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Research Article

TRAIT ASSOCIATION STUDIES AMONG VEGETATIVE, FLOWER AND SEED YIELD IN MARIGOLD (*TAGETES SPP.*)

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Abstract: Trait association studies were done among forty five genotypes of marigold for ten vegetative and three reproductive traits. At phenotypic and genotypic level, there was highly significant positive correlation between numbers of leaves with number of secondary branches per plant, plant spread, seed ripening duration and leaf biomass, whereas at environmental level, highly significant positive correlation was seen in number of leaves per plant with leaf biomass and flower yield per plant. Number of secondary branched per plant showed highly significant positive correlation with plant spread and leaf biomass; plant spread with leaf biomass, flower yield and seed yield per plant; and flower yield per plant with seed yield per plant. Similar trend of association was observed between days taken to seed ripening with leaf biomass and flower yield per plant. Diverting from the results of phenotypic and genotypic levels at environmental level, highly significant positive correlation was observed between number of leaves with leaf biomass and flower yield per plant and between average fresh and dry weight of leaf, whereas positive significant correlations were seen in between average fresh weight of leaf and seed yield per plant and in between flower yield per plant and seed yield per plant.

Keywords: Association, French marigold, Genotypic, Phenotypic, trait

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Introduction

Occupying the top most position among loose flower in northern India, marigold (*Tagetes spp.*) endows a diverse range of leaf and flower size, flower forms, oil and pigments content along with large spectrum of applications in agriculture, medicinal and industrial sector. Among different species, wild marigold (*Tagetes minuta*) and French marigold (*Tagetes patula*) bears higher content of oil in leaves which has anthelmintic, analgesic, anti-inflammatory, aromatic, bronchodilator, digestive, diuretic, emmenagogue, sedative and stomachic properties. Leaves and flowers can be easily converted to organic manure and has the property to repel insect-pest. Beside innumerable applications, marigold has huge leaf, flower and seed demand both in international and national market. Despite of so many properties, meager work on luxuriance and heterosis breeding for vegetative and reproductive yield and associated traits has been done which seriously reflects the research lacuna in getting good varieties. An efficient breeding programme in a crop expects horizontal and vertical knowledge of inter relationship among various component characters contributing the yield. This further decides the formulation of simultaneous selection schemes. Character associations may vary with environmental conditions. Association of economically important yield characters of quantitative nature is quite used as basis for selection. Since, breeder has to handle a very large population in achieving the objectives, it is impossible to evaluate the population for each and every quantitative trait. Therefore, it is necessary to have the estimates of correlation of yield with other traits for which the genotypes could be assessed visually or measured easily. This correlation analysis helps in examining the possibility of improving yield through indirect selection of its component traits which are highly correlated with yield prior to any breeding programme for genetic improvement in crops. It is imperative to obtain information regarding the interrelationship of different plant characters with yield and among themselves, since it facilitates a quick assignment of high yielding genotypes in selection program. The real or true association could be known only through genotypic correlation which eliminates the environmental influence. Considering the fact, there is a need for finding correlation between different vegetative traits along with flower and seed yield which may help in finding out the degree of inter relationship among various traits and in evolving a selection criterion for the improvement of the available germplasm. Studies on genetic association also ascertain the important traits on which selection can be made. Since very little work on this aspect has been reported in ornamentals, hence it was desirable to undertake this study to find out the correlations among of important vegetative traits with flower and seed yield.

Materials and methods

The present investigation was conducted at Model Floriculture Centre, Department of Horticulture, GBPUA&T, Pantnagar. In the given investigation, the data on ten vegetative traits along with days taken to seed ripening, flower and seed yield were analysed and presented in tabular form (Table 1). The experimental material consisted of nine parents and thirty six crosses of marigold made in diallel mating design excluding reciprocals [1]. Experiment was laid out in a randomized block design and was replicated thrice. Parents were collected from various parts of India and crosses were made. Nursery beds were prepared by mixing well rotten farmyard manure @ 15 kg/m^2 into soil. Seeds were sown at 10 cm apart and 2-3 cm depth. The seed beds were finally covered with paddy straw and sprinkled with water. Paddy straw was removed when seed germination started. Nursery beds were watered regularly. Thinning of seedlings was done to keep the plants at a distance of 4-5 cm apart to provide enough sunlight and space for proper growth of the seedlings. One month old, healthy, vigorous and uniform plants were selected for transplanting.

Table-1 *Phenotypic, genotypic and environmental correlations for different vegetative traits of marigold with flower and seed yield/plant*

Trait		L/P	PB/P	SB/P	SD	Av. FWL	Av. DWL	CC	PS	PH	DSR	LB	FY/P	SY/P
L/P	P		0.34*	0.61**	0.17	-0.06	-0.02	-0.02	0.62**	0.1	0.63**	0.92**	0.17	0.21
	G		0.35*	0.59**	0.16	-0.06	-0.03	-0.01	0.60**	0.1	0.62**	0.91**	0.17	0.21
	E		-0.03	-0.03	-0.05	-0.18	-0.14	0.005	0.18	0.07	-0.02	0.77**	0.38**	-0.07
PB/P	P			0.15	0.47**	0.04	0.05	0.11	0.48**	0.32*	0.56**	0.37*	0.37	0.37*
	G			0.14	0.45**	0.04	0.05	0.07	0.46**	0.30*	0.54**	0.35*	0.36	0.36*
	E			-0.18	-0.16	-0.08	-0.13	-0.02	0.09	0.01	0.03	-0.11	0.04	-0.06
SB/P	P				0.27	-0.24	-0.18	-0.18	0.60**	-0.11	0.30*	0.53**	0.17	0.06
	G				0.26	-0.24	-0.17	-0.13	0.58**	-0.1	0.29*	0.52**	0.17	0.06
	E				-0.003	-0.15	-0.02	-0.02	0.15	0.16	-0.008	-0.15	0.03	-0.02
SD	P					0.2	0.23	0.29*	0.53**	0.30*	0.15	0.25	-0.08	0.15
	G					0.2	0.22	0.21	0.50**	0.29*	0.15	0.24	-0.08	0.15
	E					0.12	0.1	-0.005	-0.12	0.17	0.04	-0.08	-0.06	-0.07
Av.FWL	P						0.98**	0.33*	0.02	0.31*	0.18	0.26	-0.007	-0.03
	G						0.97**	0.23	0.02	0.30*	0.17	0.25	-0.007	-0.03
	E						0.78**	-0.12	0.03	-0.03	0.14	0.19	-0.22	0.31*
Av.DWL	P							0.30*	0.09	0.31*	0.17	0.29	-0.2	0.01
	G							0.21	0.09	0.31*	0.13	0.28	-0.01	0.01
	E							-0.08	0.18	-0.005	-0.13	0.13	-0.19	0.08
CC	P								0.25	0.2	0.17	0.05	-0.2	-0.1
	G								0.17	0.14	0.13	0.03	-0.15	-0.08
	E								-0.07	-0.05	0.05	-0.03	0.009	-0.06
PS	P									0.45*	0.37*	0.58**	0.33**	0.41**
	G									0.43*	0.36*	0.56**	0.32**	0.40**
	E									0.02	-0.05	0.04	0.09	-0.05
PH	P										0.37**	0.24	0.12	0.09
	G										0.36**	0.23	0.11	0.05
	E										-0.04	-0.07	-0.03	0.06
DSR	P											0.68*	0.33*	0.17
	G											0.67*	0.33*	0.17
	E											-0.08	-0.12	-0.17
LB	P												0.17	0.2
	G												0.17	0.2
	E												0.23	0.2
FY/P	P													0.57**
	G													0.56**
	E													0.29*

The plot size was 5 × 6 m and seedlings were transplanted at 1 × 1 m spacing in main field. Ten vegetative parameters and three reproductive traits were recorded from ten randomly selected plants of each plot. The observations recorded were plant height, plant spread, number of leaves/plant, number of primary and secondary branches/plant, leaf biomass, stem diameter, average fresh and dry weight of leaf, total chlorophyll content of leaf, flower yield/plant, days taken to seed ripening and seed yield/plant. Mean values of ten plants of each germplasm in each replication were used in the computation of correlations. Phenotypic, genotypic and environmental correlations were computed following method as suggested by Al-Jibouri *et al.* (1958) [2]. Genotypic and phenotypic correlation was calculated by employing the technique of statistical analysis in variance - covariance matrix in which total variability had been split into replications, genotypes and errors. The error, phenotypic and genotypic variances and covariances were used for calculating the environmental, phenotypic and genotypic correlation, respectively. The sum of squares and the sum of products at error and varietal levels were taken as error and phenotypic variances and covariances, respectively. In case of genotypic correlation coefficient, the sum of the products and sum of squares at error level were deducted from their respective values at varietal level for obtaining genotypic covariances and variances.

Results and Discussion

Selection of improved varieties is the basic criteria for the improvement of yield and its associated traits and trait association studies is the basic plant breeding tool to find out the correct strength and direction of interrelationship between various traits. To improve the yield through selection of better varieties, knowledge of the nature of association of flower yield and its components is very essential. In plant breeding, correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component character. Correlation coefficients are not only governed at phenotypic and genotypic levels, but also affected by environment. Hence, selection of the superior plants based on yield performance as such is usually not very effective. For selecting superior genotypes, phenotypic based selection governs the efficient utilization of selected variety. The analysis of variance revealed significant variation among all the vegetative and yield traits. The data presented in [Table-1] revealed different type of correlations among thirteen traits. At phenotypic and genotypic level, there was highly significant and positive correlation between number of leaves/plant, number of secondary branches/plant, leaf biomass, plant spread and days taken to seed ripening, whereas at environment level, number of leaves/plant showed highly significant and positive correlation with leaf biomass and flower yield per plant only. There was significant but positive correlation between number of leaves/plant and number of primary branches/plant. Number of primary branches/plant was also recorded to be highly significantly and positively correlated with stem diameter, plant spread, and days taken to seed ripening and significant but positive correlation was observed in the same trait with plant height, leaf biomass and seed yield/plant. There was highly significant and positive correlation in between number of secondary branches/plant, plant spread and leaf biomass. Significant and positive correlation were exhibited in between number of secondary branches/plant and days taken to seed ripening [Table-1]. The findings are in the close conformity with the results of Singh and Singh (2005) in marigold [3]. Stem diameter attained highly significant but positive correlation with plant spread and exhibited significantly but positive correlation with total chlorophyll content of leaf and plant height. Average fresh weight of leaf was highly significant and positive correlated with average dry weight of leaf. At both the levels, stem diameter, average fresh and dry weight of leaf gave significant but positively correlation with plant height, whereas diverting from the general similar trend of correlation, significant positive correlation was observed at genotypic level only by stem diameter with total chlorophyll content of leaf. Also, in a dissimilar trend, at environmental level, significant but positive correlation was seen in between average fresh weight of leaf with seed yield per

plant. There was highly significant positive correlation observed in plant spread with leaf biomass and seed yield/plant. Significant but positive correlation was observed between plant spread, plant height and days taken to seed ripening. Highly significant and positive correlation was exhibited by plant height for days taken to seed ripening. Average fresh weight of leaf is the most economic trait flower and seed yield. The results are in conformity with the earlier studies in marigold [4-9]. Days taken to seed ripening attained significant positive correlation with leaf biomass and flower yield/plant whereas flower yield/plant was highly significant and positively correlated with seed yield/plant [Table-1]. The results are in the line Singh and Singh (2005) in marigold. The values of genotypic correlation coefficient were in general lower than respective phenotypic correlation otherwise all results were similar to that of phenotypic level. For a rational approach to the improvement of yield, it would be essential to have information among different yield components. At environmental level, number of leaves/plant showed highly significant and positive correlation with leaf biomass and flower yield/plant whereas average fresh weight of leaf attained highly significant and positive correlation with average dry weight of leaf and exhibited significant and positive correlation with seed yield/plant [10-13]. Similarly, flower yield/plant exhibited significant and positive correlation with seed yield/plant. Knowledge of such relationship is also necessary for simultaneous improvement of yield. It indicated the influence of environment to a negligible extent which is in agreement with the observation made by Singh and Singh (2005) and Reena *et al*. (2005) in marigold.

Conclusion

Since leaf biomass, flower yield and seed yield per plant are directly governed by other related traits like fresh weight and dry weight of leaf, chlorophyll content of leaf, stem diameter, plant height and so on, hence a trait association of the related trait with the final produce of the plant is mandatory for long term effect.

Application of research: Selection of improved varieties is the basic criteria for the improvement of yield and its associated traits and trait association studies is the basic plant breeding tool to find out the correct strength and direction of interrelationship between various traits.

Research Category: Crop Improvement

Abbreviations: P- phenotypic, G- Genotypic, E-environmental, L/P- no. of leaves per plant, PB/P- no. of primary branches per plant, SB/P- no. of secondary branches per plant, SD- stem diameter, Av.FWL- average fresh weight of leaf, Av.DWL- average dry weight of leaf, CC- total chlorophyll content, PS- plant spread, PH- plant height, LB- leaf biomass, DSR- days taken to seed ripening, FY/P- flower yield per plant and SY/P- seed yield per plant.

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