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Studies on effect of different Planting dates and pinching on Flower yield and quality of China aster

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Abstract
A field investigation was carried out at Floriculture Unit, Department of Horticulture, Dr. PDKV, Akola during the years, 2017-18 and 2018-19 in Factorial Randomized Block Design. Experiment comprising two factor i.e. factors "A" consists of different planting dates (D) viz. 1st September, 15th September, 1st October and 15th October and factor "B" consists of different pinching (P) viz. no pinching, single pinching at 20 DAT and single pinching at 30 DAT with 12 treatment combinations with three replications. The results of the experiment revealed that, effect of planting dates and pinching on China aster plants in respect of yield parameters *viz*. number of flowers plant^{-1}, flower yield plant^{-1}, plot^{-1}and ha^{-1} were noticed maximum in 15th September planting date and single pinching at 20 DAT treatment. In respect of quality parameters like diameter of fully opened flower, stalk length, stalk diameter, weight of flower, vase life of cut flower and shelf life of loose flower were recorded in 15th September planting date and no pinching treatment during both the years of the experimentation.

Keywords: China aster, pinching, planting date, flower yield

Introduction
Among the anuual flowers, China aster ranks next to Chrysanthemum and Marigold and is one of the important commercial flower crops of our country. China aster is a half hardy annual and it has gained considerable important in flower trade because of its wide range of colors and utility and is also found suitable for intercropping in coconut gardens (Janakiram, 1997) [5]. China aster is mainly cultivated for production of cut flowers, loose flowers, as pot plant and for bedding plant purposes in landscape. Dwarf types are highly suitable for edging and window boxes. Long stalk flowers are used in vases for decoration, preparation of bouquets and loose flowers are used in garland making. Asters can be grown successfully in open condition.

The farmers in this region generally raise this crop in *rabi* season. However, due to lack of standard production technology, the yield of quality flowers and seed per unit area is low and therefore, the planting of aster at suitable time is considered most important. The importance of cultural practices for increasing the yield of quality flowers and seed is well known. It is, therefore, essential to find the most suitable planting time for raising of aster. Increasing flower yield with quality flowers, extending vase life and duration of flower production are the prime importance in the cultivation of aster. This can be achieved with planting of suitable cultivars and pinching of terminal growth at suitable intervals. Pinching alleviates the effect of apical dominance (Cline, 1997) [3] and this practice alters the source and sink relationship leading to higher yield.

Hence, it is necessary to identify the suitable cultivar for commercial cultivation in Vidarbha region and even it is felt necessary to find out suitable planting date and pinching time for China aster to get better yields. Considering the economic importance of the crop, the present work is designed to studies on effect of different planting dates and their suitability for growth, quality and yield characteristics of China aster.

Materials and Methods
This experiment was conducted in Factorial Randomized Block Design with three replications at Floriculture Unit, Department of Horticulture, Dr. PDKV, Akola during the years 2017-18 and 2018-19. The allotment of treatments to the various plots were done randomly in each replication. Experiment comprising two factor i.e. factors "A" consists of different planting dates (D) viz. 1st September, 15th September, 1st October and 15th October and factor "B" consists of different pinching (P) viz. no pinching, single pinching at 20 DAT and single pinching at 30 DAT with 12 treatment combinations.

Seeds were sown one month before planting in well prepared nursery beds. Well grown seedlings at two leaf pair stage were transplanted at 4 different planting dates starting from 1st September to 15th October at an interval of fifteen days. Seedlings were transplanted in well prepared flat beds at a spacing of 45 x 30 cm in plot size 2.25 m x 1.80 m while transplanting, the soil was pressed firmly around the seedlings and watered thoroughly. Pinching operation was done as per treatments. The crop was applied @ 10 tonnes of FYM, 150:50:50 NPK ha^{-1}. Half does of nitrogen, full does of P and K were given at the time of transplanting and remaining half dose of nitrogen was applied 30 DAT. Intercultural operation, irrigation and plant protection measures were done as and when required. Recorded pooled data for two consecutive years were analyzed as per method suggested by Panse and Sukhatme (1995) [11] for Factorial Randomized Block Design.

Results and Discussion

The results obtained from present investigation are presented below on the basis of pooled mean of two years of experimentation (2017-2018 and 2018-2019).

Yield parameters

Effect of planning dates

The experimental findings indicated that different planting dates were significantly influenced the yield parameters (Table 1). Significantly maximum number of flowers $plant^{-1}$ (42.21) were recorded in 15th September planting date which was significantly superior than rest of all the treatments. However, significantly minimum number of flowers $plant^{-1}$ (31.11) were recorded by the 15th October planting date. The maximum number of flowers $plant^{-1}$ could be attributed to an increase in plant spread and number of branches. It was also observed that with an increase in plant density, the number of flowers $plant^{-1}$ were decreased significantly. Chanda and Roychoudhary (1991) [2] reported similar results in marigold.

The data revealed significant differences among the treatments, in respect of flower yield $plant^{-1}$, $plot^{-1}$ and ha^{-1} were recorded maximum in 15th September planting date (87.26 g, 2.62 kg and 64.64 q) which were significantly superior than rest of all the treatments. This was followed by the 1st September planting date whereas minimum flower yield $plant^{-1}$, $plot^{-1}$ and ha^{-1} (72.00 g, 2.16 kg and 53.33 q, respectively) were recorded by the 15th October planting. Planting on 15th September planting date proved best to obtain higher yield. The plants of 15th September planting which experienced congenial climatic conditions (short day) had luxurious vegetative growth which enabled them to produce more amount of photosynthates and inturn resulted in longer flowering duration and thus flower yield. The results obtained during this investigation are in close agreement with the findings of Kulkarni *and* Reddy (2010) [7] in Chrysanthemum cv. Saraval.

Effect of pinching

The yield parameters included number of flowers $plant^{-1}$, flower yield $plant^{-1}$, $plot^{-1}$ and ha^{-1}. The observations recorded on yield parameters are given in Table 1.

The data revealed presented in Table 1 exhibited significant differences among the treatments, maximum number of flowers $plant^{-1}$ (44.48) were recorded in single pinching at 20 DAT which was significantly superior than rest of all the treatments. This was followed by treatment single pinching at 30 DAT. However, significantly minimum number of flowers $plant^{-1}$ (28.33) were recorded by the no pinching treatment. Shalini *et al.* (2014) [14] observed increase in number of flowers might be due to the fact that, pinched plant induces production of large number of axillary shoots resulting in well-shaped bushy plants, bearing more number of uniform flowers in African marigold.

The yield in terms of flower yield $plant^{-1}$, $plot^{-1}$ and ha^{-1} were recorded maximum in single pinching at 20 DAT (95.79 g, 2.87 kg and 70.96 q, respectively) which were significantly superior than rest of all the treatments. This was followed by the single pinching at 30 DAT whereas minimum flower yield $plant^{-1}$, $plot^{-1}$ and ha^{-1} (58.47 g, 1.75 kg and 43.31 q, respectively) were recorded in the no pinching treatment. Narayana and Jayanti (1991) [10] noted apparent reason for more number of flowers $plot^{-1}$ might be due to more number of branches. As the apical dominance of the plant was suppressed by pinching. It allowed more number of branches to grow and result in increased number of flowers $plot^{-1}$ in African marigold.

Interaction effect

Data presented in Table 3. Interaction effect due to planting dates and pinching was found to be significant in respect of maximum number of flowers $plant^{-1}$, flower yield $plant^{-1}$, $plot^{-1}$ and ha^{-1}. The treatment combination D_2P_2 were recorded maximum flower yield (52.50, 105.93 g, 2.97 kg and 78.47 q, respectively) and was found to be at par with the treatment combinations D_1P_2 (48.14, 98.80 g, 2.77 kg and 73.18 q, respectively) and D_2P_3 (43.84, 94.79 g, 2.64 kg and 70.21 q, respectively). However, minimum flower yield were recorded by the treatment combination D_4P_1 (25.76, 57.12 g, 1.60 kg and 42.31 q, respectively).

Interaction effect of September planting with single pinching at 20 DAT was found beneficial in improving flower yield. It might be due to greater plant vigour and favorable climatic condition including temperature prevailing during that period and various pinching treatment had significant influence on flowering and significant differences in number of flowers $plant^{-1}$. Due to pinching more number of branches associated with more number of flowers $plant^{-1}$ in China aster were recorded by Malleshappa (1984) [8] and Parhi (2016) [12] in African marigold.

Quality parameters

Effect of planning dates

The observations recorded on flower quality parameters are given in Table 3. Significant by maximum diameter of fully opened flower (7.69 cm), stalk length (27.20 cm), stalk diameter (0.69 cm), weight of flower (6.79 g), vase life of cut flower (11.47 days) and shelf life of loose flower (5.26 days) were recorded in 15th September planting date compared to other planting dates and minimum diameter of fully opened flower (5.97 cm), stalk length (21.89 cm), stalk diameter (0.63 cm), weight of flower (4.28 g), vase life of cut flower (9.67 days) and shelf life of loose flower (3.97 days) were recorded in 15th October planting date.

Amin *et al.* (2014) [1] found that there was gradual increase in flower diameter of chrysanthemum as planting date was delayed. Early planting resulted in more number of flowers but with less flower size, might be due to the distribution of the photosynthates to more number of terminal buds, while late sowing gave less number of flowers, but with large size. Weight of flower might have enhanced due to increase in the length of petals and pedicel and their number which is attributable to the drawing of photosynthates to the flower as a consequence of intensification of the sink which was

reported by Kahar (2008) [6] in chrysanthemum. The significant effect of planting date on vase life of flowers might be due to fact that, late planted crop flowered during the period when climatic conditions particularly the temperature was not so scorching hence less utilization of synthesized photosynthates. The results obtained during this investigation are in close agreement with the findings of Manisha *et al*. (2018) [9] in chrysanthemum.

Effect of pinching

The data presented in Table 3 showed significant differences among the different treatments. In respect diameter of fully opened flower (7.78 cm), stalk length (27.93 cm), stalk diameter (0.70 cm), weight of flower (6.59 g), vase life of cut flower (11.36 days) and shelf life of loose flower (5.41 days) were recorded significantly maximum in no pinching compared to other treatments. This was followed by single pinching at 20 DAT. However, significantly minimum diameter of fully opened flower (5.91 cm), stalk length (21.54 cm), stalk diameter (0.64 cm), weight of flower (4.78 g), vase life of cut flower (9.97 days) and shelf life of loose flower (4.06 days) were recorded in single pinching at 30 DAT.

Maximum diameter was recorded in no pinching treatment. This might be attributed to sharing of energy by the developing side branches in pinching treatment. Similar result was also obtained by Sailaja *et al.* (2013) [13] in aster. The data showed that the maximum stalk length of flower was significantly influenced by pinching. This might be due to the accumulation of more assimilates in non-pinching treatment. Similar results were also obtained by Manisha *et al*. (2018) [9] in aster. Sailaja *et al*. (2013) [13] observed that reduction of fresh flower weight in pinching treatment might be attributed to the fact that, the developing flowers might have been supplied with comparatively lesser quantities of plant bio-regulators and food reserved resulting ultimately in reduction of fresh flower weight in aster. Dalal *et al*. (2006) [4] observed maximum vase life among different pinching treatments might be attributed to the variation in accumulation of carbohydrates since the treatments have produce varied number of leaves and indicated positive and significant correlation between these characters in carnation.

Interaction effect

Data presented in Table 3. Interaction effect due to planting dates and pinching was found to be non-significant in respect of quality parameter except in diameter of fully opened flower, the treatment combination D_2P_1 recorded maximum diameter of fully opened flower (8.73 cm) and was at par with the treatment combinations D_1P_1 (8.42 cm) and D_2P_2 (7.93 cm). However, minimum diameter of fully opened flower (5.08 cm) was recorded by the treatment combination D_4P_3 and the treatment combination D_2P_1 recorded significantly maximum vase life of cut flower (12.60 days) and was found to be at par with the treatment combinations D_1P_1 (12.45 days). However, minimum vase life of cut flower (8.85 days) was recorded by the treatment combination D_4P_3.

Table 1: Effect of different planting dates and pinching on yield parameters of China aster

Treatments	Number of flowers plant^{-1}			Flower yield plant^{-1} (g)			Flower yield plot^{-1} (kg)			Flower yield ha^{-1} (q)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Factor A. Planting dates (D)												
D_1 - 1st September	38.44	40.17	39.30	78.87	85.44	82.15	2.37	2.56	2.46	58.42	63.29	60.85
D_2 - 15th September	40.99	43.42	42.21	85.51	89.01	87.26	2.57	2.67	2.62	63.34	65.94	64.64
D_3 - 1st October	34.70	36.80	35.75	75.41	80.67	78.04	2.26	2.42	2.34	55.86	59.75	57.81
D_4 - 15th October	29.97	32.24	31.11	68.93	75.07	72.00	2.07	2.25	2.16	51.06	55.60	53.33
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m) ±	0.99	0.91	0.84	1.74	1.82	1.34	0.05	0.05	0.04	1.29	1.35	1.00
CD at 5%	2.91	2.68	2.45	5.09	5.33	3.94	0.15	0.16	0.12	3.77	3.95	2.92
Factor B. Pinching (P)												
P_1 - No pinching	27.47	29.20	28.33	56.45	60.49	58.47	1.69	1.81	1.75	41.81	44.81	43.31
P_2 - Single pinching at 20 DAT	43.14	45.82	44.48	92.93	98.65	95.79	2.79	2.96	2.87	68.84	73.07	70.96
P_3 - Single pinching at 30 DAT	37.47	39.46	38.47	82.16	88.49	85.33	2.46	2.65	2.56	60.86	65.55	63.20
'F' Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m) ±	0.86	0.79	0.72	1.50	1.57	1.16	0.05	0.05	0.03	1.11	1.17	0.86
CD at 5%	2.52	2.32	2.13	4.41	4.62	3.41	0.13	0.14	0.10	3.27	3.42	2.53

Table 2: Effect of different planting dates and pinching on quality parameters of China aster

Treatments	Diameter of fully opened flower (cm)			Stalk length (cm)			Stalk diameter (cm)			Weight of flower (g)			Vase life of cut flower (days)			Shelf life of loose flower (days)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Factor A. Planting dates (D)																		
D_1 - 1st September	7.05	7.18	7.11	24.31	25.87	25.09	0.65	0.67	0.67	5.87	6.61	6.24	10.92	11.19	11.05	4.66	4.89	4.77
D_2 - 15th September	7.58	7.80	7.69	26.32	28.06	27.20	0.67	0.69	0.69	6.59	7.00	6.79	11.19	11.74	11.47	5.10	5.41	5.26
D_3 - 1st October	6.38	6.51	6.44	23.74	24.81	24.27	0.63	0.65	0.65	5.30	5.81	5.55	10.13	10.67	10.4	4.49	4.63	4.56
D_4 - 15th October	5.98	5.97	5.97	21.26	22.52	21.89	0.62	0.63	0.63	4.06	4.51	4.28	9.59	9.74	9.67	3.94	3.99	3.97
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.

SE (m) ±	0.13	0.15	0.13	0.54	0.57	0.43	0.01	0.01	0.01	0.19	0.18	0.15	0.26	0.25	0.18	0.13	0.14	0.09
CD at 5%	0.37	0.43	0.38	1.58	1.66	1.26	0.04	0.04	0.04	0.57	0.54	0.44	0.75	0.72	0.52	0.38	0.4	0.27
Factor B. Pinching (P)																		
P_1 - No pinching	7.7	7.85	7.78	27.19	28.66	27.93	0.69	0.70	0.70	6.44	6.74	6.59	11.28	11.44	11.36	5.30	5.52	5.41
P_2 - Single pinching at 20 DAT	6.68	6.77	6.72	23.82	24.93	24.38	0.66	0.66	0.66	5.56	6.02	5.79	10.2	11.02	10.61	4.35	4.55	4.45
P_3 - Single pinching at 30 DAT	5.86	5.97	5.91	20.71	22.35	21.54	0.58	0.64	0.64	4.36	5.19	4.78	9.89	10.06	9.97	3.99	4.13	4.06
'F' Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m) ±	0.11	0.13	0.11	0.47	0.49	0.37	0.01	0.01	0.01	0.17	0.16	0.13	0.22	0.21	0.15	0.11	0.12	0.08
CD at 5%	0.32	0.37	0.33	1.37	1.44	1.09	0.04	0.03	0.03	0.50	0.46	0.38	0.65	0.62	0.45	0.33	0.35	0.23

Table 3: Interaction effect of different planting dates and pinching on yield and quality parameters of China aster

Treatment combinations	Number of flowers plant^{-1}			Flower yield plant^{-1} (g)			Flower yield plot^{-1} (kg)			Flower yield ha^{-1} (q)			Diameter of fully opened flower (cm)			Vase life of cut flower (days)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Planting dates x Pinching																		
D_1P_1	28.73	29.85	29.29	56.77	59.84	58.30	1.70	1.80	1.75	42.05	44.33	43.19	8.33	8.50	8.42	12.43	12.47	12.45
D_1P_2	47.01	49.26	48.14	97.73	99.87	98.80	2.93	3.00	2.96	72.39	73.98	73.18	6.79	6.83	6.81	10.08	11.53	10.81
D_1P_3	39.57	41.40	40.48	82.11	96.6	89.36	2.46	2.90	2.68	60.82	71.56	66.19	6.03	6.20	6.11	10.24	9.57	9.90
D_2P_1	29.36	31.81	30.59	59.98	62.87	61.43	1.80	1.89	1.84	44.43	46.57	45.50	8.60	8.87	8.73	12.47	12.73	12.60
D_2P_2	50.75	53.65	52.20	105.36	106.51	105.93	3.16	3.20	3.18	78.04	78.89	78.47	7.80	8.07	7.93	10.53	11.53	11.03
D_2P_3	42.87	44.81	43.84	91.19	97.66	94.42	2.74	2.93	2.83	67.55	72.34	69.94	6.33	6.46	6.39	10.57	10.97	10.77
D_3P_1	26.73	28.67	27.70	54.47	59.59	57.03	1.63	1.79	1.71	40.35	44.14	42.24	7.04	7.16	7.10	10.2	10.47	10.33
D_3P_2	39.71	42.21	40.96	90.87	98.70	94.79	2.73	2.96	2.84	67.31	73.11	70.21	6.13	6.20	6.17	10.07	10.93	10.50
D_3P_3	37.65	39.53	38.59	80.89	83.71	82.30	2.43	2.51	2.47	59.92	62.00	60.96	5.97	6.17	6.07	10.13	10.6	10.37
D_4P_1	25.04	26.47	25.76	54.57	59.67	57.12	1.64	1.79	1.71	40.42	44.20	42.31	6.84	6.87	6.86	10.03	10.07	10.05
D_4P_2	35.07	38.15	36.61	77.78	89.52	83.65	2.33	2.69	2.51	57.61	66.31	61.96	6.00	5.97	5.98	10.13	10.07	10.10
D_4P_3	29.79	32.11	30.95	74.45	76.01	75.23	2.23	2.28	2.26	55.15	56.30	55.72	5.10	5.07	5.08	8.60	9.10	8.85
'F' Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m) ±	1.72	1.58	1.45	3.01	3.15	2.33	0.09	0.09	0.07	2.23	2.33	1.72	0.22	0.26	0.22	0.44	0.43	0.31
CD at 5%	5.04	4.64	4.25	8.82	9.23	6.83	0.26	0.28	0.20	6.53	6.84	5.06	0.64	0.75	0.66	1.30	1.25	0.91

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