



Effect of planting distance and pinching on growth, flowering and yield of China aster (*Callistephus chinensis*.) cv. Poornima

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ABSTRACT

An experiment was conducted to study the effect of planting distance and pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees.) cv. Poornima. The experiment consisted of six spacing (20 × 10, 30 × 10, 40 × 10, 30 × 20, 30 × 30, 40 × 20;) and with unpinched and pinched and laid out in factorial randomized block design with two replications. The closer spacing 20 cm × 10 cm produced taller plants (86.74 cm) and flower production was higher / unit area than wider spacing. Pinching reduced the plant height and delayed flowering. Pinched plant yield more than unpinched plant. The interaction of spacing and pinching was found that closer spacing with pinching gave higher yield (56.75 kg/plot) and economically best than wider spacing with unpinched plants. Wider spacing with pinched plants given more number (60.90), weight (381.05 g/plot) and diameter (5.90 cm) of flowers.

Key words: China aster, Internode, Pinching, Stalk length, Vase-life

China aster (*Callistephus chinensis* L. Nees) is one of the most popular cut flowers as well as loose flowers grown throughout the world. The increasing popularity of China aster in recent year is very much evident from the statistics that Pune alone, it is being grown in an area of 400 ha; with average yield of 11–25 tonnes/ha (Janakiram and Manjunath, 2002). It bears excellent pure white flowers. Productivity and quality of flower crop can be improved either by high-yielding cultivar or improved horticulture practices including proper agriculture inputs and practices such as proper spacing and pinching, apical dominance in aster has been one of the factor limiting production of flower spacing of planting aster depends upon soil type, climate and cultivars (Janakiram and Manjunath 2002). Keeping above facts in view the present investigation is proposed to study the response of planting distance and pinching on growth, flowering and yield of China aster.

MATERIALS AND METHODS

The experiment was conducted in winter (*rabi*) season at Horticulture Nursery, Department of Horticulture, College

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of Agriculture, Indore, Madhya Pradesh during 2006–07. Seed were collected from Indian Institute of Horticulture Research (IIHR), Bangalore. Seedlings were grown in 120 × 60 × 10 cm size nursery and 40 days old uniform height seedlings having 6–10 cm height were transplanted in 2.4 m × 1.8 m size plots in the field. In pinching, main shoot was pinched retaining six pairs of leaves from the base, 25–30 days after planting. The experiment was laid out in a factorial randomized block design with 12 treatments T₁(S₁*P₀-20cm × 10cm), T₂(S₂*P₀-30cm × 10cm), T₃(S₃*P₀-40cm × 10cm), T₄(S₄*P₀-30cm × 20cm), T₅(S₅*P₀-30cm × 30 cm), T₆(S₆*P₀-40cm × 20cm), T₇(S₁*P₁-20cm × 10cm + pinching), T₈(S₂*P₁-30cm × 10cm + pinching), T₉(S₃*P₁-40cm × 10cm + pinching), T₁₀(S₄*P₁-30cm × 20cm + pinching), T₁₁(S₅*P₁-30cm × 30cm + pinching), T₁₂(S₆*P₁-40cm × 20cm + Pinching) with three replications. Field preparation, Intercultural operations, irrigation and fertigation were done as per the standard recommendations. The observations of vegetative growth characters and floral growth characters were recorded and analyzed statistically (CD at 5% level) as procedure described by Panse and Sukhatme 1978.

RESULTS AND DISCUSSION

Growth characters

It was observed that during all the stages of plant growth, plant height was maximum at the closer spacing of 20 cm × 10 cm and decreased gradually as the spacing increased in all the observation recorded at 25, 50, 75 and 100 days after

transplanting (Table 1). The maximum plant height was 86.74 cm in a spacing of 20 cm × 10 cm (100 DAT). The effect of closer spacing (20 cm × 10 cm) was supported by Singh and Sangama (2001). Higher plant height was recorded in treatments including unpinched plants (86.83 cm) as compared to the pinched plants (81.85 cm), it might be due to the reason of apical dominance in case of unpinched plants as also supported by Sehrawat *et al.* (2003) and Tomar *et al.* (2004) in African marigold. In the present experiment the best combination of spacing and pinching was found to be the interaction of 20 cm × 10 cm and unpinched plants (89.20 cm) with the greater effect on plant height as compared to the maximum spacing of 40 cm × 20 cm and pinched plants (80.12 cm). So it is evident that for higher plant height we can go for closest spacing along with unpinched plants. The findings were supported by Beniwal *et al.* (2003) in Chrysanthemum.

The maximum number of leaves was recorded at the spacing of 30 cm × 30 cm at different successive days (Table 1). It was 154.95 (100 DAT), followed by the wider spacing of 40 cm × 20 cm (153.66). This result was due to the reason that there might be less competition for light and nutrients in the wider spacing which might have resulted in well spread of plant utilizing proper carbohydrate and sunlight. A positive effect of pinching was found in the plants and the pinched plant showed maximum number of leaves (157.20) in comparison to unpinched plants (130.67) at 100 DAT. This was due to the lateral dominance in the plants, producing more number of branches and thus more leaves. The effect of the combination of spacing and pinching was found to be non-significant for the number of leaves at the 25, 50 and 75 DAT, but a significant variation was found at the final recording with maximum number of leaves were recorded at a spacing of 30 cm × 30 cm and in pinched plants followed by a spacing of 40 cm × 20 cm and pinched plants. Thus the number of leaves increased substantially with the increase in spacing and pinched plants. The results are in similarity with Ryagi *et al.* (2007).

The leaf area and leaf area index was recorded at two different stages of the plant growth, viz 75 and 100 DAT (Table 1). The leaf area was found significantly correlated with spacing at the final recording (6204.4 cm²) and it increased in ascending order with an increase in planting distance. The pinched plant showed more leaf area in comparison to the unpinched plants. The interaction of spacing and pinching was non-significantly correlated to the leaf area in China aster. The leaf area index was found significantly correlated with spacing at the final recording and it increased in ascending order with decrease in planting distance. The maximum leaf area index was found at the least spacing of 20 cm × 10 cm. The pinched plant showed more leaf area in comparison to the unpinched plants. The interaction of spacing and pinching was non-significantly correlated to the leaf area in China aster.

The numbers of branches was found to be significant with a planting distance (Table 1). The maximum number of primary branches was recorded with spacing of 30 cm × 30 cm at 100 DAT (15.34). The numbers of secondary branches was also found maximum at the spacing of 30 cm × 30 cm at 100 DAT (22.03). This may be attributed to better uptake of nutrition and sunlight due to less competition. The maximum number of branches (primary and secondary) substantially increased in the pinched plants. The similar results were found by Chauhan *et al.* (2005) in Marigold. They found that number of branches increased significantly with pinching. Among the interactions the combination of 30 cm × 30 cm spacing and pinched plants had shown maximum number of branches. In interaction, number of primary branches showed non-significant, whereas, interaction (T₁₁) produced maximum number of secondary branches (27.14). The finding was supported by Tomar *et al.* (2004)

Flowering characters

The variable planting distances and pinching adopted had a significant influence on the flowering behaviour and flower quality in the China aster (Table 2). The number of flower in the primary and secondary branches showed significant increase with the different planting distances. The maximum number of flowers in the primary branches was recorded with the planting distance of 30 cm × 30 cm (14.21). The maximum number of flowers on secondary branches was recorded with the planting distance of 40 cm × 20 cm (39.76). Both the observations were significantly superior, compared to other levels. The similar findings were reported by Yassain and Pappiah (1990) in Chrysanthemum. The maximum number of flowers in the primary and secondary branches was found significantly higher in the pinched plants than the unpinched ones. The combination of 30 cm × 30 cm spacing and pinched plants showed significantly superior results as compared to other treatment combinations in number of flowers in the primary branches. The combination of 30 cm × 20 cm and pinched plants was found superior than the other treatments for the number of flowers in the secondary branches.

The various planting distances did not significantly influenced the days of floral bud emergence, days of bud opening, days of first flowering and days of 50% flowering, whereas the pinching of the plants had a significant effect on the same. The pinched plants were significantly superior to the unpinched plants for the mentioned flowering characters. The interaction of spacing and pinching had a non-significant influence on the days of floral bud emergence and days of bud opening. But it had a significant effect on the days of first and 50% flowering. The combination of 30 cm × 30 cm spacing and pinched plants were found to be significantly superior (118.67 and 138.33, respectively) to any other combination for the first and 50% flowering.

Table 1 Influence of spacing, pinching and their interaction on vegetative growth at different successive days

	Treatments plant height (cm)						Number of leaves						Leaf area (cm ²)						Leaf area index						Number of primary branches						Number of secondary branches						
	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT	
<i>Spacing</i>																																					
S ₁ (20×10cm)	15.07	33.63	56.53	86.74	12.10	55.20	83.75	128.56	3041.59	4901.66	152.08	245.08	7.00	7.97	12.34	16.46																					
S ₂ (30×10cm)	14.37	33.17	54.89	85.52	13.37	51.97	85.39	138.01	3050.84	5310.08	101.69	177.00	6.40	8.47	12.77	17.92																					
S ₃ (40×10cm)	14.13	32.10	54.57	84.37	12.97	48.57	87.21	141.46	3188.11	5761.52	79.70	144.04	6.70	7.17	13.10	19.16																					
S ₄ (30×20cm)	13.50	32.10	53.48	83.51	14.23	50.37	90.06	146.97	3211.37	5961.75	53.52	99.36	7.37	8.47	13.23	20.06																					
S ₅ (30×30cm)	13.00	31.63	52.47	83.23	15.43	51.53	96.27	154.95	3421.96	6291.02	38.02	69.90	6.70	8.57	15.34	22.03																					
S ₆ (40×20cm)	12.77	31.83	51.70	82.71	15.13	51.20	94.21	153.66	3265.84	6204.40	40.82	77.56	6.73	8.70	14.51	21.43																					
SEm ±	0.35	0.86	0.10	0.19	0.74	1.84	0.83	0.68	204.24	139.93	5.32	5.02	0.36	0.22	0.17	0.19																					
CD (5%)	1.04	NS	0.29	0.56	2.16	NS	2.44	2.00	NS	410.42	15.61	14.73	NS	0.64	0.51	0.55																					
<i>Pinching</i>																																					
P ₀ unpinched	14.13	34.12	56.31	86.83	13.20	48.46	80.10	130.67	2898.81	5237.45	70.34	123.24	5.40	7.37	11.58	14.88																					
P ₁ (pinched)	13.48	30.70	51.57	81.85	14.54	54.49	98.86	157.20	3494.44	6239.36	84.94	147.74	8.23	9.08	15.52	24.14																					
SEm ±	0.20	0.50	0.06	0.11	0.42	1.06	0.48	0.39	117.92	80.79	3.07	2.90	0.21	0.13	0.10	0.11																					
CD (5%)	0.60	1.46	0.16	0.32	1.25	3.11	1.41	1.15	345.86	236.95	9.01	8.51	0.61	0.37	0.29	0.32																					
<i>Interaction</i>																																					
T ₁ (S ₁ P ₀)	15.33	35.60	59.47	89.20	11.47	51.47	75.82	116.75	2871.87	4565.38	143.59	228.27	5.47	7.13	10.70	13.02																					
T ₂ (S ₂ P ₀)	14.73	35.00	56.93	87.74	12.20	49.60	76.75	122.31	2824.82	4771.50	94.16	159.05	4.73	7.87	11.05	13.86																					
T ₃ (S ₃ P ₀)	14.27	33.40	56.64	86.46	12.27	44.73	78.24	125.29	2504.39	4961.37	62.61	124.03	4.87	6.47	11.28	14.20																					
T ₄ (S ₄ P ₀)	14.27	33.53	55.25	86.34	13.93	47.27	80.77	133.08	2739.75	5336.23	45.66	88.94	6.40	7.33	11.10	15.27																					
T ₅ (S ₅ P ₀)	13.40	33.80	54.94	86.00	14.20	47.00	85.25	142.96	3318.47	5921.51	36.87	65.79	5.67	7.53	13.10	16.91																					
T ₆ (S ₆ P ₀)	12.80	33.40	54.62	85.29	15.13	50.67	83.76	143.59	3133.53	5868.72	39.17	73.36	5.27	7.87	12.25	16.00																					
T ₇ (S ₁ P ₁)	14.80	31.67	53.59	84.29	12.73	58.93	91.68	140.37	3211.32	5237.93	160.57	261.90	8.53	8.80	13.99	19.90																					
T ₈ (S ₂ P ₁)	14.00	31.33	52.84	83.31	14.53	54.33	94.02	153.70	3276.86	5848.67	109.23	194.96	8.07	9.07	14.50	21.98																					
T ₉ (S ₃ P ₁)	14.00	30.80	52.51	82.28	13.67	52.40	96.17	157.63	3871.83	6561.67	96.80	164.04	8.53	7.87	14.92	24.12																					
T ₁₀ (S ₄ P ₁)	12.73	30.67	51.72	80.68	14.53	53.47	99.36	160.86	3683.00	6587.27	61.38	109.79	8.33	9.60	15.35	24.84																					
T ₁₁ (S ₅ P ₁)	12.60	29.47	50.00	80.46	16.67	56.07	107.28	166.93	3525.45	6660.54	39.17	74.01	7.73	9.60	17.58	27.14																					
T ₁₂ (S ₆ P ₁)	12.73	30.27	48.78	80.12	15.13	51.73	104.67	163.72	3398.16	6540.09	42.48	81.75	8.20	9.53	16.76	26.85																					
SEm ±	0.50	1.22	0.14	0.27	1.04	2.60	1.18	0.96	288.83	197.89	7.53	7.10	0.51	0.31	0.24	0.26																					
CD (5%)	NS	NS	0.40	0.79	NS	NS	NS	2.82	NS	NS	NS	NS	NS	NS	NS	NS																					
CV					12.98	8.73	2.27	1.15																													

NS, Non-significant; DAT, days to transplanting

Table 2 Influence of spacing, pinching and their interaction on flowering characters

Treatment	Days of floral bud emergence	Days of bud opening	Days of first flowering	Days of 50% flowering	Number of flowers on primary branches	Number of flowers on secondary branches	Flower diameter (cm)	Number of flowers/plant	Number of flowers/plot	Length of flower stalk (cm)	Flower Weight (g)	Weight of flowers/plant (g)	Weight of flowers/plot (kg)
<i>Spacing</i>													
S ₁ (20×10cm)	100.83	104.67	110.17	128.50	11.61	29.00	5.29	40.60	8493.69	29.42	5.34	216.73	45.33
S ₂ (30×10cm)	100.50	105.00	110.67	132.50	11.93	33.34	5.41	45.27	6186.98	29.29	5.99	270.92	36.98
S ₃ (40×10cm)	100.83	104.83	109.33	132.67	12.27	32.47	5.55	44.75	4550.40	30.39	5.90	263.53	26.80
S ₄ (30×20cm)	101.67	106.50	112.50	132.83	12.66	38.02	5.72	50.69	3357.83	30.45	6.30	317.01	21.01
S ₅ (30×30cm)	102.50	107.00	113.67	132.33	14.21	36.12	5.96	50.33	2204.01	31.27	7.07	353.25	15.47
S ₆ (40×20cm)	100.50	105.00	110.83	133.00	13.56	39.76	5.96	53.32	2597.38	31.11	7.21	383.39	18.68
SEm ±	1.25	1.21	1.33	1.32	0.13	0.34	0.05	0.33	101.65	0.35	0.16	7.80	0.71
CD (5%)	NS	NS	NS	NS	0.37	1.01	0.15	0.97	298.13	1.02	0.46	22.87	2.07
<i>Pinching</i>													
P ₀ unpinched	99.89	104.39	109.72	130.33	10.98	28.48	5.72	39.47	3628.63	29.70	6.59	266.91	22.66
P ₁ (pinched)	102.39	106.61	112.67	133.61	14.43	41.09	5.58	55.52	5501.46	30.94	6.02	334.70	32.10
SEm ±	0.72	0.70	0.77	0.76	0.07	0.20	0.03	0.19	58.69	0.20	0.09	4.50	0.41
CD (5%)	2.11	2.06	2.25	2.24	0.22	0.58	0.09	0.56	172.13	0.59	0.26	13.20	1.20
<i>Interaction</i>													
T ₁ (S ₁ P ₀)	99.00	103.33	109.00	127.67	10.21	20.16	5.28	30.37	6323.97	28.84	5.35	162.63	33.87
T ₂ (S ₂ P ₀)	100.67	104.67	111.00	132.67	10.45	26.18	5.48	36.63	5024.16	28.50	5.96	217.83	29.86
T ₃ (S ₃ P ₀)	101.33	105.67	109.67	131.67	10.65	21.60	5.66	32.25	3280.54	29.53	5.94	191.72	19.52
T ₄ (S ₄ P ₀)	101.67	107.00	112.67	132.67	10.86	29.61	5.78	40.47	2672.43	29.43	6.55	265.44	17.55
T ₅ (S ₅ P ₀)	99.00	103.33	108.67	126.33	12.20	35.05	6.02	47.26	2077.98	31.07	8.00	378.09	16.62
T ₆ (S ₆ P ₀)	97.67	102.33	107.33	131.00	11.53	38.29	6.13	49.82	2392.71	30.83	7.72	385.72	18.56
T ₇ (S ₁ P ₁)	102.67	106.00	111.33	129.33	13.01	37.83	5.30	50.84	10663.40	30.01	5.34	270.83	56.79
T ₈ (S ₂ P ₁)	100.33	105.33	110.33	132.33	13.41	40.51	5.35	53.92	7349.79	30.08	6.03	324.00	44.10
T ₉ (S ₃ P ₁)	100.33	104.00	109.00	133.67	13.90	43.34	5.43	57.24	5820.26	31.24	5.86	335.35	34.09
T ₁₀ (S ₄ P ₁)	101.67	106.00	112.33	133.00	14.47	46.44	5.67	60.90	4043.23	31.47	6.05	368.58	24.48
T ₁₁ (S ₅ P ₁)	106.00	110.67	118.67	138.33	16.22	37.18	5.90	53.40	2330.03	31.48	6.15	328.42	14.33
T ₁₂ (S ₆ P ₁)	103.33	107.67	114.33	135.00	15.59	41.23	5.80	56.82	2802.04	31.38	6.70	381.05	18.79
SEm ±	1.76	1.72	1.88	1.87	0.18	0.49	0.07	0.47	143.75	0.49	0.22	11.03	1.00
CD (5%)	NS	NS	5.52	5.49	0.53	1.43	NS	1.37	421.63	NS	0.65	32.34	2.93

The flower diameter (5.96 cm) was recorded maximum in the wider spacing (40 cm × 20 cm), which was statistically at par with the spacing (30 cm × 30 cm). In general, as the spacing decreased, the diameter of the flower was also reduced. The diameter of the flower (5.72 cm) for the unpinched plants was found to be significantly superior to the pinched plants (5.58 cm). The interaction among the various combinations of spacing and pinching had a non-significant effect on the flower diameter.

The number of flowers/plant increased with an increase in the planting distances (Table 2). It was observed that the increase in the number of flowers per plant in the widest spacing of 40 cm × 20 cm (52.32) followed by the spacing of 30 cm × 20 cm (50.69). Among the pinching of the plants, the pinched plants showed significantly better results than the unpinched plants. The interaction among the various combinations of spacing and pinching had a significant effect on the number of flower/plant. The number of flowers in the spacing of 30 cm × 20 cm and pinched plants were significantly higher than any other combination (60.90).

The number of flowers/plot increased with a decrease in the planting distances. It is observed that the increase in the closer spacing of 20 cm × 10 cm (8493.69), which was significantly higher than the yield recorded from any other planning distance. The yield of flowers from each plot was higher in case of pinched plants (5501.46). The finding was supported by Sehrawat *et al.* (2003) in Marigold. Among the interaction of various combinations the treatment with spacing of 20 cm × 10 cm and pinched plants were recorded the significantly higher number of flowers/plot (10663.40) than any other treatments. Also Jhon *et al.* (1995) found more number of flowers in Chrysanthemum due to similar spacing and pinching.

The long flower stalk was found at wider spacing of 30cm x30cm followed by the spacing of 40 cm × 20 cm. The closer spacing of 30 cm × 10 cm recorded the minimum length of flower stalk (29.29 cm). The pinched plants showed the significantly longer length of the flower stalk (30.94 cm) than the unpinched plants (29.70 cm). The interaction of the combination of various spacing and pinching was found significant effect on the length of the flower stalk.

Among the yield characters, i.e weight of individual flower, weight of flowers/plant and/plot was significantly influenced by the different spacing, pinching and their interactions. It was observed that the increase in the weight/flower and/plant was significantly superior in the spacing of 40 cm × 20 cm (7.21 g and 383.39 g respectively). The unpinched plants showed better results for the weight of per flower and per plant. Shah *et al.* (2005) in China aster and Chauhan *et al.* (2005) in marigold reported similar finding. The interaction of the various combinations gave a significant results and the combination of 30 cm × 30 cm spacing and unpinched plants was found significantly superior to the

other combination levels for the weight of per flower. The interaction of 40 cm × 20 cm was found better in the case of weight of flowers/plant (385.72 g).

The weight of flowers per plot, in general was found to increase with the closer spacing. The spacing of 20 cm × 10 cm showed the superior yield (45.33 kg) followed by (36.98 kg) in 30 cm × 10 cm spacing. The results were confirmed with the findings of Jankiram and Manjunath (2002), they recorded closest planting of 20 cm × 10 cm gave higher yield of flowers and seeds. The pinched plants showed significantly more weight of flowers/plot due to more number of lateral branches/plant as a result of pinching. The pinched plants produced 32.10 kg of flowers/plot. The interaction of low spacing of 20 cm × 10 cm and pinched plants gave the maximum yield of flowers/plot.

The treatment interaction of closer spacing (20 cm × 10 cm) with pinching recorded the maximum cost: benefit ratio (1:5.2) due to the maximum number of plant which produced highest flower yield per hectare, there by resulting in increased net return (₹ 430 406.25) (Table 3). While, the minimum cost: benefit ratio (1:1.38) was recorded in interaction of wider spacing 30x30 and pinching with a net return of ₹ 37 343.75. It may be due to the lower plant population per unit area. The variation in net returns and cost : benefit ratio might be due to the difference in plant population and flower yield which influenced by pinching.

Table 3 Economics of the treatments

Treatment	Particulars total	Gross returns	Net returns (₹)	C:B ratio
T ₁ (S ₁ P ₀)	10 100	317 531.25	216 531.25	1:3.14
T ₂ (S ₂ P ₀)	100 000	279 937.50	179 937.50	1:2.80
T ₃ (S ₃ P ₀)	99 000	183 000.00	84 000.00	1:1.85
T ₄ (S ₄ P ₀)	98 000	164 531.25	66 531.25	1:1.68
T ₅ (S ₅ P ₀)	96 000	155 812.50	59 812.50	1:1.62
T ₆ (S ₆ P ₀)	93 000	174 000.00	81 000.00	1:1.87
T ₇ (S ₁ P ₁)	102 000	532 406.25	430 406.25	1:5.22
T ₈ (S ₂ P ₁)	101 000	413 437.50	312 437.50	1:4.09
T ₉ (S ₃ P ₁)	100 000	319 593.75	219 593.75	1:3.20
T ₁₀ (S ₄ P ₁)	99 000	229 500.00	130 500.00	1:2.32
T ₁₁ (S ₅ P ₁)	97 000	134 343.75	37 343.75	1:1.38
T ₁₂ (S ₆ P ₁)	94 000	176 156.25	82 156.25	1:1.87

Jankiram and Manjunath (2002), Singh and Sangama (2001) have also reported similar result.

The different growth parameters responded to spacing of 30 cm × 20 cm and pinched plants, were found to be most effective, 20 cm × 10 cm and pinching was found economically superior over all and spacing of 30 cm × 30 cm gave the best results pertaining to growth and yield of China aster. Among the pinching, the pinched plants showed the best results.

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