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GROWTH ANALYSIS AS INFLUENCED BY PINCHING TIME IN GARLAND CHRYSANTHEMUM (*Chrysanthemum coronarium* L.)

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ABSTRACT
The highest yield in terms of number of flowers per plant was recorded by pinching at 20 days after sowing (nursery) which was on par with those plants pinched at 10 days after transplanting. The highest seed yield per plant was recorded by pinching in nursery at 20 DAS, which was at par with pinching at 10 DAT Plants were consistently taller in non-pinched plots. Every delay in pinching caused reduction in plant height at final stage during both *kharif* and *rabi* seasons. the highest crop growth rate during all growth stages was recorded by pinching at 20 DAS, which was significantly superior at initial growth stage and at par during later growth stages when compared to pinching treatment at 10 DAT. Pinching at 20 DAS and at 10 DAT were also significantly superior in terms of net assimilation rates indicating that the leaf area had been more efficient in assimilation process compared to other treatments. Pinching at 20 DAT also maintained a reasonable net assimilation rate which was at par with non-pinched plants.

KEY WORDS: Garland chrysanthemum, leaf area index, net assimilation rate and pinching

INTRODUCTION

Pinching is the act of cutting or nipping off the new growth on a plant in order to force branching so that the eventual number of flowers is increased. A plant generally grows straight up due to apical dominance. If the growing tips are pinched out, assimilates are diverted into lateral buds and branching occurs. Modification of plant architecture by means of pinching has been done in several commercial flower crops. The optimum time and intensity of pinching was standardized by various workers in crops like marigold, china aster, florist chrysanthemum, *etc*. Time of last pinching was shown to influence blooming date in florist chrysanthemum. However, the effect of pinching on growth, yield and quality of garland chrysanthemum has not been analyzed. Hence, in the present investigation, the effect of pinching garland chrysanthemum both at nursery stage and after transplanting, on various vegetative and reproductive parameters has been studied and presented hereunder.

MATERIAL AND METHODS

The experiment comprised six treatments as listed below.

I. Pinching at 20 DAS (pinching in nursery)
II. Pinching at 10 DAT
III. Pinching at 20 DAT
IV. Pinching at 30 DAT
V. Pinching at 40 DAT
VI. No pinching (control)

The experiment was laid out in randomized block design with three replications. The layout plan is given in figure no. 5. The gross plot size was 3.0 m x 2.1 m and the net plot size was 2.7 m x 1.8 m. The spacing adopted was 30 cm both between rows and plants within a row. A few seedlings from a part of nursery were pinched off the apical buds at 20 days after sowing. Pinching after planting was done at different stages as per the treatments by removing the apical bud along with the crown of juvenile leaves manually.

RESULTS AND DISCUSSION

Number of flowers per plant

The number of flowers per plant exhibited significant differences among the different pinching times during both the seasons (Table 1). In *kharif,* pinching at 20 DAS recorded the highest number of flowers per plant (32.04) which was significantly superior to no pinching treatment (24.65) but on par with pinching at 10 DAT (30.71). A minimum of 20.24 flowers per plant was recorded by pinching at 40 DAT. In *rabi,* pinching at 20 DAS resulted in the maximum number of flowers per plant (42.80) significantly superior to non-pinched plants (34.48 flowers per plant) but on par with the plants pinched at 10 DAT (41.29 flowers per plant). Minimum number of flowers per plant was recorded by late pinching at 40 DAT (29.52).

Flower yield per plot

Flower yield per plot exhibited significant differences among the different times of pinching both the seasons. During *kharif,* pinching at 20 DAS recorded the highest number of flowers per plot (1537.9) which was significantly superior to no pinching treatment (1183.2) but on par with pinching at 10 DAT (1474.1). A minimum of 971.5 flowers per plant was recorded by pinching at 40 DAT. In *rabi,* pinching at 20 DAS resulted in the maximum number of flowers per plot (2054.4) significantly superior to non-pinched plants (1655.0 flowers per plot) but on par with the plants pinched at 10 DAT (1981.9 flowers per plot). Minimum number of flowers per plant was recorded by late pinching at 40 DAT (1417).

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

	Number of flowers per plant			Flower yield per plot (kg)		
Treatment	*Kharif*	*Rabi*	Mean	*Kharif*	*Rabi*	Mean
Pinching at 20 DAS	32.0	42.8	**37.4**	3.16	4.67	**3.92**
Pinching at 10 DAT	30.7	41.3	**36.0**	2.98	4.47	**3.73**
Pinching at 20 DAT	22.8	32.4	**27.6**	1.90	3.13	**2.52**
Pinching at 30 DAT	20.6	29.9	**25.2**	1.64	2.77	**2.21**
Pinching at 40 DAT	20.2	29.5	**24.9**	1.40	2.43	**1.92**
No pinching	24.7	34.5	**29.6**	1.99	3.04	**2.52**
Mean	**25.2**	**35.1**	**30.1**	**2.18**	**3.42**	**2.80**
S Em	1.45	1.63	1.54	0.12	0.16	0.14
CD at 5%	4.24	4.77	4.51	0.36	0.46	0.41

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

	Seed yield per plant (g)			Seed yield per plot (g)		
Treatment	*Kharif*	*Rabi*	Mean	*Kharif*	*Rabi*	Mean
Pinching at 20 DAS	7.40	14.33	**10.87**	355.07	687.76	**521.42**
Pinching at 10 DAT	6.50	12.67	**9.59**	311.86	607.98	**459.92**
Pinching at 20 DAT	4.00	8.25	**6.13**	192.19	396.01	**294.10**
Pinching at 30 DAT	3.40	7.17	**5.29**	163.43	344.29	**253.86**
Pinching at 40 DAT	3.10	6.55	**4.83**	148.72	314.52	**231.62**
No pinching	4.74	9.62	**7.18**	227.71	461.84	**344.78**
Mean	**4.86**	**9.77**	**7.32**	**233.16**	**468.73**	**350.95**
S Em	0.50	0.89	0.70	23.82	42.76	33.29
CD at 5%	1.45	2.60	2.03	69.53	124.8	97.17

TABLE 3: Plant height (cm) 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
Pinching at 20 DAS	46.11	104.07	117.58	39.61	89.39	118.42	124.76
Pinching at 10 DAT	44.05	99.42	112.33	37.84	85.39	113.13	119.19
Pinching at 20 DAT	41.95	94.68	106.97	36.03	81.32	107.74	115.50
Pinching at 30 DAT	45.50	91.46	106.93	39.08	78.55	91.84	111.38
Pinching at 40 DAT	48.75	90.19	101.40	41.87	73.28	90.03	106.78
No pinching	48.03	108.40	122.48	41.26	93.11	105.20	129.95
Mean	**45.73**	**98.03**	**111.98**	**39.28**	**83.57**	**104.39**	**117.93**
S Em	1.26	3.62	3.88	1.08	3.63	4.56	4.35
CD at 5%	3.78	10.85	11.64	3.24	10.90	13.66	13.05

Seed yield per plant

The seed yield per plant differed significantly among the different treatments during both the seasons (Table 2). The maximum seed yield per plant (7.40 g and 14.33 g) was recorded by pinching at 20 DAS which was on par with pinching at 10 DAT (6.50 g and 12.67 g) respectively during *kharif* and *rabi* seasons while the seed yield per plant was minimum (3.10 g and 6.55 g) by late pinching at 40 DAT.

Seed yield per plot

There were significant differences with respect to seed yield per plot among the different treatments during both the seasons. The maximum seed yield per plot (355.07 g and 687.76 g) was recorded by pinching at 20 DAS which was on par with pinching at 10 DAT (311.86 g and 607.98 g) respectively during *kharif* and *rabi* seasons. Late pinching at 40 DAT recorded the lowest seed yield per plot (148.72 g and 314.52 g) during both the seasons.

Plant height

Significant differences existed in the plant height due to time of pinching at all growth stages during both the seasons (Table 3). Mean plant height increased from 45.73 cm at 25 DAT to 111.98 cm at 65 DAT during *kharif*, whereas during *rabi* it increased from 39.28 cm at 25 DAT to 117.93 cm at 85 DAT. At 65 DAT during *kharif*, maximum plant height (122.48 cm) was recorded by non-pinched plants. It was on par with the plants pinched at 20 DAS and at 10 DAT (117.58 cm and 112.33 cm) whereas the plant height was minimum (101.40 cm) in the plants pinched at 40 DAT. At 85 DAT during *rabi*, maximum plant height (129.95 cm) was recorded by was recorded by no pinching treatment. It was significantly superior to pinching at 20 DAT having plant height of 113.50 cm but at par with the plants pinched earlier. The plant height was minimum (106.78 cm) in the plants pinched at 40 DAT.

Leaf area per plant

Leaf area per plant varied significantly due to time of pinching at all growth stages during both the seasons (Table 4). Mean leaf area per plant showed an increase from 431.42 cm^2 at 25 DAT to 1063.6 cm^2 at 65 DAT during *kharif*, whereas during *rabi* it increased from 340.8 cm^2 at 25 DAT to 1050.3 cm^2 at 85 DAT. At 65 DAT during *kharif*, maximum leaf area (1315.0 cm^2) was recorded by pinching at 20 DAS. It was at par with the leaf area (1211.6 cm^2) with the pinching at 10 DAT whereas the leaf area was minimum (885.5 cm^2) with pinching at 40 DAT. At 85 DAT during *rabi*, maximum leaf area (1298.5 cm^2) was recorded by pinching at 20 DAS. It was at par with the leaf area (1196.5 cm^2) with the pinching at 10 DAT whereas the leaf area was minimum (874.4 cm^2) with late pinching at 40 DAT.

Above ground dry matter accumulation per plant

The total dry matter accumulation per plant significantly differed among various treatments at all growth stages during both the seasons (Table 5). Mean total dry matter increased from 9.41 g $plant^{-1}$ at 25 DAT to 16.44 g $plant^{-1}$ at 65 DAT during *kharif*, whereas during *rabi* it increased from 7.48 g $plant^{-1}$ at 25 DAT to 16.63 g $plant^{-1}$ at 85 DAT. At 65 DAT during *kharif*, maximum dry matter (21.75 g $plant^{-1}$) was recorded by the pinching at 20 DAS which was on par with pinching at 10 DAT (18.75 g $plant^{-1}$), while the minimum total dry matter per plant was recorded by late pinching at 40 DAT (14.24 g $plant^{-1}$) which was at par with no pinching (16.62 g $plant^{-1}$) and early pinching until 20 DAT (14.75 g $plant^{-1}$). At 85 DAT during *rabi*, maximum total dry matter per plant (21.94 g $plant^{-1}$) was recorded by pinching at 20 DAS which was on par with pinching at 10 DAT (18.92 g $plant^{-1}$), while the minimum total dry matter per plant was recorded by pinching at 40 DAT (14.55 g $plant^{-1}$) which was on par with no pinching (15.22 g $plant^{-1}$) and early pinching until 20 DAT (15.18 g $plant^{-1}$).

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
Pinching at 20 DAS	490.7	971.5	1315.0	387.6	767.5	1038.8	1298.5
Pinching at 10 DAT	452.1	895.1	1211.6	357.2	707.2	957.2	1196.5
Pinching at 20 DAT	425.1	803.5	1067.1	335.9	634.8	843.0	1053.7
Pinching at 30 DAT	408.6	770.8	898.6	322.8	608.9	709.9	887.3
Pinching at 40 DAT	405.3	765.5	885.5	320.2	604.7	699.5	874.4
No pinching	406.8	772.1	1004.0	321.4	610.0	793.2	991.4
Mean	**431.4**	**829.7**	**1063.6**	**340.8**	**655.5**	**840.2**	**1050.3**
S Em	11.34	28.28	50.54	8.96	22.34	45.25	56.56
CD at 5%	34.00	84.78	151.51	26.86	66.98	135.65	169.56

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
Pinching at 20 DAS	12.06	17.84	21.75	9.53	14.09	19.75	21.94
Pinching at 10 DAT	10.21	15.32	18.75	8.06	12.10	17.04	18.92
Pinching at 20 DAT	6.80	11.46	14.75	5.38	9.00	13.82	15.18
Pinching at 30 DAT	9.32	13.23	14.52	7.41	10.47	13.38	14.71
Pinching at 40 DAT	9.07	12.97	14.24	7.27	10.32	13.18	14.55
No pinching	8.99	13.42	16.62	7.23	10.73	13.55	15.22
Mean	**9.41**	**13.94**	**16.44**	**7.48**	**11.12**	**14.77**	**16.63**
S Em	1.37	1.28	1.49	1.35	1.01	1.12	1.26
CD at 5%	4.12	3.83	4.46	4.04	3.02	3.36	3.76

Leaf area index

There were significant differences in leaf area index values due to time of pinching at all growth stages during both the seasons (Table 6). Mean leaf area index showed an increase from 0.48 at 25 DAT to 1.18 at 65 DAT during *kharif*, whereas during *rabi* the value increased from 0.38 at 25 DAT to 1.17 at 85 DAT. At 65 DAT during *kharif*, maximum leaf area index (1.46) was recorded by pinching at 20 DAS which was on par with pinching at 10 DAT (1.35), while the minimum leaf area index was recorded by pinching at 40 DAT (0.98). At 85 DAT during *rabi*, maximum leaf area index (1.44) was recorded by pinching at 20 DAS which was on par with pinching at 10 DAT (1.33), while the minimum leaf area index was recorded by late pinching at 40 DAT (0.97).

Leaf area duration

The leaf area duration significantly differed among various pinching times at all growth stages during both the seasons (Table 7). Mean value of leaf area duration increased from 126.12 days (25 - 45 DAT) to 189.33 days (45 – 65 DAT) during *kharif*, whereas during *rabi* leaf area duration increased from 99.63 days (25 - 45 DAT) to 189.05 days (65 - 85 DAT). Between 45 and 65 DAT during *kharif*, maximum leaf area duration (228.64 days) was recorded by pinching at 20 DAS which was on par with pinching at 10 DAT (210.67 days), while the minimum leaf area duration was recorded by late pinching at 40 DAT (165.09

days). At 85 DAT during *rabi*, maximum leaf area duration (233.73 days) was recorded by pinching at 20 DAS which was on par with pinching at 10 DAT (215.36 days), while the minimum leaf area duration was recorded by late pinching at 40 DAT (157.39 days).

Crop growth rate

Significant differences existed among crop growth rate values due to time of pinching at all growth stages during both the seasons (Table 8). Mean crop growth rate decreased from 2.52 g m^{-2} day^{-1} (25 - 45 DAT) to 1.39 g m^{-2} day^{-1} (45 - 65 DAT) during *kharif*, whereas during *rabi* the value decreased from 2.02 g m^{-2} day^{-1} (25 - 45 DAT) to 1.03 (65 - 85 DAT). Between 45 and 65 DAT during *kharif*, maximum crop growth rate (2.17 g m^{-2} day^{-1}) was recorded by the pinching at 20 DAS which was on par with pinching at 10 DAT (1.91 g m^{-2} day^{-1}). The crop growth rate was minimum (0.70 g m^{-2} day^{-1}) with late pinched plots at 40 DAT. Between 65 and 85 DAT during *rabi*, maximum crop growth rate (1.22 g m^{-2} day^{-1}) was recorded by the spray of pinching at 20 DAS significantly superior to pinching at 10 DAT (1.04 g m^{-2} day^{-1}). The crop growth rate was recorded at minimum (0.74 g m^{-2} day^{-1}) with pinching at 30 DAT on par with pinching at 40 DAT (0.76 g m^{-2} day^{-1}).

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
Pinching at 20 DAS	0.55	1.08	1.46	0.43	0.85	1.15	1.44
Pinching at 10 DAT	0.50	1.00	1.35	0.40	0.79	1.06	1.33
Pinching at 20 DAT	0.47	0.89	1.19	0.37	0.71	0.94	1.17
Pinching at 30 DAT	0.45	0.86	1.00	0.36	0.68	0.79	0.99
Pinching at 40 DAT	0.45	0.85	0.98	0.36	0.67	0.78	0.97
No pinching	0.45	0.86	1.12	0.36	0.68	0.88	1.10
Mean	**0.47**	**0.92**	**1.18**	**0.38**	**0.73**	**0.93**	**1.17**
S Em	0.0189	0.0314	0.0636	0.0149	0.0248	0.0503	0.0628
CD at 5%	0.0567	0.0942	0.1908	0.0448	0.0744	0.1507	0.1884

TABLE 7: Leaf area duration as influenced by pinching time 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
Pinching at 20 DAS	146.21	228.64	115.51	180.63	233.73
Pinching at 10 DAT	134.72	210.67	106.43	166.43	215.36
Pinching at 20 DAT	122.86	187.05	97.06	147.77	189.67
Pinching at 30 DAT	117.93	166.93	93.17	131.88	159.72
Pinching at 40 DAT	117.07	165.09	92.49	130.42	157.39
No pinching	117.89	177.61	93.13	140.31	178.46
Mean	**126.12**	**189.33**	**99.63**	**149.57**	**189.05**
S Em	5.94	12.71	4.69	10.04	15.27
CD at 5%	17.80	38.12	14.06	30.11	45.78

TABLE 8: Crop growth rate as influenced by pinching time 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
Pinching at 20 DAS	3.21	2.17	2.54	3.14	1.22
Pinching at 10 DAT	2.84	1.91	2.24	2.74	1.04
Pinching at 20 DAT	2.35	1.46	2.02	1.52	1.49
Pinching at 30 DAT	2.17	0.63	1.70	1.62	0.74
Pinching at 40 DAT	2.17	0.70	1.70	1.59	0.76
No pinching	2.36	1.48	1.94	1.57	0.93
Mean	**2.52**	**1.39**	**2.02**	**2.03**	**1.03**
S Em	0.0849	0.1349	0.0685	0.1497	0.0472
CD at 5%	0.2545	0.4044	0.2054	0.4487	0.1416

Net assimilation rate

There were significant differences among net assimilation rate values due to time of pinching at all growth stages during both the seasons (Table 9). Mean net assimilation rate decreased from 3.70 x 10^{-2} g dm^{-2} day^{-1} (25 - 45 DAT) to 1.29 x 10^{-2} g dm^{-2} day^{-1} (45 - 65 DAT) during *kharif*, whereas during *rabi* it decreased from 3.77 x 10^{-2} g dm^{-2} day^{-1} (25 - 45 DAT) to 0.98 x 10^{-2} g dm^{-2} day^{-1} (65 - 85 DAT). Between 45 and 65 DAT during *kharif*, maximum net assimilation rate (1.81 x 10^{-2} g dm^{-2} day^{-1}) was recorded

by non-pinched plots at par with early pinching treatment at 20 DAS (1.72 x 10^{-2} g dm^{-2} day^{-1}), pinching at 10 DAT (1.64 x 10^{-2} g dm^{-2} day^{-1}) and pinching at 20 DAT (1.42 x 10^{-2} g dm^{-2} day^{-1}). Between 65 and 85 DAT during *rabi*, maximum net assimilation rate (0.94 x 10^{-2} g dm^{-2} day^{-1}) was recorded by pinching at 20 DAS but at par with no pinching (0.94 x 10^{-2} g dm^{-2} day^{-1}) and pinching at 10 DAT (0.88 g dm^{-2} day^{-1}). Between 45 and 65 DAT the net assimilation rate was maximum (3.16 g dm^{-2} day^{-1}) by pinching at 20 DAS on par with pinching at 10 DAT (2.99 g dm^{-2} day^{-1}) but significantly superior to rest of the treatments while the minimum value was recorded by pinching at 20 DAT (1.87 g dm^{-2} day^{-1}).

TABLE 9: Net assimilation rate as influenced by pinching time 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
Pinching at 20 DAS	4.11	1.72	4.11	3.16	0.94
Pinching at 10 DAT	3.94	1.64	3.94	2.99	0.88
Pinching at 20 DAT	3.56	1.42	3.86	1.87	1.42
Pinching at 30 DAT	3.43	0.68	3.39	2.21	0.84
Pinching at 40 DAT	3.45	0.77	3.41	2.19	0.88
No pinching	3.73	1.51	3.88	2.03	0.94
Mean	**3.70**	**1.29**	**3.77**	**2.41**	**0.98**
S Em	0.0014	0.0021	0.0015	0.0023	0.0003
CD at 5%	0.0042	0.0062	0.0044	0.0069	0.0010

The highest yield in terms of number of flowers per plant was recorded by pinching at 20 days after sowing (nursery) which was on par with those plants pinched at 10 days after transplanting. Pinching at 20 DAT registered a performance at par with non-pinched plants. Delay in pinching beyond 20 DAT, decreased the number of flowers per plant compared to non-pinched plants. Similar trend was also recorded in the weight of flowers per unit area, since the plant population is kept constant in all the treatments. Pinching in nursery increased the number of flowers per plant in china aster (Malleshappa, 1984) and in marigold (Basavaraj, 1984). Significant differences in number of flowers per plant due to time of pinching in chrysanthemum were also observed by Singh and Baboo (2003) and Beniwal *et al.* (2005). The enhanced yield due to pinching was attributed to increased number of branches per plant that could increase flowering points in china aster (Malleshappa, 1984). Arora and Khanna (1986) and Sehrawat *et al.* (2003) also observed more number of branches associated with more number of flowers per plant in marigold. Similar to the number of flowers per plant, the highest seed yield per plant was recorded by pinching in nursery at 20 DAS, which was at par with pinching at 10 DAT, indicating the dependence of seed yield on flower yield. Pinching at 20 DAT was on par with non-pinched plants with regard to seed yield per plant, other treatments being significantly inferior in seed yield. Bhat and Shepherd (2007) and Sunitha *et al.* (2007) observed significant differences in seed yield due to pinching in marigold, which were attributed to growth and flowering characters. The superiority of early pinching treatments in garland chrysanthemum can be attributed to the efficient photosynthetic area, better assimilation into reproductive parts and putting up optimum vegetative growth without interrupting floral bud initiation.

Plants were consistently taller in non-pinched plots. Every delay in pinching caused reduction in plant height at final stage during both *kharif* and *rabi* seasons. Among the plots that were pinched, the treatment of pinching at 20 DAS recorded maximum plant height at final stage followed by pinching at 10 DAT. Other treatments recorded significantly shorter plant height compared to non-pinched plants. Pinching at 20 DAT had dwarfed plants from first stage of observation itself, however, they were able to recover later to some extent showing taller plants at par with those pinched at 10 DAT. When pinching was done at 30 and 40 DAT, such plants were not able to recover and catch up the growth, thus remaining significantly dwarf compared to non-pinched plants and plants pinched earlier. Plant height was significantly reduced by the pinching treatment in chrysanthemum cv. MDU-1 (Yassin and Pappiah, 1990).

The results on total dry matter per plant revealed that the maximum dry matter was assimilated in the plants pinched at 20 DAS, which were followed by those pinched at 10 DAT. Later pinching treatments registered the values of total dry matter either significantly lesser than non-pinched plants or on par with them. Pinching at 20 DAT has recorded total dry matter at final stage in both the seasons statistically on par with non-pinched plants. This treatment was also significantly superior to later pinching treatments, though significantly inferior to nursery pinched plants and those pinched at 10 DAT in respect of total dry matter assimilation. Significant differences in dry weight of plant due to pinching were also reported by Debra and Lewis (1986) in chrysanthemum. As a consequence of higher leaf area per plant, pinching in nursery at 20 DAS and at 10 DAT recorded higher values of leaf area index and leaf area duration significantly superior to other plants pinched at later times as well as non-pinched plants. Other pinching treatments resulted in suppression of leaf area index and leaf area duration values which were closely related to the trends in leaf area. An examination of growth indices as influenced by pinching time indicated that the highest crop growth rate during all growth stages was recorded by pinching at 20 DAS, which was

significantly superior at initial growth stage and at par during later growth stages when compared to pinching treatment at 10 DAT. Both these early pinching treatments were significantly superior to non-pinched plants. Pinching at 20 DAT recorded a moderate crop growth rate which was significantly lower than early pinching treatments at 20 DAS and 10 DAT at all growth stages. Crop growth rate by this treatment was at par with non-pinched plants at almost all growth stages. Pinching at 30 DAT and pinching at 40 DAT recorded very low crop growth rate values. Non-pinched plants maintained a fair growth rate between 25 to 65 days after transplanting in both the seasons. Plants pinched in nursery at 20 DAS quickly recovered soon after transplanting maintaining a superior crop growth rate compared to other treatments. They were able to assimilate significantly higher dry matter even at 25 DAT compared to non-pinched plants. Further they continued dry matter assimilation at a higher rate and at the same time pushing a larger proportion into reproductive parts. Pinching at 10 DAT had a shock but within active vegetative growth stage, thus having enough scope to recover. Such plants could regain the initial momentum and excelled the non-pinched plants in maintaining a good growth rate on par with those pinched at 20 DAS. Comparatively, plants pinched at 20 DAT were subjected to severe shock that they took a long time to recover. They maintained the growth rate values slightly lower than non-pinched plants, though they had more initial dry matter in various parts. However, these plants continued to struggle and put up a good growth and maintained crop growth rate at par with non-pinched plants. Late pinched plants which have not been affected at 25 DAT, dropped off their growth rate subsequently after 25 DAT and maintained crop growth rate at significantly lower levels compared to even non-pinched plants, leaving a very less proportion of assimilates into reproductive parts ultimately leading to less flower production and seed production.

Pinching at 20 DAS and at 10 DAT were also significantly superior in terms of net assimilation rates indicating that the leaf area had been more efficient in assimilation process compared to other treatments. Pinching at 20 DAT also maintained a reasonable net assimilation rate which was at par with non-pinched plants. Thus growth analysis revealed that these treatments maintained a fair amount of leaf cover per unit of ground area, for a longer duration and assimilated more dry matter during the log phase of growth as well partitioned a good proportion into reproductive parts catching a better position to record significantly higher yields compared to late pinched plants. Late pinching at or after 30 DAT in garland chrysanthemum was detrimental to the crop growth impeding the process of synthesizing and sinking assimilates into reproductive parts thus failing to record reasonable production of flowers and seeds.

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