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Effect of planting dates on growth and flowering of selected rainy season annuals

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ABSTRACT

The present investigation was conducted at the experimental farm of Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (Himachal Pradesh), to evaluate the performance of eight rainy season annuals under different planting dates. The study involved tall zinnia, dwarf zinnia, balsam, gomphrena 'pink', gomphrena 'magenta', cosmos, African marigold, and china aster, planted on three dates: June 3rd, July 3rd, and August 3rd. Results revealed that tall zinnia recorded the maximum plant height, while gomphrena 'pink' showed the widest plant spread and longest flowering duration. Balsam exhibited the earliest flower bud initiation, earliest flowering, highest number of flowers per plant, and the highest flower yield both per plant and per plot. Tall zinnia produced the largest flower size. Among the planting dates, June 3rd (planting date 1) resulted in the best overall performance, including maximum plant height, plant spread, flower size, flowering duration, flower count, and yield per plant and per plot. In contrast, the earliest flower bud initiation and flowering were observed in the August 3rd planting (planting date 3). The study highlights the importance of cultivar selection and optimal planting time for maximizing growth and floral yield of rainy season annuals.

Key words: Optimal planting time, early and late flowering, maximizing growth and flowering, rainy season annuals.

INTRODUCTION

Floriculture has assumed immense significance in the diversification of agriculture. In India, commercial floriculture is growing at a 20-25 percent rate in the domestic and export market. Besides the growing attraction toward cut flowers, flowering annuals are one of the most popular cut flowers with great diversification of cultivars for different regions. Annual flowers beautify the surroundings and exhibit a good display of blooms at a low cost. These flowers bring a change in the look of the garden with a change in season (Ahmad *et al.,* 1). The herbaceous annuals have varied uses in the garden. Annuals are known for their beautiful blooms and for being easy to care for. Another advantage of annuals is that they can be planted in pots, hanging baskets and herbaceous borders. Annuals have the potential to thrive in almost all soil types (Dole *et al.,* 6). They are generally grown in the beds and in informal beds with or without perennials and bulbous flowers, particularly mixed borders to obtain a longer duration of flowering. Many species and varieties of attractive annuals with various shades of colour are available in different seasons of the year. Proper selection of annuals and their time of planting boost the beautification of landscaping. Low input cost and maintenance requirements, diversification in cultivars and colours, long vase life, and wide adaptability contribute to their popularity (Starman *et al.,* 15).

MATERIALS AND METHODS

The experiment was conducted at Experimental Farm of Department of Seed Science & Technology, Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during years 2020 and 2021. The experimental location is situated at latitude of 30º51'09" N and longitude 77º11'06" E at an elevation of 1030 m above msl, falls under mid hill zone of the state. Healthy and stocky seedlings of uniform size

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and vigorous at 4 - 5 leaf stage were selected and transplanted in the beds. The transplanting of uniform sized seedlings was done at a spacing of 30 cm × 30 cm from plant to plant and row to row accommodating twenty plants per square meter area in case of french marigold, china aster, gomphrena, tall zinnia and small zinnia and at 45 cm × 40 cm accommodating twelve plants per square meter area in case of African marigold, cosmos and balsam. The field was ploughed thoroughly well before the transplanting of seedlings. The stones, pebbles and unwanted materials were removed from the field manually. The raised beds of required size (1.5 × 1.2 m) were prepared and leveled properly. After transplanting, light irrigation was done to establish the crop in the field. The field experiment was laid out in Randomized Block Design (factorial) having three replications. There was total 24 treatment combinations. The study shall be conducted on eight rainy season annuals (tall zinnia, dwarf zinnia, balsam, gomphrena 'pink', gomphrena 'magenta', cosmos, African marigold and China aster) planted on three different dates (June 3rd, July 3rd and August 3rd). The observations regarding growth and flowering (plant height, plant spread, days taken for flower bud initiation, days taken for flowering, duration of flowering, flower size, number of flowers per plant, flower yield per plant and flower yield per plot) parameters were recorded. Statistical analysis of the recorded data was carried out using general linear model of 'standard errors of the mean'. Mean values for each of the respective parameters were tested by ANOVA (Analysis of Variance) and the difference between the treatments was compared by least significant difference (LSD) test at 5% level of confidence (probability) according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The result showed that the tallest plants were produced in zinnia (tall) (105.95 cm) while smallest plants were recorded in zinnia (dwarf) (22.40 cm). among different planting dates, D_1 (70.71 cm) resulted in the production of longest plants while smallest plants were recorded in D_3 (56.48 cm). Regarding the interaction of flowering annuals × planting dates, longest plants was recorded in zinnia (tall) (110.39 cm) when planted in D_1 i.e. first week of June while lowest plants was recorded in zinnia (dwarf) (16.96 cm) planted in D_3 *i.e.* first week of August (Table 1). These results may be attributed to the fact that the ideal weather conditions required for growth of selected rainy season annuals might be prevailing during this cropping period in comparison to other planting dates. A gradual decrease in plant height was observed with extending date of planting. Further, decrease in temperature with delay in planting dates was observed which could be the reason for decrease in vegetative growth parameters. The tallest plants were produced when planting was accomplished during the planting dates

Table 1. Effect of planting dates on plant height, plant spread and days taken for flower bud initiation of selected rainy season annuals.

Planting dates / Flowering annuals	Pooled data of year 2020-21 to 2021-22											
	Plant height (cm)				Plant spread (cm)				Days taken for flower bud initiation			
	P D 1	P D 2	P D 3	Mean	P D 1	P D 2	P D 3	Mean	P D 1	P D 2	P D 3	Mean
Tall Zinnia	110.39	106.34	101.11	105.95	44.71	40.59	35.37	40.22	39.06	32.94	29.95	33.98
Dwarf Zinnia	27.61	22.63	16.96	22.40	32.20	27.51	22.66	27.46	36.78	34.78	32.78	34.78
Balsam	71.84	65.69	57.53	65.02	40.55	31.58	24.54	32.22	30.61	26.78	22.83	26.74
Gomphrena 'Pink'	56.10	50.65	47.30	51.35	48.83	43.10	37.07	43.00	54.94	51.00	47.83	51.26
Gomphrena 'Magenta'	58.55	53.42	49.94	53.97	50.86	44.66	39.26	44.92	54.17	50.00	46.83	50.33
Cosmos	90.68	82.73	70.65	81.36	47.49	38.52	31.64	39.22	54.95	48.00	39.72	47.56
African Marigold	85.45	76.46	67.67	76.52	45.52	36.42	29.88	37.27	76.00	69.95	57.11	67.69
China aster	65.07	53.72	40.71	53.17	33.90	26.42	20.76	27.03	84.83	77.94	70.00	77.59
Mean	70.71	63.95	56.48	-	43.01	36.10	30.15	-	53.92	48.92	43.38	-
$CD_{0.05}$												
Flowering annuals		2.46				2.45				2.12		
Planting dates		1.50				1.50				1.30		
Flowering annuals × Planting dates		4.26				4.25				3.67		

in June 3rd which may be ascribed to the fact that these plants could get sufficient time for putting up more vegetative growth. They grew comparatively much longer than the later planted crops. Tallest plants of annual chrysanthemum with maximum spread have also been reported with early planting (5th October) by Jane *et al.* (8). Best results obtained with early planting got the support of Singh *et al.* (14), who recorded maximum plant height when planting was commenced on 3rd of November whereas with delay in planting (i.e. on 23rd November and 13th December) a corresponding decline in plant height was observed.

Maximum plant spread were produced in gomphrena magenta (44.92 cm) while minimum plant spread were recorded in china aster (27.03 cm). among different planting dates, D_1 (43.01 cm) resulted in the production of maximum plant spread while minimum plant spread was recorded in D_3 (30.15 cm). Regarding the interaction of flowering annuals × planting dates, maximum plant spread was recorded in gomphrena magenta (50.86 cm) when planted in D_1 i.e. first week of June while minimum plant spread was recorded in china aster (20.76 cm) planted in D_3 i.e. first week of August. The plants with more spread were produced when planting was accomplished during the month of June 3rd, which may be ascribed to the fact that these plants could get sufficient time for putting up more vegetative growth. They attained comparatively wider plant spread than the later planted crops. Minimum plant spread was observed in august planting for all the selected rainy season annuals which may be due to the reason that comparatively august 3rd planted crop could not get sufficient time to put up requisite vegetative growth. Hence plant spread was reported less in comparison to the earlier planting dates (June 3rd) for all the selected rainy season annuals. These results are in close agreement with the findings of Mishra (11) and Dilta *et al.* (4).

Minimum days taken for flower bud initiation were recorded in balsam (26.74) while maximum days taken for flower bud initiation were recorded in china aster (77.59). among different planting dates, D_3 (43.38) resulted in the production of earliest days taken for flower bud initiation while maximum days taken for flower bud initiation was recorded in D_1 (53.92). Regarding the interaction of flowering annuals × planting dates, earliest days taken for flower bud initiation was recorded in balsam (22.83) when planted in D_3 *i.e.* first week of august while maximum days taken for flower bud initiation was recorded in china aster (84.83) planted in D_1 i.e. first week of june. The earliness in bud initiation in case of august 3rd planted crop may be ascribed to congenial environmental conditions prevailing during the growth period. The temperature was comparatively mild, with increased humidity and sunshine hours, as planting was delayed there was decrease in temperature during both the years. Further the juvenile phase required for flowering might have been attained earlier under these favourable conditions. These results are in line with the findings of Sharma *et al.* (12) in African marigold. The maximum time was taken when planting was accomplished on June 3rd which may be ascribed to the fact that these plants could get sufficient time for putting up more vegetative growth. So, they took comparatively more time than the other planted crop.

Minimum days taken for flowering were recorded in balsam (36.33) while maximum days taken for flowering were recorded in china aster (Table 2). among different planting dates, D_3 (53.90) resulted in the production of earliest days taken for flowering while maximum days taken for flowering was recorded in D_1 (65.88). Regarding the interaction of flowering annuals × planting dates, earliest days taken for flowering was recorded in balsam (31.67) when planted in D_3 *i.e.* first week of august while maximum days taken for flowering was recorded in china aster (97.06) planted in D_1 *i.e.* first week of June. The maximum time was taken when planting was accomplished on June 3rd which may be ascribed to the fact that these plants could get sufficient time for gaining more vegetative growth particularly under long day conditions. These took comparatively more time than the later planted crops. The minimum days to first flowering were observed in august 3rd planting which may be due to the reason that comparatively august 3rd planted crop could not get sufficient time to put up requisite vegetative growth. These results are in close agreement with the findings of Gowda (7) and Dilta *et al.* (4).

Maximum flowering duration was taken up in gomphrena pink (97.87) while minimum flower duration were recorded in china aster (33.98). among different planting dates, D_1 (65.30) resulted in the production of maximum flower duration while minimum flower duration was recorded in D_3 (53.80). Regarding the interaction of flowering annuals × planting dates, maximum flower duration was recorded in gomphrena pink (102.22) when planted in D_1 *i.e.* first week of June while minimum flower duration was recorded in African marigold (28.28) planted in D_3 *i.e.* first week of August. The duration of flowering was observed longer in earlier planting dates than the later plantings and decreased with the corresponding delay in planting time. The maximum duration of flowering was found when planting was accomplished on june 3rd which may be ascribed to

Table 2. Effect of planting dates on days taken for flowering, duration of flowering and flower size (cm) of selected rainy season annuals.

Planting dates / Flowering annuals	Pooled data of year 2020-21 to 2021-22											
	Days taken for flowering				Duration of flowering				Flower size (cm)			
	P D 1	P D 2	P D 3	Mean	P D 1	P D 2	P D 3	Mean	P D 1	P D 2	P D 3	Mean
Tall Zinnia	49.67	42.06	38.17	43.30	66.44	59.00	56.89	60.78	7.52	7.27	6.91	7.24
Dwarf Zinnia	45.94	40.06	41.06	42.35	62.94	57.89	53.94	58.26	5.01	4.81	4.59	4.80
Balsam	40.33	37.00	31.67	36.33	57.28	51.22	42.11	50.20	4.05	3.55	3.32	3.64
Gomphrena 'Pink'	62.61	59.06	49.00	56.89	102.22	98.17	93.22	97.87	2.21	2.02	1.93	2.05
Gomphrena 'Magenta'	62.17	58.22	55.00	58.46	100.56	96.78	94.06	97.13	2.36	2.17	2.05	2.19
Cosmos	76.33	69.00	61.33	68.89	44.44	38.78	31.39	38.20	5.95	5.55	5.16	5.55
African Marigold	92.94	86.94	73.00	84.30	39.06	34.61	28.28	33.98	4.85	4.24	4.03	4.37
China aster	97.06	89.06	82.00	89.37	49.44	41.39	30.50	40.44	5.05	5.34	5.05	5.14
Mean	65.88	60.17	53.90		65.30	59.73	53.80		4.63	4.37	4.13	
$CD_{0.05}$												
Flowering annuals		2.23				3.49				0.08		
Planting dates		1.36				2.14				0.05		
Flowering annuals × Planting dates		3.86				6.04				0.14		

the fact that these plants could get sufficient time for putting up more vegetative and reproductive growth. So, they have maximum duration of flowering than the later planted crops. This could be ascribed to the genetic makeup of crop and favorable climatic conditions as well during the blooming period. These findings are in accordance with the work of Kishanswaroop *et al.* (9) in China aster, Dilta *et al.* (5) in chrysanthemum.

Pooled data incorporated in table 2 revealed that the maximum flower size were produced in zinnia (tall) (7.24 cm) while minimum flower size were recorded in gomphrena pink (2.05 cm). among different planting dates, D_1 (4.63 cm) resulted in the production of maximum flower size while minimum flower size was recorded in D_3 (4.13 cm). Regarding the interaction of flowering annuals × planting dates, maximum flower size was recorded in zinnia (tall) (7.52 cm) when planted in D_1 *i.e.* first week of June while minimum flower size was recorded in gomphrena pink (1.93 cm) planted in D_3 *i.e.* first week of August. The flower size was more in early planting dates than the later plantings. The plants with more flower size were produced when planting was accomplished on June 3rd which may be ascribed to the fact that comparatively June 3rd planted crop could not get sufficient time to put up requisite vegetative and reproductive growth particularly the flowering stems and flower yield per plant. The smallest flower size was observed in august 3rd planting which may be due to the reason that comparatively these plants could get sufficient time for putting up more vegetative growth and producing higher flowering stems and a greater number of flowers per plant. Hence size was comparatively less. These results are in close agreement with the earlier findings of Dhawle *et al.* (3).

Cumulative average data showed that the highest number of flowers were produced in balsam (271.41) while lowest number of flowers were recorded in zinnia (tall) (9.98). among different planting dates, D_1 (81.74) resulted in the production of highest number of flowers while lowest number of flowers was recorded in D_3 (62.46). Regarding the interaction of flowering annuals × planting dates, highest number of flowers was recorded in balsam (301.33) when planted in D_1 i.e. first week of June while lowest number of flowers was recorded in zinnia (tall) (7.17) planted in D_3 i.e. first week of August (Table 3). The number of flowers per plant were produced when planting was accomplished on June 3rd which may be ascribed to the fact that these plants could get sufficient time for putting up more vegetative growth particularly the production of a greater number of shoots which later on become reproductive. So, they produced comparatively more flowering stems than the later planted crop. The results are in confirmation with the findings of Dhatt and Kumar (2).

Maximum flower yield per plant were produced in balsam (155.29 g) while minimum flower yield per plant were recorded in zinnia (dwarf) (30.65 g).

Table 3. Effect of planting dates on number of flowers per plant, flower yield per plant (g) and flower yield per plot (g) of selected rainy season annuals.

Planting dates / Flowering annuals	Pooled data of year 2020-21 to 2021-22											
	Number of flowers per plant				Flower yield per plant (g)				Flower yield per plot (g)			
	P D 1	P D 2	P D 3	Mean	P D 1	P D 2	P D 3	Mean	P D 1	P D 2	P D 3	Mean
Tall Zinnia	13.11	9.67	7.17	9.98	73.55	49.69	36.58	53.27	1470.93	993.80	731.60	1065.44
Dwarf Zinnia	34.67	31.83	29.72	32.07	42.80	26.41	22.72	30.65	856.03	528.27	454.47	612.92
Balsam	301.33	282.39	230.50	271.41	207.61	142.61	115.65	155.29	2491.26	1711.36	1387.82	1863.48
Gomphrena 'Pink'	69.72	65.00	60.17	64.96	66.43	42.71	30.60	46.58	1328.57	854.13	612.03	931.58
Gomphrena 'Magenta'	73.28	67.28	62.33	67.63	68.68	46.67	34.83	50.06	1373.67	933.43	696.53	1001.21
Cosmos	105.39	89.61	78.11	91.04	55.58	44.66	37.75	46.00	666.98	535.92	452.98	551.96
African Marigold	31.11	25.33	19.39	25.28	179.43	132.71	80.71	130.95	2153.12	1592.56	968.46	1571.38
China aster	25.33	18.33	12.28	18.65	97.65	56.57	32.64	62.28	1953.00	1131.37	652.70	1245.69
Mean	81.74	73.68	62.46		98.97	67.75	48.93		1536.70	1035.11	744.57	
$CD_{0.05}$												
Flowering annuals	2.94				1.36				24.00			
Planting dates	1.80				0.84				14.70			
Flowering annuals × Planting dates	5.10				2.36				41.57			

among different planting dates, D_1 (98.97 g) resulted in the production of maximum flower yield per plant while minimum flower yield per plant was recorded in D_3 (48.93 g). Regarding the interaction of flowering annuals × planting dates, maximum flower yield per plant was recorded in balsam (207.61 g) when planted in D_1 i.e. first week of June while minimum flower yield per plant was recorded in zinnia (dwarf) (22.72 g) planted in D_3 i.e. first week of August. This might be due to the reason that the crop planted on June 3rd have more vegetative growth i.e. number of primary and secondary branches per plant that have produced more flower buds which finally contributed to a greater number of flowers per plant. Similar findings were reported by Kulkarni and Reddy (10) in Chrysanthemum and Sharma *et al.* (13) in gaillardia.

Highest flower yield per plot were produced in balsam (1863.48 g) while minimum flower yield per plot were recorded in cosmos (551.96 g). Among different planting dates, D_1 (1536.70 g) resulted in the production of maximum flower yield per plot while minimum flower yield per plot was recorded in D_3 (744.57 g). Regarding the interaction of flowering annuals × planting dates, maximum flower yield per plot was recorded in balsam (2491.26 g) when planted in D_1 i.e. first week of June while minimum flower yield per plot was recorded in cosmos (452.98 g) planted in D_3 i.e. first week of August. The highest number of flowers per plant was recorded with June 3rd planting. The highest flower yield per plot was recorded with june 3rd planting. This might be due to the reason that the crop planted on June 3rd have more vegetative growth i. e. number of primary and secondary branches per plant that have produced more flower buds which finally contributed to a greater number of flowers per plot. Similar findings were reported by Kulkarni and Reddy (10) in Chrysanthemum and Sharma *et al.* (13) in gaillardia.

Tallest plants were found in zinnia, while maximum plant spread was seen in gomphrena pink, earliest days taken for flower bud initiation and earliest days taken for flowering was balsam, duration of flowering was maximum in gomphrena pink, highest flower in tall zinnia, maximum number of flowers, flower yield per plant and flower yield per plot was balsam. Among the planting dates, planting date 1, June 3rd have maximum plant height, plant spread, duration of flowering, flower size, number of flowers per plant, flower yield per plant and flower yield per plot whereas earliest flower bud initiation and days taken for flowering in planting date 3.

AUTHORS' CONTRIBUTION

Writing original draft (JV & HSB); Investigation, Formal analysis (PKB, PKD, SRD & SB); Methology, Conceptualization, Resources (SK, AK & RN).

DECLARATION

The authors declare that they do not have any conflict of interest.

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