



Short Communication

Performance of chrysanthemum (*Dendranthema grandiflora* Tzvelve) genotypes in the plains of Kerala

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Abstract

Fifteen chrysanthemum genotypes were evaluated in RBD with three replications to select suitable genotypes for cultivation in the plains of Kerala. Significant variations were reported among the genotypes for all the traits. KAU C-7 recorded highest plant spread (47.95 cm), number of primary branches per plant (17.50) and number of leaves per branch (21.50). Earliest flower bud initiation (38.85 days) and 50 % flowering (42.80 days) was recorded in KAU C-1. KAU C-8 took minimum number of days to complete opening of a flower (35.85 days). Greatest flower diameter (8.35 cm), fresh weight (8.07 g) and field life (12.37 days) were observed in Karnool Pink. The longest flower stalk length (26.77 cm) and girth (1.49 cm) was found in KAU C-6. KAU C-4 recorded maximum duration of flowering (104.29 days), greatest number of flowers (96.95) and yield (0.31 kg) per plant. Longest shelf life was recorded in KAU C-7 (4.89 days) and vase life in KAU C-3 (14.48 days). The genotypes KAU C-4 and KAU C-6 can be recommended for both cut and loose flower purposes whereas the genotypes Karnool Pink, KAU C-1, KAU C-7, KAU C-3, KAU C-8 and KAU C-2 are best preferred for loose flower purpose and the genotype Pink Cloud was found ideal for both garden type and loose flower production under warm humid tropical plains of Kerala.

Key Words: Chrysanthemum, *Dendranthema grandiflora*, Evaluation, Genotypes.

Chrysanthemum is an herbaceous perennial plant belonging to the family Asteraceae. It is one of the most beautiful and perhaps the oldest flowering plants, commercially grown across the world. Chrysanthemum is grown as cut flowers, loose flowers and as potted plant in the international market. In India too, the crop is being commercially cultivated for cut flowers for floral arrangements, as loose flowers for religious offerings and for garland making and also for landscaping purposes. Major chrysanthemum growing states in India are Karnataka, Tamil Nadu, West Bengal and Punjab.

Chrysanthemum has different growth habit viz.

perennial and annual, and has a wide range of flower colour, size and form. Growth and flowering of chrysanthemum are very much influenced by light and temperature. Hence, performance of genotypes varies with region, season and growing conditions. There exists wide range of varieties in chrysanthemum suitable for various agro climatic situations in the country. There is great demand for chrysanthemum flowers in Kerala as loose flowers as well as potted plants. However, there has not been an attempt to evaluate suitable genotypes for Kerala. Hence the present investigation was undertaken to select suitable chrysanthemum genotypes for cultivation in the warm humid plains of Kerala.

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Fifteen genotypes of chrysanthemum (*Dendranthema grandiflora* Tzvelve) procured from different locations were evaluated at the Department of Floriculture and Landscaping, College of Agriculture, Vellanikkara, Thrissur during January to October 2022. The experimental research was conducted in randomised block design with fifteen genotypes as treatments which were replicated for three times in plots of size 2 m X 1.0 m with the spacing of 0.4 m X 0.4 m between plants. Pinching was done at 15 and 30 days after transplanting by removing 2 to 3 leaves of terminal growing portion of each plant. IIHR fertilizer recommendation (100:50:100 kg NPK/ha) for the crop was followed. Observations were recorded on vegetative parameters like plant height, plant spread, number of primary branches per plant and number of leaves per plant at bud initiation stage, flowering parameters such as days to bud initiation, days to 50 per cent flowering, days to complete opening of flower, duration of flowering, flower diameter, flower stalk length and stalk girth, flower type, flower colour, fresh flower weight, number of flowers and total yield per plant and post-harvest parameters like shelf life, vase life, physiological loss of weight and total water uptake were taken during flowering and after harvest stage. Five

flowers were harvested randomly from each genotype and kept in ambient condition for post-harvest studies. The number of days taken for more than 25 per cent wilting of flower which were kept open was recorded as shelf life of flowers. To estimate vase life, the flowers were harvested along with the stalk and placed in 300 ml distilled water. The number of days taken for wilting of more than one or two florets was recorded as vase life of flowers and mean value was figured out. PPV and FRA, 2001-DUS characters for chrysanthemum descriptor was followed for the classification of chrysanthemum genotypes based on quantitative and qualitative vegetative parameters. Analysis of variance with respect to all the parameters was done; wherever, the result found significant, the Critical Difference (CD) was calculated at one or five per cent level of significance for the comparison of all the treatment means.

Significant variation was recorded among the fifteen chrysanthemum genotypes for all the parameters studied. Quantitative vegetative parameters like plant height, plant spread, number of primary branches and number of leaves vary according to the intercultural operation *viz.* pinching, which is recommended by IIHR. The data pertaining to

Table 1. Quantitative vegetative parameters of chrysanthemum genotypes

Genotypes	Plant height (cm)	Plant spread (cm)	Number of primary branches per plant	Number of leaves per branch
Karnool Pink	28.85 ^h	28.01 ^{hi}	8.50 ^{ghi}	15.50 ^d
Dolley Orange	42.05 ^b	34.92 ^{de}	16.00 ^b	13.00 ^e
Autumn Joy	29.15 ^h	31.23 ^{fg}	7.50 ^{ij}	11.50 ^f
Roopanjali	30.38 ^{gh}	36.93 ^{cd}	9.00 ^{sh}	20.00 ^b
Coffee	45.96 ^a	40.01 ^b	15.00 ^c	18.00 ^c
Pink Cloud	22.70 ⁱ	26.65 ⁱ	6.50 ^j	10.00 ^g
KAU C-1	31.21 ^{fg}	31.82 ^f	9.50 ^{fg}	15.50 ^d
KAU C-2	33.34 ^{de}	30.99 ^{fg}	8.00 ^{hi}	17.50 ^c
KAU C-3	33.82 ^{cd}	31.12 ^{fg}	8.50 ^{ghi}	17.00 ^c
KAU C-4	35.38 ^c	33.10 ^{ef}	10.50 ^f	15.00 ^d
KAU C-5	44.84 ^a	38.35 ^{bc}	12.50 ^e	18.00 ^c
KAU C-6	32.17 ^{ef}	31.39 ^{fg}	8.50 ^{ghi}	13.50 ^e
KAU C-7	40.75 ^b	47.95 ^a	17.50 ^a	21.50 ^a
KAU C-8	29.78 ^{gh}	29.24 ^{sh}	9.50 ^{fg}	11.50 ^f
KAU C-9	34.19 ^{cd}	36.73 ^{cd}	14.00 ^d	15.00 ^d
SE (m±)	0.52	0.72	0.44	0.35
C.V (%)	2.13	3.02	5.61	3.21
C.D (0.05)	1.57	2.19	1.34	1.07

Table 2. Qualitative vegetative parameters of chrysanthemum genotypes

Genotypes	Leaf shape			Leaf dentation	Leaf colour	Stem colouration
	Terminal lobe	Predominant shape of leaf base	Length of lowest lateral sinus			
Karnool Pink	Long	Obtuse	Medium	Medium	Green-NN137-B	Absent
Dolley Orange	Medium	Obtuse	Medium	Medium	Green-137-B	Absent
Autumn Joy	Long	Cordate	Long	High	Green-137-A	Absent
Roopanjali	Short	Obtuse	Short	Low	Green-137-B	Absent
Coffee	Short	Acute	Medium	Medium	Green-137-B	Absent
Pink Cloud	Medium	Cordate	Short	Low	Green-NN137-B	Absent
KAU C-1	Short	Acute	Medium	Medium	Green-NN137-B	Absent
KAU C-2	Short	Acute	Short	Low	Green-138-A	Present
KAU C-3	Short	Acute	Short	Low	Green-138-A	Present
KAU C-4	Medium	Acute	Medium	Low	Green-NN137-B	Absent
KAU C-5	Medium	Acute	Short	Low	Green-137-B	Absent
KAU C-6	Medium	Cordate	Short	Low	Green-NN137-B	Absent
KAU C-7	Short	Obtuse	Short	Low	Green-137-C	Present
KAU C-8	Medium	Obtuse	Medium	Medium	Green-137-B	Present
KAU C-9	Medium	Obtuse	Medium	Low	Green-137-B	Absent

quantitative and qualitative vegetative parameters which were recorded at bud initiation stage are furnished in the Table 1 and 2 respectively.

Plant height ranged from 22.70 cm to 45.96 cm among the genotypes. Significantly greater plant height was recorded in the genotype Coffee (45.96 cm) which was on par with KAU C-5 (44.84 cm). Shortest plants were observed in the genotype Pink Cloud (22.70 cm). The genotype KAU C-7 was found to be superior in terms of plant spread (47.95 cm) which was followed by Coffee (40.01 cm) and KAU C-5 (38.35 cm). Among the genotypes, plant spread ranged from 26.65 cm to 47.95 cm. Lower plant spread was observed in the case of Pink Cloud (26.65 cm), Karnool Pink (28.01 cm) and KAU C-8 (29.24 cm). One of the most important parameters for screening chrysanthemum types is plant height (Shankar and Tiwari, 1993). According to Rao and Pratap (2006), taller plants are preferred for cut flower production. Medium to short plants with upright stems are preferred over taller plants in open field conditions to avoid staking and are suited for high density planting and very short plants are preferred for the production of bedding and container plants. Among fifteen different chrysanthemum genotypes, significant variation

with respect to plant height was observed at bud initiation stage. According to the descriptor of PPV and FRA, 2001-DUS characters for chrysanthemum, the plant height of the genotypes were classified into very short (<20 cm), short (20-40 cm), medium (40-60 cm) and tall (>60 cm). Based on this, the chrysanthemum genotypes under study were classified into short (Karnool Pink, Autumn Joy, Roopanjali, Pink Cloud, KAU C-1, KAU C-2, KAU C-3, KAU C-4, KAU C-6, KAU C-8 and KAU C-9) and medium (Dolley Orange, Coffee, KAU C-5 and KAU C-7). The variation among the genotypes for vegetative parameters might be due to the differential genetic makeup. Similar observations were also reported by Puneetha and Sharma (2011), Banerji et al. (2012), Madam et al. (2016), Niki et al. (2016) in chrysanthemum. The number of primary branches per plant is an essential factor in determining the plant's canopy architecture. The number of primary branches per plant and the number of leaves per branch were found significantly high in the genotype KAU C-7 (17.50 and 21.50). The arrangement of branches per plant is also influenced by environmental conditions such as temperature, relative humidity, and light intensity (Vijayalakshmi et al., 2010). The observed variations in the production of primary branches

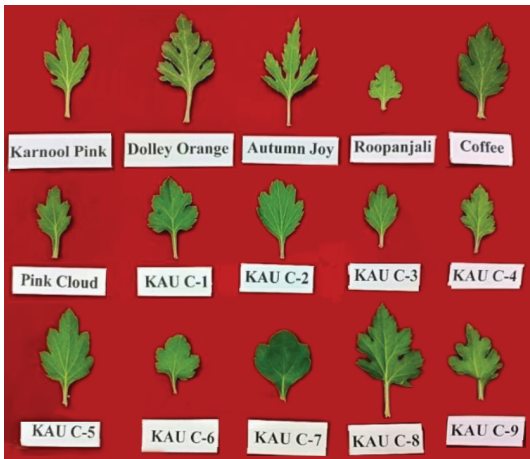


Plate 1. Leaf shape of chrysanthemum genotypes

among the genotypes might be due to the result of inherent genetic factors which was also observed by Gupta and Datta (2005) and Parmar et al. (2019) in chrysanthemum.

Chrysanthemum being an ornamental crop, the qualitative parameters are also of prime importance. Based on the descriptor of PPV and FRA, 2001-DUS characters for chrysanthemum, the terminal lobe and predominant shape of leaf base, the leaf shape of fifteen chrysanthemum genotypes were documented (Plate 1). Long terminal lobe with obtuse leaf base was recorded in Karnool Pink whereas long terminal lobe with cordate leaf base

was noticed in Autumn Joy. Medium terminal lobe with obtuse leaf base was recorded in the genotypes Dolley Orange, KAU C-8 and KAU C-9 whereas medium terminal lobe with cordate and acute leaf base was observed in Pink Cloud, KAU C-6 and KAU C-4, KAU C-5 respectively. The genotypes Roopanjali and KAU C-7 were recorded with short terminal lobe with obtuse leaf base whereas Coffee, KAU C-1, KAU C-2 and KAU C-3 showed short terminal lobe with acute leaf base. The length of the lowest lateral sinus of leaf was found short in Roopanjali, Pink Cloud, KAU C-2, KAU C-3, KAU C-5, KAU C-6 and KAU C-7, medium in Karnool Pink, Dolley Orange, Coffee, KAU C-1, KAU C-4, KAU C-8 and KAU C-9 and was longest in Autumn Joy.

Based on number of dentations on leaf margin, the chrysanthemum genotypes were classified into types with low (Roopanjali, Pink Cloud, KAU C-2, KAU C-3, KAU C-4, KAU C-5, KAU C-6, KAU C-7 and KAU C-9), medium (Karnool Pink, Dolley Orange, Coffee, KAU C-1 and KAU C-8) and high (Autumn Joy) number of dentations.

Variation in leaf colour was documented in fifteen chrysanthemum genotypes based on RHS colour chart. The genotypes Karnool Pink, Pink Cloud, KAU C-1, KAU C-4 and KAU C-6 were recorded with

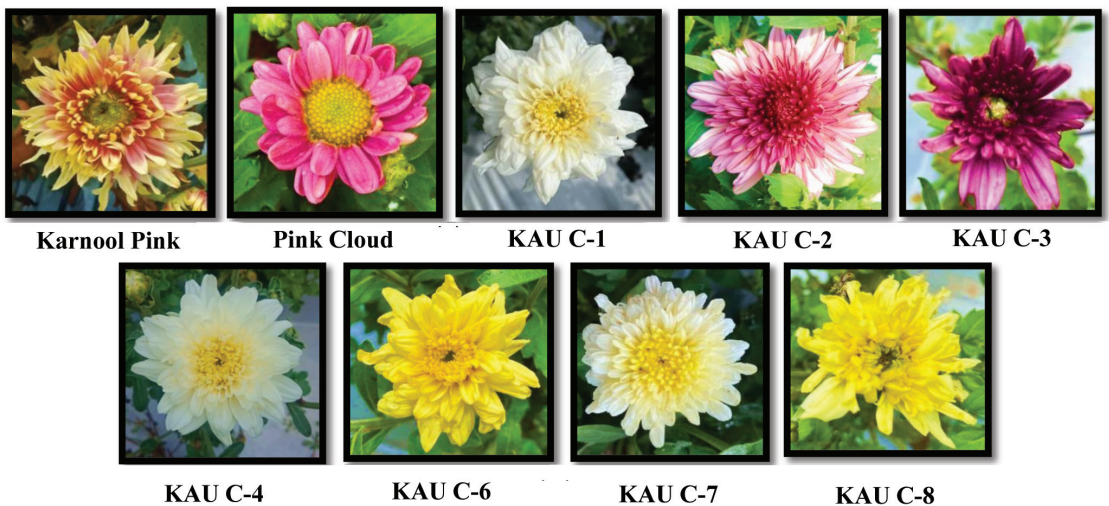


Plate2. Flowers of chrysanthemum genotypes

green group-NN137-B, genotypes Dolley Orange, Roopanjali, Coffee, KAU C-5, KAU C-8 and KAU C-9 come under green group-137-B group whereas leaf colour was green group-137-A in genotypes Autumn Joy, green group-138-A in KAU C-2 and KAU C-3 and green group-137-C in KAU C-7.

Stem colouration was absent in all the genotypes except KAU C-2, KAU C-3, KAU C-7 and KAU C-8.

The data regarding quantitative and qualitative flowering parameters are presented in Table 3 and 4 respectively. Among the fifteen genotypes, only 12 types showed flower bud initiation. Genotypes Autumn Joy, Coffee and KAU C-5 did not show any flower bud initiation during cropping season. Among the 12 genotypes, only nine types showed complete flower opening (Plate 2) while in genotypes *viz.* Dolley Orange, Roopanjali and KAU C-9, most of the buds failed to open completely and withered off. The variation with respect to flowering was attributed to the response of the genotypes to photoperiodism as well as optimum temperature requirement for the genotypes.

The number of days required for flower bud emergence and 50% flowering are essential characteristics that indicate early or late flowering, which determines the flower availability. Among the fifteen genotypes, the earliest flower bud initiation and 50% flowering were recorded in the genotype KAU C-1 with 38.85 and 42.80 days respectively which was found statistically on par with KAU C-4 (38.95 and 43.20 days). The days taken for complete opening of a flower showed wide variation among the genotypes. The genotype KAU C-8 took minimum number of days (35.85 days) for complete opening of flower which was on par with Pink Cloud (37.07 days) and KAU C-7 (39.87 days). Significant variation among the genotypes for initiation of flowering appears to be a genetically regulated character and also attributed to the influence of environment under different locations. Similar findings were reported by Joshi et al. (2009), Rao and Sushma (2014) and Yadav et al. (2014), Srilatha et al. (2015), Roopa et al. (2018) in chrysanthemum.

Whenever we consider a flower crop, the duration of flowering and field life of flowers are very

Table 3. Quantitative floral parameters of chrysanthemum genotypes

Genotypes	Days to bud initiation	Days to 50 % flowering	Days to complete opening of a flower (from bud initiation)	Duration of flowering	Flower diameter (cm)	Flower stalk length (cm)	Flower stalk girth (cm)	Field life (days)
Karnool Pink	39.95 ^{fg}	46.61 ^{ef}	45.51 ^b	101.52 ^{ab}	8.35 ^a	24.07 ^b	1.19 ^{bc}	12.37 ^a
Dolley Orange	91.20 ^b	94.85 ^b	*	*	*	*	*	*
Autumn Joy	**	**	*	*	*	*	*	*
Roopanjali	47.17 ^d	53.73 ^d	*	*	*	*	*	*
Coffee	**	**	*	*	*	*	*	*
Pink Cloud	71.49 ^c	77.40 ^c	37.07 ^{de}	76.23 ^d	4.57 ^f	5.05 ^f	0.88 ^e	9.50 ^e
KAU C-1	38.85 ^e	42.80 ^b	41.95 ^{bc}	94.48 ^c	6.88 ^{bc}	20.16 ^d	1.29 ^b	8.75 ^f
KAU C-2	42.55 ^{ef}	45.00 ^{gh}	40.73 ^{bcd}	52.61 ^e	5.90 ^{de}	10.14 ^g	1.03 ^d	6.43 ⁱ
KAU C-3	45.00 ^{de}	46.50 ^{fg}	57.42 ^a	73.71 ^d	6.10 ^d	12.39 ^f	1.10 ^{cd}	6.81 ^h
KAU C-4	38.95 ^e	43.20 ^b	45.38 ^b	104.29 ^a	7.11 ^b	21.85 ^c	1.40 ^a	8.44 ^g
KAU C-5	**	**	*	*	*	*	*	*
KAU C-6	45.40 ^{de}	48.05 ^{ef}	54.40 ^a	97.65 ^{bc}	6.56 ^{bcd}	26.77 ^a	1.49 ^a	10.70 ^c
KAU C-7	46.85 ^d	49.30 ^e	39.87 ^{cde}	77.80 ^d	6.17 ^{cd}	15.58 ^e	1.17 ^c	11.56 ^b
KAU C-8	41.65 ^{ef}	44.20 ^{gh}	35.85 ^c	55.92 ^e	5.28 ^e	7.96 ^h	1.01 ^d	10.40 ^d
KAU C-9	115.25 ^a	119.31 ^a	*	*	*	*	*	*
SE (m ±)	1.09	0.74	1.48	1.99	0.22	0.49	0.03	0.06
C.V (%)	2.79	1.95	4.73	3.44	4.84	4.28	3.97	0.95
C.D (0.05)	3.41	2.34	4.83	6.48	0.71	1.59	0.11	0.21

** : Genotypes in which there was no bud initiation * : Genotypes in which buds failed to open

Table 4. Qualitative floral parameters of chrysanthemum genotypes

Genotypes	Flower type	Economic use	Flower colour	
			Ray floret	Disc floret
Karnool Pink	Semi-double	Loose flower	RHS 15/ Yellow group N4 Light greenish yellow-B	RHS 15/ Yellow-green group N151 Strong greenish yellow-A
Dolley Orange	NF	NF	NF	NF
Autumn Joy	NF	NF	NF	NF
Roopanjali	NF	NF	NF	NF
Coffee	NF	NF	NF	NF
Pink Cloud	Semi-double	Garden display	RHS 15/ Red-purple group N70 Moderate purplish red-A	RHS 15/ Yellow-green group N153 Strong greenish yellow-B
KAU C-1	Daisy eyed double	Loose flower	RHS 15/ White group N155 Yellow white-B	RHS 15/ Yellow group N8 Brilliant greenish yellow-A
KAU C-2	Daisy eyed double	Loose flower	RHS 15/ Red-purple group N70 Moderate purplish pink-D	RHS 15/ Red purple group N59 Dark red-A
KAU C-3	Daisy eyed double	Loose flower	RHS 15/ Red purple group N70 Strong reddish purple-B	RHS 15/ Purple group N79 Dark purplish red-B
KAU C-4	Daisy eyed double	Cut flower	RHS 15/ White group N155 Pale yellow green-A	RHS 15/ Yellow group N8 Light greenish yellow-C
KAU C-5	NF	NF	NF	NF
KAU C-6	Daisy eyed double	Cut flower	RHS 15/ Yellow group N6 Brilliant greenish yellow-B	RHS 15/ Yellow-green group N144 Strong yellowish green-A
KAU C-7	Daisy eyed double	Loose flower	RHS 15/ Yellow group N4 Pale yellow green-D	RHS 15/ Yellow group N6 Brilliant greenish yellow-A
KAU C-8	Daisy eyed double	Loose flower	RHS 15/ Yellow group N3 Brilliant greenish yellow-A	RHS 15/ Yellow-green group N144 Strong yellowish green-A
KAU C-9	NF	NF	NF	NF

*NF- Not flowered

important characters. Duration of flowering varied significantly among the genotypes and it ranged from 52.61 days to 104.29 days. Longer duration of flowering was observed in KAU C-4 (104.29 days) and Karnool Pink (101.52 days) which were followed by KAU C-6 and KAU C-1 (97.65 and 94.48 days respectively). The duration of flowering is a very important trait that determines the availability of flowers in the market. Thakur et al. (2018) reported that the minimum number of days taken for first flower opening shows an earliness of the genotype, which is helpful for estimating the duration of flowering. The difference in the flowering duration among different genotypes might be attributed to environmental factors and genetic makeup. Similar results were obtained by Peddi et al. (2008), Prasad et al. (2008) and Roopa et al. (2018) in chrysanthemum.

The genotype Karnool Pink was registered with maximum field life of flowers with 12.37 days, followed by KAU C-7 (11.56 days), KAU C-6

(10.70 days) and KAU C-8 (10.40 days). The variations in field life of an individual flower might be due to genotype's genetic makeup and reaction with prevailing weather conditions. The results were in line with the findings of Mridubhashini et al. (2014), Neelima et al. (2015) and Mahadik et al. (2017).

Flower diameter is a key factor in determining flower quality. Among flowered genotypes that showed flowering, the largest flowers were observed in the genotype Karnool Pink with a diameter of 8.35 cm which was significantly high compared to all other genotypes. This was followed by KAU C-4 (7.11 cm) and KAU C-1 (6.88 cm) which were found statistically on par with each other. Smaller flowers were observed in the genotype Pink Cloud (4.57 cm). Flower diameter variation might be due to the genetic makeup. The current study's findings agree with those of Swaroopini (2013) and Kireeti et al. (2017) in chrysanthemum.

Flower stalk length is one of the significant and key factor for determining the suitability of flowers as cut or loose flower since it is one of the important parameter for grading flowers. In the present study, the genotype KAU C-6 was found most promising in terms of stalk length with 26.77 cm and was closely followed by Karnool Pink (24.07 cm), KAU C-4 (21.85 cm) and KAU C-1 (20.16 cm), while shortest stalk was noticed in the genotype Pink Cloud (5.05 cm) followed by KAU C-8 (7.96 cm). Significant variation among genotypes of chrysanthemum in terms of flower stalk length were also observed by Baskaran et al. (2010) and Beeralingappa (2016) in chrysanthemum.

The study revealed that the greatest stalk girth was recorded in the genotype KAU C-6 with 1.49 cm which was on par with KAU C-4 (1.40 cm). Thin flower stalks were observed in Pink Cloud (0.88 cm), KAU C-8 (1.01 cm) and KAU C-2 (1.03 cm). The stalk girth of flower for different genotypes are in close conformity with the earlier reports of chrysanthemum, Mohapatra et al. (2000).

The data pertaining to yield parameters are presented in the Table 5. Number of flowers per plant and weight of flower are two important yield contributing characters. Significant variation was recorded among the genotypes with respect to fresh flower weight. The greatest fresh flower weight was observed in the genotype Karnool Pink (8.07 g) compared to all other genotypes. The minimum fresh weight of a single flower was observed in the genotype Pink Cloud with 1.82 g followed by KAU C-8 (2.79 g). The results are in conformity with the findings of Gantait and Pal (2009) and Gantait and Pal (2011) in chrysanthemum.

Data with respect to number of flowers per plant varied significantly which was recorded the highest in the genotype KAU C-4 with 96.95 flowers per plant followed by KAU C-1 (79.55) and KAU C-6 (70.45). Similar findings and significant variation in quantity of flowers was recorded in chrysanthemum by Gantait and Pal (2010), Uddin

Table 5. Yield parameters of chrysanthemum genotypes

Genotypes	Flower weight (g)	Number of flowers per plant	Yield per plant (kg)
Karnool Pink	8.07 ^a	32.50 ^f	0.21 ^c
Dolley Orange	NF	NF	NF
Autumn Joy	NF	NF	NF
Roopanjali	NF	NF	NF
Coffee	NF	NF	NF
Pink Cloud	1.82 ^g	52.15 ^e	0.09 ^f
KAU C-1	3.38 ^{cd}	79.55 ^b	0.27 ^b
KAU C-2	3.03 ^{ef}	29.70 ^g	0.09 ^f
KAU C-3	3.49 ^{cd}	23.40 ^g	0.08 ^f
KAU C-4	3.57 ^{bc}	96.95 ^a	0.31 ^a
KAU C-5	NF	NF	NF
KAU C-6	3.81 ^b	70.45 ^c	0.25 ^b
KAU C-7	3.26 ^{de}	59.25 ^d	0.18 ^d
KAU C-8	2.79 ^f	51.75 ^e	0.13 ^e
KAU C-9	NF	NF	NF
SE (m ±)	0.08	1.98	7.99
C.V (%)	2.97	5.09	6.34
C.D (0.05)	0.25	6.46	26.06

*NF- Not flowered

et al. (2015) and Palai et al. (2018) in chrysanthemum.

Flower yield per plant varied significantly among different genotypes of chrysanthemum. Significantly greater yield was recorded in KAU C-4 (0.31 kg) followed by KAU C-1 (0.27 kg), KAU C-6 (0.25 kg) and Karnool Pink (0.21 kg). Hemalata et al. (1992) reported that significant variation of different genotypes for yield potential might be due to additive gene effect. Similar findings were observed by Reddy et al. (2016) in chrysanthemum.

Qualitative parameters with respect to flower is an important consideration for the selection of genotypes for different purposes. Flower colour and flower types are essential quality parameters which are used as main considerations for determining consumer's aesthetic appeal and acceptability. Flower head types of different chrysanthemum genotypes have been observed based on the arrangement of ray and disc florets.

Based on the DUS guidelines of chrysanthemum, the genotypes Karnool Pink and Pink cloud was

having semi-double type flowers whereas flowers of all other genotypes were daisy eyed double.

Based on the various floral parameters observed, an individual ranking for cut flower and loose flower type genotypes was done. Accordingly, the genotypes were classified into different groups such as cut flower type (KAU C-6 and KAU C-4), loose flower type (Karnool Pink, KAU C-1, KAU C-2, KAU C-3, KAU C-7 and KAU C-8) and garden type cum loose flower type (Pink Cloud).

Flower colour of nine chrysanthemum genotypes was recorded and categorized under various group of colours with the help of Royal Horticultural Society Colour Chart (RHSCC, 6th edition, 2015). The genotype Karnool Pink and KAU C-7 come under yellow group N4, KAU C-6 under yellow group N6 and KAU C-8 under yellow group N3. The genotypes Pink Cloud, KAU C-2 and KAU C-3 fall under red-purple group N70. Genotypes KAU C-1 and KAU C-4 come under white group N15. Post harvest characters like vase life and shelf life of genotypes assume importance while handling the flowers in the market. The data pertaining to post harvest studies are depicted in the Table 6.

Among the genotypes, significant variation was observed in terms of shelf life of the flowers which were kept open on silver foil paper plates at ambient temperature. Genotype KAU C-7 (4.89 days) found promising with respect to shelf life of flowers which was closely followed by KAU C-3 (4.52 days), KAU C-2 (4.17 days), Karnool Pink (3.72 days) and KAU C-8 (3.49 days) and KAU C-1 (3.33 days). Although all the genotypes were placed in same average temperature (29.3°C) and relative humidity (82.6%), significant variation was observed for all the post-harvest parameters which might be due to genetic differences between the genotypes. Variations in shelf life may be caused by differences in flower form, size, shape and genotype sensitivity to ethylene (Thakur et al., 2018). The same results were obtained by Joshi *et al.* (2009) and Beeralingappa (2016) in chrysanthemum.

Prolonged vase life was observed in the genotype KAU C-3 (14.48 days) which was statistically on par with KAU C-7 (13.51 days). The prolonged vase life in these genotypes might be due to greater water uptake (12.00 ml and 21.00 ml respectively). The significant difference might be due to the variations in senescence character of the genotypes that

Table 6. Post-harvest characters of chrysanthemum genotypes

Genotypes	Vase life (days)	Shelf life (days)	Physiological loss of weight (%)	Total water uptake (ml)
Karnool Pink	12.66 ^c	3.72 ^{cd}	25.74 ^e	22.50 ^a
Dolley Orange	NF	NF	NF	NF
Autumn Joy	NF	NF	NF	NF
Roopanjali	NF	NF	NF	NF
Coffee	NF	NF	NF	NF
Pink Cloud	7.28 ^g	2.46 ^f	53.43 ^a	9.50 ^d
KAU C-1	8.31 ^f	3.33 ^{de}	33.21 ^c	19.00 ^{ab}
KAU C-2	10.58 ^e	4.17 ^{b^c}	27.15 ^{de}	16.00 ^{bc}
KAU C-3	14.48 ^a	4.52 ^{ab}	29.28 ^d	21.00 ^a
KAU C-4	10.72 ^e	3.03 ^{ef}	28.47 ^{de}	20.00 ^{ab}
KAU C-5	NF	NF	NF	NF
KAU C-6	11.96 ^d	3.01 ^{ef}	19.58 ^f	19.50 ^{ab}
KAU C-7	13.51 ^b	4.89 ^a	42.19 ^b	12.00 ^{cd}
KAU C-8	8.51 ^f	3.49 ^{de}	33.51 ^c	13.00 ^{cd}
KAU C-9	NF	NF	NF	NF
SE (m ±)	0.11	0.19	1.04	1.29
C.V (%)	1.44	7.57	4.51	10.87
C.D (0.05)	0.36	0.63	3.39	4.24

*NF- Not flowered

produce more ethylene-forming enzymes, (Vetrivel and Jawaharlal, 2014). The results recorded in the present study found similar with the reports of Madhumita et al. (2006) in chrysanthemum.

Significant variation with respect to physiological loss of weight (PLW) was recorded among genotypes. The lowest PLW was observed in KAU C-6 (19.58 %) followed by Karnool Pink (25.74 %), KAU C-2 (27.15 %), KAU C-4 (28.47 %) and KAU C-3 (29.28 %).

The present study indicated wide variations among the fifteen chrysanthemum genotypes evaluated for various vegetative, floral, yield and post harvest characters. Among the fifteen genotypes evaluated only nine genotypes flowered in the plains of Kerala when planted during January, avoiding the intense South-West monsoon season. Based on the morphological and floral characters, it could be summarized that the genotypes KAU C-4 and KAU C-6 can be selected for both cut flower and loose flower purpose whereas the genotypes Karnool Pink, KAU C-1, KAU C-7, KAU C-3, KAU C-8 and KAU C-2 are best preferred for loose flower purpose as well as for gardening and the genotype Pink Cloud is preferred for both garden type and loose flower production.

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