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National Academy of Agricultural Science (NAAS)
Rating : 3. 03

Effect of Time of Planting and Spacing on Growth, Flowering and Yield of Annual Chrysanthemum

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Abstract: *The present experiment was laid out in split plot design having six planting times (mid September to December) and four spacings (30 cm x 30 cm, 30 cm x 45 cm, 45 cm x 45 cm and 45 cm x 60 cm) with three replications. The plant growth in terms of plant height, spread and number of branches per plant was recorded maximum in 15th October planting whereas minimum in 1st December planting. The numbers of branches per plant were found maximum in 15th October planting which was at par with 1st November planting. The days to bud appearance and first flowering were recorded minimum in 1st November planting which were at par with 15th October planting. The minimum days to 50% flowering were taken by 15th October planting which were at par with 1st November planting. The maximum duration of flowering and size of flower was observed in 15th October planting. In case of yield parameters, the number of flowers per plant, the maximum average weight of flowers, yield per plant and yield per acre and were observed maximum in 15th October planting which were at par with 1st November planting whereas minimum in 1st December planting. The maximum plant height was recorded at the closest spacing of 30 cm x 30 cm which decreased with increase in spacing. The maximum plant spread and number of branches per plant were recorded at the widest spacing of 45 cm x 60 cm. The minimum days to bud appearance, first flowering and 50% flowering were recorded in 45 cm x 60 cm spacing. The duration of flowering and size of flower was also recorded maximum in the spacing of 45 cm x 60 cm. The number of flowers per plant, average weight of flowers and yield per plant was recorded maximum at the widest spacing of 45 cm x 60 cm whereas minimum in 30 cm x 30 cm spacing. The maximum yield per acre was recorded at the closest spacing of 30 cm x 30 cm which decreased with increase in spacing.*

Key words: *Annual chrysanthemum, time of planting and spacing*

Annual chrysanthemum is a tall, winter season annual flowering crop. It has earned tremendous popularity for the garden display and garland making. Its flowers are also used for decoration purposes. These are available from February to April, when the market is deficient in other flowers. So, its flower can fetch good market price. The rate of traditional flowers in Delhi market ranged between Rs. 2.0 and Rs. 20 per kg. depending upon the season and demand in the market (Sindhu and Mishra, 1997). It normally forms flower buds when the day length exceeds 14.5 hrs. The demand of flowers is increasing particularly in big cities and to meet this ever-increasing demand the need of the hour is to increase the production of the flowers. The various factors responsible for increasing the production are selection of variety, planting material, time of planting, spacing and other cultural operations. Till now very less work has been reported on these aspects in annual chrysanthemum in northern part of country. The production technology of annual chrysanthemum in agro climatic condition of Haryana has not been standardized so far. Therefore, the present studies were planned with the objective to find out the best planting time and proper spacing to expose the crop for better environment for maximum productivity.

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MATERIAL AND METHODS

The present investigations were carried out at the Experimental Orchard, Department of Horticulture, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The plots measuring 1.8 m x 1.8 m were prepared. A basal dose of well rotten farm yard manure @ 5 kg m^{-2} along with full dose of phosphorus (20 gm^{-2}) and potassium (10 g m^{-2}) was mixed in the soil 15 days before transplanting. Half dose of nitrogen (10 g m^{-2}) was applied after 10 days of transplanting and remaining half dose (10 g m^{-2}) was applied one month after the application of first dose. The transplanting was done at fortnight intervals on 15th September (T_1),1st October(T_2),15th October(T_3), 1st November(T_4), 15th November(T_5) and 1st December(T_6) with different spacings. 30 cm x 30 cm (S_1), 30 cm x 45 cm(S_2), 45 cm x 45 cm (S_3) and 45 cm x 60 cm (S_4)and spilt plot design was used. The growth, floral and yield parameters were recorded during the experiment using standard methods.

Table 1
Effect of time of planting and spacing on plant height (cm) in annual chrysanthemum

Time of Planting	*30 days*	*45 days*	*60 days*	*90 days*
T_1	43.58	53.82	62.39	68.47
T_2	53.67	72.08	81.54	86.93
T_3	64.58	81.98	94.92	102.50
T_4	63.54	79.41	92.61	99.16
T_5	44.90	61.83	70.15	75.27
T_6	35.07	50.11	54.47	60.51
C.D at 5%	0.71	1.95	1.53	1.87
Spacing				
S1	54.97	70.54	80.02	86.83
S2	51.20	67.29	77.44	84.16
S3	49.08	65.68	74.18	80.19
S4	48.31	62.64	72.40	77.39
C.D at 5%	**0.87**	**0.90**	**1.00**	**0.80**

RESULT AND DISCUSSION

The perusal of data in Table 1 revealed that the time of planting and spacing significantly influenced the plant height. The plant height was taken at four interval viz. 30, 45, 60 and 90 days after transplanting. The maximum increase in growth was observed in first 45 days of transplanting. The maximum plant height was recorded in 15th October planting and the minimum height was observed in 1st December planting. The close spacing of 30cm x 30cm recorded maximum plant height whereas widest spacing of 45cm x 60cm recorded minimum height. The plant height was significantly highest in the closest spacing of 30 cm x 30 cm and minimum in the spacing of 45 cm x 60 cm. This might be ascribed to the fact that the plants which were closely planted does not have enough space to spread their branches, so they grow taller in height. Similar results were obtained by Mildernberger and Hendriks (1996) and Barman and Pal (1999) in chrysanthemum.

The table 2 shows that the time of planting and spacing had significant effect on plant spread. The planting which was done on 15th October produced plants with the maximum plant spread of 84.9 cm followed by 1st November planting with 79.8 cm spread and the planting which was done on 1st December recorded minimum plant spread of 44.4 cm. The increase in plant spacing also increased the plant spread significantly. The maximum plant spread (70.5 cm) was recorded at the widest spacing of 45 cm x 60 cm and the minimum plant spread (62.9 cm) was recorded at the closest spacing of 30cm x 30cm.Numbers of branches per plant were also significantly affected by time of planting and spacing (Table- 2). The planting which was done on 15th October resulted in maximum number of branches per plant (28.0) which were at par with 1st November planting (27.6) where as minimum branches (13.9) were recorded in 1st December planting. It is also clear from the data that with the increase in plant spacing, the number of branches per plant also increased significantly. The maximum number of branches per plant (22.9) was recorded at a spacing of 45 cm x 60 cm and the minimum number of branches per plant (18.1) was recorded at the closer spacing of 30 cm x 30 cm.

It is clear from the results that the plant spread and number of branches per plant were significantly higher in the widest spacing of 45 cm x 60 cm. It was due to the fact that at wider spacing, there is

Table 2
Effect of time of planting and spacing on plant spread (cm) and number of branches per plant in annual chrysanthemum

Time of Planting	*Plant spread (cm)*	*Number of branches per plant*
T_1	60.5	14.1
T_2	74.2	22.2
T_3	84.9	28.0
T_4	79.8	27.6
T_5	57.5	16.9
T_6	44.4	13.9
C.D at 5%	3.0	0.7
Spacing		
S1	62.9	18.1
S2	66.0	19.5
S3	68.1	21.3
S4	70.5	22.9
C.D at 5%	1.0	0.5

less competition between the plants for food and water. As a result more photosynthates synthesized in the plant resulting in more vegetative growth. Similar results were obtained by Dixit (2004) and Karavadia and Dhaduk (2002) in which they reported that the plant spread and number of branches per plant were significantly highest in the widest spacing. On contrary, Chezhiyan *et al.* (1986) reported higher number of branches per plant at a spacing of 20 cm x 30 cm as compared to 30 cm x 30 cm and 40 cm x 30 cm spacing.

The planting time, spacing and their interaction significantly effected the days to bud appearance (Table3). The minimum days to bud appearance were taken by 1st November planting (39.1) which were at par with 15th October planting (40.1) where as the maximum days to bud appearance were taken by 15th September planting (51.4). It is evident from the data that increase in plant spacing decreased the days to bud appearance significantly. The minimum days to bud appearance were recorded at the wider spacing of 45 cm x 60 cm (43.1) and the maximum numbers of days to bud appearance (47.1) were recorded at the closer spacing of 30 cm x 30 cm. The interaction between time of planting and spacing and days to bud appearance was found to be significant. The table also revealed that time of planting, spacing and their interaction significantly affected the days to first flowering. The planting which was done on 1st November took minimum days to first flowering (43.0) which was at par with 15th October planting (44.3) whereas the 15th September planting recorded the maximum days to first flowering (55.4). A perusal of the data shows that increase in plant spacing decreased the days to first flowering. The plants which were widely planted at the spacing of 45 cm x 60 cm took the minimum days to first flowering (47.5) whereas maximum days to first flowering (52.1) were taken by 30 cm x 30 cm spacing. The interaction between time of planting and spacing was found to be significant.It is obvious from the data presented in table that the time of planting and spacing had significant effect on days to 50% flowering. The minimum days to 50% flowering were taken by 15th October planting (61.6) which were par with 1st November planting (62.1) and the maximum days to 50% flowering were taken by 1st December planting (73.2) which were at par with 15th November planting (71.4) and 15th September planting (72.8). It is apparent from the data that spacing had significant effect on days to 50% flowering. The minimum days to 50% flowering were recorded at the spacing of 45cm x 60 cm (66.5) and the maximum days to 50% flowering were recorded at the closer spacing of 30 cm x 30 cm (69.7).The data presented in Table shows that time of planting, spacing and their interaction significantly influenced the duration of flowering. The maximum duration of flowering (55.7 days) was observed in 15th October planting which was at par with 1st November planting (54.7 days) whereas the planting which was done on 1st December recorded minimum duration of flowering (38.0 days). It is explicit from the data that increase in plant spacing upto 45 cm x 45 cm, significantly increased the duration of flowering. The maximum duration of flowering was recorded at the spacing of 45cm x 60 cm (48.7 days) which was at par with 45 cm x 45 cm spacing (47.9 days) and the minimum duration of flowering was recorded at the closest spacing of 30 cm x 30 cm (45.7 days). The days to bud appearance and first flowering were recorded minimum in 1st

November planting whereas days to 50% flowering were recorded minimum in 15th October planting. Before 15th October and after 1st November plantings, the days to bud appearance, first flowering and 50% flowering, increased significantly, due to slow vegetative growth, thus entering late in reproductive phase. This might be ascribed to the fact that occurrence of favourable temperature around 15th October to 1st November resulted in optimum vegetative growth in short period, resulting in early flowering since it was possible to prepare enough photosynthates which is a prerequisite in many of the flowering plants to turn to reproductive phase. These results are in close conformity with those of Jane *et al.* (2001) in which they reported minimum days were taken to bud appearance, first flowering and 50% flowering by the plants transplanted between 5th and 15th October. On contrary, Shin *et al.* (1986) reported that the rooted cutting planted in December recorded minimum days to bud appearance. A perusal of the data shown in table indicated that different planting dates and spacing affected the size of flower significantly. Among the various planting times, 15th October planting recorded the maximum size of flower (4.3 cm) followed by 1st November planting (4.31cm) whereas minimum size of flower (3.87cm) was recorded in 15th September planting. It is explicit from the data that increases in plant spacing increased the size of flower significantly. The wider spacing of 45 cm x 60 cm recorded maximum size of flower (4.16 cm) and the closer spacing of 30 cm x 30 cm recorded minimum size of flower (3.99 cm). The duration of flowering and size of flower were recorded maximum in the widest spacing of 45 cm x 60 cm. Development of more photosynthates due to increased photosynthetic activity in wider spacing might be responsible for longer duration and bigger flower size. Farina and Paterniani (1986) observed that bloom diameter fell with increasing plant density. Similar result was reported by Belgaonkar *et al.* (1997).

A review of the data presented in Table 4 shows that time of planting, spacing and their interaction had significant effect on number of flowers per plant. The planting which was done on 15th October recorded maximum number of flowers per plant (100.8) which was at par with 1st November planting (99.1) and minimum number of flowers per plant (57.9) were recorded in 1st December planting. The data shows that spacing had significant effect on number of flowers per plant. Among the various spacing, the spacing of 45 cm x 60 cm resulted in maximum number of flowers per plant (84.7) whereas the spacing of 30 cm x 30 cm resulted in

Table 3
Effect of time of planting and spacing on floral parameters in annual chrysanthemum

Time of Planting	*Bud appearance*	*First Flowering*	*50% Flowering*	*Duration of flowering (days)*	*Size of flower (cm)*
T_1	51.4	55.4	72.8	43.2	3.87
T_2	43.9	49.8	66.6	50.0	4.12
T_3	40.1	44.3	61.6	55.7	4.35
T_4	39.1	43.0	62.1	54.7	4.31
T_5	45.7	50.6	71.4	42.3	3.93
T_6	49.9	55.0	73.2	38.0	3.89
C.D at 5%	1.4	1.5	1.8	1.8	0.03
Spacing					
S1	47.1	52.1	69.7	45.7	3.99
S2	45.8	50.45	68.4	47.0	4.04
S3	44.1	48.7	67.2	47.9	4.11
S4	43.0	47.5	66.5	48.7	4.16
C.D at 5%	0.5	0.5	0.6	0.4	0.01

minimum number of flowers per plant (70.5). It is explicit from the data shown in Table that time of planting, spacing and their interaction had significant effect on average weight of flowers. The maximum average weight of flowers was recorded at 15th October planting (2.87 g) which was at par with 1st November planting (2.86 g) and the minimum observed in 1st December and 15th September planting (2.29 g and 2.32 g). It is also clear from the data that increase in plant spacing increased the average weight of flowers significantly. The plants which were planted at the spacing of 45 cm x 60 cm recorded maximum average weight of flowers (2.65 g) whereas minimum at the spacing of 30 cm x 30 cm (2.48 g).It is revealed from the data shown in Table that time of planting, spacing and their interaction had significant effect on yield per plant. The planting which was done at 15th October resulted in maximum yield per plant (290.3 g) which was at par with 1st November planting (284.1 g) whereas minimum yield per plant (132.9) was recorded at 1st December planting. It is explicit from the data that increase in plant spacing significantly increased the yield per plant. The widest spacing of 45 cm x 60 cm resulted in maximum yield per plant (228.8 g) and the closest spacing of 30 cm x 30 cm recorded minimum yield per plant (178.6 g). The time of planting had significant effect on yield per acre. The planting which was done on 15th September recorded maximum yield per acre (64.3 q) which was at par with 1st November planting (63.2 q) whereas 1st December planting recorded minimum yield per acre (29.4 q). A review of the data shows that increase in plant spacing decreased the yield per acre significantly. The closed spacing of 30 cm x 30 cm resulted in maximum yield per acre (67.5q) and minimum yield per acre (28.8 q) recorded at the spacing of 45cm x 60 cm. Plants raised in these planting times were exposed to favourable climatic conditions thus produced more shoots and leaves early in the season, entered early into flowering and ultimately gave higher flower yields. These results are in close conformity with those of Gill *et al.* (1985) in which they reported that with every delay in planting from October onwards, the quality and yield of blooms decreased to great extent. Contrary to this, Meher *et al.* (1999) reported that cut flowers yield were highest from May planting in chrysanthemum. Similar results are reported by Datta (2000). In case of spacing, the number of flowers per plant, average weight of flowers and yield per plant were recorded maximum in the plant spacing of 45 cm x 60 cm. This might be attributed to the fact that at wider spacing, due to less competition between plants for food and water maximum photosynthetic activity takes place resulting in synthesis of more photosynthates. Similar results are reported by Rao *et al.* (1992) in which they reported maximum number of flowers per plant, average weight of flowers and yield per plant at wider spacing. The closest spacing of 30 cm x 30 cm resulted in maximum yield per acre. These results are in conformity with those of Belgaonkr *et al.* (1996) in which maximum yield per hectare was reported at the closest spacing.

Table 4
Effect of time of planting and spacing on yield parameters in annual chrysanthemum

Time of Planting	*Number of flowers per plant*	*Average weight of flowers (g)*	*Yield per plant (g)*	*Yield per acre (q)*
T_1	61.4	2.32	143.3	31.5
T_2	80.0	2.55	204.3	45.7
T_3	100.8	2.87	290.3	64.3
T_4	99.1	2.86	284.1	63.2
T_5	70.5	2.55	180.2	40.0
T_6	57.9	2.29	132.9	29.4
C.D at 5%	2.8	0.06	8.3	2.1
Spacing				
S1	70.5	2.48	178.6	67.5
S2	76.3	2.55	198.8	50.1
S3	81.6	2.60	217.0	36.4
S4	84.7	2.65	228.8	28.8
C.D at 5%	0.7	0.01	1.7	0.6

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