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Morphological characterization of chrysanthemum (*Dendranthema grandiflora* Tzvelev) genotypes under central dry zone of Karnataka

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Abstract
An experiment was conducted to investigate the morphological characterization of chrysanthemum (*Dendranthema grandiflora* Tzvelev) genotypes under central dry zone of Karnataka. The experiment was laid out in randomized complete block design with three replications. Among the sixteen genotypes studied there were wide and highly significant variations observed for various growth, flowering and yield parameters. The result showed that among the 16 genotypes evaluated the genotype Lakkundi recorded maximum plant height (69.87 cm), stem girth (6.72 mm) and internodal length (4.86 cm). The genotype Chandani recorded maximum plant spread both at E-W (47.27 cm) and N-S (50.20 cm) direction, number of primary (23.67) and secondary (36.80) branches per plant, number of nodes per plant (15.53), number of leaves per plant (720.67), leaf area per plant (18718.33 cm^2), leaf area index (9.22), number of flowers per plant (692.40), flower yield per hectare (41.01 t/ha). The genotype Marigold recorded maximum leaf length (11.64 cm), leaf width (10.12 cm), least number of days taken for first flower appearance (77.33 days), minimum number of days taken for 50 per cent of flowering (100.67 days) and longest flowering duration (126.67 days). The genotype White Prolific took significantly maximum duration of crop (248.00 days). The genotype White Seventige exhibited maximum flower diameter (6.46 cm). The genotype Star Pink recorded highest individual flower weight (6.26 g). From this study it was observed that genotype 'Chandani' 'Marigold', 'Basanthi', 'Lakkundi' and 'Arka Chandrakanth' might be exploited commercially for loose flower production under central dry zone of Karnataka.

Keywords: Chrysanthemum, evaluation, genotypes, growth, flowering and yield

1. Introduction
Chrysanthemum (*Dendranthema grandiflora* Tzvelev) is one of the most important flower crops both at national and international level. It is commercially known as 'Queen of East', 'Autumn Queen' and 'Guldaudi'. It is a unique flower crop cultivated as cut flower, loose flower and also as potted plant. It ranks 2nd in national loose flower market in demand and popularity. The genus chrysanthemum belongs to the family Asteraceae includes over 200 species of annuals and herbaceous perennials. In India, chrysanthemum is being grown in 16,660 ha with the production of 1,79,970 MT of loose flowers and 5,710 MT of cut flowers (Anon., 2015) [1]. It covers nearly 17 per cent of the total area under floriculture in the country (Vetrivel and Jawaharlal, 2014) [14]. Karnataka is the most prominent chrysanthemum growing state in India with an area of 4,978 ha and production of 60,006 MT with the productivity of 12.06 MT per ha for loose flower purpose (Anon., 2015) [1]. The genus comprises of huge diversity in their growth habitat, flowering behavior, flower and foliage colour, shape and size. The major use of chrysanthemum in our country is for making garlands, veni bracelets, flower decoration and in religious offerings. It is also suitable for cut, loose flowers, pot cultures and bedding purposes.

In recent years, several new genotypes of chrysanthemum with attractive flower colours have entered the market. The performance of any crop largely depends on interaction between genotype and environment. As a result, genotypes which perform well in one region, may not perform same in other regions of varying climatic conditions. During introduction of new germplasm from diverse sources, it becomes mandatory to carry out evaluation studies in order

to identify suitable genotypes for commercial cultivation at the central dry zone. Most of the growers do not have overall idea about all of these genotypes. Keeping the above points in view, the genotypes of chrysanthemum were evaluated to select a stable genotype for yield under local conditions and to obtain clear picture on various characters which affect the yield. Thus, there is a need to identify the most suitable genotype for the commercial cultivation under central dry zone of Karnataka.

2. Material and Methods

The experiment was carried out at Department of Floriculture and Landscape Architecture, College of Horticulture, Hiriyur, Karnataka during July 2015 to January 2016. The experimental material consisted of sixteen genotypes of chrysanthemum were selected for experimentation *viz.*, T_1: Pink Cloud, T_2: Star Pink, T_3: White Prolific, T_4: Sharad Mala, T_5: Marigold, T_6: Winter Queen, T_7: Autumn Joy, T_8: Basanthi, T_9: Vasanthika, T_{10}: Chandani, T_{11}: Lakkundi, T_{12}: Bellatti, T_{13}: White Seventige, T_{14}: Arka Pink Star, T_{15}: Arka Chandrika and T_{16}: Arka Chandrakanth. The experiment was laid out in in randomized completely Block Design (RCBD) with three replications. Growing chrysanthemum plants from a sucker is the easiest and quickest way to propagate. New plant was generated by planting sucker from mother chrysanthemum. Suckers of all the sixteen genotypes were planted at 45 cm x 45 cm in a plot size of 2.7 m x 2.25 m accommodating 30 plants per plot. Uniform cultural practices were followed to all the genotypes throughout the experiment. Observations were recorded on various vegetative and floral and statistically analyzed.

3. Result and Discussion

The chrysanthemum genotypes exhibited significant variation for all the traits studied under central dry zone condition and parameters are presented in table 1, 2 and 3. The results revealed that the genotype Lakkundi recorded highest plant height (69.87 cm) and stem girth (6.72 mm) but it was on par with Chandani (67.73 cm and 6.43mm, respectively) whereas, genotype Arka Pink Star recorded the least plant height and stem diameter (24.33 cm and 4.21mm, respectively). Lakshmi *et al*. (2015) [7] suggested that the variation among the genotypes as well as could be attributed to genetic factors whose performance would be varied over a wide range of environmental conditions of the respective genotype. Increase in plant height was associated with rapid meristematic activity, probably due to rapid cell division and elongation during the tender growth period (Jamaluddin *et al.*, 2015) [4] in chrysanthemum. Similar variations in stem diameter among the genotypes were observed by Rajiv *et al.* (2007) [11]; Lakshmi *et al.* (2015) [7] and Suvija *et al.* (2016) [13] in chrysanthemum

Significantly maximum plant spread in E-W and N-S direction was found in genotype Chandani (47.27 cm and 50.20 cm, respectively) followed by Marigold (43.93 cm and 46.77 cm, respectively). Whereas, minimum plant spread was recorded in genotype Arka Pink Star (21.47 cm). Increase in plant spread might be due to the production of more number of branches and by the genetic nature of the genotype and also its wide adaptability to the prevailing environmental conditions. Similar trend of result was observed earlier by Rajiv *et al.* (2007) [11], Parul *et al.* (2011) [8] and Suvija *et al.* (2016) [13] in chrysanthemum.

The genotype Chandani had maximum number of leaves (720.67), number of primary (23.67) and secondary (36.80) branches per plant and maximum number of nodes per plant (15.53) which was significantly higher over all other genotypes and the same variety also had maximum leaf area per plant and leaf area index (18718.33 cm^2 and 9.22, respectively). While, genotype Arka Pink Star had least number of leaves (94.93) number of primary (8.00) and secondary (10.70) branches per plant and minimum number of nodes per plant (7.47), leaf area per plant and leaf area index (1466.69 cm^2 and 0.72, respectively). Peddi *et al.* (2008) [10] suggested that this character may be due to genetic behaviour of the genotype. Increased number of branches leads to production of more number of leaves and leaf area per plant in turn it will enhance the yield of flowers and sink relationship (Parul *et al.*, 2011) [8] in chrysanthemum. The increase in leaf area and number of leaves per plant will naturally result in increase of leaf area index (Suvija *et al.*, 2016) [13] in chrysanthemum.

The maximum internodal length was recorded in genotype Lakkundi (4.86 cm) and minimum in genotype Arka Pink Star (3.05 cm). Pasha *et al.* (2015) [9] reported that the internodal length among the genotypes might be due to genetic makeup of the genotypes and higher the internodal length more will be the plant height in zinnia.

The genotype Marigold had maximum leaf length (11.64 cm) and width (10.12 cm) while, the genotype Arka Pink Star had minimum leaf length (5.00 cm) and width (4.51 cm). This might be due to genetic makeup of the respective genotypes. These results are in confirmity with that of Lakshmi *et al*. (2015) [7] in chrysanthemum.

The genotype Marigold recorded least number of days for appearance of first flowers, minimum days for 50 per cent flowering (77.33 days and 100.67 days, respectively) which was on par with genotypes Arka Pink Star (85.00 days and 103.33 days, respectively) whereas, genotype White Prolific recorded the maximum number of days taken for first flower appearance and 50 per cent flowering (153.67 days and 172 days, respectively). Srilatha *et al.* (2015) [12] reported that the number of days taken for flower appearance of first flowering is an important character that signifies earliness or late flowering which determines the flower availability. The variation in time taken for flowering might be due to the genetic makeup of the genotype or the influence of genotype and environment (Suvija *et al.*, 2016, Rajiv *et al.*, 2007 and Kishan *et al.*, 2008 in chrysanthemum) [13, 11, 5].

Significantly longest flowering duration was recorded in genotype Marigold (126.67 days) and it was on par with genotype Chandani (116.67 days) whereas, the genotype Winter Queen recorded the shortest flowering duration (41.67 days). The variation in flowering duration among the varieties was attributed to genotype of the plant, environmental influence and other management factors. Similar results for variation in flowering duration among the genotypes have also been reported in chrysanthemum under different environmental conditions (Peddi *et al.*, 2008, Kumar, 2014 and Suvija *et al.*, 2016) [10, 6, 13].

The genotype White Prolific took significantly maximum duration of crop (248.00 days) from rest of genotypes studied and it was on par with genotypes Chandani (236.00 days) whereas, genotype Winter Queen registered minimum duration of crop (167.33 days). These results are in conformity with the reports of Rajiv *et al.* (2007) [11] and Kishan *et al.* (2008) [5] in chrysanthemum.

Significantly maximum number of flowers per plant was produced in genotype Chandani (692.40) which was significantly superior over all other genotypes whereas, the

genotype Sharad Mala produced least number of flowers per plant (68.17). The number of flowers produced per plant may be directly related to increase in plant height, more number of branches, greater plant spread and number of leaves and accumulation of more photosynthates, thereby leading to the production of more number of flowers. The similar results were observed by Parul *et al.* (2011) [8], Dhanumjaya and Sushma (2014) [3], Jamaluddin *et al.* (2015) [4] and Suvija *et al.* (2016) [13] in chrysanthemum.

Significantly highest individual flower weight (6.26 g) was recorded in the genotype Star Pink whereas, the genotype Arka Pink Star registered least for flower weight (0.55 g). The variation among the genotypes was mainly because of increased flower size. Similar type of variations was observed by Baskaran *et al.* (2010) [2]; Lakshmi *et al.* (2015) [7] and Suvija *et al.* (2016) [13] in chrysanthemum.

The maximum flower yield per hectare was recorded in the genotype Chandani (41.01 t/ha) which was significantly superior over all other genotypes whereas, the genotype Arka Pink Star recorded minimum flower yield per hectare (2.45 t/ha) followed by Pink Cloud (4.19 t/ha). Higher yield might be due to increase in morphological parameters like plant height, number of leaves and leaf area which might have contributed in production of more photosynthates resulting in greater accumulation of dry matter which in turn leads to production of more flower yield per hectare (Jamaluddin *et al.*, 2015) [4].

Table 1: Performance of chrysanthemum (*Dendranthema grandiflora* Tzvelev) genotypes for various vegetative parameters

Genotypes	Plant height (cm)	Stem girth (mm)	Plant spread (cm)		No. of primary branches per plant	No. of secondary branches per plant
			E – W	N – S		
Pink Cloud	31.08	5.61	27.20	25.60	10.33	18.20
Star Pink	53.07	5.97	29.80	31.73	11.00	15.27
White Prolific	43.13	5.76	31.93	29.07	13.60	23.27
Sharad Mala	30.20	4.99	25.13	22.93	10.67	17.80
Marigold	61.27	6.20	43.93	46.77	12.73	21.13
Winter Queen	55.87	5.90	36.60	38.07	14.80	26.33
Autumn Joy	52.60	5.47	32.33	31.00	13.93	24.53
Basanthi	46.80	5.82	35.33	39.53	18.87	29.60
Vasanthika	48.13	6.36	33.93	30.33	15.13	23.07
Chandani	67.73	6.43	47.27	50.20	23.67	36.80
Lakkundi	69.87	6.72	26.00	24.20	13.27	23.20
Bellatti	45.13	6.09	36.60	34.13	12.13	22.87
White Seventige	57.20	5.55	25.87	31.27	11.73	16.20
Arka Pink Star	24.33	4.21	21.47	19.20	8.00	10.70
Arka Chandrika	53.60	5.28	30.27	33.93	12.67	18.93
Arka Chandrakanth	59.73	5.94	37.00	35.40	14.67	17.20
S. Em±	1.68	0.20	1.24	1.22	0.64	1.03
CD at 5 %	4.84	0.57	3.58	3.54	1.86	2.97

Table 2: Performance of chrysanthemum (*Dendranthema grandiflora* Tzvelev) genotypes for various vegetative parameters

Genotypes	Number of nodes per plant	Internodal length (cm)	Leaf length (cm)	Leaf width (cm)	Number of leaves per plant	Leaf area (cm^2 /plant)	Leaf area Index (LAI)
Pink Cloud	9.53	3.72	5.83	5.41	121.93	2759.51	1.37
Star Pink	10.00	3.90	7.03	6.61	144.87	5158.31	2.56
White Prolific	9.73	4.07	6.60	6.33	135.87	4285.92	2.10
Sharad Mala	7.47	3.57	6.10	5.85	118.40	3310.90	1.63
Marigold	10.20	4.46	11.64	10.12	185.53	14729.57	7.28
Winter Queen	11.73	4.25	7.60	7.25	170.67	7452.03	3.69
Autumn Joy	11.53	4.16	6.57	6.31	272.20	6433.45	3.18
Basanthi	12.20	3.95	5.82	5.20	235.13	5660.07	2.84
Vasanthika	10.53	4.57	5.96	5.37	150.00	3073.33	1.51
Chandani	15.53	3.87	6.11	5.82	720.67	18718.33	9.22
Lakkundi	13.97	4.86	6.41	6.29	116.40	4002.25	1.98
Bellatti	9.20	3.71	6.93	6.66	148.00	4028.47	2.00
White Seventige	11.87	4.38	9.63	8.25	123.00	5791.89	2.85
Arka Pink Star	7.47	3.05	5.00	4.51	94.93	1466.69	0.72
Arka Chandrika	10.07	3.55	7.09	6.59	125.00	3755.80	1.85
Arka Chandrakanth	12.20	3.70	10.39	9.48	136.27	8012.09	3.93
S. Em±	0.57	0.17	0.28	0.22	7.31	151.41	0.18
CD @ 5%	1.66	0.49	0.82	0.63	21.11	437.29	0.52

Table 3: Performance of chrysanthemum (*Dendranthema grandiflora* Tzvelev) genotypes for various flowering and yield parameters

Genotypes	Number of days taken for appearance of first flowering (days)	Number of days taken for 50 per cent flowering (days)	Duration of flowering (days)	Duration of the crop (days)	Number of flowers per plant	Flower weight (g)	Flower yield per hectare (t/ha)
Pink Cloud	107.33	120.00	74.33	181.67	101.23	0.84	4.19
Star Pink	112.33	127.00	78.67	191.00	74.63	6.26	23.06
White Prolific	153.67	172.00	94.33	248.00	106.20	2.20	11.53
Sharad Mala	142.33	158.33	85.00	227.33	68.17	1.88	6.33
Marigold	77.33	100.67	126.67	204.00	90.00	5.80	25.77
Winter Queen	125.67	136.67	41.67	167.33	141.40	0.68	4.72
Autumn Joy	131.33	146.33	55.67	187.00	151.93	0.80	6.62
Basanthi	111.00	126.67	112.33	223.33	206.27	1.00	10.22
Vasanthika	136.33	151.33	77.67	214.00	121.30	1.73	10.39
Chandani	120.00	131.00	116.67	236.00	692.40	1.20	41.01
Lakkundi	128.00	140.00	68.00	196.00	94.80	1.96	9.15
Bellatti	98.33	125.53	90.00	188.33	121.70	1.32	8.03
White Seventige	124.00	134.33	80.00	204.00	106.67	2.31	12.13
Arka Pink Star	85.00	103.33	84.00	169.00	89.60	0.55	2.45
Arka Chandrika	95.00	112.67	101.67	196.67	93.93	2.24	10.35
Arka Chandrakanth	100.33	123.33	88.33	186.66	104.73	3.29	17.07
S. Em±	5.37	5.24	3.55	6.10	5.83	0.11	0.72
CD @5%	15.50	15.12	10.25	17.62	16.83	0.32	2.07

4. Conclusion

Chrysanthemum cultivars showed wide range of variations in their growth and flowering characteristics. Among the screened genotypes, the genotype 'Chandani' was found superior over the rest of the genotypes with respect to growth, flowering and yield parameters. Hence, genotype 'Chandani' might be recommended for commercial cultivation to the farmers under central dry zone of Karnataka followed by 'Marigold', 'Basanthi', 'Vasanthika', 'White Profile', 'Lakkundi' and 'Arka Chandrika' were found promising for loose flower production. Breeders can easily select the desirable characters from this wide range of variation for the development of the chrysanthemum flowers.

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