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## Influence of photoperiod manipulation on performance of potted chrysanthemum (*Dendranthema grandiflora* Tzevelev.) cultivars

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### Abstract

An experiment was conducted to investigate the effect of photoperiod manipulation on growth, flowering and quality performance of potted chrysanthemum cultivars. The treatments include three levels of photoperiodic modules and seven varieties. Among the photoperiodic modules initiated after attaining standard growth size (4-5 weeks after planting) across the varieties, maximum vegetative growth, delayed flowering and better flower quality were recorded in photoperiodic module P<sub>1</sub> (12 h dark, 12 h light). While, minimum vegetative growth, early flowering and less quality flowers were obtained in photoperiodic module of P<sub>3</sub> (16 h dark, 8 h light). Photoperiodic module of P<sub>2</sub> (14 h dark, 10 h light) was on par with some vegetative and flowering attributes. Among the cultivars, the vegetative growth, flowering and flower quality characters differed significantly. Among the cultivars, minimum plant spread and smaller flower were reported in cv. Pink Deco, while cv. Yellow Decorative and cv. Red Deco Spoon produced maximum plant spread which are the desired characters for potted plants.

**Keywords:** Photoperiod, long day, short day, cultivars, potted chrysanthemum

### Introduction

Chrysanthemum is a leading commercial flower crop grown for production of cut flowers, loose flowers and potted plants. It is commonly known as 'Queen of East', 'Autumn Queen' and 'Guldaudi' which ranks second in the International cut flower trade. Chrysanthemums have been successfully bred into a wide variety of colors, shapes, and textures, making them the flower of choice for the mass-market bouquet business (Winogron, 1999) [16]. According to first advance estimates of 2017-18 released by National Horticulture Board, the area under flower cultivation in India was 307.87 thousand hectare with the production of 1805.92 thousand MT of loose flowers and 704.23 thousand MT of cut flowers. Whereas, Area under chrysanthemum cultivation in Karnataka was 52.37 thousand hectare with 238.73 thousand MT of loose flower and 62.31 MT cut flower productions. Flowering of chrysanthemum is very seasonal, generally from August to December due to its short day in nature. It develops flower buds when day length is less and the blooming period is short under traditional cultivation method. For commercial floriculture, programmed blooming is necessary for year round availability of flowers. Flowering in chrysanthemum is controlled by length of day or rather length of light. During long days, chrysanthemum plant forms leaves and it increases its stem length and during short days, flowers are formed in the stem apex and growth in length terminates with the flowers. In natural conditions, chrysanthemum grows and produces leaves during the long days of summer, but in the shorter days of late summer and early fall, flower buds will form and the plant flowers (Prasad and Kumar, 2005) [13]. The present investigation was carried out to find out the suitable photoperiodic module for potted chrysanthemum cultivars and to know the suitable cultivars for potted chrysanthemum production.

### Materials and methods

The experiment was conducted in FRBD (factorial randomized block design) during January 2015, in the naturally ventilated polyhouse at Department of Floriculture and Landscape Architecture, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka. The experiment consisted of three levels of photoperiodic modules (P<sub>1</sub>:12 h dark period 12 h light, P<sub>2</sub>:14 h dark period 10 h light, P<sub>3</sub>:16 h dark period 8 h light ) and seven varieties

(V<sub>1</sub>:Yellow Decorative, V<sub>2</sub>:Yellow Deco, V<sub>3</sub>:Red Daisy, V<sub>4</sub>:Red Deco Spoon, V<sub>5</sub>:Pink Deco, V<sub>6</sub>:White Deco and V<sub>7</sub>: Orange Decorative). There were 21 treatment combinations, each replicated thrice. The 4 inch pots were filled with standard potting mixture and planted the rooted chrysanthemum cuttings. Subsequently, average of each five plants was worked out and recorded the growth, flowering and quality parameters of the potted chrysanthemum cultivars.

## Results and Discussion

### Growth Attributes

The growth attributes *viz.*, plant height, stem girth, plant spread and number of branches were significantly varied among the different photoperiodic modules and cultivars (table 1).

**Table 1:** Effect of photoperiod manipulation on growth attributes of potted chrysanthemum cultivars

Treatment	Plant height (cm)	Stem girth (mm)	Plant spread (cm)	Number of branches per plant
P <sub>1</sub>	29.70	5.79	17.34	5.17
P <sub>2</sub>	28.34	5.76	16.10	5.07
P <sub>3</sub>	25.86	4.93	14.97	4.29
SE. m±	0.80	0.12	0.40	0.12
CD at 5 %	2.37	0.35	1.18	0.36
V <sub>1</sub>	20.19	4.57	14.67	7.00
V <sub>2</sub>	44.87	6.03	16.14	1.00
V <sub>3</sub>	31.56	5.26	17.03	5.28
V <sub>4</sub>	29.66	5.53	18.35	4.50
V <sub>5</sub>	16.38	5.47	16.40	4.11
V <sub>6</sub>	25.16	5.86	14.76	5.94
V <sub>7</sub>	27.93	5.73	15.61	6.06
SE. m±	1.23	0.18	0.61	0.19
CD at 5 %	3.62	0.54	1.81	0.55
P <sub>1</sub> V <sub>1</sub>	20.73	5.30	15.71	7.50
P <sub>1</sub> V <sub>2</sub>	47.12	6.48	17.58	1.00
P <sub>1</sub> V <sub>3</sub>	33.18	5.06	18.00	5.17
P <sub>1</sub> V <sub>4</sub>	30.82	5.57	20.50	5.17
P <sub>1</sub> V <sub>5</sub>	16.31	5.82	16.33	5.00
P <sub>1</sub> V <sub>6</sub>	30.56	6.14	16.17	5.20
P <sub>1</sub> V <sub>7</sub>	29.17	6.13	17.08	5.20
P <sub>2</sub> V <sub>1</sub>	22.17	4.44	14.67	4.37
P <sub>2</sub> V <sub>2</sub>	45.83	6.40	15.88	1.00
P <sub>2</sub> V <sub>3</sub>	31.83	6.33	16.58	5.67
P <sub>2</sub> V <sub>4</sub>	30.00	5.82	18.92	4.33
P <sub>2</sub> V <sub>5</sub>	16.00	5.46	17.92	4.50
P <sub>2</sub> V <sub>6</sub>	24.42	5.77	13.92	6.10
P <sub>2</sub> V <sub>7</sub>	28.12	6.10	14.83	6.17
P <sub>3</sub> V <sub>1</sub>	17.67	3.98	13.90	5.67
P <sub>3</sub> V <sub>2</sub>	41.67	5.21	14.96	1.00
P <sub>3</sub> V <sub>3</sub>	29.67	4.37	16.50	5.00
P <sub>3</sub> V <sub>4</sub>	28.17	5.21	15.63	4.00
P <sub>3</sub> V <sub>5</sub>	16.83	5.13	14.96	2.83
P <sub>3</sub> V <sub>6</sub>	20.50	5.67	13.92	5.17
P <sub>3</sub> V <sub>7</sub>	26.50	4.94	14.92	6.33
SE. m±	2.12	0.32	1.06	0.32
CD at 5 %	6.27	0.94	3.13	0.96

DAP- Days after planting, D-Dark period, L- light after attaining standard growth

P- Photoperiod, V- Cultivar

Significantly maximum (29.70 cm, 5.79 mm, 17.34 cm and 5.17, respectively) plant height, stem girth, plant spread and number of branches were recorded in photoperiodic module P<sub>1</sub> (12 h dark, 12 h light) and it was on par with P<sub>2</sub> (14 h dark, 10 h light) (28.34 cm, 5.76 mm, 16.10 cm and 5.07,

respectively). Whereas minimum (25.86 cm, 4.93 mm, 14.97 cm 4.29, respectively) plant height, stem girth plant spread and number of branches were reported in photoperiodic module of P<sub>3</sub> (16 h dark, 8 h light). The growth and development largely influence on endogenous gibberellin content, which was increased with increase in long day period, while level of growth inhibitors increase with increase in short day (Antably, *et al.*, 1991) [2]. Higuchi *et al.* (2012) [5] suggested that shoot extension in chrysanthemum partially regulated by the blue light stimulated phytochrome. Flowering was not observed in the other treatments except short-day condition. It concludes that light source will affect the flowering.

Among the Cultivars, cv. White Deco produced significantly maximum (44.87 cm and 6.03 mm) plant height and stem girth. Whereas, minimum (16.38 cm) plant height was recorded in cv. Pink Deco and cv. Orange Decorative produced minimum (4.57 mm) stem girth. Cultivar Yellow Decorative recorded maximum plant spread of 18.35 cm which was at par with cv. Red Deco Spoon (17.03 cm). Whereas, minimum plant spread was noticed in cv. Orange Decorative (14.67 cm). Significantly, maximum (7.00) number of branches per plant cv. Orange Decorative. While, it was minimum (1.00) in cv. White Deco. The difference in various growth parameters among the cultivars could be due to the influence of genetical makeup of the cultivars (Mukeshkumar and Chattopadhyay, 2002; Kanamadi and Patil, 1993 in chrysanthemum) [10, 7].

Interaction of photoperiod and cultivars recorded significant variation among the growth parameters. Among the interactions, the photoperiodic module P<sub>1</sub> helped to produce significantly maximum plant height of 47.12 cm in the cv. White Deco (P<sub>1</sub>V<sub>2</sub>), which was on par with P<sub>2</sub>V<sub>2</sub> (45.83 cm) and P<sub>3</sub>V<sub>2</sub> (41.67cm).Whereas, it was minimum (16.31 cm) in P<sub>1</sub>V<sub>5</sub>. P<sub>1</sub>V<sub>2</sub> recorded maximum (6.48 mm) stem girth and minimum (4.37 mm) stem girth was notice in treatment P<sub>3</sub>V<sub>3</sub>. plant spread was maximum (20.50 cm) in P<sub>1</sub>V<sub>4</sub>. Whereas, minimum (13.90 cm) plant spread was noticed in P<sub>3</sub>V<sub>1</sub>. P<sub>2</sub>V<sub>1</sub> produced more number of branches (7.50). Whereas, minimum (1.00 each, respectively) number of branches were noticed in the treatment P<sub>1</sub>V<sub>2</sub>, P<sub>2</sub>V<sub>2</sub> and P<sub>3</sub>V<sub>2</sub>.

### Flowering Attributes

Different photoperiodic modules influenced significantly on flowering attributes, among the different cultivars (table 2). Significantly early (49.29 and 69.79 days, respectively) flower bud initiation and flowering were noticed in photoperiodic module P<sub>3</sub> (16 h dark, 8 h light). Whereas, days to flowering was on par with P<sub>2</sub> (14 h dark, 10 h light) (70.71 days). While, delayed bud initiation and flowering were observed in photoperiodic module P<sub>1</sub> (12 h dark, 12 h light) (54.50 and 71.86 days). Delayed flowering mainly due to photo period exposure might have resulted from interference with carbohydrate and florigen movement to the receptive site. Production of transmissible inhibitor and production a substance which acts antagonistically to the flowering hormone at apex under long day condition (Dutta, 1995) [4] in chrysanthemum. Early bud initiation and early flowering due to short day conditions has been reported by previous workers in chrysanthemum by Cockshull and Kofranek (1992) [3] and Kazaz (2010) [8].

The significantly early (45.33 days and 46.00 days) flower bud initiation and first flowering were noticed in cv. Yellow Decorative and delayed (57.50 days) bud initiation was observed in cv. Pink Deco. Whereas, first flowering was

delayed in the cv. Red Deco Spoon (75.83). The variation in flower bud initiation and flowering was expected among the chrysanthemum cultivars due to the differences in the genetical makeup. Similar variation was also reported previously by Rajashekaran *et al.* (1985) <sup>[14]</sup>, Negi *et al.* (1988) <sup>[11]</sup> and Manohar and Pratap (2006) <sup>[9]</sup>.

Among the interaction of photoperiodic module and cultivars, significantly early (43.00 and 64.00 days, respectively) bud initiation and first flowering was noticed in P<sub>3</sub>V<sub>1</sub>. The delayed

(59.00 days) flower bud initiation was reported in the combination of P<sub>1</sub>V<sub>5</sub> and delayed (77.00 days) first flowering was recorded in P<sub>1</sub>V<sub>3</sub>.

#### Flower quality attributes

The flowering and other quality parameters largely varied among the different potted chrysanthemum cultivars and photoperiodic modules (table 2).

**Table 2:** Effect of photoperiod manipulation on flowering and flower quality attributes of potted chrysanthemum cultivars

Treatment	Days to flower bud initiation	Days to first flowering	Number of flowers/ plant	Flower diameter (cm)	Display life of flower (days)
P <sub>1</sub>	54.50	71.86	28.10	4.96	20.19
P <sub>2</sub>	52.21	70.71	26.12	4.78	18.57
P <sub>3</sub>	49.29	69.79	24.90	4.56	17.07
SE. m±	0.71	0.49	0.35	0.04	0.18
CD at 5 %	2.10	1.44	1.04	0.13	0.53
V <sub>1</sub>	46.00	67.33	30.50	3.86	23.11
V <sub>2</sub>	55.50	72.67	12.94	6.91	18.17
V <sub>3</sub>	52.33	75.83	23.28	4.87	18.44
V <sub>4</sub>	45.33	67.67	32.50	5.87	17.89
V <sub>5</sub>	57.50	70.00	25.78	3.63	16.50
V <sub>6</sub>	57.33	70.83	30.33	3.69	17.06
V <sub>7</sub>	50.00	71.17	31.2	4.57	19.11
SE. m±	1.09	0.74	0.54	0.07	0.27
CD at 5 %	3.20	2.19	1.59	0.20	0.81
P <sub>1</sub> V <sub>1</sub>	50.00	69.00	34.00	3.93	23.83
P <sub>1</sub> V <sub>2</sub>	58.00	74.50	13.83	7.08	18.50
P <sub>1</sub> V <sub>3</sub>	56.50	77.00	24.83	5.27	19.00
P <sub>1</sub> V <sub>4</sub>	47.50	68.50	31.83	6.17	20.33
P <sub>1</sub> V <sub>5</sub>	59.00	69.50	25.67	3.77	18.83
P <sub>1</sub> V <sub>6</sub>	58.00	72.00	33.50	3.85	18.83
P <sub>1</sub> V <sub>7</sub>	52.50	72.50	33.00	4.68	22.00
P <sub>2</sub> V <sub>1</sub>	45.00	69.00	29.33	3.89	22.50
P <sub>2</sub> V <sub>2</sub>	56.00	72.00	13.17	6.87	18.83
P <sub>2</sub> V <sub>3</sub>	53.50	75.50	23.17	5.02	18.17
P <sub>2</sub> V <sub>4</sub>	44.50	67.00	30.50	5.87	18.50
P <sub>2</sub> V <sub>5</sub>	58.50	71.00	26.33	3.67	16.33
P <sub>2</sub> V <sub>6</sub>	57.50	70.50	29.17	3.63	17.33
P <sub>2</sub> V <sub>7</sub>	50.50	70.00	31.17	4.55	18.33
P <sub>3</sub> V <sub>1</sub>	43.00	64.00	28.17	3.77	23.00
P <sub>3</sub> V <sub>2</sub>	52.50	71.50	11.83	6.78	17.17
P <sub>3</sub> V <sub>3</sub>	47.00	75.00	21.83	4.32	18.17
P <sub>3</sub> V <sub>4</sub>	44.00	67.50	29.17	5.58	14.83
P <sub>3</sub> V <sub>5</sub>	55.00	69.50	25.33	3.45	14.33
P <sub>3</sub> V <sub>6</sub>	56.50	70.00	28.33	3.58	15.00
P <sub>3</sub> V <sub>7</sub>	47.00	71.00	29.67	4.47	17.00
SE. m±	1.88	1.28	0.93	0.11	0.47
CD at 5 %	5.55	3.79	2.75	0.34	1.39

DAP- Days after planting, D-Dark period, L- light after attaining standard growth  
P- Photoperiod, V- Cultivar

The flower quality attributes significantly varied among the Different photoperiodic modules (table 2). Significantly maximum (28.10, 4.96 cm and 20.19 days, respectively) number of flowers per plant, flower diameter and more display life of flower were recorded in photoperiodic module P<sub>1</sub> (12 h dark, 12 h light). The minimum (24.90, 4.56 cm and 17.07 days) of number of flowers per plant, flower diameter and more display life of flower were recorded in photoperiodic module P<sub>3</sub> (16 h dark, 8 h light). The flower quality might be attributed by the production of more vegetative growth during the growth period by the longer day condition which is resulted in the production of more photosynthates and carbohydrates. Similar findings were reported by Kahar (2008) <sup>[6]</sup> in chrysanthemum.

Significantly maximum (31.28) number of flowers per plant were noticed in cv. Yellow Decorative, which was on par with cultivars Orange Decorative (30.50), Yellow Decorative (30.50), Red Daisy (30.33) and it was minimum (12.94) in cv. White Deco. The flower diameter in cv. White Deco produced significantly maximum of 6.91 cm, whereas minimum (3.63 cm) flower diameter was observed in the cv. Pink Deco. Among display life, cv. Orange Decorative recorded maximum (23.11 days) display life of flower. Whereas, cv. Pink Deco recorded minimum (16.50 days) display life. These results are in confirmation with Poonam and Ashok (2008) <sup>[12]</sup>, and Savita (2013) <sup>[15]</sup> in chrysanthemum. Maximum (34.00) number of flowers was recorded in the combination of P<sub>1</sub>V<sub>1</sub> (34.00), which was on par with P<sub>1</sub>V<sub>6</sub>

(33.50) and P<sub>1</sub>V<sub>7</sub> (33.00). Whereas, minimum (11.83) number of flowers noticed in P<sub>3</sub>V<sub>2</sub>. The combination of P<sub>1</sub>V<sub>2</sub> produced maximum flower diameter of 7.08 cm, which was on par with P<sub>2</sub>V<sub>2</sub> (6.87 cm). Whereas, it was minimum (3.45 cm) in combination of P<sub>3</sub>V<sub>5</sub>. Combination of P<sub>1</sub>V<sub>1</sub> recorded maximum display life of 23.83 days, which was on par with P<sub>2</sub>V<sub>2</sub> (22.50 days). Whereas, minimum (14.33 days) display life was observed in the combination of P<sub>3</sub>V<sub>5</sub>.

### Conclusion

The best quality potted chrysanthemum was obtained by imposing long day period of P<sub>1</sub> (12 h dark, 12 h light). For getting early flowering the short day condition of P<sub>3</sub> (16 h dark, 8 h light) will be preferably helpful. Among the cultivars, cv. Pink Deco produced minimum plant spread and smaller flower which are the desired characters for potted plants. While, Yellow Decorative and cv. Red Deco Spo on produced maximum plant spread.

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