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Effect of Nitrogen and Phosphorus on Growth and Yield of Cowpea [*Vigna unguiculata* L.]

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

A field study was conducted during *the growing* season of 2021 at the crop research farm of the Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj in the North Eastern plains of Eastern Uttar Pradesh with the objective of studying the effects of nitrogen and phosphorus on growth, yield, and economics of cowpea (*Vigna unguiculata* L.) Var. Gomati VU 89 under a randomised block design, comprising of 9 treatments, of which treatments (T_1-T_9) with different combinations of nitrogen and phosphorus, which are replicated thrice. The experimental results revealed that 25 kg N/ha + 50 kg P/ha recorded Maximum plant height (69.02 cm), number of branches/plant (12.33), number of nodules/plant (4.0), highest plant dry weight (15.32 gm), crop growth rate (4.80 g/m^2/day), test weight (18.57 g), number of pods/plant (20.13), number of seeds/pod (15.1), seed yield (1243.97 kg/ha), harvest index (32.0%). T9 25 kg N/ha + 50 kg P/ha resulted in a higher net return (34.05 x 103/ha), gross return (63.44 x 103/ha), and benefit-cost ratio (2.16).

Keywords: Economics; growth; cowpea; nitrogen; phosphorus; yield.

1. INTRODUCTION

India has become self-sufficient with respect to the production of food grains but still lags behind the production of pulses. Moreover, burgeoning population pressure and increasing degree of protein mal-nutrition aggravated the problem and call for stepping up the pulses production. Pivotal

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role of pulses in human diet and system of farming all over the world is well known. Pulses are the major and cheap source of lysine, which is a rich quality protein, providing supplement to cereal-based diet.

"Pulses being the important source of dietary protein have unique ability of maintaining and restoring soil fertility through biological nitrogen fixation along with addition of ample amount of plant residues to the soil. In India, the pulses occupy nearly 29.46-million-hectare area with a production of 22.95 million tonnes and productivity of 779kg/ha" (Anonymous,2019). Among the different pulses, cowpea [*Vigna unguiculata* L.] is the important crop grown in arid and semi-arid regions of the state. Cowpea belongs to the family Leguminosae, and commonly referred to as lobia. Cowpea is kharif pulse crop grown for vegetables, grain, forage and green manuring. It has good promise as an alternative pulse crop in dry land farming. It also works as smother crop keeping weed infestation low.

Cowpea is highly responsive to fertilizer and manures. The adequate application of fertilizers has played a significant role in providing nutrients for growth and development of cowpea. Nitrogen plays an important role in physiological processes of plant and act as constituents of protoplasm. Nitrogen vitally associated with activity of each living cell. Nitrogen is essential constituents of compounds like amino-acids, enzyme, co-enzyme and alkaloids. Though, they have the capacity to fix atmospheric nitrogen symbiotically. The nitrogen application at lower dosed in initial stage before the plant develops sufficient root system, have been beneficial as it provides the nitrogen need of young seedling.

"Phosphorus, an important macronutrient, is among the most needed elements for crop production in most tropical soils, which tend to be deficient in phosphorus availability. In plant tissues, it is present in much smaller amount than nitrogen and potassium although it is the key plant nutrient involved in energy transfer in the plant chemical reactions" [1] and "in the biosynthesis of chlorophyll, where phosphorus as pyridoxal phosphate must be present for the biosynthesis of chlorophyll. Phosphorus is known to promote the development of roots there by flouring the nitrogen fixation in legumes. This increased amount of nitrogen fixed might be utilized by the host plant for its own growth" (Rajasree and Pillai 2001).

2. OBJECTIVES

1. To study the Effect of Nitrogen and Phosphorus on growth and yield of Cowpea.
2. To calculate the economics of different treatment combinations

3. MATERIALS AND METHODS

A field study was conducted during kharif season of 2021, at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj, Uttar Pradesh, India. This area is located at 25^o 24' 42" N latitude, 81^o 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To determine the impact of nitrogen and phosphorus on growth and yield of cowpea (*Vigna unguiculata* L.), the experiment was set up using a Randomized Block Design with nine treatments that were reproduced three times. The treatment net plots are 3m x 3m in size. The treatment are categorized as with recommended dose of potash 20 kg ha^{-1} through Muriate of Potash, in addition with Nitrogen and Phosphorus when applied in combinations as follows, (T_1) 15kg/ha nitrogen + 30kg/ha phosphorus, (T_2) 15kg/ha nitrogen + 40kg/ha phosphorus, (T_3) 15kg/ha nitrogen + 50kg/ha phosphorus, (T_4) 20kg/ha nitrogen + 30kg/ha phosphorus , (T_5) 20kg/ha nitrogen + 40kg/ha phosphorus, (T_6) 20kg/ha nitrogen + 50kg/ha phosphorus, (T_7) 25 kg/ha nitrogen + 30kg/ha phosphorus, (T_8) 25 kg/ha nitrogen + 40kg/ha phosphorus, (T_9) 25 kg/ha nitrogen + 50kg/ha phosphorus. The cowpea crop was harvested treatment wise at harvesting maturity stage. Growth parameters viz. plant height (cm), number of branches, dry matter accumulation g plant^{-1} were recorded manually on five randomly selected representative plants from each plot of each replication separately and after harvesting, seeds were separated from each net plot and were dried under sun for three days. After that, the seeds were winnowed and cleaned, and the seed yield per hectare was calculated and expressed in tonnes per hectare. Each net plot's stover yield was measured and expressed in tonnes per hectare after complete drying in the sun for 10 days. The data was generated and analyzed using the Gomez and Gomez statistical approach (1984). The benefit:cost ratio was calculated using the price of seed with straw and the overall cost of crop cultivation.

4. RESULTS AND DISSCUSIONS

4.1 Effect on Growth Parameters

4.1.1 Plant height

Plant height measurements increased as crop growth progressed, as seen in Table 1. At harvest the treatment T_9 (25 kg N/ha + 50 kg P/ha) recorded maximum height of 69.02 cm. At harvesting stage maximum plant height was measured in T_9 and treatments T_8 was found statistically at par to T_9. The highest plant height in treatment T_9 may be ascribed due to the continuous supply of nutrients throughout all growth stages with beneficial association between Nitrogen and Phosphorus along with Potassium. Increasing levels of nitrogen application up to 40 kg N ha recorded significantly higher plant height throughout the crop growth period. This was reported by Jalbi et al. [2] and Hamid et al. [3].The probable reason for increase in plant height in the application of 60 kg/ha P might have resulted in increased carbohydrate accumulation and their remobilization to reproductive parts of the plants, being the closest sink and hence, resulted in increased plant growth. It is also critical in biological energy transfer processes that are vital for life and growth of the plant. Beneficial effect of P plant growth reported by Khandelwal et al. (2012).

4.2 Number of Branches/Plant

At harvesting stage maximum number of branches (12.3) are produced by T_9 (25 kg N/ha + 50 kg P/ha) and T_6 and T_8 are statistically at par to maximum. The findings of the present study indicate that growth attributes of crop such as number of branches had marked variation under various nitrogen levels. Highest level of nitrogen fertilizer 40 kg has^{-1} produced

Table 1. Effect of Nitrogen and Phosphorus on growth parameters of cowpea var. 'Gomati (VU 89)'at harvest

S.No	T.No.	Treatments	Plant height (cm)	No. of branches plant $^{-1}$	Dry matter accumulation (g plant^{-1})
1	T_1	15 kg N/ha + 30 kg P/ha	62.99	9.80	14.52
2	T_2	15 kg N/ha + 40 kg P/ha	64.50	10.27	14.66
3	T_3	15 kg N/ha + 50 kg P/ha	65.90	10.53	14.71
4	T_4	20 kg N/ha + 30 kg P/ha	65.39	10.40	14.69
5	T_5	20 kg N/ha + 40 kg P/ha	66.75	11.27	14.81
6	T_6	20 kg N/ha + 50 kg P/ha	67.45	11.47	15.03
7	T_7	25 kg N/ha + 30 kg P/ha	66.14	10.80	14.78
8	T_8	25 kg N/ha + 40 kg P/ha	68.13	12.00	15.24
9	T_9	25 kg N/ha + 50 kg P/ha	69.02	12.33	15.32
		SEm (±)	0.33	0.29	0.10
		CD (P 0.05)	1.00	0.85	0.31

Table 2. Effect of Nitrogen and Phosphorus on yield and yield attributing characters of cowpea var. 'Gomati (VU 89)'

S. No	T. No	Treatments	No. of pods/plant	No. of seed/plant	Seed Yield (t/ha)	Straw Yield (t/ha)
1	T_1	15 kg N/ha + 30 kg P/ha	16.13	12.13	0.79	1.67
2	T_2	15 kg N/ha + 40 kg P/ha	16.50	12.50	0.74	1.76
3	T_3	15 kg N/ha + 50 kg P/ha	17.10	13.77	0.88	2.03
4	T_4	20 kg N/ha + 30 kg P/ha	17.03	13.29	0.84	1.96
5	T_5	20 kg N/ha + 40 kg P/ha	18.57	14.43	1.05	2.32
6	T_6	20 kg N/ha + 50 kg P/ha	18.77	14.63	1.10	2.40
7	T_7	25 kg N/ha + 30 kg P/ha	17.87	13.87	0.97	2.17
8	T_8	25 kg N/ha + 40 kg P/ha	19.37	14.70	1.14	2.48
9	T_9	25 kg N/ha + 50 kg P/ha	20.13	15.13	1.24	2.66
		SEm (±)	0.29	0.32	0.03	0.10
		CD (P 0.05)	0.89	0.94	0.10	0.30

Table 3. Effect of Nitrogen and Phosphorus on economics of cowpea var. 'Gomati VU 89'

S. No	T. No.	Treatments	Cost of cultivation# ($x\ 10^3 \neq ha^{-1}$)	Gross return ($x\ 10^3 \neq ha^{-1}$)	Net return ($x\ 10^3 \neq ha^{-1}$)	Benefit: Cost ratio
1	T_1	15 kg N/ha + 30 kg P/ha	28,270.00	64,000.00	35,730.00	1.26
2	T_2	15 kg N/ha + 40 kg P/ha	28,820.00	59,200.00	30,380.00	1.05
3	T_3	15 kg N/ha + 50 kg P/ha	29,360.00	70,400.00	41,040.00	1.39
4	T_4	20 kg N/ha + 30 kg P/ha	28,290.00	67,200.00	38,910.00	1.37
5	T_5	20 kg N/ha + 40 kg P/ha	28,830.00	84,000.00	55,170.00	1.91
6	T_6	20 kg N/ha + 50 kg P/ha	29,370.00	88,000.00	58,630.00	1.99
7	T_7	25 kg N/ha + 30 kg P/ha	28,300.00	77,600.00	49,300.00	1.74
8	T_8	25 kg N/ha + 40 kg P/ha	28,840.00	91,200.00	62,360.00	2.16
9	T_9	25 kg N/ha + 50 kg P/ha	29,390.00	99,200.00	69,810.00	2.37

#Data not subjected to statistical analysis

significantly higher growth attributes due to increased plant nutrient availability. These findings are supported by Kaiser et al. (2010). The probable reason for increase in branches/plant in the application of 60 kg/ha P might have resulted due to balance increased in phosphorus. In similar way that adequate P levels promote root growth and stimulate branches/tillers of plant and also, the effect of nutrients on productivity of cowpea genotype Pusa Komal was recorded by Sharma et al. [4] in the experiment application of 80kg P_2O_5/ha.

4.3 Dry matter accumulation

The treatment T_9 (25 kg N/ha + 50 kg P/ha) recorded maximum dry matter accumulation of 15.32 (g) at the harvesting stage and T_6, T_8 treatments are found statistically at par to maximum dry matter accumulation. Because all other vegetative qualities contained it, dry matter accumulation is more crucial. Nitrogen is one of the most important nutrients for crop growth and development because it influences dry matter production and photosynthetic efficiency through regulating leaf area development and maintenance. A similar statement was also found by Asaduzzaman (2008), Saini and Thakur [5] and Kumar et al. [6]. Application of phosphorus P 60 kg/ha significantly increased the dry matter yield of cowpea. This is reported by Rakesh Kumar et al. [7].

4.4 Yield and Yield Attributes

4.4.1 Number of pods/plant

The statistical examination of the number of pods per plant revealed a significant effect. Treatment 25 kg N/ha + 50 kg P/ha recorded significant and highest number of pods per plant (19.37). However, 25 kg N/ha + 40 kg P/ha recorded statistical parity with 25 kg N/ha + 50 kg P/ha. This could be attributable to the crop's accelerated nitrogen metabolism and extended moisture retention, especially during the moisture stress stage, which may have aided in bearing a higher number of pods per plant at harvest. These findings are consistent with those of Singh, R.P., and Dasharath Singh (2017), who found that foliar spray increases incremental production in pulses.

4.4.2 Seed yield

Different combinations of Nitrogen and Phosphorus with Potassium have a substantial impact on seed production. The highest seed yield was obtained with the treatment 25 kg N/ha + 50 kg P/ha (1243.9), however no other treatments are statistically at par with the treatment 25 kg N/ha + 50 kg P/ha. Application of nitrogen and phosphorus improves the growth and development of grain yield through increasing nutrient status in plant and their translocation towards sink. Phosphorus played vital role in energy transformation, metabolic process of plant and better development of root system which resulted in increasing grain yield. Significant improvement due to nitrogen and phosphorus as observed under present investigation are in close conformity with findings of Gawai et al. [8] and Shaik et al. [9].

4.4.3 Straw yield

The application of Nitrogen and Phosphorus had also significantly influenced the straw production of the cowpea crop. Highest straw yield (2656.21 kg/ha) was recorded 25 kg N/ha + 50 kg P/ha however, 20 kg N/ha + 50 kg P/ha, 25 kg N/ha + 40 kg P/ha were found to be statistically on par with 25 kg N/ha + 50 kg P/ha. Application of nitrogen and phosphorus improves the growth and development of straw yield through increasing nutrient status in plant and their translocation towards sink. Phosphorus played vital role in energy transformation, metabolic process of plant and better development of root system which resulted in increasing straw yield. Significant improvement due to nitrogen and phosphorus as observed under present investigation are in close conformity with findings of Gawai et al. [8] and Shaik et al. [9].

4.4.4 Economics

Among the different combination of nutrient source 25 kg N/ha + 50 kg P/ha recorded higher net return (34.05 x 10^3 ≠/ha), gross return (63.44 x 10^3 ≠/ha) and benefit: cost ratio (2.16).

5. CONCLUSION

Treatment 25 kg N/ha + 50 kg P/ha recorded highest growth parameters and seed yield (1243.97 kg/ha), gross return (63.44x 10^3 ≠/ha), net return (34.05x 10^3 □/ha) and benefit: cost ratio (2.16) which may be more preferable for farmers since it is economically more profitable and hence, can be recommended to the farmers after further trails [10-34].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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