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EFFECT OF DIFFERENT LEVELS OF PHOSPHORUS AND NIPPING ON YIELD AND ECONOMICS OF CHICKPEA (*Cicer arietinum* L.)

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ABSTRACT

A field experiment was conducted during the rabi season at the Crop Research Farm, School of Agricultural Sciences, ITM University, Gwalior, Madhya Pradesh, India, to evaluate the effect of different phosphorus levels and nipping practices on yield and economics of chickpea (*Cicer arietinum* L.). The experiment consisted of three phosphorus levels *viz.*, P_2O_5 @ 40, 50 and 60 kg ha^{-1} and three nipping stages at 30, 40 and 50 DAS along with an absolute control. The results revealed that phosphorus application significantly improved grain yield, stover yield and biological yield of chickpea. Among phosphorus levels, application of 60 kg P_2O_5 ha^{-1} recorded the highest grain yield (2066 kg ha^{-1}), stover yield (3745 kg ha^{-1}) and biological yield (5811 kg ha^{-1}). Among nipping treatments, nipping at 40 DAS produced maximum grain yield (2081 kg ha^{-1}), stover yield (3752 kg ha^{-1}) and biological yield (5833 kg ha^{-1}). Economic analysis indicated that the treatment comprising P_2O_5 @ 50 kg ha^{-1} along with nipping at 40 DAS recorded the highest gross return (Rs. 150,631 ha^{-1}), net return (Rs. 95,713 ha^{-1}) and benefit-cost ratio (1.74). The study concluded that optimum phosphorus fertilization coupled with timely nipping significantly enhanced productivity and profitability of chickpea under the agro-climatic conditions of Madhya Pradesh.

***Keywords* :** Chickpea, phosphorus, nipping, grain yield, economics, net return, benefit-cost ratio.

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops cultivated throughout the world and plays a significant role in ensuring nutritional security due to its high protein content. It is an excellent source of carbohydrates, dietary fibre, minerals and vitamins, making it a staple food crop in many developing countries. India is the largest producer, consumer and importer of chickpea, accounting for nearly 70 per cent of global production (FAOSTAT, 2024).

Despite its importance, chickpea productivity in India remains below its genetic potential owing to several agronomic and nutritional constraints. Among the essential plant nutrients, phosphorus is considered the second most important macronutrient after nitrogen. It plays a vital role in root development, nodulation, energy transfer, flowering, seed formation and biological nitrogen fixation. Adequate phosphorus supply enhances crop growth and improves yield attributes, ultimately increasing grain production.

Apart from nutrient management, crop canopy manipulation practices such as nipping have gained importance in pulse crops. Nipping refers to the removal of the terminal growing point at a specific growth stage, which encourages lateral branching, improves source-sink relationship and increases the number of reproductive structures. Timely nipping has been reported to improve pod formation and grain yield in chickpea by enhancing photosynthetic efficiency and assimilate partitioning.

Although phosphorus nutrition and nipping individually contribute to improved crop performance, information regarding their combined influence on yield and economics of chickpea under the agro-climatic conditions of Madhya Pradesh is limited. Therefore, the present investigation entitled "Effect of Different Levels of Phosphorus and Nipping on Yield and Economics of Chickpea (*Cicer arietinum* L.)" was undertaken to evaluate their effect on crop productivity and profitability.

Materials and Methods

Experimental Site

A field experiment was conducted during the rabi season of 2025–26 at the Crop Research Centre, School of agriculture, ITM University, Gwalior, Madhya Pradesh, India. Geographically the experiment site was located at 26^0 14′ N latitude and 78^0 14′ E longitude with an elevation of 206 meters above mean sea level (AMSL), falling in the cliff plateau and sub-tropical climatic zone of Madhya Pradesh.

Soil and Climatic Conditions

The soil of the experimental field was sandy loam in texture, low in available nitrogen, medium in available phosphorus and high in potassium. The region receives an average annual rainfall of about 700–800 mm, most of which is received during the southwest monsoon season. The weather during the crop growing period remained favourable for normal growth and development of chickpea.

Experimental Design and Treatments

The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications. The treatments consisted of three levels of phosphorus and three stages of nipping, resulting in nine treatment combinations along with an absolute control.

Phosphorus Levels (P_2O_5)

- P_1 @ 40 kg ha^{-1}
- P_2 @ 50 kg ha^{-1}
- P_3 @ 60 kg ha^{-1}

Nipping Stages

- N_1 : Nipping at 30 DAS
- N_2 : Nipping at 40 DAS
- N_3 : Nipping at 50 DAS

Crop Management

The chickpea crop was sown using recommended agronomic practices. The nitrogen (20 kg/ha) and potassium (40 kg/ha) were applied as basal dose and the phosphorus was applied according to treatment specifications. Nipping was performed manually by removing the terminal growing bud at the designated crop growth stages. Irrigation, weed management, and plant protection measures were adopted uniformly for all treatments.

Observations Recorded

Seed yield was determined from the net plot area after harvesting, drying, threshing, and cleaning the produce, and the values were expressed in kg ha^{-1}. Biological yield was recorded as the total above-ground biomass harvested from each net plot prior to threshing and expressed in kg ha^{-1}. Stover yield was calculated by deducting grain yield from the corresponding biological yield and expressed in kg ha^{-1}. Harvest index (%) was computed as the ratio of grain yield to biological yield and expressed as a percentage using the following formula:

Harvest Index (%) = (Grain Yield / Biological Yield) × 100.

Economic evaluation of the treatments was performed by calculating the cost of cultivation, gross returns, net returns, and benefit-cost ratio. The cost of cultivation for each treatment was estimated by accounting for all amounts incurred on field preparation, inputs, labour, and treatment applications. Gross returns (Rs. ha^{-1}) were computed on the basis of prevailing market prices of grain and stover yield. Net returns (Rs. ha^{-1}) were obtained by deducting the total cost of cultivation from the gross returns. The benefit-cost ratio was calculated by dividing the net returns by the total cost of cultivation.

Statistical Analysis

The experimental data were analyzed statistically using the analysis of variance (ANOVA) technique applicable to Factorial Randomized Block Design as described by Gomez and Gomez (1984). The significance of treatment effects was tested at the 5% probability level. The analysis was done using the agri analyze software.

Results and Discussion

Effect on Yield

Grain Yield (kg ha^{-1})

Grain yield of chickpea was significantly influenced by different phosphorus levels and nipping stages (Table 1). Among the phosphorus levels, application of P_2O_5 @ 60 kg ha^{-1} (P_3) recorded the highest grain yield (2066 kg ha^{-1}), which was significantly superior to P_2O_5 @ 40 kg ha^{-1} (P_1) (1800 kg ha^{-1}), while P_2O_5 @ 50 kg ha^{-1} (P_2) produced an intermediate yield (1957 kg ha^{-1}). The increase in grain yield under higher phosphorus levels may be attributed to improved root proliferation, enhanced nodulation, increased nitrogen fixation, greater nutrient uptake and efficient translocation of photosynthates towards reproductive organs, resulting in improved pod formation and seed development. Phosphorus plays a vital role in energy transfer, cell division and reproductive growth, which ultimately contributes to higher grain production. Similar improvements in grain yield of chickpea with increasing phosphorus application were reported by Parashar *et al.* (2024) and Pushpalata *et al.* (2024).

Among the nipping treatments, nipping at 40 DAS (N_2) recorded the highest grain yield (2081 kg ha^{-1}), followed by nipping at 50 DAS (N_3) (1992 kg ha^{-1}), whereas the lowest grain yield was recorded under nipping at 30 DAS (N_1) (1749 kg ha^{-1}). Timely nipping at 40 DAS might have promoted lateral branching, improved canopy architecture and enhanced assimilate partitioning towards reproductive sinks, thereby increasing pod number and seed yield. Similar results were reported by Tyagi and Sharma (2024) and Kushwaha *et al.* (2022).

Stover Yield (kg ha^{-1})

Stover yield was significantly affected by phosphorus fertilization and nipping stages. The highest stover yield was recorded under P_2O_5 @ 60 kg ha^{-1} (3745 kg ha^{-1}), followed by P_2O_5 @ 50 kg ha^{-1} (3568 kg ha^{-1}), whereas the lowest stover yield was observed under P_2O_5 @ 40 kg ha^{-1} (3300 kg ha^{-1}). Increased phosphorus availability enhanced vegetative growth, leaf area development, photosynthetic efficiency and dry matter accumulation, leading to higher biomass production. Similar findings were reported by Kumar *et al.* (2019) and Sharma *et al.* (2021).

Among the nipping stages, nipping at 40 DAS recorded the highest stover yield (3752 kg ha^{-1}), followed by nipping at 50 DAS (3628 kg ha^{-1}), while the lowest stover yield was recorded under nipping at 30 DAS (3234 kg ha^{-1}). The increased stover production under nipping at 40 DAS may be attributed to enhanced branching and greater accumulation of photosynthates in vegetative plant parts. Similar observations were reported by Patel *et al.* (2023), Kumar and Sharma (2022) and Yadav *et al.* (2024).

Biological Yield (kg ha^{-1})

Biological yield was significantly influenced by phosphorus levels and nipping treatments. The highest biological yield (5811 kg ha^{-1}) was recorded under P_2O_5 @ 60 kg ha^{-1}, followed by P_2O_5 @ 50 kg ha^{-1} (5525 kg ha^{-1}), whereas the lowest biological yield (5100 kg ha^{-1}) was obtained under P_2O_5 @ 40 kg ha^{-1}. The increase in biological yield under higher phosphorus levels may be attributed to enhanced root growth, improved nutrient uptake, greater nodulation and increased dry matter accumulation throughout the crop growth period. Adequate phosphorus availability promotes vigorous vegetative growth and efficient photosynthetic activity, resulting in higher biomass production. Similar findings were reported by Badini (2015).

Similarly, nipping at 40 DAS produced the highest biological yield (5833 kg ha^{-1}), followed by nipping at 50 DAS (5621 kg ha^{-1}), whereas the lowest biological yield was recorded under nipping at 30 DAS (4982 kg ha^{-1}). Improved branching, better canopy architecture and greater interception of solar radiation due to optimum nipping might have enhanced dry matter accumulation and biomass production. Similar findings were reported by khan *et al.* (2006).

Harvest Index (%)

Harvest index was not significantly influenced by phosphorus levels and nipping stages. However, numerically higher harvest index was recorded under P_2O_5 @ 60 kg ha^{-1} (35.54%) and nipping at 40 DAS (35.68%). The harvest index ranged from 35.26 to 35.54 per cent under phosphorus levels and from 35.07 to 35.68 per cent under nipping treatments. The non-significant variation in harvest index indicates that both grain yield and biological yield increased proportionately with phosphorus application and nipping. Similar observations regarding the non-significant effect of phosphorus on harvest index were reported by Sonboir *et al.* (2019).

Effect on Economics

Cost of Cultivation (Rs. ha^{-1})

The cost of cultivation varied among the treatment combinations due to differences in phosphorus application rates and labour requirements associated with nipping operations (Table 2). The lowest cost of cultivation (Rs. 46,230 ha^{-1}) was recorded under the control treatment, whereas the highest cost of cultivation (Rs. 57,938 ha^{-1}) was observed under treatments receiving P_2O_5 @ 60 kg ha^{-1} along with nipping. The increase in cultivation cost with higher phosphorus levels was mainly attributed to the additional expenditure incurred on fertilizer procurement and application. Similarly, the inclusion of nipping operations increased labour costs due to additional field management practices. However, the increased cost of cultivation was compensated by substantial improvements in crop productivity, resulting in higher gross and net returns. Similar observations were reported by Ramesh *et al.* (2010).

Gross Returns (Rs. ha^{-1})

Gross returns were markedly influenced by different phosphorus and nipping combinations (Table 2). The highest gross return (Rs. 150,631 ha^{-1}) was recorded under T_6 (P_2O_5 @ 50 kg ha^{-1} + Nipping at 40 DAS), followed by T_7 (Rs. 142,078 ha^{-1}) and T_9 (Rs. 140,676 ha^{-1}). The lowest gross return (Rs. 90,330 ha^{-1}) was recorded under the control treatment. Higher gross returns under T_6 were mainly due to increased grain and biological yield resulting from optimum phosphorus nutrition and timely nipping. Similar findings were reported by Raghvendra *et al.* (2018), Vikram *et al.* (2018).

Net Returns (Rs. ha^{-1})

Net returns differed significantly among treatments. The highest net return (Rs. 95,713 ha^{-1}) was recorded under T_6 (P_2O_5 @ 50 kg ha^{-1} + Nipping at 40 DAS), followed by T_7 (Rs. 87,160 ha^{-1}) and T_9 (Rs. 85,138 ha^{-1}), whereas the lowest net return (Rs. 44,100 ha^{-1}) was recorded under the control treatment. The increased net returns under T_6 may be attributed to enhanced productivity and efficient utilization of inputs, which compensated for the additional cost incurred on phosphorus application and nipping operations. Similar findings were also reported by Kumawat *et al.* (2020).

Benefit-Cost Ratio (Rs. re^{-1} ha^{-1})

The benefit-cost ratio was also significantly influenced by treatment combinations. The highest B:C ratio (1.74) was recorded under T_6 (P_2O_5 @ 50 kg ha^{-1} + Nipping at 40 DAS), followed by T_7 (1.59) and T_9 (1.53), while the lowest B:C ratio (0.95) was observed under the control treatment. The higher B:C ratio under T_6 was mainly due to greater economic yield and higher monetary returns relative to the cost of cultivation. This indicates that the combination of optimum phosphorus fertilization and timely nipping is economically viable and profitable for chickpea production. Similar results were reported by Rabari *et al.* (2022).

Table 1 : Effect of different levels of phosphorus and nipping on yield of chickpea

Treatment		Yield (kg ha^{-1})			
		Grain	**Stover**	**Biological**	**Harvest index (%)**
Phosphorus Levels					
P_1	P_2O_5 @ 40 kg ha^{-1}	1800	3300	5100	35.26
P_2	P_2O_5 @ 50 kg ha^{-1}	1957	3568	5525	35.40
P_3	P_2O_5 @ 60 kg ha^{-1}	2066	3745	5811	35.54
SE(m)±		46	83	129	--
LSD *(P=0.05)*		137	246	382	--
Nipping					
N_1	30 DAS	1749	3234	4982	35.07
N_2	40 DAS	2081	3752	5833	35.68
N_3	50 DAS	1992	3628	5621	35.45
SE(m)±		46	83	129	--
LSD *(P=0.05)*		137	246	382	--
Absolute Control					
No Phosphorus + No Nipping		1325	2512	3836	34.53
P x N interaction					
SE(m)±		80	143	223	--
LSD *(P=0.05)*		NS	NS	NS	--

Table 2 : Effect of different levels of phosphorus and nipping on economics of chickpea

S. No.	Treatments	Cost of Cultivation Rs. ha^{-1}	Gross Returns Rs. ha^{-1}	Net Returns Rs. ha^{-1}	B:C Ratio
T_1	Control	46230	90330	44100	0.95
T_2	P_2O_5 @ 40 kg ha^{-1} + Nipping @ 30 DAS	56688	109299	55011	1.01
T_3	P_2O_5 @ 40 kg ha^{-1} + Nipping @ 40 DAS	56688	119832	65544	1.21
T_4	P_2O_5 @ 40 kg ha^{-1} + Nipping @ 50 DAS	56688	127287	72999	1.34
T_5	P_2O_5 @ 50 kg ha^{-1} + Nipping @ 30 DAS	57318	125645	70727	1.29
T_6	P_2O_5 @ 50 kg ha^{-1} + Nipping @ 40 DAS	57318	150631	95713	1.74
T_7	P_2O_5 @ 50 kg ha^{-1} + Nipping @ 50 DAS	57318	142078	87160	1.59
T_8	P_2O_5 @ 60 kg ha^{-1} + Nipping @ 30 DAS	57938	131518	75980	1.37
T_9	P_2O_5 @ 60 kg ha^{-1} + Nipping @ 40 DAS	57938	140676	85138	1.53
T_{10}	P_2O_5 @ 60 kg ha^{-1} + Nipping @ 50 DAS	57938	137577	82039	1.48

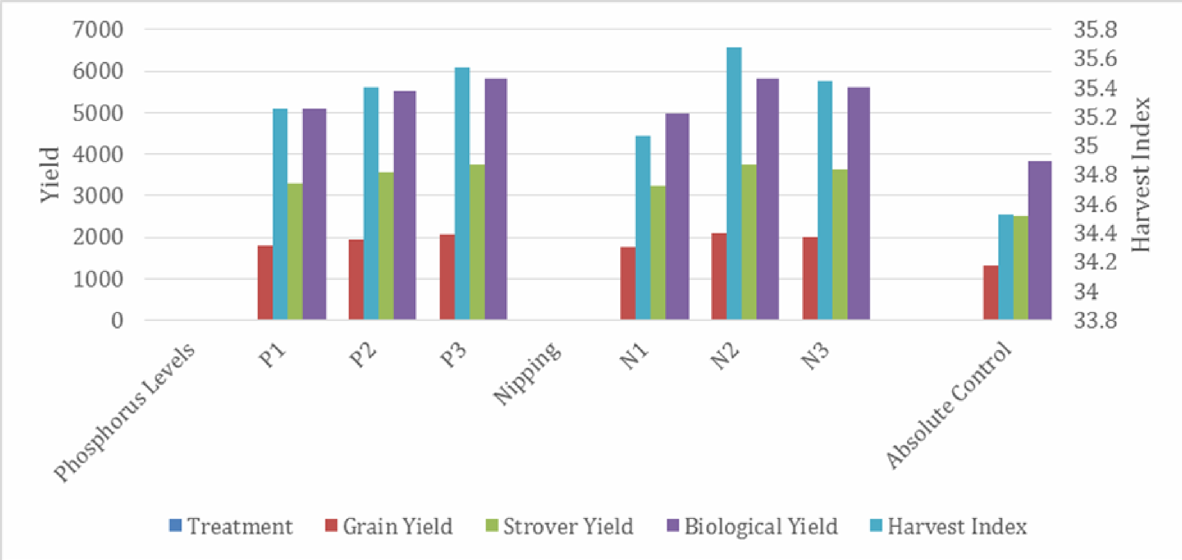

Fig. 1 : Effect of different levels of phosphorus and nipping on yield of chickpea

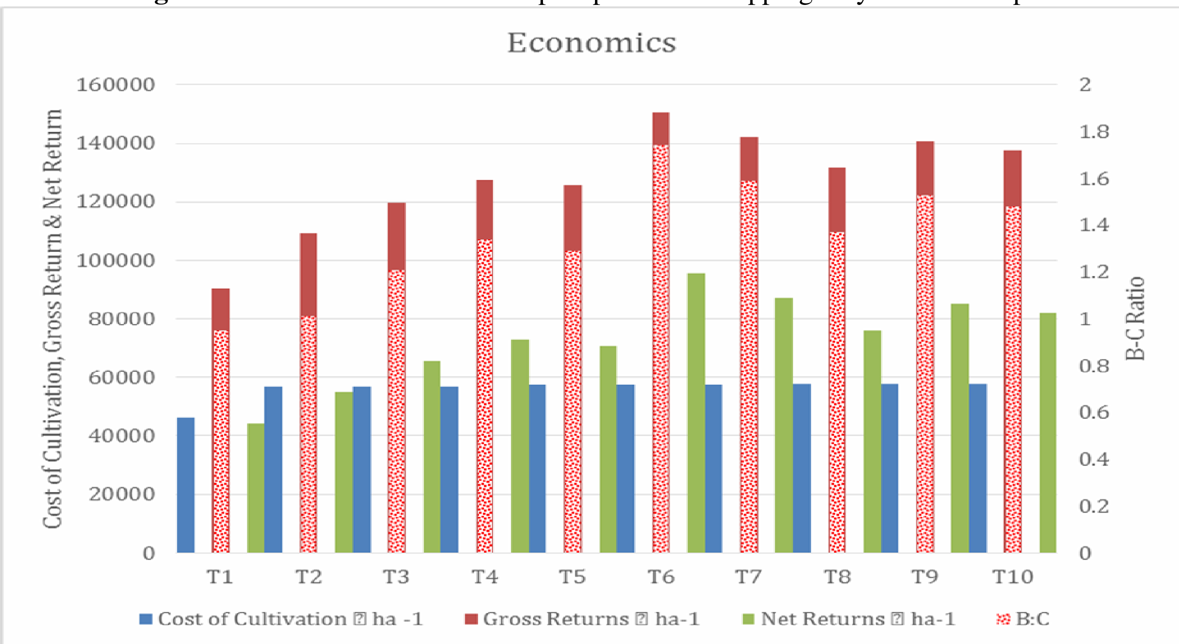

Fig. 2 : Effect of different levels of phosphorus and nipping on economics of chickpea

Conclusion

Based on the experimental findings, it may be concluded that phosphorus fertilization and nipping significantly improved yield and economic returns of chickpea. Application of P_2O_5 @ 60 kg ha^{-1} recorded the highest grain, stover and biological yields, whereas nipping at 40 DAS proved superior among the nipping treatments.

From an economic perspective, P_2O_5 @ 50 kg ha^{-1} combined with nipping at 40 DAS emerged as the most profitable treatment, recording the highest gross return (Rs. 150,631 ha^{-1}), net return (Rs. 95,713 ha^{-1}) and benefit-cost ratio (1.74). Therefore, application of 50 kg P_2O_5 ha^{-1} along with nipping at 40 DAS may be recommended for obtaining higher productivity and profitability of chickpea under the agro-climatic conditions of Madhya Pradesh.

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