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Effect of Nitrogen, Boron and Zinc on Growth and Yield of Lentil (*Lens culinaris* L.)

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2022-23 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P.) India. To study the Response of Nitrogen, Boron and Zinc on growth and yield of Lentil. The treatments consist of nitrogen 10, 20, 30 kg/ha, boron 1.6, 0.75 kg/ha and Zinc 6.0, 3.0 kg/ha. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.8), low in organic carbon (0.35%). Results revealed that the higher plant height (38.18 cm), higher number of nodules (22.88), higher plant dry weight (19.17 g/plant), higher crop growth rate (9.79 g/m^2/day) higher number of pods/plant (117.50), higher number of seeds/pod (1.92), higher 1000 seed weight (22.02 gm), higher seed yield (16.36 q/ha) and higher stover yield (28.74 q/ha) were significantly influenced with application of Nitrogen 30 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha. Higher gross return (INR 98,160.00/ha), higher net return (INR 67,318.00/ha) and higher B:C ratio (2.18) were also recorded in treatment-9 (Nitrogen 30 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha).

***Key words :** Lentil, Nitrogen, Zinc, Boron, Growth parameters, Yield attributes and Economics.*

Introduction

Lentil is one of the world's oldest agricultural crops, hardy to drought and widely farmed. Lens is a Latin term that specifies the precise form of the seed of a cultivated legume currently known as Lens culinaris, a name given by the German botanist Cubero (1981) published Medikusin, 1787. The plant known locally as "Masoor" is a member of the Fabaceae family. Lentil is a cool-season pulse crop that is also drought resistant. It is a beneficial human food that contains a significant quantity of vegetable protein. Lentil contains 23.25% protein, 59% carbs, 1.8% oils, and 0.2% ash, respectively, as well as iron, calcium, phosphorus, and magnesium. Lentil also contains a considerable quantity of vitamin A and B (Zafar *et al.*, 2003). Furthermore, lentils, like other legumes, may fix atmospheric nitrogen via a symbiotic connection with rhizobia bacteria. Nitrogen fixation in legumes is critical for sustaining soil fertility as well as natural and agro-ecosystem production (Azam and Faroq, 2003). Food production must rise to fulfil the requirements of rising populations. Nitrogen is an essential component for improving the quality of food crops. Nitrogen deficit occurs commonly across the world; hence these materials should be included as a fertiliser. Nitrogen is required for tillering in cereals to increase grain number and weight. A reasonable amount of this fertiliser was also applied to legumes, which boosted pod number, seed number, and seed weight Dezfuli *et al.* (1999).

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"Boron is essential for cell division, pod and seed formation". "Boron deficiency reduces pollen grain count, pollen germination, and so on." It also effects growth characteristics and seed filling. Boron availability is generally thought to be reduced in dry soil conditions. Boron shortage is therefore frequently related with dry weather and low soil moisture levels. This behaviour might be the connected to limited boron release from organic complexes, which subsequently reduced plants' capacity to take B from soil due to rhizosphere moisture deficiency" Ahmad (2009). "Boron influences the absorption of N, P, and K, and its deficiency altered the optimum equilibrium of those three macronutrients." Boron's structural involvement in cell wall growth, cell division, seed development, and stimulation or inhibition of certain metabolic pathways for sugar transport and hormone generation in plants are regarded to be the most essential roles of boron in plants.

Micronutrient deficits in soil have been brought on by intensive agricultural activities as a result of the expanding human population. Especially in calcareous soils, zinc insufficiency is widespread throughout the world. According to (Shukla *et al.* 2021) 51.2 and 19.2% of soils in India were found to be low in Zn and Fe, respectively. Micronutrient deficiency in people and animals has been linked to severe repercussions of micronutrient deficiencies in soils and crops, including reduced yield and low micronutrient concentration in crops. One-third and one-fifth of the population worldwide, respectively, have Zn and Fe deficits.

Considering the facts and to bridge the research gap highlighted above, the present experiment entitled, "Effect of nitrogen, boron and zinc on growth and yield of lentil (*Lens culinaris* M.)", was conducted at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during rabi season of 2022-23.

Materials and Methods

At the Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, the experiment was carried out during Rabi of 2022–2023. which is situated 98m above mean sea level (SL) at 25.24' 42'' N latitude, 81.50' 56" E longitude. Ten treatments, each replicated three times, were used in the experiment's Randomised Block Design. Each treatment's plot was 3 m by 3 m. Three levels of nitrogen (10, 20 and 30 kg/ha), two levels of zinc (3 and 6 kg/ha) and two levels of boron (1.5 and 0.75 kg/ha) are contributing factors. At the time of sowing, N, B and Zn were supplied, and three are used as basal. On November 26, 2022, the PL-406 lentil variety was sowed with a 30 cm 10 cm spacing. Each plot's 1 m^2 was used for harvesting. And three plants were randomly chosen from it for the purpose of observing the yield and growth metrics. Here are the specifics of the treatment: Nitrogen levels- 10, 20, 30 kg/ha and level of Zinc and Boron with Control. Plant height, nodules per plant, dry weight, grain production, and stover yield were all observed and reported. By using the analysis of variance approach, the data were statistically analysed.

Results and Discussion

Growth Parameters

The significantly higher plant height (38.18 cm), number of nodules (3.66), plant dry weight (19.17 gm) and crop growth rate (10.456 $g/m^2/day$) was observed in treatment-9 (Nitrogen 30 kg/ha + Zinc– 3 kg/ha + Boron – 0.75 kg/ha). However, treatment-8 (Nitrogen 30 kg/ha + Boron 1.6 kg/ha) was statistically at par with treatment- 9 (Nitrogen 30 kg/ha + Zinc– 3 kg/ha+ Boron – 0.75 kg/ha). The application of 30 kg/ha nitrogen resulted in considerably increased plant height (38.18 cm) at harvest. It is possible that nitrogen application in the soil favoured fast growth and tissue expansion. Furthermore, the administration of zinc may result in the activation of various zinc-dependent enzymes, including carbonic anhydrase, ribulose bisphosphate carboxylase, aldolase fructose 1 to 6 bis-phosphatase, starch synthetase, and sucrose synthetase. Zinc is known to create growth hormones and tryptophan, a precursor of auxins, according to Debnath *et al.*, (2018). Furthermore, when boron levels grew, plant height steadily increased, which might be attributed to increased photosynthetic activity and Boron fertilisation increased chlorophyll production, leading in improved vegetative growth, as reported by Naik *et al.*, (2022). It might be related to the use of micronutrients like as boron and zinc. Boron, as a micronutrient, plays essential functions as a component of organic structures, a constituent or activator of enzymes, an electron transporter, and in osmoregulation. Micronutrients may also have an impact on N_2 fixation in legumes and nonlegumes at different stages of the symbiotic interaction's nodule growth and nodule function. Boron's influence on Rhizobium-legume cell-surface contact and pea nodule growth. Islam *et al.* (2018) describe similar findings. Furthermore, increasing the number of nodules with zinc helps to promote nodulation and leghemoglobin formation. Plant feeding with Zn increases the quantity of glucose flowering to the roots as well as ATP production. These findings are consistent with those of Valenciano *et al.* (2010).

Yield Attributes

The significant and higher number of pods/plant (117.50), number of seeds/pod (1.92), test weight (22.02 g), seed yield (16.36 q/ha), stover yield (28.74 q/ha) and harvest index (36.29 %) were observed in treatment-9 with (Nitrogen 30 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (Nitrogen 30 kg/ha + Boron 1.6 kg/ha), was found to be statistically at par with treatment-9 (Nitrogen 30 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha).

As a result, all of these variables may boost nutrient absorption from the soil, resulting in a direct or

Table 1. Influence of Nitrogen, Boron and Zinc on growth parameters of lentil.

S. No.	Treatment combinations	Plant height	Number of nodules/ plants	Plant Dry weight	Crop growth rate(g/ m^2/day)
1.	Nitrogen 10 kg/ha+ Zinc - 6 kg/ha	33.01	17.55	14.25	7.458
2.	Nitrogen 10 kg/ha + Boron 1.6 kg/ha	33.67	19.58	14.51	6.787
3.	Nitrogen 10 kg/ha + Zinc - 3 kg/ha+ Boron – 0.75 kg/ha	34.69	20.47	15.17	9.631
4.	Nitrogen 20 kg/ha + Zinc - 6 kg/ha	34.98	20.55	15.54	7.832
5.	Nitrogen 20 kg/ha + Boron 1.6 kg/ha	35.31	22.11	16.32	10.197
6.	Nitrogen 20 kg/ha + Zinc - 3 kg/ha+ Boron – 0.75 kg/ha	35.50	21.79	17.43	10.456
7.	Nitrogen 30 kg/ha + Zinc - 6 kg/ha	36.32	21.44	18.80	7.348
8.	Nitrogen 30 kg/ha + Boron 1.6 kg/ha	37.63	22.44	18.94	9.653
9.	Nitrogen 30 kg/ha + Zinc - 3 kg/ha+ Boron – 0.75 kg/ha	38.18	22.88	19.17	9.796
10.	Control	33.71	21.47	15.46	7.524
	F test	S	S	S	S
	S Em.(±)	0.32	0.42	0.14	0.51
	CD (p=0.05)	0.96	1.24	0.41	7.458

Table 2. Influence of Nitrogen, Boron and Zinc on yield attributes of lentil.

S. No.	Treatments	Pods/ plant	Seeds/ pod (g)	Test weight (q/ha)	Seed yield (q/ha)	Stover yield	Harvest index (%)
1.	Nitrogen 10 kg/ha+ Zinc - 6 kg/ha	80.83	1.64	18.29	8.34	20.90	28.50
2.	Nitrogen 10 kg/ha + Boron 1.6 kg/ha	83.60	1.66	19.23	8.84	20.10	30.61
3.	Nitrogen 10 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha	88.63	1.67	19.56	9.72	23.46	29.44
4.	Nitrogen 20 kg/ha + Zinc - 6 kg/ha	92.50	1.57	19.37	9.26	21.99	29.58
5.	Nitrogen 20 kg/ha + Boron 1.6 kg/ha	95.83	1.71	20.27	10.94	25.62	29.87
6.	Nitrogen 20 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha	101.60	1.82	20.45	12.45	26.74	31.73
7.	Nitrogen 30 kg/ha + Zinc - 6 kg/ha	109.63	1.76	21.03	13.38	22.72	37.06
8.	Nitrogen 30 kg/ha + Boron 1.6 kg/ha	111.50	1.87	21.71	14.96	27.33	35.41
9.	Nitrogen 30 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha	117.50	1.92	22.02	16.36	28.74	36.29
10.	Control	76.40	1.70	19.70	9.01	19.24	31.90
	F-Test	S	S	S	S	S	S
	SEm±	4.66	0.02	0.18	0.21	1.20	1.12
	CD (P=0.05)	12.52	0.07	0.54	4.30	3.55	3.32

Table 3. Influence of Nitrogen, Boron and Zinc on economics of lentil.

Treatments	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
Nitrogen 10 kg/ha+ Zinc - 6 kg/ha	30,521.00	50,040.00	19,519.00	0.64
Nitrogen 10 kg/ha + Boron 1.6 kg/ha	30,308.00	53,040.00	22,732.00	0.75
Nitrogen 10 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha	30,407.00	58,320.00	27,913.00	0.92
Nitrogen 20 kg/ha + Zinc - 6 kg/ha	30,738.00	55,560.00	24,822.00	0.81
Nitrogen 20 kg/ha + Boron 1.6 kg/ha	30,525.00	65,640.00	35,115.00	1.15
Nitrogen 20 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha	30,624.00	74,700.00	44,076.00	1.44
Nitrogen 30 kg/ha + Zinc - 6 kg/ha	30,956.00	80,280.00	49,324.00	1.59
Nitrogen 30 kg/ha + Boron 1.6 kg/ha	30,743.00	89,760.00	59,017.00	1.92
Nitrogen 30 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha	30,842.00	98,160.00	67,318.00	2.18
Control	30,106.00	54,080.00	23,974.00	0.80

*Data was not subjected to the statistical analysis

indirect increase in the total number of pods/plant. These findings were consistent with those of Tojammel Haq and Ahmed (2022). Increase the quantity of pods/plant by applying boron (2kg/ha), which aids in the production of flowers and pollen grains. Similar outcomes were found in accordance with Padbhushan and Kumar (2014). Significantly increased seed yield was obtained with nitrogen treatment, which may have improved in several yield contributing characteristics due to the higher nitrogen content. These findings are consistent with those of Fatima *et al.,* (2013). Increase in these characteristics attributed to zinc's early participation in enzyme activation, membrane integrity, chlorophyll creation, stomatal balancing, and starch utilisation, which increased assimilate accumulation in the grains, resulting in heavier grains. These findings are consistent with those of Krishna *et al.,* (2022). Boron treatment may result in further increases in seed production. It is essential for improving seed output since zinc and boron are involved in numerous physiological processes in plants such as chlorophyll generation, stomatal control, and starch formation. as well as starch utilisation, which increases seed output. Boron is essential for various physiological processes and plant growth; also, appropriate nutrition is crucial for increasing crop yields and quality. These findings corroborate the study of Myageri and Dawson (2021).

Economic Analysis

Economics

The result revealed that Maximum gross return (98,160.00 INR/ha), net return (67,318.00 INR/ha) and benefit-cost ratio (2.18) was recorded in treatment-9 [Nitrogen 30 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha] as compared to other treatments (Table 3). Higher gross Return, net return and benefit cost ratio was recorded with the application of [Nitrogen 30 kg/ha + Zinc - 3 kg/ha + Boron – 0.75 kg/ha] it might be due to the higher growth and yield attributes resulting in more seed and stover yield with the recommended dose of Nitrogen, Boron and Zinc.

Conclusion

Based on the aforementioned results, it can be stated that boron 0.75 kg/ha and zinc 3 kg/ha, combined with Nitrogen applied at a rate of 30 kg per hectare, have improved growth metrics and yield characteristics while also being economically viable. Additional tests are required to corroborate the findings because they are based only on one season.

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