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Short communication

Response of China aster (*Callistephus chinensis* (L.) Nees) cv. Kamini to different combinations of NPK and biofertilizers

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ABSTRACT

An investigation was carried out to find a suitable combination of NPK and biofertilizers for maximizing flower yield in China aster cv. Kamini. The experiment was laid out in randomized block design (RBD) with 12 treatment combinations replicated thrice. The observations on various growth and flowering parameters were recorded. Results revealed that maximum plant height (56.67 cm), number of leaves per plant (103.93), flowering branches per plant (8.23), plant spread (32.32 cm), number of flowers per plant (28.58), number of flowers per plot (428.67), duration of flowering (27.20 days), flower yield per plant (73.21 g), flower yield per plot (1098.20 g), shelf-life of flowers (6.43 days) at ambient conditions were recorded in plants receiving 75% NPK (22.5:11.25:7.5 g NPK/ m^2) + *Azotobacter* + PSB. Plants supplied with 100% NPK (30:15:10 g NPK/ m^2) + *Azotobacter* + PSB were noticed with maximum leaf area (15.76 cm^2), whereas, largest flower diameter (5.41 cm) and fresh weight of individual flower head (2.70 g) were found in plants receiving 50% NPK (15:7.5:5 g NPK/ m^2) + *Azotobacter* + PSB.

Key words: China aster, NPK, *Azotobacter*, phosphorus solubilizing bacteria.

China aster (*Callistephus chinensis* (L.) Nees) belongs to family 'Asteraceae' and is native to China. It is an important loose flower in India and is being grown in Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and West Bengal. Productivity and quality of the flowers of China aster can be improved by using high yielding cultivars through improved nutrition. Though, the chemical fertilizers are important sources of nutrients, these are not only costly but growing awareness of environment pollution and limitations of non-renewable resources may introduce additional constraints. The use of chemical fertilizers also poses a major threat to sustain soil health and crop productivity. Incorporation of biofertilizers, which are eco-friendly, economical and easily available, in combination with chemical fertilizers can, to some extent, prevent the detrimental effects of current practices. Keeping in view the above facts, this investigation was undertaken.

The studies were carried out during June 2015 to November 2015 at the Research Farm of the Department of Floriculture and Landscape Architecture, Dr YSPUH&F, Nauni, Solan, Himachal Pradesh. The experimental site is located at a latitude of 30^o 52' 02" N and longitude of 77^o 11' 30" E with an elevation of 1,276 m above mean sea level. The climate of the area, in general, is sub-temperate to sub-tropical and is characterized by mild summers and cool winters. Mean maximum temperature (24.15°C) was recorded in July 2015 with minimum (15.45°C) in November 2015 during study period. The experiment was laid out in randomized block design (RBD) with twelve fertilizer treatments {T_1: 100% NPK (RDF, *i.e*. 30:15:10 g NPK/ m^2), T_2: 100% NPK + *Azotobacter*, T_3: 100% NPK + PSB, T_4: 100% NPK + *Azotobacter* + PSB, T_5: 75% NPK (22.5:11.25:7.5 g NPK/ m^2), T_6: 75% NPK + *Azotobacter*, T_7: 75% NPK + PSB, T_8: 75% NPK + *Azotobacter* + PSB, T_9: 50% NPK (15:7.5:5 g NPK/m^2), T_{10}: 50% NPK + *Azotobacter*, T_{11}: 50% NPK + PSB, T_{12}: 50% NPK + *Azotobacter* + PSB} replicated thrice. The soil of the experimental field was medium in nitrogen and high in phosphorus and potassium availability. The pH and electrical conductivity of soil was normal with high organic carbon. Nursery of China aster cv. Kamini was raised in elevated bed. There were 36 plots of 1 m x 1 m each having 15 plants with a spacing of 30 cm × 20 cm. Half dose of nitrogen and whole of the phosphorus and potassium were incorporated in soil before planting according to the treatment. The remaining half dose of nitrogen was given after 35 days of planting. *Azotobacter* and phosphate solubilizing bacteria (PSB) were applied immediately before planting by dipping the roots of the seedlings for 30 min. in the slurry prepared by dissolving 200 g of single biofertilizer or 100 g of both biofertilizers in one litre water. Pinching was done by removing the plant part above 6 inches from the ground level

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Table 1. Response of China aster cv. Kamini to different combinations of NPK and biofertilizers.

Treatment	Plant height (cm)	No. of leaves per plant	Leaf area (cm^2)	No. of flowering branches per plant	Plant spread (cm)	No. of days taken for first flower bud formation	No. of days taken for first flower opening	No. of flowers per plant	No. of flowers per plot	Flower dia. (cm)	Duration of flowering (days)	Fresh wt. of individual flower head (g)	Flower yield per plant (g)	Flower yield per plot (g)	Shelf-life of flowers in ambient conditions (days)
T_1	51.12	92.07	13.05	6.73	27.91	71.43	81.67	23.09	346.33	5.12	23.13	2.32	53.96	809.35	4.63
T_2	52.92	96.40	14.44	7.00	29.16	71.10	81.93	24.11	361.67	5.21	25.43	2.44	58.15	872.30	5.13
T_3	52.54	95.07	14.77	7.13	30.76	69.43	80.97	25.91	388.67	5.23	25.67	2.51	62.32	934.75	5.23
T_4	55.78	101.33	15.76	8.03	31.87	68.13	79.30	27.73	416.00	5.35	26.77	2.60	71.50	1072.50	5.57
T_5	49.54	89.87	12.75	6.60	26.06	66.53	78.97	22.98	344.67	5.02	22.90	2.40	53.69	805.35	4.30
T_6	53.44	98.93	13.37	7.70	30.07	68.37	80.10	25.71	385.67	5.16	24.80	2.55	61.17	917.50	6.00
T_7	54.02	99.13	14.02	7.87	31.32	66.93	78.53	27.07	406.00	5.17	24.93	2.57	66.06	990.95	6.13
T_8	56.67	103.93	15.14	8.23	32.32	65.90	77.87	28.58	428.67	5.26	27.20	2.64	73.21	1098.20	6.43
T_9	48.20	88.80	12.39	6.30	25.51	72.30	82.73	22.51	337.67	4.97	22.67	2.27	50.66	759.90	4.07
T_{10}	50.19	94.20	13.49	6.80	27.02	72.93	83.30	23.56	353.33	5.19	23.57	2.43	56.02	840.35	4.77
T_{11}	50.08	90.80	13.61	7.07	26.51	68.73	80.20	24.80	372.00	5.21	24.00	2.48	56.24	843.65	4.97
T_{12}	54.14	97.60	14.97	7.53	28.60	66.17	78.30	26.76	401.33	5.41	26.07	2.70	68.18	1022.65	5.93
$CD_{0.05}$	1.87	4.30	1.10	0.85	2.86	2.33	2.12	1.74	26.11	0.20	2.06	0.15	5.82	87.27	0.77

T_1 = 100% NPK (RDF *i.e.* 30:15:10 g; T_2 = 100% NPK + *Azotobacter* NPK/ m^2), T_3 = 100% NPK + PSB, T_4 : 100% NPK + *Azotobacter* + PSB, T_5 = 75% NPK (22.5:11.25:7.5 g NPK/ m^2), T_6 75% NPK + *Azotobacter*, T_7: 75% NPK + PSB, T_8: 75% NPK + *Azotobacter* + PSB, T_9 = 50% NPK (15:7.5:5 g NPK/m^2), T_{10} = 50% NPK + *Azotobacter*, T_{11} = 50% NPK + PSB, and T_{12} = 50% NPK + *Azotobacter* + PSB

after 30 days of transplanting to break the apical dominance and encourage the emergence of lateral branches. Observations on plant growth and flowering characters were recorded and analyzed statistically.

The plant growth parameters showed significant results due to different fertilizer treatments as depicted in Table 1. The maximum plant height (56.67 cm), number of leaves per plant (103.93), number of flowering branches per plant (8.23) and plant spread (32.32 cm) was recorded in T_8 comprising of 75% NPK + *Azotobacter* + PSB, however, higher leaf area (15.76 cm^2) was found in T_4, *i.e.* 100% NPK + *Azotobacter* + PSB. Minimum values for these characters were observed in T_9, *i.e.* 50% NPK alone. The combined application of biofertilizers with NPK resulted in better nutrition which lead to increased photosynthesis activity, enhanced cell division and enlargement as nitrogen is important constituent of nucleic acid and it might have increased the synthesis of carbohydrate, amino acids *etc*. from which the phytohormones like auxins, gibberellins, cytokines have been synthesized and phosphorus being an essential component of protoplasm and chlorophyll, caused conversion of photosynthates into phospholipids resulting in adequate vegetative growth. Biofertilizers produce several growth promoting hormones (auxins, cytokinins and gibberellins *etc*.) in addition to increasing the availability of nitrogen and phosphorus to the plants resulting in better plant growth. The reduction in plant growth characters with T_9 may be due to the lack of nutrition to the plants receiving half dose, so, they could not assimilate required food materials to support the vegetative growth and hence lesser plant growth. Similar results of increased plant growth due to combined application of biofertilizers with NPK have been reported by Chaitra and Patil (2), Patil and Agasimani (8) and Kirar *et al*. (4) on China aster; Kumar *et al*. (5) and Gupta *et al*. (3) on marigold; Airadevi (1) and Panchal *et al*. (7) on annual chrysanthemum.

The perusal of data presented in Table 1 discovered the significant results for flowering characters with application of different fertilizer treatments. The application of 75% NPK + *Azotobacter* + PSB resulted in minimum number of days taken for first flower bud formation (65.90) and first flower opening (77.87), which can 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 like auxins, gibberellins, vitamins and organic acids by the biofertilizers, which resulted in early flower bud formation and ultimately early flower opening. Further, phosphorus is an important element and essential for the initiation of flowering and PSB is known to increase the availability of phosphorus resulting in early flowering. Flower bud formation and opening were delayed with application of 50% NPK + *Azotobacter*, which can be due to the fact that the nutritional requirements of the plants were not met, so they took more time to complete their vegetative phase and delayed the flower bud formation and opening. These results got support from the findings of Chaitra and Patil (2) and Kirar *et al*. (4) on China aster; Kumari *et al.* (6) in chrysanthemum and Thane *et al.* (9) on gerbera.

The number of flowers per plant (28.58), number of flowers per plot (428.67), duration of flowering (27.20 days), flower yield per plant (73.21 g), flower yield per plot (1098.20 g) and shelf-life of flowers in ambient conditions (6.43 days) was maximum in plants applied with 75% NPK + *Azotobacter* + PSB (T_8), whereas, the application of 50% NPK, *i.e.* T_9 registered minimum values for these parameters. This might be due to proper nitrogen, phosphorus and potassium assimilation from the combined use of NPK in association with more nitrogen fixing and phosphorus solubilizing proficiency and secretion of hormones by the biofertilizers. The more number of flowering branches might have increased the number of flowers ultimately leading to increased flower yield. Better assimilation of photosynthates resulted in more food reserve, thus, more flowering duration and shelf-life. The maximum flower diameter (5.41 cm) and fresh weight of individual flower head (2.70 g) was seen in T_{12} comprised of 50% NPK + *Azotobacter* + PSB. These results were in agreement with the findings of Kirar *et al*. (4) who reported maximum length and width of flower head and fresh weight of individual flower with 50% NPK + vermicompost + *Azotobacter* + PSB in China aster. From the present studies, it can be concluded that an application of 75% NPK (22.5:11.25:7.5 g NPK/m^2) along with inoculation of *Azotobacter* and phosphate solubilizing bacteria (PSB) was found superior regarding flower production of China aster cv. Kamini.

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