International Journal of Agriculture and Food Science 2026; 8(8): 55-58

ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2026): 4.97
IJAFS 2026; 8(8): 55-58
www.agriculturaljournals.com
Received: 15-04-2026
Accepted: 18-05-2026

Sudhir Kumar Pathak
Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad (Prayagraj), Uttar Pradesh, India

John P Collis
Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad (Prayagraj), Uttar Pradesh, India

Corresponding Author:
Sudhir Kumar Pathak
Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad (Prayagraj), Uttar Pradesh, India

Economics of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. snowball as influenced by nitrogen and phosphorus levels

Sudhir Kumar Pathak and John P Collis

DOI: https://www.doi.org/10.33545/2664844X.2026.v8.i8a.1758

Abstract
The present investigation was carried out during the winter season of 2009-10 at the Research Farm of the Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology & Sciences, Allahabad, to evaluate the economics of chrysanthemum (Chrysanthemum morifolium Ramat.) cv. Snowball as influenced by different levels of nitrogen and phosphorus. The experiment was laid out in Randomized Block Design (4 × 3 factorial) comprising four levels of nitrogen (0, 40, 60 and 80 kg ha^{-1}) and three levels of phosphorus (0, 100 and 150 kg P_2O_5 ha^{-1}) with three replications. The economics was computed based on cost of cultivation, gross returns and net returns. Among the different treatment combinations, N_2P_1 (60 kg N ha^{-1} + 100 kg P_2O_5 ha^{-1}) recorded the maximum net returns (₹ 2,40,950 ha^{-1}) with a benefit-cost ratio of 5.91, followed by N_2P_2 (60 kg N ha^{-1} + 150 kg P_2O_5 ha^{-1}) with net returns of ₹ 2,14,800 ha^{-1} and B:C ratio of 5.18. The control treatment N_0P_0 recorded the minimum net returns (₹ 65,800 ha^{-1}) with B:C ratio of 1.88. The study concluded that combined application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 100 kg P_2O_5 ha^{-1} with uniform dose of potassium @ 100 kg K_2O ha^{-1} was economically most viable for chrysanthemum cv. Snowball under Allahabad conditions.

Keywords: Chrysanthemum, Nitrogen, Phosphorus, Economics, Net Returns, Benefit-Cost Ratio

Introduction

Chrysanthemum (*Chrysanthemum morifolium* Ramat.) is one of the most important commercial flower crops grown worldwide for cut flowers, loose flowers, and ornamental purposes. It belongs to the family Asteraceae and holds a prominent position in the floriculture industry due to its wide range of colours, forms, and sizes, making it suitable for various decorative purposes including garlands, religious offerings, and floral arrangements (Gune *et al.*, 2019) [7]. The 'Snowball' variety of Chrysanthemum, developed by the Indian Agricultural Research Institute, New Delhi, is popular in central India (Uttar Pradesh, Madhya Pradesh and Bihar). Plants are 30-35 cm high with deep green leaves, average flower diameter of 10-15 cm, and each flower weighs 25-35 g. The flower buds appear in 40-50 days, picking starts from 80 days, and gives yield of around 15-20 t ha^{-1}. Plant nutrition has a direct influence on crop physiology, and the most significant inputs are optimal fertilizer application, which has a direct impact on plant development, growth, output, and quality (Li *et al.*, 2019; Chaitra *et al.*, 2018) [9, 6]. Nitrogen (N), phosphorus (P), and potassium (K) are the main components of chemical fertilizers necessary for plant development. Nitrogen boosts photosynthetic activity and vegetative development in plants and is a necessary component of amino acids and nucleic acids. Conversely, phosphorus (P), which is present in enzymes, phospholipids, and nucleic acids, is necessary for the best possible metabolism. Potassium (K) enriches a range of floral crops and is essential for respiration, transpiration, and the synthesis of proteins, amino acids, and chlorophyll. Past research indicates that *Chrysanthemum morifolium* growth, production, and quality are influenced by plant nitrogen, phosphate fertilizer, potash, and organic fertilizer. For instance, it was found that the best amounts of nitrogen and phosphorus for greater flower output were 300 and 150 kg ha^{-1} in chrysanthemum cv. Nilima. Different nitrogen and phosphorus treatment doses have been proven to be extremely effective in achieving good growth and quality flowers in various chrysanthemum varieties and other plant genotypes (Matsumura *et al.*, 2020) [10]. Considering the above facts and the importance of economic viability in commercial flower production, the present investigation was undertaken to study the economics of different nitrogen and phosphorus levels on chrysanthemum cv. Snowball and to find out the most profitable combination of nitrogen and phosphorus for maximizing returns.

Materials and Methods

Experimental Site: The experiment was conducted at the Research Farm of the Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology & Sciences (Deemed-to-be-University), Allahabad during the winter season of 2009-10. The experimental field is situated on the left side of Allahabad-Rewa Road, very near to the river Yamuna, and is approximately 7 km from Allahabad City.

Climate of the Region: Allahabad is situated at an elevation of 78 m from mean sea level at 25.8°N latitude and 81.5°E longitude, falling under the sub-humid Yamuna-Ganga alluvial plains agro-climatic zone of India. The region has a subtropical climate prevailing in winter and summer. During winter months, temperature drops to as low as 1°C while in summer the temperature reaches above 47°C. The average rainfall is approximately 900-1000 mm, with maximum concentration during the monsoon (July to September).

Experimental Details: The experiment was laid out in Randomized Block Design (4 × 3 factorial) comprising four levels of nitrogen (0, 40, 60 and 80 kg ha⁻¹) and three levels of phosphorus (0, 100 and 150 kg P_2O_5 ha⁻¹) making twelve treatment combinations, each replicated three times. Potassium (K_2O) @ 100 kg ha⁻¹ was uniformly applied in all the plots.

Table 1: Treatment Combinations

Treatment	N (kg ha⁻¹)	P_2O_5 (kg ha⁻¹)	Symbol
T_0	0	0	N_0P_0
T_1	0	100	N_0P_1
T_2	0	150	N_0P_2
T_3	40	0	N_1P_0
T_4	40	100	N_1P_1
T_5	40	150	N_1P_2
T_6	60	0	N_2P_0
T_7	60	100	N_2P_1
T_8	60	150	N_2P_2
T_9	80	0	N_3P_0
T_{10}	80	100	N_3P_1
T_{11}	80	150	N_3P_2

Variety Studied

'Snowball' variety of Chrysanthemum, developed by the Indian Agricultural Research Institute, New Delhi, was selected for the experiment. Cuttings were procured from the market and transplanted on 30th October 2009 in the evening.

Fertilizer Application

Nitrogen and phosphorus were applied through urea (46% N) and single super phosphate (16% P_2O_5), respectively, as per treatment details. Potassium was applied through muriate of potash (60% K_2O) uniformly @ 100 kg ha⁻¹. Half dose of nitrogen, total phosphorus and potash were applied as basal dressing before transplanting, and the remaining half quantity of nitrogen was applied at 20 days after transplanting as top dressing.

Economics Computation

The economics was worked out on the basis of prevailing market prices for different inputs (fertilizers, labour, plant protection chemicals, etc.) and output (flowers). The following parameters were computed:

Cost of Cultivation (₹ ha⁻¹): The total cost incurred on various inputs and operations including land preparation, fertilizers, planting material, irrigation, plant protection, weeding, harvesting and miscellaneous expenses.

Gross Returns (₹ ha⁻¹): Calculated by multiplying the total flower yield (t ha⁻¹) with the prevailing market price of flowers (₹ 10,000 per tonne).

Net Returns (₹ ha⁻¹): Calculated by subtracting the cost of cultivation from the gross returns.

Benefit-Cost (B: C) Ratio: Calculated by dividing the gross returns by the cost of cultivation.

Results and Discussion

Flower Yield (t ha⁻¹)

The data presented in Table 1 reveals that different levels of nitrogen, phosphorus and their interaction significantly influenced flower yield. Nitrogen level N_2 (60 kg ha⁻¹) recorded maximum flower yield (22.91 t ha⁻¹) followed by 14.78 t ha⁻¹ with N_3 (80 kg ha⁻¹). Phosphorus level P_1 (100 kg P_2O_5 ha⁻¹) recorded maximum flower yield (17.75 t ha⁻¹) followed by 16.35 t ha⁻¹ with P_2 (150 kg P_2O_5 ha⁻¹). Treatment combination N_2P_1 (60 kg N ha⁻¹ + 100 kg P_2O_5 ha⁻¹) recorded maximum flower yield (28.17 t ha⁻¹) followed by 25.63 t ha⁻¹ with N_2P_2 (60 kg N ha⁻¹ + 150 kg P_2O_5 ha⁻¹). N_0P_0 (control) recorded the minimum (10.08 t ha⁻¹). The flower yield per plot was corresponding to the number of flowers per plant, size and weight of the flowers. The increase in flower yield might be owing to increased roots, relative leaf water content and root biomass that could be ascribed to a better vegetative growth due to photosynthetic activity, which induces better translocation and partitioning of assimilates towards the yield (Santosh and Datta, 2006) [14].

Cost of Cultivation: The cost of cultivation for different treatment combinations varied depending upon the quantity of nitrogen and phosphorus fertilizers applied (Table 2). The cost of cultivation increased with increasing levels of nitrogen and phosphorus. The minimum cost of cultivation (₹ 35,000 ha⁻¹) was recorded in control treatment N_0P_0 (0 kg N + 0 kg P_2O_5 ha⁻¹), while the maximum cost of cultivation (₹ 42,250 ha⁻¹) was recorded in treatment N_3P_2 (80 kg N + 150 kg P_2O_5 ha⁻¹). This increase in cost of cultivation was attributed to the additional cost of fertilizers and their application.

Gross Returns, Net Returns and B:C Ratio

The economics of different treatment combinations is presented in Table 3. The gross returns were calculated based on the flower yield obtained from each treatment at the prevailing market price of ₹ 10,000 per tonne. Among all the treatment combinations, N_2P_1 recorded the highest gross returns (₹ 2,81,700 ha⁻¹), followed by N_2P_2 (₹ 2,56,300 ha⁻¹), while N_0P_0 recorded the lowest gross returns (₹ 1,00,800 ha⁻¹). The treatment combination N_2P_1 (60 kg N ha⁻¹ + 100 kg P_2O_5 ha⁻¹) recorded maximum net returns of ₹ 2,40,950 ha⁻¹ with a B:C ratio of 5.91, followed by N_2P_2 (60 kg N ha^{-1} + 150 kg P_2O_5 ha^{-1}) with net returns of ₹ 2,14,800 ha^{-1} and B:C ratio of 5.18. The control treatment N_0P_0 recorded minimum net returns (₹ 65,800 ha^{-1}) with B:C ratio of 2.88.

Nitrogen Levels and Economics: Among the nitrogen levels, N_2 (60 kg N ha^{-1}) recorded the highest net returns (mean of all phosphorus levels) of ₹ 1,55,900 ha^{-1}, followed by N_3 (80 kg N ha^{-1}) with ₹ 1,07,183 ha^{-1} (Table 4). The lowest net returns (₹ 79,350 ha^{-1}) were recorded with N_0 (0 kg N ha^{-1}).

Phosphorus Levels and Economics: Among the phosphorus levels, P_1 (100 kg P_2O_5 ha^{-1}) recorded the highest net returns (mean of all nitrogen levels) of ₹ 1,37,313 ha^{-1}, followed by P_2 (150 kg P_2O_5 ha^{-1}) with ₹ 1,22,513 ha^{-1} (Table 5). The lowest net returns (₹ 89,138 ha^{-1}) were recorded with P_0 (0 kg P_2O_5 ha^{-1}).

Benefit-Cost Ratio Analysis

The benefit-cost ratio is an important parameter for assessing the economic viability of different treatments. The data revealed that the B:C ratio ranged from 2.88 (N_0P_0) to 5.91 (N_2P_1). Among the nitrogen levels, N_2 (60 kg N ha^{-1}) recorded the highest mean B:C ratio of 5.75, followed by N_3 (3.64) (Table 4). Among the phosphorus levels, P_1 (100 kg P_2O_5 ha^{-1}) recorded the highest mean B:C ratio of 4.42, followed by P_2 (3.99) (Table 5). The higher net returns and B:C ratio with N_2P_1 treatment could be attributed to the significantly higher flower yield obtained under this treatment, which more than compensated the additional cost of fertilizers. These findings are in close conformity with the results reported by several researchers. The economic analysis clearly demonstrated that the treatment combination N_2P_1 (60 kg N ha^{-1} + 100 kg P_2O_5 ha^{-1}) was the most profitable for chrysanthemum cv. Snowball. The higher net returns and B:C ratio under this treatment could be attributed to the significantly higher flower yield, which was the result of optimum nutrient supply. Nitrogen plays a crucial role in promoting vegetative growth, which provides better photosynthetic area and more assimilates for flower formation. Phosphorus plays a vital role in energy transfer reactions and promotes cell division, leading to more flower buds and flowers (Rao *et al*., 1992; Baboo and Sharma, 1997) [4, 13]. The increase in flower yield with N_2P_1 treatment might be owing to increased roots, relative leaf water content and root biomass that could be ascribed to a better vegetative growth due to photosynthetic activity, which induces better translocation and partitioning of assimilates towards the yield (Santosh and Datta, 2006) [14]. The application of phosphorus @ 100 kg P_2O_5 ha^{-1} significantly improved the flower yield, which ultimately increased the gross returns, leading to higher net returns and B:C ratio. The results of the present investigation are in close conformity with the findings of various researchers. Rao *et al*. (1992) [13] reported that application of nitrogen and phosphorus significantly increased the flower yield and economics of chrysanthemum. Baboo and Sharma (1997) [13] observed that combined application of nitrogen and phosphorus gave the maximum net returns in chrysanthemum. Amit *et al.* (2004) [3] reported that the treatment combination of 60 kg N + 100 kg P_2O_5 ha^{-1} gave the highest net returns and B:C ratio in chrysanthemum. Baboo and Singh (2003) [4] also reported similar findings in chrysanthemum. Agrawal *et al*. (2002) and Pushkar *et al.* (2008) [2, 12] reported that nitrogen and phosphorus application significantly improved the economics of marigold. Santosh and Datta (2006) [14] also observed maximum net returns with optimum NPK application in gladiolus. The higher B:C ratio under N_2P_1 treatment (5.91) indicates that the investment is highly profitable and sustainable for commercial production of chrysanthemum. The incremental B:C ratio of 31.46 further confirms that every additional rupee invested in this treatment gives exceptionally high returns, making it the most economically viable option.

Table 2: Effect of nitrogen and phosphorus on flower yield (t ha^{-1})

Treatment	N_0	N_1	N_2	N_3	Mean (P)
P_0	10.08	11.83	14.92	13.50	12.58
P_1	13.00	14.25	28.17	15.58	17.75
P_2	12.00	12.50	25.63	15.25	16.35
Mean (N)	11.69	12.86	22.91	14.78	
S.Em.±					
N	0.162				
P	0.140				
N × P	0.281				
CD at 5%					
N	0.474				
P	0.410				
N × P	0.821				

Table 3: Economics of different treatment combinations

Treatment	Yield (t ha^{-1})	Gross Returns (₹ ha^{-1})	Cost of Cultivation (₹ ha^{-1})	Net Returns (₹ ha^{-1})	B:C Ratio
N_0P_0	10.08	1,00,800	35,000	65,800	2.88
N_0P_1	13.00	1,30,000	38,500	91,500	3.38
N_0P_2	12.00	1,20,000	39,250	80,750	3.06
N_1P_0	11.83	1,18,300	36,500	81,800	3.24
N_1P_1	14.25	1,42,500	40,000	1,02,500	3.56
N_1P_2	12.50	1,25,000	40,750	84,250	3.07
N_2P_0	14.92	1,49,200	37,250	1,11,950	4.01
N_2P_1	28.17	2,81,700	40,750	2,40,950	5.91
N_2P_2	25.63	2,56,300	41,500	2,14,800	5.18
N_3P_0	13.50	1,35,000	38,000	97,000	3.55
N_3P_1	15.58	1,55,800	41,500	1,14,300	3.75
N_3P_2	15.25	1,52,500	42,250	1,10,250	3.61

Conclusion

Based on the findings of the present investigation, it can be concluded that for obtaining higher flower yield, maximum net returns and higher benefit-cost ratio in Chrysanthemum cv. Snowball under Allahabad conditions, combined application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 100 kg P_2O_5 ha^{-1} with a uniform dose of potassium @ 100 kg K_2O ha^{-1} is recommended. The treatment N_2P_1 not only gave the highest flower yield but also proved economically most viable with a B:C ratio of 5.91, making it highly suitable for commercial cultivation.

References

1. Acharya S, Dashora LK. Effect of nitrogen and phosphorus on growth and flowering of marigold. J Ornam Hortic. 2004;7(1):75-78.
2. Agrawal RP, Singh R, Singh KK. Effect of nitrogen and phosphorus on growth and flower yield of marigold. Prog Hortic. 2002;34(2):189-192.
3. Amit M, Singh K, Kumar S, Singh KP. Effect of nitrogen and phosphorus on growth and flowering of chrysanthemum. J Ornam Hortic. 2004;7(1):42-46.
4. Baboo R, Sharma SK. Effect of nitrogen and phosphorus on growth and flowering of chrysanthemum. Haryana J Hortic Sci. 1997;26(1-2):24-27.
5. Baboo R, Singh R. Response of nitrogen and phosphorus on growth and flower yield of chrysanthemum. J Ornam Hortic. 2003;6(2):148-151.
6. Chaitra R, Krishnappa KS, Prashanth M, Reddy SK. Effect of integrated nutrient management on growth, yield and quality of chrysanthemum. Int J Curr Microbiol Appl Sci. 2018;7(5):210-219.
7. Gune S, Kumar S, Singh P. Chrysanthemum: A medicinal and ornamental plant. Med Plants Res. 2019;9(4):56-68.
8. Jackson ML. Soil Chemical Analysis. New York: Prentice Hall Inc.; 1958.
9. Li J, Zhang Y, Wang X. Effect of NPK fertilization on chrysanthemum growth and quality. J Plant Growth Regul. 2019;38(2):567-578.
10. Matsumura Y, Tanaka H, Watanabe H. Optimum fertilizer dose for chrysanthemum flower yield. J Hortic Sci Biotechnol. 2020;95(6):789-798.
11. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circ. 1954;939:1-19.
12. Pushkar D, Singh B, Sharma AK. Effect of nitrogen and phosphorus on growth and flowering of marigold. J Agric Sci. 2008;48(3):245-249.
13. Rao MM, Reddy BS, Prasad R. Effect of nitrogen and phosphorus on growth and flowering of chrysanthemum. J Res APAU. 1992;20(1):45-50.
14. Santosh K, Datta S. Effect of NPK on growth and flowering of gladiolus. J Ornam Hortic. 2006;9(2):112-116.
15. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Curr Sci. 1956;25:259-260.
16. Walkley A, Black IA. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci. 1934;37:29-38.