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CORRELATION AND PATH ANALYSIS IN AFRICAN MARIGOLD (TAGETES ERECTA L.)

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ABSTRACT
A study was undertaken to determine association between different quantitative traits of 28 genotypes of African marigold collected from various sources. The positive and significant correlation was recorded for flower yield per plant with plant height (0.64), stem girth (0.60), number of flowers per plant (0.53), flower size (0.70), single flower weight (0.69) and number of petals per flower (0.52). The results of path analysis indicated that total duration (0.77), number of flowers per plant (0.56), flower size (0.51), single flower weight (0.38) and number of harvest per plant (0.21) had maximum direct effect. This result suggests that these traits can be directly used to improve the yield of African marigold.

INTRODUCTION

Marigold (*Tagetes erecta* L) is a hardy annual branching herb about 60 to 90 cm tall and erect, grown in tropical regions of India. Marigold is not only grown as loose flower and landscape plant but also as a source of natural carotenoid pigment for poultry feed. The pigment is added to intensify the yellow-orange colour of eggs yolk by adding in the poultry feed. Marigold flowers accounting for more than half of the nation's loose flower production. The demand for uniform, medium sized, compact bright colour flowers with more shelf life are very high in domestic flower market (Singh and Misra, 2012). Presently available loose flower varieties of African marigold are less vigorous, prone to lodging and low yielding. Development of high yielding semi tall varieties of marigold requires genetically stable genotypes having high yield potential.

The knowledge of association of plant characters as determined by the correlation coefficient is helpful for selection of desirable characters under a breeding program. Thus measurements of correlation coefficient between characters are a matter of considerable importance in selection indices and also permit the prediction of correlated response (Lerner, 1958). The information on the nature of association between yield and its components helps in simultaneous selection for many characters associated with yield improvements. (Mahajan *et al.,* 2011). A study on correlation alone is not enough to give an exact figure of relative importance of direct and indirect influence of each of the component traits on flower yield. In such case, path coefficient analysis is an important technique for partitioning the correlation coefficient into direct and indirect effect of independent variables on dependent variable.

Genetic variation and genetic relationship among genotypes is an important consideration for classification, utilization of germplasm resources and breeding (Kumar *et al.*, 2013). The presence and magnitude of genetic variability in a gene pool is the pre-requisite of a breeding programme (Bhujpal *et al.*, 2013). Apart from this correlations as well as path coefficient are important tools for the selection of desirable traits and to enhance the productivity of the African marigold. The main objective for a plant breeder is to evolve high yielding varieties. It is therefore, desirable for plant breeder to know the extent of relationship between yield and its various components, which will facilitate selection based on component traits (Prasad *et al.*, 2011). Keeping in view the above facts present investigation was undertaken with an objective to analyze and determine the traits having greater interrelationship with flower yield utilizing the correlation and path analysis and to help breeders in improvement of African marigold.

MATERIALS AND METHODS

The present experiment was carried out at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore-3. The experiment was laid out in randomized block design with three replications. Twenty eight genotypes of African marigold were used as experimental material and plants were raised at a spacing of 60 x 40 cm. Five randomly selected plants from each genotypes and

replication were tagged for recording the observations. The quantitative characters such as plant height, days to flower bud appearance, days to flower bud opening, number of primary branches, number of secondary branches, number of flowers per plant, flower size, number of petals per flower, single flower weight, stem girth, total crop duration and flower yield per plant were studied. The observed data were subjected to statistical analysis. The estimates of correlation coefficient were done by the method suggested by Hayes *et al*. (1955) and Al-jibouri *et al*. (1958). The path coefficient analysis was carried out by using the technique outlined by Dewey and Lu (1959) for flower yield and its components keeping flower yield as resultant variable and its component as causal variables.

RESULTS AND DISCUSSION

Association analysis

The simple correlation coefficients between yield and various yield components and interrelationship among the traits were computed and they are presented in Table 1. The results obtained through the correlation coefficients indicate a strong association between plant morphological characters with yield. A positive correlation between desirable characters is favorable to the plant breeder which helps in simultaneous improvement of both the characters.

Flower yield is a complex trait, the expression of which depends on the action and multiple interactions of various components. Flower yield per plant showed positive and significant association with plant height (0.64), stem girth (0.60), number of flowers per plant (0.53), flower size (0.70), single flower weight (0.69) and number of petals per flower (0.52). The associations of these characters with flower yield per plant are in desirable direction and selection of these traits may ultimately improve the yield. Similar results were quoted by Mathad *et al*. (2005), Singh and Saha (2009), Karuppaiah and Kumar (2010) and Kavitha and Anburani (2010) in African marigold.

Highly positive and significant correlation was observed for plant height with number of primary branches per plant (0.59), number of secondary branches per plant (0.61), stem girth (0.51), days to flower bud appearance (0.43), number of harvests per plant (0.52), total crop duration (0.64), number of flowers per plant (0.59) and flower size (0.40). These results are in accordance with the findings of Kavitha and Anburani (2010) in African marigold. Rao (1982) and Negi *et al*. (1983) reported significant and positive association of plant height with flower diameter in China aster and Vikas *et al*. (2011) for number of flowers per plant in Dahlia.

Number of primary branches per plant had positive and significant association with number of secondary branches per plant (0.63), stem girth (0.45), days to flower bud appearance (0.76) days to flower bud opening (0.70), total crop duration (0.80) and number of flowers per plant (0.70). The trait number of secondary branches per plant recorded positive and significant correlation with stem girth (0.71), days to flower bud appearance (0.68), days to flower bud opening (0.58), number of harvests per plant (0.42), total crop duration (0.76) and number of flowers per plant (0.86). This indicates

Table 1: Simple correlation coefficient among various characters in the African marigold genotypes

Characters	Number of primary branches per plant	Numberof secondary branches per plant	Stem girth (cm)	Days to flower bud appearance	Days to flower bud opening	Number of harvests per plant	Total crop duration (days)	Number of flowers per plant	Flower size (cm)	Single flower weight (g)	Number of petals per flower	Flower yield per plant (g)
Plant height (cm)	0.59**	0.61**	0.51**	0.43**	0.31	0.52**	0.64**	0.59**	0.40*	0.27	0.19	0.64**
Number of primary branches per plant		0.63**	0.45**	0.76**	0.70**	0.27	0.80**	0.70**	0.04	0.04	-0.17	0.29
Number of secondary branches per plant			0.71**	0.68**	0.58**	0.42*	0.76**	0.86**	-0.07	-0.06	-0.32	0.36
Stem girth (cm)				0.49**	0.37*	0.26	0.50**	0.66**	0.27	0.27	0.05	0.60**
Days to flower bud appearance					0.85**	0.09	0.83**	0.65**	-0.20	-0.29	-0.36	0.06
Days to flower bud opening						0.01	0.74**	0.48**	-0.28	-0.30	-0.29	-0.09
Number of harvests per plant							0.35	0.28	-0.03	0.02	0.03	0.34
Total crop duration (days)								0.76**	-0.16	-0.17	-0.10	0.34
Number of flowers per plant									0.10	0.11	-0.17	0.53**
Flower size (cm)										0.88**	0.58**	0.70**
Single flower weight (g)											0.64**	0.69**
Number of petals per flower												0.52**

Table 2: Direct and indirect effects of component characters on yield of African marigold genotypes

Characters	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Stem girth (cm)	Days to flower bud appearance	Days to flower bud opening	Number of harvests per plant	Total crop duration (days)	Number of flowers per plant	Flower size (cm)	Single flower weight (g)	Number of petals per flower	Correlation coefficient with flower yield per plant (g)
Plant height (cm)	0.02	-0.31	-0.09	-0.19	-0.02	-0.03	0.11	0.50	0.33	0.21	0.10	0.00	0.64**
Number of primary branches per plant	0.01	-0.50	-0.09	-0.16	-0.03	-0.07	0.06	0.64	0.40	0.02	0.01	0.00	0.29
Number of secondary branches per plant	0.01	-0.32	-0.14	-0.24	-0.03	-0.06	0.09	0.60	0.49	-0.03	-0.02	0.01	0.36
Stem girth (cm)	0.02	-0.43	-0.18	-0.18	-0.04	-0.06	0.10	0.74	0.68	0.26	0.20	0.00	0.60**
Days to flower bud appearance	0.01	-0.39	-0.10	-0.17	-0.04	-0.08	0.02	0.65	0.37	-0.10	-0.11	0.01	0.06
Days to flower bud opening	0.01	-0.48	-0.11	-0.17	-0.04	-0.07	0.00	0.74	0.34	-0.19	-0.14	0.01	-0.09
Number of harvests per plant	0.01	-0.14	-0.06	-0.09	0.00	0.00	0.21	0.27	0.16	-0.02	0.01	0.00	0.34
Total crop duration (days)	0.01	-0.41	-0.11	-0.18	-0.03	-0.07	0.07	0.77	0.42	-0.08	-0.07	0.00	0.34
Number of flowers per plant	0.01	-0.36	-0.12	-0.23	-0.03	-0.04	0.06	0.59	0.56	0.05	0.04	0.00	0.53**
Flower size (cm)	0.01	-0.02	0.01	-0.09	0.01	0.03	-0.01	-0.12	0.05	0.51	0.34	-0.01	0.70**
Single flower weight (g)	0.00	-0.02	0.01	-0.10	0.01	0.03	0.00	-0.13	0.06	0.46	0.38	-0.01	0.69**
Number of petals per flower	0.00	0.09	0.04	-0.01	0.01	0.03	0.01	-0.08	-0.09	0.30	0.24	-0.02	0.52**

Residual effect = 0.382

that selection of plants with more number of branches per plant does not necessarily produce bigger flowers and higher single flower weight and flower yield. Similar result was obtained by John *et al.* (1994) in Zinnia and Singh and Kumar (2008) in marigold.

Stem girth had significant and positive correlation with days to flower bud appearance (0.49), days to flower bud opening (0.37), total crop duration (0.50) and number of flowers per plant (0.66).

Highly positive and significant correlation was recorded for days to flower bud appearance with days to flower bud opening (0.85), total crop duration (0.83) and number of flowers per plant (0.65). Days to flower bud opening showed positive and significant correlation with total crop duration (0.74) and number of flowers per plant (0.48). Number of harvests per plant had no significant correlation with any other traits. Total crop duration had highly significant and positive association with number of flowers per plant (0.76).

Flower size had significant positive correlation with single flower weight (0.88) and number of petals per flower (0.58). Singh and Kumar (2008) and Singh and Saha (2009) recorded significant and positive association between flower diameter and average fresh flower weight in marigold. Highly significant and positive correlation was observed for single flower weight with number of petals (0.64). These results derive support from the findings of Singh and Saha (2009) in marigold.

Path coefficient analysis

Path coefficient analysis measures the direct influence of one variable upon the other and permits separation of correlation coefficient into components of direct and indirect effects. The path coefficient analysis suggested by Dewey and Lu (1959) specifies the effective measure of the direct and indirect causes of association and depicts the relative importance of each factor involved in contributing to the flower yield. This partitioning of total correlation into direct and indirect effects provides the actual information on contribution of the characters and thus forms the basis for selection of suitable characters to improve the yield. The simple correlation co-efficient of African marigold was apportioned into direct effects and indirect effects by path analysis and the results are presented in Table 2. The residual effect (0.38) indicated that most of the yield contributing characters were included in the study.

The path coefficient analysis indicated that the total crop duration (0.77) had high positive direct effect on flower yield per plant followed by number of flowers per plant (0.56), flower size (0.51), single flower weight (0.38). Number of harvests per plant (0.21) had moderate positive direct effect on flower yield per plant. Plant height (0.02) had negligible positive direct effect on flower yield per plant. These results derive support from the findings of Singh *et al.* (2008); Kavitha and Anburani (2010) and Karuppaiah and Kumar (2010) in marigold.

Number of petals per flower (-0.02), days to flower bud appearance (-0.04) and days to flower bud opening (-0.07) showed negligible negative direct effect on flower yield. Number of secondary branches per plant (-0.14) and stem girth (-0.18) had low negative positive effect on flower yield per plant. Number of primary branches per plant (-0.50) had

high negative direct effect on flower yield per plant. The results are in line with the findings of Kumar *et al*. (2012) in chrysanthemum. Mathad *et al*. (2005), Singh and Singh (2005) and Kavitha and Anburani (2010) also observed negative direct effect of number of branches per plant with flower yield per plant in marigold. The increased number of branches per plant after a certain limit produces more number of flowers with reduced flower size which limits the overall marketable flower yield. This might be also due to the lesser regional adaptability and growth habit of some of the genotypes resulting in higher proportion of morphological growth than the reproductive growth finally leading to reduced flower yield.

It is evident from the correlation study that the characters plant height, number of flowers per plant, flower size, single flower weight and number of petals per flower need to be given importance for selection during breeding for high flower yield in African marigold. The path coefficient analysis indicated that the characters *viz*., plant height, number of flowers per plant, flower size, single flower weight, number of petals, number of harvests per plant and total crop duration are reliable indices for selection of genotypes for yield.

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