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Divergence Studies in Chrysanthemum (*Dendranthema grandiflora* Tzvelev) Based on Agro-Morphic Traits

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ABSTRACT

The investigation was carried out with twenty chrysanthemum genotypes at Horticultural Research Centre (HRC) of SVPUAT, Meerut, UP during 2016-17 to study the genetic diversity among the genotypes. The maximum days to flower bud initiation (43.53 days) and days to flowering (69.53 days) was observed in the cultivar of Ajay while cultivar White Star produced larger size flower (9.97 cm). The maximum flowering duration (57.53 days) was observed with the cultivar of Haldighati and maximum plant height at flower bud initiation stage (28.27 cm) and plant height at full bloom (57.53 cm) was observed with the cultivar of Sunny. Cultivar of Basanthi produced maximum number of primary branches (7.93), plant spread (70.73 cm) and maximum number of flowers (218.67). D^2 analysis grouped among the genotypes into five clusters showing the existence of considerable amount of variation among the genotypes. Cluster pattern revealed that, cluster V had largest number of 6 cultivars, followed by cluster III (5 cultivars), cluster II (4 cultivars), cluster IV (3 cultivars) and cluster I had only (2 cultivars). Highest intra-cluster distances were found for cluster III (D^2 =2.117) whereas, highest inter-cluster distance was observed between clusters V and IV (D^2 4.402). The cluster means revealed the best cluster for various growths and flowering traits depending upon the aim of breeding programme and potential line can be selected from different clusters as parents.

Key words: *Chrysanthemum, Genetic diversity, Morphological characterization, Cultivar identification.*

INTRODUCTION

Flowers have been associated with mankind since time immemorial. Floriculture is fast emerging as a sunrise business activity and has taken a different perspective in the horticultural business domain. Enormous flower shops have materialized the markets in cities and towns across the country after westernization. Market led floriculture has assumed importance worldwide and demand for the flowers are being satisfied based on consumer preference.

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The consumer preference has been changing from time to time for both traditional and cut flowers and there is demand for varieties based on colour, shape, size, shelf life, etc. Due to this phenomenal change, at present, India's floriculture industry has attained a status of a huge opportunity sector aiming to become an industry worth of Rs. 100,000 million by 2010 [10]. [14] stressed the importance of research in developing high yielding varieties with year round production in chrysanthemum.

Chrysanthemum is one of the oldest cultivated flower crops which plays a significant role in the culture and life of people. It is cultivated almost throughout the world and commonly known as many names like Guldaudi, Queen of the East and Glory of the East [12]. Most of the cultivated species have basic chromosome number of 9 (x) with wide range of ploidy level (2n=36-75). Most of them are allo-hexaploid and aneuploid having most frequent somatic chromosome number of 54 [5,16]. Reported that currently, the number of chrysanthemum cultivars worldwide is 20,000 to 30,000 [1]. There is hardly any other garden flower which has such diverse and beautiful range of colour, shapes, and height as that of Chrysanthemum. The utility and popularity of chrysanthemum have increased immensely with the introduction of technique of year round production based on scientific research in the field of photo-periodic and genetics. Chrysanthemum cultivars exhibits a wide range of diversity in morphological traits like flower number, size, colour and flowering duration. Such wide variations exhibited by the large number of cultivars make the crop suitable for every purpose of decoration [6]. Genetic diversity is being used as source of genes in crop improvement for production of high yielding varieties, hybrids and to effect ecologically sustainable economic and social development. Among the varieties of chrysanthemum genetic factors are responsible for such variability. Growth and flowering characters are highly heritable, interrelationship of all these characters and their direct and indirect contribution towards yield becomes very essential to plan the cultural manipulations for achieving the better yield and quality in chrysanthemum. Divergence analysis is performed to identify the diverse genotypes which can be further utilized in breeding programme. [8] generalized distance (1936) estimated by D^2 statistics has been used as an efficient tool in the quantitative estimation of genetic diversity for a rational choice of potential parent for breeding programme. Present investigation was undertaken to analyse diversity in chrysanthemum genotypes and grouping of these genotypes based on their clustering pattern which further aids the breeder in selection of divergent genotypes in crop improvement programme.

MATERIALS AND METHODS

A total of 20 genotypes of chrysanthemum collected from Indian Agricultural Research Institute New Delhi, were used for divergence study (Table 4). The present investigation was established in 2016 at Horticultural Research Centre (HRC) of Sardar Vallabhbhai Patel University of Agriculture &Technology, Meerut research farm (29^0 04', N latitude and77^0 42' E longitude a height of 237m above mean sea level) U.P., India. The region has a semi-arid sub-tropical climate with an average annual temperature of 16.8^0C. The highest mean monthly temperature (38.9^0C) is recorded in May, and the lowest mean monthly temperature (4.5^0C) is recorded in January. The average annual rainfall is about 665 to 726 mm (constituting 44% of pan evaporation) of which about 80% is received during the monsoon period. The predominant soil at the experimental site is classified as *Typic Ustochrept*. Soil samples for 0–20 cm depth at the site were collected and tested prior to applying treatments and the basic properties were non-saline (EC 0.42 dS m^{-1}) but mild alkaline in reaction (pH 7.98). The soil initially had 4.1 g kg^{-1} of SOC and 1.29 g kg^{-1} of total N (TN), 1.23 g kg^{-1} of total phosphorus, 17.63 g kg^{-1} of total potassium, 224mg kg^{-1} of available N, 4.0 mg kg^{-1} of available phosphorus, and 97 mg kg^{-1} of available potassium. The experiment was laid

down in Randomized Block Design with three replications. Each plot comprised one row of 4.5 m length and rooted plant spaced at 45 cm. All agronomical practices were followed under irrigated conditions as per crop needs. The observations were recorded on five random competitive plants per replication for each genotype on eight important characters *i.e.* (i) days to flower bud initiation, (ii) days to flowering, (iii) flower size, (iv) flowering duration, (v) plant height at flower bud initiation stage(vi), plant height at full bloom, (vii) number of primary branches per plant, (viii) Plant spread. In order to study the magnitude of genetic divergence in germplasm, Mahalanobis D^2 (1936) statistics was used to quantify genetic diversity among the genotypes. The D^2 values were used to classify the entire germplasm into distinct clusters, which was done by Tocher's method [11]. The data were subjected to statistical analysis as suggested by Cochran *et al* [3].

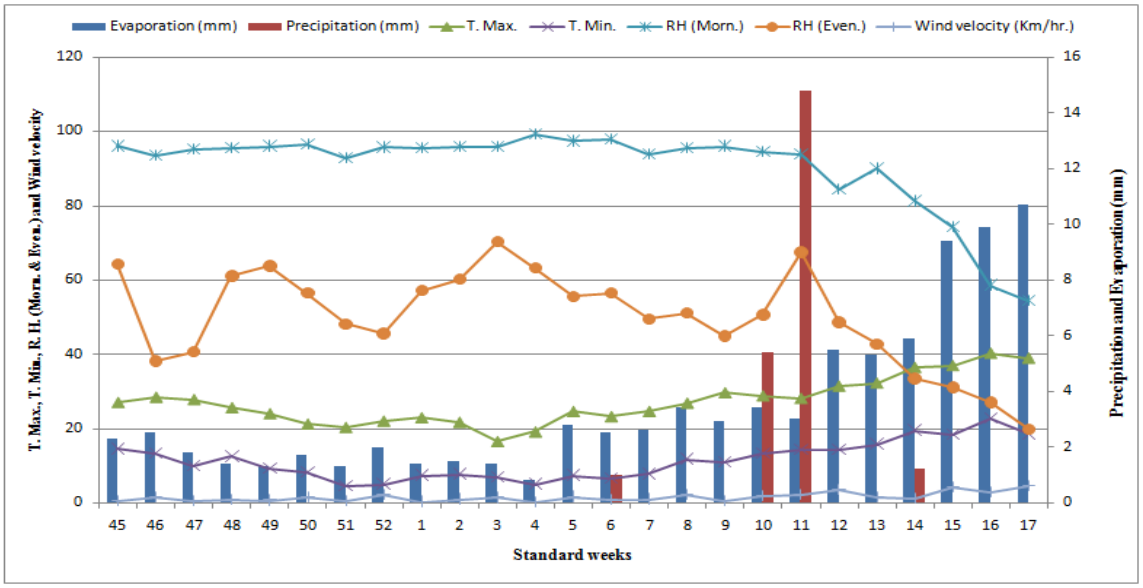

Fig. 1: Weekly precipitation, evaporation, temperature, relative humidity and wind velocity during the experimental season 2016-17

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among the genotypes of chrysanthemum for all the morphological traits, indicating the considerable amount of variability (Table-1 and 2). The mean performance of chrysanthemum cultivars varied significantly for growth and flowering parameters. The data pertaining to vegetative and flowering characters is presented in the (Table 2). Cultivar Ajay Orange initiated early bud (52.47 days) and maximum days taken in the cultivar Liliput (116.33 days). The maximum days to flowering was recorded with cultivar Ajay (69 days) followed by Ajay Orange (82.47 days) and maximum days taken to floweing was recorded with the cultivar Liliput (116.33 days). White Star produced larger size flower (9.92 cm) followed by Pusa Centurary (9.08 cm) and cultivar Liliput gave the smaller flower (2.21 cm). Maximum flower duration (57.53 days) was recorded with the cultivar of Haldighati followed by Thai Chin Queen an Ramlal Dada (35.53 days) and minimum flower duration (35.53 days) were observed with the cultivar Pusa Sona. Significant variation in plant height at flower bud initiation was observed among the genotypes and maximum plant height (28.27 cm) was observed in the cultivar of Sunny and minimum height (13.33 cm) was observed with the cultivar of Sadhbhawna. Cultivar Sunny showed maximum plant height (51.53 cm) at plant attained after full bloom while

minimum height (18.47 cm) gave by the cultivar of Sadbhawana. Variation in number of primary branches per plant was observed among the genotypes and cultivar Basanthi produced maximum number of primary branches per plant (7.930 followed by the cultivar Thai Chin queen (6.27 branches) and minimum number of primary branches (3.27) gave by the cultivar Lalpari. Plant spread also showed significant differentiation among the genotypes and cultivar Basanthe gained maximum (70.73 cm) plant spread and minimum plant spread (21.73 cm) attained by the cultivar White Star. Cultivar Basanthi produced maximum number of flowers (218.67) followed by, Yellow Charm (199.67 flowers) and minimum number of flowers (31.41) gave by White Star. Differences in vegetative and flowering characters of different cultivars may be due to varied growth rate and their genetic makeup of plant. Similar observation was reported by [15] in gladiolus

Tocher's cluster analysis grouped the 20 genotypes into five clusters, revealing the presence of diversity for different growth and flowering traits **(Table 3).** It was observed that cluster V consists of maximum number of genotypes (6) followed by cluster III with 5 genotypes and cluster II having 4 genotypes whereas cluster I had minimum number (2) genotypes followed by cluster IV (3 genotypes). The genotypes within a cluster have smaller D^2 values among themselves than those belonging to different clusters. The genotypes from distinct clusters are genetically diverse in nature, which can be utilized in the crop improvement programme for various commercial traits.

The intra and inter cluster distance presented in **Table 4** revealed highest intra cluster distances for cluster III (2.117) followed by cluster V (2.073) and highest inter-cluster distance was observed between clusters V and IV (4.402), followed by cluster IV and I (4.224) clusters indicating wide diversity between the cultivars of these groups. The genotype from individual cluster can be utilized in the selection/breeding programme for desirable economic characters in chrysanthemum. As far as the cluster means are concerned different clusters have higher mean values for different traits **(Table 5)** indicating that of the cluster contained genotypes with all the desirable characters, so recombination breeding between cluster is needed. Cluster II showed the maximum cluster means value for days to flower bud initiation (72.87), days to flowering (105.92) and plant spread (57.00), flower size (6.09), plant height at flower bud initiation stage (25.91) and plant height after full bloom (43.48) recorded maximum cluster means value for cluster III. Flowering duration (53.82), number of primary branches per plant (5.69) and number of flowers per plant (144.92) recorded maximum cluster means value for cluster V. Cultivar identification and cultivar morphological characterization are important issues for horticultural breeders. Genetic variation among Dendranthema species, related to the cultivated chrysanthemum, is extremely high, with a very low similarity among species. Besides that, genetic variation within species is also very high. To obtain new desirable recombinants in chrysanthemum, studies on gene actions and interactions are possible in the expression of quantitative traits and it is advisable to make crosses between genotypes selected from the clusters with high mean performance to get desirable transgressive segregates[4]. Therefore, based on D^2 analysis it has been understood that, different genotypes had significant effect on the clustering pattern, the characters contributing for divergence and cluster means, hence these characters need to be given more weight age, while selecting parents for crop improvement. These results were in good agreement with the findings of [9,2,13,7] in chrysanthemum.

Table 1: Analysis of variance mean sum square

Source of Variation	DF	Days to flower bud initiation	Days to flowering	Flower size (cm)	Flowering duration (days)	Plant height at flower bud initiation stage (cm)	Plant height after full bloom (cm)	No. of primary branches plant^{-1}	Plant spread (cm)	No. of flowers plant^{-1}
Rep	2	6.79	0.11	0.01	0.66	6.57	16.10	0.01	10.52	12.70
Treat	19	276.16**	383.90**	12.47**	167.65**	57.85**	219.89**	4.36**	388.38**	8059.31**
Error	38	0.94	1.21	0.01	1.23	0.74	0.17	0.01	0.62	0.47

Table 2: Mean performance of growth and flowering of chrysanthemum

S.L.	Name of Genotype	Days to flower bud initiation	Days to flowering	Flower size (cm)	Flowering duration (days)	Plant height at flower bud initiation stage (cm)	Plant height after full bloom (cm)	No. of primary branches plant^{-1}	Plant spread (cm)	No. of flowers plant^{-1}
1	Thai Chin Queen	60.47	90.27	7.25	52.67	26.33	45.53	5.67	46.47	154.73
2	Pusa Arunoday	72.27	109.47	3.79	35.67	15.67	23.53	3.67	41.73	199.67
3	Yellow Charm	60.53	90.33	3.63	35.53	15.33	22.73	3.53	37.33	46.07
4	Pusa Sona	71.73	105.47	9.08	53.67	27.73	42.47	4.47	62.53	61.53
5	Pusa Centenary	71.47	104.33	5.64	38.47	27.53	40.33	3.73	43.73	66.53
6	Pusa Aditya	64.73	106.73	5.75	42.27	28.27	51.53	4.47	36.27	102.47
7	Sunny	57.47	97.53	8.75	50.47	24.27	42.27	5.67	44.33	141.73
8	Pusa Kesari	64.13	95.47	3.56	41.47	13.33	18.47	5.47	46.67	80.67
9	Sadbhavana	64.47	95.53	5.16	39.47	25.67	39.73	3.73	40.53	94.53
10	Lalith	43.53	69.53	4.77	50.53	21.43	41.53	3.67	42.73	64.47
11	Ajay	78.53	107.53	5.76	41.53	21.27	40.47	3.47	58.73	77.33
12	Pusa Chitraksha	60.47	90.27	7.25	52.67	26.33	45.53	5.67	46.47	154.73
13	Basanthi	60.27	96.67	4.14	49.33	26.67	48.47	7.93	70.73	218.67
14	Ramlal Dada	59.47	91.53	4.18	56.47	22.33	37.27	4.33	47.53	100.47
15	Haldighati	55.53	88.47	3.86	57.53	26.47	41.67	4.27	35.53	115.47
16	White Star	82.33	112.47	9.97	54.33	27.53	47.33	3.27	21.73	31.47
17	Lal pari	77.47	102.53	3.96	42.47	20.53	38.47	3.53	28.27	167.47
18	Jaya	67.53	94.33	5.94	40.73	24.47	43.27	3.87	56.27	118.73
19	Ajay Oranage	52.47	82.47	4.84	37.33	23.53	41.47	3.27	47.67	78.47
20	Lilyput	73.67	116.33	2.21	46.53	20.33	34.47	4.13	50.47	42.33
	Mean	64.88	97.13	5.45	46.15	23.01	38.77	4.42	44.89	105.06
	Min.	43.53	69.53	2.21	35.53	13.33	18.47	3.27	21.73	31.47
	Max	82.33	116.33	9.97	57.53	28.27	51.53	7.93	70.73	218.67
	C.D.	1.61	1.82	0.14	1.84	1.43	0.69	0.19	1.31	1.13
	SE(d)	0.79	0.90	0.07	0.91	0.70	0.34	0.10	0.64	0.56
	C.V.	1.49	1.13	1.56	2.41	3.73	1.07	2.64	1.76	0.65

Table 3: Clustering pattern of 20 genotypes of chrysanthemum

Clusters	No of genotypes	Genotype name
I	2	Ajay, Ajay Orange
II	4	Pusa Centenary, Pusa Chitraksha, Jaya, Lilyput
III	5	Pusa Aditya, Sunny, Lalith, White Star, Lal Pari
IV	3	Yellow Charm, Pusa Sona, Sadbhavana
V	6	Thai Chin Queen, Pusa Arunoday, Pusa Kesari, Basanthi, Ramlal Dada, Haldighati

Table 4: Cluster distance values in 20 genotypes of chrysanthemum

Clusters	I	II	III	IV	V
I	1.214				
II	3.913	1.919			
III	3.848	2.193	2.117		
IV	4.224	3.748	4.056	1.815	
V	3.294	3.100	3.196	4.402	2.073

Table 5: Cluster mean for different growth and floweringin in chrysanthemum

Clusters	Days to flower bud initiation	Days to flowering	Flower size (cm)	Flowering duration (days)	Plant height at flower bud initiation stage (cm)	Plant height after full bloom (cm)	No. of primary branches plant^{-1}	Plant spread (cm)	No. of flowers plant^{-1}
I	48.00	76.00	4.81	43.93	22.48	41.50	3.47	45.20	71.47
II	72.87	105.92	5.75	45.62	23.45	40.17	3.98	57.00	74.98
III	72.09	104.32	6.09	43.40	25.91	43.48	3.75	34.11	92.49
IV	65.64	98.42	3.66	37.56	14.78	21.58	4.22	41.91	108.80
V	58.79	91.67	5.82	53.82	24.59	41.61	5.69	47.18	144.92

CONCLUSION

From the present investigation, it could be concluded that the success of breeding programmes depends upon the genetic diversity present among the parents. Divergence has to be studied in different environments for selection of diverse varieties/cultivars and crosses between the genotypes of divergent clusters may be tried for crop improvement.

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