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Economic analysis of varying levels of nitrogen, on potato (*Solanum tuberosum* L.) cultivation under Chhattisgarh plains

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Abstract

A field experiment was conducted during the *Rabi* season of 2025-26 at the Research cum Demonstrational Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, to work out the economics of potato cv. Kufri Khyati cultivation under eight levels of nitrogen (T₁: 0, T₂: 50, T₃: 100, T₄: 150, T₅: 200, T₆: 250, T₇: 300 and T₈: 350 kg N/ha), each combined with a uniform basal dose of 100 kg P₂O₅/ha and 100 kg K₂O/ha, laid out in a Randomized Block Design with three replications. The gross return, net return and benefit-cost (B:C) ratio were worked out for each treatment on the basis of prevailing input costs and market price of tubers. Gross return and net return, did not increase linearly with increasing dose of nitrogen both were maximum under 300 kg N/ha, to Rs. 538860/ha and Rs. 426649.2 /ha respectively and declined slightly at the highest dose (T₈: 350 kg N/ha). The lowest gross return (Rs. 170380/ha) and net return (Rs. 62023.15/ha) were recorded under the control (T₁: 0 kg N/ha). The benefit-cost ratio followed the same trend, being maximum (4.80) under T₇ (300 kg N/ha), closely followed by T₆ (250 kg N/ha, 4.76), T₈ (350 kg N/ha, 4.72) and T₅ (200 kg N/ha, 4.58) and minimum (1.57) under T₁ (0 kg N/ha). Importantly, the yield data showed that 200, 250, 300 and 350 kg N/ha were statistically at par.

Keywords: Potato, nitrogen levels, gross return, net return, Benefit Cost ratio

Introduction

Potato (*Solanum tuberosum* L.) ranks as the fourth most important food crop in the world after rice, maize and wheat (Anon., 2021) ^[1] and is valued both as a staple food and as a source of farm income across diverse agro-climatic zones. In India, the crop is cultivated over about 22.25 lakh hectares with a total production of 561.7 lakh MT and an average productivity of 25.2 t/ha (Anon., 2022) ^[2]. In Chhattisgarh, potato is grown on 35,611 hectares with an annual production of 6,36,162 tonnes and a comparatively low productivity of 17.86 t/ha (Anon., 2024) ^[3], indicating considerable scope for improving both yield and profitability through better nutrient management. Nitrogen is the most critical and cost-intensive input in potato production, exerting a dominant influence on vegetative growth, tuber bulking and final yield (Kumar *et al.*, 2007) ^[6]. Potato is a nutrient-exhaustive, shallow-rooted crop with limited capacity to extract nutrients from the soil, it depends heavily on external nitrogen supply to realize its yield potential (Muhammad *et al.*, 2015) ^[9]. While an adequate nitrogen supply promotes canopy development and tuber yield, excessive application raises the cost of cultivation without a corresponding gain in yield, and can even depress tuber bulking by favouring vegetative growth over assimilate partitioning to tubers (Mengel *et al.*, 2001) ^[7].

Potato crop response to nitrogen and its economic efficiency under the nitrogen-deficient soils of the Chhattisgarh plains is limited. Therefore, the present investigation was undertaken with the specific objective.

Materials and Methods

The field experiment was carried out during the *Rabi* season of 2025-26 at the Research cum Demonstrational Farm of the College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya,

Raipur, Chhattisgarh. The potato variety Kufri Khyati was used for the study. The experimental soil was clay loam, locally referred to as “Dorsa,” with an initial soil pH of 7.15 and organic carbon content of 0.30%. The initial available nutrient status of the soil was 199.56 kg/ha nitrogen, 19.85 kg/ha phosphorus, and 219.38 kg/ha potassium. The trial was laid out in a Randomized Block Design (RBD) with three replication and eight treatments viz., 0 kg N/ha, 50 kg N/ha, 100 kg N/ha, 150 kg N/ha, 200 kg N/ha, 250 kg N/ha, 300 kg N/ha, 350 kg N/ha a uniform dose of phosphorus and potassium at 100:100 kg P₂O₅ and K₂O ha⁻¹, respectively, were applied to all treatments. The crop was planted on 2nd December 2025 at a spacing of 60 cm × 20 cm, with a gross plot size of 3.0 m × 2.4 m and a net plot size of 2.4 m × 2.2 m.

Economics analysis

The cost of cultivation was determined by considering the expenses incurred on seed tubers, fertilizers, labour, land preparation, and irrigation, based on the prevailing prices of inputs and the standard rates prescribed by the state government. Gross returns were estimated by multiplying the total tuber yield obtained under each treatment by the prevailing market price of potato (14,000 Rs/t). Net returns were calculated by deducting the total cost of cultivation from the gross returns. The benefit–cost (B:C) ratio was determined by dividing the gross returns by the corresponding cost of cultivation, using the formula given below. Gross return (Rs/ha) = Yield (t/ha) × Price of Yield (Rs/t)

Net return (Rs/ha) = Gross return (Rs/ha) - Cost of Cultivation (Rs/ha)

Benefit:Cost ratio = Gross return (Rs/ha) / Cost of Cultivation (Rs/ha)

Results and Discussion

The data on the cost of cultivation, gross returns, net returns, and benefit–cost ratio of potato under different levels of nitrogen are presented in Table 1. These economic parameters were calculated based on the prevailing input costs and market price of potato. A detailed breakup of the total cost of cultivation, including expenditure on seed, fertilizers and general cultivation operations for each treatment, is provided separately in Table 2.

Cost of cultivation (Rs/ha)

The cost of cultivation increased progressively with the level of nitrogen application, from Rs. 108356.9/ha under T₁ (0 kg N/ha) to a maximum of Rs. 112853.1/ha under T₈ (350 kg N/ha). This trend is a direct reflection of the additional expenditure incurred

on fertilizer as the nitrogen dose was raised, while the cost of seed tubers and other cultivation operations remained constant across treatments. Similar increases in cost of cultivation with higher nitrogen doses have been reported by De *et al.* (2025) ^[5] and Pandey *et al.* (2025) ^[10], who also recorded the highest cost of cultivation at the highest fertilizer level tested.

Gross return (Rs/ha)

Gross return varied widely, from Rs. 170380/ha under T₁ (0 kg N/ha) to a maximum of Rs. 538860/ha under T₇ (300 kg N/ha), after which it declined marginally to Rs. 532420/ha under T₈ (350 kg N/ha). Since gross return is directly derived from tuber yield at a fixed sale price, this pattern mirrors the yield response, which increased with nitrogen application up to 300 kg N/ha and did not improve further at 350 kg N/ha. This finding is in agreement with De *et al.* (2025) ^[5] and Mozumdar *et al.* (2014) ^[8], who similarly reported that gross return increased with nitrogen application up to an optimum level (300 kg N/ha).

Net return (Rs/ha)

Net return followed a trend similar to gross return, ranging from Rs. 62023.15/ha under T₁ (0 kg N/ha) to a maximum of Rs. 426649.2/ha under T₇ (300 kg N/ha). However, it was declining to Rs. 419566.9/ha under T₈ (350 kg N/ha). The wide margin between the lowest and highest net returns underscores the strong influence of nitrogen fertilization on farm profitability, while the slight fall at the highest dose indicates that the marginal cost of additional nitrogen beyond 300 kg N/ha was no longer matched by a corresponding marginal gain in yield or return. These results corroborate the findings of De *et al.* (2025) ^[5] and Das *et al.* (2015) ^[4].

Benefit:Cost ratio

The benefit–cost ratio, which expresses the efficiency of investment rather than its absolute magnitude, was lowest (1.57) under T₁ (0 kg N/ha) and rose consistently with nitrogen application to a maximum of 4.80 under T₇ (300 kg N/ha), followed closely by T₆: 250 kg N/ha (4.76) and T₈: 350 kg N/ha (4.72). The decline in B:C ratio beyond 300 kg N/ha, despite the continued rise in cost of cultivation, confirms that 300 kg N/ha represented the most economically efficient nitrogen dose in this study, rather than merely the highest-yielding one. Comparable trends of a peak B:C ratio at an intermediate to high nitrogen or fertility level, rather than at the maximum dose tested, have been reported by De *et al.* (2025) ^[5], Parganiha *et al.* (2022) ^[11] and Patel *et al.* (2015) ^[12].

Table 1: Economics of potato cultivation as affected by different nitrogen levels

Treat.	NPK (kg/ha)	Yield (t/ha)	Cost of Cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B:C Ratio
T ₁	0:100:100	12.17	108356.9	170380.0	62023.15	1.57
T ₂	50:100:100	18.70	108999.2	261800.0	152800.8	2.40
T ₃	100:100:100	25.11	109641.5	351586.7	241945.2	3.21
T ₄	150:100:100	31.69	110283.8	443613.3	333329.5	4.02
T ₅	200:100:100	36.25	110926.1	507500.0	396573.9	4.58
T ₆	250:100:100	37.95	111568.5	531346.7	419778.2	4.76
T ₇	300:100:100	38.49	112210.8	538860.0	426649.2	4.80
T ₈	350:100:100	38.03	112853.1	532420.0	419566.9	4.72

Market price of potato tuber = 14000 Rs/t

Table 2: Break-up of cost of cultivation of potato under different treatment

Treat.	NPK (kg/ha)	Seed cost (Rs/ha)	Fertilizer cost (Rs/ha)	Cultivation cost (Rs/ha)	Total cost (Rs/ha)
T ₁	0:100:100	40000	13031.5	55325.35	108356.9
T ₂	50:100:100	40000	13673.82	55325.35	108999.2
T ₃	100:100:100	40000	14316.14	55325.35	109641.5
T ₄	150:100:100	40000	14958.46	55325.35	110283.8
T ₅	200:100:100	40000	15600.78	55325.35	110926.1
T ₆	250:100:100	40000	16243.1	55325.35	111568.5
T ₇	300:100:100	40000	16885.42	55325.35	112210.8
T ₈	350:100:100	40000	17527.74	55325.35	112853.1

Conclusion

Nitrogen management strongly influenced the profitability of potato under the Chhattisgarh plains. Application of 300:100:100 kg/ha N:P:K produced numerically higher tuber yield (38.49 t/ha), gross return (Rs.538,860/ha), net return (Rs. 426,649.2 /ha) and B:C ratio (4.80). However, the treatments receiving 200, 250, 300 and 350 kg N/ha were statistically at par for yield parameters. Hence, 300 N kg/ha might be identified on the bases of economical study while, 200:100:100 kg/ha N:P:K might be recommended as it produce significantly similar yield as the higher dose and might be appropriate to the farmers of the state.

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