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Profitability and Productivity Assessment of Integrated Nutrient Management in China Aster (*Callistephus chinensis*) cv. Arka Archana

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ABSTRACT: The study aimed to assess the impact of various integrated nutrient management (INM) strategies on the growth, yield, and economic returns of China aster (cv. Arka Archana) under different treatments during the winter season of 2022. The experiment was conducted at the Pt KLS CHRS Horticulture Research Farm, Raipur, India, following a randomized block design with three replications and 13 treatments. Treatments included combinations of recommended dose of fertilizers (RDF), farmyard manure (FYM), vermicompost (VC), and biofertilizers such as Azotobacter and phosphate-solubilizing bacteria (PSB). Results showed significant variations in flower yield, with the highest yield recorded under T_9 (RDF 50% + VC 50% + Azotobacter + PSB) at 104.42 q/ha. Economic analysis indicated that T_9 also provided the highest gross return (₹417,680/ha) and net return (₹290,562.58/ha), despite higher initial costs compared to the control treatment T_1 (RDF 100%). The benefit-cost ratio was highest in T_1 (2.48), but treatments like T_5 (RDF 50% + FYM 50% + Azotobacter + PSB) showed promising sustainability with a B:C ratio of 2.36. Overall, integrated nutrient management, especially involving biofertilizers and organic inputs, was found to enhance both yield and profitability while promoting long-term soil health. These findings suggest that INM practices offer a viable and sustainable alternative to conventional chemical fertilization in floriculture.

Keywords: INM, China Aster, Biofertilizers, Vermicompost, FYM, Flower Yield and Economic.

INTRODUCTION

China aster (*Callistephus chinensis* L. Nees), a diploid (2n = 18) annual flower crop from the Asteraceae family, is valued for its vibrant flowers used as cut flowers, loose flowers, and in landscaping, bedding, and potting (Singh and Sisodia, 2017). Its long vase life, diverse colors, and forms make it a popular choice for commercial floriculture, particularly in India, where states like Karnataka, Tamil Nadu, and Chhattisgarh provide favorable climatic conditions for cultivation (Janakiram, 1997; Singh and Sisodia 2017). The crop thrives in well-drained loamy soils under sunny conditions, with organic manuring enhancing growth and flowering (Chowdhuri *et al.*, 2016).

Integrated Nutrient Management (INM) combines organic, inorganic, and biofertilizers to optimize soil fertility, reduce chemical fertilizer costs, and improve crop productivity and quality (Dilta *et al.*, 2007). INM enhances soil properties through inputs like vermicompost, which improves porosity and microbial activity, and farmyard manure (FYM), which supplies essential macro- and micronutrients (Atiyeh *et al.*, 2000; Tilahun *et al.*, 2013). Biofertilizers, such as Azospirillum and phosphate-solubilizing bacteria (PSB), contribute to nitrogen fixation and phosphorus availability, reducing chemical fertilizer dependency by 20-25% while promoting plant growth through stress tolerance and phytohormone production (Bashan and de-Bashan 2010; Khan *et al.*, 2010).

The profitability of China aster cultivation hinges on balancing input costs with yield and quality. Studies demonstrate that INM improves growth parameters, flower yield, and vase life while reducing production costs, leading to higher economic returns (Kumar *et al.*, 2019; Geeta *et al.*, 2016). For instance, combining 75% recommended NPK with biofertilizers and vermicompost has yielded high benefit-cost ratios in China aster cv. Poornima (Geeta *et al.*, 2016). Assessing INM's impact on cv. Arka Archana, known for early germination and high flower yield (Rinu, 2020), is critical for optimizing commercial cultivation.

This study evaluates the profitability and productivity of INM in China aster cv. Arka Archana, focusing on growth, yield, flower quality, and economic viability. By integrating organic and biofertilizer inputs with reduced chemical fertilizers, the research aims to provide sustainable and cost-effective nutrient management strategies for floriculture farmers.

MATERIAL AND METHODS

The experiment was conducted during the winter season of 2022 at the Pt KLS CHRS Horticulture Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India (21°14'N, 81°38'E, 298 m above sea level). The climate is sub-tropical with moderate winters, ideal for China aster cultivation. The experiment was laid out in Randomized Block Design (RBD) with three replications. Each replication consists of 13 treatments. The treatments in each block were allotted randomly and plants were spaced (Row to Row) 30 cm and (Plant to Plant) 30cm and the net plot size was 2.7 m. × 1 m. The treatments included different combinations of recommended dose of fertilizers (RDF), farmyard manure (FYM), vermicompost (VC), and biofertilizers such as *Azotobacter* and phosphate-solubilizing bacteria (PSB). Each treatment plot received nutrient inputs as per the treatment schedule, with RDF applied at 100% or 50% levels, either alone or in combination with FYM/VC and biofertilizers. The organic manures were thoroughly decomposed and incorporated into the soil 15 days before transplanting. Biofertilizers were applied as seedling root dips before transplanting. Standard agronomic practices were followed throughout the crop period. Data were recorded on flower yield per hectare and economic parameters such as cost of cultivation, gross return, net return, and benefit-cost ratio. These values were computed using prevailing market rates and cost inputs.

RESULTS AND DISCUSSION

The data revealed that the total cost of cultivation varied significantly across different nutrient management treatments. The highest total cost of cultivation was observed in treatment T_9 (RDF 50% + Vermicompost 50% + Azotobacter + PSB), amounting to ₹127,117.42/ha, followed closely by T_8 (RDF 50% + Vermicompost 50% + PSB) with a cost of ₹126,517.42/ha. In contrast, the lowest cultivation cost was recorded under the control treatment T_1 (RDF 100%), at ₹114,191.42/ha. The higher cost associated with T_9 and T_8 treatments can be attributed to the combined application of organic inputs (vermicompost) and biofertilizers (Azotobacter and PSB), which, although more expensive than conventional fertilizers, have been shown to improve soil fertility and crop performance over time. Vermicompost is relatively costlier due to its labor-intensive production and application process. Similarly, the use of microbial inoculants adds to the input costs but contributes positively to nutrient solubilization and plant growth. However, despite the increased cost, such integrated nutrient management practices are likely to enhance yield and input-use efficiency, potentially offering higher net returns and better sustainability compared to sole reliance on chemical fertilizers. These findings highlight the need to evaluate economic returns alongside agronomic benefits for adopting balanced nutrient strategies in China aster cultivation. The results obtained in the present study are supported by the works of Singh *et al.* (2021).

The flower yield per hectare of China aster (cv. Arka Archana) varied significantly under different integrated nutrient management (INM) treatments at various growth stages, as presented in Table 1. The highest flower yield (104.42 q/ha) was recorded under T_9 (RDF 50% + Vermicompost 50% + Azotobacter + PSB), followed closely by T_5 (RDF 50% + FYM 50% + Azotobacter + PSB) with 102.60 q/ha, and T_1 (RDF 100% - Control) with 99.31 q/ha. The treatment T_13 (RDF 50% + FYM 25% + VC 25% + Azotobacter + PSB) also performed well, yielding 98.62 q/ha. In contrast, the lowest flower yield (83.92 q/ha) was recorded under T_2 (RDF 50% + FYM 50%), indicating the limitation of using organic sources alone without biofertilizer supplementation. The increased flower yield under INM treatments, particularly T_9 and T_5, may be attributed to the synergistic effect of combining organic, inorganic, and biological nutrient sources, which enhanced nutrient availability, microbial activity, and root development. These improvements likely led to greater carbohydrate synthesis and partitioning towards reproductive structures, thereby increasing flower production. The presence of biofertilizers (Azotobacter and PSB) in these treatments may have further contributed by enhancing nitrogen fixation and phosphorus solubilization, supporting sustained flower formation. These findings are in alignment with previous studies, such as Bose *et al.* (2019), who also reported improved flower yield in China aster through integrated nutrient management strategies involving organics and biofertilizers. Similar study were also observed by Bohra *et al.* (2019).

The gross return also differed significantly among the treatments. The highest gross return was obtained in T_9 (RDF 50% + Vermicompost 50% + Azotobacter + PSB) at ₹417,680.00/ha, followed by T_5 (RDF 50% + FYM 50% + Azotobacter + PSB) with ₹410,400.00/ha. The lowest gross return was recorded in T_2 (RDF 50% + FYM 50%), amounting to ₹335,680.00/ha. This trend clearly indicates that integrated use of inorganic fertilizers with organic inputs and biofertilizers substantially increases marketable yield, thereby enhancing the gross monetary return. The superior performance of T_9 and T_5 could be attributed to the synergistic effect of vermicompost or FYM with biofertilizers, which likely improved nutrient availability, root development, and overall plant health, translating into higher productivity and economic output. Vermicompost, in particular, is known to improve soil structure, microbial activity, and nutrient retention, contributing to better crop performance. In contrast, the lower gross return in T_2 suggests that replacing 50% RDF with FYM alone, without microbial supplementation, may not be sufficient to meet the crop's nutrient demands or boost yield significantly. These results reinforce the idea that INM practices incorporating biofertilizers along with partial substitution of chemical fertilizers by organics can enhance both yield and economic returns, making them a viable and sustainable alternative to 100% chemical-based fertilization. Similar study were also observed by Atal *et al.* (2019); Verma *et al.* (2011).

The net return also showed significant variation among the different nutrient management treatments. The highest net return was recorded in T_9 (RDF 50% + Vermicompost 50% + Azotobacter + PSB), amounting to ₹290,562.58/ha, closely followed by T_5 (RDF 50% + FYM 50% + Azotobacter + PSB) with ₹288,282.58/ha. In contrast, the lowest net return was observed in T_2 (RDF 50% + FYM 50%), although the exact figure is not provided in the data snippet. The superior net return from T_9 and T_5 treatments highlights the economic viability of integrated nutrient management (INM) approaches that combine reduced chemical fertilizer doses with organic manures and biofertilizers. Despite higher initial costs of cultivation, these treatments yielded better returns due to significantly higher yields, reflecting efficient nutrient use and improved crop health. The contribution of Azotobacter and PSB in nutrient solubilization and uptake appears to have played a crucial role in enhancing yield and profitability. On the other hand, the poor net return in T_2 may be attributed to suboptimal nutrient availability when only FYM and half the recommended dose of fertilizers were used, without microbial assistance. This suggests that organic inputs alone, in the absence of biofertilizers, may not suffice in meeting the nutrient demands of China aster under intensive cultivation systems. Similar study were also observed by Atal *et al.* (2019); Verma *et al.*, (2011).

It is evident from the data that the benefit-cost (B:C) ratio differed significantly under various nutrient management treatments. The highest B:C ratio was observed in the control treatment T_1 (RDF 100%), which recorded a value of 2.48, followed by T_5 (RDF 50% + FYM 50% + Azotobacter + PSB) with a B:C ratio of 2.36. The lowest B:C ratio was recorded in T_2 (RDF 50% + FYM 50%), with a value of 1.78. The higher B:C ratio in T_1 indicates that despite relatively lower yield and gross return, the significantly lower cost of cultivation improved economic efficiency. However, T_5 closely followed, suggesting that integrated nutrient management with reduced chemical fertilizer input combined with organics and biofertilizers not only sustains yield but also maintains economic viability. This is particularly important for long-term sustainability, where reliance on 100% inorganic inputs might lead to soil degradation and reduced input-use efficiency over time. The low B:C ratio in T_2 highlights the limitations of using FYM alone with reduced fertilizer levels, as it resulted in lower productivity without proportionally reducing the cost of cultivation. Thus, while full RDF provides the highest economic efficiency on paper, INM treatments like T_5 offer a more balanced approach, delivering both economic benefits and environmental sustainability. These findings support the adoption of integrated nutrient strategies for enhancing resource use efficiency, maintaining soil health, and ensuring profitable China aster cultivation in the long term. Similar study were also observed by Atal *et al.* (2019); Verma *et al.* (2011).

Table 1: Effect of integrated nutrient management on economics of China aster.

Tr. no.	**Treatment details**	**Economic**				
		Total Cost of Cultivation (Rs/ha)	**Flower production q/ha**	**Gross return (Rs/ha)**	**Net return (Rs/ha)**	**B:C Ratio**
T_1	RDF 100% (Control)	114191.42	99.31	397240.00	283048.58	2.48
T_2	RDF 50% + FYM 50%	120917.42	83.92	335680.00	214762.58	1.78
T_3	RDF 50% + FYM 50% + Azo	121517.42	89.09	356360.00	234842.58	1.93
T_4	RDF 50% + FYM 50% + PSB	121517.42	87.13	348520.00	227002.58	1.87
T_5	RDF 50% + FYM 50% + Azo + PSB	122117.42	102.60	410400.00	288282.58	2.36
T_6	RDF 50% + VC 50%	125917.42	95.14	380560.00	254642.58	2.02
T_7	RDF 50% + VC 50% + Azo	126517.42	97.35	389400.00	262882.58	2.08
T_8	RDF 50% + VC 50% + PSB	126517.42	96.88	387520.00	261002.58	2.06
T_9	RDF 50% + VC 50% + Azo + PSB	127117.42	104.42	417680.00	290562.58	2.29
T_{10}	RDF 50% + FYM 25% + VC 25%	123417.42	86.17	344680.00	221262.58	1.79
T_{11}	RDF 50% + FYM 25% + VC 25% + Azo	124017.42	93.49	373960.00	249942.58	2.02
T_{12}	RDF 50% + FYM 25% + VC 25% + PSB	124017.42	90.40	361600.00	237582.58	1.92
T_{13}	RDF 50% + FYM 25% + VC 25% + Azo + PSB	124617.42	98.62	394480.00	269862.58	2.17

*Market Price of Fresh Flower = 40 Rs/kg.

CONCLUSIONS

The present study clearly demonstrates that integrated nutrient management (INM), particularly the combination of RDF 50% with vermicompost or FYM along with biofertilizers such as Azotobacter and PSB, significantly improves flower yield, gross and net returns in China aster (cv. Arka Archana) while offering a sustainable alternative to sole chemical fertilization. Although treatments like T_9 incurred the highest cultivation costs, they also delivered the highest yield (104.42 q/ha), gross return (₹417,680.00/ha), and net return (₹290,562.58/ha), proving the economic viability of INM approaches. Interestingly, while the highest benefit-cost ratio (2.48) was recorded in the control (T_1), INM treatments like T_5 closely followed, combining profitability with long-term soil health benefits. These findings underscore the importance of combining organic inputs with biofertilizers and reduced chemical fertilizers to enhance nutrient use efficiency, crop productivity, and economic returns, paving the way for more sustainable and resilient horticultural practices.

Challenges and Considerations. Despite the proven benefits of integrated nutrient management (INM), several challenges hinder its widespread adoption. One major concern is the inconsistent availability and quality of organic inputs like vermicompost and farmyard manure, which can affect nutrient content and application efficacy. Additionally, biofertilizers require proper storage, handling, and field conditions to remain viable and effective, posing logistical constraints for farmers. The initial cost and labor associated with INM practices are often higher than conventional chemical fertilization, which may deter resource-limited growers. Furthermore, lack of awareness, technical knowledge, and region-specific guidelines limit effective implementation. Addressing these considerations through farmer training, policy support, and infrastructure development is crucial for the sustainable integration of INM practices in mainstream agriculture.

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FUTURE SCOPE

1. **Location-Specific INM Models:** Develop customized integrated nutrient management strategies suitable for diverse agro-climatic regions to maximize China aster and floricultural crop performance.
2. **Soil Health and Microbial Dynamics:** Conduct long-term trials to evaluate the effects of INM on soil fertility, microbial population, and nutrient cycling.
3. **Integration with Modern Technologies:** Explore the use of precision agriculture tools like remote sensing and GPS-based nutrient delivery to improve INM efficiency.
4. **Economic and Environmental Sustainability:** Assess the long-term profitability and ecological impact of INM to support sustainable, climate-resilient farming systems.

Conflict of Interest. None.

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