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Effect of organic manures and biofertilizers on growth, flowering and yield of China aster cv. Arka Archana

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ABSTRACT

A field experiment was conducted during the Rabi season of 2025–26 at the experimental premises of Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon, Chhattisgarh, to study the effect of organic manures and biofertilizers on growth, flowering and yield of China aster (*Callistephus chinensis* L.) cv. Arka Archana. The experiment consisted of twelve treatment combinations arranged in a Randomized Block Design with three replications. Farmyard manure (FYM), vermicompost, phosphate-solubilizing bacteria (PSB) and Azotobacter were evaluated individually and in different combinations. Among the treatments, T_{11} comprising FYM @ 18 t ha⁻¹ (50%) + vermicompost @ 6 t ha⁻¹ (50%) + PSB @ 50 ml per 15 L water + Azotobacter @ 30 ml per 15 L water recorded the highest values for major growth parameters. T_{11} recorded maximum plant height (61.76 cm), number of leaves per plant (234.60), number of primary branches per plant (22.08) and plant spread (29.76 cm). It also resulted in the earliest flower bud initiation (55.12 days) and first flowering (63.09 days), along with maximum flowering duration (31.30 days), stalk length (29.80 cm) and flower diameter (7.17 cm). The highest flower yield was recorded under T_{11} , with 130.99 g flower yield per plant and 3.27 kg per plot. Economic analysis also showed the highest benefit-cost ratio of 2.40 under T_{11} . The integrated application of FYM, vermicompost, PSB and Azotobacter therefore showed a favourable response for improving growth, flowering, flower yield and economic returns of China aster cv. Arka Archana under the agro-climatic conditions of Rajnandgaon, Chhattisgarh.

Keywords: China aster, Arka Archana, FYM, Vermicompost, Azotobacter, PSB, Flower yield, Biofertilizer

Introduction

China aster (*Callistephus chinensis* L.) is an important winter annual ornamental crop belonging to the family Asteraceae. It is valued for its attractive flowers and is widely cultivated for loose flowers, cut flowers, bouquets, garlands, bedding, edging and ornamental purposes. The crop produces attractive flower heads consisting of ray and disc florets and is an important annual flower crop. Flower production and quality are strongly influenced by nutrient availability. Organic manures such as farmyard manure and vermicompost improve soil physical conditions, nutrient availability and microbial activity, while biofertilizers such as Azotobacter and phosphate-solubilizing bacteria contribute to improved Assistant Professor Assistant Professor nitrogen and phosphorus availability. Integrated use of organic manures and biofertilizers may therefore provide a balanced and sustained nutrient supply and improve crop growth, flowering and yield. Previous studies have reported beneficial effects of biofertilizers and organic manures on China aster and other ornamental crops. Kumar *et al.* (2003) [1] reported improved vegetative growth of China aster with biofertilizer application, while Ravindra *et al.* (2013) [2] observed improved flowering and yield under integrated nutrient management. Bohra *et al.* (2019) [3] also reported favourable growth and flowering responses of China aster to combined application of FYM, vermicompost, PSB and Azotobacter. Keeping these aspects in view, the present investigation was undertaken to evaluate different combinations of organic manures and biofertilizers for improving growth, flowering and yield of China aster cv. Arka Archana under the agro-climatic conditions of Rajnandgaon, Chhattisgarh.

Materials and methods

The experiment was conducted during the Rabi season of 2025–26 at the experimental premises of the Department of Floriculture and Landscaping, Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon, Chhattisgarh. The experimental site was situated at 21°10' N latitude and 81°03' E longitude with an elevation of approximately 307 m above mean sea level. Seeds of China aster cv. Arka Archana were procured from ICAR–Indian Institute of Horticultural Research (IIHR), Bengaluru. The experiment was laid out in a Randomized Block Design with twelve treatments and three replications. Each plot measured 1.5 m × 1.5 m and contained 25 plants at a spacing of 30 cm × 30 cm.

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Table 1.1. Treatment details

Notation	Treatment combination
T ₀	Control
T ₁	FYM @ 36 t ha ⁻¹
T ₂	Vermicompost @ 12 t ha ⁻¹
T ₃	PSB @ 50 ml/15 L
T ₄	Azotobacter @ 30 ml/15 L
T ₅	FYM @ 28.8 t ha ⁻¹ (80%) + PSB @ 50 ml/15 L
T ₆	FYM @ 28.8 t ha ⁻¹ (80%) + Azotobacter @ 30 ml/15 L
T ₇	Vermicompost @ 9.6 t ha ⁻¹ (80%) + PSB @ 50 ml/15 L
T ₈	Vermicompost @ 9.6 t ha ⁻¹ (80%) + Azotobacter @ 30 ml/15 L
T ₉	FYM @ 18 t ha ⁻¹ (50%) + vermicompost @ 6 t ha ⁻¹ (50%) + PSB @ 50 ml/15 L
T ₁₀	FYM @ 18 t ha ⁻¹ (50%) + vermicompost @ 6 t ha ⁻¹ (50%) + Azotobacter @ 30 ml/15 L
T ₁₁	FYM @ 18 t ha ⁻¹ (50%) + vermicompost @ 6 t ha ⁻¹ (50%) + PSB @ 50 ml/15 L + Azotobacter @ 30 ml/15 L

Results and discussion

Growth parameters

Plant height (cm)

The plant height significant influenced by the organic manures and biofertilizers among the treatments, T₁₁ (FYM 18 ton (50%) + Vermicompost 6 ton (50%) + PSB @ 50 ml/15 L + Azotobacter @ 30 ml/15 L) recorded the peak value (61.76 cm), which was followed by T₁₀ (FYM 18 ton (50%) + Vermicompost 6 ton (50%) + Azotobacter @ 30 ml/15 L) with (55.34 cm). On the other hand, the lowest value (36.42 cm) was observed under the control treatment T₀. FYM supplies essential macro- and micronutrients that support healthy plant growth (Kumar *et al.*, 2011). The higher plant height under T₁₁ may be due to better availability of N and P, which promote cell division, elongation and root development. PSB and Azotobacter further improve nutrient availability through phosphorus solubilization and biological nitrogen fixation. Similar results were reported by Mogal *et al.* (2006) [4] in China aster and Kumar *et al.* (2006).

Number of leaves per plant

The number of leaves per plant significant influenced by the organic manures and biofertilizers among the treatments, the maximum value (234.60) was recorded under T₁₁, comprising FYM 18 ton (50%) + vermicompost 6 ton (50%) + PSB (50 ml/15 L) + Azotobacter (30 ml/15 L). This was followed by T₁₀ (216.23). In contrast, the minimum value (140.18) was observed under the control treatment (T₀). Thus, the combined application of FYM, vermicompost, PSB and Azotobacter (T₁₁) exhibited the most favorable response and recorded the highest value among the treatments. The increased chlorophyll content and higher number of leaves under T₁₁ may be attributed to the combined application of FYM, vermicompost, PSB and Azotobacter, which improved the availability and uptake of essential nutrients (Sharma and Thakur, 2002). Adequate nitrogen supplies enhanced chlorophyll formation, cell division and photosynthetic activity, resulting in better vegetative growth and increased leaf production. Biofertilizers further improved nitrogen and phosphorus availability, promoting root development and nutrient absorption. Similar findings were reported by Kumar *et al.* (2003) [1]; Bohra *et al.* (2014) [5].

Number of primary branches

The number of primary branches significant influenced by the organic manures and biofertilizers among the treatments, the topmost value (22.08 cm) was recorded under T₁₁, comprising FYM 18 ton (50%) + vermicompost 6 ton (50%) + PSB (50 ml/15 L) + Azotobacter (30 ml/15 L), followed by T₁₀ (20.12 cm). In contrast, the lowest

value (12.29 cm) was recorded under the control treatment (T₀). Azotobacter showed a favorable effect, with T₁₁ recording the maximum value. The combined application of FYM and vermicompost improved nutrient availability and supported vigorous plant growth (Kumar *et al.*, 2011). PSB and Azotobacter further enhanced nutrient uptake through phosphorus solubilization and nitrogen fixation, which promoted root activity and the development of axillary buds, resulting in more branches. Similar findings were reported by Ravindra *et al.* (2013) [2] and Kameswari *et al.* (2013).

Plant spread (cm)

The Plant spread significant influenced by the organic manures and biofertilizers among the treatments, the greatest value (29.76 cm) was obtained under T₁₁, comprising FYM 18 ton (50%) + vermicompost 6 ton (50%) + PSB (50 ml/15 L) + Azotobacter (30 ml/15 L). This was followed by T₁₀ (26.99 cm), receiving FYM 18 ton (50%) + vermicompost 6 ton (50%) + Azotobacter (30 ml/15 L). The minimum value (16.50 cm) was observed under the control treatment (T₀). The greater plant spread under T₁₁ may be associated with enhanced vegetative growth and better leaf development, which increased the photosynthetic surface and facilitated greater production and translocation of photosynthates to different plant parts. The application of FYM and vermicompost may have improved soil structure, nutrient availability and microbial activity. The present findings are in agreement with the observations of Airadevi *et al.* (2012) [6].

Floral parameters

Days taken to first flower bud initiation

The earliest flower bud initiation was recorded in T₁₁ (55.12 days), followed by T₁₀ (61.98 days), whereas the control (T₀) took the longest time (69.83 days). The earlier bud initiation under T₁₁ may be due to better nutrient availability from FYM and vermicompost, along with improved N and P nutrition through Azotobacter and PSB. This balanced nutrition promoted healthy growth and an earlier shift from the vegetative to reproductive phase. In contrast, poor nutrient availability in the control delayed flowering. Similar results were reported by Ravindra *et al.* (2013) [2]; Naik *et al.* (2014) [7].

Day of first flowering

The earliest flowering showed that the treatment T₁₁ (63.09 days), followed by T₁₀ (69.65 days), whereas flowering was delayed in the control (T₀), which took 78.21 days. The early flowering in T₁₁ could be attributed to improved nutrient availability from FYM and vermicompost, supported by the beneficial effects of PSB and Azotobacter. The better nutritional status of plants may have accelerated vegetative growth and promoted an early transition to flowering. The delayed flowering under control may be due to inadequate nutrient supply. Similar results were reported by Singh *et al.* (2013); Ravindra *et al.* (2013) [2]; Naik *et al.* (2014) [7].

Duration of flowering (days)

The longest flowering period was recorded in T₁₁ (31.30 days), followed by T₁₀ (28.66 days), while the control (T₀) showed the shortest flowering period (20.43 days). The prolonged flowering under T₁₁ may be due to the balanced nutrient supply from FYM, vermicompost, PSB and Azotobacter. Better nutrient availability and improved nitrogen and phosphorus uptake may have supported photosynthesis, delayed leaf ageing and maintained a better source-sink balance, resulting in a longer flowering period. Similar findings were reported by Bohra *et al.* (2016) [8].

Stalk length of flower (cm)

The highest stalk length was recorded in T₁₁ (29.80 cm), followed by T₁₀ (26.02 cm), while the lowest was observed in the control (T₀) at 15.69 cm. The longer stalks under T₁₁ may be due to better nutrient availability from FYM, vermicompost, PSB and Azotobacter. Azotobacter improved nitrogen availability, while PSB enhanced phosphorus uptake. Vermicompost also supplied essential nutrients and improved soil conditions. The combined effect of these inputs

likely promoted better nutrient uptake, photosynthesis and cell elongation, resulting in longer stalks. Similar results were reported by Hadwani (2012).

Flower diameter (cm)

The largest flower diameter was recorded in T₁₁ (7.17 cm), followed by T₁₀ (6.45 cm), while the control (T₀) recorded the smallest diameter (4.36 cm). The larger flower size under T₁₁ may be due to the better availability of nutrients from FYM, vermicompost, PSB and Azotobacter. Organic manures improved nutrient availability and uptake, while PSB and Azotobacter enhanced phosphorus and nitrogen availability. Better nutrition may have increased photosynthesis and the supply of assimilates to developing flowers, resulting in larger flower diameter. Similar findings were reported by Bertand *et al.* (2008) [9] and Ravindra *et al.* (2013) [2].

Yield parameters

Flower yield/plant (g)

The highest observed value (130.99 g) was recorded under T₁₁, comprising FYM @ 18 t ha⁻¹ (50%) + vermicompost @ 6 t ha⁻¹ (50%) + PSB (50 ml/15 L) + Azotobacter (30 ml/15 L). This was followed by T₁₀ (120.54 g), where FYM + vermicompost were applied along with Azotobacter. The minimum value (51.16 g) was observed in the con-

trol (T₀). The integrated application of FYM, vermicompost, PSB and Azotobacter may have enhanced flower yield through their complementary effects on soil fertility and plant physiological processes. The improved availability and uptake of nitrogen, phosphorus and potassium may have increased chlorophyll formation and photosynthetic activity, resulting in greater production of photosynthates, reported by Bohra *et al.* (2016) [8].

Flower yield/plot (kg)

The superior value (3.27 kg) was recorded under T₁₁, comprising FYM @ 18 t ha⁻¹ (50%) + vermicompost @ 6 t ha⁻¹ (50%) + PSB (50 ml/15 L) + Azotobacter (30 ml/15 L). This was followed by T₁₀ (2.96 kg) with FYM + vermicompost + Azotobacter, the minimum value (1.28 kg) was observed in the control (T₀). The application of organic manures may have improved microbial activity in the soil, resulting in better availability and uptake of N, P and K. This improved nutrient supply and favourable soil conditions supported plant growth and flower development (Bertand *et al.*, 2008) [9]. Adequate nitrogen and potassium may have promoted assimilate production and its movement towards developing flowers, leading to better flower size and weight. PSB and Azotobacter further improved nutrient availability through phosphorus solubilization and biological nitrogen fixation. Similar findings were reported by Ravindra *et al.* (2013) [2].

Table 1.2. Effect of organic manures and biofertilizers on Vegetative, Floral and Yield parameter on China aster cv. Arka Archana.

Notation	Plant height (cm)	Number of leaves per plant	Number of primary branches per plant	Plant spread (cm)	Days taken to first flower bud initiation	Days to first flooring	Duration of flowering (days)	Stalk length of flower (cm)	Flower diameter (cm)	Flower yield/plant(g)	Flower yield/plot (kg)
T ₀	36.42	140.18	12.29	16.5	69.83	78.21	20.43	15.69	4.36	51.16	1.28
T ₁	41.71	151.53	14.63	20.71	65.85	73.75	23.62	20.25	5.18	67.87	1.7
T ₂	42.43	162.29	14.86	21.03	65.23	73.06	23.94	20.57	5.27	70.03	1.75
T ₃	39.56	165.27	13.94	19.73	66.59	74.58	22.65	19.3	4.94	61.64	1.54
T ₄	40.92	168.49	14.37	20.35	66.18	74.12	23.26	19.9	5.09	65.55	1.64
T ₅	45.76	175.08	15.92	22.54	63.34	72.82	26.1	22.04	5.64	80.43	2.01
T ₆	47.21	184.65	16.39	23.2	63.05	70.62	25.44	22.69	5.81	85.19	2.13
T ₇	50.25	193.32	17.36	24.58	63.35	71.59	28.4	24.03	6.15	95.6	2.39
T ₈	52.33	206.31	18.03	25.52	62.76	70.05	27.47	24.95	6.39	102.07	2.58
T ₉	54.12	211.02	18.92	26.78	62.05	69.89	28.21	26.23	6.23	113.12	2.84
T ₁₀	55.34	216.23	20.12	26.99	61.98	69.65	28.66	26.02	6.45	120.54	2.96
T ₁₁	61.76	234.6	22.08	29.76	55.12	63.09	31.3	29.8	7.17	130.99	3.27
C.D.	6.12	16.85	1.94	2.82	5.88	6.3	3.44	2.54	0.66	9.13	0.21
SE(m)	2.07	5.71	0.65	0.89	1.99	2.13	1.16	0.86	0.22	3.09	0.07
C.V.	7.59	5.37	6.88	6.02	5.41	5.15	7.83	6.59	6.79	6.16	5.73

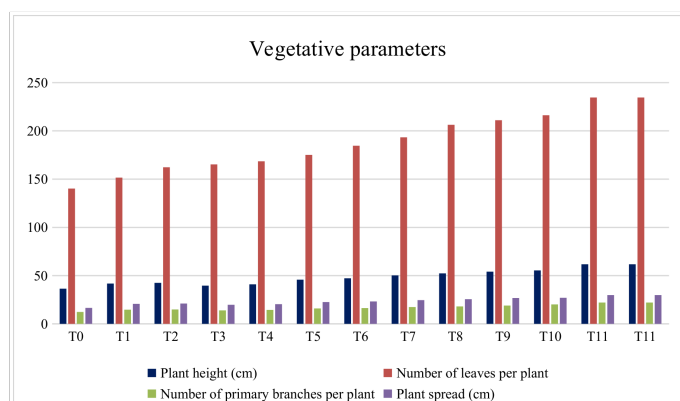


Figure 1.1. Effect of organic manures and biofertilizers on vegetative parameters.

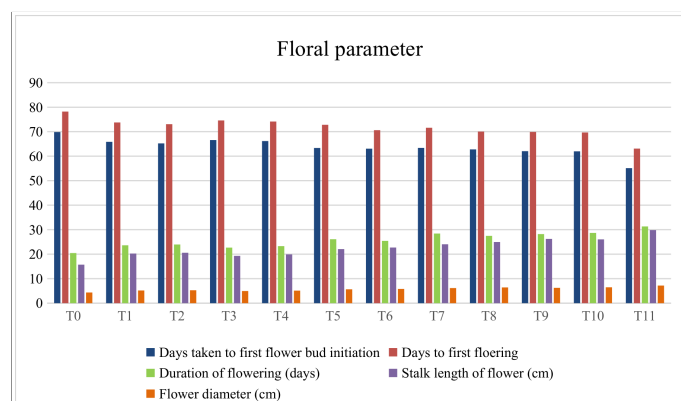


Figure 1.2. Effect of organic manures and biofertilizers on floral parameters.

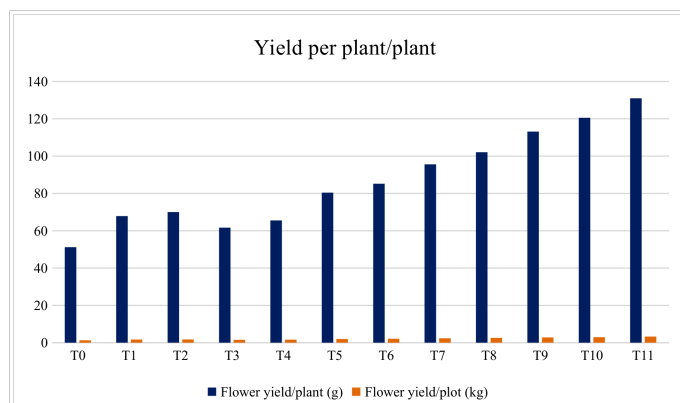


Figure 1.2. Effect of organic manures and biofertilizers on yield parameters.

Conclusion

The present investigation demonstrated that integrated application of organic manures and biofertilizers considerably influenced growth, flowering, flower quality and yield of China aster cv. Arka Archana. Among the treatments, T₁₁ comprising FYM @ 18 t ha⁻¹ (50%) + vermicompost @ 6 t ha⁻¹ (50%) + PSB @ 50 ml per 15 L water + Azotobacter @ 30 ml per 15 L water recorded the highest values for major growth and yield parameters, earlier flowering, longer flowering duration and superior flower quality. It also recorded the highest flower yield and benefit-cost ratio (2.40). Therefore, under the experimental conditions of Rajnandgaon, the integrated application represented by T₁₁ showed favourable performance for China aster cv. Arka Archana production.

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