International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 1777-1780

Received: 04-07-2018
Accepted: 05-08-2018

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Studies on variability, heritability and genetic advance in genotypes of *Tagetes erecta* L.

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Abstract
Thirty one genotypes of African marigold (*Tagetes erecta* L). Collected from different indigenous sources were evaluated at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam to know the nature and magnitude of variability among them for different horticultural traits. The study revealed high phenotypic coefficient of variability (PCV), genotypic coefficient of variability (GCV) and heritability estimates coupled with high genetic gain were observed for number of flowers per plant and flower yield per plant indicated the existence of wide range of variations and offers better scope for improvement through selection. The genotype AM-29 gave maximum mean value for number of flowers, flower diameter, individual flower weight, duration of flowering and total flower yield per plant.

Keywords: variability, heritability and genetic, genotypes, *Tagetes erecta*

Introduction
Tagetes erecta is often referred to as the African marigold. African marigold is not only grown as a free flowering annual in landscape but also as a rich source of pigment for poultry feed. It has large, showy, dense, almost spherical flowers which often will grow from a foot to three feet tall and ½ to one foot in diameter. Indian Production of marigold accounts 360.10 tonnes/ha. The leading states of marigold production are Karnataka, Gujarat, Maharashtra, Haryana, Andhra Pradesh, Orissa, Chhattisgarh, Uttar Pradesh. The marigold have yellow, orange or golden flowers, but some of the yellows are so pale that they look white. A few even have bicolor flowers. It has lot of variation with respect to growth and floral characters which varies with germplasm. Variability among genotypes is the pre requisite to exercise evaluation and selection. The extent of improvement depends upon the amount of variability in different characters in the crops, which is indispensible prerequisite for successful breeding programmes. High heritability along with high genetic advance as per cent of mean provides a best guiding to formulate an effective selection programme. Germplasm serves as a valuable natural reservoir in providing needed attributes for developing high yielding varieties. There is an urgent need to conserve and characterize the available variability and its evaluation, and to identify potential genotypes, which would result in further improvement and to develop cultivar for specific uses. Hence the investigation was carried out at Horticultural College and Research Institute, Periyakulam to conserve the African marigold germplasm and to find out the extent of variabilty among the available genotypes.

Materials and Method
The experimental material consisted of 31 genotypes of African marigold collected from different places of India. They were grown at Horticultural College and Research Institute, Tamil Nadu Agricultural University Periyakulam in Randomized Block Design with three replications during two seasons from August, 2013 to March, 2014. Observations of five plants in each replication was recorded for twenty quantitative characters *viz.*, germination percentage, plant height, internodal length, number of branches per plant, das to flowering, bud appearance, bud diameter, buds per plant, number of flowers per plant, flower diameter, flower stalk length, flower stalk girth, duration of flowering, days to harvest, shelf life, crop duration, individual flower weight, flower yield per plant, xanthophyll content and carotenoid content. Data from mean of individual genotypes were subjected to analysis of variance as suggested by Panse and Sukhatme (1967) [13]. The phenotypic and genotypic variances were calculated by utilizing the respective mean sum of square from variance table suggested by Lush (1940).

Heritability and genetic advance were calculated according to Allard (1960) [1] and genetic gain was estimated as per the method given by Johnson *et al*. (1955) [11].

Results and Discussion

Per se performance

Growth parameters

Characterization of germplasm and identification of genotypes based on morphological traits are considered as the most widely accepted tool in any crop improvement. Growth parameters are the ultimate determinants of flower yield in marigold. In the present study plant height, number of branches per plant, internodal length, days to flowering revealed remarkable variation among the different genotypes of marigold. Of all 31 genotypes of *Tagetes erecta* evaluated the mean performance of AM-29 excelled the others with regard to the growth characters such as number of branches (36.93) and days to flowering (48.40 days). These variations in plant growth traits may be attributed to the genetic characters of the plant. The results are in accordance with the findings of marigold; in chrysanthemum. They observed excellent yielding genotypes in marigold germplasm with characteristic features of its tallest nature, profuse branching and precocity in flowering. Similarly Gomathy (1996) [8] in marigold recorded the same results.

Yield parameters

The prime objective of marigold crop improvement is enhancement of yield. It is accepted that yield is a complex phenomenon which is influenced by a number of its component traits *viz.*, bud appearance, bud diameter, buds per plant, number of flowers per plant, flower diameter, flower stalk length, flower stalk girth, duration of flowering, days to harvest, crop duration, individual flower weight and flower yield per plant. In the present study, substantial variations were noticed for all the yield parameters studied. Obviously, high number of flowers per plant (46.59), flower diameter (6.06 cm), duration of flowering (85.00 days) and flower yield per plant (430.65g) were observed in the genotype AM-29 of *Tagetes erecta*. The results are in line with the findings of in marigold; in china aster; Bose and gerbera; Ponnuswami *et al*. (1985) [14]; in chrysanthemum; in China aster.

Improvement in yield can be achieved by identifying elite genotypes which are prominent in yield attributing characters. It is absolutely necessary to select genotypes with more number of branches per plant, flower diameter, number of flowers per plant and individual flower weight for yield up gradation. To end in good yield and for affecting the selection, centering the above traits would contribute better yield potential. Based on yield and its stable performance, there is a scope for identification and isolation of a superior genotype for near future

Variability

The phenotypic variability expressed as co efficient over mean (PCV) was the highest for characters such as germination percentage, plant height, internodal length, bud appearance, buds per plant, flower stalk length, flower stalk girth, days to harvest and crop duration. The highest phenotypic co efficient of variation indicates the influence of environment over the character observed. Heritable traits of yield and flower quality are complex characters and are known to be collectively influenced by various polygenically inherited traits which are highly vulnerable to the environment effects. The above findings are in concurrence with the findings of Bhattacharjee (1981b) [4] in gerbera, Reddy *et al.* (2002) [15] in crossandra, Singh and Sangama (2003) [16], Dwivedi and Kareem (2004) [6] in carnation, Vijayalaxmi *et al*. (2010) [18] in tuberose.

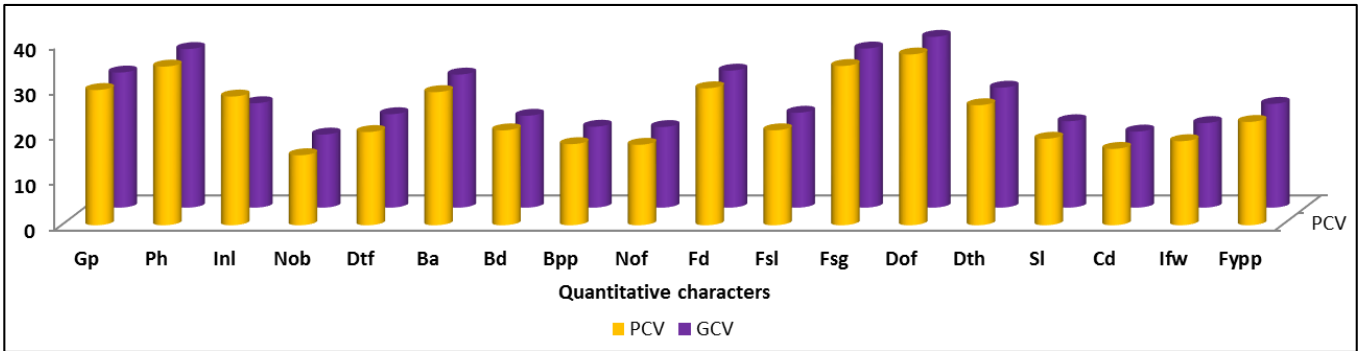

Fig 1: Phenotypic and genotypic co efficient for different characters in *Tagetes erecta* L

Heritability and genetic advance as per cent of mean

In the present investigation the higher heritability along with the genetic advance was recorded in plant height, bud diameter, number of flowers, flower diameter, flower stalk, flower stalk girth, duration of flowering, days to harvest, individual flower weight and flower yield per plant in *Tagetes erecta*. High heritability associated with highest genetic advance indicates the presence of additive gene action. From the study, it was clear that heritability estimates coupled with high genetic advance could be improved straight through selection. The characters such as flower yield per plant, flower diameter, number of flowers per plant and duration of flowering may be considered for selection of superior genotypes in marigold. This finding is in accordance with the findings of Veluswamy (1981) [19] in jasmine, Ponnuswami *et al*. (1985) [14] in marigold, Chrysanthemum, Kannan *et al*. (1990) [12] in gerbera, Anuradha *et al.* (1990) [2] in gladiolus, Jhon *et al.* (1994) [10], Beura *et al.* (1995) [3] in dahlia, Gomathy (1996) [8] in African marigold, Sirohi *et al.* (2000) [17] in chrysanthemum.

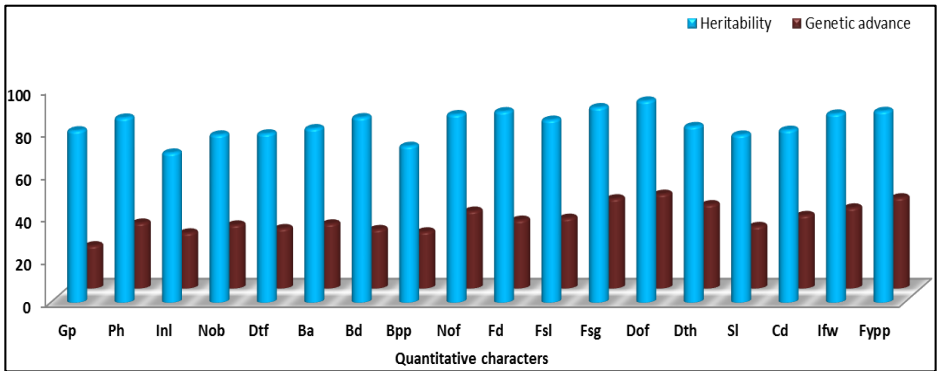

Fig 2: Heritability and genetic advance as per cent of mean for different characters in *Tagetes erecta* L.

Table 1: *Per se* performance of marigold (*Tagetes erecta* L.) genotypes for growth and yield characters

S. No	Acc. No	Plant height	Number of branches	Number of flowers per plant	Flower diameter	Individual flower weight	Flower yield per plant
1.	AM-1	121.83	30.86	38.38	3.16	8.60	320.35
2.	AM-2	123.31	31.23	46.29	5.85	10.9	358.65
3.	AM-3	140.88	31.12	43.61	7.27	8.15	281.11
4.	AM-4	124.33	31.32	35.35	6.74	10.0	240.19
5.	AM-5	121.86	30.95	40.06	5.95	7.75	225.40
6.	AM-6	98.33	33.49	39.39	3.55	8.61	300.05
7.	AM-7	133.22	29.05	31.14	7.96	8.23	325.19
8.	AM-8	103.75	31.09	36.19	6.17	9.27	360.35
9.	AM-9	89.89	30.77	31.31	3.59	6.35	210.15
10.	AM-10	86.87	30.56	36.36	3.48	6.35	220.25
11.	AM-11	87.01	30.97	30.30	3.67	6.66	230.65
12.	AM-12	76.40	31.29	36.36	4.07	6.76	213.07
13.	AM-13	110.52	34.53	30.30	4.81	8.12	226.93
14.	AM-14	96.96	31.47	31.31	3.94	7.71	252.97
15.	AM-15	125.76	33.4	32.28	7.17	7.44	236.48
16.	AM-16	121.20	31.08	37.20	4.66	6.91	222.06
17.	AM-17	135.41	30.90	44.44	5.59	11.13	321.07
18.	AM-18	121.16	32.62	30.30	3.48	8.11	226.93
19.	AM-19	121.62	34.16	34.34	6.87	9.86	428.48
20.	AM-20	117.32	34.08	30.30	3.85	8.265	218.14
21.	AM-21	116.68	31.54	38.38	3.07	8.31	305.89
22.	AM-22	93.44	32.39	38.04	7.84	8.49	256.51
23.	AM-23	104.25	35.59	38.21	6.25	7.30	224.53
24.	AM-24	113.03	32.49	31.31	4.77	8.52	253.70
25.	AM-25	118.44	28.03	36.36	6.93	12.4	330.78
26.	AM-26	119.465	31.76	39.39	5.83	7.60	217.53
27.	AM-27	124.425	32.62	36.36	6.15	8.29	326.90
28..	AM-28	119.63	30.98	41.41	3.40	8.26	330.25
29.	AM-29	138.08	36.67	46.29	6.07	12.59	437.35
30.	AM-30	115.31	34.14	43.43	3.65	8.45	335.45
31.	AM-31	90.28	30.98	39.39	3.41	7.36	230.66
	MEAN	113.25	32.006	37.963	5.138	8.482	279.68
	SE.d	5.992	0.703	0.445	0.015	0.133	4.992
	CD	11.745	1.378	0.871	0.018	0.260	9.783

Table 2: Varibility, heritability and genetic advance as per cent of mean for different characters in *Tagetes erecta* L.

S. No	Characters	*Tagetes erecta*			
		PCV	GCV	Heritability	Genetic advance
1.	Germination percentage	29.84	29.81	80.96	20.21
2.	Plant height	35.01	35.00	86.96	30.89
3.	Internodal length	28.40	23.04	70.51	26.25
4.	Number of branches	15.45	16.13	79.01	29.98
5.	Days to flowering	20.57	20.62	79.52	28.28
6.	Bud appearance	29.37	29.36	81.96	30.48
7.	Bud diameter	20.94	20.27	87.13	27.84
8.	Buds per plant	17.89	17.86	73.66	26.74
9.	Number of flowers	17.75	17.79	88.57	36.49
10.	Flower diameter	30.22	30.23	89.95	32.24
11.	Flower stalk length	20.95	20.94	85.96	33.14
12.	Flower stalk girth	35.14	35.11	91.85	42.28

13.	Duration of flowering	37.68	37.69	94.96	44.43
14.	Days to harvest	26.48	26.47	82.96	39.52
15.	Shelf life	19.09	19.07	78.96	29.28
16.	Crop duration	16.85	16.79	81.22	34.45
17.	Individual flower weight	18.55	18.66	88.85	38.00
18.	Flower yield per plant	22.80	22.90	90.08	42.75

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