



Effect of different black-out materials on off-season pot mum production of chrysanthemum (*Dendranthema grandiflora*)

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ABSTRACT

The present investigation on effect of different black-out material(s) on off-season pot mum production of chrysanthemum (*Dendranthema grandiflora* Tzevelev) was carried out at the experimental farm of the Department of Floriculture and Landscape Architecture, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) during 2011. The investigations were conducted on 10 selections/cultivar of chrysanthemum. Off-season flowering was induced by providing artificial short days (16 hr dark period with effect from 5.00 PM to 9.00 AM) starting from 9 June 2011, till 60-70% flower buds showed colour. Artificial short days were provided by three different materials, viz. Tarpaulin, High density polyethylene – White outside and black inside, Black satin cloth. Findings revealed that among different covering materials, HDPE resulted in minimum days for visible flower bud formation in ‘UHFSCChr -43’ (60.67) and maximum diameter of flower in ‘UHFSCChr -68’ (4.22 cm). However, black satin cloth recorded maximum plant height in cultivar ‘Ajay’ (70.00 cm), number of flowers per pot and number of flowers per plant in ‘UHFSCChr -64’ (367.30 and 123.00 respectively). In this experiment, all selections/cultivar tried for off-season pot mum production under different black out materials flowered successfully. Among different black-out materials used, HDPE was best for Solan –Nauni conditions of Himachal Pradesh.

Key words: Black-out material, Chrysanthemum, Flowering, Growth, Off-season

Chrysanthemum (*Dendranthema grandiflora* Tzvelev), popularly known as ‘Guldaudi’ in India and ‘Glory of the East’ or ‘Mum’ in USA, is one among the top cut flowers and pot plants traded in the world. It is native to northern hemisphere, chiefly Europe and Asia and belongs to the family Asteraceae. The varied Indian agro-climatic conditions are highly suitable for its commercial production. In Himachal Pradesh, it is cultivated on an area of 315.31 ha, out of 913.79 ha total area under floriculture in the state (Anonymous 2015-16). Because of varied agro-climatic conditions, its time of planting and flowering in hills is different than the plains. Under mid hill conditions of Himachal Pradesh, it is generally planted in the first fortnight of June and due to nature of flowering under short day conditions, flowers of one or the other cultivar(s) are often seen in the market from October to December months, however, flower availability of particular

commercial cultivar(s) is restricted only to 10-15 days. But as a result of intensive research by scientists and practical experience of many growers, its flowers can be produced throughout the year to precise schedules at any time by environmental manipulation, fertilization, using growth regulating chemicals, by manipulating lighting, different blackout systems, altering day lengths, its blooming time can be controlled accurately and flower can be produced throughout the year. This department of university has already developed year round flower production technology by using artificial and/or natural short/long days under mid hill conditions. Moreover, the flowers produced during off-season fetch more income to the growers. Successful flowering of chrysanthemum, throughout the year, by using thick dark coloured tarpaulin, have been obtained under Nauni, Solan conditions of Himachal Pradesh in selected cultivars by Sita Ram (1991), Pathak (2002) and Usha (2010). Different covering materials like Tarpaulin, high density polyethylene – white outside and black inside, black satin cloth can be used for providing artificial short days (16 hours dark period with effect from 5.00 PM to 9.00 AM). Use of black cloth for the production of early blooms of the chrysanthemum was also reported by Post (1931). Off-season flowers are being produced in chrysanthemum by farmers in Himachal Pradesh using tarpaulin as covering material for providing artificial short

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days under mid hill conditions. Tarpaulin although found effective as covering material for excluding all the light from the plants, but it has to be handled carefully and tears easily. Besides being heavy, several persons are required while covering and uncovering of the plants. It is also costly and hence, not economical from the cost of production point of view. So, for large scale year-round off-season production of chrysanthemum flowers, cost effective and easy to handle covering material are required. Suitability of these covering is different for different places. The generated technology will directly be applicable to the growers of chrysanthemum following which they can supply chrysanthemum to the market through out the year fetching more returns. Also the use of pot plants is increasing among people especially living in cities to decorate their dwellings and surroundings. And there is always a search for new cultivars which are suitable for off-season flowering. Hence, keeping this in view, the present investigation on effect of different black-out material(s) on pot mum production of chrysanthemum was carried out.

MATERIALS AND METHODS

The present study was carried out at the experimental farm of the Department of Floriculture and Landscape Architecture, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2011. The experimental farm of the department is located at an elevation of 1276 m above mean sea level. The climate, in general, is sub-temperate to sub-tropical characterized by mild summer and relatively cool and dry winter. The annual rainfall ranged between 800-1300 mm. The normal monsoon rain in this tract starts from the month of June and continues up to the month of September with pre-monsoon showers starting from mid-May. The present study was conducted by laying out the experiment on 10 selections/cultivar of chrysanthemum in CRD (factorial) with 3 replications. Off season flowering was induced by providing artificial short days (16 hours dark period with effect from 5.00 PM to 9.00 AM) starting from 9 June 2011, till 60-70% flower buds showed colour. Artificial short days were provided by three different material, viz. Tarpaulin, high density polyethylene – White outside and black inside, Black satin cloth. The planting material of these cultivars used for experimentation was raised by using shoot tip cuttings. Shoot tip cuttings of 8-10 cm length were taken from healthy and disease free mother plants. These were dipped in a solution of Dithane M-45 (0.2%) and Bavistin (0.1%) for 30 min. After dipping treatment, basal leaves of each cutting were removed. Then, the cuttings were given a sharp cut just below the basal node. The cut end was then dipped in a solution of NAA (500 ppm) following quick dip method prior to planting for rooting in the sand filled-in beds of propagation chamber. Just after planting, the beds were irrigated thoroughly. Thereafter, cuttings were maintained under intermittent misting till rooting. Rooted cuttings were shifted to shade net house for hardening. The hardened rooted cuttings of uniform size were planted in

pot filled with mixture of sand, soil and FYM (1:1:1). The plants were raised following routine intercultural operations like; watering, weeding, hoeing and control of insect-pest and diseases etc. as per the requirement. The data on various growth and flowering parameters were recorded and subjected to analysis of variance following CRD (factorial) (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

All selections flowered successfully under both controlled as well as natural photoperiodic conditions. In general, covering materials were successful in inducing early bud formation than natural photoperiodic conditions.

Data presented in Table 1 show that, earliest buds were observed in the plants grown under HDPE (64.17 days), followed by plants grown under Tarpaulin (64.57 days). However, maximum number of days for visible flower bud formation was observed in plants growing under natural photoperiod conditions (109.20 days). Among different cultivars, UHF5Chr-43 (62.33 days) took minimum days for visible flower bud formation which was found at par with UHF5Chr-44 (64.42 days) and Ajay (70.42 days). Whereas, maximum days for visible flower bud formation was taken by UHF5Chr 70 (101.50 days) among different selections.

Table 1 Effect of different blackout material on days taken for visible flower bud formation of different selections/cultivar of chrysanthemum

Cultivar	Days taken for visible flower bud formation				
	Black-out treatment				
	Control (Natural photo- period)	Tarpaulin	HDPE*	Black satin cloth	Mean
UHF5Chr 43	64.33	61.00	60.67	63.33	62.33
UHF5Chr 44	66.00	64.00	62.67	65.00	64.42
UHF5Chr 70	128.00	76.00	79.00	123.00	101.50
UHF5Chr 68	124.00	65.00	65.67	122.00	94.17
UHF5Chr 56	126.00	62.33	61.33	96.00	86.42
UHF5Chr 64	124.30	61.33	61.33	98.67	86.42
UHF5Chr 62	119.00	62.33	63.00	99.33	85.92
UHF5Chr 21	128.00	64.00	65.00	123.00	95.00
UHF5Chr 63	126.00	61.00	61.00	119.00	91.75
Ajay	86.00	64.67	66.00	65.00	70.42
Mean	109.20	64.57	64.17	97.43	-
CD _(0.05) for					
Blackout materials			5.67		
Cultivars			8.96		
Blackout materials × cultivars			2.53		

* High density polyethylene – White outside and black inside

Interaction between photoperiod and cultivars revealed that UHF5Chr-43 (60.67 days) took minimum days for visible flower bud formation under HDPE which was at par with selections UHF5Chr-56, UHF5Chr-63 and UHF5Chr-64 under Tarpaulin and HDPE. In contrast, maximum days for visible flower bud formation was observed in UHF5Chr21 and UHF5Chr70 (123.00 days) under black satin cloth. This variation shown by cultivars may be attributed to the difference in the genetic make –up of these selections, in climatic conditions in which different selections were grown and the type of covering material used. As under controlled photoperiodic conditions, selections/cultivars were exposed to 16 hr dark period continuously, which was variable under natural photoperiod. Besides, variation in temperature of natural and controlled photoperiod and different types of covering material used might have played important role in changing the behavior of different selections. Similar variations in growth and flowering parameters were also reported by Larson (1931) and Gloeckner (1985-86) in chrysanthemum.

Data presented in Table 2 show that plant height was more under plants covered with black satin cloth (54.63 cm) followed by natural photoperiod (40.27 cm). In contrast, minimum plant height was observed under HDPE (30.40 cm). Plants grown under HDPE and tarpaulin cover were shorter in height which was in conformity with results

obtained by Post (1931) and Talent *et al.* (1979) who found that, the earlier the plants flowered the shorter was their stems, corresponding to their earliness to flowering. Under natural photoperiod, plants received full light intensities but in controlled photoperiodic conditions light intensities are interrupted by covering materials which results into plants with more height under natural conditions. The plants under black satin cloth cover were the tallest which was in conformity with the findings of Singh *et al.* (2005) who found that, satin cloth is not completely opaque: it allows certain amount of light to pass through it. And plants grown under black satin cloth received more light intensities than other covering material which help in more vegetative growth of the plants. Among different cultivars, Ajay resulted in to maximum plant height followed by UHF5Chr-43 (49.08 cm). Whereas, minimum plant height was obtained in UHF5Chr 44 (28.67). Interaction between photoperiod and cultivars revealed that, Ajay resulted in to maximum plant height (70.00 cm) when grown under black satin cloth followed by UHF5Chr63 (60.67 cm) under black satin cloth. In contrast, minimum plant height was recorded in UHF5Chr-56 (19.00 cm) under HDPE. Variations shown for plant height in the present studies under both photoperiodic conditions may also be attributed to the difference in the genetic make –up of these selections and as plants kept under natural photoperiodic conditions

Table 2 Effect of different blackout materials on plant height (cm) of different selections/cultivar of chrysanthemum

Cultivar	Plant height (cm)				
	Black- out treatment				
	Control (Natural photoperiod)	Tarpaulin	HDPE*	Black Satin Cloth	Mean
UHF5Chr 43	50.00	47.33	41.33	57.67	49.08
UHF5Chr 44	24.33	23.33	29.67	37.33	28.67
UHF5Chr 70	35.33	23.00	31.67	50.67	35.17
UHF5Chr 68	32.00	28.33	23.33	58.33	35.50
UHF5Chr 56	41.33	32.00	19.00	57.67	37.50
UHF5Chr 64	42.33	33.00	30.00	59.67	41.25
UHF5Chr 62	36.67	26.00	27.33	48.00	34.50
UHF5Chr 21	29.00	21.00	19.67	46.33	29.00
UHF5Chr 63	56.17	36.00	39.67	60.67	48.12
Ajay	55.50	43.67	42.33	70.00	52.87
Mean	40.27	31.37	30.40	54.63	-
CD _(0.05) for:					
Blackout materials		1.43			
Cultivars		2.26			
Blackout materials × cultivars		0.49			

* High density polyethylene – White outside and black inside

Table 3 Effect of different blackout materials on number of flowers/pot of different selections/cultivar of chrysanthemum

Cultivar	Number of flowers per pot				
	Black-out treatment				
	Control (Natural photoperiod)	Tarpaulin	HDPE*	Black Satin Cloth	Mean
UHF5Chr 43	74.33	70.67	119.70	57.67	80.50
UHF5Chr 44	160.30	138.00	127.00	132.30	139.40
UHF5Chr 70	135.30	133.00	126.70	190.00	146.20
UHF5Chr 68	293.70	187.00	180.70	194.30	213.90
UHF5Chr 56	202.00	115.70	123.00	264.00	176.20
UHF5Chr 64	205.00	122.00	127.00	367.30	205.30
UHF5Chr 62	349.00	157.70	176.70	228.00	227.80
UHF5Chr 21	242.70	231.70	189.70	125.70	197.40
UHF5Chr 63	191.00	131.30	127.70	173.30	155.80
Ajay	162.00	80.00	111.30	76.00	107.30
Mean	201.50	140.90	136.70	180.90	-
CD _(0.05) for:					
Blackout materials		12.78			
Cultivars		20.20			
Blackout material × cultivars		4.03			

* High density polyethylene – White outside and black inside

were exposed to more number of long days, which might have favoured vegetative growth. This was in conformity with results obtained by Sita Ram (1991).

Data presented in Table 3 shows that number of flowers per pot was more under natural photoperiod (201.50) followed by plants covered with black satin cloth (180.90). In contrast, minimum number of flowers/pot was observed under HDPE (136.70). Among different cultivars, UHF5Chr 62 resulted in to maximum number of flowers per pot (227.80) which was at par with UHF5Chr68 (213.90). Whereas, minimum number of flowers/pot was obtained in UHF5Chr43 (80.50). Interaction between photoperiod and cultivars revealed that, UHF5Chr64 resulted in to maximum number of flowers per pot (367.30) when grown under black satin cloth followed by UHF5Chr62 (349.00) under natural photoperiod. In contrast, minimum number of flowers per pot was recorded in UHF5Chr43 (57.67) under black satin cloth.

Data presented in Table 4 show that number of flowers per plant was more under natural photoperiod (67.17) followed by plants covered with black satin cloth (59.54). The number of flowers per plant and pot was highest in plants under natural photoperiod which was in conformity with the findings of Sangma (2012) and Sulatanpuri (2014) in chrysanthemum.

In contrast, minimum number of flowers per plant was

Table 4 Effect of different blackout materials on number of flowers/plant of different selections/cultivar of chrysanthemum

Cultivar	Number of flowers/plant				
	Black- out treatment				
	Control (Natural photoperiod)	Tarpaulin	HDPE*	Black Satin Cloth	Mean
UHF5Chr 43	24.77	23.53	39.88	19.22	26.85
UHF5Chr 44	53.44	46.00	42.33	44.11	46.47
UHF5Chr 70	45.11	44.33	42.22	63.33	48.74
UHF5Chr 68	97.88	62.33	60.22	64.77	71.30
UHF5Chr 56	67.33	38.55	41.00	80.00	56.72
UHF5Chr 64	68.33	40.66	42.33	123.00	68.58
UHF5Chr 62	116.30	52.55	58.88	76.00	75.94
UHF5Chr 21	80.89	77.22	63.22	41.89	65.80
UHF5Chr 63	63.67	51.39	42.55	57.77	53.84
Ajay	54.00	26.66	37.11	25.33	35.77
Mean	67.17	46.32	46.97	59.54	-
CD _(0.05) for					
Blackout materials	2.01				
Cultivars	4.75				
Blackout materials × cultivars	1.50				

* High density polyethylene – White outside and black inside

Table 5 Effect of different blackout materials on diameter of flower (cm) of different selections/cultivar of chrysanthemum

Cultivar	Diameter of flower (cm)				
	Black- out treatment				
	Control (Natural photoperiod)	Tarpaulin	HDPE*	Black satin cloth	Mean
UHF5Chr 43	3.57	3.63	3.50	3.53	3.56
UHF5Chr 44	3.75	3.73	3.75	3.7	3.73
UHF5Chr 70	3.17	3.77	4.10	3.28	3.58
UHF5Chr 68	4.00	4.18	4.22	4.17	4.14
UHF5Chr 56	2.83	3.13	2.78	2.80	2.89
UHF5Chr 64	2.88	2.82	2.85	2.63	2.80
UHF5Chr 62	1.90	2.30	1.70	2.03	1.98
UHF5Chr 21	3.18	2.33	2.75	3.40	2.92
UHF5Chr 63	3.01	2.78	2.60	2.93	2.83
Ajay	3.33	3.20	3.35	3.33	3.30
Mean	3.16	3.19	3.16	3.18	-
CD _(0.05) for					
Blackout materials	1.02				
Cultivars	1.61				
Blackout materials × cultivars	0.32				

*High density polyethylene – White outside and black inside

observed under Tarpaulin (46.32). Among different cultivars, UHF5Chr62 resulted in to maximum number of flowers per plant (75.94) followed by UHF5Chr68 (71.30). Whereas, minimum number of flowers per plant was obtained in UHF5Chr43 (26.85). Interaction between photoperiod and cultivars revealed that, UHF5Chr64 resulted in to maximum number of flowers per plant (123.00) when grown under black satin cloth followed by UHF5Chr62 (116.30) under natural photoperiod. In contrast, minimum number of flowers per plant was recorded in UHF5Chr43 (19.22) under black satin cloth.

Data presented in Table 5 shows that flower diameter was more under Tarpaulin (3.19 cm) followed by plants covered with black satin cloth (3.18 cm). In contrast, minimum flower diameter was observed under HDPE and natural photoperiod (3.16 cm). Among different cultivars, UHF5Chr68 resulted in maximum flower diameter (4.14 cm) followed by UHF5Chr44 (3.73 cm). Whereas, minimum flower diameter was obtained in UHF5Chr62 (1.98 cm). Interaction between photoperiod and cultivars revealed that, UHF5Chr68 resulted in maximum flower diameter (4.22 cm) when grown under HDPE followed by same selection under Tarpaulin. In contrast, minimum flower diameter was recorded in UHF5Chr 62 (1.70) under HDPE. These results were in conformity with the findings of Sita Ram and Sehgal (1993) and Singh (2001) in chrysanthemum.

It can be concluded that in this experiment all selections/cultivar tried for off –season pot mum production under different black out materials flowered successfully. Among different black-out material used, HDPE best for Solan – Nauni condition of Himachal Pradesh.

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REFERENCES

- Anonymous. 2015-16. Status of floriculture in Himachal Pradesh. Directorate of Horticulture, Shimla, Himachal Pradesh.
- Gloeckner F C. 1985-86. Chrysanthemum manual, New York.
- Gomez L A and Gomez A A. 1984. *Statistical Procedure for Agricultural Research*, 3rd ed, p 680. John Wiley and Sons, Singapore.
- Larson R A. 1931. The effect of three darkening regimes on development of *Chrysanthemum morifolium* Ramat grown during spring. *Swedish Journal of Agriculture Research* **11**(1): 35–9.
- Palmsey S. 2012. ‘Studies on the effect of covering material(s) on off-season cut flower production of chrysanthemum (*Dendranthema grandiflora* Tzvelev)’. M Sc thesis, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh.
- Pathak N. 2002. ‘Screening of chrysanthemum cultivars for year round flower production’. Ph D thesis, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh.
- Post K. 1931. Reducing the day length of chrysanthemum for the production of early blooms by the use of black satin cloth. *Proceedings of the American Society for Horticultural Science* **28**: 382–8.
- Singh K. 2001. Effect of photoperiod on growth and flowering of chrysanthemum. *Journal of Ornamental Horticulture New Series* **4**(1): 63–4.
- Singh R P, Beniwal B S and Joon M S. 2005. Effect of different shade intensities on growth, flowering and yield of chrysanthemum cv. Vasantika. *Crop Research, Hisar* **29**(2): 275–6.
- Sita Ram. 1991. ‘Studies on year round flower production in chrysanthemum’. M Sc thesis, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh.
- Sita Ram and Sehgal O P. 1993. Studies on year round flower production in pot chrysanthemum. I. Effect of controlled photoperiod and growth retardant on vegetative growth. *Journal of Ornamental Horticulture* **1**(2): 21–7.
- Sultanpuri A. 2014. ‘Effect of number of plants per pot, pot spacing and photoperiod on production of potted chrysanthemum (*Dendranthema grandiflora* Tzvelev)’. M Sc thesis, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh.
- Talent C J W, Watkinson A, Langton F A and Cockshull K E. 1979. The effects of periods of short days on early-flowering chrysanthemums grown under glass. *Experimental Horticulture* **31**: 67–4.
- Usha. 2010. ‘Screening of newly evolved selection of chrysanthemum for off season flower production’. M Sc thesis, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh.
- Velmurugan S and Vadivel E. 2003. Effect of photoperiod and paclobutrazol on year round flower production in chrysanthemum. *South Indian Horticulture* **51**(1/6): 51–9.