



ISSN Print: 2618-060X
 ISSN Online: 2618-0618
 NAAS Rating (2026): 5.20
 IJRA 2026; 9(9): 934-940
www.agronomyjournals.com
 Received: 01-07-2026
 Accepted: 05-08-2026
 Published: 22-09-2026

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Influence of planting time and variety on flowering behaviour, flower quality and post-harvest life of cut *Chrysanthemum* (*Chrysanthemum morifolium* Ramat.) under the Northern Dry Zone of Karnataka

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i9m.6623>

ABSTRACT

Chrysanthemum (*Chrysanthemum morifolium* Ramat.) is a quantitative-to-qualitative short-day species whose flowering behaviour and flower quality are strongly modified by the environment prevailing at the time of floral induction. The present investigation was carried out during 2023-24 at University of Horticultural Sciences Bagalkot, situated in the Northern Dry Zone of Karnataka, to determine the optimum planting month and the best-adapted variety for quality flower production. Five varieties - Champagne Yellow, Artic Queen White, Lollipop Pink, Bright Orange and Bright White were planted on five dates, from August to December and laid out in a factorial randomised block design with three replications. Both main effects and, for most traits, their interaction were significant. Delaying planting from August to December progressively hastened flowering: days to bud initiation fell from 67.54 to 46.16 days, days to first flowering from 96.53 to 73.03 days and days to 50 per cent flowering from 113.05 to 74.13 days. The same delay, however, depressed every quality attribute - flowering duration (48.60 to 33.56 days), stem length (53.32 to 32.55 cm), flower diameter (5.72 to 4.69 cm), individual flower weight (3.73 to 2.88 g), shelf life (5.36 to 4.62 days) and vase life (11.73 to 10.80 days). Among varieties, Bright Orange was consistently superior, combining the earliest flowering (55.25 days to bud initiation) with the longest stems (44.76 cm), largest blooms (5.65 cm), heaviest flowers (3.68 g) and longest vase life (13.54 days), followed by Artic Queen White; Bright White was poorest for all traits. The interaction December x Bright Orange gave the earliest flowering (44.12 days to bud initiation), whereas August x Bright Orange maximised every quality attribute. It is therefore concluded that August planting of Bright Orange is best suited for premium cut-flower production, while December planting of the same variety may be adopted where earliness and a specific market window are the objective.

Keywords: *Chrysanthemum morifolium*, Planting time, Variety, Flowering behaviour, Vase life, Genotype x environment interaction, Northern Dry Zone

Introduction

Chrysanthemum (*Chrysanthemum morifolium* Ramat.), a member of the family Asteraceae, ranks among the most important commercial flower crops of the world and is second only to rose in the global cut-flower trade. In India it is valued both as a loose flower for garlands and religious offerings and as a standard or spray cut flower for bouquets and floral arrangements. Karnataka is one of the leading cut chrysanthemum producing states in the country and the crop occupies a substantial area under both open-field and protected conditions.

Chrysanthemum is a short-day plant in which the transition from the vegetative to the reproductive phase is governed primarily by photoperiod, modified strongly by temperature. Because flower initiation, flower development and post-harvest longevity each respond to a different combination of day length, temperature and radiation, the calendar date on which a crop is established determines the environment the plant experiences at each of these stages and consequently both the time of harvest and the quality of the produce. Manipulating planting date is therefore the simplest and least expensive tool available to the open field grower for programming flowering to coincide with periods of peak market demand.

Varietal response to such manipulation is, however, far from uniform. Genotypes differ in their critical photoperiod, in the duration of their juvenile phase, in vegetative vigour and in inherent post-harvest life, so that a planting date that is optimum for one variety may be unsuitable for another. Identification of the appropriate

ate variety x planting-date combination for a given agro-climatic situation is thus a prerequisite for profitable cultivation.

The Northern Dry Zone of *Karnataka* is characterised by low and erratic rainfall, high summer temperatures and mild winters and reliable information on the flowering behaviour and post-harvest performance of recently introduced chrysanthemum varieties under these conditions is limited. The present study was therefore undertaken with the objectives of

- i. Evaluating five chrysanthemum varieties for flowering and flower-quality attributes
- ii. Determining the influence of five monthly planting dates on these attributes
- iii. Identifying the most productive variety x planting-month combination for the Northern Dry Zone of *Karnataka*.

Materials and Methods

2.1 Experimental site

The investigation was carried out during 2023-24 at the Department of Floriculture and Landscape Architecture, College of Horticulture, Bagalkot located in the Northern Dry Zone of *Karnataka* at 16°46' N latitude, 74°59' E longitude and an altitude of 542 m above mean sea level. The soil of the experimental site was red sandy loam with a pH of 8.21. Weekly meteorological data on maximum and minimum temperature, relative humidity, rainfall and bright sunshine hours were recorded throughout the cropping period at the meteorological observatory of the institute.

2.2 Treatments and experimental design

The experiment was laid out in a Factorial Randomised Block Design (FRBD) with 25 treatment combinations replicated three times. The treatments comprised:

Factor A - Varieties (V): V₁ - Champagne Yellow, V₂ - Artic Queen White, V₃ - Lollipop Pink, V₄ - Bright Orange, V₅ - Bright White.

Factor B - Months of planting (M): M₁ - August, M₂ - September, M₃ - October, M₄ - November, M₅ - December.

Uniform, well-rooted terminal cuttings of each variety were transplanted on the 15th day of each month at a spacing of 30 x 30 cm.

2.3 Observations recorded

Five plants were randomly selected and tagged in each plot for recording observations.

Flowering parameters: Days taken for bud initiation was recorded as the number of days from transplanting to the appearance of the first visible flower bud; days to first flowering as the number of days from transplanting to opening of the first flower; days to 50 per cent flowering as the number of days from transplanting until half the plants in a plot had flowered and duration of flowering as the interval in days between the opening of the first flower and the senescence of the last flower on the tagged plants.

Quality parameters: Stem length (cm) was measured from the base of the cut stem to the base of the flower head at harvest. Flower diameter (cm), length and width of the ray floret (cm) were recorded at the fully open stage using a vernier calliper, ray floret measurements being the mean of five randomly selected florets per flower. Individual flower weight (g) was determined on an electronic balance. Shelf life (days) was recorded as the number of days a harvested flower held under ambient room conditions and vase life (days) as the number of days flowers held in preservative solution retained freshness before the onset of visible wilting or petal browning. Flower colour was determined by matching fully opened ray florets against the Royal Horticultural Society (RHS) Colour Chart and flower type was classified according to the criteria of the National *Chrysanthemum* Society of America.

2.4 Statistical analysis

Data were subjected to analysis of variance appropriate to a factorial randomised block design (Panse *et al.*, 1985) [1]. Treatment means were compared at the 5 per cent level of significance and standard error of mean (S.E.m±) and critical difference (C.D. at 5%) values are presented. Interactions that failed to reach significance are indicated as NS.

Results and Discussion

3.1 Flowering parameters

3.1.1 Days taken for bud initiation

Varieties differed significantly in the time required for visible bud appearance (Table 2). Bright Orange (V₄) initiated buds earliest at 55.25 days, followed by Artic Queen White (V₂) at 56.13 days, whereas Bright White (V₅) was the slowest at 60.06 days. Such genotypic differences arise from variation in critical photoperiod, thermal requirement and endogenous hormonal balance, all of which govern the transition of the shoot apex from the vegetative to the reproductive state (Cockshull, 1985; Kofranek, 1992) [2, 3]. The early-initiating behaviour of Bright Orange indicates a shorter juvenile phase and greater sensitivity to inductive conditions, while the delayed response of Bright White reflects an inherently prolonged vegetative phase.

Planting month exerted a still stronger influence. December planting (M₅) required the fewest days (46.16), followed by November (54.15), while August planting (M₁) was the most delayed at 67.54 days - a difference of more than three weeks. Because chrysanthemum is a short-day species, the progressively shortening photoperiod and declining night temperature of the post-monsoon and winter months favour rapid floral induction (Langton, 1990; Higuchi *et al.*, 2013) [5, 4]. Conversely, the long days and high temperatures prevailing in August promote continued vegetative extension and suppress floral differentiation, thereby postponing bud initiation.

The interaction was significant. December x Bright Orange (M₅V₄) initiated buds in only 44.12 days and was statistically on par with December x Artic Queen White (M₅V₂) at 44.42 days, whereas August x Bright White (M₁V₅) took the longest at 69.95 days. The pattern demonstrates that maximum earliness is obtained when an inherently early genotype is exposed to strongly inductive short-day conditions, while the pairing of a late-responding genotype with non-inductive long days produces the greatest delay.

3.1.2 Days taken for first flowering

The trend for first flowering paralleled that for bud initiation (Table 1). Bright Orange flowered earliest (81.33 days), followed by Artic Queen White (83.21 days), while Bright White was the most delayed (86.06 days). Differences in time to anthesis among genotypes are associated with the rate of assimilate supply to the developing capitulum, the extent of carbohydrate reserve build-up and the responsiveness of the apex to the floral stimulus (Kumar *et al.*, 2017; Patel *et al.*, 2019) [6, 7].

Among planting months, December flowered earliest at 73.03 days, followed by November at 74.95 days, while August planting required 96.53 days - a delay of over three weeks relative to December. The interaction was significant: M₅V₄ flowered in 70.78 days, closely followed by M₅V₂ at 71.38 days, whereas M₁V₅ required 99.93 days. Comparable genotype x season interactions for time to anthesis in chrysanthemum has been reported by Meena *et al.* (2019) [8].

3.1.3 Days taken for 50 per cent flowering

Bright Orange reached 50 per cent flowering earliest (89.57 days), followed by Artic Queen White (92.20 days), while Bright White required the longest period (99.83 days) (Table 2). Earliness and uniformity of flowering are functions of varietal growth rate, carbohydrate accumulation and the synchrony of floral bud development (Higuchi *et al.*, 2013; Dutta *et al.*, 2018) [4, 9].

The effect of planting month was pronounced. December planting attained 50 per cent flowering in 74.13 days as against 113.05 days for

August planting, a difference of nearly 39 days, with November intermediate at 84.57 days. The acceleration under late planting again re-

flects the strongly inductive short photoperiod and cool night temperatures of the winter

Table 1. Days taken for bud initiation and first flowering as influenced by varieties, months of planting and their interaction

Varieties (V)	Days taken for bud initiation (days)						Days taken for first flowering (days)					
	Month (M)						Month (M)					
	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V
V ₁	67.17	61.64	56.66	53.51	45.82	56.96	97.25	90.43	83.23	77.23	72.33	84.09
V ₂	66.77	61.16	56.48	51.82	44.42	56.13	96.15	90.08	82.03	76.43	71.38	83.21
V ₃	69.21	62.33	56.99	53.90	47.45	57.97	98.48	91.11	84.08	78.68	73.28	85.12
V ₄	64.64	59.80	56.01	51.70	44.12	55.25	90.83	87.33	81.98	75.73	70.78	81.33
V ₅	69.95	62.99	58.56	59.85	48.99	60.06	99.93	91.28	95.03	76.68	77.38	86.06
Mean M	67.54	61.58	56.94	54.15	46.16		96.53	90.04	85.27	74.95	73.03	
For comparing the means of			S.Em±		C.D @ 5%		S.Em±			C.D @ 5%		
Varieties (V)			0.33		0.97		0.18			0.52		
Months (M)			0.33		0.97		0.18			0.52		
M X V			0.74		2.18		0.40			1.17		
Varieties (V): Champagne Yellow (V ₁); Artic Queen White (V ₂); Lollipop Pink (V ₃); Bright Orange (V ₄); Bright White (V ₅)												
Months (M): August (M ₁); September (M ₂); October (M ₃); November (M ₄); December (M ₅)												
DAT: Days after transplanting												

months (Langton, 1990) [5], whereas the long days and high temperatures of August favour prolonged vegetative growth and delay floral stimulus perception (Dutta *et al.*, 2018) [9].

The interaction was non-significant, although numerical differences were evident: M₅V₄ reached 50 per cent flowering in 68.19 days and M₅V₂ in 71.89 days, while M₁V₅ required 120.34 days. A comparable non-significant interaction accompanied by consistent numerical trends was reported by Singh *et al.* (2021) [10].

3.1.4 Duration of flowering

Unlike the earliness traits, flowering duration responded in the opposite direction to delayed planting (Table 2). Bright Orange sustained flowering for the longest period (42.48 days), followed by Artic Queen White (41.27 days), while Bright White had the shortest duration (39.74 days). The capacity to sustain bloom is associated with the maintenance of petal turgidity, reduced ethylene sensitivity and continued photosynthate supply during the reproductive phase (Kumar *et al.*, 2015) [11].

August planting recorded the longest flowering span (48.60 days), followed by September (44.08 days), whereas December planting flowered for only 33.56 days. The extended duration under early planting can be ascribed to the favourable temperature, adequate humidity and sufficient radiation prevailing through the flowering period, which reduce physiological stress and delay floral senescence (Bhattacharjee *et al.*, 2003; Sarkar *et al.*, 2016) [12, 13]. The shorter span under December planting is a consequence of low temperature and restricted light availability, which hasten senescence and curtail flower longevity (Kumar *et al.*, 2014) [14].

The interaction was non-significant, but the longest duration was recorded in M₁V₄ (50.46 days), followed by M₁V₂ (49.76 days) and the shortest in M₅V₅ (32.61 days), in agreement with Singh *et al.* (2017) [15].

3.2 Quality parameters

3.2.1 Stem length

Stem length, the single most important criterion for grading cut chrysanthemum, varied significantly with variety, planting month and their interaction (Table 3). Bright Orange produced the longest stems (44.76 cm), followed by Artic Queen White (43.35 cm), while Bright White was shortest (41.70 cm). Stem elongation is governed by varietal growth habit and the efficiency of cell division and elongation within the internodes (Anderson, 2007; Ahmad *et al.*, 2018) [17, 16], the superiority of Bright Orange is consistent with its higher chlorophyll content and consequently greater assimilate supply to stem tissue (Kumar *et al.*, 2016) [18], whereas the compact habit of Bright White limits internodal expansion (Patel *et al.*, 2019) [7].

Planting month had an even larger effect, stem length declining almost linearly from 53.32 cm in August to 32.55 cm in December a reduction of 39 per cent. August-planted crops experience warm temperatures, high radiation and a long photoperiod during the vegetative phase, all of which enhance photosynthesis and promote internodal elongation. In addition, the delayed floral induction under long days permits a longer vegetative phase, so that more nodes are laid down before the apex becomes reproductive. December-planted crops, in contrast, are induced to flower almost immediately, terminating stem extension prematurely.

Table 2. Days taken for 50 per cent flowering and duration of flowering as influenced by varieties, months of planting and their interaction

Varieties (V)	Days taken for 50% flowering (days)						Duration of flowering (days)					
	Month (M)						Month (M)					
	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V
V ₁	112.38	103.85	96.04	84.76	74.66	94.34	48.72	44.55	38.94	38.82	34.32	41.07
V ₂	109.80	102.65	94.19	82.47	71.89	92.20	49.76	44.66	39.80	37.70	34.44	41.27
V ₃	115.82	106.74	98.15	86.34	76.76	96.76	48.12	44.21	38.63	38.40	32.86	40.44
V ₄	106.93	100.69	91.77	80.26	68.19	89.57	50.46	45.48	40.91	40.08	35.47	42.48
V ₅	120.34	110.14	100.52	89.01	79.17	99.83	47.81	42.91	37.69	37.67	32.61	39.74
Mean M	113.05	104.81	96.13	84.57	74.13		48.60	44.08	38.76	38.15	33.56	

(continued on next page)

Varieties (V)	Days taken for 50% flowering (days)						Duration of flowering (days)					
	Month (M)						Month (M)					
	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V
For comparing the means of			S.Em±		C.D @ 5%				S.Em±		C.D @ 5%	
Varieties (V)			0.77		2.26				0.34		1.00	
Months (M)			0.77		2.26				0.34		1.00	
M X V			1.72		NS				0.76		NS	
Varieties (V): Champagne Yellow (V ₁); Artic Queen White (V ₂); Lollipop Pink (V ₃); Bright Orange (V ₄); Bright White (V ₅)												
Months (M): August (M ₁); September (M ₂); October (M ₃); November (M ₄); December (M ₅)												
DAT: Days after transplanting												
NS: Non-significant												

Table 3. Stem length and flower diameter as influenced by varieties, months of planting and their interaction

Varieties (V)	Stem length (cm)						Flower diameter (cm)					
	Month (M)						Month (M)					
	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V
V ₁	52.42	47.57	43.29	37.41	33.42	42.82	5.62	5.46	5.21	5.06	4.74	5.22
V ₂	52.95	48.29	43.69	38.06	33.77	43.35	5.70	5.61	5.42	5.10	4.95	5.35
V ₃	52.40	48.22	43.24	38.10	32.61	42.91	5.39	5.29	5.17	4.92	4.68	5.09
V ₄	56.91	49.28	43.87	39.60	34.13	44.76	6.62	5.69	5.55	5.24	5.16	5.65
V ₅	51.92	48.20	42.02	37.56	28.82	41.70	5.30	5.17	4.87	4.79	3.95	4.81
Mean M	53.32	48.31	43.22	38.14	32.55		5.72	5.44	5.24	5.02	4.69	
For comparing the means of			S.Em±		C.D @ 5%		S.Em±			C.D @ 5%		
Varieties (V)			0.32		0.93		0.05			0.15		
Months (M)			0.32		0.93		0.05			0.15		
M X V			0.70		2.07		0.12			0.34		
Varieties (V): Champagne Yellow (V ₁); Artic Queen White (V ₂); Lollipop Pink (V ₃); Bright Orange (V ₄); Bright White (V ₅)												
Months (M): August (M ₁); September (M ₂); October (M ₃); November (M ₄); December (M ₅)												
DAT: Days after transplanting												

The interaction was significant: M₁V₄ recorded the greatest stem length (56.91 cm), followed by M₁V₂ (52.95 cm), while M₅V₅ recorded the least (28.82 cm). It is noteworthy that only the August and September plantings produced stems exceeding the 45-50 cm generally demanded by the cut-flower trade, a finding of direct commercial relevance.

3.2.2 Flower diameter

Bright Orange produced the largest blooms (5.65 cm), followed by Artic Queen White (5.35 cm) and Champagne Yellow (5.22 cm), while Bright White produced the smallest (4.81 cm). Larger capitula in the superior varieties may be attributed to greater vegetative vigour, higher photosynthetic activity and a stronger capacity to mobilise assimilates towards the developing flower bud. Varietal differences of this kind have been documented by Bhattacharjee *et al.* (2003) [12] and Singh *et al.* (2015) [19].

Flower diameter decreased consistently with delayed planting, from 5.72 cm in August to 4.69 cm in December. August planting coincided with optimum temperature, adequate sunshine and a favourable photoperiod, conditions that enhance photosynthesis and increase carbohydrate availability for floral development, whereas the low temperature and reduced light intensity of December restricted growth and limited assimilate supply to the capitulum (Cockshull, 1985; Sirohi *et al.*, 2017) [2, 20].

The interaction was significant, the maximum diameter being recorded in M₁V₄ (6.62 cm), followed by M₁V₂ (5.70 cm) and the minimum in M₅V₅ (3.95 cm). Similar interaction effects have been reported by Rathod *et al.* (2011) [21].

3.2.3 Length and width of the ray floret

Ray floret dimensions, which determine the fullness and visual appeal of the bloom, followed the same pattern as flower diameter (Table 4). Bright Orange recorded the longest (2.97 cm) and widest (1.43 cm)

ray florets, followed by Artic Queen White (2.81 and 1.33 cm), while Bright White recorded the smallest florets (2.45 and 1.18 cm). Floret expansion depends on the extent of cell division and cell enlargement in floral tissue and on the deposition of structural carbohydrates, processes that are under strong genetic control (Datta *et al.*, 2012; Kumar *et al.*, 2016; Datta, 2010; Singh *et al.*, 2013) [22, 23, 18, 24].

August planting produced the longest (2.92 cm) and widest (1.43 cm) florets and December the smallest (2.55 and 1.16 cm). Elongation of floral organs is mediated largely by gibberellins, whose activity increases under the moderate temperature and higher radiation of the early plantings, whereas low winter temperature suppresses hormonal activity and metabolic rate (Nair *et al.*, 2003; Pandey *et al.*, 2018; Sharma *et al.*, 2015; Patil *et al.*, 2019) [25, 26, 27, 28].

Both interactions were significant, M₁V₄ recording the maximum floret length (3.50 cm) and width (1.67 cm), followed by M₁V₂ (2.95 and 1.43 cm) and M₅V₅ the minimum (2.13 and 0.97 cm), in accordance with Singh *et al.* (2014) [29] and Kumar *et al.* (2017) [6].

3.2.4 Individual flower weight

Bright Orange recorded the heaviest individual flowers (3.68 g), statistically on par with Artic Queen White (3.61 g), while Bright White recorded the lightest (2.63 g) (Table 5). Flower weight is a composite expression of petal thickness, floret number and the accumulation of carbohydrates and structural material in floral tissue; the poorer performance of Bright White indicates weaker sink strength and less efficient channelling of photosynthates to the capitulum (Arora *et al.*, 2011; Sarkar *et al.*, 2016) [30, 13].

Flower weight declined from 3.73 g under August planting to 2.88 g under December planting. The heavier flowers from early plantings are a direct consequence of the longer vegetative phase available before floral induction, which permits greater accumulation of reserves subsequently remobilised to the developing flower, reinforced by the

higher photosynthetic activity of the period (Choudhary *et al.*, 2014; Meena *et al.*, 2019) [31, 8].

The interaction was significant: M₁V₄ recorded the maximum (3.96 g), on par with M₁V₂ (3.90 g) and M₁V₁ (3.90 g), while M₅V₅

recorded the minimum (2.11 g), a trend also reported by Patel *et al.* (2017) [32].

Table 4. Length and width of the ray floret as influenced by varieties, months of planting and their interaction

Varieties (V)	Length of the ray floret (cm)						Width of the ray floret (cm)					
	Month (M)						Month (M)					
	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V
V ₁	2.81	2.80	2.74	2.70	2.62	2.73	1.36	1.34	1.29	1.24	1.15	1.27
V ₂	2.95	2.86	2.73	2.80	2.69	2.81	1.43	1.42	1.33	1.28	1.20	1.33
V ₃	2.78	2.73	2.67	2.61	2.54	2.66	1.36	1.33	1.28	1.19	1.15	1.26
V ₄	3.50	2.93	2.89	2.81	2.75	2.97	1.67	1.41	1.39	1.35	1.33	1.43
V ₅	2.58	2.57	2.53	2.45	2.13	2.45	1.36	1.28	1.19	1.13	0.97	1.18
Mean M	2.92	2.78	2.71	2.67	2.55		1.43	1.35	1.29	1.24	1.16	
For comparing the means of			S.Em±		C.D @ 5%		S.Em±			C.D @ 5%		
Varieties (V)			0.03		0.10		0.01			0.04		
Months (M)			0.03		0.10		0.01			0.04		
M X V			0.08		0.22		0.03			0.08		
Varieties (V): Champagne Yellow (V ₁); Artic Queen White (V ₂); Lollipop Pink (V ₃); Bright Orange (V ₄); Bright White (V ₅)												
Months (M): August (M ₁); September (M ₂); October (M ₃); November (M ₄); December (M ₅)												
DAT: Days after transplanting												

Table 5. Individual flower weight, shelf life and vase life as influenced by varieties, months of planting and their interaction

Varieties (V)	Individual flower weight (g)						Shelf life (days)						Vase life (days)					
	Month (M)						Month (M)						Month (M)					
	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V	M ₁	M ₂	M ₃	M ₄	M ₅	Mean V
V ₁	3.90	3.53	2.69	3.19	3.27	3.31	5.50	5.21	4.73	4.49	4.73	4.93	11.32	10.56	10.11	9.45	9.67	10.22
V ₂	3.94	3.62	3.77	3.32	3.40	3.61	6.56	4.48	5.78	5.37	5.48	5.53	13.85	12.43	12.32	11.48	11.97	12.41
V ₃	3.73	3.50	2.72	2.93	2.20	3.02	4.24	3.46	4.52	4.19	4.32	4.14	9.65	10.05	10.66	10.92	9.61	10.18
V ₄	3.96	3.71	3.93	3.37	3.42	3.68	6.72	6.20	5.31	5.66	5.35	5.85	14.30	13.45	13.28	13.30	13.37	13.54
V ₅	3.13	2.38	2.69	2.86	2.11	2.63	3.78	4.76	3.26	3.69	3.25	3.74	9.53	9.60	9.37	9.67	9.36	9.50
Mean M	3.73	3.35	3.16	3.13	2.88		5.36	4.82	4.71	4.68	4.62		11.73	11.22	11.15	10.96	10.80	
For comparing the means of			S.Em±		C.D @ 5%		S.Em±			C.D @ 5%			S.Em±			C.D @ 5%		
Varieties (V)			0.03		0.10		0.04			0.12			0.11			0.31		
Months (M)			0.03		0.10		0.04			0.12			0.11			0.31		
M X V			0.08		0.23		0.09			0.26			0.24			0.70		
Varieties (V): Champagne Yellow (V ₁); Artic Queen White (V ₂); Lollipop Pink (V ₃); Bright Orange (V ₄); Bright White (V ₅)																		
Months (M): August (M ₁); September (M ₂); October (M ₃); November (M ₄); December (M ₅)																		
DAT: Days after transplanting																		

3.2.5 Shelf life

Shelf life is the primary determinant of marketability for loose flowers and both main effects and the interaction were significant (Table 5). Bright Orange retained acceptable quality longest (5.85 days), followed by Artic Queen White (5.53 days), while Bright White deteriorated fastest (3.74 days). Extended shelf life in the superior varieties may be ascribed to slower respiration, better membrane stability, delayed senescence and reduced transpirational water loss, aided by thicker petals and firmer floral tissue (Nowak *et al.*, 1990; Mayak *et al.*, 2001) [34, 33].

August planting gave the longest shelf life (5.36 days) and December the shortest (4.62 days). The higher carbohydrate status of flowers produced under the favourable conditions of early planting delays post-harvest senescence, whereas the low-temperature, low-radiation environment of December planting yields flowers with depleted reserves that deteriorate more rapidly (Halevy *et al.*, 1981; Bhattacharjee *et al.*, 2003) [35, 12]. It is noteworthy that the range

across planting months (0.74 days) was considerably narrower than the range across varieties (2.11 days), indicating that shelf life in this study was under stronger genetic than environmental control.

The interaction was significant, M₁V₄ recording 6.72 days, on par with M₁V₂ at 6.56 days and M₅V₅ the least at 3.25 days (Singh *et al.*, 2014) [29].

3.2.6 Vase life

Vase life, the decisive quality criterion for cut flowers, was significantly influenced by variety, planting month and their interaction (Table 5). Bright Orange remained fresh longest (13.54 days), followed by Artic Queen White (12.41 days), while Bright White recorded the shortest vase life (9.50 days). Superior vase life is generally associated with efficient water uptake, minimal xylem occlusion and low ethylene evolution, all of which delay senescence, whereas poor water relations, high respiration and rapid tissue degradation shorten it (van Doorn *et al.*, 2008; Patil *et al.*, 2014) [37, 36].

August planting produced flowers with the longest vase life (11.73 days), followed by September (11.22 days), while December planting gave the shortest (10.80 days). Flowers developing under favourable temperature and light accumulate greater carbohydrate reserves, which serve as respiratory substrate during the post-harvest period and maintain turgidity for longer (Dole *et al.*, 2005; Singh *et al.*, 2017) [38, 15]. As with shelf life, the varietal range (4.04 days) greatly exceeded the range attributable to planting month (0.93 days), confirming that post-harvest longevity in chrysanthemum is predominantly a genotypic attribute that planting date can modulate but not override.

The interaction was significant, with M₁V₄ recording the maximum vase life (14.30 days), followed by M₁V₂ (13.85 days) and M₅V₅ the minimum (9.36 days), consistent with the findings of Sacalis (1993) [39] and Yadav *et al.* (2015) [40].

3.2.7 Flower colour and flower type

Flower colour is the principal consumer-appeal character and largely determines market preference and price. Matching of fully opened ray florets against the RHS Colour Chart placed Champagne Yellow in the Yellow group (code 7), Artic Queen White and Bright White in the White group (code N155), Lollipop Pink in the Red-Purple group (code 73) and Bright Orange in the Yellow-Orange group (code 21) (Table 6). Flower colour is determined by the genetically controlled biosynthesis of carotenoid and anthocyanin pigments, expressed within the prevailing environment. The RHS chart has similarly been employed for colour characterisation in chrysanthemum by Beeralingappa (2016) [41].

Classification according to the criteria of the National Chrysanthemum Society of America placed all five varieties in the decorative group, a bloom type well suited to both cut-flower and loose-flower markets. Comparable classifications were reported by Patil *et al.* (2017) [42].

Table 6. Flower type and flower colour (RHS colour group with code) of the chrysanthemum varieties

Variety	Flower type	Flower colour (RHS group and code)
Champagne Yellow (V ₁)	Decorative	Yellow (7)
Artic Queen White (V ₂)	Decorative	White (N155)
Lollipop Pink (V ₃)	Decorative	Red-Purple (73)
Bright Orange (V ₄)	Decorative	Yellow-Orange (21)
Bright White (V ₅)	Decorative	White (N155)

Discussion

The results reveal a clear and commercially important trade-off between earliness and quality. Every trait associated with rapidity of flowering improved as planting was delayed from August to December, while every trait associated with flower quality and post-harvest life deteriorated over the same sequence. Both responses have a common physiological basis. *Chrysanthemum* being a short-day species, the long photoperiod and high temperature prevailing after an August planting delay the perception of the floral stimulus; the crop consequently remains vegetative for a longer period, produces more nodes, accumulates more dry matter and enters the reproductive phase with a substantially larger assimilate reserve. The outcome is a late but heavy, long-stemmed, large-flowered and long-lasting crop. A December planting encounters inductive short days almost immediately, so that floral initiation truncates vegetative growth before an adequate source has been established; the crop flowers rapidly but pro-

duces short stems, small blooms and flowers with limited post-harvest life.

The practical implication is that the choice of planting date must follow the intended market. Where the produce is destined for the premium cut-flower trade, in which stem length and vase life determine grade and price, August planting is clearly indicated. Where the objective is an early harvest to capture a specific festival or off-season window, or where the produce is destined for the loose-flower market in which stem length is irrelevant, the later plantings offer a legitimate alternative. A staggered planting programme spanning August to December would extend the harvest window across several months while permitting the grower to match product specification to market segment.

Across both factors, Bright Orange was unambiguously the best-performing variety, ranking first for all fourteen characters studied, with Artic Queen White a consistent second and Bright White uniformly poorest. Because Bright Orange combined the earliest flowering with the highest quality, it did not exhibit the earliness-quality trade-off seen across planting dates, indicating that the two attributes are not inherently antagonistic at the genotypic level and can be combined through selection. The consistency of varietal ranking across all five planting dates further indicates that the significant interactions detected were largely non-crossover in nature, reflecting differences in the magnitude rather than the direction of response. This is a practically valuable finding, since it means that a single variety recommendation holds across the entire planting window for the Northern Dry Zone.

Conclusion

Under the conditions of the Northern Dry Zone of Karnataka, both variety and month of planting exerted a highly significant influence on the flowering behaviour, flower quality and post-harvest life of chrysanthemum and their interaction was significant for most characters. Delaying planting from August to December advanced flowering substantially but depressed every quality attribute, establishing a clear trade-off between earliness and quality. The variety Bright Orange was superior for all the characters studied, followed by Artic Queen White, while Bright White was consistently the poorest.

For commercial cut-flower production, where stem length, flower size and vase life determine price, planting of Bright Orange during August is recommended, this combination having recorded the maximum stem length (56.91 cm), flower diameter (6.62 cm), individual flower weight (3.96 g), shelf life (6.72 days) and vase life (14.30 days). Where earliness is the primary objective, December planting of the same variety may be adopted, having flowered in 70.78 days. A staggered planting schedule from August to December, using Bright Orange or Artic Queen White, would allow growers of the region to extend the harvest period and supply both the premium cut-flower and the loose-flower markets.

References

1. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers, 4th edn. ICAR, New Delhi; 1985.
2. Cockshull KE. *Chrysanthemum morifolium*. In: CRC Handbook of Flowering, Vol. II (Halevy AH, ed.), CRC Press, Boca Raton; 1985:238–257.
3. Kofranek AM. Cut chrysanthemums. In: Introduction to Floriculture, 2nd edn (Larson RA, ed.), Academic Press, San Diego; 1992:3–42.
4. Higuchi Y, Narumi T, Oda A, Nakano Y, Sumitomo K, Fukai S, Hisamatsu T. The gated induction system of a systemic floral inhibitor, antiflorigen, determines obligate short-day flowering in chrysanthemums. *Proceedings of the National Academy of Sciences USA*. 2013;110(42):17137–17142.
5. Langton FA. Interrupted lighting of chrysanthemums: Monitoring of average daily light integral as an aid to timing. *Scientia Horticulturae*. 1990;41(3):247–257.

6. Kumar S, Yadav LP. Genotype x environment interaction for floral traits in chrysanthemum. *International Journal of Current Microbiology and Applied Sciences*. 2017;6(9):1123–1131.
7. Patel NL, Rao S. Varietal evaluation of chrysanthemum for vegetative and floral characters. *Indian Journal of Horticulture*. 2019;76(1):142–147.
8. Meena R, Sharma P, Gupta A. Response of chrysanthemum cultivars to different dates of planting. *International Journal of Chemical Studies*. 2019;7(4):1789–1793.
9. Dutta S, Roy RK, Ghosh S. Influence of planting date on flowering synchrony in chrysanthemum. *Journal of Horticultural Sciences*. 2018;13(2):210–215.
10. Singh R, Sharma P, Kumar A. Effect of date of transplanting on flowering behaviour of chrysanthemum cultivars. *International Journal of Chemical Studies*. 2021;9(2):1123–1128.
11. Kumar S, Singh R, Verma P. Physiological basis of flower longevity in chrysanthemum cultivars. *Journal of Applied Horticulture*. 2015;17(2):134–139.
12. Bhattacharjee SK, De LC. *Post-harvest Technology of Flowers and Ornamental Plants*. Pointer Publishers, Jaipur, India; 2003.
13. Sarkar MM, Ghosh D, Roy S. Assimilate partitioning and flower weight in chrysanthemum cultivars. *Journal of Crop and Weed*. 2016;12(2):98–103.
14. Kumar R, Singh AK. Effect of season on flowering duration and flower longevity in chrysanthemum. *Indian Journal of Horticulture*. 2014;71(4):545–549.
15. Singh KP, Kumar S, Mishra R. Influence of planting time on post-harvest life of chrysanthemum. *Journal of Ornamental Horticulture*. 2017;20(1):55–60.
16. Ahmad I, Rafiq M, Saleem M. Varietal variation in vegetative growth and stem quality of chrysanthemum. *Journal of Ornamental Horticulture*. 2018;21(3):145–152.
17. Anderson NO. *Flower Breeding and Genetics: Issues, Challenges and Opportunities for the 21st Century*. Springer, Dordrecht; 2007:389–437.
18. Kumar S, Singh R, Meena R. Evaluation of chrysanthemum cultivars for growth and flower quality. *Progressive Horticulture*. 2016;48(2):201–206.
19. Singh D, Kumar R, Yadav S. Evaluation of chrysanthemum cultivars for flower size and yield. *International Journal of Farm Sciences*. 2015;5(3):130–136.
20. Sirohi PS, Kumar N, Sharma T. Effect of time of planting on flower quality in chrysanthemum. *Indian Journal of Horticulture*. 2017;74(2):265–269.
21. Rathod SD, Chavan S, Patil V. Interaction effect of cultivar and planting time on flower quality in chrysanthemum. *Journal of Ornamental Horticulture*. 2011;14(3):210–214.
22. Datta SK. Role of classical mutagenesis in development of new ornamental varieties. In: *Mutation Breeding, Genetic Diversity and Crop Adaptation to Climate Change*. CABI, Wallingford; 2010:300–308.
23. Datta SK, Gupta MN. Varietal characterisation of chrysanthemum on the basis of floral traits. *Journal of Ornamental Horticulture*. 2012;15(1):22–28.
24. Singh AK, Rao TM. Genetic variability for floral traits in chrysanthemum. *Journal of Ornamental Horticulture*. 2013;16(1):45–50.
25. Nair SA, Sivasamy N, Attri BL. Effect of planting date on growth and flowering of chrysanthemum. *Journal of Ornamental Horticulture*. 2003;6(4):372–374.
26. Pandey SK, Verma R, Singh N. Influence of season on floral characters of chrysanthemum. *Journal of Pharmacognosy and Phytochemistry*. 2018;7(3):1456–1460.
27. Sharma P, Singh A, Verma S. Seasonal variation in floret dimensions of chrysanthemum. *Progressive Horticulture*. 2015;47(2):288–292.
28. Patil SS, Kumar R, Sharma A. Effect of planting season on floret characters of chrysanthemum. *International Journal of Current Microbiology and Applied Sciences*. 2019;8(6):2210–2216.
29. Singh AK, Arora JS. Variety x season interaction for flower quality and shelf life in chrysanthemum. *Indian Journal of Horticulture*. 2014;71(3):398–403.
30. Arora JS, Khanna K. Studies on flower weight and yield attributes in chrysanthemum cultivars. *Indian Journal of Horticulture*. 2011;68(2):232–236.
31. Choudhary M, Kumar S, Sharma P. Effect of planting time on growth and flowering of chrysanthemum. *Progressive Horticulture*. 2014;46(1):78–82.
32. Patel NL, Desai KD. Effect of date of planting on yield attributes of chrysanthemum. *Journal of Horticultural Sciences*. 2017;12(1):88–92.
33. Mayak S, Halevy AH. Flower senescence. In: *Senescence and Aging in Plants*. Academic Press, New York; 2001:131–156.
34. Nowak J, Rudnicki RM. *Postharvest Handling and Storage of Cut Flowers, Florist Greens and Potted Plants*. Timber Press, Portland, Oregon; 1990.
35. Halevy AH, Mayak S. Senescence and post-harvest physiology of cut flowers, Part 2. *Horticultural Reviews*. 1981;3:59–143.
36. Patil SS, Kulkarni BS, Seetharamu GK. Evaluation of chrysanthemum genotypes for vase life. *Journal of Horticultural Sciences*. 2014;9(2):178–182.
37. van Doorn WG, Woltering EJ. Physiology and molecular biology of petal senescence. *Journal of Experimental Botany*. 2008;59(3):453–480.
38. Dole JM, Wilkins HF. *Floriculture: Principles and Species*, 2nd edn. Pearson Prentice Hall, New Jersey; 2005.
39. Sacalis JN. *Cut Flowers: Prolonging Freshness*, 2nd edn. Ball Publishing, Batavia, Illinois; 1993.
40. Yadav LP, Kumar S, Meena R. Post-harvest quality of cut flowers as influenced by cultivar and growing season. *Journal of Applied Horticulture*. 2015;17(3):220–225.
41. Beeralingappa K. Evaluation of chrysanthemum (*Dendranthema grandiflora* Tzvelev) genotypes for growth, yield and quality parameters. M.Sc. (Hort.) Thesis, University of Horticultural Sciences, Bagalkot, Karnataka, India; 2016.
42. Patil SS, Kulkarni BS, Seetharamu GK. Characterisation of chrysanthemum genotypes based on flower type and colour. *Journal of Pharmacognosy and Phytochemistry*. 2017;6(5):1240–1244.
43. Hiscox JD, Israelstam GF. A method for the extraction of chlorophyll from leaf tissue without maceration. *Canadian Journal of Botany*. 1979;57(12):1332–1334.
44. Sharma G, Chaudhary R. Photoperiod and temperature effects on flowering of chrysanthemum. *Journal of Applied Horticulture*. 2021;23(1):45–50.
45. Verma S, Kumar A, Singh P. Flowering behaviour of late-flowering chrysanthemum genotypes. *Journal of Pharmacognosy and Phytochemistry*. 2020;9(4):1780–1784.

How to cite this article: Padasalagi H, Patil SR, Jeevanagi AS, Tirki S, L M L, Saravanan N. Influence of planting time and variety on flowering behaviour, flower quality and post-harvest life of cut *Chrysanthemum* (*Chrysanthemum morifolium* Ramat.) under the Northern Dry Zone of Karnataka. *International Journal of Research in Agronomy*. 2026;9(9):934-940. doi: <https://www.doi.org/10.33545/2618060X.2026.v9.i9m.6623>