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Effect of sowing dates on enhancing the flowering time in chrysanthemum (*Chrysanthemum morifolium*)

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Abstract

The experiment was conducted at Hazara Agriculture Research Station Abbottabad Pakistan during 2010-11 in order to evaluate the impact of various sowing dates on plant height, number of branches, leaves and suckers per plant, leaf area, number days to flowering, number of flowers per plant, flowering period, flower size and fresh weight. The seeds of chrysanthemum var. Fanfare mix were sown on five different dates (20th February, 7th March, 22nd March, 6th April and 21st April) in trays. After a month of each sowing, plants were transplanted individually to 28 cm pots. The sowing dates significantly affected most of the studied variables. Late sowing (21st and 6th April) produced significant results with leaf area (110.0, 106.1 cm^2), days to flowering (160, 181 days) and flower size (5.9 cm) respectively as compared to the rest of sowing dates. On the other hand the plants raised from the seeds sown on 21st and 6th April produced less number of branches per plant (5.2, 5.0), leaves (46, 45), suckers (4.1, 5.2), flowers (12, 14), and had short flowering period (35, 37days) respectively. The early sowing (20th February) performed well with higher number of branches (6.9), produced more number of leaves (74), had maximum flowering period (40 days) as well as maximum number of flowers (24). Sowing on 6th April and 21st April produced early flowering and enhanced the flowering time. Hence sowing on 6th and 21st April produced flowers between 27th September and 4th October, which was earlier than the normal time of flowering. It was concluded that late sowing produced early flowers and prolonged the flowering duration in chrysanthemum.

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Introduction

Chrysanthemum is one of the important cut flowers cultivated throughout the world since ancient times. The flowers have a great potential of export as cut flowers to many countries due to their beauty, and outstanding varietal colours (Erler and Seigmund, 1986). Chrysanthemum is grown as potted plant, bedding plant as well as cut flowers almost all over the world including Pakistan. Cut flowers have largest share in flower trade and chrysanthemum is one of the leading flowers with millions of stems sold in Europe and North America (Bhattacharjee and De, 2003).

In Pakistan, chrysanthemum is among those flowers, which bloom during autumn and can accomplish the demand for cut flower market. There has been an increase in demand of cut flowers in Pakistan particularly in autumn, as growers have to supply flowers to retailers throughout the year. Sowing dates play an important role in the quality production and marketing of chrysanthemum (Balaji *et al.,* 2010).

Experiments have been conducted to find out proper planting times for various cut flowers including Tuberose (Khobragade *et al.*, 1997) and Lily (Gilbertz and Lewis, 1990). Large sized chrysanthemum flowers were recorded by planting in May (Brez and Jerzy, 2004). Late cultivation also causes shortening of growth period and flowering period with high temperature in summer. A study on the other species from *Asteraceae* family has confirmed these results (Jamshidi, 2000). Similarly Adam *et al.* (1998) investigated three sowing dates and found that late sowing (March) produced early flowers in petunia. Comprehensive information on planting dates for growers in Pakistan is very limited, due to which the growers are unable to produce quality chrysanthemum flowers at the specified time. The growers can earn more profits by adjusting the proper sowing date to avoid crop flood in the market. The objectives were focused on to evaluate the effect of different sowing dates on early or late flowering, to enhance flower availability in the market and to assess the suitable sowing date (time).

Materials and methods

The experiment was conducted at Hazara Agriculture Research Station Abbottabad Pakistan during 2010-11 in order to evaluate the impact of various sowing dates on plant height, number of branches, leaves and suckers per plant, leaf area, number days to flowering, number of flowers per plant, flowering period, flower size and fresh weight. The experiment was laid out in completely randomized design with five sowing dates replicated 4 times.

Plant Material

The seeds of chrysanthemum var. Fanfare mix were sown on five different dates in 50 x 40 cm trays with 8 cm depth. One hundred seeds were sown in each tray. Trays were filled with one part of silt and one part of sand. The seeds were irrigated with a spray gun to avoid damage and displacement of seeds. After a month of each sowing, plants were transplanted individually to 28 cm clay pots. The pots were filled with two parts of well rotten leaf mold and one part of silt. Fertilizer NPK was applied at the rate of 1.5 g per pot. Pots were placed in open field. Five pots with single plant were randomly selected from 20 pots for each treatment as a study sample. There were total of 5 treatments (sowing dates) including 20th February, 7th March, 22nd March, 6th April and 21st April.

Data Analysis

The experiment with all same inputs and treatments was repeated in 2011 and average data of both years were analyzed at the end providing year wise detail and interaction between year and fertilizer was calculated using computer statistical software "Statistix 9.0". (www.statistix.com). Statistical significance is given at $p < 0.05$.

Vegetative Characters

The physical traits considered included plant height which was the measure of stem length from the crown to the top of the stem. The number of branches plant^{-1} grown on plant were counted and recoded after the last flower harvested. All the leaves grown on plant were counted and recorded after the last flower harvested. Leaf area was measured with the help of an

automatic Leaf Area meter (Model, Delta- T Devices Ltd., Burwell Bs, UK).

Flowering Characters

The number of days taken to flowering were counted from the date of sowing to the date of flower bud break. All flowers grown on the main stalk and the side branches were counted up to the last flower harvested. For blooming period, number of days from flower bud break till its petal fadding were counted. The flower size was recorded by measuring the diameter of the flower in cm. Full bloomed flowers were excised and weighed on electronic balance individually.

Results and discussions

Vegetative Characteristics

Plant Height (cm)

The data on plant height showed that seed sowing dates in chrysanthemum significantly influenced the plant height, while it was not affected by interactive effect of year and sowing dates (Table 1). The seeds sown on 20th February significantly increased the plant height (88.3 cm) as compared to seeds sown on 21st April that attained the plant height (60.5 cm). There was significant difference among all sowing dates (Table 1).

Table 1. Effect of sowing dates on plant height, number of branches/plant and number of suckers/plant in Chrysanthemum for year 1 (2010) and year 2 (2011).

Sowing date	Plant height (cm)			Number of branches/plant			Number of suckers/plant		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
20 Feb.	91.3 a	85.3 a	88.3 a	7.0 a	6.7 a	6.9 a	6.7 ab	7.3 a	7.0 a
7 March	85.1 b	80.7 ab	83.0 b	6.2 ab	5.9 ab	6.1 b	7.7 a	6.8 b	7.2 a
22 March	80.8 b	76.5 b	78.6 c	5.9 bc	5.3 bc	5.6 bc	5.7 bc	5.5 c	5.6 b
6 April	67.1 c	64.3 c	65.7 d	5.2 c	4.9 c	5.0 c	5.0 cd	5.4 c	5.2 b
21 April	59.3 d	61.8 c	60.5 e	5.4 bc	5.0 bc	5.2 c	3.9 d	4.2 d	4.1 c
LSD	*4.9(**)*	*6.5(**)*	3.9(**)	*0.9(**)*	*0.9(**)*	0.6(**)	*1.3(**)*	*0.5(**)*	0.7(**)
Year									
2010	--	--	75.6	--	--	5.9	--	--	6.0
2011	--	--	74.8	--	--	5.6	--	--	6.0
LSD (P=0.05)	--	--	NS	--	--	NS	--	--	NS
Sowing Date x Year									
LSD (P=0.05)		NS			NS			NS	

Least significant differences (LSD) are used to compare treatment means within the column for the data pooled over two growing years 2010 and 2011; while LSD given in italics are used to compare treatment means within the columns for individual year.

NS = Non significant: * P< 0.05.

The plant height significantly decreased with late seed sowing that may be due to the duration of growing period. As growing period was prolonged, more photosynthates produced which ultimately increased the plant height. Current studies are confirmed by Meher *et al.,* (1999) who found that early planting produced taller plants in chrysanthemum. Similarly Nawaz *et al.,* (2009) reported maximum plant height in 18th February planting in Chrysanthemum, while Poonam *et al.*, (2002) has reported an increase in plant height when Zinnia was planted at an early date.

Total number of branches plant-1

More number of branches (6.9) per plant were recorded when seeds were sown on 20th February as compared to seeds sown on 6th April having 5 branches per plant. 20th February sowing showed significant difference with 7th March, 22nd March, 6th April and 21st April sowing. The difference between 7th March and 22nd March sowing was non significant.

The effect of 6th and 21st April sowing was statistically at par (Table 1).

These findings indicate that it may be attributed to the early sowing which produced more number of branches most probably due to increased plant height. Nawaz *et al.* (2009) observed the maximum branches per plant on 18th February planting in chrysanthemum. These results also are in line with those of Poonam *et al.,* (2002) who recorded more number of branches on early planting in Zinnia.

Table 2. Effect of sowing dates on number of leaves/ plant and leaf area in Chrysanthemum for year 1 (2010) and year 2 (2011).

Sowing date	Number of leaves/plant			Leaf area (cm²)		
	2010	2011	Mean	2010	2011	Mean
20 Feb.	78 a	69 a	74 a	76.5 c	83.2 b	80.0 c
7 March	69 b	67 a	68 b	88.0 b	80.7 b	84.4 c
22 March	48 c	56 b	52 c	105.0 a	87.5 b	96.3 b
6 April	44 c	45 c	45 d	100.4 a	111.8 a	106.1 a
21 April	43 c	48 c	46 d	100.6 a	119.3 a	110.0 a
LSD(P=0.05)	*6.21(**)*	*6.6(**)*	4.36(**)	*8.56(**)*	*9.4(**)*	6.12(**)
Year						
2010	--	--	56.0	--	--	95.1
2011	--	--	57.9	--	--	95.5
LSD (P=0.05)	--	--	NS	--	--	NS
Sowing Date x Year						
LSD (P=0.05)			NS			NS

Least significant differences (LSD) are used to compare treatment means within the column for the data pooled over two growing years 2010 and 2011; while LSD given in italics are used to compare treatment means within the columns for individual year.

NS = Non significant: * P< 0.05.

Total number of suckers plant-1

The number of suckers significantly varied among the plants sown on various dates, while the variable was not affected by the year and its interaction with sowing dates (Table 1). Greater number of suckers per plant (7.0) were noticed when the seeds were sown on 7th March, while less number of suckers per plant (4.1) were recorded in plants sown in the third week of April (21st April). The number of suckers produced by the plants sown on 20th February and 7th March were at par with each other. Similarly the effect of 22nd March and 6th April sowing on number of suckers was also statistically same, while they were significantly different from rest of the sowing dates.

The number of suckers per plant reduced with the delay in sowing dates may be attributed with the shorter growing period due to which sufficient amount of photosynthates were not produced to promote suckers growth (Nawaz *et al.*, 2009). The environmental conditions may also have affected the number of suckers. These results are supported by Nawaz *et al.* (2009) who noticed more number of suckers in early planting in chrysanthemum.

Total number of leaves Plant-1

The number of leaves were significantly higher (74) in plants sown on 20th February, while the plants raised from seeds sown on 6th April produced significantly lowest number of leaves (45). All sowing dates were significantly different from each other regarding number of leaves per plant, while 6th and 21st April sowing were statistically at par with each other (Table 2).

The maximum number of leaves per plant were recorded in plants sown early on 20th February might

had acquired the maximum efficiency for development due to adequate environmental conditions (Iftikhar *et al.*, 2011). The reason might also be that those treatments produced more number of leaves which had more number of branches and more plant height. The number of leaves have direct relation with number of branches and plant height (Nawaz *et al.*, 2009). These results are in close conformity with Barman *et al.* (1997) who recorded maximum number of leaves in early planting in chrysanthemum.

Table 3. Effect of sowing dates on days to flowering, number of flowers/plant and blooming period in Chrysanthemum for year 1 (2010) and year 2 (2011).

Sowing Date	Days to flowering			Number of flowers/plant			Blooming period		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
20 Feb.	244 a	256 a	250 a	22 a	26 a	24 a	38	42 a	40 a
7 March	230 b	237 b	234 b	20 a	19 b	20 b	38	40 ab	39 a
22 March	207 c	209 c	208 c	19 a	17 bc	18 b	38	39 ab	39 a
6 April	185 d	177 d	181 d	13 b	15 cd	14 c	37	37 bc	37 ab
21 April	155 e	164 d	160 e	12 b	12 d	12 c	37	34 c	35 b
LSD	*10.2(**)*	*13.1(**)*	8.0(**)	*4.0(**)*	*2.9(**)*	2.4(**)	*NS*	*4.1(*)*	3.2(*)
(P=0.05)									
Year									
2010	--	--	205	--	--	17	--	--	37.5
2011	--	--	209	--	--	18	--	--	38.4
LSD (P=0.05)	--	--	NS	--	--	NS	--	--	NS
Sowing Date x Year									
LSD (P=0.05)			NS		NS			NS	

Least significant differences (LSD) are used to compare treatment means within the column for the data pooled over two growing years 2010 and 2011; while LSD given in italics are used to compare treatment means within the columns for individual year.

NS = Non significant: * P< 0.05.

Leaf Area (cm²)

Leaf area was significantly higher (110.0 cm²) when seeds were sown late in third week of April (on 21st April), followed by (106.1 cm²) the plants sown on 6th April, while it was (80.0 cm²) when seeds were sown on 20th February. All sowing dates showed significant difference regarding leaf area, whereas plants raised from 20th February and 7th March sowings had statistically same effect on leaf area (Table 2).

The leaf area was less in early sowing despite having prolonged growing period. It might be due to the presence of more number of leaves. The food reserves diverted to maintain the higher number of leaves, and not to increase the leaf area. These findings are supported by Deotale *et al.* (1995) who found that leaf area was more at late planting in chrysanthemum.

Flowering Characteristics

Number of days to flowering (flower bud break)

The number of days to flowering showed significant difference between sowing dates. More number of days to flower (250 days) were recorded in the plants sown on 20th February as compared to those sown on 21st April and spent (160 days). All under test five dates of sowing produced flowers at significantly different times from each other (Table 3).

The plants raised from early sowing took more number of days to flower. The reason could be that the early sown plants resulted in prolonged juvenile period and hence took longer period to initiate flowering. In fact the flowering in plants is regulated by photoperiod. Like many other short day plants, flowering in chrysanthemum is controlled naturally

by shortening of day length (Dole and Wilkins, 2005). It is not necessary that delayed planting will result in delayed flowering (Anjum *et al*., 2007). Deotale *et al.* (1994) reported that time to flowering was reduced when chrysanthemum was planted late. Adam *et al.* (1998) investigated three sowing dates and found that late sowing produced early flowers in petunia.

Table 4. Effect of sowing dates on flower size and flower fresh weight in Chrysanthemum for year 1 (2010) and year 2 (2011).

Sowing date	Flower size (cm)			Flower fresh weight (g)		
	2010	2011	Mean	2010	2011	Mean
20 Feb.	3.9 c	3.9 c	3.9 c	3.0 c	2.9 c	2.9 d
7 March	4.2 bc	3.8 c	4.0 c	3.3 b	3.2 c	3.2 c
22 March	4.6 b	5.2 b	4.9 b	3.5 b	3.9 b	3.7 b
6 April	5.6 a	6.1 a	5.9 a	4.1 a	4.2 a	4.2 a
21 April	6.0 a	5.8 a	5.9 a	4.3 a	4.2 a	4.2 a
LSD(P=0.05)	*0.43(**)*	*0.4(**)*	0.37(**)	*0.23(**)*	*0.29(**)*	0.17(**)
Year						
2010	--	--	5.0	--	--	3.6
2011	--	--	4.9	--	--	3.7
LSD (P=0.05)	--	--	NS	--	--	NS
Sowing Date x Year						
LSD (P=0.05)		NS			NS	

Least significant differences (LSD) are used to compare treatment means within the column for the data pooled over two growing years 2010 and 2011; while LSD given in italics are used to compare treatment means within the columns for individual year.

NS = Non significant: * P< 0.05.

Total number of flowers plant^{-1}

Highest number of flowers per plant (24) opened in plants sown 20th February, while lowest number of flowers (12) were recorded in plants sown on 21st April, closely followed by the plants sown on 6th April (14).

Early sown plants attained increased height and produced higher number of branches, hence they produced more number of flower buds that ultimately resulted in more flowers.. Higher number of flowers production might be due to the dominating effect of early sowing and higher number of leaves. Additionally, due to prolonged period of photosynthetic activity, the plants had sufficient food reserves to convert in to more flowering buds (Balaji *et al*., 2010). These findings are also supported by the findings of Park *et al.* (1989) in *Liatris spicata* who observed that number of flowers decreased in delayed planting. Anjum *et al.* (2007) recorded lowest number of flowers in 17th June planting in chrysanthemum. Moreover, Meher *et al.* (1999) also reported higher flower yield in May planting in chrysanthemum.

Blooming period (Days)

The blooming period remained same for sowing dates from 20th February to 22nd March, and then it decreased with delay in sowing. Flowers stayed longer (40 days) when sowing was carried out on 20th February, while it was (35 days) in plants sown on 21st April. The effect on plants raised from first three dates of sowing (20th February, 7th and 22nd March) was statistically the same. Likewise, it was non significant in 6th and 21st April sowing (Table 3).

Flowers opened in early sown treatments were smaller in size and more compact. That could be the reason which led the flowers to bloom for longer period in early sown plants than those plants which were sown late and produced flowers of bigger size but comparatively less compact. Barman *et al.* (1997) concluded that the maximum blooming period was recorded in early dates of planting in chrysanthemum. The temperature at the sowing time also plays an important role in flower life on plant (Anjum *et al.*, 2007).

Flower Size (cm)

Flower size revealed significant difference as affected by various sowing dates presented in table 4. However the flower size was not changed by year and interaction of sowing dates and year. The flower size was higher (5.9 cm) in chrysanthemum plants sown on 6th and 21st April respectively as compared to plants sown on 20th February and 7th March, which produced small sized (3.9 cm) and (4.0 cm) flowers respectively. The effects of sowings on 6th and 21st April were statistically same, while both these sowing dates were significantly different from the rest of under observation sowing dates. The effects of sowings on 20th February and 7th March were also statistically at par with each other.

Late sown plants had enough food supply to increase the size of flower. This reveals that the late sowing showed significant supremacy over early sowing (Anjum *et al.*, 2007). Barman *et al.* (1997) found that there was gradual increase in flower diameter of chrysanthemum as planting date was delayed. Early sowing resulted in more number of flowers but with less flower size, might be due to the distribution of the photosynthates to more number of terminal buds, while late sowing gave less number of flowers, but with large size.

Flower fresh weight (g)

Data pertaining to flower fresh weight revealed significant difference among various sowing dates, whereas year wise as well as interaction among sowing dates and year did not affect the flower fresh weight (Table 4). Higher flower fresh weight (4.2 g) was recorded in plants sown on 21st April, and 6th April. The lowest weight (2.9 g) was recorded in plants sown earlier on 20th February. Late sowings on 21st April and 6th April were statistically same regarding flower fresh weight while they were significantly different from 20th February, 7th March and 22nd March sowings.

The decrease in flower fresh weight in early sowing may be attributed to the greater number of flowers produced in early sowings that reduced the nutrients required to increase the size, while late sowings produced less number of flowers and increased the flower size. Anjum *et al.* (2007) recorded higher flower fresh weight in late planting in chrysanthemum. Similar results were recorded by Barman *et al.* (1997) in chrysanthemum.

This study has highlighted the importance of sowing dates for early flowering. From the current experiment it can be concluded that late sowing from first to third week of April is suitable for growers in cool areas of Pakistan, where summer is mild and winter starts earlier in October. The late sowing results early flowering and provides an opportunity of off season condition and increased availability of chrysanthemum as cut flowers.

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