depends on the magnitude of the genetic variability and the efficiency of selection. Coefficient of variation (GCV and PCV) provides the estimate about the amount of variability present in the available genotypes.(Panwar *et al.,* 2013).Presently available loose flower varieties of African marigold are less vigorous, prone to lodging and low yielding. Development of high yielding semi tall varieties of marigold requires genetically stable genotypes having high yield Potential.(Bharathi*et al*.2014). Heritability alone is not useful for selection process. Heritability along with genetic advance increases the efficiency of selection in a breeding programme by assessing the influence of environmental factors and additive gene action. (Vishnupriy *et al.,* 2015).

Genetic variability plays an important role in crop breeding for selecting the elite genotypes for making rapid improvement in yield and other desirable characters as well as to select the potential parent for hybridization programme. Heritability is an index for calculating the relative influence of environment on expression of genotypes. It becomes very difficult to judge how much of the variability is heritable and how much is non-heritable. In Chhattisgarh, also marigold is one of the dominating flowers which fetches high price in the local market. Moreover, looking to the diverse marigold available in the different agro-climatic condition of Chhattisgarh, there is a scope of finding remarkable variations in the growth, flowering and xanthophyll content in the locally available marigold flowers.

Keeping these points in view, the present investigation was undertaken with an objective to find out the high yielding marigold genotype for Chhattisgarh plains and to find out genetic variation for growth and yield parameters.

MATERIALS AND METHODS

The present investigation was conducted at the Horticultural Research cum Instruction Farm of the Department of Floriculture and Landscape Architecture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during the kharif season of year 2015-2016.

The treatment consisted of seventeen genotypes of African marigold collected from diverse sources were used for present study. The experimental field was laid out in Randomized Block Design with three replications. The seeds of all the genotypes were sown in the nursery beds to raise seedlings and transplanting was done after 23 days of sowing with spacing of 40 x 40 cm between rows and plants within a row. The observations were recorded on five random competitive plants from each replication after discarding the border plants. The genotypes were assessed and observations were recorded for various growth and flowering related traits *viz*. plant height (cm), plant spread (cm), number of primary branches per plant, number of secondary branches per plant, number of leaves per plant, days to 50% flowering, number of flowers per plant, flower diameter (cm), flower yield per plant (kg), dry flower weight per plant(kg), flowering duration (days), xanthophyll content.The phenotypic and genotypic coefficient of variation was calculated according to Burton and De Vane (1953), heritability was calculated according to the Hanson *et al*. (1956) and genetic advance and genetic gain were calculated according to the formulae of Johnson *et al*. (1955).

RESULTS AND DISCUSSION

The plant height ranged from 73.73 cm to 141.66 cm (Table 1). The maximum plant height was recorded in the genotype CGSG-2 (141.66 cm) whereas, minimum plant height was recorded in the genotype pusabasanti (73.73 cm). The plant spread ranged from 37.00 cm to 56.66 cm. The maximum recorded in pusaarpita(56.66 cm) followed by pusabasanti(52.7 cm) and CGSG-1(50.63 cm) whereas, the minimum plant spread was noticed in CGMS-1 (37.00 cm). The maximum number of primary branches plant^{-1} was noticed in CGJS-2(12.46). Whereas, minimum number of primary branches plant^{-1} was recorded in CGRJ-1 (8.60). The maximum number of secondary branches plant^{-1} was recorded in CGRG-1(18.13). However, the minimum number of secondary branches plant^{-1} was recorded in CGJS-1-2 (6.80). Number of secondary branches plant^{-1} ranged from 6.80 to 18.13 with a grand mean of 11.61. The days to 50 percent flowering ranged from 54.66 to 78.33 Among all the genotypes, 50 per cent flowering was earliest in the genotype pusabasanti(54.66 days). Whereas, pusaarpita(78.33 days) took the maximum number of days for 50 per cent flowering. Significantly maximum number of flowers plant^{-1} (85.66) was recorded in the genotype CGJS-1 followed by the genotype CGJS-2 (85.00) and CGMS-2 (84.00) and minimum number of flowers plant^{-1} was recorded in the genotype CGR-3 (48.33). The number of flowers plant^{-1} ranged from 48.33 to 85.66. The flower diameter (cm) ranged between 3.10 to 4.50 cm with grand mean of 4.06 cm. The genotype CGRG-1recorded maximum flower diameter (4.60 cm) and minimum flower diameter was observed in pusaarpita (3.10 cm). The maximum flower yield plant^{-1} (kg) was recorded in CGJS-2(0.362 kg). However, minimum flower yield plant $^{-1}$ was obtained in pusaarpita(0.148 kg) and its ranged from 0.148 kg to 0.362 kg. The genotype CGSG-1 recorded longest duration of flowering (62.00 days) followed by CGSG-2 and pusanarangi(60.66 and 59.33 days, respectively) whereas, the minimum duration of flowering was observed in CGJS-1

Table 1: Mean performance of deferent characters in African marigold genotypes

Treatment	Characters												
	1	2	3	4	5	6	7	8	9	10	11	12	13
CGRG-1	136.00	11.13	18.13	41.73	141.23	65.33	63.66	4.60	0.229	0.055	51.00	9.17	15.96
CGJS-1	92.66	9.13	7.46	45.33	78.13	55.33	85.66	4.10	0.229	0.037	48.33	9.14	16.23
CGJS-2	114.66	12.46	16.33	43.00	170.16	64.66	85.00	4.30	0.362	0.087	56.66	14.49	17.94
CGRJ-1	113.20	8.60	15.46	48.13	181.00	60.00	55.66	3.40	0.215	0.048	53.66	8.61	14.13
CGMS-1	92.86	7.46	9.86	37.00	86.40	61.00	66.66	3.40	0.236	0.051	56.33	9.42	15.24
CGMS-2	108.93	8.20	12.60	38.90	96.66	62.66	84.00	4.26	0.227	0.038	54.00	9.07	19.79
CGSG-1	120.33	11.63	14.26	50.63	179.70	64.66	50.66	3.66	0.243	0.053	62.00	9.72	14.97
CGDU-1	110.86	9.43	11.60	46.43	116.86	64.33	73.33	4.33	0.228	0.050	53.33	9.10	16.16
CGSG-2	141.66	9.13	12.60	47.66	134.33	64.66	64.00	4.26	0.226	0.054	60.66	9.02	20.20
CGR-1	125.20	9.06	13.46	46.10	132.40	66.33	64.33	4.30	0.243	0.063	52.33	9.70	14.20
CGR-2	115.26	9.20	14.13	40.93	70.06	64.00	60.00	4.20	0.170	0.031	51.00	6.79	14.58
CGR-3	124.26	8.43	6.73	39.53	92.10	62.66	48.33	4.30	0.187	0.036	53.00	7.47	16.25
CGJS-1-1	120.46	9.76	9.06	37.16	120.06	65.33	49.33	4.03	0.153	0.037	52.33	6.11	15.49
CGJS-1-2	129.40	8.36	6.80	39.43	67.76	64.66	51.66	4.10	0.131	0.018	54.66	5.22	14.82
PusaBasanti	73.73	6.63	8.93	52.70	52.40	54.66	77.66	4.50	0.264	0.074	51.66	10.56	15.78
PusaArpita	85.33	7.80	8.86	56.66	66.13	78.33	63.33	3.15	0.149	0.023	51.33	5.95	16.22
PusaNarangi	77.20	9.80	11.20	39.70	108.20	56.00	73.33	4.14	0.286	0.063	59.33	11.43	20.09
SEm+	2.60	0.24	0.49	1.25	5.46	2.26	1.70	0.15	0.007	0.0016	0.83	0.34	0.02
C.D. at 5%	7.50	0.70	1.42	3.61	15.75	6.53	4.91	0.45	0.022	0.004	2.40	0.99	0.07

1.Plant height (cm)
2.Plant spread (cm)
3.Number of primary branches plant^{-1}
4.Number of secondary branches plant^{-1}
5.Number of leaves plant^{-1}
6.Days to 50% flowering
7.Number of flowers plant^{-1}
8.Flower diameter (cm)
9.Fresh flower weight plant^{-1} (kg)
10.Dry flower weight plant^{-1} (kg)
11.Flowering duration (days)
12.Yield hectare^{-1} (t)
13.Xanthophyll content

Table 2: Estimation of genetic parameter of deferent characters of African marigold genotypes

S.N.	Characters	GCV (%)	PCV (%)	Heritability %	Genetic Advance	GA as % mean
1	Plant height	17.84	18.30	95.0	39.67	35.83
2	Plant spread	12.57	13.50	86.7	10.65	24.11
3	Primary branches /plant	15.93	16.53	92.2	2.9	31.51
4	Secondary branches/plant	29.13	30.05	94.0	6.76	58.17
5	Number of leaves/plant	36.13	37.12	94.8	80.71	72.45
6	Days to 50% flowering	7.69	9.89	60.5	7.79	12.32
7	Number of flowers/plant	18.81	19.33	94.6	24.82	37.67
8	Diameter of flower	9.54	11.67	66.8	0.65	16.05
9	Fresh flower weight/plant	24.72	25.46	92.2	0.11	49.44
10	Dry flower weight/plant	37.0	37.46	97.53	0.03	75.27
11	Flowering duration	6.65	7.16	86.1	6.89	12.70
12	Xanthophyll content	12.09	12.09	99.9	4.07	24.89

Table 3: Genetic parameters for different characters in African marigold genotypes

SN.	Characters	GCV	PCV	Heritability	GA as per cent of mean
1	Plant height	M	M	H	H
2	Plant spread	M	M	H	H
3	Primary branches /plant	M	M	H	H
4	Secondary branches/plant	H	H	H	H
5	Number of leaves/plant	H	H	H	H
6	Days to 50% flowering	L	L	H	M
7	Number of flowers/plant	M	M	H	H
8	Diameter of flower	L	M	H	M
9	Fresh flower weight/plant	H	H	H	H
10	Dry flower weight/plant	H	H	H	H
11	Flowering duration	L	L	H	M
12	Yield/ha	H	H	H	H
13	Xanthophyll content	M	M	H	H

L = Low, M = medium, H = High

(48.33 days). Flowering duration varied from 48.33 to 62.00 days. The xanthophyll content range varied from 14.13 g to 20.20 g. Significantly maximum xanthophyll content (20.20 g) was recorded in the genotype CGSG-2 followed by pusanarangi(20.09 g) and CGMS-2 (19.79 g). Minimum xanthophyll content was recorded in CGRJ-1(14.13 g).

Genetic variability

The coefficient of variation was estimated at genotypic and phenotypic levels for each character (Table 2 and 3). High genotypic coefficient of variation was recorded for dry flower weight plant^{-1} (37.0%), number of leaves plant $^{-1}$ (36.13%), number of secondary branches plant^{-1} (29.13%) and fresh flower weight plant^{-1} (24.72%). Moderate genotypic coefficient of variation was observed in number of flowers plant^{-1} (18.81%), plant height (17.84%), number of primary branches plant^{-1} (15.93%), plant spread (12.57%) and xanthophyll content (12.09%).

High phenotypic coefficient of variation was recorded for dry flower weight plant^{-1} (37.46%), number of leaves plant^{-1} (37.12%), number of secondary branches plant^{-1} (30.05%) and fresh flower weight plant^{-1} (25.46%). Moderate phenotypic coefficient of variation was observed in number of flowers plant^{-1} (19.33%), plant height (18.30%) number of primary branches plant^{-1} (16.53%), plant spread (13.50%), xanthophyll content (12.09%) and diameter of flower (11.67%). Low phenotypic coefficient of variation was observed in flowering duration (7.16%) and days to 50% flowering (9.89%).

For all the parameters, the estimates of phenotypic coefficient of variance (PCV) was higher as compared to genotypic coefficient variance (GCV), indicating the role of environmental factors for the expression of these characters. However, apart from flower weight plant^{-1} and xanthophyll content the difference among genotypic coefficient variance and phenotypic coefficient variance was very less for rest of the characters, indicating the fact that these characters are not much influenced by environmental factors. This also suggests the presence of sufficient genetic variability, which can be exploited by practicing pure line selection. The results are in conformity with the findings of also reported similar finding Karuppaiah and Kumar(2010) in African marigold, Panwar*et al*. (2013) in African marigold and Sharma *et al*. (2011) in French marigold.

Heritability and Genetic advance

The estimates of heritability, genetic advance and genetic advance as a per cent of mean in African marigold genotypes obtained from the present study (Table2). High heritability (99.9%) coupled with 4.07% genetic advance and high genetic advance as percentage of mean (24.89%) was noticed for xanthophyll content. Similarly, high heritability (97.53%) coupled with 0.03% genetic advance and high genetic advance as percentage of mean (75.27%) was noticed for dry

flower weight plant^{-1}. High heritability (95.0%) coupled with 39.67 % genetic advance and high genetic advance as percentage of mean (35.83%) was observed for plant height. In case of number of leaves plant^{-1}, high heritability (94.8%), 80.71% genetic advance and high genetic advance as percentage of mean (72.45%) was recorded as also in number of flowers plant^{-1} where high heritability (94.6%), 24.82% genetic advance and high genetic advance as percentage of mean (37.67%) was recorded and also in number of secondary branches plant^{-1} high heritability (94.0%) coupled with 6.76 % genetic advance and high genetic advance as percentage of mean (58.17%) was obtained. Likewise, high heritability (92.2%) coupled with 0.11 % genetic advance and high genetic advance as percentage of mean (49.44%) was observed for fresh flower weight plant^{-1} and number of primary branches plant^{-1} (92.2%, 2.9% and 31.51%, respectively).

Similarly, for plant spread, high heritability (86.7%) coupled with 10.65 % genetic advance and high genetic advance as percentage of mean (24.11%) was recorded. In case of flowering duration, high heritability (86.1%), 6.89% genetic advance and moderate genetic advance as percentage of mean (12.70%) was recorded as also in diameter of flower where in high heritability (66.8%), 0.65% genetic advance and moderate genetic advance as percentage of mean (16.05%) was recorded. For the days to 50% flowering, high heritability (60.5%), 7.79% genetic advance and moderate genetic advance as percentage of mean (12.32%) was observed. It indicates that these characters are highly heritable and the phenotypic values could give a fairly good idea about their genetic potential but it does not mean a high genetic gain. However, high heritability associated with high genetic advance proves more useful for efficient improvement of a character through simple selection. When high heritability is accompanied with high genetic advance, it indicates additive gene effect and selection may be effective. Similar findings were also observed by Karuppaiah and Kuamr(2010) in African marigold, Yuvraj and Dhatt (2014) in marigold and Sharma *et al*. (2011) in French marigold. It is, thus, obvious from the above findings that these are the most suitable characters for selection.

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