Genetic Variability, Heritability and Genetic Advance in French Marigold (*Tagetes patula* L.)

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Genetic variability, heritabality and genetic advance were estimated for various vegetative and floral characters in 30 genotypes of French marigold (*Tagetes patula*). The studies showed high range for total yield per plant (59.08-559.35g), weight per flower (0.96-8.59g) and number of flowers per plant (35.33-206.0). The coefficient of variation (PCV and GCV) was maximum for weight per flower (PCV=59.75, GCV=59.49) and minimum for duration of flowering (PCV=11.08, GCV=10.84). The phenotypic coefficients of variations were higher than those of genotypic coefficient of variation, which indicate greater GxE interaction. High estimates of heritability (broad sense) were obtained for all the characters studied. The highest value of heritability was obtained for weight of flower per plant (99.1), plant-spread (99.0), and plant height (98.9). Thus, these characters can be improved through direct selection. In the present study, flower yield showed maximum genetic gain (233.99). High heritability along with high genetic gain was observed for number of flowers per plant (h^2 = 97.4, GA = 77.53) and total flower yield per plant (h^2 =94.3, GA=233.99). High heritability with low genetic gain was observed for weight per flower (h^2 = 99.1, GA=4.02) and stalk length (h^2 = 96.6, GA=5.78). So, improvement in these characters could be brought about by practicing phenotypic selection.

Key words: Marigold, Variability, Heritability and Genetic advance

Marigold, a native of Central and South America is a member of Asteraceae family. It is one of the top five flowers grown widely for loose flower production in India. Mainly two species of marigold i.e. African marigold (*Tagetes erecta* L.) and French marigold (*Tagetes patula* L.) are grown for this purpose accounting for more than half of the nation's loose flower production. In French marigold, most of the varieties being local are poor flower yielders. Therefore, there is a scope to develop high yielding varieties in this species. Estimation of genetic variability in the germplasm of a particular crop is prerequisite for making any effective breeding programme. Selection of parents to be included in the hybridization programme should be based on genetic distance. Most of the important characters including yield are highly influenced by environment, since they are polygenically controlled, which make the selection process difficult. Heritability is an index for calculating the influence of environment on the expression of genotypes. Estimates of genetic advance together with heritability would be helpful in assessing the nature of gene action. Therefore, present investigation was carried out for estimating genetic variability, heritability and genetic advance for various vegetative and floral characters in 30 genotypes of French marigold (*Tagetes patula*).

Material and Methods

The experiment was undertaken in the Division of Floriculture and Landscaping, IARI, New Delhi with 30 genotypes of French marigold grown in RBD with three replications. Seeds of all the genotypes were sown on 15 cm raised seedbeds in the nursery and the seedlings were transplanted in the main field after one month at a spacing of 30 x 30 cm. Uniform cultural operations were followed regularly. Five plants per replication were selected randomly from each genotype and used for recording observations. Phenotypic and genotypic coefficient of variations (broad sense) were estimated according to Burton and Devane (1953). Genetic advance was calculated according to the formula given by Johnson *et al.* (1955). Heritability was estimated according to Allard (1960).

Results and Discussion

The data depicted in Table 1 reveals that there were significant differences among genotypes for various characters. High ranges for total yield of flower per plant (59.08-559.35g), weight per flower (0.96-8.59g) and number of flowers per plant (35.33-206.0) were observed. The higher phenotypic coefficient of variation than those of genotypic coefficient of variation indicated the predominant role of environment in the expression of the traits, which is in consonance with the results obtained by Ponnuswamy *et al.* (1985).

Phenotypic and genotypic coefficient of variation was maximum for weight per flower (PCV=59.75, GCV=59.49) followed by total yield per plant (PCV=49.80, GCV=48.36) and number of flowers per

Table 1. Range, mean, coefficient of variation, heritability (broad sense) and genetic advance for various characters in French marigold (*Tagetes patula*)

Characters	Range	Mean	PCV	GCV	h^2	GA
Plant height (cm)	31.33-85.50	49.02	36.29	36.09	98.9	36.25
Plant spread (cm)	32.83-110.17	54.36	36.83	36.63	99.0	40.81
Branch number	7.0-25.67	15.22	31.32	27.62	77.8	7.64
Leaf length (cm)	7.50-23.33	16.40	28.26	26.31	86.6	7.76
Leaflets per leaf	9.33-25.33	19.31	20.63	15.53	56.6	4.65
Leaflet length (cm)	2.33-7.33	4.34	27.84	23.22	69.56	1.73
Leaflet breadth (cm)	0.70-1.73	0.99	36.51	24.48	45.0	0.33
Stalk length (cm)	5.60-17.67	8.75	33.22	32.65	96.6	5.78
Flowers per plant	35.33-206.0	82.50	46.84	46.32	97.4	77.53
Flower size (cm)	2.57-5.93	4.63	19.13	17.37	82.5	1.51
Weight/flower (g)	0.96-8.59	3.29	59.75	59.49	99.1	4.02
Days to first flowering	56.67-120.0	76.89	23.93	23.70	98.2	37.20
Flowering duration (days)	78.67-119.33	94.91	11.08	10.84	95.6	20.72
Total yield/plant (g)	59.08-559.35	241.89	49.80	48.36	94.3	233.99

plant (PCV=46.84, GCV=46.32). These findings are in accordance with the observations recorded by Nandkishore and Raghava (2001) in African marigold and Raghava and Negi (1994) in China aster. Janakiram and Rao (1995) also reported high PCV and GCV for total yield per plant in African marigold. Similarly, Sirohi and Behera (2000), Chaugule (1985) and Chattopadhyay *et al.* (1992) also reported high PCV and GCV for number of flowers per plant but it was minimum for duration of flowering. Our results are in close conformity with the findings of Singh and Sen (2000) who worked on chrysanthemum. Narrow differences between GCV and PCV, gave evidence to the genotypes that the variability existing in them was mainly due to their genetic make up.

High estimates of heritability in broad sense were obtained for all the characters. According to Panse (1957), the magnitude of heritable value is the most important aspect of genetic constitution of breeding material, which has close bearing on the response to selection. The high values for heritability were obtained for weight per flower (99.1), plant spread (99.0), plant height (98.9), time taken for flowering (98.2) and number of flowers per plant (97.4). Janakiram and Rao (1995) also found similar results in African marigold for flower weight and number of flowers per plant. Ponnuswany *et al.* (1985) observed high heritability for number of flowers per plant and plant spread in chrysanthemum. Chaugule (1985) noted it for number and weight of flowers per plant in chrysanthemum. These findings suggest that there is scope for improvement in these characters through direct selection. In the present study total flower yield per plant showed maximum genetic gain (233.99), followed by number of flowers per plant (77.53) and plant spread (40.81). Singh and Sen (2000) and Janakiram and Rao (1995) reported high genetic advance for total flower yield per plant.

Heritability along with genetic gain are more useful criteria in predicting the resultant effect for selecting the best individual (Johnson *et al.* (1955). Burton (1952) suggested that characters with high heritability coupled with high genetic advance would respond to selection better than those with high heritability and low genetic advance. High heritability along with high genetic gain was observed for total flower yield per plant (h^2 = 97.4, GA = 77.53). These results are in accordance with the findings of Barad (1992) and Singh and Sen (2000). Here practicing phenotypic selection could bring about improvement in these characters. It is also suggested that variation for different characters in the genotypes studied were due to high additive gene effect. Similar observations have also been reported by Panse (1957).

High heritability and low genetic gain were observed for weight per flower (h^2 = 99.1, GA= 4.02), stalk length (h^2 = 96.6, GA= 5.78) and duration of flowering (h^2 = 95.6, GA=20.72). It reflects that high heritability is not always associated with genetic advance (Swarup and Chaugale, 1962). Hence, selection on the basis of these characters will be less effective as these are controlled by non-additive genes.

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