Influence of Phosphorus and Potassium on Yield and Economics of lentil (*Lens culinaris L.)*

ABSTRACT

The Field experiment was conducted during *Rabi* season 2022 at experimental field of Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology& Sciences, Prayagraj and Uttar Pradesh, India. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH7.3), low in organic carbon (0.48%), available nitrogen (230 kg/ha), available phosphorus (13.60 kg/ha) and available potassium (215.4 kg/ha). The treatments consist of 3 levels of Phosphorus 30, 40, 50 kg/ha and Potassium 15, 20, 25 kg/ha. The experiment was layout in Randomized Block Design with 9 treatments each replicated thrice. Higher plant height (25.20 cm), plant dry weight (10.34 g), and the yield attributes namely seeds/pod (2.27), pods/plant (91.90), seed yield (1847.93 kg/ha) and stover yield (2948.20 kg/ha), maximum gross return (112200.00 INR/ha), net return (81025.00 INR/ha) and B: C ratio (2.59) were also obtained highest in the treatment 9 [Phosphorus 50 kg/ha + Potassium 25 kg/ha].

Keywords: *Lentil, Phosphorus, Potassium, Yield and Economics*

INTRODUCTION

Lentil is one of the world's oldest crops having been cultivated in southwestern Asia since 7000 bc. The crop is best adapted for production in temperate climates but is now produced in different parts of the world. India ranked first in area and second in the production with 39.79% and 22.79% of world area and production respectively. The highest productivity was recorded in Croatia (2862 kg/ha) followed by New Zealand (2469 kg/ha). Canada rank first in production (41.16%) due to very high level of productivity (1633 kg/ha) as compared to India (611 kg/ha). It is grown in different cropping systems under irrigated (10%) as well as rainfed conditions (90%) in most regions of the world. It is grown as mono cropping, mixed cropping, intercropping and relay cropping. As intercropping it better exploits the resources than sole crops and also provides “Biological Insurance” i.e. when one crop fails then second crop provides some returns. It can be intercropped successfully in wheat, barley, mustard and linseed. Humans benefit from lentils due to their high nutrient content and health benefits. It is also high in carbohydrates and has a high protein content. Lentil also contains the essential amino acids isoleucine and lysine, making it a low-cost protein source in developing countries **(Callaway *et al.*, 2004).** In recent years, India has imported a large quantity of pulses to meet the demand. In terms of global production, India is the largest producer of lentils. It improves soil fertility when grown in rainfed and unirrigated conditions. During the winter season in India, lentil is mostly grown as a post-rainy season crop with receding soil moisture conditions. Lentils contain a variety of bioactive substances such as enzyme inhibitors, lectins, phytates, oligosaccharides, and phenolic compounds that play metabolic roles in humans and animals that consume these foods on a regular basis. These effects can be positive, negative, or both **(Champ, 2002).** Because of their impact on diet quality, some of these substances have been labelled as antinutritional. Protein digestibility and nutrient absorption can be reduced by enzyme inhibitors and lectins, respectively, but both have little effect after cooking **(Lajolo and Genovese, 2002).**

Phosphorus is the key element for successful pulse production because it is involved in root development, stalk and stem strength, flower and seed formation, crop maturity and production, N-fixation, crop quality and resistance to plant diseases by enhancing the physiological functions. It plays an important role in stimulating biological activities such as nodulation, nitrogen fixation, and nutrient uptake in the soil and rhizosphere environment, resulting in higher legume crop yield. Phosphorus application reduces the negative effects of drought on physiological parameters and has the potential to increase yield in water-stressed conditions. **(Singh. N and Singh. G 2016).**

Potassium contributes to protein synthesis, carbohydrate metabolism, and enzyme activation. It helps with cation-anion balance, osmoregulation, water movement, energy transfer, and a variety of other processes **Wang (2013).** A poor root system, lodging, and yield reductions are all common symptoms of K deficiency. Lack of K fertiliser makes plants more susceptible to various diseases and pest infestations, as well as vulnerable to damage under various stress conditions **Hasanuzzaman (2018).** Most soils in Bangladesh's different agro-ecological zones are deficient in potassium, particularly calcareous soils **Quddus (2018).**

MATERIALS AND METHODS

The methodology, materials, and the techniques adopted in this present experiment entitled, "Effect of Phosphorus and potassium on growth and yield of lentil", was carried out at Crop Research Farm of the Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) during *Rabi* season of 2022. The details of the procedures adopted for raising the crop and criteria used for treatment evaluation and methods adopted during the course of investigation are presented in this chapter are summarized here under the following headings.

In order to study the two nutrients, phosphorus and potassium are taken. The experiment was conducted at during *Rabi* 2022, at Crop Research Farm, Naini Agricultural Institute, SHUATS, Prayagraj. The experimental site of the study is geographically located at 25.28^{o}N latitude, 81.54^{o}E longitude and 98 m altitude above the mean sea level (MSL). The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. Pre- sowing soil samples were taken from a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil was sandy loam in texture, low in organic carbon (0.36%) and medium in available nitrogen (171.48 kg/ha), phosphorous (15.2 kg/ha) and low in potassium (232.5 kg/ha). The treatments consist of phosphorus (30, 40, 50 kg/ha) and potassium (15, 20, 25 kg/ha) respectively. The experiment was laid out in randomized block design with nine treatments each replicated thrice and control i.e., recommended N, P and K (20:40:20 kg/ha). The plots were prepared with dimension of 3m × 3m and seeds were sown with a spacing of 30cm × 10cm. At 15DAS plants were thinned to appropriate density. Weeds were controlled manually at 20, 35 DAS to maintain a uniform plant population. Irrigations were given uniformly and regularly to all plots as per requirement so as to prevent the crop from water stress at any stage. Growth characteristics namely plant height (cm), plant dry weight (g), crop growth rate (g/m^2/day) and relative growth rate (g/g/day) were recorded. The crop was completely harvested at physiological maturity stage and their post-harvest observations such as number of seeds/pod, pods/plant, test weight (g), seed yield (kg/ha), stover yield (kg/ha) and harvest index (%) were recorded. The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez (1984).

RESULTS AND DISCUSSION

YIELD ATTRIBUTES AND YIELD

Number of seeds/pod

At harvest, the data recorded more seeds/pod (2.27) in treatment no.9 [Phosphorus 50 kg/ha + Potassium 25 kg/ha]. However, treatment no.7 [Phosphorus 50 kg/ha + Potassium 15 kg/ha], treatment no.8 [Phosphorus 50 kg/ha + Potassium 20 kg/ha] was statistically at par with treatment no.9.

More supply of Phosphorus which increase the vegetative growth but not reproductive. At grain filling stage, balanced nutrition improves the photosynthesis efficiency and assimilates production which leads to enhance the yield. Similar results are observed by **Singh, N and Singh, G. (2016).**

Number of pods/plant

At harvest, the data recorded highest pods/plant (91.90) in treatment no.9 [Phosphorus 50 kg/ha + Potassium 25 kg/ha]. However, treatment no.7 [Phosphorus 50 kg/ha + Potassium 15 kg/ha], treatment no.8 [Phosphorus 50 kg/ha + Potassium 20 kg/ha] was statistically at par with treatment no.9.

Phosphorus helps in utilizing nutrient

efficiency, resulting in better canopy and a further increase in radiant energy uptake and utilization with a greater effective and total number of pods per plant. Similar results are observed by **Goud *et al.* (2021).** Potassium serves as a catalyst for a variety of enzymes and in the synthesis of peptide bonds. Due to fewer flower drop and more efficient transfer of photosynthates from source to sink resulting in higher number of pods per plant. Similar results are observed by **Tauseef *et al.* (2022).**

Seed yield (kg/ha)

At harvest, the data recorded higher seed yield (1847.93 kg/ha) in treatment no.9 [Phosphorus 50 kg/ha + Potassium 25 kg/ha]. However, treatment no.8 [Phosphorus 50 kg/ha + Potassium 20 kg/ha] was statistically at par with treatment no.9.

Phosphorus is known to encourage flowering and fruiting, which may have stimulated plants to produce more pods per plant and also allows more seeds to develop per pod resulting in increased grain yield. Similar results are observed by **Goud *et al.* (2021).** The higher grain yield could be due to potassium in that application stimulates the cumulative effect improvement in yield attributes viz., ear head length, number of grains/ear head, test weight and enhances the development of strong cell walls and therefore stiffer straw which might be resulted into profuse tillering. Similar results are observed by **Reddy *et al.* (2021).**

Stover yield (kg/ha)

At harvest, the data recorded higher stover yield (2948.20 kg/ha) in treatment no.9 [Phosphorus 50 kg/ha + Potassium 25 kg/ha]. However, treatment no.7 [Phosphorus 50 kg/ha + Potassium 15 kg/ha] and treatment no.8 [Phosphorus 50 kg/ha + Potassium 20 kg/ha] was statistically at par with treatment no.9.

Phosphorus increases the production of plant biomass, nodule number and weight and chlorophyll content in leaf exhibited significant positive correlation with grain and straw yield. Similar results have been reported by **Prajapati *et al.* (2022).**

ECONOMICS

Gross return (INR/ha)

Gross return (112200.00 INR/ha) was found to be highest in treatment no.9 [Phosphorus 50 kg/ha + Potassium 25 kg/ha] and minimum gross return (69000.00 INR/ha) was found to be in treatment no. 1 [Phosphorus 30 kg/ha + Potassium 15 kg/ha].

Net return (INR/ha)

Net return (81025.00 INR/ha) was found to be highest in treatment no.9 [Phosphorus 50 kg/ha + Potassium 25 kg/ha] and minimum net return (38325.00 INR/ha) was found to be in treatment no. 1 [Phosphorus 30 kg/ha + Potassium 15 kg/ha].

Benefit cost ratio (B:C)

The maximum Benefit cost ratio (2.59) was recorded in treatment no.9 [Phosphorus 50 kg/ha + Potassium 25 kg/ha] which was superior to rest of all treatment combinations.

This might be attributed to higher seed and Stover yield obtained with comparatively less cost than additional income. Similar results are obtained by **Degala *et al.*, (2021).**

CONCLUSION

From the study, it is concluded that with the application of Phosphorus 50 kg/ha along with Potassium 25 kg/ha (treatment 9) in Lentil was recorded significantly Highest grain yield and benefit cost ratio in Lentil crop.

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Table 1. Effect of phosphorus and potassium on yield attributes and yield of lentil.

S. No.	Treatment combination	Seeds/pod (no.)	Pods/plant (no.)	Seed yield (kg/ha)	Stover yield (kg/ha)
1.	Phosphorus 30 kg/ha + Potassium 15 kg/ha	1.73	87.90	1471.23	2084.17
2.	Phosphorus 30 kg/ha + Potassium 20 kg/ha	1.80	88.53	1489.67	2113.03
3.	Phosphorus 30 kg/ha + Potassium 25 kg/ha	1.87	88.87	1525.07	2204.93
4.	Phosphorus 40 kg/ha + Potassium 15 kg/ha	1.93	89.23	1573.10	2356.80
5.	Phosphorus 40 kg/ha + Potassium 20 kg/ha	2.00	89.63	1634.30	2500.93
6.	Phosphorus 40 kg/ha + Potassium 25 kg/ha	2.07	89.97	1732.00	2640.40
7.	Phosphorus 50 kg/ha + Potassium 15 kg/ha	2.13	90.30	1749.40	2790.87
8.	Phosphorus 50 kg/ha + Potassium 20 kg/ha	2.20	91.43	1828.97	2938.37
9.	Phosphorus 50 kg/ha + Potassium 25 kg/ha	2.27	91.90	1847.93	2948.20
	F-Test	S	S	S	S
	SEm(±)	0.05	0.15	22.19	53.49
	CD (p = 0.05)	0.16	0.63	65.93	158.93

Table 2. Effect of phosphorus and potassium on economics of lentil.

S. No.	Treatment combination	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net returns (INR/ha)	B:C ratio (%)
1.	Phosphorus 30 kg/ha + Potassium 15 kg/ha	30675.00	69000.00	38325.00	1.24
2.	Phosphorus 30 kg/ha + Potassium 20 kg/ha	30800.00	72000.00	41200.00	1.33
3.	Phosphorus 30 kg/ha + Potassium 25 kg/ha	30925.00	77400.00	46475.00	1.50
4.	Phosphorus 40 kg/ha + Potassium 15 kg/ha	30775.00	81600.00	50825.00	1.65
5.	Phosphorus 40 kg/ha + Potassium 20 kg/ha	30900.00	89400.00	58500.00	1.89
6.	Phosphorus 40 kg/ha + Potassium 25 kg/ha	31075.00	96000.00	64925.00	2.08
7.	Phosphorus 50 kg/ha + Potassium 15 kg/ha	30875.00	105000.00	74125.00	2.40
8.	Phosphorus 50 kg/ha + Potassium 20 kg/ha	31000.00	106800.00	75800.00	2.44
9.	Phosphorus 50 kg/ha + Potassium 25 kg/ha	31175.00	112200.00	81025.00	2.59