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Effect of boron and phosphorus on growth and yield of lentil

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Abstract
A field experiment was conducted on lentil.during *rabi* season of 2023-24 at Crop Research Farm Department of Agronomy. The treatment consisted of 3 levels of boron (1, 2 and 3 kg/ha) and 3 levels of phosphorus (20, 40 and 60 kg/ha) along with recommended doses of nitrogen and potash and a control (20-40-20 N-P-K/ha). The experiment was laid out in a Randomized Block Design with 10 treatment and replication thrice. The treatment details are as follows: T1: Boron 1 kg/ha + Phosphorus 20 kg/ha, T2: Boron 1 kg/ha + Phosphorus 40 kg/ha, T3: Boron 1 kg/ha + Phosphorus 60 kg/ha, T4: Boron 2 kg/ha + Phosphorus 20 kg/ha, T5: Boron 2 kg/ha + Phosphorus 40 kg/ha, T6: Boron 2 kg/ha + Phosphorus 60 kg/ha, T7: Boron 3 kg/ha + Phosphorus 20 kg/ha, T8: Boron 3 kg/ha + Phosphorus 40 kg/ha, T9: Boron 3 kg/ha + Phosphorus 60 kg/ha, T10: Control (20:40:20) NPK kg/ha. Application of boron 3 kg/ha along with phosphorus 40 kg/ha (treatment 8) recorded Highest plant height (30.40 cm), higher plant dry weight (10.43 gm), higher crop growth rate (12.05 g/m/ day) 60-80 days, maximum number of pods/plant (150.86), maximum number of seeds/plant (1.80), higher seed yield (1.92 t/ha), higher Haulm yield (3.43t/ha).

Keywords: Boron, growth, lentil, phosphorus, yield

Introduction

Lentil (*Lens culinaris* Medik.) is among the oldest domesticated crop cultivated in the world. Lentil, also known as red dhal, masur or split peas is a staple food often eaten with cereal grains (Reddy and Reddy 2010) [7]. It is an excellent source of vitamin A and provides fibre, potassium, B-vitamin and iron. It also has an important role in crop rotation and enhancing soil fertility and providing other environmental services in production systems such as promoting sustainable cereal-based production systems with a potential of fixing free nitrogen up to 107 kg/ha (Chand *et al*. 2015) [2]. Lentils are rich in carbohydrates, protein, fat, fiber, folate, thiamine, vitamins, minerals, potassium, copper, zinc, iron, and other essential nutrients and used widely in the processing sector (unhusked seeds, split cotyledon dahl, savouries etc.). Lentil is the principal legume crop in the rice fallow belts of eastern India and also taken by farmers of central India. As per fourth advanced estimate from DES, MOAF&W, Govt. of India, 2022- Uttar Pradesh is the leading lentil producing state in India (0.47 million tonnes from 0.49 ha. acreage, 36.43% of national production), followed by Madhya Pradesh (0.44 million tonnes from 0.49 million ha. acreage, 34.55% of national production), West Bengal (10.53%), Bihar (8.84%) and Jharkhand (4.50%) depending on their contribution in the national production of lentil. (IIPR, Gov.in)

There is a lot of scope for increasing its production through application of required nutrients especially boron. The demand for boron by legumes is more as compared to most of the field crops. Boron being a less mobile element in the phloem, its deficiency usually appears on young growth. Boron plays a vital role in transport of carbohydrates as well as in cell wall metabolism, permeability and stability of cell membranes and phenol metabolism, with primary role in lignin biosynthesis. Deficiency of boron restricts stomata opening and transpiratory water loss and also leads to enhanced leakage of solutes across the plasma membrane. In addition, it has an important role in improving the quality of produce (Noor *et al*. 1997) [5].

Phosphorus (P) is one of the major essential primary nutrients after nitrogen for better crop growth and development. Pulses are heavy feeders of P because it is constituent of all living organism. Especially in the early stages of plant development, adequate supply of P is required for development of the reproductive parts and has a positive effect on root growth, early maturity and reduced disease incidence. The phosphorus requirement is greater for healthy crop growth with efficient root system and profuse nodulation. Phosphorus also plays a key role in pod filling and ultimately enhances the grain yield. The nitrogen-fixing capability of legumes can be enhanced by the supply of adequate amounts of nutrients, especially phosphorus (P) and sulphur (S) (Choubey *et al.* 2013) [3].

Keeping in view of the above fact, the experiment was conducted to find out "Effect of Boron and Phosphorus on Growth and Yield of Lentil".

Materials and Methods

The experiment was conducted during rabi season of 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the field constituting a part of central gangetic alluvium is neutral and deep. The soil of the experimental field was sandy loam in texture, with soil (pH - 7.7), organic carbon (0.57%), available N (172.48 kg/ha), available P (27.01 kg/ha) and available K (291.3 kg/ha). The experiment was laid out in Randomized Block Design, with 10 treatments replicated thrice. The treatment consists of: T1: Boron 1 kg/ha + Phosphorus 20 kg/ha, T2: Boron 1 kg/ha + Phosphorus 40 kg/ha, T3: Boron 1 kg/ha + Phosphorus 60 kg/ha, T4: Boron 2 kg/ha + Phosphorus 20 kg/ha, T5: Boron 2 kg/ha + Phosphorus 40 kg/ha, T6: Boron 2 kg/ha + Phosphorus 60 kg/ha, T7: Boron 3 kg/ha + Phosphorus 20 kg/ha, T8: Boron 3 kg/ha + Phosphorus 40 kg/ha, T9: Boron 3 kg/ha + Phosphorus 60 kg/ha, T10: Control (20:40:20) NPK kg/ha. The observations were recorded for plant height (cm), plant dry weight (g), Number of pods/plant, Number of seeds/pod, Test weight (g), Seed yield (t/ha), Haulm yield (t/ha).

Results and Discussion

Growth Parameters

Plant height (cm)

Significantly higher plant height was recorded (30.35 cm) in treatment 8 (boron 3 kg/ha + Phosphorus 40 kg/ha). However, treatment 5 (Boron 2 kg/ha + phosphorus 40 kg/ha), treatment 6 (Boron 2 kg/ha + Phosphorus 60 kg/ha), treatment 7 (Boron 3 kg/ha + phosphorus 20 kg/ha) and treatment 9 (Boron 3 kg/ha + phosphorus 60 kg/ha) were statistically at par with treatment 8 (boron 3 kg/ha + Phosphorus 40 kg/ha). The significant and higher plant height was with application of phosphorus (50 kg/ha) might be due to with increased levels of P function in most of the physiological and metabolic processes resulting in increased growth and development, resulting in higher plants height. Similar result was also reported by Yumnam *et al*. (2018) [8].

Plant dry weight (g)

Significantly maximum plant height (13.15 g/plant) was recorded in treatment 8 (boron 3 kg/ha + phosphorus 40 kg/ha). However, treatment 9 (Boron 3 kg/ha + phosphorus 60 kg/ha) was statistically at par with treatment 8 (boron 3 kg/ha + Phosphorus 40 kg/ha). The application of phosphorus (50 kg/ha) being an energy bond compound and its major role is transformation of energy essential for almost allmetabolic processes photosynthesis, respiration, cell elongation and cell division, activation of amino acids for synthesis of protein and carbohydrate metabolism which ultimatelyincrease all the growth attributes and dry weight of plants Goud *et al*. (2021) [4].

Crop growth rate (g/m2/day)

During 60-80 DAS significantly higher crop growth rate (6.61 g/m^2/day) was recorded in treatment 8 (boron 3 kg/ha + phosphorus 40 kg/ha). However, treatment 9 (boron 3 kg/ha + phosphorus 60 kg/ha) was statistically at par with treatment 8 (boron 3 kg/ha + Phosphorus 40 kg/ha).

Relative growth rate (g/g/day).

During 60-80 interval DAS, no significant difference was recorded among all the treatments. Statistically highest relative growth rate was recorded in treatment 5 (boron 2 kg/ha + phosphorus 40 kg/ha).

Yield Parameters

Number of pods/plant

Treatment-8 (boron 3 kg/ha + phosphorus 40 kg/ha) recorded significantly higher number of pods/plant (150.87 However, treatment 6 (Boron 2 kg/ha + Phosphorus 60 kg/ha), treatment 7 (Boron 3 kg/ha + phosphorus 20 kg/ha), treatment 9 (Boron 3 kg/ha + phosphorus 60 kg/ha) were statistically at par with treatment 8 (boron 3 kg/ha + Phosphorus 40 kg/ha). Significant and higher numberof pods/plants was with the application of phosphorus, which it might be the reason of moderate plant nutrients availability due to which the plant produces more pods/plant as compare to other treatments and phosphorus strongly increases thereproduction of the plants *i.e*., flowering and fruiting. These results were similar with that of Abid *et al*. (2017) [1].

Number of seeds/pod

Treatment-8 (boron 3 kg/ha + phosphorus 40 kg/ha) was recorded significantly higher number of seeds/pod (1.87 However, which is statistically at par with treatment 4 (boron 2 kg/ha + phosphorus 20 kg/ha), treatment 5 (Boron 2 kg/ha + phosphorus 40 kg/ha). The significant and higher number of seed/plants was with the application of phosphorus (50 kg/ha) which may be the reason of moderate plant nutrients availability due to which the plant produces more number of seed/pod is a genetically controlled character and the difference among genotypes was due to their different genetic ability for this parameter Rahman *et al*. (2013) [6].

Test weight (g)

At harvest significantly higher test weight (23.14 g) was recorded in treatment 8 (boron 3 kg/ha + Phosphorus 40 kg/ha). However, which is statistically at par with treatment 7 (boron 3 kg/ha + phosphorus 20 kg/ha), treatment 9 (Boron 3 kg/ha + phosphorus 60 kg/ha).

Seed yield (t/ha)

Treatment-8 (boron 3 kg/ha + phosphorus 40 kg/ha) was recorded significantly higher seed yield (1.92 t/ha). However which is statistically at par with treatment 7 (boron 3 kg/ha + phosphorus 20 kg/ha), treatment 9 (boron 3 kg/ha + phosphorus 40 kg/ha). Significant and higher seed yield was with application of phosphatic fertilizer therefore provided balance nutrition to the crop which resulted in higher seed yield of lentil. Phosphorus also increased the photosynthesis and translocation of assimilates to different plant parts for enhanced growth and yield attributing characters of the crop as observed in number of pods per plant and number of seeds per pod. In the later stage, the excess assimilates stored in the leaves was translocated towards sink development which ultimately contributed to higher seed yield. These findings were supported by Choubey *et al*. (2013) [3] in lentil.

Haulm yield (t/ha)

Treatment-8 (boron 3 kg/ha + phosphorus 40 kg/ha) was recorded significantly higher haulm yield (3.43 t/ha). However which is statistically at par with treatment 7 (boron 3 kg/ha + phosphorus 20 kg/ha), treatment 9 (boron 3 kg/ha + phosphorus 40 kg/ha). Higher Stover yield was with application of phosphorus might have contributed for better growth of plant as expressed in terms of plant height, number of nodules/plants, dry weight, which improved nutrient uptake, resulted increased in stover yield. Similar findings were reported by Choubey *et al*. (2013) [3].

Harvest index (%): At harvest, no significant difference was recorded among all the treatments. Statistically highest Harvest Index was recorded in treatment 9 (boron 3 kg/ha + phosphorus 60 kg/ha).

Table 1: Effect of Boron and Phosphorus on growth attributes of lentil

	Treatment Combinations	Plant height (cm)	Plant dry weight (g)	Crop Growth Rate (g/m2/day)	Relative Growth Rate (g/g/day)
1.	Boron 1 kg/ha + Phosphorus 20 kg/ha	24.67	8.83	4.44	0.030
2.	Boron 1 kg/ha + Phosphorus 40 kg/ha	21.49	9.40	5.04	0.033
3.	Boron 1 kg/ha + Phosphorus 60 kg/ha	23.86	8.63	3.93	0.026
4.	Boron 2 kg/ha + Phosphorus 20 kg/ha	27.82	9.80	4.44	0.026
5.	Boron 2 kg/ha + Phosphorus 40 kg/ha	26.99	10.10	4.15	0.023
6.	Boron 2 kg/ha + Phosphorus 60 kg/ha	27.60	10.17	4.85	0.028
7.	Boron 3 kg/ha + Phosphorus 20 kg/ha	29.21	11.03	5.15	0.027
8.	Boron 3 kg/ha + Phosphorus 40 kg/ha	30.35	13.15	6.61	0.030
9.	Boron 3 kg/ha + Phosphorus 60 kg/ha	29.36	11.83	5.93	0.030
10.	Control RDF (20-40-20 kg/ha)	20.61	9.23	5.00	0.033
	F test	S	S	S	NS
	SEm(±)	1.77	0.41	0.44	0.002
	CD (p=0.05)	5.25	1.23	1.31	-

Table 2: Effect of Boron and Phosphorus on yield attributes at harvest of lentil

	Treatment Combinations	No. of pods/plant	No. of seeds/pod	Test weight (g)	Seed yield (t/ha)	Haulm yield (t/ha)
1.	Boron 1 kg/ha + Phosphorus 20 kg/ha	129.00	1.40	22.26	1.41	2.53
2.	Boron 1 kg/ha + Phosphorus 40 kg/ha	134.60	1.73	22.49	1.39	2.36
3.	Boron 1 kg/ha + Phosphorus 60 kg/ha	134.40	1.53	23.04	1.48	2.69
4.	Boron 2 kg/ha + Phosphorus 20 kg/ha	135.40	1.27	22.23	1.67	2.73
5.	Boron 2 kg/ha + Phosphorus 40 kg/ha	135.67	1.80	22.83	1.68	2.87
6.	Boron 2 kg/ha + Phosphorus 60 kg/ha	137.20	1.40	22.22	1.76	2.87
7.	Boron 3 kg/ha + Phosphorus 20 kg/ha	140.33	1.80	23.10	1.82	3.07
8.	Boron 3 kg/ha + Phosphorus 40 kg/ha	150.87	1.87	23.14	1.92	3.43
9.	Boron 3 kg/ha + Phosphorus 60 kg/ha	144.47	1.67	22.97	1.83	2.97
10.	Control RDF (20-40-20 kg/ha)	120.73	1.47	21.73	1.36	2.17
	F test	S	S	S	S	S
	SEm(±)	5.03	0.05	0.26	0.05	0.15
	CD (p=0.05)	14.95	0.15	0.78	0.14	0.46

Conclusion

From the results, it can be concluded that better production and economic returns in lentil were recorded with the application of 3 kg/ha + Phosphorus 40 kg/ha in treatment 8.

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