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Determination of genetic variation for vegetative and floral traits in African marigold (*Tagetes erecta*)

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ABSTRACT

Twenty-one genotypes of African marigold were (*Tagetes erecta* L.) evaluated for 11 growth and flowering related traits to study their genetic parameters such as variability, heritability, genetic (GCV), phenotypic (PCV) coefficient of variation and correlation and path coefficient analysis. Analysis of variance for all the traits showed significant differences among genotypes for all the growth and flowering related traits. High range in mean performance has been observed for traits, viz. plant height (64.00-106.67 cm), plant spread (49.33-72.00 cm), flower diameter (3.77-6.17 cm), days required for flowering (78.67-99.33 days), number of secondary branches (22.13-37.47) and flower duration (26.00-44.83 days). Higher genotypic and phenotypic coefficient of variation was observed for traits such as fresh flower weight per plant, flower fresh weight per 10 flowers, number of flowers per plant, stem girth, flowering duration, etc. The high value (> 90%) of heritability was observed for all traits except plant height, plant spread and stem girth. The genetic advance was found ranged from 1.23 for flower diameter to 288.69 for fresh flower weight per plant. High values of genetic advance as per cent of mean was recorded for number of flowers (59.79%) followed by fresh flower weight per plant (59.32%) and flower fresh weight per 10 flowers (58.09%). Fresh flower weight per plant is significantly and positively correlated both at genotypic and phenotypic level for plant spread, flower fresh weight per flower, number of flowers per plant and flower diameter. Path coefficient analysis at genotypic level revealed that the number of primary branches per plant contributed highest and has significantly positive direct effect on fresh flower weight per plant followed by number of flowers per plant, flower diameter, flower fresh weight per flower, days required for flowering and stem girth.The different genotypes were identified to be performing differently for different quantitative traits. Hence, those genotypes with superior traits could be involved in the hybridization programme for assembling of desirable traits in a single genotype.

Key words: Correlation coefficient, Genetic advance, GCV, Heritability, Path coefficient and PCV

African marigold (*Tagetes erecta* L.) belongs to Asteraceae and is native to the South and Central America, especially Mexico. It is one of the important commercial flower crop grown world wide. It is being utilized in traditional medicine as well as for ornamental purpose. In India, it is grown as a major loose flower crop and is being used in religious and social ceremonies. The flowers are commercially cultivated, harvested and processed on an industrial scale and is one of the most important natural source for xanthophylls. Success of crop improvement programme depends on the magnitude of the genetic variability and the efficiency of selection. Phenotypic coefficient of variation (PCV) and Genotypic coefficient of variation (GCV) provides the estimate about the amount of variability present in the available genotypes. It allows a meaningful comparison of the variation of several traits of the plants belonging to the same population as well as a comparison of the variation of the same traits as expressed by different populations (of the same or different crops). Heritability tells about the additive genetic and phenotypic variance (Nyquist 1991). High heritability alone is not enough to make efficient selection in segregating generation unless the information is accompanied by substantial amount of genetic advance (Johnson *et al.* 1995). Genetic advance is directly proportional to heritability and selection intensity. The studies on variability and genetic parameters are of paramount importance for crop improvement programme. Since, meagre information is available on these aspects, the present investigation was undertaken to obtain information on genetic parameters, correlation and path analysis. This information can be of prime importance and further useful in formulating appropriate breeding strategies for genetic improvement of African marigold.

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MATERIALS AND METHODS

The present study was carried out at the research farm

of the Division of Floriculture and Landscaping, Indian Agricultural Research Institute, New Delhi during 2012-13. The experimental material comprised 21 genotypes namely Af/SR-12-1, Af/SR-19-2, Af/SR-29, Af/SR-2, Af/SR-8, Af/SR-15-1, Af/SR-41-1, Af/SR-49, Af/SR-2-1, Af/SR-31, Af/SR-17-4, Af/SR-7, Af/SR-50 ,Af/SR-47 , Af/SR-6 , Af/SR-17-1 , Af/SR-17, Af/SR-1, Af/SR-12, Af/SR-19, Af/SR-2-2 of African marigold. The experiment was laid out in a Randomized Block Design with three replications. The seeds of all the genotypes were sown in the nursery to raise seedlings and transplanting was done one month after sowing with a spacing of 45 cm between rows and plants within a row. The trial was done in open field conditions. The observations were recorded from 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, v*iz.* plant height (cm), plant spread (cm), stem girth (mm), flower fresh weight/10 flowers (g), number of flowers, flower diameter (cm), days required for flowering, fresh flower weight/plant (g), number of primary branches, number of secondary branches, flowering duration (days). The data were subjected to analysis of variance as per procedure described by Panse and Sukhatme (1967). The phenotypic and genotypic coefficients of variation were calculated according to Burton and De Vane (1953) and heritability (Broad sense), genetic advance and genetic advance as per cent mean were calculated according to the formulae of Johnson *et al*. (1955).

RESULTS AND DISCUSSION

Analysis of variance revealed highly significant differences among genotypes for all the growth and flowering related traits under study. The study indicated the existence of wide range of variability for different traits. Mean performance of genotypes revealed that a single genotype was not superior for all growth and flowering traits. Hence, in our study different genotypes were identified which were superior for various growth and flowering related traits.The superiority of genotypes may be due to varied growth rate and their genetic make-up.

Per se mean performance of genotypes for growth and flowering traits

Mean performance of 21 marigold genotypes for various growth and flowering related traits in marigold are presented in Table 1. The maximum plant height was recorded in genotype 'Af/ SR-17 (106.67 cm) followed by Af/ SR-12-1 (100.67 cm) and Af/ SR-17-1 (97.67 cm).These were significantly superior over other genotypes. However, minimum plant height was recorded in Af/Sr-8 (64.00 cm). The maximum plant spread was recorded in genotype 'Af/ SR-41-1 (72.00 cm), followed by Af/SR-29 (66.67cm) and Af/SR-50 (65.33 cm) whereas minimum plant height was

Table 1 Mean performance of 21 marigold genotypes for various growth and flowering related traits in marigold

Genotype	Plant height (cm)	Plant spread (cm)	Stem girth (mm)	Fresh flower weight/ flower	No. of flowers/ plant	Flower diameter (cm)	Days required for flowering	Fresh flower weight/ plant (g)	Number of primary branches/ plant	Number of secondary branches/ plant	Flowering duration (days)
Af/SR-12-1	100.67	59.00	25.20	6.00	70.67	6.17	91.67	423.47	12.03	29.23	31.50
Af/SR-19-2	79.67	51.00	19.73	4.00	64.33	5.63	79.33	254.60	9.13	25.30	34.50
Af/SR-29	75.67	66.67	14.73	2.00	197.00	3.77	84.33	393.67	13.73	32.23	29.50
Af/SR-2	78.00	63.67	19.43	4.07	121.00	5.70	78.67	493.40	11.37	28.03	39.00
Af/SR-8	64.00	56.00	16.13	2.87	122.67	4.57	86.33	350.47	10.20	27.50	26.67
Af/SR-15-1	93.33	62.00	17.80	3.80	108.67	5.23	89.00	412.53	16.37	37.47	38.50
Af/SR-41-1	96.00	72.00	19.67	4.67	140.33	5.47	85.00	654.93	11.17	28.40	31.00
Af/SR-49	77.67	55.33	21.77	3.73	138.00	5.27	81.00	515.20	9.37	26.10	32.17
Af/SR-2-1	83.67	52.00	16.30	6.07	108.33	5.53	85.33	656.87	9.10	25.43	30.83
Af/SR-31	81.67	55.33	16.13	4.63	134.00	5.50	86.33	620.40	11.20	29.07	26.00
Af/SR-17-4	80.33	58.67	14.53	3.33	143.33	5.50	80.33	475.13	11.33	28.83	32.50
Af/SR-7	95.00	55.00	24.47	2.27	122.00	4.67	99.33	276.53	10.30	26.90	26.17
Af/SR-50	84.00	65.33	18.33	2.60	159.67	4.17	92.33	414.80	13.07	30.73	42.00
Af/SR.47	95.33	59.67	17.73	2.97	196.00	5.03	87.33	506.40	12.37	30.47	42.83
Af/SR-6	85.33	63.67	25.13	3.53	171.00	5.37	84.33	604.07	10.17	28.03	43.17
Af/SR-17-1	97.67	61.67	24.17	4.60	142.33	6.00	95.00	656.60	9.43	25.43	38.00
Af/SR-17	106.67	63.67	21.53	3.40	174.67	5.60	89.67	594.20	10.17	27.63	44.83
Af/SR-1	87.33	63.00	18.97	3.33	202.67	4.63	91.00	675.40	10.47	27.87	32.50
Af/SR-12	69.00	49.33	17.23	2.53	86.33	4.73	80.00	219.07	8.30	22.13	34.17
Af/SR-19	91.00	51.67	16.43	4.20	91.33	4.50	98.67	383.60	9.37	24.00	29.50
Af/SR-2-2	84.33	59.33	22.10	4.67	137.00	5.87	83.33	639.07	12.23	30.50	42.00
Mean	86.02	59.24	19.41	3.77	134.83	5.19	87.06	486.69	10.99	28.16	34.63
SEm	3.11	2.09	1.12	0.19	3.49	0.13	1.50	22.04	0.29	0.44	0.56

recorded in Af/SR-12 (49.33cm). The maximum stem girth was recorded in genotype Af/SR-12-1 (25.20 mm) followed by Af/SR-6 (25.13 mm) and Af/SR-7 (24.47 mm). Minimum stem girth was recorded in Af/SR-17-4 (14.53 mm).The maximum fresh weight per flower for genotype 'Af/SR-2-1 (6.07 g) followed by Af/SR- 12-1 (6.00 g) and Af/SR- 2-2, Af/SR-41-1 (4.67 g), whereas the minimum fresh weight per flower for genotype Af/SR- 29 (2.00 g). Significantly highest number of flowers per plant was recorded in genotype 'Af /SR -1 (202.67) followed by Af/SR-29 (197.00) and Af/SR- 47 (196.00), whereas lowest number of flowers was observed in AF/SR-19-2 (64.33).The maximum flower diameter was observed in AF/SR- 12-1 (6.17 cm) followed by AF/SR-Af/SR- 17-1 (6.00 cm), whereas minimum flower diameter was observed in the genotype Af/SR-29 (3.77 cm). Days required for flowering is an important trait in marigold because early or late flowering genotypes may be useful for regular availability of flowers. However, earliness is a desirable trait in flower crops as early flowering reduces the crop duration and improves the profit. The desirable genotypes for early flowering were Af/SR-2 (78.67 days), followed by Af/SR-19-2 (79.33 days). The maximum fresh flower weight per plant for genotype Af/SR-1 (675.40 g) followed by Af/SR-2-1 (656.87 g) and Af/SR- 17-1 (656.60 g), whereas the minimum fresh weight per flower for genotype Af/SR-12 (219.07 g). The maximum number of primary branches was observed in Af/SR-15-1 (16.37) followed by Af/SR- 29 (13.73) and Af/SR -50 (13.07) whereas minimum number was observed in Af/SR-12 (8.30). The maximum number of secondary branches was observed in Af/SR-15-1 (37.47) followed by Af/SR-29 (32.23) and Af/SR-50 (30.73), whereas minimum number of primary branches was observed in Af/SR-12 (22.13). The flowering duration was maximum in Af/SR-17 (44.83 days) followed by Af/SR-6 (43.17 days) and Af/SR-47 (42.83days), whereas minimum flowering duration was in Af/SR- 31 (26.00 days). The weight per flower is an important trait as they are sold in the market on the basis of weight. Different genotypes were identified to be performing differently for different quantitative traits. These diverse genotype with superior traits could be involved in the hybridization programme for assembling of desirable traits in a single genotype. The data revealed a high range in mean performance for traits like plant height (64.00-106.67 cm), plant spread (49.33-72.00 cm), flower diameter (3.77-6.17 cm), days required for flowering (78.67-99.33 days), number of secondary branches (22.13-37.47) and flower duration (26.00-44.83 days). Similar observations were also made by Namita *et al.* (2008) and Panwar *et al*. (2013) for various vegetative and flowering related traits in marigold.

The extent of variability present in germplasm was estimated in terms of range, genotypic and phenotypic coefficient of variation (GCV and PCV), heritability, and genetic advance as per cent of mean (Table 2). The phenotypic coefficient of variation (PCV) estimates was greater than genotypic coefficient of variation (GCV) with respect to all the quantitative traits studied. The phenotypic coefficient of variation (PCV) exhibited nearby similar trend for the traits as in GCV and had higher value than GCV indicating that genotypic expression was superimposed by the environmental influence and hence, selection may be misleading. Similar findings were reported in marigold by Namita *et al.* (2008), Pratap *et al*. (2009), Singh and Singh (2010), Anuja and Jahnavi (2012) and Panwar *et al*. (2013). Highest genotypic coefficient of variation (GCV) was recorded for fresh flower weight per plant (29.31) followed by number of flowers per plant (29.20) and fresh flower weight per flower (28.77), whereas lowest GCV (6.80) was observed for days required for flowering. The PCV was highest for fresh flower weight per plant (29.83) followed by fresh flower weight per flower (29.42) and number of flowers (29.37), whereas lowest PCV value was recorded in days required for flowering (7.12). Highest value of GCV and PCV were observed for traits like fresh flower weight per plant, fresh flower weight per flower, number of flowers per plant, flowering duration, stem girth, etc. which indicates that selections of these traits would be effective. Kishore and Raghava (2001) reported high GCV and PCV for flower weight and flower yield per hectare in marigold. Similar results where reported by Singh and Singh (2010) for number of flowers per plant and fresh weight per flower in marigold. Kavitha and Anburani (2010)

Table 2 Genetic parameters for various growth and flowering related traits in African marigold

Character	Range	GCV (%)	PCV (%)	Heritability	Genetic advance	GA as percent of mean
Plant height (cm)	64.00–106.67	12.04	12.84	88.0	20.03	23.29
Plant spread (cm)	49.33–72.00	9.50	10.44	82.7	10.54	17.79
Stem girth (mm)	14.53–25.20	16.95	18.39	85.0	6.24	32.15
Flower fresh weight per 10 flowers (g)	2.00–6.07	28.77	29.42	95.6	2.19	58.09
Number of flowers	64.33–202.67	29.20	29.37	98.8	80.62	59.79
Flower diameter (cm)	3.77–6.17	11.96	12.38	93.4	1.23	23.69
Days required for flowering	78.67–99.33	6.80	7.12	91.2	11.64	13.37
Fresh flower weight per plant (g)	219.07–675.40	29.31	29.83	96.5	288.69	59.32
Number of primary branches	8.30–16.37	16.95	17.26	96.5	3.77	34.30
Number of Secondary branches	22.13–37.47	11.36	11.52	97.2	6.49	23.05
Flowering duration (days)	26.00–44.83	17.20	17.32	98.7	12.19	35.20

also observed maximum coefficients of variation both at genotypic and phenotypic levels for number of flowers per plant.

Estimation of genetic parameters for growth and flowering related traits

The genotypic coefficient of variation alone does not provide reliable information about the assessment of variation that is heritable and therefore, estimation of heritability becomes imperative.The high value (> 90%) of heritability was observed for all traits except plant height, plant spread, stem girth. This revealed that these growth and flowering related traits were influenced by environmental changes suggesting that the selection based on phenotype would be ineffective for these traits. The genetic advance ranged from 1.23 for flower diameter to 288.69 for fresh flower weight per plant. High values of genetic advance as per cent of mean was recorded for number of flowers (59.79%) followed by fresh flower weight per plant (59.32%) and flower fresh weight per 10 flowers (58.09%). However, lowest value was observed for days required for flowering (13.37%) followed by plant spread (17.79%). The heritability together with genetic advance was more reliable than either of these parameters alone in predicting the resultant effects of selecting the best individuals. Therefore, in our study the genetic advance was considered along with heritability in the coherent selection for breeding of marigold. High heritability with high genetic advance as per cent of mean was reported for traits like number of flowers per plant, fresh flower weight per plant and fresh flower weight per 10 flowers. This indicated additive gene action for these traits and as a result simple selection is advocated. Similarly Mathew *et al.* (2005) obtained high heritability coupled with high genetic advance for flower yield in French marigold. Singh and Singh (2010) obtained similar results for fresh weight per flower in marigold and Panwar *et al.* (2013) for fresh weight per flower and flower yield per plant. Sharma and Raghuvanshi (2011) also reported high coefficient of variation, high heritability and high genetic gain for traits like number of flowers per picking, 100-loose flower weight, flower yield per square meter.The studies revealed that genetically diverse genotypes should be further utilized as parents in crop improvement programme for the development of the varieties/hybrids with broad genetic base.

Genotypic and phenotypic correlation for various traits in African marigold

The results indicated that statistically significant and positive correlation both at genotypic and phenotypic level was observed for various vegetative and floral characters (Table 3). Since fresh flower weight per plant is the most economic character so the positive and significant correlation was observed for plant spread (0.441 and 0.484), flower fresh weight per flower (0.498 and 0.493), number of flowers

Table 3 Estimation of correlation coefficients at the phenotypic and genotypic levels

		Plant height (cm)	Plant spread (cm)	Stem girth (mm)	Fresh flower weight/ flower (g)	Number of flowers /plant	Flower diameter (cm)	Days required for flowering	Fresh flower weight/ plant (g)	Number of primary branches/ plant	Number secondary branches/ plant	Flowering duration (days)
Plant height (cm)	P	1.000	0.350	0.446*	0.307	0.119	0.354	0.552*	0.346	0.166	0.179	0.312
	G		0.350	0.552*	0.330	0.135	0.394	0.619*	0.372	0.190	0.205	0.339
Plant spread (cm)	P		1.000	0.131	–0.098	0.591*	–0.048	0.037	0.441*	0.500*	0.525*	0.347
	G			0.165	–0.114	0.643*	–0.027	0.035	0.484*	0.564*	0.585*	0.383
Stem girth (mm)	P			1.000	0.205	–0.076	0.421*	0.234	0.148	–0.151	–0.109	0.298
	G				0.250	–0.079	0.524*	0.308	0.184	–0178	–0.119	0.330
Fresh flower weight/flower (g)	P				1.000	–0.441*	0.742*	–0.005	0.498*	–0.121	–0.104	–0.053
	G					–0.451*	0.764*	–0.016	0.493*	–0.137	–0.102	–0.058
Number of flowers/ plant	P					1.000	–0.339	0.050	0.499*	0.260	0.336	0.322
	G						–0.351	0.059	0.505*	0.261	0.340	0.329
Flower diameter (cm)	P						1.000	–0.199	0.424*	–0.143	–0.082	0.258
	G							–0.241	0.432*	–0.157	–0.079	0.265
Days required for flowering	P							1.000	0.003	0.058	0.016	–0.131
	G								0.003	0.063	0.021	–0.139
Fresh flower weight/plant (g)	P								1.000	0.014	0.124	0.261
	G									0.009	0.130	0.266
Number of primary branches/	P									1.000	0.952*	0.222
	G										0.985*	0.233
Number secondary branches/ plant	P										1.000	0.252
	G											0.254
Flowering duration (days)	P											1.000
	G											

per plant (0.499 and 0.505) and flower diameter (0.424 and 0.432). However, the non significant and positive associations were observed for plant height (0.346 and 0.372), stem girth (0.148 and 0.184), days required for flowering (0.003 and 0.003), number of primary branches (0.014 and 0.009), number of secondary branches (0.124 and 0.130) and flowering duration (0.261 and 0.266). The character number of flower per plant is also equally important so significant and positive correlations has been observed for plant spread (0.591 and 0.643) and flower fresh weight per plant (0.499 and 0.505). Similarly for flower diameter the significant and positive correlations were observed for stem girth (0.421 and 0.524), flower fresh weight per flower (0.742 and 0.764) and flower fresh weight per plant (0.424 and 0.432). Some of the significant and positive associations were observed for plant height and stem girth (0.446 and 0.552), plant height and days required for flowering (0.552 and 0.619), plant spread and number of primary branches (0.500 and 0.564), plant spread and number of secondary branches (0.525 and 0.585), number of primary branches per plant and number of secondary branches per plant (0.952 and 0.985). A positive association was recorded for flower diameter and flower fresh weight per flower and also with fresh flower weight per plant, which is similar to the findings as reported in African marigold (Karuppaiah and kumar, 2010), dahlia (Vikas *et al*., 2011), and rose (Verma *et al*., 2008). Number of flowers is significantly correlated with fresh flower weight per plant. Similar observations were reported by Mathew *et al*. (2005) and Singh and Saha (2009) in French marigold. Similarly negative associations both at phenotypic and genotypic level were observed for traits like fresh flower weight per 10 flower and number of flowers per plant (–0.441, –0.451); number of flowers and flower diameter (–0.339, –0.351). These findings are similar to the results as reported in marigold by Panwar *et al*. (2012) and Namita *et al*.(2009).

Path coefficient analysis for various traits in African marigold

Path coefficient analysis (genotypic and phenotypic) was carried out by taking fresh flower weight per plant as depending character (Table 4). The portioning of genotypic correlation into direct and indirect effects revealed that number of primary branches per plant (5.331) contributed highest and significantly positive direct effect on fresh flower weight per plant followed by number of flowers per plant, flower diameter, flower fresh weight per flower, days required for flowering and stem girth. However, negative direct effect on fresh flower weight per plant was attributed by number of secondary branches per plant followed by plant height, plant spread, and flowering duration. The portioning of phenotypic correlation into direct and indirect effects revealed that the number of flowers per plant (0.850) contributed highest and significantly positive direct effect on fresh flower weight per plant followed by flower fresh weight per flower, number of secondary branches, flower diameter, plant spread, days required for flowering

Table 4 Path coefficient analysis of different quantitative traits on fresh flower weight per plant

		Plant height (cm)	Plant spread (cm)	Stem girth (mm)	Fresh flower weight/ flower (g)	Number of flowers /plant	Flower diameter (cm)	Days required for flowering	Number of primary branches/ plant	Number secondary branches/ plant	Flowering duration (days)	Fresh flower weight/ plant (g)
Plant height (cm)	P	**–0.117**	0.043	–0.02	0.238	0.101	0.064	0.05	–0.055	0.034	0.008	0.346
	G	**–0.759**	–0.17	0.168	0.254	0.297	0.527	0.204	1.011	–1.054	–0.107	0.371
Plant spread (cm)	P	–0.041	**0.122**	–0.006	–0.076	0.502	–0.009	0.003	–0.164	0.101	0.009	0.441
	G	–0.265	**–0.485**	0.05	–0.088	1.412	–0.035	0.012	3.008	–3.003	–0.121	0.485
Stem girth (mm)	P	–0.052	0.016	**–0.045**	0.16	–0.064	0.076	0.021	0.05	–0.021	0.007	0.148
	G	–0.419	–0.08	**0.305**	0.193	–0.172	0.699	0.101	–0.948	0.61	–0.104	0.185
Fresh flower	P	–0.036	–0.012	–0.009	**0.777**	–0.375	0.134	0	0.04	–0.02	–0.001	0.498
weight/flower (g)	G	–0.25	0.055	0.076	**0.771**	–0.989	1.021	–0.005	–0.728	0.524	0.018	0.493
Number of flowers/	P	–0.014	0.072	0.003	–0.343	**0.85**	–0.061	0.005	–0.085	0.065	0.008	0.5
plant	G	–0.103	–0.312	–0.024	–0.347	**2.195**	–0.468	0.019	1.393	–1.743	–0.104	0.506
Flower diameter	P	–0.041	–0.006	–0.019	0.577	–0.288	**0.181**	–0.018	0.047	–0.016	0.006	0.423
(cm)	G	–0.299	0.013	0.16	0.589	–0.77	**1.336**	–0.079	–0.839	0.405	–0.083	0.433
Days required for	P	–0.065	0.004	0.01	–0.004	0.043	–0.036	**0.09**	–0.019	0.003	–0.003	0.023
flowering	G	–0.47	–0.017	0.094	–0.013	0.129	–0.322	**0.33**	0.338	–0.11	0.044	0.003
Number of primary	P	–0.019	0.061	0.007	–0.094	0.221	–0.026	0.005	**–0.329**	0.183	0.006	0.015
branches/plant	G	–0.144	–0.274	–0.054	–0.105	0.573	–0.21	0.021	**5.331**	–5.055	–0.073	0.01
Number of secondary	P	–0.021	0.064	0.005	–0.081	0.286	–0.015	0.001	–0.313	**0.192**	0.006	0.124
branches/plant	G	–0.156	–0.284	–0.036	–0.079	0.745	–0.105	0.007	5.25	**–5.132**	–0.08	0.13
Flowering duration	P	–0.036	0.042	–0.013	–0.041	0.274	0.047	–0.012	–0.073	0.048	**0.025**	0.261
(days)	G	–0.257	–0.186	0.1	–0.044	0.722	0.353	–0.046	1.24	–1.301	**–0.315**	0.266

and flowering duration. However, negative direct effect on fresh flower weight per plant were attributed by number of primary branches followed by plant height and stem girth

The present investigation revealed that there is existence of significant variability among marigold genotypes that can be utilized for breeding novel genotypes with superior traits.

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