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Original Research Paper

Effect of photoperiod and chemical retardants on growth and flowering of pot mums (*Dendranthema grandiflora* Ramat)

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ABSTRACT

Potted plants of chrysanthemum varieties namely Arun Kumar and Sweta Singar, were exposed to 8 h light and 16 h darkness and natural photoperiod, and spayed with maleic hydrazide (1000 and 2000 ppm), cycocel (1500 and 3000 ppm) and control (distilled water) in factorial complete block design with three replications. The results revealed that controlled photoperiod of 8 h light and 16 h darkness was found significantly superior over natural photoperiod with regard to minimum internodal length (2.85 cm), days to floral bud initiation (98.88), maximum flowering duration (23.14 days), flowers plant^{-1} (189.50), flower diameter (2.72 cm), fresh weight of flower (1.16 g) and vase life (14.86 days). Among growth retardants, maleic hydrazide (2000 ppm) significantly recorded minimum plant height, maximum branches plant^{-1} (18.85), flowering duration (25.25 days), flower diameter (2.95 cm), flowers per plant^{-1} (194.90) and weight of flower (1.20 g), while, maleic hydrazide (1000 ppm) recorded minimum internodal length (2.65 cm) and maximum vase life (18.00 days). The cv. Arun Kumar under controlled photoperiod recorded minimum internodal length (2.38 cm) and early floral bud initiation (91.04 days), however, maleic hydrazide (2000 ppm) recorded maximum flower diameter (4.05 cm), fresh weight of flower (1.53 g) and vase life (18.50 days). cv. Arun Kumar under controlled photoperiod treated with CCC-3000 ppm showed the best performance in recording the maximum number of flowers plants-1 (138.00) during first fortnight of flowering.

Keywords: Chrysanthemum, growth retardants, photoperiod, pot plant

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflora* Ramat) is a popular flower crop of commercial importance and ranks 3rd (next to rose and carnation) in the international cut flower trade. It has diverse and beautiful range of color shades, shapes and size, making it suitable for every purpose conceivable for a flower crop. It is grown as cut flower, loose flower, potted flowering plants, bedding plant and for exhibitions. In many countries, including the United States and Japan, it is considered as the number one dollar earning flower crop. Among ornamental plants, the demand of chrysanthemum in developed countries is more than 90% (Verma et al., 2014).

The utility and popularity of chrysanthemum has increased immensely with the introduction of the technique of year-round blooming based on scientific research in the field of photoperiodism. In addition, pot mums have become a profitable form of its commercial culture. Plants can be kept short by early exposure to photo-inductive cycles (short days). Such benefits can be obtained by subjecting the plants to artificial short days after it has attained proper growth by controlling photoperiod and by application of growth retardants which are also useful for developing resistance in plants to low temperature injury and delaying senescence leading to increased duration of flowering and flower size. Collectively all the beneficial effects lead to advancement in flowering which can fetch good market at national level at the time when flowers are not available there. Thus, there is a need to produce pot mums earlier than its usual blooming period in addition to prolonging the flowering period which can be accomplished by manipulation of photoperiod and application of growth retardants. Consequently, the present investigation was undertaken to study the influence of photoperiod and growth retardants on growth and flowering of pot mums.

MATERIALS AND METHODS

The investigation was carried out at the experimental farm of the Division of Floriculture and Landscape Architecture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kshmir, Srinagar, Jammu & Kashmir, using clay pots (20 cm) for two commercial cvs. *viz.*, Arun Kumar and Sweta Singar, during 2021-22 in factorial CRD with three replications. Rooted cuttings (1/pot) were planted in pots containing a mixture of soil, sand and FYM in the ratio of 2:1:1 (v/v). Soft pinching was done after 4 to 5 weeks of planting in pots when the plants were 8 to 9 cm tall (about 10-12 leaves). Other operations, like fertilization, irrigation and plant protection measures were properly followed as per the recommendation for the crop. The growth retardants *viz.*, maleic hydrazide (1000 and 2000 ppm), cycocel (1500 and 3000 ppm) and distilled water (control), were sprayed 28 to 32 days after pinching. The photoperiodic treatment was given 10 days after the application of growth retardants when side shoots attained the length of 5 to 8 cm. The plants were transferred to artificial short days (8 h light and 16 h darkness), mini tunnel shaped wooden frames (6.5 x 3.5 m) completely covered with thick dark tarpaulin, were placed over the pots for 16 h daily from 5:00 pm to 9:00 am. Black out covers were continued up to the stage till 60 to 70 per cent flower buds showed color. The artificial short days were provided from mid-August to end of September and rest of the plants were placed under natural photoperiod as control.

For data analysis, factorial CRD with three factors namely photoperiod, cultivar at 2 levels each and growth retardants at 5 levels was adopted and biometric observations on plant growth and flowering were analyzed.

RESULTS AND DISCUSSION

Effect of variety

The cv. Arun Kumar recorded significantly minimum plant height, internodal length (2.66 cm), maximum branches plant^{-1} (22.16) and leaf area plant^{-1} (1774.20 cm^2), minimum days to flower bud initiation (100.26) and full bloom (11.24), extended flowering duration (23.52 days), highest flowers plant^{-1} (189.50), flower diameter (3.63 cm) and vase life (15.16 days) (Fig. 1). The difference in growth and flowering parameters between the cultivars might be due to difference in their genetic make-up. The similar findings were also obtained by Dutta & Gupta (2012) and Singh & Madhu Balla (2018) on response of artificial short days on chrysanthemum varieties.

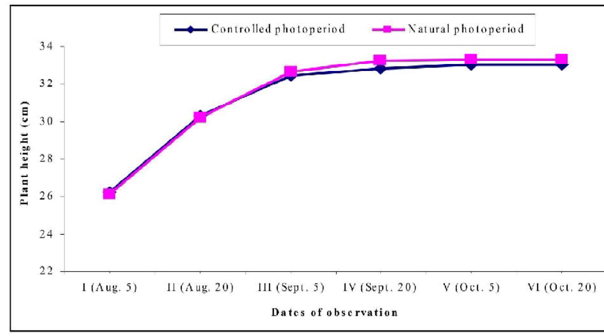

Fig. 1 : Effect of variety on plant height of chrysanthemum at different dates of observation

Effect of photoperiod

The effect of photoperiod on most of the growth parameters was found to be non-significant except intermodal length, which was reduced significantly to 2.85 cm by photoperiod of 8 h light and 16 h darkness in comparison to natural photoperiod (3.05 cm). This could be due to completion of maximum growth stages before the application of short-day treatment. Effect of photoperiod on plant height is presented in Fig. 2.

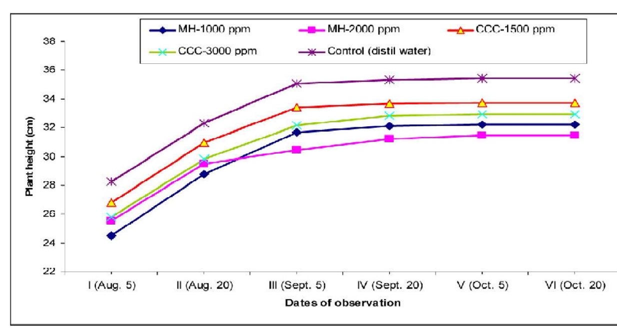

Fig. 2 : Effect of photoperiod on plant height of chrysanthemum at different dates of observation

Significantly minimum days to flower bud initiation (98.88 days) were recorded under controlled photoperiod. The possible reason for such early flower bud initiation may be that plants received shorter day length under controlled photoperiod. According to Singh (2001) the decrease in number of days to flowering was due to early completion of short-day requirement of plants for their initiation. Controlled photoperiod also recorded significantly maximum duration of flowering (23.14 days), flower diameter (2.72 cm), fresh weight (1.16 g/flower) and vase life

Table 1 : Effect of photoperiod and growth retardants on vegetative and floral parameters of chrysanthemum cultivars

Treatment	Inter nodal length (cm)	Branches plant^{-1} (Nos.)	Leaf area/ plant (cm^2)	Days to initial floral bud	Flowering duration (days)	Flowers/ Plant (Nos.)	Flower diameter (cm)	Fresh weight of flower (g)	Vase life (days)
Variety									
Arun Kumar	2.66	22.16	1774.20	100.26	23.52	189.50	3.63	1.46	15.16
Sweta Singar	3.23	12.34	1427.20	112.04	22.38	183.92	1.62	0.82	13.60
LSD 5%	0.15	0.54	49.21	0.53	0.29	0.66	0.04	0.008	0.22
Photoperiod 8 hr light & 16 hr darkness	2.85	17.14	1596.60	98.88	23.14	186.98	2.72	1.16	14.86
Natural photoperiod	3.05	17.36	1604.90	113.42	22.76	186.44	2.53	1.12	13.90
LSD 5%	0.15	NS	NS	0.53	0.29	NS	0.04	0.008	0.22
Growth retardant									
MH 1000 ppm	2.65	17.60	1557.50	107.10	24.10	182.55	2.81	1.17	18.00
MH 2000 ppm	2.82	18.85	1510.40	109.35	25.25	179.30	2.95	1.20	15.00
CCC 1500 ppm	3.09	16.70	1608.80	104.50	21.70	194.90	2.47	1.11	14.00
CCC 3000 ppm	2.86	16.95	1580.90	106.55	22.90	186.45	2.65	1.14	13.00
Control (distilled water)	3.33	16.75	1745.90	103.25	20.80	190.35	2.25	1.08	11.90
LSD 5%	0.23	0.86	77.80	0.84	0.46	1.04	0.06	0.01	0.35

(14.86 days) (Table 1). Extended flowering duration and significant number of flowers under controlled photoperiod could be due to the fact that plants initiated flowering early which extended to a maximum period. Maximum fresh weight under controlled photoperiod might be due to significantly larger size of flowers. Dutta et al., (1998) and Nxumalo & Wahome (2010) also obtained increased weight of flowers due to controlled photoperiod than control in chrysanthemum.

Effect of retardants

During initial growth phase, maleic hydrazide (1000 ppm) and during later phase, maleic hydrazide (2000 ppm) recorded minimum plant height (Fig. 3). Reduction in plant height due to maleic hydrazide is due to suppression of apical dominance completely by inhibiting the cell division on the apical meristem thereby resulting in shorter internodes (Cathey, 1964). Maleic hydrazide (2000 ppm) recorded significantly maximum branches plant^{-1} (18.85). Maleic hydrazide has been shown to be an anti-auxin (Leopold & Klein, 1952). Based on this fact by many workers (Naylor & Davis, 1950; Naylor, 1950) observed loss of apical dominance and increase in lateral breaks in chrysanthemum due to maleic hydrazide.

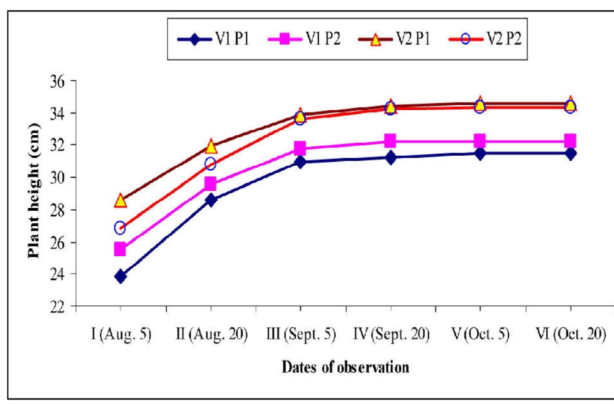

Fig. 3 : Effect of growth retardants on plant height of chrysanthemum at different dates of observation

Minimum days to flower bud initiation (103.25) and full bloom (9.85) was recorded in plants sprayed with distilled water (control). Retardants delay the flowering not by inhibiting stem extension but by interfering with the pattern of endogenous gibberellins (Saikia & Madhumita, 1997). Such delayed flowering with MH is supposed to be due to its inhibitory effect on growth, rather than any specific action against the photoperiodic mechanism (Klein & Leopold, 1953). The maximum duration of flowering (25.25 days) was recorded in plants sprayed with maleic hydrazide (2000 ppm) which was probably due to the reduction in transpiration (Cathey, 1975) and decrease in the production of ethylene (Halevy et al., 1966). Highest number of flowers plant^{-1} (194.90) were recorded in plants sprayed with cycocel (1500 ppm), however, maximum flower diameter (2.95 cm) and fresh weight of flower (1.21 g) was recorded with maleic hydrazide (2000 ppm). According to Sen & Maharana (1971), the increase in flower size due to maleic hydrazide was due to the availability of more carbohydrates during the development of buds. Increased size of flowers resulted in heavier flowers. Similar results were reported by Cathey & Stuart (1961). The maximum vase life (18.00 days) was recorded with maleic hydrazide (1000 ppm).

Effect of interactions

The interactive effect of variety and photoperiod on plant height at initial growth phase was found to be significant and cv. Arun Kumar under controlled photoperiod recorded minimum internodal length (2.38 cm), days to floral bud initiation (91.04) and maximum flowers plant^{-1} (189.72). The maximum number of branches plant^{-1} (22.56) was recorded in cv. Arun Kumar under natural photoperiod. Langtion (1978) reported photoperiodic response on chrysanthemum cultivars and found that cultivars reacted as quantitative short-day plants with flower bud initiation and development occurring more rapidly under short days than in long days.

Table 2 : Interaction effect of variety x photoperiod, variety x growth retardants and photoperiod x growth retardants on floral characters of chrysanthemum

Treatment	Days to initial floral bud	Flowers plant^{-1} (Nos.)	Flower diameter (cm)	Fresh weight of flower (g)	Vase life (days)
Variety x photoperiod					
$V_1 P_1$	91.04	189.28	3.73	1.48	15.64
$V_1 P_2$	109.48	189.72	3.53	1.44	14.68
$V_2 P_1$	106.72	184.68	1.71	0.84	14.08
$V_2 P_2$	117.36	183.16	1.54	0.79	13.12
LSD 5 %	0.75	0.93	NS	NS	NS
Variety x chemical					
$V_1 C_1$	101.80	185.50	3.88	1.50	16.00
$V_1 C_2$	104.00	183.10	4.05	1.53	18.50
$V_1 C_3$	98.30	197.70	3.44	1.44	13.90
$V_1 C_4$	96.70	188.50	3.68	1.47	14.90
$V_1 C_5$	100.50	192.70	3.12	1.38	12.50
$V_2 C_1$	112.40	179.60	1.75	0.84	14.00
$V_2 C_2$	114.70	175.50	1.86	0.86	17.50
$V_2 C_3$	110.70	192.10	1.51	0.79	12.10
$V_2 C_4$	109.80	184.40	1.63	0.82	13.10
$V_2 C_5$	112.60	188.00	1.39	0.77	11.30
LSD 5 %	1.19	1.47	0.09	0.01	0.49
Photoperiod x chemical					
$P_1 C_1$	99.90	182.80	2.94	1.20	15.60
$P_1 C_2$	102.00	179.50	3.06	1.22	18.90
$P_1 C_3$	96.90	195.50	2.56	1.13	13.40
$P_1 C_4$	96.00	186.50	2.76	1.16	14.50
$P_1 C_5$	99.60	190.60	2.30	1.09	11.90
$P_2 C_1$	114.30	182.30	2.69	1.14	14.40
$P_2 C_2$	116.70	179.10	2.85	1.17	17.10
$P_2 C_3$	112.10	194.30	2.39	1.10	12.60
$P_2 C_4$	110.50	186.40	2.55	1.12	13.50
$P_2 C_5$	113.50	190.10	2.21	1.07	11.90
LSD 5%	NS	NS	NS	NS	0.49

V_1=Arun Kumar, V_2 =Sweta Singar, P_1=controlled photoperiod, P_2=natural photoperiod, C_1= maleic hydrazide 1000 ppm, C= maleic hydrazide 2000 ppm, C_3 =cycocel 1500 ppm, C_4 = cycocel 3000 ppm, C_5 =control (distilled water), NS=non-significant

The cv. Arun Kumar sprayed with cycocel (3000 ppm) took minimum days to flower bud initiation (96.70), however, flower yield was recorded maximum (197.70 flowers plant^{-1}) in cv. Arun Kumar sprayed with cycocel (1500 ppm). Maleic hydrazide (2000 ppm) recorded maximum flower diameter (4.05 cm), fresh weight of flower (1.53 g) and vase life (18.50 days). Plants under controlled photoperiod sprayed with maleic hydrazide (2000 ppm) recorded maximum vase life (18.90 days).

Second order interaction results revealed that cv. Arun Kumar under controlled photoperiod treated with Cycocel (3000 ppm) showed the best performance in recording the maximum number of flowers plant^{-1} (138.00) during first fortnight of flowering (Table 3).

Table 3 : Combined effect of variety x photoperiod x growth retardants on number of flowers plant^{-1} during 1st fortnight of flowering in chrysanthemum

Treatment	No. of flowers plant^{-1}
$V_1 P_1 C_1$	125.00
$V_1 P_1 C_2$	119.60
$V_1 P_1 C_3$	131.00
$V_1 P_1 C_4$	138.00
$V_1 C_1 C_5$	104.00
$V_1 P_2 C_1$	108.80
$V_1 P_2 C_2$	104.80
$V_1 P_2 C_3$	114.80
$V_1 P_2 C_4$	120.60
$V_1 P_2 C_5$	99.40
$V_2 P_1 C_1$	116.20
$V_2 P_1 C_2$	111.40
$V_2 P_1 C_3$	121.40
$V_2 P_1 C_4$	128.20
$V_2 P_1 C_5$	104.60
$V_2 P_2 C_1$	110.40
$V_2 P_2 C_2$	105.60
$V_2 P_2 C_3$	113.80
$V_2 P_2 C_4$	118.80
$V_2 P_2 C_5$	99.40
LSD 5%	3.32

V_1=Arun Kumar, V_2=Sweta Singar, P_1=controlled photoperiod, P_2=natural photoperiod, C_1=MH 1000 ppm, C=MH 2000 ppm, C_3=CCC 1500 ppm, C_4=CCC 3000 ppm, C_5=control (distilled water)

CONCLUSION

From the present study, it can be concluded that chrysanthemum cv. Arun Kumar proved best in advancing the flowering, producing more number of heavy flowers with better vase life. Photoperiod of 8 h and 16 h darkness proved superior over natural photoperiod for flower advancement and cycocel (1500 ppm) produced maximum number of flowers/ plant.

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