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# Effect of bio-fertilizers and inorganic manures on plant growth, flowering and yield attributes of China aster (*Callistephus chinensis* L. Nees) cv. Kamini

**Nileema Pandey, T Tirkey, Mithilesh N Pandey and Oshin Pali**

**Abstract**
China aster (*Callistephus chinensis* (L.) Nees.) is a half-hardy annual and commercial flower crop belonging to the family Asteraceae. It is an important annual crop of our country and grown all over the world. It is the third most significant flower after marigold and chrysanthemum. The growth, flowering and quality of China aster is significantly influenced by application of major nutrients along with organic manures. It is evident from the reviews that integrated nutrient management has a well-established positive impact on performance. The recent approaches of saving fertilizers by using fertigation will enhance the nutrient along with water use efficiency. An investigation entitled "Effect of different combinations of Inorganic, Organic and Bio-fertilizers on growth and Flower yield of China aster (*Callistephus chinensis* L. Nees.) cv. 'Kamini' been held at Horticultural Research Farm, Department of floriculture and Landscape Architecture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G) during the year 2019-2020 in Rabi period. The experiment was conducted in Randomized Block Design with three replications and eleven treatment combinations including control.

**Keywords:** Azotobacter, fertigation**,** inorganic manures**,** phosphorus solubilizing bacteria

## Introduction
China aster (*Callistephus chinensis* L. Nees) belongs to family 'Asteraceae' and is intuitive to China. The species has only a solitary species, namely, *Callistephus chinensis*. The genus originates its appellation from 2 Greek prose 'kalistos', most beautiful, and 'stephos', a crown, entailing to the flower. The colours are varied, including natural pink shades of white, pink, primrose, light blue, lavender, fuchsia, purple, dark blue and scarlet. 'Kamini' variety was derived by crossing two pure lines (AST 6 x AST- 36) and was developed through pedigree method of breeding with the intent of obtaining pink coloured flowering variety for cut flower purpose, which is exceptional to the 'Local Pink' variety. A biofertilizer is described as a preparation that maintains living cells or latent cells of effective microbial strains. When they are spread through nucleoli or dirt, they help crops absorb nutrients through cooperation in the rhizosphere. In modern agricultural systems, the use of chemical fertilizers is the only major contribution to cumulative production. The instability in large-scale use of chemical fertilizers also contributes in increasing soil infertility and soil structure degradation. Therefore, the research was conducted with the following specific objectives, bearing in mind the use of modern and biofertilizers in horticulture:

- To study the effect of inorganic fertilizers and biofertilizers on growth, flowering and yield attributes of China aster.
- To assess the best combinations of inorganic fertilizers along with biofertilizers on growth and flowering behavior of China aster.

## Materials and Methods
The experiment was conducted at Horticultural Research Farm, Department of Horticulture and landscape architecture, College of Agriculture, I G K V, Raipur, (C.G.) during *Rabi* season of the year 2019-20. The seeds of China aster cv. Kamini were sown in pro-trays and kept in germination chamber for proper germination.

**Table 1:** Treatment Details

| S. No. | Notation | Treatments Combinations |
|---|---|---|
| 1 | $T_1$ | 100% RDF (Control) |
| 2 | $T_2$ | 75% RDF + PSB + Azotobacter |
| 3 | $T_3$ | 50% RDF + PSB + Azotobacter |
| 4 | $T_4$ | 75% RDF + 25% FYM |
| 5 | $T_5$ | 50% RDF + 50% FYM |
| 6 | $T_6$ | 75% RDF + 25% Vermicompost |
| 7 | $T_7$ | 50% RDF + 50% Vermicompost |
| 8 | $T_8$ | 75% RDF + 25% FYM + PSB + Azotobacter |
| 9 | $T_9$ | 75% RDF + 25% Vermicompost + PSB+ Azotobacter |
| 10 | $T_{10}$ | 50% RDF + 50% Vermicompost + PSB+ Azotobacter |
| 11 | $T_{11}$ | 50% RDF + 50% FYM+ PSB + Azotobacter |

Where,
RDF = Recommended Dose of fertilizer.
PSB = Phosphorus Solubilizing Bacteria.
FYM= Farm Yard Manure

After the acceleration of germination, the trays were transferred in primary hardening unit for 10-12 days and then in secondary hardening unit for 10-15 days.25-30 days old seedling was then transplanted in field. The experiment was laid out in randomized block design (RBD) with 11 treatment combinations replicated thrice. Solution of PSB and Azotobacter was prepared by mixing 5gof PSB and Azotobacter 1 liter of water. Observations on plant growth and flowering parameters were recorded and analyzed statistically.

## Results and Discussion

### A. Vegetative characters

Vegetative parameters viz., plant height, number of primary branches per plant, number of secondary branches per plant, no. of leaves per plant and plant spread, were recorded at different stages of plant growth after transplanting and the results from the observations made are as follows.

**Plant height (cm)**

Considerable differences regarding plant height were found among the treatments, at 30, 50 and 70 days after transplanting, where $T_8$ recorded the highest plant height with increasing level of bio fertilizers and inorganic manure at all successive stages of growth. This was found statistically *at par* with the treatment $T_9$. The marginal plant height was observed in $T_1$ (100% RDF control) at all stages of growth. The probable inference for increases in plant height may be because of united function of organic & bio fertilizer with 75% of RDF resulted in improved nutrient which helps to escalation photosynthesis activity improved division of cell & amplification comparable outcomes were also stated by Chaitra and Patil (2007) [3] Patil & Agasimani (2013) [8] and Kirar (2014) [5] in China Aster; Airadevi (2012) [2] in annual chrysanthemum..

**Number of primary branches per plant**

A significant difference among the treatments regarding the primary branch number was recorded, the maximum primary branches each plant (12.50) was noted with the treatment $T_8$ (75% RDF + 25% FYM + PSB + Azotobacter) which was found similar with treatment $T_9$ (75% RDF + 25% Vermicompost PSB +Azotobacter*)*. The minimum number of primary branches (4.30) was found in $T_1$ (100% RDF control). The outcomes are add in with finding of Chaitaa & Patil (2007) [3] who reported that maximum count of Primary branches per plant with inoculation of Azotobacter and PSB in China Aster.

**Number of secondary branches per plant**

The perusal of data presented in Table.2 discovered the significant results for the secondary branches number, the highest number of secondary branches per plant (14.50) was obtained with treatment $T_8$ (75% RDF + 25% FYM + PSB + Azotobacter) (Table 4.3) which was *at par* with treatment $T_9$ (75% RDF +25% Vermicompost +PSB +Azotobacter*)*. Same result found in increased in flowering branches number reported by Patil and Agasimani (2013) [8] in China Aster; Gupta *et al.,* (1999) [4] in African Marigold; Verma *et al.,* (2011) [11] in Chrysanthemum.

**Number of leaves per plant**

There were considerable significant differences found among the treatments, at 30, 50 and 70 days after transplanting, where $T_8$ recorded the maximum leaf numbers per plant. The number of leaves showed steady increase with increasing level of bio fertilizers and inorganic manure (75% RDF + 25% FYM + PSB + Azotobacter) at all successive stages of growth. The minimum number of leaves were observed in $T_1$ (100% RDF control). These outcomes are accordance at par with the findings of Kirar *et al.,* (2014) [5] in China Aster cv 'Princess' Gupta *et al.,* (1999) [4] reported in marigold.

**Plant spread (cm)**

The data on plant spread of China aster shows that the superior plant spread (23.70 cm) was noticed in treatment $T_9$ (75% RDF + 25% Vermicompost + PSB + Azotobacter) which was statistically *at par* with $T_8$ and $T_{10}$.The lowest plant spread (13.80cm) was noticed in $T_1$ (100% RDF control). Above results are in conformity with the findings of Panchal *et al.,* (2010) [7] in annual chrysanthemum.

### B. Floral attributes

Floral parameters viz., days to bud initiation, days to flower opening, number of flowers per plant, number of flowers per plot, flower diameter and length of flower stalk were recorded at different stages of plant growth and the results from the observations are as follows.

**Days to bud initiation**

The number of days to bud initiation showed significant results due to application of different inorganic fertilizer, organic fertilizers and bio-fertilizers to all the treatments. The earliest to bud initiation (69.00 days) was observed in treatment $T_9$ (75% RDF + 25% Vermicompost + PSB + Azotobacter) and maximum days to bud initiation (87.00 days) were taken in treatment $T_1$ (100% RDF control). Related results in improvement in bud initiation in garland chrysanthemum Airadevi (2012) [2].

**Number of days to flower opening**

The observation of flower opening days showed the significant results. Treatment $T_9$ (75% RDF + 25% Vermicompost + PSB + Azotobacter) observed minimum day (75.67 days) to flower opening. The maximum days to flower

opening (94.01days) was recorded by $T_1$ (100% RDF control). Related results of earlier flowering by integrated use of nitrogen, phosphorous, potassium and biofertilizers are reported by Chaitra and Patil (2007) [3] and Kirar *et al*., (2014) [5] in China Aster.

**Number of flowers per plant**

Statistically analyzed data revealed the results for number of flowers per plant. The peaked flower number in each plant (30.51) were showed in treatment $T_9$(75% RDF + 25% Vermicompost + PSB + Azotobacter) which was statistically similar with treatments $T_8$ (75% RDF + 25% FYM + PSB + Azotobacter). Similar results were also reported by Gupta *et al.,* (1999) [4] in marigold; Mittal *et al.,* (2010) [6] in African Marigold.

**Number of flowers per plot**

The data recorded on average number of flowers per plot revealed that the higher count of florets each plot (1068.70) was noted in the treatment $T_9$ (75% RDF + 25% Vermicompost + PSB+Azotobacter) which was statistically similar with treatment (1008.00) $T_8$ (75%RDF+25%FYM+PSB+Azotobacter). However, it differed significantly with rest of the other treatments. This results in accordance with findings of Chaitra and Patil (2007) [3], Kirar *et al*., (2014) [5] in China Aster; Mittal *et al.,* (2010) [6] in African Marigold; Panchal *et al.,* (2010) [7] in annual chrysanthemum.

**Flower diameter (cm)**

The flower diameter differed significantly due to application of different fertilizer treatments, the largest flower diameter (4.50cm) was noted in treatment $T_9$ (75% RDF + 25% Vermicompost + PSB +Azotobacter) and it was found *at par* with $T_7$,$T_8$,$T_{10}$ and $T_{11}$.The smallest flower diameter (3.80cm) was noticed in $T_1$ (100% RDF control). The results are consistent with the findings of Kirar *et al.,* (2014) [5].

**Length of flower stalk (cm)**

The data regarding average flower stalk length determined in various treatments are as follows, the length of flower stalk ranged from 33.00 cm to 41.04 cm. Longest length of flower stalk (41.04 cm) was recorded in plants receiving treatment $T_9$(75% RDF + 25% vermicompost +PSB + Azotobacter). The similar result also reported of Agrawal *et al.* (2002) [1] in African Marigold.

**C. Yield parameters**

**Weight of individual flower (g)**

The data presented in Table.3 reveals that the maximum individual flower weight (1.63g) was recorded in the treatment $T_9$(75% RDF + 25% vermicompost +PSB + azotobacter) which was showed significant difference with all other treatment. The result can supported by the finding of Agrawal *et al.,* (2002) [1], Panchal *et al.,* (2010) [7] in annual chrysanthemum.

**Flower yield per plant (g)**

Flower yield per plant recorded significant variations among the different treatments, the maximum flower yield (39.36g) per plant was obtained in treatment $T_9$ (75%RDF +25% Vermicompost +PSB + Azotobacter) which was exhibited similar result with the treatment $T_8$ (75% RDF + 25% FYM + PSB +Azotobacter). The result showed significant differences with rest of the all other treatments. Similar results were also reported by Gupta *et al.,* (1999) [4] in marigold.

**Flower yield per plot (g)**

On the basis of data analyzed flower yield per plot exhibited significant variation among different treatment. The maximum flower yield (1378.53g) per plot was recorded with the treatment $T_9$ (75% RDF + 25% Vermicompost + PSB + Azotobacter).

**Flower yield per hectare (q)**

The flower yield of China aster per hectare was significantly influenced among all the treatments. The maximum flower yield per hectare (44.44qt) was obtained in treatment $T_9$ (75%RDF + 25%Vermicompost + PSB + Azotobcter) and it was found *at par* with treatment $T_8$ (75% RDF + 25% FYM + PSB + Azotobacter). The minimum flower yield (26.86qt) of china aster per hectare was noted with treatment $T_1$ (100% RDF). These results are accordance in the finding of Sunitha *et al.* (2005) [9] in African marigold.

**Table 2:** Growth and floral attributes under different treatment conditions

| Treatments | Growth/Vegetative Attributes | | | | | | | | | Floral Attributes | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plant height (cm) | | | Number of primary branches | Number of secondary branches | Number of Leaves per plant | | | Plant spread (cm) | Bud initiation (days) | Number of days to flower opening | Number of flowers per plant | Number of flowers per plot | Flower diameter (cm) | Stalk length (cm) |
| | 30 DAP | 50 DAP | 70 DAP | | | 30 DAP | 50 DAP | 23.60 | | | | | | | |
| $T_1$ | 4.20 | 7.00 | 11.00 | 4.30 | 9.10 | 4.01 | 7.50 | 26.41 | 13.80 | 87.00 | 94.01 | 23.60 | 826.00 | 3.80 | 33.00 |
| $T_2$ | 5.00 | 8.50 | 13.90 | 7.70 | 11.00 | 5.200 | 10.30 | 25.7 | 16.30 | 75.00 | 81.67 | 26.41 | 924.01 | 4.00 | 36.09 |
| $T_3$ | 4.80 | 7.90 | 13.30 | 9.50 | 12.00 | 5.40 | 9.70 | 25.71 | 17.90 | 82.30 | 89.50 | 25.7 | 900.71 | 4.00 | 37.30 |
| $T_4$ | 5.20 | 7.80 | 13.80 | 8.70 | 11.10 | 5.70 | 9.70 | 25.00 | 19.00 | 71.70 | 78.20 | 25.71 | 900.70 | 4.01 | 37.71 |
| $T_5$ | 5.00 | 8.30 | 13.90 | 6.50 | 10.90 | 5.40 | 10.40 | 26.52 | 16.00 | 75.30 | 82.94 | 25.00 | 875.00 | 4.01 | 37.60 |
| $T_6$ | 5.20 | 8.70 | 12.70 | 9.70 | 11.60 | 5.10 | 9.30 | 26.21 | 19.00 | 71.30 | 77.33 | 26.52 | 928.70 | 4.02 | 38.10 |
| $T_7$ | 5.30 | 8.30 | 12.60 | 8.80 | 11.60 | 6.20 | 10.40 | 28.80 | 16.20 | 79.00 | 85.52 | 26.21 | 917.00 | 4.20 | 37.70 |
| $T_8$ | 5.80 | 9.50 | 15.70 | 12.50 | 14.50 | 7.10 | 13.10 | 30.51 | 21.70 | 70.70 | 77.45 | 28.80 | 1008.00 | 4.30 | 38.60 |
| $T_9$ | 5.40 | 9.10 | 14.50 | 11.50 | 13.00 | 6.90 | 10.50 | 24.52 | 23.70 | 69.00 | 75.67 | 30.51 | 1068.70 | 4.50 | 41.04 |
| $T_{10}$ | 4.70 | 9.00 | 13.70 | 9.10 | 11.70 | 5.80 | 11.30 | 26.11 | 21.70 | 70.70 | 78.60 | 24.52 | 856.30 | 4.20 | 38.06 |
| $T_{11}$ | 5.40 | 9.10 | 13.40 | 8.50 | 10.90 | 5.70 | 9.40 | **1.21** | 15.20 | 71.70 | 78.32 | 26.11 | 914.70 | 4.20 | 38.09 |
| SEm± | 0.20 | 0.32 | 0.47 | 1.21 | 0.60 | 0.34 | 0.63 | 3.57 | 0.70 | 3.90 | 1.93 | 1.21 | 42.40 | 0.12 | 0.93 |
| CD @ 0.05% | 0.61 | 0.97 | 1.40 | 3.59 | 1.80 | 1.02 | 1.88 | 3.30 | 2.06 | 11.54 | 5.72 | 3.57 | 125.28 | 0.36 | 2.77 |

**Table 3:** Yield attributes under different treatment conditions

| Yield Attributes | | | | |
|---|---|---|---|---|
| **Treatment** | **Flower weight (g)** | **Flower yield per plant (g)** | **Flower yield per plot (g)** | **Flower yield per hectare (qt)** |
| $T_1$ | 1.01 | 23.79 | 832.72 | 26.86 |
| $T_2$ | 1.02 | 26.82 | 938.7 | 30.28 |
| $T_3$ | 1.03 | 26.51 | 927.97 | 29.23 |
| $T_4$ | 1.05 | 27.15 | 950.23 | 30.65 |
| $T_5$ | 1.04 | 26.01 | 910.23 | 29.36 |
| $T_6$ | 1.07 | 28.43 | 995.10 | 32.10 |
| $T_7$ | 1.08 | 28.30 | 990.36 | 31.94 |
| $T_8$ | 1.16 | 33.46 | 1171.0 | 37.44 |
| $T_9$ | 1.63 | 39.36 | 1378.53 | 44.44 |
| $T_{10}$ | 1.31 | 32.09 | 1123.29 | 36.23 |
| $T_{11}$ | 1.08 | 28.32 | 991.29 | 31.97 |
| SEm± | 0.33 | 2.00 | 40.44 | 2.59 |
| CD @ 0.05% | 0.11 | 5.91 | 119.49 | 7.67 |

## Conclusion

The majority of the vegetative growth characteristics of plants, including plant height, leaf count per plant, primary and secondary branch count, and plant spread, were found to respond best to treatment T8 (75% RDF + 25% FYM + PSB + Azotobacter).

Treatment $T_9$ (75% RDF + 25% Vermicompost + PSB + Azotobacter) was discovered to be the treatment that appeared to be the most suitable treatment regarding flower yield and quality parameters, including flower bud initiation, days to flower opening, number of flowers per plant and per plot, floral diameter, and flower yield per plant, per plot, and per hectare.

Since treatments $T_8$ and $T_9$ were found to be superior and recorded maximum flower yield in China aster, it can be inferred that the application of inorganic fertilizers in conjunction with organic fertilizers and biofertilizers is a better technique for taking flower production in China aster.

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