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Effect of Different Sowing Dates and Planting Distance on Growth, Yield and Quality of China Aster (*Callistephus chinensis* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out to find out the best planting time and spacing in terms of growth and flower yield and quality of China aster during Rabi season 2022. The research was laid out in Randomized Complete Block Design, which had nine treatments replicated thrice. The dates of sowing were kept in the month of October at an interval of one week i.e., 2nd, 9th and 16th having different planting distance (30x20 cm, 30x30 cm, 30x40 cm). This experiment reviled that that Treatment T1 in which seed were sown in 1st week of October having planting distance of 30 x 20 cm performed best in with respect to growth, flower yield and quality of China aster.

Keywords: Different sowing dates; planting distance; China aster; RCBD.

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1. INTRODUCTION

China aster, scientifically known as Callistephus chinensis Nees., belongs to the family Asteraceae, is one of the most demanding winter annual flowers ranks third just next to Chrysanthemum and Marigold (Sheela, 2008). The genus named 'Callistephus' was derived from the greek words 'Kalistos' meaning 'most beautiful' and 'Stephos' meaning 'a crown'. China aster is one of the most preferable commercial flower crops, grown as cut flower, loose flower, bedding plant, floral decoration, bouquets and garland preparation, consisting a wide spectrum of attractive colors including violet, purple, magenda, many shades of pink, pure white, pale blue, mauve, dark blue, scarlet and comparatively longer vase life (Chaitra and Patil, 2007; Dilta et al., 2007). China aster being well adapted to diversified soil and climatic condition, it is now-a-days successfully grown in various agro-climatic zones of India [1-4]. China aster estimated to be commercially grown over an area of 3500 ha in India by marginal and small farmers in Karnataka, Tamil Nadu, Telangana, Andhra Pradesh, Maharashtra and West Bengal (Pratiksha et al., 2017), among which Karnataka itself has covered an area of 1531 ha with a productivity of 9.05 t/ha [5]. The standardization of sowing dates for different varieties of China Aster is crucial for enhancing the production efficiency of the crop. It can also help in reducing the production costs and improving the overall profitability of the farmers [6,7]. However, the optimum sowing dates of China Aster may vary depending on various factors such as climatic conditions, soil types, and the specific variety of China Aster being grown. The current research study aims to investigate the effects of different sowing dates on the vegetative growth, floral parameters, and vase life of China Aster [8-12].

Plant density plays an important role in case of physiological functioning of plant. The planting distance affect the availability of nutrients, water, and light to plant which affect the photosynthetic activities which have ultimate effect on plant growth and yield. Thus, plant density at which a crop is planted has an immense role in growth, yield and flowering of crop. It has been reported by many workers that a close spacing has an adverse effect on the growth and quality of flowers even though the total yield increases, while wide spacing induces vigorous vegetative growth but yields are due to limited plant population.

Time of planting is the most important factor in influencing the yield of crop performance of genotype entirely depends upon the time of planting. Delay in planting generally results in yield reduction which cannot be compensated by any other means. Timely transplanting seedlings results in earlier harvest than early transplanting. Tender aged or over aged seedlings are not suitable for better yield. Medium aged seedlings result in greater leaf area, high yield [13].

2. MATERIALS AND METHOD

This experiment was conducted at Floriculture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) in the month of October to March during the winter season of the year 2022-2023. The experiment has been under taken in open field conditions. The nursery trays were prepared with a well-aerated mixture of sand, soil, and well-rotted farmyard manure (FYM) in equal proportions (1:1:1, v/v). Mixed seed of healthy and disease-free seeds were sown in protray on three different dates: 2nd October, 9th October, and 16th October, in 2022-23. After sowing, a layer of vermi-compost was applied over the seeds, and the trays were covered with gunny bags. Careful watering was provided through sprinkling to prevent seed wash-off.

Chart 1. Treatment details

Treatment symbol	Treatment combination
T_1	Oct – 1st week 30x20 cm
T_2	Oct – 1st week 30x30 cm
T_3	Oct – 1st week 30x40 cm
T_4	Oct – 2st week 30x20 cm
T_5	Oct – 2st week 30x30 cm
T_6	Oct – 2st week 30x40 cm
T_7	Oct – 3st week 30x20 cm
T_8	Oct – 3st week 30x30 cm
T_9	Oct – 3st week 30x40 cm

Throughout the nursery raising period, adequate irrigation and weeding were carried out. Thinning of seedlings was done to promote better growth and the development of robust and disease-resistant seedlings. The seedlings, which were healthy, disease-free, and of consistent size and vigor at the 3-4 leaf stage, were carefully chosen and transplanted in field on three different spacing for planting: S1, S2, and S3, in the 2022-23 season.

3. RESULTS AND DISCUSSION

An experiment was carried out in the Experimental field. Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Science, Naini, Prayagraj, District, Uttar Pradesh. During Rabi season 2022 Observations were recorded at 30, 60 and 90 (DAT) days after transplanting on different vegetative, photosynthetic, floral and vase life characters. The entire data were subjected to statistical analysis to get information on the effect of different Sowing dates and Planting distance and their interactions on the above parameters. The results are presented in this chapter under the following subheads with appropriate discussion.

3.1 Effect of Different Sowing Dates and Planting Distance on Plant Height (cm)

The plant height of China aster at different sowing dates and planting distance found Significant at 30 DAT, with interaction found non-significant at 30 DAT however it was non-significant at other two intervals 60, 90 DAT.

In the different levels of sowing dates and planting distance, the maximum plant height was observed in T1 (OCT 2nd week 30x20cm) with 8.51 cm at 30 DAT, 16.84 cm at 60 DAT ,55.67 cm at 90 DAT. Followed by T4 (OCT 3nd week 30x20cm) with 8.52 cm at 30 DAT, 15.09 cm at 60 DAT, 54.78 cm at 90 DAT in and minimum plant height was observed in T9 (OCT 4th week 30x40cm) with 5.60 cm at 30 DAT, 11.22 cm at 60 DAT, 40.56 cm at 90 DAT respectively.

The plant height of a crop is a direct index to measure growth and vigor. In general, plant height increases gradually with the advancement of age. Maximum plant height was recorded in OCT 2nd week with closer spacing (30x20 cm) and the minimum were recorded in OCT 4th week with wider spacing (30x40 cm), this might be because, at a closer planting distance, less space is available for the spread of the plant, and hence all the food material is utilized in erect growth of the plant, resulting in more plant height. While as planting distance increased, plants got more space for their spread and food material is used for the growth of spread as well as height, resulting in less height of the plant as compared to closer planting distance. The same result is reported by Chaudhary et al. [14] in zinnia, Karuppaiah et al. (2005) in marigold.

3.2 Number of Leaves

The number of leaves of China aster with different sowing dates found significant at 60 DAT, with spacing and their interaction found non-significant at 60DAT and non-significant at other two intervals 30, 90 DAT.

In the different levels of sowing dates and planting distance, the maximum number of leaves was observed in T1 (OCT 2nd week 30x20 cm) with 7.78 at 30 DAT, 21.22 at 60 DAT ,172.89 at 90 DAT. Followed by T3 (OCT 2nd week 30x40 cm) with 7.56 at 30 DAT, 20.22 at 60 DAT, 164.55 at 90 DAT and minimum number of leaves was observed in T9 (OCT 4th week 30x40 cm) with 5.78 at 30 DAT, 14.78 at 60 DAT, 132.45 at 90 DAT respectively.

An increasing trend was observed in number of leaves from 30 DAT to 90 DAT till harvest. Here, in OCT 2nd week with closer spacing (30x20 cm) resulted a greater number of leaves, while a lesser number of leaves per plant was recorded OCT 4th week with wider spacing (30x40 cm), this might be because, at a closer planting distance, less space is available for the spread of the plant, and hence all the food material is utilized in erect growth of the leaf, resulting in more plant leaf. While as planting distance increased, plants got more space for their spread and food material is used for the growth of leaf bud formation, resulting in less leaves of the plant as compared to closer planting distance. Agarwal et al. [15] in golden rod and Jain et al. (2018) in statice reported that maximum no of leaves was recorded in closer spacing.

3.3 Plant Spread (cm^2)

The Plant spread of China aster with different sowing dates and planting distance their interaction found non-significant at all three intervals 30, 60, 90 DAT.

In the nine treatment of different sowing dates and planting distance the maximum Plant spread (cm^2) was recorded in T_3 (OCT 2nd week 30x40 cm) with 10,27 cm^2 at 30 DAT, 18.86 cm^2 at 60 DAT ,25.33 cm^2 at 90 DAT. Followed by T_4 (OCT 3rd week 30x20 cm) with 9.66 cm^2 at 30 DAT, 18.28 cm^2 at 60 DAT, 25.22 cm^2 at 90 DAT, and minimum number of leaves was observed in T_9 (OCT 4th week 30x40 cm) with 6.78 cm^2 at 30 DAT, 13.52 cm^2 at 60 DAT, 18.28 cm^2 at 90 DAT respectively.

The plant spread was recorded maximum in OCT 2nd week with wider spacing (30x40 cm) where there is rapid decrease in OCT 2nd week with closer spacing (30x20 cm) to spread the plant, it needs to have more spacing. Pratibha et al. (2018) reported that maximum plant spread was observed in wider spacing.

3.4 Chlorophyll Content (Spectrophotometer)

The chlorophyll content of China aster with different sowing dates and planting distance their interaction found non-significant at all three interval 30, 60, 90 DAT.

In the Nine treatments of different sowing dates and planting distance the maximum chlorophyll content was recorded in T_8 (OCT 4th week 30x30 cm) with 42.65 SPAD value at 30 DAT, 47.46 SPAD value at 60 DAT, 46.54 SPAD value at90 DAT. Followed by T_6 (OCT 3rd week 30x40 cm) with 41.82 SPAD value at 30 DAT, 45.84 SPAD value at 60 DAT, 45.02 SPAD value at 90 DAT, and minimum chlorophyll content was recorded in T_7 (OCT 4th week 30x20 cm) with 40.02 SPAD value at 30 DAT, 43.15 SAPD value at 60 DAT, 45.00 SAPD value at 90 DAT.

It is observed from the data that the total chlorophyll content of China aster plants was recorded maximum in OCT 4th week with wider spacing (30x30cm) and found minimum in OCT 4th week with closer spacing (30x20cm)**.** Similarly [16] reported that with the wider spacing the chlorophyll content was also increased in African marigold cv.Pusa Narangi Gainda under Jabalpur condition.

3.5 Day taken from Planting to Bud Emergence

The Number of days required for flower bud emergence in China aster with different sowing dates and planting distance their interaction found non-significant.

In the Nine treatment of different sowing dates and planting distance the minimum days required for flower bud emergences was observed in T_3 (OCT 2nd week 30x40 cm) with 77.33 days, followed by T_6 (OCT 3rd week 30x40 cm) with 77.80 days and maximum days required for flower bud emergences is observed in T_1 (OCT 2nd week 30x20 cm) with 85.11 days

Transplanting at OCT 2nd week with closer (30x20 cm) spacing showed early flower bud due to less space all the food material is utilized in erect growth of the plant, resulting in early flower bud than wider planting distance. While planting distance increased, plants got more space for their spread and food material is used for vegetative growth. Kaur et al. (2009) reported the similar results in chrysanthemum. And Jadhav et al. [17] reported that minimum days to first flower bud emergences.

3.6 Days taken for Buds Break from Planting.

Days taken for buds break from planting in China aster with different sowing dates and planting distance their interaction found non-significant.

In the Nine treatment of different sowing dates and planting distance the minimum days required for flower bud break from planting was observed in T_3 (OCT 2nd week 30x40 cm) with 87.26 days, followed by T_2 (OCT 2nd week 30x30 cm) with 96.45 days and maximum days required for flower bud break from planting was observed in T_1 (OCT 2nd week 30x2 0cm) with 97.78 days.

Transplanting at 35 days old seedlings with closer spacing showed maximum length of stalk were transplanted at 25 days old seedlings with wider spacing showed minimum length of stalk**.** Which might be attributed to a more vertical growth of the plant under dense spacing which in turn might be the effect of competition for space and light. Deshpande et al. [18] in statice and Khobragade et al. (2012) observed the similar result in China aster.

3.7 No. of Flower Buds per Plant

No. of flower buds per plant with different sowing dates and planting distance their interaction found non-significant.

In the Nine treatments of different sowing dates and planting distance in the maximum No. of flower buds per plant was observed in T_1 (OCT 2nd week 30x20 cm) with 13.22 days, followed by T_2 (OCT 2nd week 30x30 cm) 12.22 buds and minimum No. of flower buds per plant was observed in T_8 (OCT 3rd week 30x30 cm) with 9.00 buds.

Transplanting 42 days old seedlings with wider spacing showed minimum days where transplanting 30 days old seedlings with closer spacing showed maximum days. It was evident from the data that closer spacing showed early flowering than wider planting distance while flowering was late in wider planting distance. Similarly, the duration required for harvesting from the appearance of flower stalk was less in more plant spacing and a longer period was required for harvesting from the appearance of the flower stalk in closer planting distance. Jadhav et al. [17] observed in calendula that minimum days required for flower opening from bud initiation in closer spacing.

3.8 Stalk Length

Stalk length in China aster with different sowing dates and planting distance their interaction found non-significant.

In Nine treatments of different sowing dates and planting distance the maximum stalk length was observed in T_1 (OCT 2nd week 30x20 cm) with 16.44cm, followed by T_4 (OCT 3rd week 30x20 cm) with 15.67 cm and minimum stalk length was observed in T_9 (OCT 4th week 30x40 cm) with 14.78 cm.

Transplanting at OCT 2nd week with closer spacing (30x20 cm) showed maximum length of stalk were transplanted at OCT 4th week with wider spacing (30x40 cm) showed minimum length of stalk**.** Which might be attributed to a more vertical growth of the plant under dense spacing which in turn might be the effect of competition for space and light. Deshpande et al. [18] in statice and Khobragade et al. (2012) observed the similar result in China aster.

3.9 Number of Flowers per Plants

Number of flowers per plant in China aster with different sowing dates and planting distance their interaction found non-significant.

In the Nine treatments of different sowing dates and planting distance the maximum number of flowers per plant was observed in T_1 (OCT 2nd week 30x20 cm) with 14.55, followed by T_2 (OCT 2nd week 30x30 cm) with 13.22 and minimum number of flowers per plant was observed in T_8 (OCT 4th week 30x30 cm) with 10.55.

Earlier sowing dates in China Aster resulted in a higher number of flowering stems per plant compared to later sowing dates. This is attributed to the plants having more time for vegetative growth, allowing for the production of additional shoots that later develop into reproductive stems. The presence of more branches also contributes to an increased number of potential flower-bearing stems. Consequently, early sowing promotes greater vegetative growth and enhances flower production in China Aster Singh et al. (2018), Dhatt and Kumar (2010).

3.10 Shelf Life of Individual Flower (days)

Shelf life of individual flower in China aster with different sowing dates and planting distance their interaction found non-significant.

In the Nine treatments of sowing dates and planting distance the maximum days of shelf life was observed in T_5 (OCT 3rd week 30x30 cm) with 23.67 days, followed by T_1 (OCT 2nd week 30x20 cm) with 23.56 days and minimum shelf life of individual flower is observed in T_6 (OCT 3rd week 30x40 cm) with 21.67 days.

3.11 Fresh Weight of Flower (g)

Fresh weight of flower in China aster with different sowing dates and planting distance their interaction found non-significant.

In the Nine treatments of sowing dates and planting distance the maximum weight of flower of China aster was observed in T_7 (OCT 4th week 30x20 cm) with 8.81 gram, followed by T_6 (OCT 2nd week 30x40 cm) with 8.60 gram and minimum fresh weight of flower is observed in T_1 (OCT 2nd week 30x20 cm) with 5.10 gram.

3.12 Vase Life of Different Levels of Sorbitol of 2:2-Gram Salt and Sugar

Vase life of different levels of sorbitol of China aster with different sowing dates and planting distance their interaction found non-significant. In the Nine treatments of different sowing dates and

Table 1. Effect of different sowing dates and planting distances on Growth parameters and Flower bud characteristics of China aster

	Growth parameters				Flower bud characteristics		
Treatment	**Plant height (cm)**	**Number of leaves / plant**	**Plant spread (cm)**	**Chlorophyll content (SPAD value)**	**Days taken from planting to bud emergence (days)**	**Days taken for bud break from planting (days)**	**No. of flower bud per plant / plant**
T1	55.67[1]	172.89[1]	20.44	44.17	85.11[1]	97.78[1]	13.22[1]
T2	54.78	164.55	23.44	44.54	80.56	96.45	12.22
T3	51.33	169.89	25.33	45.56	77.33	87.26	11.89
T4	54.56	149.56	25.22	42.40	79.89	96.78	11.67
T5	52.33	146.44	21.72	45.00	79.22	97.00	10.22
T6	45.22	152.22	18.89	45.02	77.80	96.89	9.89
T7	50.56	143.00	22.56	44.02	80.11	96.34	9.22
T8	49.22	139.11	19.35	46.54[1]	82.33	97.00	9.00
T9	40.56	132.45	18.28	44.98	81.00	97.11	9.22
Spacing							
F-test	NS	NS	NS	NS	NS	NS	NS
S(Ed.)	1.185	24.15	0.831	1.87	2.79	2.44	2.061
CD	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Different sowing dates							
F-test	NS	NS	NS	NS	NS	NS	NS
S(Ed.)	1.185	24.15	1.185	2.311	2.85	2.44	2.061
CD	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spacing x sowing dates							
F-test	NS	NS	NS	NS	NS	NS	NS
S(Ed.)	2.053	41.83	2.053	2.903	4.84	4.226	3.57
CD	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: 1 superior result obtained

Table 2. Effect of different sowing dates and planting distance on Flowering characteristics and Quality parameters of China aster

	Flowering characteristics				Quality parameters
Treatment	**Stalk length (cm)**	**No. of flower / plant**	**Shelf life of individual flower (days)**	**Fresh weight of flower (g)**	**Vasa life (Sorbitol-different levels) 2:2 g salt & sugar**
T1	16.44[1]	14.55[1]	23.56	5.10	15.11
T2	15.56	13.78	23.00	7.07	15.56
T3	15.44	13.22	23.45	7.25	15.44
T4	15.67	11.89	23.11	8.60	15.67
T5	15.11	12.22	23.67[1]	8.26	16.44[1]
T6	15.67	12.78	21.67	8.60	15.32
T7	15.63	10.78	22.89	8.81[1]	14.78
T8	15.44	10.55	23.44	8.08	15.44
T9	14.78	10.67	22.78	8.03	15.20
Spacing					
F-test	NS	NS	NS	NS	NS
S(Ed.)	0.235	2.269	0.79	0.797	0.332
CD	N/A	N/A	N/A	N/A	N/A
Different Sowing Dates					
F-test	NS	NS	NS	NS	NS
S(Ed.)	0.235	2.269	0.79	0.797	0.332
CD	N/A	N/A	N/A	N/A	N/A
Spacing X Sowing Dates					
F-test	NS	NS	NS	NS	NS
S(Ed.)	0.407	3.93	1.369	1.381	0.575
CD	N/A	N/A	N/A	N/A	N/A

Table 3. Economics of various treatment in China aster cultivation

Treatment	Cost of cultivation (Rs/ha)	Total yield (Flower/plots)	Selling (Rs)	Gross Return (Rs/plots)	Net return (Rs/plots)	Benefit cost return
T1	12,460	1260	25	31,500	19040	2.53
T2	12,460	840	25	21,000	8,540	1.68
T3	12,460	675	25	16,875	4,415	1.36
T4	12,460	1224	25	30600	18140	2.46
T5	12,460	900	25	22500	10040	1.81
T6	12,460	702	25	17550	5090	1.41
T7	12,460	1152	25	28800	16340	2.31
T8	12,460	864	25	21600	9140	1.74
T9	12,460	657	25	16425	3965	1.32

planting distance the maximum days for vase life of different levels of sorbitol was observed in T_5 (OCT 3rd week 30x30 cm) with 16.44 days, and followed by days of vase life of different levels of sorbitol was observed in T_4 (OCT 3rd week 30x20 cm) with 14.78 days and minimum days of vase life of different levels of sorbitol was observed in T_7 (OCT 4th week 30x20 cm) with14.78 days.

4. CONCLUSION

From the present investigation it is concluded that treatment (T1) (Oct – 1st week 30x20cm) performed best in terms of plant growth (plant height (cm), Plant Spread (cm), amount of Leaves/plant after 90 days, flower yield and quality (color, self-life, and vase life) and Economics cultivation.

The highest benefit cost ratio was found in Treatment (T1) with (2.53).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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