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EVALUATION OF CUT CHRYSANTHEMUM (*DENDRANTHEMA GRANDIFLORA*) GENOTYPES UNDER NATURALLY VENTILATED POLYHOUSE

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ABSTRACT

The present investigation, was carried out at the Department of Floriculture and Landscaping, Kittur Rani Chennamma College of Horticulture, Arabhavi, University of Horticultural Sciences, Bagalkot, during 2024. The experiment was conducted in a Randomized Complete Block Design with fifteen genotypes replicated thrice to assess growth, flowering, yield and quality traits under a naturally ventilated polyhouse. DD-Colour exhibited superior vegetative performance with maximum plant height, stem girth, and chlorophyll content, while Champagne Peach showed the highest leaf area, plant spread, internodal length and fresh weight of flower stalk. Calimor Yellow produced the maximum number of leaves. Santani Black was the earliest in bud initiation and flowering, Champagne Peach required the fewest days for 50% flowering and showed the longest flowering duration, whereas Article Queen White recorded the largest flower diameter. In terms of yield, Santani Black was superior with maximum flower stems, gross and net returns, and the highest B:C ratio, followed by DD-Colour and Champagne Peach.

Keywords **:** Polyhouse, genotype, yield, quality, flowering, B:C ratio

Introduction

Chrysanthemum (*Dendranthema grandiflora L.*), belonging to the family Asteraceae, is one of the most important cut flowers after roses in global trade. Known as the “Queen of the East,” it holds cultural and economic significance and is cultivated extensively across Asia, Europe and India. More than 60,000 cultivars are reported worldwide and over 500 in India, making it one of the most diverse flower crops. Chrysanthemums are cultivated on approximately 40,000–50,000 hectares in India, producing 1.5–2 billion stems per year, with Karnataka, Tamil Nadu, and Maharashtra being the top producers. Chrysanthemums are among the top three cut flower crops in the global market, second only to roses and carnations, with major producers in Japan, China, the Netherlands, Italy, and the USA. Because of the great variety of types, sizes, colors, and forms, there are over 500 cultivars. It can be cultivated in open fields as well as polyhouses, greenhouses and shade houses. For cut flower purposes, polyhouses are preferred by the majority of farmers. Crop variety evaluation is critical in decision-making in crop variety release, crop seed marketing or distribution and generating crop variety recommendations for farmers.

Materials and Methods

Climatic conditions

The present investigation, was carried in at the Department of Floriculture and Landscaping, Kittur Rani Channamma College of Horticulture, Arabhavi, Gokak, Belagavi, Karnataka, India, during the kharif season of the year 2024. KRCCH, Arabhavi, is situated in the Northern dry zone (Zone-III) of Karnataka, with geographical coordinates around 16°15' north latitude and 94° 45' East longitude. With an elevation of 640 meters above sea level.


Candor Red
Santani Black
DD-Colour
Candor Pink
Calimor Yellow
Calimor White
Calimor Pink
Wp-Petals
Calimor Red
Champagne Peach
Candor orange
Champagne Golden
Aishwarya 2
Article Queen White
Feeling Green Dark

Polyhouse

The present investigation was carried out in a naturally ventilated polyhouse (NVPH) with ridge and furrow design. The covering was made of 200-micron-thick, ultra-stabilised polythene material. In order to provide changeable shading and cooling effects when needed, a 50% shade net in green was also put within the greenhouse. A 15-watt bulbs were used to meet the long day requirement (*i.e.*, 16 hours of light) during vegetative growth. As advised, water-soluble fertilizers were used in a fertigation system to apply fertilizer to the plants and drip irrigation was used to irrigate them. The entire agricultural area was equipped with drip irrigation, which is also utilized for fertigation. Drip irrigation, integrated with a fertigation system using water-soluble fertilizers, was employed throughout the cultivation area.

Design and layout of experimental plot

The experiment was laid out in a Randomized Complete Block Design (RCBD) design. There were fifteen genotypes and three replications in the experiment, namely Calimor Yellow, Candor Pink, Article Queen White, Santani Black, Feeling Green Dark, Candor Orange, Wp-Petals, Calimor White, Champagne Golden, Aishwarya-2, Candor Red, Calimor Pink, DD-Colour, Calimor Red, Champagne Peach which are presented in Figure 1. For healthy chrysanthemum production, beds were sterilised with Biosil (Nano Silver 10 ml/L) drench, the polyhouse sealed for 7 days, mulched for a week for solar sterilisation, nd flushed with ~100 L water/m²; planting was done 2 weeks later. Rooted cuttings (20–25 days old) were planted at 20 × 20 cm spacing after irrigating beds a day earlier. Well-decomposed FYM was mixed 2 weeks prior; P, K and 50% N were applied a week before, with the remaining N top-dressed 30 days after transplanting, and beds raked to loosen soil. Black plastic mulch (25 µ) was used to conserve moisture, stabilise temperature and suppress weeds

Lightning and netting in polyhouse

Chrysanthemums are photoperiod-sensitive plants, meaning their flowering and growth are strongly influenced by the duration of light exposure they receive. Artificial lighting is often used to manage and optimize these photoperiod requirements, ensuring consistent and high-quality flower production, especially in regions with limited sunlight or for off-season production. Cut chrysanthemums need long days (16 hours of light) to grow vegetatively. This can be achieved by mounting six 15-watt LED lamps over the beds at a distance of three meters and a height of two meters. Since it was not possible to generate artificially short days, the timer was set to deliver 16 hours of light per day until the plants reached a height of 40 to 45 cm. At that point, the extra light was turned off, exposing the plants to the natural short-day circumstances. A general view of artificial lightning condition is The nylon net was purchased from Sonite Agriventures Pvt Ltd, Kamakshipalya, Bangalore. Supporting nets are set up for plants with a cell size of 1M X 16M X 6 of quantity 96 Sqmts for total of 6 beds. The purpose of the nylon netting was to retain the appropriate form of the bloom and to keep the stems upright. In order to sustain the plants, it was intended that the net would be moved upward as the plants grew.

Statistical analysis

The data collected during the investigation were analyzed using standard analysis of variance methods as outlined by Panse and Sukhatme (1985). The standard error of the mean (S.Em±) and the critical difference (CD) at the 5% level were calculated. Key results are presented with the help of tables, graphs and plates.

Results and Discussion

Vegetative parameters

Plant height (cm)

Among different genotypes of cut chrysanthemum. The genotype DD-Colour significantly recorded maximum plant height (145. 93 cm) and it was on par with Calimor Yellow (139.00 cm), Calimor White (127.24 cm), Calimor Pink (126.67 cm), while the minimum plant height was recorded in the genotype Aishwarya-2 (112.00 cm) and Candor Orange (113.22 cm). Variations in plant height among cut chrysanthemum genotypes are influenced by both genetic factors and genotype-specific responses to environmental conditions. Light, temperature, and nutrient availability can enhance or limit genetic expression, while production methods and cultural practices also play a role. Similar varietal differences in plant height have been reported by Thiripurasundari *et al.* (2021), Chaudhari *et al.* (2023) and Negi *et al.* (2018) in chrysanthemum.

Number of leaves

The number of leaves per plant varied significantly among the different genotypes of cut chrysanthemum at 90 DAT. The genotype Calimor Yellow recorded significantly maximum number of leaves per plant (105.28), followed by Calimor White (98.60) at 90 DAT. The minimum number of leaves per

plant was produced in the genotype Candor Orange (50.13). Leaves are essential for photosynthesis, transpiration, and defence, contributing to overall plant health and quality blooms. Variation in leaf numbers among genotypes is mainly due to genetic differences, with higher leaf production reflecting inherent varietal traits. In cut chrysanthemum, stems are harvested with production and plant function. Similar findings were reported by Pawar *et al.* (2023), Kumar *et al.* (2021), Rishi *et al.* (2021) in chrysanthemum.

Leaf area (cm^2)

The leaf area varied significantly among the different genotypes of cut chrysanthemum. The genotype Champagne Peach had maximum leaf area (8351.36 cm^2) which was followed by Santani Black (6299.70 cm^2) and DD-Colour (5685.15 cm^2) while the genotype Calimor Yellow had the minimum leaf area (1200.78 cm^2). Leaf size, shape, and growth rate are largely determined by the genetic makeup of each genotype. Varieties with stronger root systems and higher chlorophyll content absorb water and nutrients more efficiently and optimize photosynthesis, resulting in larger leaves. Similar observations were reported by Punetha *et al.* (2011), Siddiqua *et al.* (2018) in chrysanthemum.

Flowering parameters

Days taken for bud initiation

The genotypes varied significantly with respect to days taken for bud initiation. Among the different genotypes studied, the genotype Santani Black recorded minimum days taken for bud initiation (63.73 days) which was on par with DD-Colour (65.46 days) and Article Queen White (65.73 days), Champagne Peach (66.20 days), Wp-Petals (66.93 days) whereas the genotype Candor Pink (73.40 days) and Candor Red (72.46 days) recorded maximum days taken for bud initiation. Flower availability is largely determined by the time required for bud initiation, a key trait indicating the earliness of flowering in cut chrysanthemums. Genotypes showed significant variation in this regard. Early bud initiation enables quicker harvesting and generally requires fewer resources, early-flowering types utilize water nutrients more efficiently than late-maturing ones. This variation is mainly governed by genetic makeup, though environmental factors also play an important role. Similar findings were reported by Thakur *et al.* (2018), Siddiqua *et al.* (2018) in chrysanthemum.

Days taken for first flowering

The genotypes varied significantly with respect to days taken for first flowering appearance of first flower. Among the different genotypes studied, the genotype Santani Black significantly recorded minimum number of days for first flower (76.13 days) and which is on par with DD-Colour (78.00 days) while the genotype Champagne Golden significantly recorded the maximum days taken for first flowering (103.80 days). Variation in flowering time is largely genetic. Early-flowering genotypes carry genes that hasten floral initiation through efficient meristem activity, supported by favorable light, temperature, and moisture. Delayed flowering, on the other hand, may result from slower hormone synthesis, prolonged vegetative growth, or specific photoperiodic requirements. Similar patterns were reported by Uddin *et al.* (2015) in chrysanthemum.

Days taken for 50 per cent flowering

The genotype Champagne Peach recorded the minimum days taken for 50 per cent flowering (84.00 days), which is on par with Santani Black (86.66 days), while the genotype Champagne Golden recorded the maximum days taken for 50 per cent flowering (114.00 days). Genetic variations in flowering pathways and regulatory genes primarily govern differences in the time required for 50% flowering among genotypes. Some are photoperiod-sensitive, while others respond flexibly to environmental cues. Genotype-specific biological clocks, developmental rates, and efficiency in resource allocation to reproductive growth further influence flowering time. Environmental factors such as light, water, and soil conditions also interact with genetic makeup to determine flowering rate. These findings agree with Siddiqua *et al.* (2018) in chrysanthemum.

Duration of flowering

The genotype Champagne Peach recorded maximum duration of flowering (21.46 days), followed by Champagne Golden and DD- Colour (19.16 days each), while the genotype Feeling Green Dark recorded minimum duration of flowering (12.76 days). A shorter flowering duration may result from smaller flowers that bloom rapidly, while slow petal opening can extend the flowering period. A shorter flowering period can be caused by the flowers' quick blooming and modest size. Genotype-specific hormonal regulation, particularly by florigens and gibberellins, also plays a key role. These findings are consistent with Negi *et al.* (2018) and Thiripurasundari *et al.* (2021) in chrysanthemum.

Quality parameters

Flower diameter

Significantly, the maximum flower diameter was recorded in the genotype Article Queen White (7.50

cm), which was on par with other genotype Champagne Peach (7.26 cm) while the minimum flower diameter was recorded in the genotype Calimor Pink (2.62 cm) and Calimor Yellow (2.64 cm). Flower diameter varied among genotypes due to inherent genetic traits. Genotypes with double flowers having five whorls of florets recorded larger diameters, supported by greater leaf area that enhanced dry matter accumulation. In contrast, reduced floret length and compactness resulted in smaller flowers. Similar observations were reported by Negi *et al.* (2018) and Thiripurasundari *et al.* (2021) in chrysanthemum.

Stalk length (cm)

The maximum stalk length was recorded significantly in the genotype DD-Colour (101.48 cm) and was on par with Aishwarya-2 (97.66 cm) while the minimum stalk length was recorded in the genotype Champagne Golden (77.16 cm). Variation was influenced by genotypic differences and greater dry matter deposition from enhanced vegetative growth. Stalk length increased with more internodes and longer internodal length, which was directly related to plant height. Improved assimilate supply to flowers contributed to extended vase life. These results agree with Rishi *et al.* (2021) in chrysanthemum.

Fresh weight of flower stalk (g)

The fresh weight of flower stalk significantly differed among the genotypes. The maximum fresh weight of flower stalk was recorded in genotype Champagne Peach (77.69 g) which was followed by genotype Calimor Red (73.69 g) and Santani Black (71.16 g) Whereas, genotype Candor Pink resulted in the minimum fresh weight of flower stalk (42.00 g). The maximum fresh weight of flower stalks may be attributed to larger leaf area, which enhanced dry matter accumulation and photosynthate production, resulting in larger flowers with higher carbohydrate content and consequently greater stalk weight. Genotypic differences may also have contributed to this variation. Similar results were reported by Negi *et al.* (2018) and Thiripurasundari *et al.* (2021) in chrysanthemum.

Chlorophyll content (SPAD values)

Significant differences were observed among different genotypes of cut chrysanthemum in terms of total chlorophyll content in the leaves. The total chlorophyll content was maximum in genotype DD-Colour (75.40), which was followed by Wp-Petals (54.21), whereas significantly the minimum total chlorophyll was recorded in the genotype Candor Red (26.02) compared to the other genotypes. Chlorophyll production, degradation, and total content are genotype-dependent. Genotypes with higher photosynthetic efficiency generally retain more chlorophyll, while their capacity to adapt to varying light conditions differs, with some maintaining higher levels even under low light.

Yield parameters

Number of flowers per stalk

Among different genotypes of cut chrysanthemum, significantly the maximum number of flowers per stalk was recorded in the genotype Calimor White (23.80) which was on par with Calimor Yellow (21.93), Calimor Pink (19.23) and Santani Black (17.20) while minimum number of flowers per stalk was recorded in the genotype Feeling Green Dark (10.60). This variation may be attributed to the genetic makeup of the genotype. A higher number could be due to the smaller flower size and the anemone type, as well as the rate of photosynthate production. Similar observations were reported by Siddiqua *et al.* (2018) in chrysanthemum.

Number of flower stalks per m^2 and 1000 m^2

The genotype Santani Black yielded the most flower stems per square meter (29.97) and per 1000 square meters (29967), respectively. which, in turn, was comparable to genotype DD-Colour (29.04) per square meter and per 1000 square meters (29040). However, the minimum number of flower stems per m^2 (24.10) and number of flower stems per 1000 m^2 (24103) was observed in the genotype Feeling Green Dark, respectively. The genotype's genetic composition, increased rate of photosynthetic production, and increased stem durability are the causes of this variation. attributable to both varietal characteristics and the genotypes' increased adaptability to the local environment. Similar variation for stalk yield was also observed by Pawar *et al.* (2023) in chrysanthemum.

Economics

The genotype Santani Black realized maximum gross returns of (Rs. 1123763) and net returns of (Rs. 655725) per 1000 m^2 per year with B:C ratio of (2.40) which was followed by DD-Colour (2.34), Champagne Peach (2.13) as compared to other genotypes. The genotype Santani Black recorded maximum with B:C ratio (2.40). Higher B:C ratio in the genotype Santani Black is due to higher gross income and net income. Higher gross and net incomes are the cause of the genotype Santani Black's higher B:C ratio. Due to its exceptional quality and widespread use in stage decorating, flower baskets, bouquets, wreaths. The results indicate that DD-Colour, Champagne Peach and Santani Black are profitable options for growing in the Arabhavi region under protected conditions. Their superior flower output is the reason for the higher

returns per rupee outlay observed in these genotypes, which makes them financially appealing choices for growers. B:C ratio has also been reported by Chaudhary *et al.* (2020), Amarjeet *et al.* (2017) in chrysanthemum.

Conclusion

In terms of economic viability, quality, yield, and benefit-cost ratios, fifteen distinct cut chrysanthemum genotypes were evaluated in detail under a naturally ventilated polyhouse (NVPH). The results clearly show that the Champagne Peach genotype, followed by DD-Colour and Santani Black, were superior in the majority of morphological, flowering, quality, and yield parameters. The experiment's findings explicitly demonstrated that these genotypes perform better than any other and are the best option for increasing cut chrysanthemum cultivation. These findings highlight the adaptability of these genotypes to North Karnataka conditions and their potential to meet diverse consumer preferences through superior quality and extended postharvest longevity. Hence, cultivation of these genotypes is recommended to enhance production, profitability and market competitiveness.

Table 1 : Vegetative and quality parameters of different genotypes of cut chrysanthemum.

Genotypes	Plant height (cm)	Number of leaves	Leaf area (cm^2)	Flower diameter (cm)	Fresh weight of flower stalk	Total chlorophyll (SPAD values)
Calimor Yellow	139.00	105.28	1200.78	2.64	43.82	37.93
Candor Pink	119.24	75.33	3967.77	3.34	42.00	46.51
Article Queen White	120.1	86.80	3260.35	7.50	57.95	45.67
Santani Black	123.14	76.06	6299.70	3.02	71.16	38.56
Feeling Green Dark	124.94	62.80	5045.11	2.97	45.53	42.10
Candor Orange	113.22	50.13	2982.42	6.60	44.97	42.97
Wp-Petals	123.64	67.06	1714.16	5.57	54.13	54.21
Calimor White	127.24	98.60	1461.71	2.76	42.19	45.20
Champagne Golden	125.18	82.53	3550.09	5.60	52.98	28.90
Aishwarya-2	112.00	64.33	2788.67	3.61	51.57	40.71
Candor Red	118.06	79.33	4614.16	4.96	65.99	26.02
Calimor Pink	126.67	95.40	1772.55	2.62	65.82	39.06
DD-Colour	145.93	60.66	5685.15	5.98	64.11	75.40
Calimor Red	112.06	66.33	2819.04	7.11	73.69	51.21
Champagne Peach	126.70	69.93	8351.36	7.26	77.69	48.90
Mean	**122.66**	**76.88**	**1233.62**	**4.77**	**59.14**	**44.22**
S. Em±	3.70	8.65	668.46	0.14	1.48	1.35
CD @ 5%	**10.73**	**25.06**	**1936.47**	**0.42**	**4.31**	**3.91**

Table 2 : Flowering parameters of different genotypes of cut chrysanthemum

Genotypes	Days taken for bud initiation	Days taken for first flowering	Days taken for 50 % flowering	Duration of flowering (days)
Calimor Yellow	67.66	84.40	94.33	17.33
Candor Pink	73.40	98.78	106.72	15.10
Article Queen White	65.73	86.80	95.67	18.13
Santani Black	63.73	76.13	86.66	17.63
Feeling Green Dark	70.66	85.32	99.00	12.76
Candor Orange	69.86	87.40	94.67	15.31
Wp-Petals	66.93	89.54	98.70	16.43
Calimor White	72.20	85.00	91.33	17.36
Champagne Golden	70.20	103.80	114.00	19.16
Aishwarya-2	72.13	99.65	105.00	14.90
Candor Red	72.46	94.30	100.33	16.26
Calimor Pink	69.13	85.66	96.33	14.86
DD-Colour	65.46	78.00	87.00	19.16
Calimor Red	71.33	88.00	99.66	16.23
Champagne Peach	66.20	80.65	84.00	21.46
Mean	**69.14**	**94.59**	**95.80**	**16.81**
S. Em±	1.37	1.69	1.95	0.37
CD @ 5%	**3.98**	**4.91**	**5.66**	**1.08**

Table 3 : Performance of cut chrysanthemum genotypes for yield parameters

Genotypes	Number of flowers per stalk	Number of flower stalks per m^2	Number of flower stalks per 1000 m^2
Calimor Yellow	21.93	26.39	26390
Candor Pink	12.13	25.04	25043
Article Queen White	11.46	26.67	26667
Santani Black	17.20	29.97	29967
Feeling Green Dark	10.60	24.10	24103
Candor Orange	11.40	26.44	26440
Wp-Petals	11.00	25.16	25157
Calimor White	23.80	26.86	26860
Champagne Golden	12.26	25.56	25563
Aishwarya-2	16.46	26.51	26513
Candor Red	14.46	25.29	25287
Calimor Pink	19.23	25.47	25470
DD-Colour	16.73	29.04	29040
Calimor Red	11.20	27.11	27113
Champagne Peach	15.70	28.29	28290
Mean	**14.63**	**26.52**	**26526**
S. Em±	0.63	0.69	691.73
CD @ 5%	**1.83**	**2.00**	**2003.87**

Table 4 : Economics of cultivation of different cultivars of cut chrysanthemum under Naturally ventilated polyhouse (1000 m^2) for one season

Genotypes	Total cost (Rs)	Number of flower stalks per 1000 m^2	Price per stalk	Gross returns (Rs)	Net returns (Rs)	B:C
Calimor Yellow	467101	26390	180	593775	126674	1.27
Candor Pink	466851	25043	200	626075	159224	1.34
Article Queen White	465710	26667	250	833344	367634	1.79
Santani Black	468037	29967	300	1123763	655725	2.40
Feeling Green Dark	464105	24103	160	482060	17955	1.04
Candor Orange	464248	26440	260	859300	395052	1.85
Wp-Petals	464105	25157	170	534586	70481	1.15
Calimor White	462988	26860	180	604350	141362	1.31
Champagne Golden	461929	25563	170	543214	81284	1.18
Aishwarya-2	463570	26513	200	662825	199255	1.43
Candor Red	461430	25287	170	537349	75919	1.16
Calimor Pink	463114	25470	180	573075	109961	1.24
DD-Colour	464640	29040	300	1089000	624360	2.34
Calimor Red	463570	27113	230	779499	315929	1.68
Champagne Peach	465710	28290	280	990150	524440	2.13

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