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Effect of Nitrogen and Spacing on Growth and Yield of China Aster (*Callistephus chinensis* L. Nees.) cv. Powder Puff Mix

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ABSTRACT: The present investigation entitled "Effect of nitrogen and spacing on growth and yield of China aster (*Callistephus chinensis* L. Nees.) cv. Powder puff mix" was carried out during 2019-20 at Agricultural Research Station, Chhatabar; Institute of Agricultural Sciences, Bhubaneswar. The experiment was laid out in Randomized Block Design (RBD) with factorial concept where eight treatment combinations were replicated thrice. The treatment comprised of two levels of spacing between the plants *viz.*, 60 × 40 cm (S1), 40 × 30 cm (S2) and three levels of nitrogen doses *i.e.* 200 kg/ha (N1), 150 kg/ha (N2) and 100 kg/ha(N3). Nitrogen was applied in two split doses *i.e.* 50 % in basal and rest 50% as topdressing after 40 days of transplanting along with recommended dose of phosphorus and potassium. The vegetative growth of flowering and total yield and quality of flowers were influenced by different levels of spacing and nitrogen. Maximum reading in plant height (42.68 cm), number of leaves (21.39) was recorded in 60 cm × 40 cm spacing, while highest reading in plant spread (74.37), earliness in bud initiation (64.83 days), number of flower per plant (15.96), flower diameter (8.41 cm), lowest blooming period of bud (10.75 days), highest duration of flowering in plot (40.25 days) and highest yield (1.29 kg) along with vase life (11.08 days) was recorded in spacing 40 cm × 30 cm. Similarly, the best in case of vegetative parameters such as maximum plant height (15.07 cm), number of leaves (20.57), plant spread (76.70 cm)was observed for nitrogen dose of 200 kg/ha; while the best in case of the yield parameters *viz*., number of flowers per plant (17.93), flower diameter (9.27 cm), earliness in bud initiation (62.33 days), lowest blooming period (9.33 days), highest duration of flowering in plot (44 days), highest weight of fresh flower (10.83 gm), highest yield (1.56 kg) with vase life (11 days) was observed in nitrogen dose of 150 kg/ha.

Keywords: Spacing, Nitrogen, China Aster, Cut flower, Growth and yield.

INTRODUCTION

China aster (*Callistephus chinensis* L. Nees.) cv. Powder puff mix is a semi-hardy winter annual crop belonging to the family *Asteraceae*. The genus Callistephus is derived from two Greek words '*kalli'*- meaning beautiful and '*stephos'*- meaning a crown in reference to the flowers. The flower having commercial value is native to China and has spread to Europe and other tropical countries during 1731 A.D. The present day asters have been developed from a single form of wild species, *Callistephus chinensis*. It is commercially grown in Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and West Bengal. In our state, the significant area and production data is yet to be achieved. In Odisha, China aster can be grown during rabi season, as a heavy feeder crop for which, nutrient management is of prime importance.

Increased flower production, quality of flowers and perfection in the form of plants are important objectives to be reckoned in commercial flower production. Although china aster is being grown in a considerable area, its cultivation is concentrated around big cities and there is a need to popularize under different agro-climatic conditions. Though the crop has great significant in the market due to good production, quantity but there are some bottlenecks associated in its cultivation. Non availability of quality planting materials, lack of improved varieties, uneven flower maturity, high market fluctuation are some of the problems which are often faced by farmers.

Proper spacing is another important factor, which is dependent on the variety, soil and climatic conditions. If plants are closely planted, it results in competition for fertilizer, water and sunlight etc. and causes poor growth of plants whereas wider spacing results in wastage of valuable space. Therefore, it is essential to know the proper spacing and requirement of fertilizer doses of crop or a variety under a particular soil and agro-climatic conditions.

MATERIALS AND METHODS

The present investigation entitled "Effect of nitrogen and spacing on growth and yield of China aster (*Callistephus chinensis* L. Nees.) cv. Powder puff mix" was carried out during 2019-20 at Agricultural Research Station, Chhatabar; Institute of Agricultural Sciences, Bhubaneswar. The experiment was laid out in Randomized Block Design (RBD) with factorial concept where eight treatment combinations were replicated thrice. The treatment comprised of two levels of spacing *viz.,* 60 × 40 cm (S1), 40 × 30 cm (S2) and three levels of nitrogen doses *i.e.* 200 kg/ha (N1), 150 kg/ha (N2) and 100 kg/ha (N3). Nitrogen was applied in two split doses *viz., i.e.* 50 % in basal and rest 50% as topdressing after 40 days of transplanting along with recommended dose of phosphorus and potassium. Observations on various vegetative parameters such as Plant height (cm), Number of leaves per plant , Plant spread (cm), Number of primary branches, Number of secondary branches; and flowering parameters such as Number of days taken for first flower bud formation, Number of buds per plant, Number of Flowers per plant, Number of Flowers per plot, Vase life of flowers (days), Duration of flowering in plot (day), Stalk length (cm), Flower diameter (cm), Flower weight (g), Flower yield per plot (kg), Number of days taken for flower opening (bud to bloom). All the data concerning various vegetative growth parameters and flowering components such as flower characters and quantity were analyzed statistically. The critical difference at 5 % level was calculated for comparing treatment means.

RESULT AND DISCUSSIONS

Vegetative parameters. The best result of plant height (42.68 cm) was noted with the plant spacing of 60*40 cm and the higher plant height of 44.48 cm was noted with the application of nitrogen @ 150kg/ha Similar findings with respect to nutrient quantity was obtained by Varma *et al*. (2023). Maximum number of leaves count (21.39) primary and secondary branch count of 11.64 and 14.66 respectively were recorded with the spacing of 60*40 cm. Similar result of higher count in terms of leaves and branches were accounted with application of 150 kg/ha of nitrogen (Table 1). Reduction in plant spread was registered with higher plant spacing. The highest plant spread was noted with 40*30 cm spacing and 79.77 cm was noted with application of nitrogen @150kg/ha. Similar results have been reported by Pandey *et al.* (2024) in china aster. In account of the interaction effect the highest observations in terms of plant height, Number of leaves, Number of branches, plant spread were recorded with S1N2(s1- 60*40 cm, N2-150kg/Ha). Significant increase in plant height may be due to better nutrition which leads to increased photosynthesis activity, as nitrogen is important constituent of nucleic acid and it might have increased the synthesis of carbohydrate, amino acids etc. and wider spacing took the advantage of more space, moisture, light and air for growth. This is in line with Mishra *et al.* (2018). Reason for increase in number of leaves were found due to the cell division, cell enlargement, better nutrition and wider spacing helped the plants to utilize the energy properly in the production of leaves. Similar positive effect was also recorded by Sunita *et al*. (2007); Yadav *et al*. (2004). Reason for increase in plant spread may be nitrogenous compounds such as proteins, amino acids, nucleic acids, various enzymes and coenzymes which were responsible for cell division and cell enlargement and wider spacing might have helped the plants for utilization of nutrients and less competition. This finding corroborates with the findings of Dixit (2004); Kumar *et al*. (2014); Shah *et al.* (2005). Similar increase in number of branches may be attributed to the availability of more space for growth of roots and shoots as well as utilization of more nutrients by the plants, less competition among the plants for available resources and overlapping from adjacent plants. The results are in conformation with Kumar *et al*. (2014); Chauhan *et al*. (2014).

Reproductive Parameters. The minimum number of days taken for first flower bud initiation accounted in spacing of 40*30 cm along with nitrogen dose of 150 kg/ha, Amongst the interaction effects, early flower bud initiation 62.33 days was noted in the treatment S_2N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha) Similar results have been reported by Pandey *et al.* (2024) in china aster. the maximum number of flower bud per plant, Number of flowers per plant , Number of flowers per plot were registered in the spacing of 40*30 cm along with nitrogen dose of 150 kg/ha . minimum days taken for flower opening (bud-bloom) 10.75 days was recorded with the plant spacing of 60 × 40 cm, where as Minimum bud-bloom period of 9.67 days was recorded with the application of nitrogen 150 kg/ha Similar findings was recorded by Sandhu *et al*. (2024) in china aster var. arka poornima. While considering the interaction effects, 9.33 days of bud-bloom period was noted in the interaction of treatment S_2N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha). Maximum flower buds of 14.03 numbers was registered in plant spacing at 40 × 30 cm and 13.57 was recorded with the application of nitrogen 150 kg/ha, which was significantly higher over other treatments. Similarly maximum number of flower buds 15.20 were noted due to the interaction of treatment S_2N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha) which was at par with interactions of S_2N_1 (S_2-40 × 30 cm, N_1-200 kg/ha) 14.20 and found significant. Maximum number of flowers per plant of 15.96 was registered in plant spacing at 40 × 30 cm and 15.65 was recorded with the application of nitrogen 150 kg/ha, which was significantly higher over other treatments. The highest number of flowers per plant 17.93 was noted due to the interaction effects of nitrogen and spacing S_1N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha). The reason for earliness could be attributed to early completion of vegetative growth and changing of vegetative primordia to reproductive primordia, probably due to the secretion of growth promoting substances and closer spacing helped the plants in less

vegetative growth, which was in confirmation with the findings of Mishra *et al.* (2018). Similar results in increasing flowering period have been reported by Vijaykumar *et al.* (1988). corresponding reduction in number of flower buds registered with the maximum plant spacing because nitrogen accelerate the development of reproductive phase and closer spacing results more competition. Similar results in increasing number of flower buds have been reported by Dhemre *et al.* (1997). The increase in flower yield might be due to application of the higher nitrogen dose and active role of nitrogen in producing more vigorous growth of plant due to the production and accumulation of more photosynthates. This may also be fact that optimum plant population per unit area and better nutrient levels brought better growth of plant which resulted in more flowers. Similar findings were also reported by Birade *et al.* (2003); Mishra *et al.* (2018); Acharya and Dashora (2004)**.**

Yield Parameters. Maximum number of flowers per plot 52.92 was registered in plant spacing at 40 × 30 cm and with the application of nitrogen 150 kg/ha (53.67), which was significantly higher over other treatments (Table 2) These results were in close similarity to that of varma *et al*. (2023) in gompherna. Due to the interaction effects of nitrogen and spacing S_2N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha) recorded the highest number of flowers per plot (55). Maximum duration of flowering in plot of 40.25 days was registered in plant spacing at 40 × 30 cm and 40.83 days was recorded with the application of nitrogen 150 kg/ha, which was significantly higher over other treatments. Similarly longer duration of flowering in plots (44.00 days) was noted due to the interaction effects of nitrogen and spacing S_2N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha). Maximum fresh weight of flower 10.24 g was registered in plant spacing at 40 × 30 cm and 10.15 g was recorded with the application of nitrogen 150 kg/ha, which was significantly higher over other treatments. Application of different levels of nitrogen and spacing significantly influenced the weight of flower due to the interaction effects and 10.83 g was noted as highest in S_2N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha). Maximum yield per plot 1.29 kg was registered in plant spacing at 40 × 30 cm and 1.22 kg was recorded with the application of nitrogen 150 kg/ha, which was significantly higher over other treatments. Yield per plot 1.56 kg was noted due to the interaction effects of nitrogen and spacing S_2N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha). Maximum flower diameter of 8.41 cm was registered in plant spacing at 40 × 30 cm and 8.65 cm was recorded with the application of nitrogen 150 kg/ha, which was significantly higher over other treatments. Flower diameter 9.27 cm was noted due to the interaction effects of nitrogen and spacing S_2N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha) which was the maximum. Maximum stalk length of 28.17 cm was registered in plant spacing at 40 × 30 cm and 29.22 cm was recorded with the application of nitrogen 150 kg/ha, which was higher over other treatments. Stalk length of 31.23 cm was noted due to the interaction effects of nitrogen and spacing S_2N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha) which was at par with interactions and found non-significant. Maximum vase life of 11.08 days was registered in plant spacing at 40 × 30 cm and 11.33 days was recorded with the application of nitrogen 150 kg/ha, which was significantly higher over other treatments. Vase life 12.33 days was noted due to the interaction effects of nitrogen and spacing in S_2N_2 (Spacing- 40 × 30 cm and Nitrogen @ 150 kg/ha) which observed as the highest and was at par with interactions and found non-significant. The minimum vase life 7.33 days was recorded in treatment S_1N_0 (control) receiving nitrogen 0 kg/ha with spacing 60 × 40 cm. Photosynthesis enhanced food production which might have resulted in better plant growth and enhance the number of flowers per plot, the higher yield in terms of flowers per unit area can be attributed to the higher population per unit area with closer spacing levels. Similar results in increasing number of flowers per plot have been reported by Rajesh *et al.* (2012); Mishra *et al.* (2018). Increase in duration of flowering in plots and flowers remained presentable for maximum time in the plants because nitrogen helps in increasing growth parameters and translocation and accumulation of photosynthates might be the reason for increase in flowering duration. Similar results in increasing duration of flowering have been reported by Jamkhande *et al.* (2004); Singh *et al.* (2018). As nitrogen influence the growth characters which will in turn increase the photo-assimilates diversion to the developing flower buds and thus increased the flower weight. Closer spacing might be optimum which increased root activity to overcome competition and distined the nutrients to sink by means of higher uptake. Similar results in increasing weight of flower have been reported by Acharya and Dashora (2004); Singh and Sangma (2001); Jules Jonick and Durkin (1968); Mishra *et al.* (2018). The increase in flower yield per plot might be due to numerically more number of plants per plot. Supply of nitrogen to the plant is considered to be important in promoting rapid growth with increase in net photosynthesis. Similar results in increasing yield per plot have been reported by Dixit (2004); Maharnoe *et al.* (2011); Khobragade *et al.* (2012); Chauhan *et al.* (2014); Karavadia and Dhaduk (2002); Rajesh *et al.* (2012). Flower diameter increased due to optimum spacing and efficient utilization of soil surface area along with more sunlight further higher root activity because of competition between plants might have accumulated higher carbohydrate reserves. Similar results in increasing flower diameter have been reported by Jamkhand *et al.* (2004); Belorkar *et al.* (1992); Koley and Khan (2012). The increase in stalk length may be attributed to growth on radial aspect of plant as observed through increase in plant height with nutrient application. Plants tend to grow vertically when they are crowded owing to shadowing effect of plants on one another. Similar results have been reported by Maharnor *et al.* (2011); Barman and Pal (1992); Singh *et al.* (2018).

Application of nutrient sources influences flower longevity due to the increased nutrient uptake by plants and greater development of water conducting tissue. Similar results have been reported by Rajan *et al.* (2019).

Table 1: Effect of nitrogen and spacing on Plant height, Number of leaves, Plant spread, primary and secondary branches, days taken for bud formation, days taken for flower opening (bud-bloom) of China Aster.

Treatments	Plant height (cm)	Number of leaves	Plant spread (cm)	Primary branches	Secondary branches	Days taken for bud formation	Days taken for flower opening (bud-bloom) (days)
Factor A : Spacing (S)							
S_1 - 60 × 40 cm	42.68	21.39	72.91	11.64	14.66	66.50	12.25
S_2 - 40 × 30 cm	41.19	20.18	74.37	10.98	13.66	64.83	10.75
Sem(±)	0.47	0.33	0.46	0.18	0.19	0.38	0.24
CD at 5%	2.50	1.16	2.44	0.55	0.60	1.99	0.47
Factor B : Nutrients (N)							
N_0 – Control	37.43	18.48	68.87	9.35	11.82	66.50	12.67
N_1- Nitrogen @ 200 kg/ha	44.07	21.65	74.32	11.93	15.15	66.83	11.00
N_2- Nitrogen @ 150 kg/ha	44.48	22.68	79.77	13.27	16.35	64.00	9.67
N_3- Nitrogen @ 100 kg/ha	41.75	20.02	71.60	10.68	13.32	65.33	12.50
Sem(±)	0.67	0.47	0.65	0.25	0.27	0.53	0.26
CD at 5%	3.53	1.48	3.46	0.95	1.02	2.82	0.90
Interactions (S × N)							
S_1N_0 (S_1-60 × 40 cm, N_0-Control)	37.03	18.37	67.37	8.40	11.47	67.67	15.00
S_1N_1 (S_1-60 × 40 cm, N_1-200 kg/ha)	45.13	22.73	71.93	12.73	15.23	68.00	11.33
S_1N_2 (S_1-60 × 40 cm, N_2-150 kg/ha)	46.90	24.90	83.07	14.33	17.80	65.67	10.00
S_1N_3 (S_1-60 × 40 cm, N_3-100 kg/ha)	41.63	19.57	69.27	11.10	14.13	64.67	12.67
S_2N_0 (S_2-40 × 30 cm, N_0-Control)	37.83	18.60	70.37	10.30	12.17	65.33	10.33
S_2N_1 (S_2-40 × 30 cm, N_1-200 kg/ha)	42.07	20.57	76.70	12.20	15.07	65.67	10.67
S_2N_2 (S_2-40 × 30 cm, N_2-150 kg/ha)	43.00	20.47	76.47	11.13	14.90	62.33	9.33
S_2N_3 (S_2-40 × 30 cm, N_3-100 kg/ha)	41.87	21.10	73.93	10.27	12.50	66.00	12.33
Sem(±)	0.94	0.66	0.92	0.36	0.38	0.75	0.37
CD at 5%	5.00	3.51	4.89	1.20	1.24	3.99	1.24

Table 2: Effect of nitrogen and spacing on duration of flowering in plot, flower diameter, number of flower buds/plant, number of flowers/plant, number of flowers/plot, weight of flower, stalk length, yield/plot, vase life of China Aster.

Treatments	Duration of flowering in plot (days)	Flower diameter	Number of flower buds per plant	Number of flowers per plant	Number of flowers per plot	Weight of flower (g)	Stalk length (cm)	Yield per plot (kg)	Vase life (days)
Factor A : Spacing (S)									
S1 - 60 × 40 cm	37.67	7.75	11.45	12.17	47.92	8.75	25.28	0.83	8.92
S2 - 40 × 30 cm	40.25	8.41	14.03	15.96	52.92	10.24	28.17	1.29	11.08
Sem(±)	0.49	0.13	0.15	0.14	0.47	0.10	0.46	0.01	0.25
CD at 5%	1.58	0.68	0.79	0.77	1.46	0.51	1.45	0.07	1.33
Factor B : Nutrients (N)									
N0 – Control	37.33	7.23	11.72	12.52	46.00	8.45	23.98	0.83	8.67
N1- Nitrogen @ 200 kg/ha	39.67	8.55	13.53	14.63	52.33	9.85	28.43	1.13	10.33
N2- Nitrogen @ 150 kg/ha	40.83	8.65	13.57	15.65	53.67	10.15	29.22	1.22	11.33
N3- Nitrogen @ 100 kg/ha	38.00	7.85	12.13	13.45	49.67	9.53	25.27	1.04	9.67
Sem(±)	0.69	0.18	0.21	0.20	0.66	0.14	0.66	0.02	0.35
CD at 5%	2.04	0.97	1.11	0.98	2.08	0.72	1.86	0.10	1.88
Interactions (S × N)									
S1N0 (S1-60 × 40 cm, N0-Control)	36.00	6.70	10.57	11.30	43.00	7.33	23.20	0.66	7.33
S1N1 (S1-60 × 40 cm, N1-200 kg/ha)	37.67	8.68	12.93	12.50	50.67	9.47	27.27	0.89	9.67
S1N2 (S1-60 × 40 cm, N2-150 kg/ha)	40.00	7.83	11.87	13.37	52.33	9.27	27.20	0.92	10.33
S1N3 (S1-60 × 40 cm, N3-100 kg/ha)	37.00	7.80	10.43	11.50	45.67	8.93	23.47	0.84	8.33
S2N0 (S2-40 × 30 cm, N0-Control)	38.67	7.77	12.87	13.73	49.00	9.57	24.77	1.01	10.00
S2N1 (S2-40 × 30 cm, N1-200 kg/ha)	39.33	8.70	14.20	16.77	54.00	10.43	29.60	1.35	11.00
S2N2 (S2-40 × 30 cm, N2-150 kg/ha)	44.00	9.27	15.20	17.93	55.00	10.83	31.23	1.56	12.33
S2N3 (S2-40 × 30 cm, N3-100 kg/ha)	39.00	7.90	13.83	15.40	53.67	10.13	27.07	1.24	11.00
Sem (±)	0.97	0.26	0.30	0.29	0.93	0.19	0.93	0.03	0.50
CD at 5%	3.15	1.37	1.57	0.83	2.92	0.72	NS	0.14	NS

CONCLUSIONS

The investigation concluded in the spacing and nitrogen doses required for cultivation of China Aster Cv. Powder puff mix in Bhubaneswar condition along with the recommended dose of phosphorus and potassium. In this view, it is opined that though wider spacing of 60 cm × 40 cm with 150 kg/ha of nitrogen was proved to be the best with respect to the vegetative character, but moderate spacing of 40 cm × 30 cm along with 150

kg/ha of nitrogen provided the reasonably good vegetative characters along with better flower yield in course of quantity along with quality. So, it is recommended to follow the plant spacing of 40 cm between the rows and 30 cm between the plants (in between the rows) and nitrogen dose of 150 kg/ha along with recommended dose of phosphorus and potassium for China Aster Cv. Powder puff mix.

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