Original Research Article

Effect of Nitrogen and Phosphorous on Growth of China Aster
[Callistephus chinensis (L.) Nees]

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A B S T R A C T

The present investigations were undertaken at experimental farm of department of Floriculture and Landscaping, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) during the years 2012-2013. The China aster cv. ‘Kamini’ was selected for conducting the investigations. The experiment was laid out in RBD (Factorial) with 20 treatments and 3 replications. Tallest plant (83.32 cm) obtained with a combined application of 30 g N/m² and 25 g P₂O₅/m² (N₂P₃) that proved to be at par with N₂P₁, N₂P₂ and N₄P₃ whereas minimum plant height (46.42 cm) recorded in plants without nitrogen and phosphorus dose (N₀P₀). A combined dose of nitrogen and phosphorus significantly improved the plant spread. Maximum plant spread (76.00 cm) found in those plants with a combined dose of 30 g N/m² and 25 g P₂O₅/m² (N₂P₃) and proved to be significantly higher over all other treatments. Maximum number of branches per plant (7.01) recorded with 30 g N/m² (N₂) that proved superior over other treatments including control (N₀). Largest leaf area (21.72 cm²) found with a combined application of 30 g N/m² and 25 g P₂O₅/m² (N₂P₃) and it proved to be at par with N₃P₁. However, minimum leaf area (9.82 cm²) recorded in plants supplied with 40 g N/m² and 25 g P₂O₅/m² (N₄P₃).

Key words
China aster
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Introduction
China aster [Callistephus chinensis (L.) Nees.], belongs to family Asteraceae and is a native of China and Europe. The genus Callistephus derived its name from two greek words ‘Kalistos’ and ‘Stephos’ meaning ‘most beautiful’ and ‘a crown’, respectively. Cassini described the China aster as Callistephus hortensis. It was first named by Linnaeus as Aster chinensis, and Nees changed this name to Callistephus chinensis. China aster is a very popular annual flower crop and is mainly cultivated for production of cut flowers, loose flowers, as pot plant and for bedding plant purposes in landscape. It is gaining fast popularity in India because of its easy cultural practices, diversity of colours and varied uses. Evolution of aster flowers brought a new range of colours starting from white, rose, red, lavender, magenta and blue to their innumerable variations (Desai, 1967).
Plants of China aster are erect and attain a maximum height of 60-80 cm depending upon the genotypes.

Out of various factors influencing the growth of China aster, balanced nutrition is very important. The growth and development of production plants, generally, depends on their judicious feeding right from very beginning. China aster is a heavy feeder and hence has larger requirements for nitrogen, phosphorus and potassium. The emphasis at an early stage for vegetative growth should be especially on nitrogen. Gaikwad et al., (2004) were of the opinion that the plant growth during initial seven weeks needs maintenance of higher levels of nitrogen. Plants do need phosphorus throughout the growing period and it should be applied as a basal dose.

There is a vast scope of growing China aster in Himachal Pradesh throughout the year except in severe winters and scorching summer months for the purpose of cut flowers and loose flower production. There is scanty informations on the effect of nitrogen and phosphorus on growth of China aster particularly in North Indian conditions. However, no systematic work has been conducted on NPK studies of this crop which influences overall health and quality of the plants. Therefore, this study can be helpful to the farmers in order to increase flower production. The present work is being undertaken on cultivar 'Kamini' which is in a great demand in the Indian florist trade So, keeping in view the above facts, the present studies have been planned with the objective to optimize the dose of nitrogen and phosphorus for growth of China aster [*Callistephus chinensis* (L.) Nees].

**Materials and Methods**

The present investigations were undertaken at experimental farm of department of Floriculture and Landscaping, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) during the years 2012-2013. The China aster cv. ‘Kamini’ was selected for conducting the investigations. The experiment details are as followed:

- **Nitrogen levels**: 5 (Through: Urea) - 0 g/m²(Control), 25.0 g/ m², 30.0 g/ m², 35.0 g/ m² and 40.0 g/ m²
- **Phosphorus levels**: 4 (Through: SSP) - 0.0 g/ m², 15.0 g/ m²,20.0 g/ m², 25.0 g/ m²
- **Total No. of treatments**: 5×4=20 (T₁ to T₂₀)
- **No. of replications**: 3
- **Plot size**: 1×1 square meter
- **Design**: RBD (Factorial)

The Plant height recorded at 50 per cent of flowers opening. It was recorded from ground level to the top of inflorescence using meter scale. The plant spread of the plants was recorded as the average distance measured in centimetres in East-West and North-South directions of the plant with a metre scale at peak flowering. Total number of axillary branches per plant were counted at peak flowering. At peak flowering, the leaves were collected randomly at different heights from the plant. The leaf area measured with the help of Leaf Area Meter.

The statistical analysis was carried out for each observed character under the study using MS-Excel and OPSTAT packages. The observations recorded on various growth and flowering parameters were subjected to analysis of variance (ANOVA) using Randomized block design RBD (factorial) as described by Gomez and Gomez (1984).

**Result and Discussion**

It is evident from perusal of Table 1 that nitrogen application significantly improved
the plant height. Tallest plant (74.38 cm) found with an application of 30 g N/m² (N₂) and it was found to be at par with N1 and N3. Minimum plant height (55.63 cm) was recorded in those plants without application of nitrogen (N₀). Application of phosphorus doses did not influence the plant height. Tallest plant (83.32 cm) obtained with a combined application of 30 g N/m² and 25 g P₂O₅/m² (N₂P₃) that proved to be at par with N₂P₁, N₂P₂ and N₄P₃ whereas minimum plant height (46.42 cm) recorded in control (N₀). Plant spread was not significantly improved with different doses of phosphorus. A combined dose of nitrogen and phosphorus significantly improved the plant spread. Maximum plant spread (76.00 cm) found in those plants with a combined dose of 30 g N/m² and 25 g P₂O₅/m² (N₃P₃) and proved to be significantly higher over all other treatments. Whereas, the minimum plant spread (42.34 cm) was recorded in plants without nitrogen and phosphorus (N₀P₀).

It is envisaged from the data of Table 3 that the nitrogen doses influenced the number of branches per plant. Maximum number of branches per plant (7.01) recorded with 30 g N/m² (N₂) that proved superior over other treatments including control (N₀). Application of phosphorus did not influence the number of branches per plant. Combined applications of nitrogen and phosphorus did not affect the number of branches per plant. Data pertaining to leaf area as influenced by various levels of nitrogen and phosphorus have been presented in Table 4. Largest leaf area (15.87 cm²) recorded with 30 g N/m² (N₂) and found to be at par with N₃ and N₄. Minimum leaf area (11.22 cm²) observed in those plants without application of nitrogen (N₀). Leaf area was not influenced with different doses of phosphorus. Largest leaf area (21.72 cm²) found with a combined application of 30 g N/m² and 25 g P₂O₅/m² (N₂P₃) and it proved to be at par with N₃P₁. However, minimum leaf area (9.82 cm²) recorded in plants supplied with 40 g N/m² and 25 g P₂O₅/m² (N₄P₃).

Plants of maximum height with greater plant spread, number of branches and leaf area recorded with application of 30 g N/m² in China aster cv. ‘Kamini’ (Tables 1, 2, 3 and 4, respectively). It is evident that nitrogen is one of the major key elements for the plant growth and increase in nitrogen supply accelerates the synthesis of chlorophyll and amino acids which enhanced the vegetative growth in terms of plant height, stem length, number of leaves etc. (Mengel and Kirkby, 1987; Devlin, 1973). There is a general agreement that all the nutrient amendments made to soils, N fertilizer application has the most important effects in terms of increasing crop productivity. Although crops usually respond to N fertilizers, there is not much always the case. Response of N depends on soil conditions, the particular crop species and the plant nutrients supplied, in general.

The results got the support from the findings of various workers in China aster viz. Monish et al., (2008) observed improvement for growth parameter viz. plant height, number of leaves of China aster cv. ‘Poornima’ with 300 kg N/ha (30 g N/m²). Maximum plant spread and number of branches noticed with 200 kg N/ha (20 g N/m²) in China aster cv. ‘Phule Ganesh White’ (Gaikwad et al., 2004). Jamkhande et al., (2004) reported an increase in the vegetative growth of China aster cv. ‘Local’ with 150 kg N/ha (15 g N/m²). In the initial stages, nitrogen improved the vegetative growth of chrysanthemum (Hosoya et al., 1978). Also, the beneficial effect of nitrogen
application in China aster have been reported by different workers viz. Kumar et al., (2003); Singh and Sangama (2000) and Maheshwar (1977). Other than China aster, improvement have been noticed for various growth parameter with an application of 5 kg of FYM and 30 g of N/m² in chrysanthemum standard cv. ‘Snow Ball’ and spray cv. ‘Ajay’ (Sharma, 2003). The beneficial effect of nitrogen application in chrysanthemum have been reported by various workers viz. Jhon and Paul (1999); Sawaan et al., (1999); De and Barman (1997); Mostafa (1996); Lodhi and Tiwari (1993) and Rao et al., (1992). A reduction noticed for plant height, plant spread, number of branches per plant and leaf area (Tables 1, 2, 3 and 4, respectively) in China aster cv. ‘Kamini’ as the level of nitrogen increased from 30 to 40 g N/m².

**Table 1** Effect of nitrogen, phosphorus and their interactions on plant height (cm) of China aster cv. ‘Kamini’

| Phosphorous Nitrogen | P0 (0.0 g/m²) | P1 (15.0 g/m²) | P2 (20.0 g/m²) | P3 (25.0 g/m²) | Mean |
|----------------------|--------------|---------------|---------------|---------------|------|
| N0 (0.0 g/m²)        | 46.42        | 57.00         | 64.94         | 54.16         | 55.63|
| N1 (25.0 g/m²)       | 61.79        | 59.97         | 63.69         | 64.29         | 62.44|
| N2 (30.0 g/m²)       | 65.32        | 76.29         | 72.58         | 83.32         | 74.38|
| N3 (35.0 g/m²)       | 65.20        | 65.09         | 55.14         | 62.64         | 62.02|
| N4 (40.0 g/m²)       | 70.58        | 67.04         | 66.12         | 74.09         | 69.46|
| Mean                 | 61.86        | 65.08         | 64.50         | 67.70         |      |

CD0.05 - N: 5.35  P: NS  N × P: 10.70

**Table 2** Effect of nitrogen, phosphorus and their interactions on plant spread (cm) of China aster cv. ‘Kamini’

| Phosphorous Nitrogen | P0 (0.0 g/m²) | P1 (15.0 g/m²) | P2 (20.0 g/m²) | P3 (25.0 g/m²) | Mean |
|----------------------|--------------|---------------|---------------|---------------|------|
| N0 (0.0 g/m²)        | 42.34        | 51.22         | 47.87         | 55.09         | 49.13|
| N1 (25.0 g/m²)       | 58.79        | 55.24         | 47.72         | 48.04         | 52.45|
| N2 (30.0 g/m²)       | 48.43        | 61.59         | 55.30         | 76.00         | 60.33|
| N3 (35.0 g/m²)       | 55.26        | 56.36         | 55.97         | 59.73         | 56.83|
| N4 (40.0 g/m²)       | 51.75        | 53.38         | 69.50         | 58.39         | 58.26|
| Mean                 | 51.32        | 55.56         | 55.27         | 59.45         |      |

CD0.05 - N: 6.86  P: NS  N × P: 13.72

**Table 3** Effect of nitrogen, phosphorus and their interactions on number of branches/plant of China aster cv. ‘Kamini’

| Phosphorous Nitrogen | P0 (0.0 g/m²) | P1 (15.0 g/m²) | P2 (20.0 g/m²) | P3 (25.0 g/m²) | Mean |
|----------------------|--------------|---------------|---------------|---------------|------|
| N0 (0.0 g/m²)        | 5.37         | 4.68          | 4.40          | 5.72          | 5.04 |
| N1 (25.0 g/m²)       | 5.10         | 5.21          | 5.45          | 4.63          | 5.10 |
| N2 (30.0 g/m²)       | 6.98         | 8.20          | 6.37          | 6.52          | 7.01 |
| N3 (35.0 g/m²)       | 4.95         | 5.04          | 5.61          | 5.30          | 5.22 |
| N4 (40.0 g/m²)       | 5.97         | 5.49          | 5.51          | 4.75          | 5.43 |
| Mean                 | 5.67         | 5.72          | 5.47          | 5.38          |      |

CD0.05 - N: 0.78  P: NS  N × P: NS
Table 4 Effect of nitrogen, phosphorus and their interactions on leaf area (cm$^2$) of China aster cv. ‘Kamini’

| Phosphorous Nitrogen | P0 (0.0 g/m$^2$) | P1 (15.0 g/m$^2$) | P2 (20.0 g/m$^2$) | P3 (25.0 g/m$^2$) | Mean  |
|----------------------|-----------------|-----------------|-----------------|-----------------|-------|
| N0 (0.0 g/m$^2$)    | 10.37           | 9.83            | 12.95           | 11.73           | 11.22 |
| N1 (25.0 g/m$^2$)   | 13.31           | 10.02           | 14.51           | 13.63           | 12.87 |
| N2 (30.0 g/m$^2$)   | 16.24           | 14.50           | 11.00           | 21.72           | 15.87 |
| N3 (35.0 g/m$^2$)   | 15.83           | 16.69           | 12.39           | 14.87           | 14.95 |
| N4 (40.0 g/m$^2$)   | 12.49           | 15.11           | 15.96           | 9.82            | 13.34 |
| Mean                | 13.65           | 13.23           | 13.36           | 14.35           |       |

CD0.05 - N: 2.65 P: NS N × P: 5.30

It indicated that the nitrogen requirement of these plants was met out with 30 g N/m$^2$ only and thus further increase in nitrogen may not prove beneficial to these plants. These results got the support from the findings of Jhon and Paul (1999) and Lodhi and Tiwari (1993) in chrysanthemum, however, the difference observed in the rates of the nitrogen applications reported by various workers seemed to be due to the variety soils in use and their varying fertility status.

Although phosphorus levels exhibited non-significant effects for various growth parameter of China aster cv. ‘Kamini’, yet plants with more plant height, spread and leaf area recorded with 25 g P$_2$O$_5$/m$^2$ (Tables 1, 2 and 4, respectively) and maximum number of branches noticed with 15 g P$_2$O$_5$/m$^2$ (Table 3). Increase in N uptake noticed with the application of higher levels of phosphorus that resulted in vigorous growth (Balyan and Singh, 1984).

Beneficial effects of phosphorus on the growth were probably being the resultant of the increased synthesis of metabolites in the presence of directly applied phosphorus to these plants. Since phosphorus is found in nucleic acids and is involved through ATP in the activation of amino acids for the synthesis of proteins, thus importance of this element is well documented (Devlin, 1973). These results obtained are in agreement with Monish et al., (2008) who found taller plants in China aster cv. ‘Poornima’ using 200 kg P$_2$O$_5$ per hectare (20 g P$_2$O$_5$/m$^2$) in comparison to lower levels.

Gaikwad et al., (2004) reported increase in plant height, spread and number of branches with 150 kg/ha phosphorus (15 g P$_2$O$_5$/m$^2$) in China aster cv. ‘Phule Ganesh White’. Plants supplied with 50 or 100 kg P$_2$O$_5$/ha (5 or 10 g P$_2$O$_5$/m$^2$) observed with more plant height and number of branches with increasing rates of phosphorus in China aster cv. ‘Local’ (Jamkhande et al., 2004). Bose and Das (1966) found plant height of China aster to be maximum with increasing levels of phosphorus. Similarly, number of branches and leaves/plant increased with the higher levels of phosphorus. Beneficial effects of phosphorus for growth of plants have been reported by other workers viz., Singh and Sangama (2000) and Mantur (1988) in China aster. Other than China aster, phosphorus application at 45 g N/m$^2$ obtained taller plants while more numbers of branches per plant with 30 g P$_2$O$_5$/m$^2$ in chrysanthemum cv. ‘Flirt’ (Lodhi and Tiwari, 1993). Kofranek (1980) found 150 g of single super phosphate (SSP) as an optimal dose for promoting the growth of plants of chrysanthemum.

The combined effects of nitrogen and phosphorus applications seemed to be more consistent and have influenced various growth parameters under study. Increasing level of nitrogen along with phosphorus significantly increased the plant height, plant spread, number of branches per plant and leaf area of China aster cv. ‘Kamini’. A combined dose of 30 g N/m$^2$ and 25 g P$_2$O$_5$/m$^2$ produced taller plants.
with maximum plant spread as well as leaf area (Tables 1, 2 and 4, respectively) and number of branches per plant found to be higher with 30 g N/m$^2$ and 15 g P$_2$O$_5$/m$^2$ (Table 3).

The beneficial effect of N×P interactions are well understood and under present investigations also the superiority was manifested with increasing levels of nitrogen (0-40 g N/m$^2$) corresponding to the increasing levels of phosphorus (0-25 g P$_2$O$_5$/m$^2$) or this could be due to the cumulative effects of nitrogen and phosphorus on growth of the plants in one direction. The results got the support from the findings of various workers in China aster viz., Monish et al., (2008) reported taller plants of China aster cv. ‘Poornima’ with more number of branches fertilized with the application of 300 kg N/ha (30 g N/m$^2$) and 200 kg P$_2$O$_5$/ha (20 g P$_2$O$_5$/m$^2$).

Jitendra kumar et al., (2003) also observed the similar trend for the plant height and number of branches per plant in China aster with 300 kg/ha (30 g/m$^2$) N and P each. Singh and Sangama (2000) found the plants of greatest plant height and plant spread with the highest level of N and phosphorus application in China aster cv. ‘Kamini’.

Similar effects of nitrogen × phosphorus have been reported in China aster by other workers namely Jamkhande et al., (2004); Gaikwad et al., (2004); Nethra et al., (1999); Mantur (1988); Narayana Gowda (1985) and Maheshwar (1977). Other than China aster, Dorajeerao et al., (2012) and Chezhiyan et al., (1986) found taller plants, maximum number of branches and leaf area with simultaneous increase both in nitrogen and phosphorus levels in chrysanthemum.

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