International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 624-627

Received: 14-09-2018
Accepted: 15-10-2018

Santhosh N
Ph.D. Scholar,
College of Horticulture,
UHS Campus, Bangalore,
Karnataka, India

Tejaswini
Principal Scientist,
Division of Ornamental Crops,
IIHR, Bangalore, Karnataka,
India

Shivashankar KS
Principal Scientist,
Department of Plant Physiology and Biochemistry, IIHR,
Bangalore, Karnataka, India

Seetharamu GK
Associate Professor,
Department of Floriculture and Landscape Architecture, College of Horticulture, Arabhavi,
Bangalore, Karnataka, India

Archana Gadre
Senior Research Fellow,
IIHR, Bangalore, Karnataka,
India

Correspondence
Santhosh N
Ph. D. Scholar, College of Horticulture, UHS Campus,
Bangalore, Karnataka, India

Genetic diversity for morphological characters and biochemical components in African marigold

Santhosh N, Tejaswini, Shivashankar KS, Seetharamu GK and Archana Gadre

Abstract
Thirty three genotypes of African marigold (*Tagetes erecta*) were evaluated for 27 characters contributing for yield, carotenoid and lutein. Based on the method of propagation, the study material comprised of three vegetative propagated and thirty seed propagated genotypes. Phenotypic coefficient of variability (PCV) and genotypic coefficient of variation (GCV) was maximum for fresh petal meal per flower and dry petal meal per flower. High broad sense heritability coupled with high genetic gain was observed for number of secondary branches, fresh petal meal per flower, dry petal meal per flower, dry weight per flower, flower weight per plant, flower number per plant, zea-xanthin content, lutein content, total carotenoid content, seed number per flower, 100 seed weight, number of seeds per gram and shelf life. It indicates that most likely the heritability due to additive gene effects and selection will be effective. Efficiency of hybrid seed production depends on ability of seed production. Attempts have been made to study seed production in both apetaloid and petaloid sterile lines. Variability analysis was attempted to analyse the characters contributing for seed yield and the results suggested that the characters that contribute for flower yield also contributed for seed yield.

Keywords: Genetic diversity, morphological characters, biochemical components, African marigold

Introduction
Marigold (*Tagetes sps.*), is one of the most important flower crop that has proved its potentiality all around the world as an ornamental flower and has also been identified as a plant with many medicinal properties. Marigold is widely used as colorant in the food and animal feed industry. Commercially, marigold flowers were used in chicken feed to provide yellow colour to the skin of broiler sand yolks of layers (Hojnik *et al*., 2008) [2].

Marigold has gained popularity due to its habit of short duration to produce marketable flowers, wide spectrum of attractive colours, shape, size and good keeping quality. Marigold occupies a prominent place in ornamental Horticulture, is one of the commercially exploited flower crops belonging to the family Asteraceae. Marigold is broadly classified into two groups, *viz*., African marigold (*Tagetes erecta* Linn.) and French marigold (*Tagetes patula* Linn). The former generally grows tall and is known as tall marigold whereas the latter is short and is called as dwarf marigold.

A knowledge about variability, genetic advance and heritability would support breeding program in marigold. The estimation of genetic coefficient of variation indicates the amount of genetic variation present for different desirable traits. Genetic variability in the breeding material is important for the improvement of a crop plant. Such information helps in locating suitable parental lines for a breeding programme. Thus, in order to make selection and improvement programs effective, it is essential to study and partition the total variability existing in a germplasm into genetic, phenotypic and environmental variability. Thus enables the breeder to adopt a suitable breeding programme.

For any genetic improvement programme in crop plants, the aim would be evolving genotypes that are more efficient and show substantial increase over the existing types in respect of yield and other economic characters. The degree of improvement depends upon the beneficial and utilizable variability.

The estimation of genetic coefficient of variation indicates the amount of genetic variation present for different desirable traits while the heritability gives an insight into the proportion of variation which is inherent. The heritability estimates gives an idea about the proportion of observed variability, which is attributed to genetic difference.

Material and Methods

Plant material for the experiment consisted of three pure lines and seven male sterile lines isolated at Indian Institute of Horticulture Research, Bangalore. Based on floral morphology, seven male sterile lines were classified into two groups *viz*., petaloid and apetaloid sterile types. In flowers of petaloid male sterile lines, stamens are replaced by petal like organs and thereby male reproductive function is eliminated. In apetaloid sterile lines, all the florets are degenerated in to filament like structures. In both petaloid and apetaloid sterile types, flowers were characterised by absence of androecium but well developed and functional gynoecium. Detailed description of line and testers used in the study are presented in Table 1. Twenty one hybrid combinations along with ten parents were planted in randomized block design with three replications. The observations were recorded from five plants selected randomly in each genotype per replication for 27 characters namely, plant height (cm), days for flower bud initiation, days taken for 50 per cent flowering, plant spread (cm), number of primary branches, number of secondary branches, flowering duration (days), flower diameter (cm), number of flowers per plant, flower weight per plant (g) and flower yield (tonnes per ha), fresh petal meal per flower (g), dry petal meal per flower (g), fresh weight per flower (g), dry weight per flower (g), shelf life (days), lutein content (mg/100 g of dry weight), zea-xanthin content (mg/100 g of dry weight), total carotenoid content (mg/100 g of dry weight), seed number per flower, 100 seed weight and number of seeds per gram.

Table 1: Variability, heritability and genetic advance for 27 characters in line x tester study of marigold

Sl. No.	Character/Source	Mean	Range	GCV (%)	PCV (%)	h^2 (%)	GA (%)
1.	Days to bud initiation	23.37	17.67-36.33	15.26	16.15	89.27	29.71
2.	Days taken for 50% flowering	34.83	27.67-48.67	12.65	12.93	95.81	25.52
3.	Plant height at 30 Days after planting (cm)	26.28	11.33-35.33	21.26	22.15	92.16	42.05
4.	Plant height at 60 Days after planting (cm)	36.03	18.33-46.00	15.68	17.32	81.90	29.34
5.	Plant height at 90 Days after planting (cm)	48.60	26.07-66.33	19.38	20.79	86.93	37.23
6.	Plant height at 120 Days after planting (cm)	49.36	26.53-67.47	19.44	20.41	90.67	38.14
7.	Number of primary branches	11.42	4.53-16.55	24.48	28.00	76.43	44.10
8.	Number of Secondary branches	66.95	26.47-105.33	32.78	33.40	96.35	66.30
9.	Plant spread-East-West (cm)	34.61	18.33-44.07	15.17	16.41	85.47	28.89
10.	Plant spread-North-South (cm)	35.39	19.27-47.23	15.71	17.42	81.39	29.21
11.	Flower number per plant	119.50	70.83-193.83	27.72	29.63	87.53	53.44
12.	Flower weight per plant (g)	388.11	179.17-723	43.41	44.53	95.03	87.18
13.	Flower yield (tonnes per ha)	16.17	7.47-30.12	43.41	44.53	95.03	87.18
14.	Fresh petal meal per flower (g)	0.99	0.14-2.72	76.88	77.43	98.57	157.24
15.	Number of harvests	9.13	8.67-10.00	2.58	4.05	40.78	3.40
16.	Dry petal meal per flower (g)	0.16	0.02-0.54	74.52	76.14	95.78	150.24
17.	Flower size/diameter (cm)	5.73	4.70-6.57	8.48	8.73	94.28	16.96
18.	Fresh weight of flower (g)	3.29	1.56-4.88	24.89	25.85	92.75	49.40
19.	Dry weight of flower (g)	0.48	0.25-0.74	27.74	28.31	95.99	56.00
20.	Shelf life (Days)	3.37	2.00-5.33	27.08	27.25	98.80	55.46
21.	Flowering duration (Days)	98.16	83.67-109.00	6.11	6.27	95.04	12.28
22.	Seed number per flower	159.52	50.77-300.10	34.75	34.78	99.83	71.53
23.	100 seed weight (mg)	231.80	105.05-413.36	29.21	29.25	99.76	60.12
24.	Number of seeds per gram	471.69	242.02-952.23	32.60	33.65	99.71	67.07
25.	Lutein content (mg/100 g of dry petal meal)	710.03	261.80-1262.70	43.71	43.81	99.56	89.86
26.	Zea-xanthin content (mg/100 g of dry petal meal)	3.04	0.83-7.18	48.75	49.35	97.58	99.20
27.	Total carotenoids (mg/100 g of dry petal meal)	906.53	428.31-1571.18	37.77	37.81	99.82	77.75

GCV: Genotypic coefficient of variation PCV: Phenotypic coefficient of variation h^2b: Heritability (broad sense)
GA: Genetic advance over percentage of mean

Estimation of Biochemical components

Total carotenoids content were analyzed by spectrophotometric method (Lichtenthaler, 1987) [5]. 0.1 g of dry marigold petals was taken into a mortar and one spatula of $CaCO_3$ added and ground with acetone. Residue was extracted with solvent until the supernatant becomes colourless. All the extractions were carried out under low light or red light. Extract was taken in separating funnel and added 10 ml hexane and 100 ml water. Allowed to stand for a few minutes. The two phases formed were separated and the lower aqueous phase was re-extracted with additional hexane, until the aqueous phase was colourless. Collected the upper layer and repeated the same by taking 5 ml hexane. Dried with anhydrous Na_2SO_4 and made up the volume to 50 ml with hexane and read absorbance at 470 nm for total carotenoids. Calculated the carotene content using standard *β*-carotene or lycopene and expressed as mg/100 g dry weight using standard curve.

Lutein estimation

Fresh flowers were dried and used for estimation of biochemical parameters. Dry petals were extracted by using acetone and further separation was carried out by using hexane. Total carotenoid was estimated using spectrophotometer at 470nm absorbance. Lutein content was estimated by UPLC (Equity UPLC-H class Waters limited, USA) connected to a PDA detector with quaternary pump and controlled by Mass Lynx software of Waters. The column used was equity UPLC BEH C18 (50mm x 2.1 mm, 1.7 µm) with security guard column BEH C18 (5mm x 2.1 mm, 1.7 µm). The mobile phase was Acetonitrile: Methanol: Tetrahydrofuran (10:60:30) as solvent A and pure methanol as solvent B with a flow rate of 0.1ml per min. Wavelength used for lutein was at absorbance of 446 nm.

Results and Discussion

The analysis of variance revealed highly significant differences (P<0.01) among the genotypes for 27 characters

considered in the study. This suggested the presence of wide range of variability for different characters. The extent of variability present in germplasm was estimated in terms of range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance as per cent over mean. Estimates of phenotypic coefficient of variation (PCV) were found to be higher than their corresponding genotypic coefficient of variation (GCV), which is mainly due to environmental effect. PCV and GCV were maximum for fresh petal meal per flower (77.43 and 76.88), dry petal meal per flower (76.14 and 74.52), zea-xanthin content (49.35 and 48.75), lutein content (43.81 and 43.71) and flower weight per plant (44.53 and 43.41). Anuja and Jahnavi (2012) [1]. Reported that the high GCV was observed for flower yield per plant in French marigold. Kavitha and Anburani (2010) [3]. Observed that the PCV and GCV were maximum for number of flowers per plant. Recorded that the PCV and GCV was maximum for flower weight and minimum for duration for flowering in marigold.

Plate 1: General view of the experimental plot

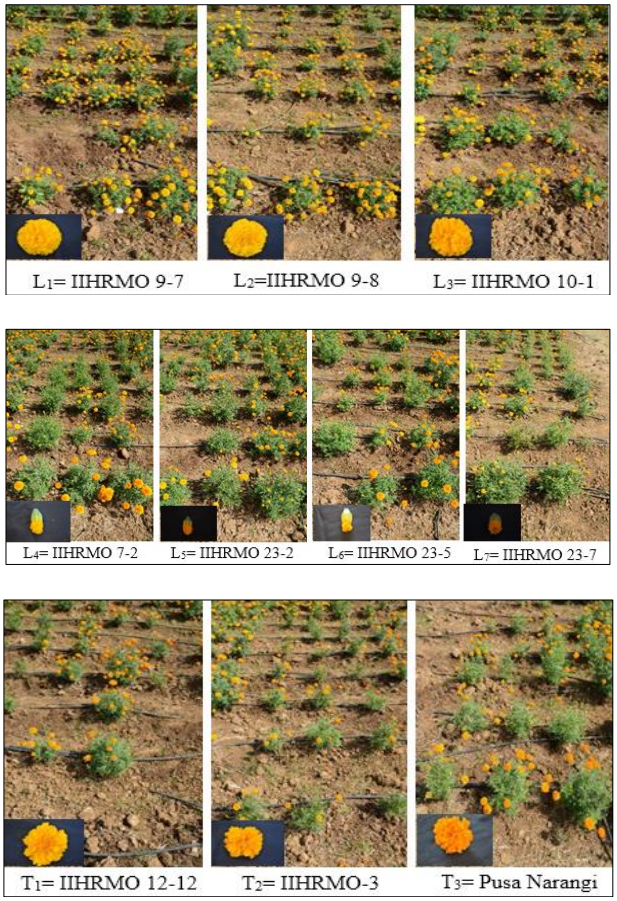

Plate 2: Lines (Petaloid male sterile lines and apetaloid male sterile lines) and Testers (Pollen parents) used in the study

Narrow differences between GCV and PCV revealed that variability existing among different genotypes mainly due to genetic makeup and there is very little environmental influence on the expression of these traits. PCV and GCV were minimum in number of harvests (4.05 and 2.58) followed by flowering duration (6.27 and 6.11).

According to Panse (1957) [7]. The magnitude of heritable value is the most important aspect of genetic constitution of breeding material, which has close bearing on the response of selection. Heritability estimates (broad sense) estimates ranged from 40.78% for number of harvests to 99.83% for seed number per flower. The high value (>60%) of heritability was observed for all the characters under study except number of harvests. It indicates that this charactersare least influenced by the environmental effects. Kishore and Raghava (2001) [4]. Observed that the high estimates of heritability (broad-sense) were obtained for days to flowering, flower diameter, plant height, plant spread, number of primary and secondary branches, shelf life, flowering duration, number of flowers per plant, seed yield per flower, seed yield per plant, flower weight, flower weight per plant and flower yield per hectare in marigold.

The genetic advance over percentage of mean ranged from 3.40% for number of harvests to 157.24% to fresh petal meal per flower. High values of genetic advance over percentage of mean were recorded for fresh petal meal per flower followed by dry petal meal per flower and zea-xanthin content. It shows that the character is governed by additive genes and selection will be rewarding for improvement of such character. Singh and Singh (2010) [9]. Studied genetic advance over mean in Marigold.

High heritability along with high genetic gain was observed for fresh petal meal per flower, dry petal meal per flower, zea-xanthin content, flower weight per plant, lutein content, total carotenoid content, seed number per flower, weight of 100 seeds, number of seeds per gram, number of secondary branches, dry weight per flower, shelf life and flower number per plant. It indicates that most likely the heritability due to additive gene effects and selection may be effective. Panwar *et al*. (2013) [8]. Reported high heritability with high genetic advance over the mean for traits like flower yield per plant, fresh weight per flower, flower diameter and 1000 seed weight in marigold. Singh and Singh (2010) [9]. Reported high heritability along with maximum genetic gain for numbers of flowers per plant followed by fresh weight of flower, weight of seeds per peduncle, plant height, number of primary branches and flower diameter in marigold.

High heritability along with low genetic gain was observed for flowering duration and flower diameter. It indicates character governed by non-additive gene action. High heritability along with low genetic gain is due to favourable influence of environment rather than genotype and heterocyst breeding will be useful. Pal and Kumar (2010) [6]. Reported that the flowering duration, number of branches and flower diameter show moderate to low genetic advances along with high heritability in marigold.

The studies revealed that genetically diverse genotypes should be further utilized as parents in crop improvement programme for the development of hybrids with broad genetic base.

References

1. Anuja S, Jahnavi K. Variability, heritability and genetic advance studies in French marigold. Asian J Hort. 2012; 7(2):362-364.

2. Hojnik M, Skerget M, Knez Z. Extraction of lutein from marigold flower petals- Experimental and kinetics modeling. Food sci. tech. 2008; 41:2008-2016.
3. Kavitha R, Anburani A. Genetic diversity in African marigold (*Tagetes erecta* L.) genotypes. J Orn. Hort. 2010; 12(3):198-201.
4. Kishore N, Raghava SPS. Variability studies in African marigold. J Orn. Hort. 2001; 4(2):124-125.
5. Lichtenthaler HK. Chlorophylls and carotenoids: Pigments of photosynthetic bio membranes. Methods in enzymology. 1987; 148:350-382.
6. Pal K, Kumar J. Study on genetic variability, heritability and genetic advance in African marigold (*Tagetes erecta* L.) under Meerut region. Prog. Hort. 2010; 10(3):144-149
7. Panse VG. Statistical Methods for Agricultural Workers. ICAR Publication, New Delhi, 1957; 100-109:152-161.
8. Panwar S, Singh KP, Janakiram T, Jain N. Genetic variability, heritability and genetic advance in African marigold (*Tagetes erecta* L.) genotypes. Prog. Hort. 2013; 45(1):135-140.
9. Singh AK, Singh D. Genetic variability, heritability and genetic advance in marigold. Indian J Hort. 2010; 67(1):132-136