Research **P**aper

Effect of different planting densities on performance of gerbera under polyhouse conditions

■ A.B. BHOSALE, M.R. DESHMUKH[1] **AND** R.L. TAKTE[2]

Members of the Research Forum

Associated Authors:
[1]College of Horticulture, PUNE (M.S.) INDIA

[2]Hi-tech Floriculture Project, College of Agriculture, PUNE (M.S.) INDIA

Author for correspondence :
A.B. BHOSALE
Department of Horticulture, NARP, Zonal Agricultural Research Station (M.P.K.V.), SOLAPUR (M.S.) INDIA
Email :arunbhosale@rediffmail.com

ABSTRACT : Before a decade the concept of protective cultivation / polyhouse technology was introduced in India. Now-a-days it is popularized among the farmers in Maharashtra and some other States. The farmers have realized the importance of this technology and started cultivation of different floricultural, vegetable and fruit crops under the protective cover. Gerbera is one of the most important cash crop which requires less maintenance than the other floricultural crops. Planting density plays an important role in success of crop. In general the planting density should be such that it provides a congenial root environment and results in healthy growth of plants. Gerbera cultivation under polyhouse is quite popular in Maharashtra, but very meagre work related with the systematic study regarding the planting density has been reported. Planting density plays a vital role in influencing the quality of flowers as well as the incidence of diseases and pests. Keeping in view the importance of planting density on growth and quality of flowers the experiment was undertaken at Precision Farming Development Center, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (M.S) continuously for three consecutive years on different planting densities *viz.,* 30 x 30 cm, 30x 37.5 cm, 30x 45 cm, 37.5 x 37.5 cm and 45 x 45 cm. Plants grown at 30x 30 cm produced maximum flowers/ m^2/ year (317.00) followed by 37.5 x 37.5 cm (304.17). The average stalk length, top diameter of flower and number of flowers /plant/ year were significantly superior in 30x 30 cm. Among the varieties cultivar Diablo proved to be the vigorous and yielded 335.63 flowers/ m^2/ year.

KEY WORDS : Polyhouse, Gerbera, Planting density, Irrigation, Fertigation

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Gerbera commonly known as Transvaal Daisy, Barberton Daisy or African Daisy produces attractive flowers. It is an important commercial flower grown throughout the world in a wide range of climatic conditions. This is ideal for beds, borders, pots and rock gardens. The flowers are of various colours and suit very well in different floral arrangements. The cut blooms when placed in water last for a long time (Loeser, 1986). The genus Gerbera consists of about forty species of half hardy and perennial flowering plants (Bailey, 1963).

Greenhouse technology is becoming popular amongst the progressive cultivators. Land holding of cultivators is decreasing day by day due to increase in population. Taking into the consideration, the land holding of farmers and their

limited resources, the new technology may be suited to indigenous conditions and needs to be developed. Agricultural Ministry, Government of India has established the Precision Farming Development Centres to undertake the research on the use of plastics in agriculture. Precision Farming Development Centre, M.P.K.V., Rahuri (M.S.) is one of the centre.

Maharashtra is emerging as a one of the leading state in green house cultivation and also floriculture. Gerbera also called as a 'transvaal daisy' is one of the leading cut flower having single and double flowers. It belongs to the family Compositae and has a origin in South Africa and can be grown successfully in polyhouse. Planting density plays an important role in success of crop. In general the planting density should

be such that it creates the congenial root environment and results in healthy growth of plant. Gerbera cultivation under polyhouse is quite popular in Maharashtra, but there is meagre systematic study regarding the plant spacing. Planting density plays a vital role in quality and quantity of flowers as well as in incidence of diseases and pests. Hence, the experiment was undertaken at Precision Farming Development Centre, Dr. A.S. College of Agril. Engg., Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist Ahmednagar (M.S.) continously for three consecutive years to see the response in respect of quality and quantity of flowers.

RESEARCH METHODS

Polyhouse and environment control:

The centre has erected a controlled polyhouse (exhaust fan and pad) of 21 x 12 m size (252 m^2). Height at the centre was 4.5 m and at gutter it was kept 2.7 m. G.I. pipes were used for the framework. The structure was covered using ultra-violet stabilized low density polyethylene (LDPE) film of 200 micron thick as a cladding material. The total cost of construction for the entire structure was about Rs. 2,20,500/-

The environment inside the polyhouse was controlled by exhaust fan and cooling pad. To control the light intensity inside the polyhouse in 50 per cent green colour shaded net was used. In order to control the humidity in polyhouse the fogging arrangement was made by providing overhead foggers.

Bed preparation and planting of gerbera:

The raised beds (9.60 x 0.60 m each) were prepared and the planting densities adopted were as given below,

- D_1- 30x 30 cm
- D_2- 30 x 37.5 cm
- D_3- 30 x 45cm
- D_4- 37.5 x 37.5 cm
- D_5- 45 x 45 cm

Media were disinfected by using the fumigant formalin @ 25 ml/l and the solution of 5 l/ m^2. Three varieties of gerbera viz., Dana Ellen, Sangria, Carrera and Diablo were planted. The treatment combinations were 20 with 3 replications. The statistical design of experiment was Factorial Randomized Block Design.

Irrigation and fertigation:

The most efficient irrigation method i.e. drip method of irrigation was used in the polyhouse. Water was applied daily through drip round the year. The irrigation was applied at the rate of 70 per cent of daily pan evaporation rate.

The water soluble fertilizers were applied weekly through drip as per the recommended dose of 20 : 10 : 24 NPK g/ plant/ year.

Plant protection and observations:

Spraying of pesticides was done throughout the crop period as and when necessary. Yellow and dried leaves of gerbera were removed from time to time. Biometric observations in respect of flower quality and yield viz., stalk length and thickness, diameter of flower, flowers/ plant /year and flowers/ m^2/ year were recorded as and when harvesting was done.

RESEARCH FINDINGS AND DISCUSSION

The data pertaining to growth and floral characters of gerbera influenced by different planting densities and varieties tabulated under Table 1 and 2 showed a significant effect.

Qualitative parameters:

From the data presented in Table 1 revealed that there was a significant effect of different planting densities and varieties on the qualitative characters of gerbera. Planting density D_1 (30x 30 cm) significantly influenced the growth parameters than the other treatments

The individual effect of various planting densities on stalk length of gerbera revealed that the planting densitiy D_1 (30x 30 cm) gave flowers with maximum stalk length of 48.54 cm followed by D_5 (48.50 cm) which were at par with each other. The stalk thickness (0.57 cm) was found to be maximum under planting densitiy D_3 (30x 45 cm). The most important character from the market point of view is diameter of flower which was found to be maximum (10.45 cm) under planting density D_1 (30x 30 cm). Laurie et al. (1968) suggested to set the plants at 30-37.5 cm apart for obtaining better quality flowers.

The pooled data regarding the individual effects of various varieties on the qualitative characters of gerbera revealed that the variety V_4 (Diablo) gave flowers with maximum stalk length (54.97 cm) followed by V_1 (Dana Ellen) with (49.92 cm).The top diameter of the flower was found to be maximum with Diablo (10.63 cm).

Quantitative parameters:

The individual effects of various planting densities on the quantitative parameters of gerbera as depicted in Table 2 revealed that the planting density D_1 gave the maximum number of flowers /plant / year(51.36) and the maximum number of flowers /m^2/year (317) which was significantly superior over the other planting densities. Skalska (1985) reported that cultivar Lada gave the highest yield of 244.86 flowers per m^2 when planted at 30 x 30 cm. In case of varieties the variety Diablo gave the highest number of flowers /plant / year (55.44) and the highest number of flowers /m^2 / year (335.63). These results are in close agreement with those reported by Steen (1975) who grew gerbera on raised beds in rows 30 cm apart. The spacing in rows ranged from 20 to 40 cm giving 9.4 to 4.7 plants /m^2. The closest spacing produced the largest number of flowers/m^2 and the widest spacing the least. David (1977) reported that winter production could be increased by 15-20

Table 1 : Effect of various spacings on floral characters of gerbera

Sr. No.	Treatments	Av. stalk length (cm)				Av. stalk thickness (cm)				Dia. of flower (cm)			
		2003	2004	2005	Pooled	2003	2004	2005	Pooled	2003	2004	2005	Pooled
	Planting densities												
1.	D_1 – 30 x 30 cm	49.29	48.77	47.57	48.54	0.55	0.53	0.53	0.53	10.64	10.54	10.20	10.45
2.	D_2 – 30 x 37.5 cm	46.14	45.53	43.87	45.17	0.57	0.55	0.54	0.55	10.37	10.24	9.81	10.14
3.	D_3 – 30 x 45 cm	48.42	48.05	46.44	47.63	0.59	0.58	0.57	0.57	10.13	10.01	9.70	9.94
4.	D_4 – 37.5 x 37.5 cm	46.98	46.46	45.15	46.19	0.52	0.50	0.49	0.50	10.10	9.97	9.60	9.89
5.	D_5 – 45.0 x 45.0 cm	49.49	49.02	47.00	48.50	0.57	0.55	0.53	0.54	9.97	9.89	9.56	9.80
	S.E. ±	0.206	0.210	0.177	0.113	0.001	0.002	0.002	0.006	0.021	0.027	0.030	0.015
	C.D. (P=0.05)	0.610	0.621	0.525	0.315	0.002	0.007	0.006	0.016	0.061	0.081	0.089	0.043
	Varieties												
1.	V_1- Dana Ellen	50.71	50.38	48.68	49.92	0.53	0.52	0.50	0.51	10.27	10.14	9.84	10.08
2.	V_2- Sangria	44.70	44.14	42.61	43.81	0.54	0.53	0.52	0.53	9.91	9.80	9.53	9.73
3.	V_3 – Carrera	41.09	40.49	38.85	40.14	0.59	0.58	0.56	0.57	9.91	9.80	9.47	9.72
4.	V_4 – Diablo	55.75	55.27	53.89	54.97	0.57	0.55	0.55	0.55	10.88	10.78	10.26	10.63
	S.E. ±	0.184	0.188	0.159	0.098	0.001	0.002	0.002	0.005	0.018	0.024	0.027	0.036
	C.D. (P=0.05)	0.546	0.556	0.469	0.274	0.001	0.007	0.006	0.015	0.055	0.072	0.080	0.125
	Interaction												
1.	D_1V_1	45.38	44.90	42.75	44.34	0.51	0.49	0.47	0.48	10.08	9.92	9.70	9.89
2.	D_1V_2	55.66	54.85	53.65	54.71	0.56	0.54	0.53	0.54	10.78	10.67	10.10	10.51
3.	D_1V_3	41.47	40.90	38.85	40.40	0.57	0.54	0.53	0.54	9.82	9.73	9.45	9.66
4.	D_1V_4	57.81	57.45	55.50	56.91	0.58	0.56	0.56	0.56	11.30	11.24	10.85	11.13
5.	D_2V_1	53.75	53.55	52.75	53.35	0.54	0.53	0.52	0.52	10.54	10.38	9.95	10.28
6.	D_2V_2	57.25	56.75	55.15	56.38	0.55	054	0.52	0.53	11.01	10.90	10.15	10.68
7.	D_2V_3	40.83	40.05	38.90	39.92	0.62	0.60	0.57	0.59	9.81	9.65	9.50	9.65
8.	D_2V_4	45.32	44.75	43.50	44.52	0.57	0.55	0.54	0.55	10.13	10.05	9.65	9.94
9.	D_3V_1	50.73	50.55	49.00	50.09	0.57	0.56	0.54	0.55	10.61	10.49	10.10	10.40
10.	D_3V_2	55.13	54.75	53.80	54.55	0.57	0.55	0.55	0.55	10.93	10.79	10.25	10.65
11.	D_3V_3	39.99	39.35	37.35	38.89	0.62	0.61	0.58	0.60	10.31	10.19	9.85	10.11
12.	D_3V_4	47.85	47.55	45.60	47.00	0.61	0.60	0.58	0.59	10.33	10.23	10.00	10.18
13.	D_4V_1	50.84	50.45	48.80	50.02	0.495	0.48	0.48	0.48	9.85	9.72	9.55	9.70
14.	D_4V_2	52.90	52.55	51.35	52.26	0.51	0.49	0.47	0.48	9.83	9.73	9.55	9.70
15.	D_4V_3	40.51	40.00	38.60	39.70	0.55	0.53	0.51	0.52	9.72	9.59	9.25	9.51
16.	D_4V_4	43.67	42.85	41.85	42.78	0.52	0.50	0.50	0.50	9.92	9.78	9.35	9.67
17.	D_5V_1	52.89	52.45	50.10	51.81	0.53	0.52	0.49	0.51	10.26	10.21	9.90	10.12
18.	D_5V_2	42.05	41.50	40.25	41.26	0.55	0.53	0.51	0.52	10.37	10.29	9.95	10.20
19.	D_5V_3	42.64	42.15	40.55	41.77	0.63	0.61	0.58	0.60	9.92	9.85	9.30	9.68
20.	D_5V_4	44.62	44.05	41.85	43.50	0.58	0.55	0.55	0.55	9.35	9.22	9.10	9.22
	S.E. ±	0.412	0.420	0.354	0.205	0.001	0.005	0.004	0.010	0.041	0.055	0.060	0.053
	C.D. (P=0.05)	1.220	1.242	1.049	0.569	0.003	0.015	0.013	0.028	0.122	0.162	0.179	0.149

Table 2 : Effect of various spacings on yield of gerbera								
Sr. No.	Treatments	No. of flowers / plant /year				Flowers /m^2 /year			
Planting densities		2003	2004	2005	Pooled	2003	2004	2005	Pooled
1.	D$_1$ – 30 x 30 cm	52.80	51.48	49.80	51.36	327.25	316.62	307.12	317.00
2.	D$_2$ – 30 x 37.5 cm	50.28	48.72	45.72	48.24	302.25	291.00	280.75	291.33
3.	D$_3$ – 30 x 45 cm	42.60	40.80	38.64	40.68	255.63	243.62	230.87	243.37
4.	D$_4$ – 37.5 x 37.5 cm	52.56	50.64	47.88	50.28	315.50	302.62	294.37	304.17
5.	D$_5$ – 45.0 x 45.0 cm	43.32	41.52	39.24	41.40	260.63	246.87	235.00	247.50
	S.E. ±	0.132	0.300	0.432	0.108	0.802	1.104	1.461	0.592
	C.D. (P=0.05)	0.384	0.900	1.272	0.228	2.373	3.267	4.323	1.162
Varieties									
1.	V$_1$- Dana Ellen	37.80	36.00	34.20	36.00	228.90	216.70	208.10	217.90
2.	V$_2$- Sangria	44.28	42.96	40.56	42.60	268.40	255.70	243.80	255.97
3.	V$_3$ – Carrera	53.76	51.84	49.08	51.48	324.90	312.20	302.50	313.20
4.	V$_4$ – Diablo	57.36	55.80	53.28	55.44	346.80	336.00	324.10	335.63
	S.E. ±	0.120	0.276	0.384	0.096	0.717	0.987	1.306	0.530
	C.D. (P=0.05)	0.336	0.804	1.140	0.204	2.123	2.922	3.866	1.039
Interaction									
1.	D$_1$V$_1$	36.96	35.40	33.00	35.16	232.00	221.50	214.50	222.67
2.	D$_1$V$_2$	43.44	42.00	40.20	41.88	270.50	256.00	242.50	256.33
3.	D$_1$V$_3$	62.88	61.80	60.60	61.68	387.50	376.00	367.50	377.00
4.	D$_1$V$_4$	68.16	66.84	65.40	66.84	419.00	413.00	404.00	412.00
5.	D$_2$V$_1$	43.68	41.40	39.60	41.52	262.50	250.00	240.00	250.83
6.	D$_2$V$_2$	47.28	46.68	43.80	45.84	283.50	272.00	261.50	272.33
7.	D$_2$V$_3$	55.32	53.64	48.60	52.56	331.50	320.50	313.00	321.67
8.	D$_2$V$_4$	55.20	53.04	51.00	53.04	331.50	321.50	308.50	320.50
9.	D$_3$V$_1$	37.08	36.12	34.20	35.76	223.00	209.00	200.50	210.83
10.	D$_3$V$_2$	42.24	40.68	37.80	40.20	253.50	242.50	230.00	242.00
11.	D$_3$V$_3$	42.96	39.48	37.20	39.84	258.00	245.50	231.50	245.00
12.	D$_3$V$_4$	47.88	46.92	45.60	46.80	288.00	277.50	261.50	275.67
13.	D$_3$V$_1$	38.28	36.72	35.40	36.72	229.50	218.00	211.00	219.50
14.	D$_3$V$_2$	46.32	44.88	42.60	44.52	278.00	265.00	254.00	265.67
15.	D$_3$V$_3$	59.52	57.60	54.00	57.00	357.00	342.00	336.50	345.17
16.	D$_3$V$_4$	66.24	63.60	59.40	63.00	397.50	385.50	376.00	386.33
17.	D$_5$V$_1$	32.88	30.48	28.80	30.72	197.50	185.00	174.50	185.67
18.	D$_5$V$_2$	42.72	40.56	38.40	40.56	256.50	243.00	231.00	243.50
19.	D$_5$V$_3$	48.36	46.80	45.00	46.68	290.50	277.00	264.00	277.17
20.	D$_5$V$_4$	49.68	48.48	45.00	47.64	298.00	282.50	270.50	283.67
	SE ±	0.252	0.612	0.852	0.228	1.604	2.208	2.921	1.185
	CD	0.756	1.800	2.532	0.456	4.747	6.535	8.646	2.324

Table 3 : Economics of gerbera for different planting densities under polyhouse (125 m^2)

Sr. No.	Particulars	D1– 30 x 30 cm	D2– 30 x 37.5 cm	D3– 30 x 45 cm	D4– 37.5 x 37.5 cm	D5– 45.0 x 45.0 cm
1.	Fixed cost					
	Cost of structure (excluding cladding material) (Rs.)	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000
	b) Life of structure (Years)	25	25	25	25	25
	Depreciation /year (a / b)	4000	4000	4000	4000	4000
	Cost of cladding material (Rs.)	12,500	12,500	12,500	12,500	12,500
	Life of cladding material (Years)	5	5	5	5	5
	Depreciation/ Year (d / e)	2,500	2,500	2,500	2,500	2,500
2.	Repair and maintenance cost (Rs.) @ 2 %	2000	2000	2000	2000	2000
3.	Interest cost @ 10 %	5,625	5,625	5,625	5,625	5,625
4.	Total operational cost / m^2 (Rs.) $\frac{1 c + 1 f + 2 + 3}{125 m^2}$	113	113	113	113	113
5.	Cost of cultivation / m^2 (Rs.)	227	211	192	235	216
6.	Total cost of cultivation (4 + 5) (Rs./ m^2)	340	324	305	348	329
7.	Av. yield of produce (fls / m^2)	317	291	243	304	247
8.	Av. market price (Rs. / fl)	2	2	2	2	2
9.	Revenue Rs. / m^2 (7 x 8)	634	582	486	608	494
10.	Net profit / m^2 (9 – 6)	294	258	181	260	165
11.	B. C. Ratio (9 / 6)	1.86	1.79	1.59	1.74	1.50

per cent by closer planting

Interactions:

Among the interactions, interaction D_1V_4 was found to be superior among all the interactions with maximum average stalk length (56.91cm), flower diameter (11.13 cm), number of flowers/plant/year (66.84) and flowers/m^2/year (412.00).

Cost economics:

In the present studies the cost economics of gerbera was worked out by considering the fixed cost, cost of cultivation, operational cost, yield etc as reported in Table 3. From Table 3 it is revealed that the maximum B:C ratio (1.86) was observed in planting density D_1 (30x 30 cm). The maximum net profit per sqm (Rs.294/-) was found under the same planting density.

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