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Short communication

Genetic variability, heritability and genetic advance in marigold

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Genetic variability in a group of germplasm is a pre-requisite for a successful breeding programme. Since, most of the characters influencing yield are polygenic, it is essential for plant breeders to estimate the type of variation available in the germplasm. Therefore, the present investigation was undertaken to estimate the magnitude and nature of variation in the collected germplasm of marigold with respect to different growth, floral and seed traits which can be used in the improvement programme.

The experiment was carried out at Horticulture Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar. The experimental material consisted 44 genotypes of marigold *viz.*, 29 of *Tagetes erecta* (TEG1 to TEG29), 13 of *T. patula* (TPG1 to TPG13) and 2 of *T. minuta* (TMG1 and TMG2). Seeds of germplasm were collected from National Bureau of Plant Genetic Resources Regional Station, Bhowali and different parts of India. The seeds of all the germplasm were sown on September on nursery beds in 44 separate plots. Uniform and healthy seedlings were transplanted on October 15. The plot size was kept 3.0 m × 2.0 m. Each plot consisted of 16 plants. All the cultural practices were adopted uniformly for all the genotypes. The experiment was laid out in randomized block design with three replications. Observations were recorded on growth, flowering and yield characters, *i.e.* number of primary branches/plant, plant height, plant spread, stem diameter, days taken to bud initiation, days taken to flowering, flower longevity, duration of flowering, flower diameter, number of flowers/plant, fresh weight of flower and weight of seeds/peduncle on four randomly selected plants from each genotype per replication. Method of Panse and Sukhatme (6) was applied for analysis of variance and interpretation of experimental data. Heritability in broad sense was estimated as suggested by Hanson *et al*. (3). Genetic advance (GA) was calculated according to the formula given by Johnson *et al.* (4).

Analysis of variance of all the three species for 12 different characters revealed significant differences among genotypes (Tables 1&2). This suggested the presence of wide range of variability for different characters in the materials studied. Maximum number of primary branches per plant, stem diameter and number of flowers per plant were in the genotype TMG1. While, TMG2 performed better in terms of plant height. Maximum plant spread was found in TEG21 followed by TEG22. Among the flowering characters, maximum days to flowering was taken by the genotype TEG28 followed by TEG26, while TPG7 showed earliest flower bud opening. Maximum flower longevity was observed in TEG17 followed by TEG26 and TPG3. Duration of flowering was maximum in TEG13 followed by TPG12. Maximum flower diameter and weight of seeds per peduncle were observed in TEG26 followed by TEG19 and TEG29, respectively. Germplasm TEG17 exhibited maximum fresh weight of flower which was statistically superior to others. The genotype TEG27 showed maximum weight of seeds per peduncle followed by TEG29, whereas minimum weight of seeds per peduncle was observed in TMG1 and TMG2. Variation in different genotypes of African marigold on various growth and flowering attributes have also been observed by Reddy *et al.* (9), and Sreekala *et al.* (11).

The phenotypic coefficients of variation (PCV) were higher than those of genotypic coefficients of variation (GCV) for the characters under study and are in agreement with the results of Ponnuswamy *et al.* (8). In this study, phenotypic and genotypic coefficients of variation were high for number of flowers per plant (PCV = 331.28; GCV = 331.22) followed by fresh weight of flower (PCV = 102.85; GCV = 102.79), weight of seeds per peduncle (PCV = 88.34; GCV = 88.32), plant height (PCV = 63.40; GCV = 62.92) and number of primary branches per plant (PCV = 54.04; GCV = 53.49). It was least for days taken to bud initiation (PCV = 19.18; GCV = 17.17) and duration of flowering (PCV = 18.90 and GCV = 78.39). Similar results were obtained by Patnaik and Mohanty (7), and Chaugule (2) while working with chrysanthemum. Variability was observed in different characters in marigold by Nand Kishore and Raghava (5). The heritability estimates obtained were generally high for all the characters studied indicating a great scope for improvement of these characters through selection. High heritability estimates were also reported by Chaugule (2) for number and weight of flowers per plant. High heritability

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Table 1. Mean performance of marigold germplasm with respect to different traits.

Germplasm	No. of primary branches/ plant	Plant height (cm)	Spread of plant (cm)	Stem dia. (cm)	Days taken to bud initiation	Days taken to flowering	Flower longevity (days)	Duration of flowering (days)	Flower dia. (cm)	No. of flowers/ plant	Fresh weight of flower (g)	Weight of seeds/ peduncle (g)
TEG1	11.67	59.90	46.45	0.77	20.00	57.33	45.67	126.00	5.57	47.33	3.73	1.52
TEG2	15.33	60.23	48.12	1.13	24.67	58.00	39.00	84.3	6.77	45.33	5.93	0.98
TEG3	13.33	58.77	44.30	1.13	23.00	58.33	47.67	102.33	6.13	32.33	7.27	0.74
TEG4	11.33	49.57	40.77	1.53	30.67	74.00	34.33	82.67	4.17	24.33	2.94	1.26
TEG5	13.33	54.07	52.43	1.13	21.67	56.00	56.67	84.33	4.63	77.00	6.57	0.97
TEG6	12.00	62.87	60.30	1.03	24.67	53.00	45.33	93.33	7.36	28.00	8.14	1.36
TEG7	12.00	63.07	54.08	1.17	13.67	46.67	48.00	107.67	2.70	60.00	0.77	0.11
TEG8	18.67	55.67	44.25	1.37	18.00	56.67	36.33	97.00	4.80	27.33	2.08	0.92
TEG9	11.33	64.37	35.70	0.97	25.33	70.00	28.33	86.67	5.63	24.33	3.07	0.86
TEG10	16.00	63.97	36.85	1.23	23.00	61.33	33.67	123.00	5.13	23.33	3.43	0.76
TEG11	14.00	51.07	66.13	0.73	22.00	55.00	40.00	105.67	4.80	34.33	5.34	0.95
TEG12	12.67	63.97	45.77	0.87	26.00	71.33	35.00	98.00	7.23	35.67	12.42	0.90
TEG13	14.00	43.60	53.13	1.03	22.67	58.33	52.33	135.33	8.63	34.00	10.12	0.76
TEG14	16.67	60.00	48.70	1.73	26.67	61.67	40.67	86.33	8.13	40.67	6.68	0.86
TEG15	14.00	57.53	47.73	1.37	25.33	58.00	45.33	93.33	7.23	27.67	5.52	0.91
TEG16	18.00	50.90	64.43	1.30	21.33	60.00	47.67	87.67	4.27	85.67	2.36	0.67
TEG17	15.00	51.43	58.53	1.40	29.00	74.67	66.00	76.67	8.67	47.00	26.06	0.94
TEG18	9.00	37.00	67.33	1.73	28.67	74.33	35.00	83.67	5.67	35.33	8.39	0.88
TEG19	17.33	56.07	67.20	1.40	24.67	63.00	49.00	91.67	9.83	62.67	23.90	0.78
TEG20	10.00	56.87	64.30	1.50	18.33	70.33	43.67	72.67	7.70	44.00	10.57	0.93
TEG21	11.00	54.57	79.10	0.87	15.33	54.00	51.33	92.00	6.53	53.33	9.41	0.67
TEG22	13.33	66.57	70.30	1.27	16.00	47.67	57.00	116.67	6.03	47.67	3.56	0.94
TEG23	6.00	56.23	56.17	0.50	19.67	55.33	37.33	94.00	6.37	20.00	7.90	0.88
TEG24	10.00	66.53	57.80	1.53	28.33	74.67	49.00	75.33	5.80	33.67	4.57	0.78
TEG25	8.00	70.57	67.70	1.57	24.00	60.33	43.67	88.33	5.80	39.33	4.84	0.93
TEG26	15.67	73.10	55.43	1.77	22.67	84.00	57.33	68.67	10.83	53.00	16.57	3.10
TEG27	13.00	65.20	45.83	1.60	24.00	51.33	53.33	76.33	5.00	59.67	5.57	0.66

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Germplasm	No. of primary branches/ plant	Plant height (cm)	Spread of plant (cm)	Stem dia. (cm)	Days taken to bud initiation	Days taken to flowering	Flower longevity (days)	Duration of flowering (days)	Flower dia. (cm)	No. of flowers/ plant	Fresh weight of flower (g)	Weight of seeds/ peduncle (g)
TEG28	13.00	61.07	59.00	1.37	27.33	87.00	55.00	54.33	8.27	27.00	10.37	2.50
TEG29	13.00	62.47	67.33	1.37	26.67	79.33	36.33	72.67	7.53	46.67	11.80	2.65
TPG1	14.67	34.67	19.87	0.70	24.67	51.00	42.67	105.00	3.67	127.67	1.55	0.13
TPG2	10.00	27.23	24.17	0.83	23.33	49.67	49.00	105.00	3.50	70.33	1.68	0.15
TPG3	12.00	33.40	21.10	1.00	19.33	47.67	57.33	103.67	2.87	62.33	2.74	0.28
TPG4	12.00	44.63	21.02	0.77	23.33	46.67	56.67	102.33	3.53	119.67	1.07	0.17
TPG5	12.00	32.67	24.67	0.67	22.00	47.67	55.67	110.67	3.37	110.00	1.13	0.22
TPG6	12.67	29.40	25.60	1.10	23.00	41.67	44.67	110.33	2.83	113.33	0.92	0.09
TPG7	12.00	34.00	24.80	0.67	23.00	41.33	48.33	111.33	4.03	158.67	1.95	0.11
TPG8	10.67	47.12	25.70	1.07	23.67	39.33	37.33	104.67	3.83	95.00	1.34	0.12
TPG9	12.00	32.00	24.97	1.57	22.67	36.67	54.00	120.00	3.90	110.00	1.74	0.16
TPG10	13.33	43.37	22.33	0.77	23.33	39.33	40.00	117.00	2.70	107.00	0.85	0.12
TPG11	13.33	34.70	23.90	0.53	27.33	49.00	36.67	127.33	2.73	147.67	0.77	0.08
TPG12	11.33	37.40	24.97	0.43	23.33	38.67	27.33	131.00	3.27	104.33	1.11	0.23
TPG13	13.33	38.77	42.90	0.27	22.00	35.00	37.00	113.33	2.83	64.33	0.86	0.17
TMG1	53.67	208.20	63.67	1.93	36.67	61.33	32.67	108.33	0.60	3673.67	0.03	0.04
TMG2	39.67	226.87	59.47	1.83	31.33	62.67	26.00	118.67	0.40	3194.00	0.02	0.04
General mean	14.35	58.99	46.69	1.17	23.73	57.26	44.67	98.76	5.26	215.34	5.63	0.82
CD at 5%	1.79	7.43	4.93	0.16	3.30	5.63	2.58	6.95	0.17	11.01	0.318	0.02

Table 2. Estimates of variance and other genetic parameters in *Tagetes* spp.

Trait	Range	General mean ± SE	Phenotypic variance	Genotypic variance	PCV	GCV	Heritability (h^2) %	Genetic advance	Genetic gain (%)
Number of primary branches/plant	6.00-53.67	14.35 ± 0.64	60.13	58.90	54.04	53.48	97.97	15.64	108.94
Plant height (cm)	27.23-226.87	58.99 ± 2.64	1396.32	1375.26	63.40	62.92	98.50	75.89	128.64
Plant spread (cm)	18.87-79.10	46.69 ± 1.76	293.93	284.73	36.77	36.19	96.86	34.75	73.36
Stem diameter (cm)	0.43-1.93	1.17 ± 0.06	0.15	0.15	33.72	32.63	93.59	0.76	64.95
Days taken to bud initiation	13.67-36.67	23.73 ± 1.17	20.74	16.60	19.18	17.17	80.06	7.51	31.68
Days taken to flowering	35.00-87.00	57.26 ± 2.00	172.28	160.33	22.94	22.13	93.02	25.17	43.95
Flower longevity (days)	26.00-66.00	44.67 ± 0.92	94.05	91.55	21.71	21.42	97.31	19.44	43.51
Duration of flowering (days)	54.33-135.33	98.76 ± 2.47	348.40	329.86	18.90	18.39	94.73	36.42	36.87
Flower diameter (cm)	0.40-10.83	5.26 ± 0.06	5.36	5.35	44.02	43.98	99.80	4.75	90.30
Number of flowers/ plant	20.00-367.67	215.34 ± 3.92	508662.85	508724.28	331.28	331.12	99.99	1469.18	682.26
Fresh weight of one flower (g)	0.02-26.06	5.63 ± 0.11	33.53	33.49	102.85	102.79	99.88	11.90	211.36
Weight of seeds/ peduncle (g)	0.04-3.10	0.82 ± 0.007	0.52	0.52	88.34	88.32	99.97	1.50	182.93

PCV: Phenotypic coefficient of variation, GCV : Genotypic coefficient of variation.

with low genetic advance was observed for days taken to bud initiation and duration of flowering. Heritability along with genetic gain is more useful criterion in predicting the resultant effect for selecting the best individual (Johnson *et al.*, 4). In the present study, number of flowers per plant showed the high heritability (99.99%) along with maximum genetic gain (682.26) followed by fresh weight of flower, weight of seed per peduncle, plant height, number of primary branches per plant and diameter of flower. These results are in accordance with the findings of Barad (1) who suggested that crop improvement could be brought about by practicing phenotypic selection in marigold. Similar results were obtained by Singh *et al.* (10).

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