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## **Effect of Phosphorous and Boron Levels on Growth and Yield of Lentil (*Lens culinaris* L.)**

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### **Authors' contributions**

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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### **ABSTRACT**

A field experiment was conducted during *Rabi* season (2021) at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.). The soil of experimental plot was sandy loam in texture, nearly natural in soil reaction (pH 7.1), low in organic carbon (0.28%), available Nitrogen (225 kg/ha), available Phosphorous (19.50 kg/ha) and available potassium (213.7 kg/ha). The Treatments consisted of 3 levels of Phosphorous (Phosphorous -30 kg/ha), (Phosphorous -45 kg/ha) (Phosphorous -60 kg/ha) and 3 levels of Boron (Boron -1 kg/ha), (Boron -1.5 kg/ha) and (Boron - 2 kg/ha). The experiment was laid out in Randomized Block Design with 9 treatments and replicated thrice. The results reported that significantly maximum plant height (53.50 cm), dry weight (8.26 g/plant) and a greater number of nodules (7.80) were found higher with application of treatment 60 kg/ha phosphorous + 2 kg/ha Boron. No. pods/plant (103.70), seeds/pod (2.00), test weight (24.38 g), grain yield (1837.72 kg/ha) and Stover yield (2906.16 kg/ha) were recorded in (treatment-9) that is with 60 kg/ha phosphorous + 2 kg/ha Boron.

*Keywords: Boron; growth & yield; phosphorous.*

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## 1. INTRODUCTION

“Lentil (*Lens culinaris* L.) is an important cool season grain legume crop in India, which is second major winter sown legume after chickpea. It belongs to the sub-family Papilionaceae under the family Fabaceae (Leguminosae). Lentil (*Lens culinaris* M.) Medik a name given by the German botanist Medikus in 1778” [1]. “It is locally known as Masoor. It is one of the oldest cultivated legume crops and predominantly grown in Asia which accounts for 80 percent of global area and 75% of world production. It is one of the important pulse crops of India which can adapt well to a wide range of climate and soil condition. It can tolerate frost & severe winter. In 2020, total lentil production was recorded at 6,537,581 metric tons. It has decreased upto 8.3% compared to 2017 production. But increased 13% compared with previous year; in 2019. In 2020, total lentil exports volume were stood at 5,137,412 metric tons globally, increased upto 31,6% compared to previous year; in 2019. Canada is the largest exporter of lentils in the world with 56.5% share” [2].

“Lentil is an important grain legume in Asia. It occupies an important position in this region. In India it is cultivated in area of 1.47 million ha with the production of 0.9 million tones and productivity of 675 kg/ha” [3]. “It is an important source of protein and several essential micronutrients. It synthesizes N in symbiosis with rhizobia and enriches the soil. It improves the fertility status of soil through atmospheric N fixation” [4]. “Pulse crops are generally grown in marginal and poorly fertile soils, almost exclusively under rain-fed condition without proper management practices. Among the major constraints affecting the production of pulses, lack of proper management practices” [5] “assumes importance on account of continuous depletion of micronutrients due to over mining by way of intensive cropping and continuous application of major nutrients (NPK) nitrogen, phosphorous, potassium only” [6].

“Sufficient application of phosphorus to plant, hastens the maturity and increases the rate of nodulation and pod development. It is also an important constituent of vital substances like phospholipids and phosphoprotein. Since legume is heavy feeder of phosphorus, therefore, application of phosphatic fertilizer to lentil promotes the growth, nodulation and the yield. Phosphorus also imparts hardness to shoot,

improves the quality and regulates the photosynthesis and covers other physico-biochemical process” [7-10]. “Most of the phosphorus present in the soil is unavailable to plants which are made available through the activities of efficient micro-organism like bacteria, fungi and even cyanobacteria with production of organic acid and increasing phosphatase enzyme activity” [11]. “Phosphorus is important macro elements for growth of legumes. It is the key element for successful pulse production. Phosphorus enhances the root proliferation, nodulation and nitrogen fixation in legume crops, increases dry matter production and seed yield” [12].

“Micronutrients like boron is one of the mineral nutrients required for normal plant growth. The most important functions of boron in plants are thought to be its structural role in cell wall development, cell division, seed development and stimulation or inhibition of specific metabolic pathways for sugar transport and hormone development” [13]. “Furthermore, boron deficiency causes decrease in pollen grain count, pollen germination etc. It also influences growth parameters and filling up of seeds. It is usually accepted that boron availability is decreased under dry soil conditions. Thus, boron deficiency is often associated with dry weather and low soil moisture conditions. This behaviour may be related to restricted release of boron from organic complexes which ultimately impaired ability of plants to extract B from soil due to lack of moisture in the rhizosphere. Even if B levels in soil is high, then also low soil moisture impairs transport of B to absorbing root surfaces” (Das, 2011).

The present experiment is conducted to study the “Effect of Phosphorous and Boron on growth and yield of Lentil.

## 2. MATERIALS AND METHODS

A field experiment was conducted during Rabi season of 2021-2022, at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj which is located at 25°24' 42" North latitude, 81°50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the effect of phosphorous and boron on growth and yield of Lentil. The experiment was laid out in Randomized Block Design comprising of 9 treatments which are replicated thrice. Each treatment net plot size is 3m x 3m. The treatment

are categorized as with recommended Nitrogen through Urea and potash through Muriate of Potash, in addition with Phosphorous was applied through DAP and Boron through Boric acid when applied in combinations as follows, T<sub>1</sub>: 30 kg/ha phosphorous + 1 kg/ha boron, T<sub>2</sub>: 30 kg/ha phosphorous + 1.5 kg/ha boron, T<sub>3</sub>: 30 kg/ha phosphorous + 2 kg/ha boron, T<sub>4</sub>: 45 kg/ha phosphorous + 1 kg/ha boron, T<sub>5</sub>: 45 kg/ha phosphorous + 1.5 kg/ha boron, T<sub>6</sub>: 45 kg/ha phosphorous + 2 kg/ha boron, T<sub>7</sub>: 60 kg/ha phosphorous + 1 kg/ha boron, T<sub>8</sub>: 60 kg/ha phosphorous + 1.5 kg/ha boron, T<sub>9</sub>: 60 kg/ha phosphorous + 2 kg/ha boron. The lentil crop was harvested treatment wise at harvesting maturity stage. Growth parameters viz. plant height (cm), no of nodules and dry matter accumulation g plant<sup>-1</sup> 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. Later winnowed, cleaned and grain yield per ha was computed and expressed in tonnes per hectare. After complete drying under sun for 10 days Stover yield from each net plot was recorded and expressed in kg per hectare. The data was computed and analyzed by following statistical method of Gomez and Gomez (1984).

### 3. RESULTS AND DISCUSSION

#### 3.1 Plant Height (cm)

It is evident from Table 1 that maximum plant height (53.50 cm) was recorded with application of 60 kg/ha phosphorous + 2 kg/ha boron which was significantly superior over all other treatments and treatment with application of 60 kg/ha phosphorous + 1.5 kg/ha boron (52.90 cm) is statistically at par with treatment application of 60 kg/ha phosphorous + 2 kg/ha boron. With the application of phosphorus plant height was increased. This may be due to increase in plant height may due to stimulation of biological activities in the presence of balanced supply of phosphorus. Similar results on the increased plant height with increased levels of phosphorus application have been reported by "Phosphorus encourage formation of new cells, promote plant vigour and hastens leaf development, which help in harvesting more solar energy and better utilization of nitrogen, which help towards higher growth attributes" Mir et al. [14]. Increase in plant height might be the involvement of boron in different physiological processes like enzyme activation, electron transport, chlorophyll

formation, stomatal regulation, etc. With the increase in levels of boron the plant height gradually increased, which might be attributable to greater photosynthetic activity and chlorophyll synthesis due to boron fertilization resulting into better vegetative growth. Similar results were reported by Shil et al. [15].

#### 3.2 Number of Nodules/Plant

Maximum number of nodules per plant (7.80) was recorded with application of 60 kg/ha phosphorous + 2 kg/ha boron which was significantly superior over all other treatments and treatment with application of 60 kg/ha phosphorous + 1.5 kg/ha boron (7.60) is statistically at par with treatment application of 60 kg/ha phosphorous + 2 kg/ha boron. Increase in number of nodules per plant due to increase in phosphorus application. Phosphorus is essential for cell division, root development and proliferation, nodulation and nitrogen fixation. Similar results were in Nadeem et al. [16].

#### 3.3 Dry Weight/Plant

Treatment with 60 kg/ha phosphorous + 2 kg/ha boron recorded maximum plant dry weight (8.26 g) which was significantly superior over all other treatments and treatment with application of 60 kg/ha phosphorous + 1.5 kg/ha boron (8.00 g) is statistically at par with treatment application of 60 kg/ha phosphorous + 2 kg/ha boron. The plants attained more vigour with phosphorus, due to adequate supply and availability of nitrogen, phosphorus, potassium and spacing in balanced combination, resulting in increased dry weight of the plant. The application of Phosphorus 60 kg/ha to lentil significantly increased dry matter production. Kumar et al. [17] noted the similar results. "Dry weight was increased significantly with increasing levels of Boron. As boron generally influences cell division and nitrogen absorption from the soil might enhance plant growth which reflects in terms of plant dry weight. These findings are in harmony with those obtained by" Tekale et al. [18].

#### 3.4 Yield and Yield Attributes

##### 3.4.1 Number of pods/plant

Treatment with application of 60 kg/ha phosphorous + 2 kg/ha boron was recorded maximum number of pods per plant (103.70) which was significantly superior over all other and treatment with application of 60 kg/ha

**Table 1. Effect of phosphorous and boron levels on growth parameters of lentil**

S.No	Treatments	Plant height (cm)	Nodules/plant	Dry weight (g)
1.	30 kg/ha phosphorous + 1 kg/ha boron	48.90	5.70	7.09
2.	30 kg/ha phosphorous + 1.5 kg/ha boron	49.70	6.10	7.28
3.	30 kg/ha phosphorous + 2 kg/ha boron	50.40	6.70	7.51
4.	45 kg/ha phosphorous + 1 kg/ha boron	49.90	6.20	7.44
5.	45 kg/ha phosphorous + 1.5 kg/ha boron	51.50	6.90	7.88
6.	45 kg/ha phosphorous + 2 kg/ha boron	51.80	7.10	7.89
7.	60 kg/ha phosphorous + 1 kg/ha boron	50.90	6.70	7.74
8.	60 kg/ha phosphorous + 1.5 kg/ha boron	52.90	7.60	8.00
9.	60 kg/ha phosphorous + 2 kg/ha boron	53.50	7.80	8.26
	<b>F- test</b>	S	S	S
	<b>SEm (±)</b>	0.24	0.16	0.08
	<b>CD (P 0.05)</b>	0.73	0.47	0.26

**Table 2. Effect of phosphorus and boron levels on yield attributes and yield of lentil**

S.No	Treatments	No. of pods per plant	No. of seeds per pod	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
1	30 kg/ha phosphorous + 1 kg/ha boron	91.0	1.1	19.54	1213.44	2191.35
2	30 kg/ha phosphorous + 1.5 kg/ha boron	95.0	1.2	20.57	1234.39	2285.75
3	30 kg/ha phosphorous + 2 kg/ha boron	97.2	1.4	21.17	1352.10	2451.38
4	45 kg/ha phosphorous + 1 kg/ha boron	96.1	1.4	20.86	1307.30	2381.93
5	45 kg/ha phosphorous + 1.5 kg/ha boron	100.2	1.7	22.05	1525.14	2612.75
6	45 kg/ha phosphorous + 2 kg/ha boron	101.8	1.8	23.03	1553.53	2705.48
7	60 kg/ha phosphorous + 1 kg/ha boron	99.7	1.7	21.42	1415.42	2529.88
8	60 kg/ha phosphorous + 1.5 kg/ha boron	102.9	1.9	23.35	1729.88	2835.91
9	60 kg/ha phosphorous + 2 kg/ha boron	103.7	2.0	24.38	1837.72	2906.13
	<b>F- test</b>	S	S	S	S	S
	<b>SEm (±)</b>	0.93	0.09	0.54	52.55	48.34
	<b>CD (p=0.05)</b>	2.79	0.28	1.62	157.56	144.94

phosphorous + 1.5 kg/ha boron (102.90) which was statistically at par with the treatment with application of 60 kg/ha phosphorous + 2 kg/ha boron. The numbers of seeds per pod are increased with application of phosphorus, which leads to transfer of photosynthesis accumulates from growing parts of plant to seeds and make them plump and bold and it also effects the seed size and weight. Similar findings are observed with Singh et al. [19]. The positive effect of boron may be due to key role in plant metabolism and in the synthesis of nucleic acid. Similar findings were under the conformity Kumar et al. [20].

### **3.4.2 Number of seeds/pod**

Treatment with application of 60 kg/ha phosphorous + 2 kg/ha boron was recorded maximum number of seeds per pod (2.00) which was significantly superior over all other and treatment with application of 60 kg/ha phosphorous + 1.5 kg/ha boron (1.90) and 45 kg/ha phosphorous + 2 kg/ha boron (1.80) which was statistically at par with the treatment with application of 60 kg/ha phosphorous + 2 kg/ha boron. Increase in number of pods per plant might due to availability of other nutrients which increased carbohydrate metabolism and their remobilization to reproductive parts of the plant. Phosphorus is known to encourage flowering and fruiting which might have stimulated the plants to produce more number of pods per plant and enables development of more number of seeds per pod. Similar findings were reported by Edwin-Luikham et al. [21].

### **3.5 Test Weight (g)**

Treatment with application of 60 kg/ha phosphorous + 2 kg/ha boron was recorded maximum test weight (24.38 g) which was significantly superior over all other and treatment with application of 60 kg/ha phosphorous + 1.5 kg/ha boron (23.35) and 45 kg/ha phosphorous + 2 kg/ha boron (2303 g) which was statistically at par with the treatment with application of 60 kg/ha phosphorous + 2 kg/ha boron. Increase in this attribute by foliar spray might be due to the involvement of the boron in enzyme activation, membrane integrity, chlorophyll formation, stomatal balance and starch utilization at early stages which enhanced accumulation of assimilate in the grains resulting in heavier grains. These results are in agreement with the findings of Ceyhan and Onder (2007).

### **3.6 Seed Yield (kg/ha)**

Treatment with application of 60 kg/ha phosphorous + 2 kg/ha boron was recorded maximum grain yield (1837.72 kg/ha) which was significantly superior over all other and treatment with application of 60 kg/ha phosphorous + 1.5 kg/ha boron (1729.88 kg/ha) which was statistically at par with the treatment with application of 60 kg/ha phosphorous + 2 kg/ha boron. Increase in seed yield due to translocation of assimilates to different plant parts enhanced growth and yield attributing characters as observed in number of pods and number of seeds per plant. The assimilates stored in leaves was translocated towards sink which ultimately contributed higher seed yield. Similar findings were reported by (Patil et al. 2007). Boron plays a vital role in increasing seed yield because zinc and boron takes place in many physiological process of plant such as chlorophyll formation, stomatal regulation, starch utilization which enhance seed yield. Boron is a required for many physiological processes and plant growth, also adequate nutrition is a critical for increase yields and quality of crops. These results are in confirmatory with the work of Tekale et al. [18].

### **3.7 Stover Yield (kg/ha)**

“Treatment with application of 60 kg/ha phosphorous + 2 kg/ha was recorded maximum Stover yield (2906.13 kg/ha) which was significantly superior over all other and treatment with application of 60 kg/ha phosphorous + 1.5 kg/ha (2835.91 kg/ha) which was statistically at par with the treatment with application of 60 kg/ha phosphorous + 2 kg/ha. Higher straw yield were recorded due to better growth of plant in terms of plant height, number of branches, and dry weight of plant as a result of nutrient uptake. These results were supported by” Togay et al. (2005).

## **4. CONCLUSION**

Based on the findings of the investigation it may be concluded that treatment with 60 kg/ha phosphorous + 2 kg/ha performed exceptionally in all growth and yield parameters and in obtaining maximum grain yield of lentil. Hence, 60 kg/ha phosphorous + 2 kg/ha may be more preferable and can be recommended to the farmers.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Cubero JI. Origin, domestication and evolution. In: Webb, C. and Hawtin, G.C. eds Lentils. Commonwealth Agricultural Bureau, Slough, UK. 1981;15-38.
2. Lentil Market - Growth, Trends, Covid-19 Impact, and Forecasts. Mordor Intelligence; 2022–2027.
3. Singh AK, Bhatt BP. Effects of foliar application of zinc on growth and seed yield of late-sown lentil. Indian J. Agril. Sci. 2013;83 (6):622-626.
4. Quddus MA, Naser HM, Hossain MA, Hossain MA. Effect of zinc and boron on yield and yield contributing characters of lentil in low ganges river floodplain soil at Madaripur, Bangladesh. Bangladesh J. Agril. Res. 2014;39 (4):591-603.
5. Chakraborty A. Growth and yield of lentil (*Lens culinaris* L.) as affected by Boron and Molybdenum application in lateritic soil. J. Crop and Weed. 2009;5(1):88- 91.
6. Fageria NK, Baligar C, Clark RB. Micronutrients in crop production. Adv. Agron. 2002;77:185-68.
7. AOAC. Official methods of analysis, Association of official Analytical Chemists. 15<sup>th</sup> ed. Washington, D.C, USA; 1995.
8. Das S, Pareek BL, Kumawat A, Dhikwal SR. Effect of phosphorous and biofertilizers on productivity of Chickpea (*Cicer arietinum* L.) in north western Rajasthan, India. Legume Research. 2013; 36(6):511-514.
9. Nutrition value, Copyright 2022 NutritionValue.org All rights reserved, NutritionValue.Org.
10. Patil BN, Lakkineni KC, Bhargava SC. Onto genic changes in growth and assimilate distribution as influenced by N supply in rapeseed-mustard. Journal of Agron. Crop. Sci. 1997;178:15-21.
11. Meena LR, Singh RK, Goutam RC. Effect of moisture conservation practices, P levels and bacterial inoculation on yield and economic returns under dry land conditions. Annals of Agriculture Research. 2006;23(2):284-288.
12. Sepetoglu H. Grain legumes. Department of Field Crops, Faculty of Agriculture, University of Ege Publication : 24/4, Izmir, Turkey; 2002.
13. Ahmad W, Niaz A, Kanwal S, Rahmatullah, Rashed MK. Role of boron in plant growth: a review. Journal of Agriculture Research. 2009;47(3):329-338.
14. Mir AN, Lal SB, Salmani M, Abid M, Khan I. Growth yield and nutrient content of Black gram (*Vigna mungo*) as influence by levels of phosphorous, sulphur and phosphorous solubilizing Bacteria. SAARCJ. Agri. 2013;11(1):1-6.
15. Shil NC, Noor S, Hossain MA. Effects of boron and molybdenum on the yield of chickpea. Journal of Agriculture and Rural Development. 2007;5(1&2):17-24.
16. Nadeem MA, Vikas Singh, Dubey RK, Pandey AK, Singh B, Kumar N, Sudhakar Pandey. Influence of Phosphorous and Biofertilizers on growth and yield of cowpea (*Vigna unguiculata* (L.) Walp.) in acidic soil of NEH region of India. Legume Research. 2017;3790 :1-4.
17. Kumar S, Tomar S, Tomar TS. Integrated phosphorus management in black gram (*Vigna mungo*) in western Uttar Pradesh during summer season. Annals of Agricultural Research. 2014;35(3):290-297.
18. Tekale RP, Guhey A, Agrawal K. Impact of boron, zinc and IAA on growth, drymatter accumulation and sink potential of pigeonpea (*Cajanus cajan* L.). Agriculture Science Digest. 2009;29(4):246-249.
19. Singh A, Tzudir LA, Hangsing N. Effect of spacing and levels of phosphorous on the growth and yield of Green gram (*Vigna radiata*) under rainfed condition of Nagaland. Agricultural Science Digest – A Research Journal. 2020;40(01).
20. Kumar D, Padbhusan R. Influence of soil and foliar applied Boron on Green gram calcareous soils. International Journal of Agriculture, Environment & Bio technology. 2013;7(1):129-136.

21. Edwin Luikham, Lhungdim J, Singh AI. Greengram (*Vigna radiata* L. Wilczek) OF. Legume Research. 2005;(28):59–61.  
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