



E-ISSN: 2278-4136

P-ISSN: 2349-8234

www.phytojournal.com

JPP 2021; 10(1): 2162-2165

Received: 18-10-2020

Accepted: 21-12-2020

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Evaluation of cut chrysanthemum (*Dendranthema grandiflora* Tzvelev.) under open field and polyhouse in Coimbatore conditions

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Abstract

The present investigation was conducted to evaluate ten varieties of cut chrysanthemum in polyhouse and open-field conditions during 2019-2020 at Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. The study was conducted in FRBD with ten treatments and three replications and morphological, flowering parameters were recorded. The results revealed that, Salvador White (T₁) the overall plant growth such as plant height (95.2 cm); flower diameter (7.6 cm); flower yield (74 g/plant) were found to be maximum both under polyhouse and open-field conditions followed by Artic Queen (T₉) with plant height (94.1 cm); flower diameter (7.2 cm); flower yield (64.5 g/plant) and vase life of flower (5.97 days). The variety Artic Queen (T₉) produced longest flower stalk both under polyhouse (117.35) and open-field conditions (79.87). The emergence of flower bud and occurrence of blooming was found to be earlier in open-field than in the polyhouse in all the varieties. Early flower bud appearance (58.5 days) and number of flowers per plant (42.1) was noticed in the variety Tanta Pink (T₅). Under polyhouse conditions, the duration of flowering was found to be the longest in Salvador White (T₁) and Artic Queen (T₉) (47 days), followed by Chaproan Yellow (T₆) (45 days) respectively. The shortest flowering duration was observed in open field and least flowering duration was observed in Marigold (T₁₀ control) (22 days).

Keywords: Cut chrysanthemum, polyhouse, open-field

Introduction

Cut Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) belongs to the family Asteraceae ($2n=2x=18$) and is commonly called as 'Queen of East', 'Glory of the East', 'Guldaudi' and Autumn Queen. Chrysanthemum ranks next to Rose in the international flower market due to its vast range of growth habit, flower shapes, sizes, brilliant colour tones and long lasting floret life. The Netherlands and Columbia are the leading exporters of chrysanthemum. In India its cultivation is concentrated mainly in Himachal Pradesh (the most prominent cut chrysanthemum growing state), Madhya Pradesh, Karnataka, Tamil Nadu and West Bengal. Chrysanthemum cultivation covering 11.05 thousand hectare area with loose flower production of 106.76 million tonnes and cut flower production of 6.03 lakh cut stems in India. (NHB, 2013-14).

Chrysanthemum is most commercially cultivated for its varied colours, shapes and long keeping quality. They are grouped as large standard flowers and small spray flowers. A short stemmed flower is best suitable for pots while the longer ones are used as cut flowers in flower arrangements. The exhibition varieties can be used to create many amazing plant forms, like large disbudded blooms, spray forms, and many artistically trained forms such as thousand-bloom, standard, fans, hanging baskets, topiary, bonsai and cascades.

Chrysanthemum is a partial sciophyte generally grown under polyhouse conditions. Direct sunlight significantly affects the quantity and quality of flower production. Performance of the crop is different under protected or partially protected conditions compared to the open-field. Hence identification of varieties suitable for polyhouse and open-field conditions is an important priority in chrysanthemum breeding production.

Since chrysanthemums are facultative short-day plants, these are grown under high cost polyhouse for optimum growth and development. In South Indian conditions, large scale farmers are able to cultivate in polyhouses whereas small and marginal farmers find financial difficulties in polyhouse construction. In order to overcome this problem, this evaluation study had been taken under open field and polyhouse condition for the selection of suitable varieties in Coimbatore region.

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Materials and methods

The present investigation was conducted at Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India, which is located at 11°02' N latitude and 76° 57' E longitude and at an altitude of 426.72 m above MSL. The treatment included 10 leading varieties from Krishnagiri district, transplanted in the field during the month of December to March 2019-2020. The rooted plants of these ten varieties, procured from a local nursery "Green Plants and Flowers", Denkanikottai, Krishnagiri. The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replication, the rooted plants were planted at a spacing of 15 x 15 cm and beds of 13 x 1 m size under polyhouse and in 3 x 3 m size plots under open field. The observations on growth, flowering and yield parameters such as plant height (cm), number of leaves plant⁻¹, first bud appearance (days), days to first flowering (days), duration of flowering (days), yield per plant (g), number of sprays, total number of flowers plant⁻¹, flower stalk length (cm), vase-life of flower (days) were recorded and the data were subjected to statistical analysis (using SPSS software Package) as per Panse and Sukhatme (1967),

Table 1: Treatments details

Growth conditions (G)	Treatments	Varieties (V)
Polyhouse and Open field	T ₁	Salvador White
	T ₂	Splender Barga
	T ₃	Tanta purple
	T ₄	Barg Red
	T ₅	Tanta Pink
	T ₆	Chaproan Yellow
	T ₇	Olive Green
	T ₈	GPF Yellow
	T ₉	Artic Queen
	T ₁₀ (Control)	Marigold

Results and discussion

The data recorded on vegetative, flowering and yield characters under different growth environment are presented in Tables 1 to 3, the results revealed significant variations among the different cut chrysanthemum varieties. Varieties grown under polyhouse exhibited better yield and yield attributes compared to that under open field conditions. Similar findings were reported in chrysanthemum by Saud and Talukdar (1999) [10].

The growth of the plant usually shows a good index of plant vigour which includes greater productivity. It serves a guide to determine the suitable plant variety with maximum yield. Plant height is one of the essential criteria for screening of chrysanthemum varieties. (Shankar and Tewari, 1993) [11]. Among the varieties, Salvador White (T₁) (95.25 cm) recorded the maximum plant height with earlier flower bud appearance during harvesting followed by Artic Queen (T₉) (94.15 cm), while the lowest plant height was recorded in the control variety Marigold (T₁₀) (44.45 cm). In the interaction, Salvador White (T₁) under polyhouse recorded the tallest plant variety of 120.2cm while the least value of plant height was recorded in variety Marigold (T₁₀ control). Under open field conditions, Salvador White (T₁) (70.3 cm) and Artic Queen (T₉) (69.0 cm), found to be a tall varieties and Marigold (T₁₀) as a control (30.7 cm) found as a dwarf one. Such variations for plant height has been observed among different cultivars of spray chrysanthemum and also can be attributed to genetic constitution of the genotypes, similar observations were made by Chezhi-yan *et al.*, 1985 and

Singh, *et al.*, 2008).

Leaves are the functioning unit for photosynthesis and flower yield depends greatly on photosynthesis. (Meera *et al.*, 2003). The leaf production was maximum in polyhouse condition compared to open field. Maximum number of leaves were observed in the variety Salvador White (T₁) (40.2) and minimum number of leaves in Olive Green (T₇) (18.3). Among the growing conditions the number of leaves in all varieties under polyhouse condition was highly significant when compared to open conditions. In the interaction, Salvador White (T₁) recorded the highest number of leaves (47.3) while the least number of leaves was recorded in Olive Green (T₇) (16.3). Similar variation in leaf production has been reported by Nalawadi, 1982 [9].

The time taken for first bud appearance and days to first flowering by different varieties under polyhouse did not show any significant difference. Emergence of flower bud and occurrence of blooming was found to be earlier in open-field than in the polyhouse in all the varieties. Early flower bud appearance was noticed in the variety Tanta Pink (T₅) (58.5) and followed by Barg Red (T₄) (59.0) were on par with each other. The variety Chaproan Yellow (T₆) (92 days) took minimum days for first flowering followed by Barg Red (T₄) (92.5 days), Tanta Pink (T₅) (94 days), Splender Barga (T₂) (94 days) which were on par with each other. In the interaction, early bud appearance was noticed in Olive Green (T₇) (40 days) under polyhouse followed by Tanta Pink (T₅) (45 days), which were on par with each other and early flowering among the varieties was observed in Olive Green (T₇) and Barg Red (T₄) (70 days). Among the varieties, Marigold (T₁₀) (82.5) took maximum days for flower bud appearance and also took maximum days for first flowering (126 days).

Among the growing conditions, the first bud appearance and days to first flowering of all the varieties under open-field condition was highly significant when compared to polyhouse conditions, which might be due to short day conditions prevailing under open field, it results in early bud appearance and flowering. However, the flower bud induction and blooming were delayed in plants exposed with increased day length extension, which was observed in polyhouse conditions. Days taken to flower bud appearance and days taken to attain blooming stage were studied in different cultivars of spray chrysanthemum. (By Chezhi-yan *et al.*, 1985, Gupta and Dutta, 1997) [4].

Duration of flowering is a very important character while breeding for flowering plant which signifies that the availability of the flowers in the market. Among the evaluated varieties, under polyhouse the duration of flowering was not significant with all varieties. The highest flower duration was recorded in Salvador White (T₁) and Artic Queen (T₉) with (47 days), followed by Chaproan Yellow (T₆) (45 days) while, it was least in Marigold (T₁₀ control) (22 days). In the interaction, the highest duration of flowering was recorded in Salvador White (T₁) (54 days) followed by Splender Barga (T₂), Chaproan Yellow (T₆) and Artic Queen (T₉) with (52 days) respectively, while the shortest blooming duration was recorded in Olive Green (T₇) and Marigold (T₁₀ control) (22 days).

There is no significant mean difference between the growing conditions of all the varieties. In the interaction, the highest number of sprays was registered in Artic Queen (T₉) with 15 while, least number of sprays was registered in Marigold (T₁₀ control) (2.0). Among the varieties, the number of sprays in all varieties under polyhouse condition was highly significant when compared to open conditions.

Table 1: Evaluation of growth and flowering attributes of cut chrysanthemum under open field and polyhouse conditions

Treatments	Plant height (cm)			Number of leaves plant ⁻¹			First bud appearance (days)			Days to first flowering (days)		
	Poly-house	Open field	Mean	Poly-house	Open field	Mean	Poly-house	Open field	Mean	Poly-house	Open field	Mean
T ₁	120.2	70.3	95.25	47.3	33.0	40.2	78	49	63.5	120	78	99.0
T ₂	109.7	65.4	87.55	36.0	25.7	30.8	73	46	59.5	113	75	94.0
T ₃	104.7	60.3	82.50	29.0	20.3	24.6	73	46	59.5	113	78	95.5
T ₄	104.7	61.6	83.15	22.3	17.7	20.0	70	48	59.0	115	70	92.5
T ₅	110.9	63.0	86.95	25.0	18.3	21.6	72	45	58.5	110	78	94.0
T ₆	108.6	68.6	88.60	22.0	18.7	20.3	69	50	59.5	109	75	92.0
T ₇	90.6	65.2	77.90	20.3	16.3	18.3	82	40	61.0	138	70	104.0
T ₈	89.2	64.7	76.95	33.7	18.0	25.9	71	51	61.0	120	76	98.0
T ₉	119.3	69.0	94.15	32.0	19.3	25.7	78	55	66.5	112	80	96.0
T ₁₀	58.2	30.7	44.45	30.7	20.2	25.5	80	85	82.5	140	112	126.0
Mean	101.61	61.88	81.74	29.8	20.8	25.3	74.6	51.5	63.05	119	79.2	99.1
	G	V	G×V	G	V	G×V	G	V	G×V	G	V	G×V
SE(d)	0.129	0.288	0.407	0.877	1.961	2.773	0.435	0.976	1.375	0.643	1.438	2.034
CD (P = 0.05)	0.261	0.584	0.826	1.782	3.984	5.635	0.884	1.976	2.795	1.307	2.923	4.134
F cal	95.21**	5.03**	617.9**	108.5**	22.57**	2.50*	2.82 ^{NS}	111.3**	73.72**	3.82 ^{NS}	98.53**	31.30**

There is no significant difference for the number of flowers per plant. Total number of flowers per plant was maximum in Tanta Pink (T₅) (32.05) and the minimum number of flowers were found in Marigold (T₁₀ control) (16.50). In the interaction, the highest number of flowers was registered in Tanta Pink (T₅) (42.1) while, least number of flowers was registered in Marigold (T₁₀ control) (16.0). The total number

of flower produced per plant was determined either by genotype of the plant or by additive gene effects (Jin Hee Lim *et al.*, 2010). The results obtained in the present study are in agreement with that of Jayanthi and Vasanthachari, 2003^[5] and Manohar Rao and pratap, 2003 and 2006^[7, 8] in chrysanthemum.

Table 2: Evaluation of flowering characters in cut chrysanthemum under open field and polyhouse conditions

Treatments	Duration of flowering (days)			Number of sprays			Total number of flowers plant ⁻¹			Flower diameter (cm)		
	Poly-house	Open field	Mean	Poly-house	Open field	Mean	Poly-house	Open field	Mean	Poly-house	Open field	Mean
T ₁	54	40	47.0	11.0	8.0	9.5	27.6	27.3	27.45	7.6	6.8	7.2
T ₂	52	35	43.5	6.7	4.0	5.4	17.4	16.5	16.93	5.8	4.2	5.0
T ₃	48	34	41.0	7.0	5.0	6.0	22.0	15.0	18.50	5.7	4.0	4.8
T ₄	45	24	34.5	12.0	4.0	8.0	24.3	12.0	18.15	4.5	3.2	3.8
T ₅	48	33	40.5	12.0	8.0	10.0	42.1	22.0	32.05	5.1	3.9	4.5
T ₆	52	38	45.0	9.7	7.0	8.35	29.7	20.0	24.85	4.5	3.2	3.8
T ₇	49	22	35.5	7.3	5.0	6.2	16.7	8.0	12.35	2.7	1.6	2.2
T ₈	38	31	34.5	5.7	5.0	5.4	22.5	18.0	20.25	4.2	3.1	3.6
T ₉	52	42	47.0	15.0	11.0	13.0	35.3	10.0	22.65	7.2	5.1	6.2
T ₁₀	22	22	22.0	5.0	2.0	3.5	17.0	16.0	16.50	3.2	1.8	2.5
Mean	46	32.1	39.05	9.14	5.9	7.52	25.46	16.48	20.97	5.1	3.7	4.3
	G	V	G×V	G	V	G×V	G	V	G×V	G	V	G×V
SE(d)	0.226	0.505	0.714	0.043	0.097	0.138	0.205	0.459	0.649	0.024	0.054	0.077
CD (P = 0.05)	0.459	1.026	1.714	0.088	0.198	0.280	0.417	0.933	1.320	0.050	0.111	0.157
F cal	3.787 ^{NS}	463.7**	106.4**	12.89**	5.378*	1.875 ^{NS}	2.65 ^{NS}	646.2**	167.65**	3.052 ^{NS}	1.594 ^{NS}	20.643**

In flower diameter and yield, there is no significant difference between all the varieties under different growing conditions. Highest flower diameter (7.2 cm) and maximum yield (74 g/plant) was recorded in the variety Salvador White (T₁), which was on par with flower diameter of Artic Queen (T₉) (6.2 cm) and an yield of 64.5 g/plant. Among the growing conditions, the Salvador White (T₁) registered maximum size of flower diameter (7.6 cm) and produced high yield flowers (86 g/plant) when compared to other varieties. Variation in flower diameter and yield might be due to the genetic makeup of the varieties and their interaction with prevailing genotype and environmental factors. These findings are similar to that study reported by Manohar Rao and Pratap (2003 and 2006)^[7, 8] in chrysanthemum.

The variety Artic Queen (T₉) produced highest flower stalk length of 98.61 cm followed by Splendor Barga (T₂) (93.86 cm) respectively, while it was least in Marigold (T₁₀ control) 45.03 cm). Among the growing conditions, the longest flower stalk was recorded in Artic Queen (T₉) both under polyhouse (117.35) and open-field conditions (79.87). There is no significant difference between all the varieties under open-field conditions. Maximum stalk length with thicker straight

stems having high accumulation of carbohydrates (Paraneetha, 2006). These results are in line with the earlier findings of Jayanthi and Vasanthachari (2003)^[5] and Manohar Rao and pratap (2003)^[7].

Vase-life or keeping quality of the flowers is of great importance in determining the safe marketing of flowers to the distant markets. Gantait and Pal, 2011 reported that, plants grown under polyhouse exhibited better vase-life of flowers compared to those grown under open-field. There was a significantly extended period of vase-life in variety Chaproan Yellow (T₆) (6.10 days) followed by Salvador White (T₁) (6.05 days), Artic Queen (T₉) (5.97) and were on par with each other. Among the growing conditions the plant height of all varieties under polyhouse condition was highly significant when compared to open conditions. In the interaction, the longest vase-life was recorded in the variety Chaproan Yellow (T₆) (8.56 days) while, the shortest vase-life was recorded in GPF Yellow (T₈). These variations in vase-life of flowers must be due to the difference in senescencing behaviour of the varieties by producing higher amount of ethylene forming enzymes. (Kandpal *et al.*, 2003).

Table 3: Evaluation of yield and qualitative characters in cut chrysanthemum under open field and polyhouse conditions

Treatments	Flower stalk length (cm)			Yield per plant (g)			Vase-life of flower (days)		
	Poly-house	Open field	Mean	Poly-house	Open field	Mean	Poly-house	Open field	Mean
T ₁	108.15	65.48	86.82	86	62	74.0	8.04	3.97	6.05
T ₂	111.25	76.47	93.86	39	44	41.5	8.01	3.52	5.76
T ₃	98.68	54.23	76.45	42	37	39.5	4.06	2.68	3.37
T ₄	92.45	53.69	73.07	42	27	34.5	7.12	2.90	5.01
T ₅	97.68	56.89	77.28	60	28	44.1	7.89	3.02	5.45
T ₆	110.41	72.65	91.53	52	45	48.5	8.56	3.65	6.10
T ₇	68.98	48.39	58.68	19	34	26.5	7.10	2.98	5.04
T ₈	89.28	52.43	70.85	40	29	34.5	6.50	2.00	4.25
T ₉	117.35	79.87	98.61	82	47	64.5	8.05	3.90	5.97
T ₁₀	52.18	37.89	45.03	65	12	38.5	7.86	3.50	5.68
Mean	94.64	59.79	77.22	52.7	33.98	43.34	7.31	3.21	5.27
	G	V	G×V	G	V	G×V	G	V	G×V
SE(d)	0.115	0.256	0.362	0.335	0.749	1.059	0.037	0.084	0.118
CD (P = 0.05)	0.233	0.521	0.736	0.681	1.522	2.152	0.076	0.170	0.240
F cal	5.716*	1.695 ^{NS}	152.5**	3.124 ^{NS}	807.8**	500.11**	12.04**	220.67**	71.767**

Note: (F tab t Error df (5%), 4.09, 2.13, 2.13; t Error df (1%), 7.35, 2.91, 2.91) * Significant, ** Highly significant, NS Non Significant

Production of year round high quality cut flowers is a challenge for farmers as seasonal variations in daily light integrals are affecting the yield and quality. From this study, plant growth, flowering, yield and qualitative traits from ten varieties were evaluated under two environmental factors. Among the growing conditions the growth, flowering, yield and qualitative traits of all the varieties under polyhouse condition was significant when compared to open conditions. The varieties like, Salvador White (T₁), Splendor Barga (T₂) Chaproan Yellow (T₆) and Artic Queen (T₉) were found to be promising varieties for cut flower production as they were observed as tall plant with long sprays and optimum blooming compared to other varieties and control. Though, polyhouse cultivation recorded high significant difference with the flowering traits, the other varieties like Tanta Purple (T₃), Tanta Pink (T₅), Barg Red (T₄), Olive Green (T₇), Marigold (T₁₀) recorded early blooming, with short stalk length and optimum flower size when planted in open-field. Therefore, these varieties are more suitable for loose flower production, pot culture and garden display under Coimbatore conditions.

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