Agric Res J **58** (5) : 845-850, *October* 2021
DOI No. 10.5958/2395-146X.2021.00121.6

VARIABILITY AND CORRELATION ANALYSIS FOR YIELD AND RELATED TRAITS IN CHRYSANTHEMUM

Parvathi Bennurmath[1*], Dipal S. Bhatt[2], Harish M Patil[3] and Sudha Patil [2]

[1]Division of Flowers and Medicinal Crops, ICAR- Indian Institute of Horticultural Research, Bengaluru-560089, Karnataka*
[2,4] Department of Floriculture and Landscape Architecture, [3] Department of Fruit Science, Navsari Agricultural University, Navsari-396450, Gujarat

ABSTRACT

The experiment was conducted to understand the correlation and path analysis in chrysanthemum utilizing 15 genotypes. Association between various characters studied indicated that phenotypic coefficient of variation was higher than genotypic coefficient of variation. Yield of flowers per plot was noted to be highly significant and had positive correlation with plant height, plant spread, days to bud initiation, flower diameter, number of ray florets per flower, flower weight, number of flowers per plant per plot and yield of flowers per plant at both genotypic and phenotypic levels. Whereas, significant and positive correlation was observed with leaf length and days to flowering at genotypic level. Path coefficient analysis indicated that number of flowers per plant had positive effect on yield of flowers per plot followed by leaf area. Based on these findings, it can be suggested that for improving flower yield in chrysanthemum, more emphasis should be given on flower diameter, number of flowers per pant, plant height and flower weight.

Keywords: Chrysanthemum, Correlation, Heritability, Variability

Chrysanthemum (*Chrysanthemum morifolium* Ramat.) commonly known as 'Guldaudi', 'Autumn Queen' or 'Queen of East' and belonging to the family 'Asteraceae' is cultivated for its commercial and aesthetic value. In India, it occupies a place of pride both as commercial flower crop and as a popular exhibition flower. Because of its multifarious traditional uses, the crop has its own commercial value and good number of varieties has been released from various institutes.

A variety may perform well only in a particular environment and therefore, the genetic potential of different genotypes and their interaction with environmental condition are to be established. The knowledge of certain genetic parameters is essential for proper understanding and their manipulation in any crop improvement programme. Genotypic and phenotypic coefficients of variation are useful in detecting the amount of variability present in the genotypes (Kumar *et al*, 2012). Correlation and path coefficient analysis furnishes information regarding the nature and magnitude of various associations and helps in the measurement of direct influence of one variable on others. Yield is a complex variable and depends upon a large number of factors and their interactions. As the breeders are always interested in the improvement of several economic characters including yield, the knowledge of correlation among the traits is important to have the idea of concurrent changes which would be brought about in other traits while making selection for one trait (Bhatia, 2004). Keeping in view the importance of this method, the present study was planned to investigate the genetic parameter, correlation coefficient and path analysis along with genetic traits to identify the best genotypes on the basis of results for future exploitation.

MATERIALS AND METHODS

The present investigation was conducted at Floriculture Research Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during 2016-17 involving 15 genotypes of chrysanthemum namely Ravi Kiran, Shyamal, Flirt, Maghi, Jaya, Lalpari, Red-2, Neelima, Ratlam Selection, Ajina Purple, Pancho, Harvest, Dolly White, Mayur and Thai Chen Queen. The experimental plot was thoroughly prepared by using plough, cultivator and harrow. Well rotten FYM (10 tons/ha) was uniformly incorporated in the beds. The plots were prepared of 130 cm x 60 cm dimensions accommodating 16 plants in each plot. The field was divided into three blocks; each block was further divided into fifteen plots i.e. one plot for each treatment. The total number of plots in the experiment was forty five. The thirty days old terminal rooted cuttings were planted in open field conditions at spacing of 30 cm × 30 cm in randomized block design (RBD) with three replications. The transplanted rooted cuttings were immediately watered. Five plants were selected

*Corresponding author : parvathiflori18@gmail.com
Date of receipt: 23.05. 2021, Date of acceptance: 14.10.2021

from each replication for recording observations. The observations were recorded after bud initiation stage. Uniform package of practices was followed throughout the cropping season to grow a successful crop. Data were recorded for several growth, flowering and yield characters, *viz.,* plant height (cm), plant spread (cm), leaf size (cm), leaf area (cm^2), days to bud initiation, days to flowering, flower diameter (cm), number of ray florets/flower, flower duration (days), flower weight (g), number of flowers/plant/plot and yield of flowers/plant/plot (g). The data collected from the genotypes of chrysanthemum on different parameters were subjected to statistical analysis. Genetic parameters of variability were estimated as per formula given by Burton and Devane (1953) and phenotypic and genotypic correlations among traits were computed by the method of Burton (1952) on the basis of expected mean square and heritability was calculated as suggested by Allard (1960) and genetic advance as percentage of mean by Johnson *et al*. (1955).

RESULTS AND DISCUSSION

The results regarding variance and genetic parameters like mean, range, genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV), heritability in broad sense (%), genetic advance and expected genetic advance (as per cent of mean) for 17 characters morphological as well as flowering are presented in the Table 1. Analysis of variance revealed the significant differences among fifteen genotypes for all the characters studied. The magnitude of range was highest for yield of flowers per plot (585.95g to 4330.2g) followed by number of flowers per plot (412.51 to 1898.94) and number of ray florets per flower (33.66 to 342.66) while the lowest range was observed for leaf width (3.53 to 4.25) followed by leaf petiole length (1.64 to 3.10) and leaf length (3.84 to 5.61). A positive correlation between desirable characters is favorable to the plant breeder which helps in simultaneous improvement. The estimates of phenotypic coefficient of variance (PCV) were found higher than genotypic coefficient of variance (GCV) for all the seventeen characters studied indicating that the apparent variation was not only due to genotypes but was also due to the influence of environment in the expression of characters whereas, highest GCV (73.79 %) and PCV (74.67 %) were recorded for flower weight followed by yield of flowers per plot, number of flowers per plant, number of ray florets per flower and yield of flowers per plant, suggesting the possibility of simultaneous selection for these traits for improving yield. On the contrary, lowest phenotypic and genotypic coefficients of variation were observed for days to flowering (PCV = 9.60 %, GCV

Table 1. Range, mean and components of variance, genotypic, phenotypic and environmental coefficient of variation, heritability and genetic advance as per cent of mean for various traits in chrysanthemum

Character	Range		Mean	Components of variance			GCV %	PCV %	Heritability (Broad sense %)	Genetic advance % of mean
	Min.	Max.		σ^2g	σ^2p	σ^2e				
Plant height (cm)	23.93	54.87	37.89	101.49	111.97	10.48	26.59	27.93	90.64	52.14
Plant spread (N-S) (cm)	20.97	29.64	24.76	10.88	17.81	6.93	13.32	17.05	61.07	21.45
Plant spread (E-W) (cm)	22.40	40.08	31.19	22.89	30.82	7.93	15.34	17.80	74.27	27.24
Length of leaf (cm)	3.84	5.62	4.90	0.28	0.52	0.24	10.82	14.69	54.26	16.42
Width of leaf (cm)	3.53	4.25	3.89	0.03	0.24	0.27	4.75	12.56	14.30	3.70
Petiole length (cm)	1.65	3.10	2.41	0.13	0.91	0.06	14.96	18.25	67.13	25.24
Leaf area (cm^2)	8.00	17.50	13.07	5.48	9.73	4.25	17.92	23.87	56.35	27.71
Days to bud initiation	63.99	88.51	74.40	38.81	69.21	30.40	8.37	11.18	56.08	12.92
Days to flowering	71.73	94.12	81.67	16.77	61.41	44.64	5.01	9.60	27.30	5.40
Flower diameter (cm)	4.30	12.66	5.64	4.34	4.73	0.39	36.96	38.57	91.85	72.97
Number of ray florets/flower	33.67	342.67	165.97	12107.46	14533.22	2425.76	66.30	72.64	83.31	124.66
Flower duration (days)	35.67	47.67	45.60	13.72	38.51	24.78	8.12	13.61	35.63	9.99
Flower weight (g)	1.25	9.78	2.78	4.21	4.31	0.10	73.79	74.67	97.65	150.20
Number of flowers/plant	17.67	99.67	41.24	784.44	800.77	16.33	67.90	68.61	97.96	138.45
Number of flowers/plot	412.52	1898.94	880.58	228280.55	235797.68	7517.13	54.26	55.14	96.81	109.98
Yield of flowers/plant (g)	26.50	199.33	93.63	3507.94	3613.51	123.57	63.26	64.36	96.60	128.07
Yield of flowers/plot (g)	585.94	4330.27	2139.91	2214895.27	2247692.15	32796.89	69.55	70.06	98.54	142.22

Table 2. Genotypic and phenotypic correlation coefficient analysis among the different characters on yield of flower per plot in various genotypes of chrysanthemum

Traits		PT	N-S	E-W	LT	WT	PL	BI	DFR	FD	NRF	FDU	FWT	NFP	NFPL	YFP	LA
	rg	0.53**	0.81**	0.72**	0.36**	0.35*	-0.02	0.62**	0.70**	0.48**	0.64**	0.27	0.50**	0.71**	0.72**	0.99**	0.18
YFPL	rp	0.50**	0.65**	0.61**	0.25	-0.12	-0.012	0.45**	0.36*	0.45**	0.59**	0.16	0.48**	0.69**	0.70**	0.97**	0.14
PT	rg		0.44**	0.98**	-0.13	0.56**	-0.21	0.22	0.63**	0.19	0.63**	0.27	0.09	0.39**	0.45**	0.43**	-0.41
	rp		0.32*	0.75**	-0.12	-0.16	-0.16	0.15	0.34*	0.16	0.53**	0.12	0.07	0.36*	0.43**	0.41**	-0.25
N-S	rg			0.69**	0.26	-0.08	-0.14	0.56**	0.58**	0.15	0.41**	0.53**	0.12	0.83**	0.87**	0.81**	0.21
	rp			0.45**	0.13	-0.01	-0.06	0.52**	0.23	0.13	0.23	0.18	0.08	0.62**	0.69**	0.59**	0.06
E-W	rg				0.12	0.30*	-0.21	0.58**	0.95**	0.28	0.75**	0.2	0.21	0.54**	0.62**	0.65**	-0.06
	rp				-0.01	-0.14	-0.12	0.34*	0.33*	0.21	0.57**	0.21	0.18	0.46**	0.52**	0.54**	-0.02
LT	rg rp					-0.39	0.38**	0.12	0.02	0.46**	0.26	0.48**	0.47**	-0.02	-0.02	0.42**	1.17**
						0.16	0.14	0.06	-0.04	0.39**	0.29*	0.31*	0.37*	-0.01	-0.06	0.33*	0.49**
WT	rg rp						-0.47**	0.34*	1.28**	-0.23	0.45**	0.31*	0.02	0.36*	0.36*	0.33*	-0.28
							0.06	-0.04	-0.01	0.06	-0.21	0.36*	0.03	-0.11	-0.12	-0.05	0.36*
PL	rg rp							-0.42	-0.56	0.28	0.18	0.16	0.37*	-0.46	-0.38	0.01	0.22
								-0.24	-0.36	0.18	0.11	0.06	0.27	-0.37	-0.36	0.01	0.22
BI	rg								1.18**	-0.04	0.28	0.08	0.04	0.68**	0.80**	0.58**	0.05
	rp								0.55**	-0.02	0.14	-0.07	0.02	0.48**	0.60**	0.39**	0.04
DFR	rg									0.13	0.74**	0.11	0.19	0.66**	0.81**	0.60**	-0.15
	rp									0.003	0.34*	0.12	0.09	0.31*	0.38**	0.35*	0.05
FD	rg										0.60**	0.18	0.97**	-0.2	-0.21	0.56**	0.39**
	rp										0.52**	0.08	0.93**	-0.21	0.52**	0.22	-0.13
NRF	rg											0.46**	0.62**	0.11	0.16	0.61**	0.33*
	rp											0.17	0.57**	0.1	0.14	0.55**	0.13
FDU	rg												0.09	0.15	0.23	0.17	0.41**
	rp												0.09	0.13	0.09	0.15	0.31*
FWT	rg													-0.21	-0.20	0.56**	0.41**
	rp													-0.20	-0.20	0.54**	0.28
NFP	rg														0.97**	0.66**	-0.06
	rp														0.94**	0.65**	-0.03
NFPL	rg															0.66**	-0.12
	rp															0.63**	-0.08
YFP	rg																0.26
	rp																0.24
LA	rg																
	rp																

** - Significant at p = 0.01 and *- Significant at p = 0.05

rg = Genotypic correlation coefficient , rp = Phenotypic correlation coefficient

Table 3. Direct and indirect effects of different characters on flower yield per plot in chrysanthemum.

Traits	Direct effect on flower yield/ plot	Indirect effect																Correlation coefficient
		PT (cm)	N-S (cm)	E-W (cm)	LT (cm)	WT (cm)	PL (cm)	BI	DFR	FD (cm)	NRF	FDU (days)	FWT (g)	NFP	NFPL	YFP (g)	LA (cm^2)	
PT (cm)	0.12		0.45	0.98	-0.14	0.56	-0.22	0.23	0.64	0.19	0.63	0.27	0.09	0.39	0.45	0.43	-0.41	0.52
N-S (cm)	-0.43	0.45		0.70	0.26	-0.08	-0.15	0.57	0.58	0.16	0.41	0.54	0.12	0.83	0.88	0.82	0.22	0.82
E-W (cm)	0.06	1.00	0.70		0.12	0.31	-0.22	0.58	0.96	0.29	0.75	0.21	0.20	0.54	0.63	0.66	-0.07	0.73
LT (cm)	0.01	-0.14	0.26	0.12		-0.40	0.38	0.13	0.02	0.46	0.27	0.49	0.48	-0.02	-0.02	0.42	1.18	0.36
WT (cm)	-0.02	0.56	-0.08	0.31	-0.40		-0.47	0.35	1.28	-0.24	0.45	0.30	0.03	0.36	0.36	0.34	-0.28	0.36
PL (cm)	0.42	-0.22	-0.15	-0.30	0.40	-0.48		-0.42	-0.56	0.29	0.19	0.16	0.38	-0.47	-0.39	0.01	0.22	-0.023
BI	0.01	0.23	0.57	0.58	0.13	0.35	-0.42		1.18	-0.05	0.29	0.09	0.05	0.69	0.80	0.58	0.06	0.62
DFR	0.09	0.64	0.59	0.96	0.02	1.29	-0.56	1.18		0.13	0.74	0.11	0.20	0.66	0.82	0.60	-0.16	0.70
FD (cm)	0.52	0.20	0.16	0.29	0.46	-0.24	0.29	-0.05	0.13		0.60	0.18	0.98	-0.20	-0.21	0.56	0.39	0.49
NRF	0.06	0.63	0.41	0.75	0.27	0.45	0.19	0.29	0.74	0.60		0.46	0.63	0.11	0.16	0.61	0.33	0.64
FDU (days)	0.01	0.27	0.54	0.21	0.49	0.30	0.16	0.09	0.11	0.18	0.46		0.10	0.16	0.24	0.18	0.41	0.27
FWT(g)	0.35	0.10	0.12	0.20	0.48	0.03	0.38	0.05	0.19	0.98	0.63	0.10		-0.22	-0.20	0.57	0.41	0.50
NFP	1.51	0.39	0.83	0.54	-0.03	0.36	-0.47	0.69	0.66	-0.20	0.11	0.16	-0.22		0.98	0.67	-0.06	0.71
NFPL	0.07	0.45	0.88	0.63	-0.02	0.36	-0.39	0.80	0.82	-0.21	0.16	0.24	-0.20	0.98		0.66	-0.12	0.72
YEP (g)	-0.41	0.43	0.82	0.66	0.42	0.34	0.01	0.58	0.60	0.56	0.62	0.18	0.57	0.67	0.66		0.27	0.99
LA(cm^2)	0.68	-0.41	0.22	-0.07	1.18	-0.28	0.22	0.06	-0.16	0.39	0.33	0.40	0.41	-0.06	-0.12	0.27		0.18

PT: Plant height, N-S: Plant spread, E-W: Plant spread (E-W), LT: Leaf length, WT: Leaf width, PL: Petiole length, BI: Days to bud initiation, DFR: Days to flowering, FD: Flower diameter, NRF: Number of ray florets/ flower, FDU: Flower duration, FWT: Flower weight, NFP: Number of flowers/ plant, NFPL: Number of flowers/ plot, YFP: Yield of flowers/ plant, YFPL: Yield of flowers/ plot, LA: Leaf area

= 5.01 %) followed by days to bud initiation (PCV = 11.18 %, GCV = 8.37 %). Singh and Singh (2005) in marigold also reported the same result for correlation with number of flowers per plant with individual flower weight showing significant and positive correlation with flower yield per plant. Similar results were shown by Mishra *et al*. (2006) in spray chrysanthemum and Suvija *et al*. (2016) in chrysanthemum

The magnitude of heritability is the most important aspect of genetic constitution of the breeding material and in determining the methods to be used for their improvement. All the characters showed a higher broad sense heritability estimates ranging from 27.30 % to 98.54 %. High estimates of heritability were observed for yield of flowers per plot (98.54 %) followed by number of flowers per plant (97.96 %) while the minimum estimate of heritability was observed for days to flowering (27.30 %). Characters studied with high heritability values could be improved directly through selection since these traits are relatively less influenced by environment and there would be greater correspondence between phenotypic and breeding values.

The heritability estimates obtained were moderate to high for all the characters studied. High heritability coupled with high expected genetic advance was observed for yield of flowers per plot followed by number of flowers per plant. High heritability coupled with high genetic gain suggests that the gene action is mostly of additive type and therefore, these traits are improved directly through selection. This result was in accordance with Peddilaxmi *et al*. (2008) for traits like yield per plant, number of flowers per plant and duration of flowering in chrysanthemum.

Correlation coefficient study

The correlation matrix between yield of flowers/ plot and various morphological attributes in different varieties of chrysanthemum was studied. The genotypic correlation coefficients were higher as compared to phenotypic and environmental correlation coefficient in most of the cases (Table 2). This indicates greater contribution of genotypic factor in the development of the character associations. The yield of flowers per plot (g) showed highly significant and positive correlation with plant height (rg = 0.53 and rp = 0.50), plant spread (N-S) (rg = 0.81 and rp = 0.65), plant spread (E-W) (rg = 0.72 and rp = 0.61), days to bud initiation (rg = 0.62 and rp = 0.45), flower diameter (rg = 0.48 and rp = 0.45), number of ray florets per flower (rg = 0.64 and rp = 0.59), flower weight (rg = 0.50 and rp = 0.48), number of flowers per plant (rg = 0.71 and rp = 0.69), number of flowers per plot (rg = 0.72 and rp = 0.70) and yield of flowers per plant (rg = 0.99 and rp = 0.97) at genotypic and phenotypic levels whereas, significant and positive genotypic correlation was observed with leaf length (rg = 0.36) and days to flowering (rg = 0.70). The present findings are in agreement with the findings of Sirohi and Behera (1999) for plant spread in chrysanthemum. These results were also in accordance with Mathew *et al.* (2005) for number of flowers per plant and number of buds per plant in marigold.

Path coefficient study

The result of genotypic correlation coefficients was partitioned into direct and indirect effects through various yield contributing characters, which are presented in Table 3. The number of flowers per plant (1.51) exhibited the maximum significant positive effect on yield of flowers per plot followed by leaf area (0.68), flower diameter (0.52), petiole length (0.42), flower weight (0.35) and plant height (0.12). Characters days to flowering (0.09) followed by number of flowers per plot (0.07), plant spread (E-W) (0.06), number of ray florets per flower (0.06), leaf length (0.01), days to bud initiation (0.01) and flower duration (0.01) also registered positive direct effect but was noted negligible. The maximum negative direct effect was observed for plant spread (N-S) (-0.43) followed by yield of flower/ plant (-0.41). This suggests the usefulness of all the above mentioned traits for component selection and method to improve the yield. Flower yield per plant was significantly and directly influenced by individual flower weight (1.165), which is in accordance with the results of Kameshwari *et al*.(2015), Suvija *et al*. (2016) and Hebbal *et al*. (2018) in chrysanthemum. Deka and Paswan (2002) in chrysanthemum reported similar association with number of flowers per plant. All the direct effects were less than one except number of flowers per plant which indicated that inflation due to multicollinearity was minimal. Partitioning of genotypic correlation between yield of flowers per plot and its component traits revealed that the direct effects were in general of higher magnitude for most of the traits than that of their indirect effects.

There is sufficient genetic variability in the chrysanthemum genotypes for various characters. High heritability as per cent of mean was observed in yield of flowers per plot, number of flowers per plant and flower duration indicating scope for improvement through selection. Correlation and path coefficient analysis revealed that traits like flower weight, yield of flowers per plot, number of flowers per plant contributed directly to flower.

Authors' contribution

Conceptualization of research work and designing of experiments (DSB, PB); Execution of field/lab experiments and data collection (PB); Analysis of data and interpretation (PB, DSB, HMP); Preparation of manuscript (PB, DSB, SP)

LITERATURE CITED

Allard R W 1960. *Principles of Plant Breeding*. John Willey and Sons, Inc. New York, 221p.

Bhatia R 2004*. Genetic* variability and correlation studies in gladiolus. M Sc thesis, Punjab Agricultural University, Ludhiana.

Burton G N 1952. Quantitative Inheritance in Grasses. *Proceedings of sixth international Grassland Congress* **1:** 277-83.

Burton G W and Devane E H 1953. Estimating heritability in tall fescue (*Festuca arundinaceae)* from replicated clonal material. *Agron J* **45:** 478-81.

Deka K K and Paswan L 2002. Correlation and path analysis studies in chrysanthemum. *Int Information System for the Agric Sci Technol* **4(5):** 40-45.

Hebbal M, Shiragur M, Naika M B N, Seetharamu G K, Nishani S and Patil B C 2018. Genotypic and phenotypic path analysis for flower yield in chrysanthemum (*Dendranthema grandiflora* Tzvelve). *Int J Curr Microbiol Appl Sci* **7(8):** 4515-21.

Johnson H W, Robinson H F and Comstock R E 1955. Estimates of genetic and environmental variability in soybeans. *Agron J* **47:** 314-18.

Kameshwari P L, Pratap M, Begum H U and Anuradha G 2015. Studies on genetic variability and character association for yield and its attributes in chrysanthemum (*Dendranthema grandiflora* Tzvelev). *Agric Sci Digest* **35(1):** 25-30.

Kumar R, Deka B C and Venugopalan R 2012. Genetic variability and trait association studies in gerbera (*Gerbera jamesonii*) for quantitive traits. *Indian J Agric Sci* **82(7):** 615–19.

Mathew R, Beniwal B S, Bhatia S K and Deswal D P 2005. Variability and correlation studies in African marigold (*Tagetes erecta* L.). *Res on Crops* **6(2):** 322-27.

Mishra H N, Das J N and Palai S K 2006. Genetic variability studies in spray type chrysanthemum. *Orissa J Hort* **34(1):** 8-12.

Peddilaxmi, Pratap M and Reddy S A 2008. Evaluation of yellow coloured chrysanthemum (*Dendranthema grandiflora* L.) cultivars for growth, flowering and yield. *Orissa J Hort* **36(1):** 116-19.

Singh D and Singh A K 2005. Correlation and path coefficient analysis in marigold (*Tagetes* spp.). *Prog Hort* **37(2):** 385-88.

Sirohi P S and Behera P K 1999. Correlation and path analysis studies in chrysanthemum. *J Ornam Hort* **2(2):** 80-83.

Suvija N V, Suresh J, Subesh R K and Kannan M 2016. Evaluation of chrysanthemum cultivars (*Chrysanthemum morifolium* Ramat.) genotypes for loose flower, cut flower and pot mums. *Inter J Innov Research and Advanced Studies* **3(4):** 2394-2404.