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Genetic variability, heritability and correlation in chrysanthemum (*Dendranthema grandiflora*)

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Chrysanthemum [*Dendranthema grandiflora* (Tzvelve)] is one of the most beautiful and perhaps the oldest flowering plants, belongs to the family Asteraceae. It is commercially grown across the world for cut and loose flowers, and also for landscaping purposes. There exists wide range of varieties in chrysanthemum suitable for various agro-climatic situations in the country. Therefore, the genetic potentialities of different genotypes and their interaction with environmental conditions are to be established and according to their performance, selection of genotypes with superior growth and flowering traits needs to be done. Kerala is a state with a lot of potential for floriculture due to its diverse agro-climatic conditions. It is experiencing a flower revolution due to the strong demand and profitable crop. Though there is ample scope for chrysanthemum flowers, there has not been an attempt to evaluate suitable genotypes for commercial cultivation in Kerala.

The effectiveness of any breeding strategy depends significantly on understanding the genetic variability present in a crop species (Bhujbal *et al.* 2013). Thus, a detailed analysis of genotypic and phenotypic variability is necessary for an effective selection programme (Kumari *et al.* 2017, Thakur and Sarma 2023). The correlation study aids in selection by examining how other parameters impact the desirable characters. Since an improvement in one trait may result in an improvement in the other, the positive correlation suggests that both attributes can be enhanced at the same time (Bennurmath *et al.* 2021). With the aforementioned facts, the present study was carried out with the aim of aiding chrysanthemum breeders in the crop improvement by using correlation to analyze and identify the qualities having better interrelationship with the production of flowers per plant.

Fifteen genotypes of chrysanthemum procured from different locations were evaluated at the Department of Floriculture and Landscaping, College of Agriculture, Vellanikkara, Thrissur, Kerala during January to October 2022. One-month old chrysanthemum genotypes were collected and planted in pots to raise the mother stock and planting material required for the experiment was raised from the mother stock using terminal cuttings. The uniform and healthy rooted cuttings of each genotype were selected and transplanted at the spacing of 0.4 m × 0.4 m in the main field. The experiment was conducted in a randomized block design with 15 genotypes as treatments and 3 replications in plots of size 2 m × 1.0 m. ICAR-Indian Institute of Horticultural Research (IIHR), Bengaluru, Karnataka fertilizer recommendation (100:50:100 kg NPK/ha) for the crop was followed. Out of 15 genotypes, 6 were collected from ICAR-IIHR (Karnool Pink, Dolley Orange, Autumn Joy, Roopanjali, Coffee and Pink Cloud) and 9 local genotypes from Kyadigere, Chitradurga, Karnataka (KAU C-1, KAU C-2, KAU C-3, KAU C-4, KAU C-5, KAU C-6, KAU C-7, KAU C-8 and KAU C-9).

The genetic distances among 15 chrysanthemum genotypes were worked out by using K means cluster analysis (Mahalanobis 1928). The genotypes were categorised into different clusters by Tocher's method (Rao 1952). Genetic parameters were estimated according to the method suggested by Burton (1992) and covariance analysis was worked out with the help of formula suggested by Fisher (1954). Heritability was estimated using the formula suggested by Burton and Devane (1953). At 5% selection intensity, the predicted genetic advance was evaluated using the formula suggested by Lush (1949) and Johnson *et al.* (1955). Correlation studies were conducted in all possible combinations as suggested by Johnson *et al.* (1955).

Significant variations were reported among the genotypes for all the traits. Tocher's method of Cluster analysis grouped the 15 chrysanthemum genotypes into 4 clusters, revealing the presence of diversity for different growth and flowering parameters. Results showed that cluster 2 consists of maximum number of 5 genotypes (Pink Cloud, KAU C-2, KAU C-3, KAU C-7, KAU C-8)

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followed by cluster 3 (Autumn Joy, Roopanjali, Coffee, KAU C-5) and cluster 4 (Karnool Pink, KAU C-1, KAU C-4, KAU C-6) (4 genotypes respectively) whereas cluster 1 had minimum number of (2) genotypes (Dolley Orange and KAU C-9). The genotypes from different clusters found genetically diverse and can be used in crop development for various commercial traits.

Highest inter-cluster distance (304.06) was observed between cluster 1 and 4 which means maximum homogeneity existed among the genotypes in this cluster and highest intra-cluster distance (222.89) was recorded for cluster 2 which meant greater heterogeneity existed among genotypes in this cluster (Fig. 1). Individual cluster genotypes can be used in selection or breeding programmes for desirable economic characteristics in chrysanthemum. Cluster mean values (CMV) towards various growth and yield parameters are given in Table 1. Cluster 1 showed the maximum CMV for plant height, number of primary branches per plant, days to bud initiation and 50% flowering. Cluster 2 showed highest CMV for shelf-life. Cluster 3 showed highest CMV for plant spread, more number of leaves per plant and Cluster 4 showed highest CMV for days to complete opening of flower, duration of flowering, flower diameter, stalk length, stalk girth, field life, flower weight, vase life, flowers and yield/plant. As a result of this analysis, it was determined that different genotypes had a significant effect on the clustering pattern, the characters contributing to divergence and cluster means, and thus these characters should be given more weightage when selecting parents for crop improvement. These results are in agreement with the findings of Kumar *et al.* (2016) and Prakash *et al.* (2017) in chrysanthemum.

The wide variation among various characteristics indicated the presence of considerable diversity within most of the traits, offering enough opportunity for the selection of lines with desired feature combinations. Estimation of the genetic parameters such as genotypic variance (GV), phenotypic variance (PV), environmental variance (EV), environmental coefficient of variation (ECV), phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (H^2) and genetic advance as per cent of mean (GAM) are furnished in Table 2. The trait flower yield per plant recorded maximum GCV and PCV of 47.69 and 48.1% respectively whereas the trait shelf-life recorded minimum GCV and PCV of 16.78 and 16.34% respectively. For all the traits, H^2 estimates were greater than 95% except for the traits days to complete opening of flower (92.3%), flower diameter (92.4%), flower stalk length (94.9%) and shelf-life (88.5%) which indicated high range of heritability. This was coupled with high range of GAM as it was recorded more than 20% for all the traits due to additive gene effect. High H^2 estimates coupled with high GCV would give picture of the extent of genetic advance under selection. High heritability values suggest that these attributes have excellent scope for improvement. Similar results were reported by Gantait and Pal (2014) in chrysanthemum.

Table 3 shows genotypic and phenotypic correlation between vegetative and flowering traits. The genetic correlation coefficient was greater than the equivalent phenotypic correlation coefficient, indicating that the environment had a negligible influence on phenotypic variation. According to research on character association, since the parameter flower yield/plant showed a substantial positive correlation with number of flowers/plant, flower diameter, stalk length, stalk girth and flower weight at

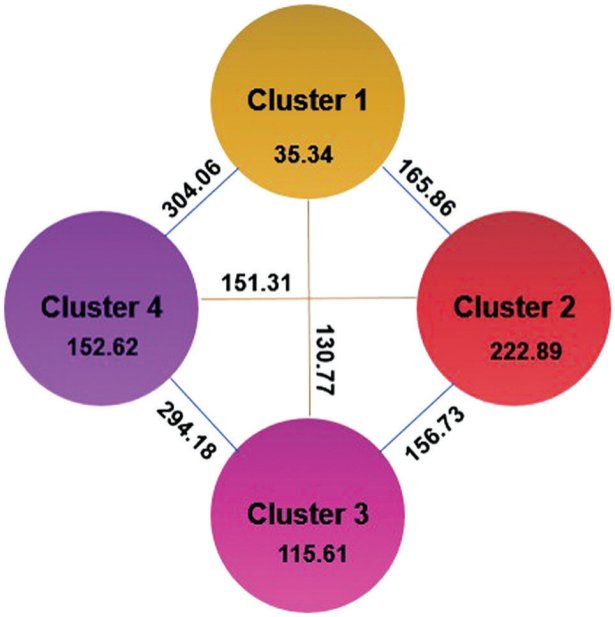

Fig. 1 Cluster diagram showing inter and intra cluster distance.

Table 1 Cluster mean for different growth and flowering traits in chrysanthemum

Cluster	1	2	3	4
Plant height	38.12	32.08	37.58	31.90
Plant spread	35.83	33.19	36.63	31.08
Primary branches/plant	15.00	10.00	11.00	9.30
Leaves/branch	14.00	15.50	16.90	14.90
Days to bud initiation	103.23	49.51	11.79	40.79
Days to 50% flowering	107.08	52.48	13.43	45.17
Days to complete opening of flower	-	42.19	-	46.81
Duration of flowering	-	67.25	-	99.49
Flower diameter	-	5.60	-	10.22
Flower stalk length	-	10.22	-	23.21
Flower stalk girth	-	1.04	-	1.34
Field life	-	8.94	-	10.06
Flower weight	-	2.88	-	4.71
Flowers/plant	-	43.25	-	69.86
Yield/plant	-	114.20	-	258.48
Vase life	-	10.87	-	10.91
Shelf-life	-	3.91	-	3.27

Table 2 Estimation of genetic parameters in chrysanthemum

	GV	PV	EV	ECV (%)	PCV (%)	GCV (%)	H^2 (%)	GAM (%) (i=5%)
Plant height	24.07	24.69	0.62	2.47	15.53	15.33	97.50	31.18
Plant spread	38.16	39.22	1.06	3.12	19.42	19.15	97.30	38.91
Primary branches per plant	19.25	19.72	0.47	6.79	43.92	43.39	97.60	88.31
Leaves/branch	11.44	11.57	0.12	2.32	22.34	22.22	98.90	45.53
Days to bud initiation	100.50	102.66	2.16	3.21	22.15	21.92	97.90	44.68
Days to 50% flowering	115.87	116.67	0.79	1.81	21.94	21.87	99.30	44.89
Days to complete opening of flower	52.60	56.98	4.38	4.73	17.06	16.39	92.30	32.44
Duration of flowering	363.67	371.57	7.89	3.44	23.63	23.37	97.90	47.64
Flowers/plant	593.92	601.77	7.84	5.09	44.54	44.25	98.70	90.55
Flower diameter	1.14	1.23	0.09	4.85	17.56	16.87	92.40	33.41
Flower stalk length	57.90	58.37	0.47	4.28	47.42	47.23	99.20	96.89
Flower stalk girth	0.04	0.04	0.002	3.80	16.78	16.35	94.90	32.80
Flower weight	3.02	3.04	0.01	2.97	47.18	47.09	99.60	96.81
Field life	4.12	4.13	0.008	0.94	21.52	21.50	99.80	44.25
Vase life	6.33	6.45	0.12	2.99	21.86	21.65	98.10	44.18
Shelf-life	0.58	0.65	0.07	7.54	22.23	20.91	88.50	40.52
Yield/plant	7233.17	7360.90	127.73	6.34	48.11	47.69	98.30	97.39

both phenotypic and genotypic level, these qualities might be enhanced by choosing genotypes that produced larger flower yield. This finding shows that indirect selection of any one of these traits will result in a simultaneous increase in flower production. Present studies of significant and positive correlation between various vegetative and floral parameters are in good agreements with Prakash *et al.* (2018) in chrysanthemum.

Individual cluster genotypes can be used in selection or breeding programmes for desirable economic characteristics in chrysanthemum. Most of the characters showed high range of GCV and PCV, indicating a broad genetic base that would be useful for further selection and crop improvement. From the present investigation, it could be concluded that parameters affecting flower yield with positive correlation and direct effect are primary branches, duration of flowering, flowers/plant, flower stalk girth and flower weight. Hence, for the better enhancement of flower yield per plant, all these traits should be taken into consideration.

SUMMARY

Chrysanthemum is a herbaceous perennial flowering crop that holds great potential for commercial cultivation. Fifteen chrysanthemum genotypes were studied at the Department of Floriculture and Landscaping, College of Agriculture, Vellanikkara, Kerala Agricultural University, Thrissur, Kerala during 2022 for variability studies in morphological, flowering and post-harvest parameters. Significant variations were recorded among the genotypes for all the traits. Cluster analysis grouped the 15 chrysanthemum genotypes into 4 clusters based on all the characters. Cluster 2 consists of maximum number of 5 genotypes followed by 4 genotypes each in cluster 3 and cluster 4. Highest intra-cluster distance was recorded for cluster 2 and highest inter-cluster distance was observed between cluster 1 and 4. Results revealed that GCV was greater than the equivalent PCV, indicating that the environment had a negligible influence on phenotypic variation. High heritability coupled with high genetic advance for all the characters, indicating additive gene effect suggests that there is excellent scope for selection and improvement. Flower yield per plant showed a substantial positive correlation with flowers/plant, flower diameter, stalk length, stalk girth and flower weight at both phenotypic and genotypic level which could be focused for yield improvement.

REFERENCES

Bennurmath P, Bhatt D S, Patil H M and Patil S. 2021. Variability and correlation analysis for yield and related traits in chrysanthemum. *Agricultural Research Journal* **58**(5): 845–50.

Bhujbal G B, Chavan N G and Mehetre S S. 2013. Evaluation of genetic variability, heritability and genetic advances in gladiolus (*Gladiolus grandiflorus* L.) genotypes. *The Bioscan* **8**(4): 1515−20.

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

Burton G W. 1992. Quantitative inheritance in grasses. Proceedings of 6th *International Grassland Congress* **1**: 277–83.

Table 3 Genotypic and phenotypic correlation between vegetative and floral parameters in chrysanthemum

GC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1																
2	0.858**	1															
3	0.782**	0.986**	1														
4	0.871**	0.805**	0.738**	1													
5	-0.577*	-0.188	-0.17	-0.46*	1												
6	-0.63**	-0.23	-0.199	-0.487*	0.997**	1											
7	0.248	-0.086	-0.191	0.197	-0.286	-0.302	1										
8	0.041	0.009	0.015	-0.004	-0.212	-0.105	0.41*	1									
9	0.186	0.216	0.205*	-0.142	-0.149	-0.114	-0.13	0.57*	1								
10	0.281	0.052	0.071	0.376*	-0.715**	-0.606**	0.41*	0.748**	0.15	1							
11	0.35	0.176	0.143	0.268	-0.579*	-0.503*	0.527*	0.841**	0.439*	0.879**	1						
12	0.447*	0.223	0.148	0.207	-0.578*	-0.555*	0.556*	0.757**	0.653**	0.677**	0.931**	1					
13	0.003	-0.131	-0.048	0.2	-0.471*	-0.357*	0.295	0.52*	-0.234	0.891**	0.631**	0.31	1				
14	-0.062	0.229	0.381*	-0.063	0.039	0.104	-0.207	0.395*	0.152	0.316	0.393*	0.184	0.494*	1			
15	0.649**	0.4*	0.357*	0.448*	-0.455*	-0.519*	0.683**	0.067	-0.135	0.274	0.402*	0.446*	0.241	0.118	1		
16	0.759**	0.683**	0.639**	0.901**	-0.412*	-0.469*	0.208	-0.38*	-0.516*	0.177	-0.057	-0.134	0.163	-0.102	0.549*	1	
17	0.269	0.171	0.18*	0.058	-0.504*	-0.423*	0.134	0.83**	0.83**	0.683**	0.832**	0.88**	0.321*	0.34	0.067	-0.332	1
PC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1																
2	0.842**	1															
3	0.772**	0.964**	1														
4	0.859**	0.785**	0.715**	1													
5	-0.567*	-0.173	-0.162	-0.459*	1												
6	-0.628**	-0.23	-0.204	-0.481*	0.977**	1											
7	0.229	-0.055	-0.186	0.187	-0.264	-0.289	1										
8	0.031	0.009	0.011	-0.011	-0.21	-0.1	0.389*	1									
9	0.178	0.223	0.206*	-0.146	-0.139	-0.114	-0.117	0.568*	1								
10	0.287	0.06	0.077	0.361*	-0.686**	-0.58*	0.368*	0.687**	0.133	1							
11	0.336	0.171	0.144	0.26	-0.57*	-0.498*	0.507*	0.838**	0.439*	0.824**	1						
12	0.429*	0.209	0.137	0.194	-0.574*	-0.533*	0.52*	0.751**	0.629**	0.625**	0.914**	1					
13	0.009	-0.127	-0.05	0.201	-0.468*	-0.358*	0.283	0.514*	-0.234	0.854**	0.625**	0.305	1				
14	-0.058	0.221	0.377*	-0.061	0.039	0.102	-0.207	0.388*	0.147	0.305	0.389*	0.177	0.493*	1			
15	0.649**	0.397*	0.356*	0.437*	-0.445*	-0.517*	0.634**	0.069	-0.132	0.273	0.394*	0.44*	0.242	0.119	1		
16	0.691**	0.597*	0.586*	0.843**	-0.375*	-0.444*	0.128	-0.341	-0.489*	0.113	-0.047	-0.127	0.153	-0.086	0.514*	1	
17	0.259	0.177	0.174*	0.054	-0.493*	-0.416*	0.136	0.827**	0.83**	0.634**	0.828**	0.856**	0.317*	0.334	0.067	-0.318	1

Fisher R A. 1954. A fuller theory of junctions in breeding. *Heredity* **8**: 187–219.

Gantait S S and Pal P. 2014. Variability and Correlation analysis for the yield and its traits in spray chrysanthemum (*Chrysanthemum morifolium* Ramat.). *Indian Horticulture Journal* **4**(2): 95–97.

Johnson H W, Robinson H E and Comstock R E. 1955. Estimation of genetic and environmental variability in soybean. *Agronomy Journal* **47**: 314–18.

Kumar S, Kumar M, Kumar R, Malik S, Singh M K and Kumar S. 2016. Analysis of genetic divergence in chrysanthemum (*Dendranthema grandiflora* Tzvelev) germplasm using morphological markers. *International Journal of Agricultural and Statistical Sciences* **12**(1): 255–60.

Kumari P, Rajiv Kumar, Rao T M, Dhananjay M V and Bhargav V. 2017. Genetic variability, character association and path coefficient analysis in China aster (*Callistephus chinensis* L.). *Journal of Horticultural Sciences* **7**(2): 3353−62.

Lush J L. 1949. *Animal Breeding Plans*, pp. 473. Lown state university press. Annes.

Mahalanobis P C. 1928. A statistical study at Chinese head measurements. *Journal of Asiatic Society Bengal* **25**: 301–07.

Prakash A, Kumar M, Naresh R K, Malik S, Singh M K, Kumar V and Kumar A. 2017. Divergence studies in chrysanthemum (*Dendranthema grandiflora* Tzvelev) based on agro-morphic traits. *International Journal of Pure and Applied Bioscience* **5**(3): 982–88.

Prakash A, Kumar M, Singh C, Kumar A, Badal D S and Singh S. 2018. Correlation and path analysis studies in chrysanthemum (*Dendranthema grandiflora* Tzvelev). *Journal of Pharmacognosy and Phytochemistry* **7**(2): 3890–93.

Rao C R. 1952. *Advanced Statistical Methods in Biometrical Research*, pp. 390. John Willey and Sons, New York.

Thakur K and Sarma M K. 2023. Genetic diversity and principal component analysis in cultivated rice (*Oryza sativa*) varieties of Assam. *The Indian Journal of Agricultural Sciences* **93**(2): 145–50. https://doi.org/10.56093/ijas.v93i2.132052