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Flower regulation in standard chrysanthemum (*Dendranthema grandiflora* Tzvelev) by staggered planting

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ABSTRACT

The present studies were done at the experimental farm of the Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP during 2008. The investigation was carried out on four standard commercial cultivars of chrysanthemum which were planted on different planting dates at an interval of 15 days starting from 9 April to 7 August. Significant differences were observed among the cultivars for all vegetative and floral parameters. Though successful flowering in standard type cultivars included in the studies was obtained in all the planting dates however later plantings resulted in cut stems of shorter length. Hence the optimum planting date for producing marketable cut stems was found to differ with the cultivar which was planted on 8 June in case of Purnima, 24 May in case of White Star and Tata Century and 23 July in case of Yellow Star among standard types. With the help of planting dates flowering could be regulated from 21 September to 25 November.

Keywords: Flower regulation; chrysanthemum; planting dates; flowering

INTRODUCTION

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. In addition its flowers are also used for making garlands, Venis, Gazras and religious offerings. It is native to northern hemisphere chiefly Europe and Asia and belongs to the family Asteraceae. In Himachal Pradesh it is cultivated on an area of 315.31 hectares out of 913.79 hectares total area under floriculture in the state (Anon 2012-13). Light, temperature and relative humidity are the most important limiting factors for its plant growth and development. Adverse effect of these climatic factors may lead to low yields or complete failure of any crop. Hence the effect of date of planting on growth and development of chrysanthemum is very important for its commercial cultivation. Under mid-hill conditions of Himachal Pradesh it is generally planted in the first fortnight of June

and due to its 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. However flower availability of particular commercial cultivar(s) is restricted only to 10-15 days. Preliminary studies have shown that different cultivars of chrysanthemum behave differently for their growth and flowering parameters due to variation in the planting time even though it is a short day plant. Hence keeping these facts in view the possibility of supplying cut flowers of a particular commercial cultivar to the market for longer duration thereby fetching remunerative prices of the produce was explored by staggered planting of four commercial standard cultivars of chrysanthemum.

MATERIAL and METHODS

The present study was carried out at the experimental farm of the Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP. The experimental farm is located at an elevation of 1276 m amsl at latitude of 30°51'0" N and longitude of 77°11'30" E. The annual rainfall ranged between 800-1300 mm. The experiment was laid out on four standard commercial cultivars of chrysanthemum in split-plot design with three replications. The four cultivars were planted on 9 different dates starting from 9 April to 7 August 2008 at 15 days interval. Planting dates were considered as main plot and four standard cultivars namely Purnima, White Star, Yellow Star and Tata Century as sub-plots. The healthy, disease free and hardened rooted cuttings of uniform size were planted in well prepared raised beds in the field. At the time of bed preparation FYM (5 kg/ m^2), full recommended dose of phosphorus (30 g/m^2) and potassium (30 g/m^2) and half dose of nitrogen (15 g/m^2) was also mixed in soil. Remaining half dose of nitrogen (15 g/m^2) was mixed in soil after 45 days of planting. Plants were fertigated fortnightly with a water soluble fertilizer (2 g/l) having N, P and K in the ratio of 19:19:19 by applying 200-500 ml solution per plant starting after pinching that was continued till flowering. The planting was done at a spacing of 30 x 30 cm from plant to plant and row to row. Pinching was done by removing 2-3 cm apical growing portion of the plant after 15-25 days of planting leaving 6-10 leaves below the pinch. The operation of de-shooting was performed continuously by removing all secondary side shoots which originated in the leaf axils. Dis-budding was done by retaining terminal flower bud and removing all the axillary flower buds. The data on various growth and flowering parameters were recorded and subjected to analysis of variance following split-plot design.

RESULTS and DISCUSSION

The results of the findings showed that planting dates had significant influence

on growth and flowering of standard cultivars. In general last planted crop ie 7 August took least time for flowering (99.77 days) whereas 9 April planting took maximum time (171.35 days) for this process to occur (Table 1). Interaction between planting dates and cultivars as well as the average effect showed earliest flowering in cultivar Purnima in all planting except for April and 9 May planting. The cultivars also showed variation with respect to these parameters which may be attributed to their genetic make up as reported by Barman et al (1997) and Kulkarni and Reddy (2010).

In general earliest planted crop (9 April) attained maximum plant height (97.01 cm) which decreased significantly with every 15 days delay in planting till 23 July (Table 1) and non-significant thereafter. This may be attributed to the fact that chrysanthemum is a short day plant and requires sufficient number of long days for vegetative growth which otherwise are reduced due to later planting. The earlier planted crops received more number of longer days for vegetative growth than the later planted crops of those cultivars. Deotale et al (1995) and Meher et al (1999) reported tallest plants in early planted chrysanthemum. Interaction between planting dates and cultivars as well as the average effect showed maximum plant height of Yellow Star in all plantings. Differences in the behaviour of cultivars may be due to their genetic make-up (Mahopatra et al 2000, Pathak 2002) in chrysanthemum.

In general earlier plantings produced longer stem than the late planted crops probably due to the fact that earlier plantings received more number of longer days. The earliest planted crop (9 April) attained maximum stem length (79.45 cm) which decreased significantly with every 15 days delay in planting till 23 July and non-significant thereafter. Interaction between planting dates and cultivars as well as the average effect showed maximum stem length of Yellow Star in all planting dates. Similar results have been reported by Grewal et al (2004) and Li et al (2009).

Because of the differences in the genetic make-up of chrysanthemum cultivars and different dates of planting providing variable number of long days to the crop, variations were also observed in the number of side shoots per plant. It was found that earlier planted crop resulted in more number of side shoots/plant as compared to later planted crop (Table 1). In general 24 April planted crop gave maximum number of side shoots/plant (5.24) followed by other planting dates. Interaction between planting dates and cultivars as well as the average effect showed maximum number of side shoots/ plant in cultivar Tata Century. Similar results have been reported by Mahopatra (2000) and Pathak (2002) in chrysanthemum.

In general earlier planted crop resulted in lesser number of marketable cut flower stems as same shoots forming buds did not develop properly and produced

Table 1. Effect of planting dates on various growth parameters of standard chrysanthemum cultivars

Planting date	Days taken for flowering					Plant height (cm)				
	Purnima	White Star	Yellow Star	Tata Century	Mean	Purnima	White Star	Yellow Star	Tata Century	Mean
9 April	176.25	170.90	171.32	166.99	171.35	86.25	80.66	133.58	87.56	97.01
24 April	161.09	162.40	153.92	155.48	158.22	68.31	72.48	120.22	70.40	82.85
9 May	148.56	147.80	151.28	152.31	150.10	67.58	68.63	113.18	66.22	78.90
24 May	139.71	147.50	150.38	145.09	145.68	55.69	55.55	95.76	51.94	64.73
8 June	124.47	134.80	140.16	129.61	132.27	51.26	48.32	83.54	47.25	57.59
23 June	111.42	125.40	126.07	116.79	119.92	42.02	36.41	70.68	36.83	46.48
8 July	95.00	113.20	118.15	101.88	107.70	42.46	32.75	62.17	33.94	42.83
23 July	91.72	109.80	113.37	100.36	103.81	29.59	32.52	54.86	29.68	36.66
7 August	76.38	107.40	110.45	104.86	99.77	25.73	29.11	54.94	30.13	34.98
Mean	119.96	135.50	136.51	130.37	-	52.10	50.71	87.66	50.44	-

$CD_{0.05}$

	Days taken for flowering	Plant height
Planting dates	1.82	2.90
Cultivars	1.13	2.12
Planting dates x cultivars	3.40	6.36

Table 1. contd….

Planting date	Stem length (cm)					# side shoots/plant				
	Purnima	White Star	Yellow Star	Tata Century	Mean	Purnima	White Star	Yellow Star	Tata Century	Mean
9 April	71.52	63.38	110.9	71.99	79.45	5.88	5.13	3.35	4.57	4.73
24 April	55.22	60.03	93.28	54.35	65.72	5.33	6.12	3.29	6.23	5.24
9 May	56.18	55.99	97.33	57.50	66.75	3.86	4.29	3.65	6.01	4.45
24 May	47.19	41.55	82.26	43.87	53.72	3.12	4.21	3.37	4.25	3.74
8 June	43.80	35.73	74.89	37.62	48.01	4.96	3.42	3.31	3.66	3.84

23 June	32.85	26.24	59.87	27.93	36.72	3.10	2.86	2.72	2.97	2.91
8 July	33.79	24.16	52.33	24.49	33.69	2.40	3.13	3.22	3.05	2.95
23 July	24.27	26.54	43.90	21.27	28.99	2.69	4.47	3.47	4.70	3.72
7 August	18.01	24.56	50.71	25.87	29.79	3.01	4.18	2.64	3.80	3.41
Mean	42.53	39.8	73.94	40.54	-	3.82	4.20	3.22	4.31	-

$CD_{0.05}$

	Stem length	# side shoots
Planting dates	3.55	0.26
Cultivars	1.93	0.15
Planting dates x cultivars	5.81	0.46

Table 1. contd….

Planting date	# marketable cut flower stems/plant					Flower size (cm)				
	Purnima	White Star	Yellow Star	Tata Century	Mean	Purnima	White Star	Yellow Star	Tata Century	Mean
9 April	1.88	2.40	2.27	1.77	2.08	9.45	8.14	10.77	10.62	9.74
24 April	1.20	3.06	1.45	1.29	1.75	10.67	8.12	13.58	10.65	10.74
9 May	1.04	1.84	3.07	1.76	1.93	10.37	8.33	11.34	8.47	9.63
24 May	2.02	3.04	3.31	2.79	2.79	9.91	7.82	12.27	8.39	9.60
8 June	3.62	2.86	3.13	2.51	3.03	9.47	7.88	12.32	7.82	9.37
23 June	2.78	1.74	2.70	2.17	2.35	9.66	9.34	12.08	8.42	9.87
8 July	2.13	2.95	3.22	2.61	2.72	11.31	12.37	12.38	9.45	11.38
23 July	2.65	4.22	3.44	4.60	3.72	10.36	12.40	12.57	9.94	11.32
7 August	3.02	3.94	2.60	3.80	3.34	10.88	12.12	12.23	9.73	11.24
Mean	2.26	2.89	2.80	2.59	-	10.22	9.61	12.17	9.28	-

$CD_{0.05}$

	# marketable cut flower stems	Flower size
Planting dates	0.40	0.48
Cultivars	0.25	0.27
Planting dates x cultivars	0.77	0.83

Table 1. contd….

Planting date	Duration of flowering (days)					Vase life (days)				
	Purnima	White Star	Yellow Star	Tata Century	Mean	Purnima	White Star	Yellow Star	Tata Century	Mean
9 April	27.39	35.35	44.14	41.30	37.04	12.67	13.33	14.00	13.33	13.33
24 April	28.79	33.44	41.65	36.49	35.09	13.00	13.67	13.67	14.33	13.67
9 May	31.09	33.89	37.60	31.33	33.48	13.67	14.00	14.33	15.33	14.33
24 May	33.68	23.83	28.46	28.15	28.53	14.00	14.67	14.33	15.33	14.58
8 June	32.40	22.77	28.78	27.60	27.91	14.33	15.00	14.33	15.67	14.83
23 June	30.92	21.86	25.34	27.91	26.51	14.33	15.33	14.33	15.67	14.92
8 July	29.91	21.10	21.07	29.15	25.31	14.67	15.67	15.67	16.00	15.50
23 July	29.83	15.27	22.76	23.79	22.91	15.33	15.67	15.67	16.67	15.83
7 August	31.54	20.94	22.90	19.33	23.68	16.67	16.33	15.67	16.67	16.33
Mean	30.62	25.38	30.30	29.45	-	14.30	14.67	14.85	15.44	-

$CD_{0.05}$

	Duration of flowering	Vase life
Planting dates	1.12	0.46
Cultivars	0.58	0.59
Planting dates x cultivars	1.76	0.78

Table 1. contd….

Planting date	Weight of cut flower stems (g)				
	Purnima	White Star	Yellow Star	Tata Century	Mean
9 April	84.33	41.00	148.66	36.66	77.66
24 April	73.77	20.55	165.67	25.55	71.39
9 May	34.33	20.55	140.11	17.89	53.22
24 May	29.33	23.58	68.22	15.77	34.22
8 June	26.77	19.22	72.10	15.55	33.41
23 June	50.66	16.66	71.66	17.11	39.02
8 July	60.33	24.61	86.11	24.72	48.94
23 July	38.66	32.66	57.66	24.44	38.35
7 August	29.66	12.53	47.66	8.33	24.54
Mean	47.54	23.48	95.32	20.67	-

$CD_{0.05}$

	Weight of cut flower stems
Planting dates	4.58
Cultivars	2.15
Planting dates x cultivars	6.47

green centres. If buds are selected too early they may develop green centres since the day length is marginal for development. Bud selection at a later date ensures that the days are amply short to promote proper bud development if the minimum temperature is adequate. This may probably be attributed to the fact that earlier plantings resulted in greater plant height, more side shoots and greater stem length as compared to late planting (Table 1). Interaction between planting dates and cultivars as well as the average effect showed maximum number of marketable cut flower stems/plant of cultivar White Star in most of planting dates followed by Yellow Star in remaining planting dates. Similar results were obtained by Meher et al (1999) and Grewal et al (2004). The 8 July planted crop resulted in larger size of flowers (11.38 cm) which was at par with other later planting dates while the size of earlier planted crops was smaller (Table 1). Interaction between planting dates and cultivars as well as the average effect showed maximum flower size of Yellow Star in all planting dates. Later planted crops resulted in larger flower size as compared to earlier ones. Similar results were reported by Anjum et al (2007) and Barman et al (1997).

Earliest planted crop (9 April) resulted in maximum duration of flowering (37.04 days) which decreased significantly with every 15 days delay in planting. This indicates that the temperature at the time of planting (Table 2) played a significant role in flower life on plant. The findings of Barman et al (1997) and Kulkarni and Reddy (2010) also revealed that the

chrysanthemum planted on early dates had the longest flowering season. Among cultivars duration of flowering was greater of White Star, Yellow Star and Tata Century when planted on earlier dates as compared to later plantings. Interaction between planting dates and cultivars as well as the average effect showed maximum duration of flowering of Yellow Star. Vase life of cut stems was observed maximum in later planted crops as compared to earlier planted crops (Table 1). In general later planted crop (7 August) attained maximum vase life (16.33 days) which decreased significantly with each planting date till earliest planted crop. The possibility of lesser vase life of these flowers may be due to the reason that in earlier planted crops the cut stems were of woody nature which might have reduced the water uptake from the vases. Interaction between planting dates and cultivars showed maximum vase life in cultivar Tata Century and Purnima whereas the average effect showed maximum vase life in Tata Century. Differences in the behaviour of cultivars may be due to their genetic make-up as reported by Mahopatra et al (2000) and Pathak (2002) in chrysanthemum.

Earliest planted crop (9 April) resulted in maximum weight of cut flower stem (77.66 g) which decreased significantly with every 15 days delay in planting till 23 July planted crop and non-significant thereafter (Table 1). Interaction between planting dates and cultivars as well as the average effect showed maximum weight of cut flower stem of Yellow Star in all plantings. The higher weight in early plantings may be attributed to increased plant height and number of side shoots/plant. In early plantings growing period was long with more photosynthetic activity resulting

Table 2. Meteorological data during the period of study (2008)

Month	Maximum temperature (%)	Minimum temperature (%)	Mean	RH (%)	Sunshine hours	Rainfall (mm)
January	17.2	2.4	9.8	55.0	4.7	44.1
February	20.0	3.9	11.9	51.0	6.5	31.0
March	27.3	8.9	18.1	38.0	8.3	0.4
April	28.9	12.5	20.7	43.0	8.6	38.4
May	30.0	15.1	22.5	45.0	6.1	95.9
June	28.5	19.3	23.9	79.0	6.2	261.5
July	28.8	20.2	24.5	78.0	6.2	98.7
August	27.9	19.7	23.8	81.0	4.0	248.3
September	27.6	15.8	21.7	73.0	7.4	348.9
October	27.0	10.9	18.5	65.0	8.4	13.5
November	25.2	5.9	15.5	56.0	8.1	5.4
December	23.2	4.0	13.6	51.0	8.1	0.2

in more biomass of plants. Similar results were reported by Anjum et al (2007) and Kulkarni and Reddy (2010). However the results are not consistent particularly in May and June planted crop which may probably be due to lesser number of green leaves on the stem during the period of *Septoria* attack.

CONCLUSION

Successful flowering was observed in all cultivars in all planting dates but the later plantings resulted in cut stems of shorter length. Hence the optimum planting date for producing marketable cut stems was found to differ with the cultivar which was 8 June in Purnima, 24 May in White Star and Tata Century and 23 July in Yellow Star. It showed that with the help of planting dates flowering could be regulated from 21 September to 25 November.

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