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Effect of sulphur and boron on growth and yield of lentil (*Lens culinaris* Medik)

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Abstract
Lentil (*Lens culinaris* Medik) are farmed as an important pulse crop. The purpose of this study was to evaluate how boron and sulphur affected the growth and yield of lentils. A randomized complete block design with three replications was used in a field investigation. Different combinations of sulphur (10 kg/ha, 20 kg/ha, and 30 kg/ha) and boron (1.5 kg/ha, 2 kg/ha, and 2.5 kg/ha) levels were used in the treatments. The results showed that the growth and yield parameters of lentils were considerably impacted by the application of boron and sulphur. Significant improvements were seen in plant height, nodule count per plant, plant dry weight, pod count per plant, seed count per pod, seed weight, seed yield, and stover yield with the application of 30 kg/ha of sulphur and 2.5 kg/ha of boron (Treatment 9). These findings imply that applying sulphur and boron together can improve the development and output of lentils, increasing productivity and providing farmers with financial advantages. Treatment 9 produced the following specific results: plant height of 28.15 cm, 29.67 nodules per plant, plant dry weight of 14.19 g/plant, 142.60 pods per plant, 2.07 seeds per pod, 23.57 g for 1000 seeds, 2.08 t/ha for seed, and 3.16 t/ha for stover.

Keywords: Boron, lentil, sulphur, growth and yield

Introduction

Lentil known by its common name, Masoor, lentil (*Lens culinaris* or *Lens esculenta*) is an edible legume that is distinguished by its lens-shaped seeds. The plant is an annual species that grows to a height of 40 cm (16 inches). It produces pods that typically hold two seeds apiece. The two biggest producers, Canada and India, account for 33% and 25% of the world total correspondingly, making up the global production. Potassium, copper, zinc, iron, fiber, protein, fat, folate, thiamine, and other vital nutrients are all abundant in lentils, making them a nutrient-dense superfood. They are extensively used in the processing industry for many different savory cuisines, split cotyledon dal, and unhusked seeds.

India accounts for 18% of the world's total 6.5 million tonnes of lentil production. Lentils are grown on around 1.42 million hectares in India, producing 1.28 million tonnes at a productivity of about 904 kg/ha on average. With 0.49 million hectares (34.87% of India's total lentil area) and 0.47 million tonnes (36.46% of India's total production), Uttar Pradesh contributes significantly and has a productivity of 944 kg/ha (Agricultural Statistics at a Glance, 2022) [3].

Sulphur is essential for plant growth and is only marginally less significant than phosphorus. It is frequently referred to as the fourth key nutrient after nitrogen, phosphorus, and potassium. In addition to being a necessary amino acid, sulphur is also important for the metabolism of proteins, lipids, and carbohydrates. It aids in the synthesis of chloroplast protein, which raises yield by improving photosynthetic efficiency. According to Sharma and Singh (2004) [24], sulphur is necessary for the production of amino acids that include sulphur, such as cystine, cysteine, and methionine, and is involved in a number of enzymatic and metabolic activities in plants. Furthermore, it is essential for the synthesis of co-enzymes, volatile chemicals, and vitamins (thiamine and biotin), which encourages nodulation in legumes. Application of sulphur not only increases crop output but also improves quality, increasing the amount of protein and oil, the nutritional value of fodder, and the amount of starch in tubers. By promoting nodule development, it promotes the generation of seeds, growth, and nitrogen fixation in addition to helping to produce chlorophyll.

Boron shortage usually appears 5–6 weeks after sowing and is common in lentil crops. According to Chaney (1993) [4], symptoms include green mature leaves that turn yellowish-white and eventually brown, leaf drop in extreme cases, reduced growth, and poor pod development. According to Ahmad *et al*. (2009) [25], boron controls the concentration of auxin and aids in the production of proteins, chlorophyll, and other essential substances. During the reproductive phase, it is essential, particularly during fertilization, and pollen grains contain significant quantities of it. During fertilization, the majority of boron is directed toward seeds (Jenik PD, Kathryn BM, 2014) [9]. A lack of boiron inhibits the synthesis of proteins, ribosomal stability, and enzyme activity, all of which are factors in the growth and development of plants. This deficit can result in limited seed set, ovule deformity, and sterility in flowers and ultimately yield reduction.

Material and Methods

During the Rabi season of 2023–2024, the research was carried out at the Crop Research Farm of the Department of Agronomy at Sam Higginbottom University of Agriculture, Science and Technology (SHUATS), Naini, Prayagraj, Uttar Pradesh. The treatments were as follows: T_1: 10 kg/ha of sulphur + 1.5 kg/ha of boron; T_2: 10 kg/ha of sulphur + 2 kg/ha; T_3: 10 kg/ha of sulphur + 2.5 kg/ha; T_4: 20 kg/ha of sulphur + 1.5 kg/ha; T_5: 20 kg/ha of sulphur + 2 kg/ha; T_6: 2.5 kg/ha of boron and 20 kg/ha of sulphur T_7: 30 kg/ha of sulphur plus 1.5 kg/ha of boron; T_8: 30 kg/ha of sulphur plus 2 kg/ha; T_9: 30 kg/ha of sulphur plus 2.5 kg/ha of boron; and a Control Plot with 20:40:20 NPK kg/ha. Ten treatments, each replicated three times, were used in the experiment, which was set up using a randomised block design. Plant height, the quantity of nodules per plant, the dry weight of the plant, the crop growth rate, the relative growth rate, the number of pods per plant, the number of seeds per pod, the weight of the seeds, the yield of the stover, and the harvest index were among the parameters that were observed. The analysis of variance (ANOVA) method was then applied to the acquired data.

Results and Discussion

1. **Plant Height:** At harvest, the treatments showed significant differences. The tallest plants, measuring 28.15 cm, were found in treatment T_9 (Sulphur 30 kg/ha + Boron 2.5 kg/ha). Treatment T_8 (Sulphur 30 kg/ha + Boron 2 kg/ha) had a similar plant height, statistically comparable to T_9. The shortest plants, with a height of 23.74 cm, were observed in the control plot.
2. **Plant dry weight:** At harvest, significant differences in plant dry weight were observed among the treatments. The highest plant dry weight, 14.19 g, was recorded in treatment T_9 (Sulphur 30 kg/ha + Boron 2.5 kg/ha). Treatment T_8 (Sulphur 30 kg/ha + Boron 2 kg/ha) was statistically similar to T_9. The lowest plant dry weight, 10.83 g, was found in the control plot.
3. **Nodules per plant:** At harvest, significant differences in the number of nodules were observed among the treatments. The highest number of nodules, 29.67, was recorded in treatment 9 (Sulphur 30 kg/ha + Boron 2.5 kg/ha). Treatment 8 (Sulphur 30 kg/ha + Boron 2 kg/ha) had a statistically comparable number of nodules to treatment 9. The lowest number of nodules, 25.73, was found in the control plot.
4. **Pods per plant:** The significant and higher number of pods/plant (142.60) was recorded in treatment-9 with (Sulphur 30 kg/ha + Boron 2.5kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 30 kg/ha+ Boron 2 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 30 kg/ha+ Boron 2.5kg/ha).
5. **Seeds per pod:** The significant and higher number of seeds/pod (2.07) was recorded in treatment-9 with (Sulphur 30 kg/ha + Boron 2.5kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 30 kg/ha+ Boron 2 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 30 kg/ha+ Boron 2.5kg/ha).
6. **Test weight:** The significant and higher test weight (23.57 gm) was recorded in treatment-9 with (Sulphur 30 kg/ha + Boron 2.5kg/ha), which was significantly superior over rest of thetreatments. However, treatment-8 (Sulphur 30 kg/ha+ Boron 2 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 30 kg/ha+ Boron 2.5kg/ha).
7. **Seed yield:** The significant and higher seed yield (2.32 t/ha) was recorded in treatment-9 with (Sulphur 30 kg/ha + Boron 2.5kg/ha), which was significantly superior over rest of the Treatments. However, treatment-8 (Sulphur 30 kg/ha+ Boron 2 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 30 kg/ha+ Boron 2.5kg/ha).

Stover yield: The significant and higher stover yield (3.16 t/ha) was recorded in Treatment-9 with (Sulphur 30 kg/ha + Boron 2.5kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 30 kg/ha+ Boron 2 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 30 kg/ha+ Boron 2.5kg/ha).

Table 1: Influence of Sulphur and Boron on growth and yield attributes of lentil

S. No.	Treatments	Plant height (cm)	Dry weight (g)	Nodules/ plant	Pods/ plant	Seeds/ pod	Test weight	Seed yield	Stover yield
1.	Sulphur 10 kg/ha+ Boron 1.5kg/ha	23.92	10.60	26.07	130.73	1.40	22.06	1.35	2.45
2.	Sulphur 10 kg/ha + Boron 2 kg/ha	23.97	11.61	25.80	129.80	1.47	22.73	1.44	2.38
3.	Sulphur 10 kg/ha + Boron 2.5kg/ha	24.88	12.42	27.33	131.53	1.53	23.09	1.55	2.60
4.	Sulphur 20 kg/ha + Boron 1.5kg/ha	26.24	12.33	27.73	133.53	1.67	22.86	1.70	2.72
5.	Sulphur 20 kg/ha + Boron 2 kg/ha	24.79	12.44	28.20	136.80	1.73	23.06	1.82	2.81
6.	Sulphur 20 kg/ha + Boron 2.5kg/ha	25.70	12.80	28.73	138.20	1.80	23.19	1.93	2.87
7.	Sulphur 30 kg/ha + Boron 1.5kg/ha	26.89	12.95	28.97	139.53	1.93	23.17	2.09	2.99
8.	Sulphur 30 kg/ha + Boron 2 kg/ha	27.70	13.27	29.07	140.87	2.00	23.22	2.18	3.06
9.	Sulphur 30 kg/ha + Boron 2.5kg/ha	28.15	14.19	29.67	142.60	2.07	23.57	2.32	3.16
10.	Control (RDF) - 20:40:20 kg/ha	23.74	10.86	25.73	128.67	1.27	21.95	1.19	2.24
	F - test	S	S	S	S	S	S	S	S
	S.Em (±)	0.78	0.55	0.78	0.75	0.07	0.83	0.23	0.15
	CD (p=0.05)	2.31	1.64	2.32	2.22	0.19	0.28	0.08	0.05

Conclusion

In conclusion, the study revealed notable differences in various growth and yield parameters across the treatments. The application of Sulphur at 30 kg/ha combined with Boron at 2.5 kg/ha (Treatment 9) led to significantly improved plant height, dry weight, number of nodules per plant, number of pods per plant, number of seeds per pod, test weight, seed yield, and stover yield compared to other treatments, including the control. These results indicate that using Sulphur and Boron enhances plant growth, nutrient absorption, and seed yield. The observed improvements in growth and yield are likely due to the beneficial nutritional effects of these treatments. This study supports previous research and underscores the value of adopting advanced agricultural practices to boost crop productivity.

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