Original Research Article

Effect of phosphorous and Boron levels on growth and yield of lentil (*Lens culinaris* L.)

Study of the effect of phosphorus and Boron levels on lentil (Lens culinaris L.) growth and yield.

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 N (225 kg/ha), available P (19.50 kg/ha) and available K (213.7 kg/ha). The treatments consisted of 3 levels of Phosphorous (P_1-30 kg/ha), (P_2-45 kg/ha) (P_3-60 kg/ha) and 3 levels of Boron (B_1-1 kg/ha), (B_2-1.5 kg/ha) and (B_3- 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.

Key words: *Boron, Growth Phosphorous, yield*.

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 **(Cubero, 1981).** 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 (**Lentil Market, Mordor intelligence 2022-2027**.).

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 (**Singh and Bhatt 2013**). 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 (**Quddus *et al.* 2014**). 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 (**Chakraborthy 2009**) 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) only (***Fageria et al. 2002***).

Sufficient supply 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 chickpea promotes the growth, nodulation and the yield. Phosphorus also imparts hardiness to shoot, improves the quality and regulates the photosynthesis and covers other physico- biochemical process. 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 (**Meena *et al.* 2006**). 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 (**Sepetoglu, 2002**)

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 (**Ahmed et al., 2009**). 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 the 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 of 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.

MATERIALS AND METHODS

A field experiment was conducted during k*harif* season of 2021, at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj which 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 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 × 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_1: 30 kg/ha phosphorous + 1 kg/ha boron, T_2: 30 kg/ha phosphorous + 1.5 kg/ha boron, T_3: 30 kg/ha phosphorous + 2 kg/ha boron, T_4: 45 kg/ha phosphorous + 1 kg/ha boron, T_5: 45 kg/ha phosphorous + 1.5 kg/ha boron, T_6: 45 kg/ha phosphorous + 2 kg/ha boron, T_7: 60 kg/ha phosphorous + 1 kg/ha boron, T_8: 60 kg/ha phosphorous + 1.5 kg/ha boron, T_9: 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^{-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. 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 analysed by following statistical method of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

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*. (2013).** 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.* (2007).**

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*. (2017)**.

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* (2014)** 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.* (2009).**

Yield and Yield Attributes:

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 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.* (2020).** 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*. (2013).**

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 remobilisation 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*. (2005)**.

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).**

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. Assimilates stored in leaves were translocated towards sinks, resulting in higher seed yields. Similar findings were reported by **(Patil *et al*. 2007).** Boron plays a vital role in increasing seed yield because zinc and boron takesplace 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*. (2009).**

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).**

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

S.No	Treatments	Plant height (cm)	Nodules/plant	Dry matter (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
	F- test	S	S	S
	SEm (±)	0.24	0.16	0.08
	CD (P 0.05)	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
	F- test	S	S	S	S	S
	SEm (±)	0.93	0.09	0.54	52.55	48.34
	CD (5%)	2.79	0.28	1.62	157.56	144.94