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GROWTH ANALYSIS AS INFLUENCED BY PLANTING GEOMETRY IN GARLAND CHRYSANTHEMUM (*Chrysanthemum coronarium* L.)

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ABSTRACT
A study was conducted to evaluate the effect of planting geometry on growth and yield parameters of garland chrysanthemum at Dharwad. The flower yield per ha was found to be highest at $S_{30 \times 30}$ level which is at par with $S_{30 \times 40}$ level in both *kharif* and *rabi* seasons. The number of flowers per plant was increasing as the plants were widely spaced, highest being recorded at $S_{60 \times 60}$ level. Maximum values in respect of leaf area index, crop growth rate and net assimilation rate were recorded by closer spacing level of 30 cm x 30 cm. Plants spaced closely at 30 cm x 30 cm recorded more plant height however, significantly lesser leaf area and above ground dry matter accumulation per plant compared to widely spaced plants at 60 cm x 60 cm.

KEY WORDS: Garland chrysanthemum, growth analysis and planting geometry.

INTRODUCTION
Garland chrysanthemum, botanically known as *Chrysanthemum coronarium* L., is an annual under the chrysanthemum group of flowers. It is more hardy, vigorous and grows taller. Its flowers are in various shades of yellow, white, having single or double forms (Desai, 1962). They are hermaphrodite. The plant is self-fertile and seed propagated. In India, the crop has been naturalized and locally called 'Bijli' in Nagpur (Meshram *et al.,* 2008), 'Baboona' in Haryana (Mishra *et al.,* 2002) 'Guldhak' in Punjab, 'Market' in Delhi and 'Gendi' in Uttar Pradesh area (Arora, 1990). Search for new species is increasing in floriculture, which has emerged as a field of great commercial importance both nationally and internationally. In India, there is a total of 1,60,720 ha under commercial floriculture with a loose flower production of 8,70,000 tonnes during the year 2007-2008 (Mistry *et al.,* 2008). There was a 230 per cent increase in loose flower and 480 per cent increase in total flower production between the years 1993-94 and 2001-02 (Singh and Upadhyaya, 2007). In the present investigation an attempt was made to increase the productivity of garland chrysanthemum by manipulating plant population per unit area. Planting geometry was varied in different treatments, which resulted in different population levels. The values of growth indices as influenced by various population levels in garland chrysanthemum are presented in this paper.

MATERIAL AND METHODS
The present study was carried out at Floriculture unit of Main Agricultural Research Station, Department of Horticulture, University of Agricultural Sciences, Dharwad, during the years 2007-2009. The objective of study was to evaluate the effect of planting geometry on growth parameters of garland chrysanthemum (*C. coronarium* L.). The experiment was conducted with five treatments corresponding to different populations as mentioned below.

Treatment	Planting geometry	Population	
		per plot	per ha
$S_{30 \times 30}$	30 cm x 30 cm	120	111111
$S_{40 \times 30}$	40 cm x 30 cm	90	83333
$S_{45 \times 45}$	45 cm x 45 cm	45	49383
$S_{60 \times 45}$	60 cm x 45 cm	35	37037
$S_{60 \times 60}$	60 cm x 60 cm	30	27778

The experiment was laid out in randomized block design with four replications, having a gross plot size of 3.9 m x 3.3 m which allowed a net plot size of 3.6 m x 3.0 m. The data recorded on each character were analyzed by the ANOVA technique as described by Panse and Sukhatme (1967). The treatment means were compared using the critical difference values calculated at 5 per cent level of significance.

RESULTS & DISCUSSION
Number of flowers per plant
The number of flowers per plant exhibited significant differences among the different levels of planting geometry during both the seasons (Table 1). In *kharif,* $S_{60 \times 60}$ level recorded the highest number of flowers per plant (58.59) which was significantly superior to closer levels $S_{40 \times 30}$ (39.11) whereas, a minimum of 34.65 flowers per plant was recorded by $S_{30 \times 30}$. In *rabi,* $S_{60 \times 60}$ level had the most productive plants with 71.66 flowers per plant which were significantly superior to $S_{40 \times 30}$ (58.82).

TABLE 1: Flower yield parameters as influenced by planting geometry in garland chrysanthemum during *kharif* and *rabi*

Treatment	Number of flowers per plant			Flower yield per plot (kg)		
	Kharif	*Rabi*	Mean	*Kharif*	*Rabi*	Mean
30 x 30 cm	34.65	44.73	**39.7**	7.02	11.14	**9.08**
40 x 30 cm	39.11	49.74	**44.4**	6.12	9.89	**8.01**
45 x 45 cm	47.18	58.82	**53.0**	5.23	8.64	**6.94**
60 x 45 cm	53.25	65.65	**59.5**	5.22	8.62	**6.92**
60 x 60 cm	58.59	71.66	**65.1**	5.17	8.55	**6.86**
Mean	**46.56**	**58.12**	**52.3**	**5.75**	**9.37**	**7.56**
S Em	4.92	5.53	5.23	0.39	0.54	0.47
CD at 5%	14.36	16.15	15.26	1.14	1.59	1.37

Flower yield per plot

Flower yield per plot exhibited significant differences among the different levels of planting geometry during both the seasons. In *kharif,* $S_{30 \times 30}$ level recorded the highest number of flowers per plot (4158) which was significantly superior to wider levels $S_{45 \times 45}$ (2264.6) whereas, a minimum of 1757.7 flowers per plot was recorded by $S_{60 \times 60}$. In *rabi,* $S_{30 \times 30}$ level was the most productive with 5367.6 flowers per plant on par with $S_{40 \times 30}$ (3979.2 flowers per plot) but significantly superior to $S_{45 \times 45}$ (2823.4 flowers per plot).

Seed yield per plant

Planting geometry influenced seed yield per plant significantly during both the seasons (Table 2). During *kharif,* $S_{60 \times 60}$ level recorded the highest seed yield per plant (12.49 g) which was significantly superior to $S_{30 \times 30}$ (7.79 g) but on par with rest of the levels. During *rabi,* $S_{60 \times 60}$ level was the most productive with 22.14 g seeds per plant which was followed by $S_{30 \times 30}$ (14.57 g) but on par with other treatments. During both seasons, minimum seed yield per plant was recorded by $S_{30 \times 30}$ at par with wider spacings up to $S_{60 \times 45}$ (12.10 g and 21.63 g).

TABLE 2: Seed yield parameters as influenced by planting geometry in garland chrysanthemum during *kharif* and *rabi*

Treatment	Seed yield per plant (g)			Seed yield per plot (g)		
	Kharif	*Rabi*	Mean	*Kharif*	*Rabi*	Mean
30 x 30 cm	7.79	14.57	**11.18**	934.3	1748.8	**1341.6**
40 x 30 cm	8.28	15.27	**11.78**	662.3	1221.4	**941.8**
45 x 45 cm	10.32	18.66	**14.49**	495.6	895.9	**695.7**
60 x 45 cm	12.10	21.63	**16.87**	484.1	865.4	**674.7**
60 x 60 cm	12.49	22.14	**17.32**	374.6	664.3	**519.4**
Mean	**10.20**	**18.47**	**14.34**	**590.2**	**1079.1**	**834.7**
S Em	1.49	2.43	1.96	1.49	2.43	1.96
CD at 5%	4.35	7.10	5.73	4.35	7.10	5.73

Seed yield per plot

There were significant differences with respect to seed yield per plot among the different levels of planting geometry during both the seasons. During *kharif,* $S_{30 \times 30}$ level recorded the highest seed yield per plot (934.3 g) which was significantly superior to widest level $S_{60 \times 60}$ (374.6 g) but at par with all the other planting geometry levels.. In *rabi,* $S_{30 \times 30}$ level was the most productive with 1748.8 g per plot seed yield which was on par with other spacing levels except $S_{60 \times 60}$ (664.3 g).

Plant height

Significant differences existed in the plant height due to planting geometry at all growth stages during both the seasons (Table 3). Mean plant height increased from 36.82 cm at 25 DAT to 91.16 cm at 65 DAT during *kharif*, whereas during *rabi* it increased from 27.94 cm at 25 DAT to 97.13 cm at 85 DAT. At 65 DAT during *kharif*, maximum plant height (122.48 cm) was recorded by the planting at 30 cm x 30 cm ($S_{30 \times 30}$).

TABLE 3: Plant height (cm) as influenced by planting geometry in garland chrysanthemum during *kharif* and *rabi*

Treatment	*Kharif* 25 DAT	45 DAT	65 DAT	*Rabi* 25 DAT	45 DAT	65 DAT	85 DAT
30 x 30 cm	48.03	108.40	122.48	36.45	82.27	103.89	129.41
40 x 30 cm	42.25	95.35	103.51	32.07	72.37	91.39	110.63
45 x 45 cm	34.98	78.95	85.70	26.55	59.92	75.66	91.59
60 x 45 cm	32.25	72.78	79.01	24.48	55.24	69.76	84.44
60 x 60 cm	26.58	59.99	65.12	20.17	45.53	57.49	69.60
Mean	**36.82**	**83.09**	**91.16**	**27.94**	**63.06**	**79.64**	**97.13**
S Em	4.22	6.34	5.57	3.20	4.81	4.56	4.93
CD at 5%	12.64	19.01	16.71	9.59	14.43	13.67	14.79

It was significantly superior to the next wider spacing ($S_{40 \times 30}$) which recorded a plant height of 103.51 cm. The plant height was at minimum (65.12 cm) with $S_{60 \times 60}$ which was on par with $S_{60 \times 45}$ (79.01 cm). At 85 DAT during *rabi*, maximum plant height (129.41 cm) was recorded by $S_{30 \times 30}$. It was followed by $S_{40 \times 30}$ (110.63 cm) while the minimum plant height was recorded by $S_{60 \times 60}$ (69.60 cm) which was significantly lesser to that recorded at $S_{60 \times 45}$ (84.44 cm).

Leaf area per plant

There were significant differences in leaf area per plant due to planting geometry at all growth stages during both the seasons (Table 4). Mean leaf area per plant showed an increase from 613.7 cm^2 at 25 DAT to 1420.8 cm^2 at 65 DAT during *kharif*, whereas during *rabi* it increased from 491 cm^2 at 25 DAT to 1450.9 cm^2 at 85 DAT. At 65 DAT during *kharif*, maximum leaf area (1751.7 cm^2) was recorded by plating geometry level of 60 cm x 60 cm. However, it was on par with all the other treatments except $S_{30 \times 30}$ (1113.7). At 85 DAT during *rabi*, maximum leaf area (1857.7 cm^2) was recorded by $S_{60 \times 60}$ which was at par with closer levels until $S_{45 \times 45}$ (1397.1 cm^2) but significantly superior to $S_{40 \times 30}$ and $S_{30 \times 30}$. Minimum leaf area per plant (1156.9 cm^2) was recorded in $S_{30 \times 30}$.

TABLE 4: Leaf area (cm^2) as influenced by planting geometry in garland chrysanthemum during *kharif* and *rabi*

	Leaf area (cm^2)						
	Kharif			*Rabi*			
Treatment	25 DAT	45 DAT	65 DAT	25 DAT	45 DAT	65 DAT	85 DAT
30 x 30 cm	415.6	822.8	1113.7	332.5	658.3	894.3	1156.9
40 x 30 cm	511.8	997.9	1253.8	409.4	798.4	1007.2	1289.6
45 x 45 cm	612.8	1194.9	1378.7	490.2	955.9	1107.9	1397.1
60 x 45 cm	713.8	1391.8	1606.0	571.0	1113.5	1290.5	1553.1
60 x 60 cm	814.8	1588.8	1751.7	651.8	1271.0	1141.5	1857.7
Mean	**613.7**	**1199.3**	**1420.8**	**491.0**	**959.4**	**1141.5**	**1450.9**
S Em	79.09	152.29	172.49	62.48	120.31	102.20	187.55
CD at 5%	237.12	456.57	517.11	187.32	360.69	306.39	562.25

Above ground dry matter accumulation per plant

The total dry matter accumulation per plant significantly differed among various levels of planting geometry at all growth stages during both the seasons (Table 5). Mean total dry matter increased from 12.19 g $plant^{-1}$ at 25 DAT to 29.93 g $plant^{-1}$ at 65 DAT during *kharif*, whereas during *rabi* it increased from 9.63 g $plant^{-1}$ at 25 DAT to 26.72 g $plant^{-1}$ at 85 DAT. At 65 DAT during *kharif*, maximum dry matter (39.83 g $plant^{-1}$) was recorded by the planting geometry level $S_{60 \times 60}$ which was on par with $S_{60 \times 45}$ (35.04 g $plant^{-1}$), while the minimum total dry matter per plant was recorded by closer level of planting geometry $S_{30 \times 30}$ (19.72 g $plant^{-1}$) which was at par with $S_{40 \times 30}$ (24.96 g $plant^{-1}$). At 85 DAT during *rabi*, maximum total dry matter per plant (34.92 g $plant^{-1}$) was recorded by $S_{60 \times 60}$ which was on par with $S_{60 \times 45}$ (31.42 g $plant^{-1}$), while the minimum total dry matter per plant was recorded by closer level of planting geometry $S_{30 \times 30}$ (16.60 g $plant^{-1}$) which was significantly lower than $S_{40 \times 30}$ (23.05 g $plant^{-1}$).

TABLE 5: Above ground dry matter accumulation per plant as influenced by planting geometry in garland chrysanthemum during *kharif* and *rabi*

	Kharif			*Rabi*			
Treatment	25 DAT	45 DAT	65 DAT	25 DAT	45 DAT	65 DAT	85 DAT
30 x 30 cm	8.19	14.56	19.72	6.47	11.50	15.58	16.60
40 x 30 cm	10.19	18.52	24.96	8.05	14.63	19.72	23.05
45 x 45 cm	12.19	22.49	30.11	9.63	17.76	23.79	27.59
60 x 45 cm	14.19	26.45	35.04	11.21	20.90	27.69	31.42
60 x 60 cm	16.19	30.42	39.83	12.79	24.03	31.47	34.92
Mean	**12.19**	**22.49**	**29.93**	**9.63**	**17.76**	**23.65**	**26.72**
S Em	1.58	2.09	1.99	1.25	1.65	1.57	1.60
CD at 5%	4.74	6.27	5.96	3.74	4.95	4.71	4.78

Leaf area index

There were significant differences in leaf area index values due to planting geometry levels at all growth stages during both the seasons (Table 6). Mean leaf area index showed an increase from 0.34 at 25 DAT to 0.81 at 65 DAT during *kharif*, whereas during *rabi* the value increased from 0.27 at 25 DAT to 0.83 at 85 DAT. At 65 DAT during *kharif*, maximum leaf area index (1.24) was recorded by $S_{30 \times 30}$ which was on par with $S_{40 \times 30}$ (1.04) but significantly superior to $S_{45 \times 45}$ (0.68) whereas the leaf area index was minimum in the plots with a planting geometry level of 60 cm x 60 cm (0.49). At 85 DAT during *rabi*, maximum leaf area index (1.29) was recorded by $S_{30 \times 30}$ which was on par with $S_{40 \times 30}$ (1.07) but significantly superior to $S_{45 \times 45}$ (0.69) whereas the minimum value was recorded with $S_{60 \times 60}$ (0.52).

Leaf area duration

The leaf area duration significantly differed among various levels of planting geometry at all growth stages during both the seasons (Table 7). Mean value of leaf area duration increased from 181.30 days (25 - 45 DAT) to 262 days (45 – 65 DAT) during *kharif*, whereas during *rabi* leaf area duration increased from 145.04 days (25 - 45 DAT) to 259.24 days (65 - 85 DAT). Between 45 and 65

DAT during *kharif*, maximum leaf area duration (334.05 days) was recorded by $S_{60 \times 60}$ which was on par with closer levels of planting geometry until $S_{45 \times 45}$ (257.36 days). $S_{60 \times 60}$ was followed by $S_{40 \times 30}$ (225.18 days). Between 65 and 85 DAT during *rabi*, maximum leaf area duration (326.56 days) was recorded by $S_{60 \times 60}$ which was on par with $S_{60 \times 45}$ (284.36 days) but significantly superior to $S_{45 \times 45}$ (250.50 days).

TABLE 6: Leaf area index as influenced by planting geometry in garland chrysanthemum during *kharif* and *rabi*

	Leaf area index						
	Kharif			*Rabi*			
Treatment	25 DAT	45 DAT	65 DAT	25 DAT	45 DAT	65 DAT	85 DAT
30 x 30 cm	0.46	0.91	1.24	0.37	0.73	0.99	1.29
40 x 30 cm	0.43	0.83	1.04	0.34	0.67	0.84	1.07
45 x 45 cm	0.30	0.59	0.68	0.24	0.47	0.55	0.69
60 x 45 cm	0.26	0.52	0.59	0.21	0.41	0.48	0.58
60 x 60 cm	0.23	0.44	0.49	0.18	0.35	0.39	0.52
Mean	**0.34**	**0.66**	**0.81**	**0.27**	**0.53**	**0.65**	**0.83**
S Em	0.051	0.102	0.159	0.041	0.081	0.126	0.166
CD at 5%	0.154	0.307	0.477	0.122	0.242	0.377	0.497

TABLE 7: Leaf area duration as influenced by planting geometry in garland chrysanthemum during *kharif* and *rabi*

	Leaf area duration (days)				
	Kharif		*Rabi*		
Treatment	25- 45 DAT	45- 65 DAT	25- 45 DAT	45- 65 DAT	65-85 DAT
30 x 30 cm	123.84	193.65	99.07	155.25	205.12
40 x 30 cm	150.97	225.18	120.78	180.55	229.68
45 x 45 cm	180.76	257.36	144.61	206.38	250.50
60 x 45 cm	210.56	299.78	168.45	240.39	284.36
60 x 60 cm	240.35	334.05	192.28	267.89	326.24
Mean	**181.30**	**262.00**	**145.04**	**210.09**	**259.24**
S Em	23.14	28.14	18.28	22.23	23.41
CD at 5%	69.37	84.36	54.80	66.64	70.19

Crop growth rate

Significant differences existed among crop growth rate values due to planting geometry at majority of growth stages during both the seasons (Table 8). Mean crop growth rate decreased from 2.76 g m^{-2} day^{-1} (25 - 45 DAT) to 2.07 g m^{-2} day^{-1} (45 - 65 DAT) during *kharif*, whereas during *rabi* the value decreased from 2.18 g m^{-2} day^{-1} (25 - 45 DAT) to 0.70 (65 - 85 DAT). Between 45 and 65 DAT during *kharif*, maximum crop growth rate (2.87 g m^{-2} day^{-1}) was recorded by $S_{30 \times 30}$ which was on par with wider levels until $S_{45 \times 45}$ (1.88 g m^{-2} day^{-1}) but significantly superior to $S_{60 \times 45}$ (1.59 g m^{-2} day^{-1}). The crop growth rate was minimum (1.31 g m^{-2} day^{-1}) with the treatment $S_{60 \times 60}$. Between 65 and 85 DAT during *rabi*, maximum crop growth rate (0.57 g m^{-2} day^{-1}) was recorded by $S_{30 \times 30}$ but there were no significant differences with other treatments. However, between 45 and 85 DAT significant differences were observed wherein $S_{30 \times 30}$ recorded maximum crop growth rate (2.27 g m^{-2} day^{-1}) which was at par with $S_{40 \times 30}$ (2.12 g m^{-2} day^{-1}) but significantly superior to $S_{60 \times 45}$ (1.26 g m^{-2} day^{-1}). The crop growth rate was recorded at minimum (1.03 g m^{-2} day^{-1}) with $S_{60 \times 60}$.

TABLE 8: Crop growth rate as influenced by planting geometry in garland chrysanthemum during *kharif* and *rabi*

	Crop growth rate (g m^{-2} day^{-1})				
	Kharif		*Rabi*		
Treatment	25- 45 DAT	45- 65 DAT	25- 45 DAT	45- 65 DAT	65-85 DAT
30 x 30 cm	3.54	2.87	2.79	2.27	0.57
40 x 30 cm	3.47	2.68	2.74	2.12	0.83
45 x 45 cm	2.54	1.88	2.01	1.49	0.94
60 x 45 cm	2.27	1.59	1.79	1.26	0.69
60 x 60 cm	1.98	1.31	1.56	1.03	0.48
Mean	**2.76**	**2.07**	**2.18**	**1.63**	**0.70**
S Em	0.35	0.34	0.28	0.27	0.21
CD at 5%	1.06	1.02	0.84	0.81	NS

Net assimilation rate

The effect of planting geometry on net assimilation rate was found significant at all growth stages during both the seasons (except at final stage during *rabi*) (Table 9). Mean net assimilation rate decreased from 3.16 x 10^{-2} g dm^{-2} day^{-1} (25 - 45 DAT) to 1.56 x 10^{-2} g

dm^{-2} day^{-1} (45 - 65 DAT) during *kharif*, whereas during *rabi* the value decreased from 3.12 x 10^{-2} g dm^{-2} day^{-1} (25 - 45 DAT) to 0.51 x 10^{-2} (65 - 85 DAT). Between 45 and 65 DAT during *kharif*, maximum net assimilation rate (2.69 x 10^{-2} g dm^{-2} day^{-1}) was recorded by $S_{30 \times 30}$ which was on par with $S_{40 \times 30}$ (2.15 x 10^{-2} g dm^{-2} day^{-1}). $S_{30 \times 30}$ was significantly superior to $S_{45 \times 45}$ (1.32 x 10^{-2} g dm^{-2} day^{-1}) while the minimum value was recorded by $S_{60 \times 60}$ (0.71 x 10^{-2} g dm^{-2} day^{-1}). Between 65 and 85 DAT during *rabi*, maximum net assimilation rate (0.50 x 10^{-2} g dm^{-2} day^{-1}) was recorded by $S_{30 \times 30}$ but the differences were not significant. Between 45 and 65 DAT the net assimilation rate was maximum (2.65 x 10^{-2} g dm^{-2} day^{-1}) at planting geometry level $S_{30 \times 30}$ which was on par with $S_{40 \times 30}$ (2.12 x 10^{-2} g dm^{-2} day^{-1}). $S_{30 \times 30}$ was significantly superior to $S_{45 \times 45}$ (1.30 x 10^{-2} g dm^{-2} day^{-1}) while the minimum value was recorded by $S_{60 \times 60}$ (0.69 x 10^{-2} g dm^{-2} day^{-1}).

TABLE 9: Net assimilation rate as influenced by planting geometry in garland chrysanthemum during *kharif* and *rabi*

	Net assimilation rate (x 10^{-2} g dm^{-2} day^{-1})				
	Kharif		*Rabi*		
Treatment	25- 45 DAT	45- 65 DAT	25- 45 DAT	45- 65 DAT	65-85 DAT
30 x 30 cm	5.34	2.69	5.27	2.65	0.50
40 x 30 cm	4.29	2.15	4.24	2.12	0.66
45 x 45 cm	2.62	1.32	2.59	1.30	0.68
60 x 45 cm	2.01	0.96	1.99	0.94	0.44
60 x 60 cm	1.53	0.71	1.51	0.69	0.27
Mean	**3.16**	**1.56**	**3.12**	**1.54**	**0.51**
S Em	0.80	0.42	0.79	0.41	0.09
CD at 5%	2.40	1.25	2.37	1.23	0.26

The flower yield as well as seed yield per plot in terms of weight is found to be highest at $S_{30 \times 30}$ level which is at par with $S_{30 \times 40}$ level in both *kharif* and *rabi* seasons. Flower yield in terms of number of flowers per plot also showed the same trend. With wider spacing levels, such yield parameters were found to decrease significantly. The higher yield in terms of flowers as well as seeds per unit area can be attributed to the higher population per unit area with closer spacing levels. Arora and Saini (1976) and Narayanagowda (1985) found that the flower production increases with the increase in plant density per square meter in case of china aster. Plants at high density might have fully exploited space, efficiently utilized the available resources as expressed by Rajanna (2001), Vijayakumar *et al.* (1988) in china aster and Venugopal (1991) in helichrysum. However, the number of flowers per plant was increasing as the plants were spaced widely. The increase was non- significant from $S_{30 \times 30}$ to $S_{45 \times 45}$ levels. The highest number of flowers per plant is recorded at $S_{60 \times 60}$ level, which was significantly superior to plant spacing levels from $S_{30 \times 30}$ to $S_{45 \times 45}$. Similar observations were also recorded by Jaswinder Singh and Arora (1990) in marigold, Vijayakumar *et al.* (1988) in china aster. The enhanced production in widely spaced plants was attributed to increase number of branches, number of leaves, leaf area and total dry matter production per plant (Rajanna, 2001). The highest leaf area per plant was observed with $S_{60 \times 60}$, it had been more significantly superior during earlier stages. At the advanced stage *i.e.* 65 DAT during *kharif* and 85 DAT during *rabi,* the leaf area per plant was recorded at par among all the spacing levels except at $S_{30 \times 30}$. The values of leaf area index clearly established that closely spaced plants were more significantly successful to maintain a higher leaf cover per unit of ground area on account of higher population, thus taking an advantageous situation in harvesting maximum amount of light energy. On the contrary, widely spaced plants in spite of maintaining higher number of leaves and leaf area per plant, were left with less than 50 per cent of leaf area per unit ground area at the final stage compared to the plants at $S_{30 \times 30}$ treatment. Similar report of decrease in leaf area index at wider spacing levels was also reported in china aster (Vijayakumar *et al.,* 1988).

However, leaf area duration values indicate that significantly superior values of leaf area per plant had been maintained among different growth stages at wider spacing levels of $S_{60 \times 60}$ and $S_{60 \times 45}$ compared to closer spacing levels of $S_{30 \times 30}$, $S_{30 \times 40}$ and $S_{45 \times 45}$. This shows that the differences among the leaf covers exhibited at different spacing levels were multiplied over time between two successive growth stages and became more significant. This can perhaps explain how widely spaced plants were able to record more number of flowers per plant. It is interesting to note that widely spaced plants were also superior in terms of number of branches per plant. Each of such branches terminated with flowers, which later produced a few more flowers from the buds located below the terminal bud, thus contributing to enhance flower yield. However, since leaf area duration did not take ground area into account, it does not explain the yield differences on per plot basis. An examination of dry matter partitioning among various parts of plant revealed that per plant dry matter production was more in case of widely spaced plants. Significantly higher total dry matter per plant was recorded at a spacing level $S_{60 \times 60}$, on par with $S_{60 \times 45}$. The same trend was also observed by different parts of plant. With increase in spacing level, the corresponding increase in dry matter partitioned to leaf and stem was lesser to that partitioned to flowers. Thus it might had led to more significant increase in the number of branches and number of flowers per plant rather than leaf area per plant by increasing spacing level from $S_{30 \times 30}$ to $S_{60 \times 60}$. More total dry matter per plant at wider spacing was positively related to flower yield per plant in marigold

(Nalawadi, 1982), in helichrysum (Venugopal, 1991) and in gaillardia (Hugar, 1997). A three-fold reduction in above ground bio-mass production by *C. coronarium* and *Anacylus radiatus* plants at high density was reported by Bastida and Menendaz (2003). On the contrary, the total dry matter per plot decreased significantly with increase in the spacing level, showing that above ground bio-mass production per plot had been drastically cut down as the spacing level increased from $S_{30 \times 30}$ to $S_{60 \times 60}$.
Further, crop growth rate and net assimilation rate was more between 25 to 45 days after transplanting compared to later intervals of crop life. Maximum growth rates per unit ground area as well as per unit leaf area were recorded at closer spacing levels of $S_{30 \times 30}$ and $S_{40 \times 30}$ which were at par with each other. Since these indices took the ground area into consideration, they explained how closely spaced garland chrysanthemum plants had been able to produce more flowers and seeds per plot. These differences can be attributed to those in plant population per unit area in the respective spacing levels. Growth indices, *viz.* crop growth rate, relative growth rate and net assimilation rate were recorded at maximum with closer spacing's in China aster (Vijayakumar *et al.,* 1988).

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