INFLUENCE OF SULPHUR AND ZINC ON YIELD AND ECONOMICS OF LENTIL (*Lens culinaris* L.)

Abstract

At the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj (U.P.), India, a field experiment was carried out during *Rabi* season of 2022. To study how zinc and sulphur affect lentil growth and output. Sulphur (20, 30, 40 kg/ha) and zinc (5, 6, 7 kg/ha) make up the treatments. 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 in yield attributes *viz.* number of pods/plant (148.77), maximum number of seeds/pod (1.80), 1000 seed weight (25.27 g), maximum seed yield (1.78 t/ha), stover yield (3.05 t/ha) and economics *viz.* Higher gross returns (INR 1,06,980/ha), net returns (INR 74,445/ha) and B:C ratio (2.29) were also recorded in treatment-9 (Sulphur 40 kg/ha + Zinc 7.0 kg/ha).

Keywords: Lentil, Zinc, Sulphur, Yield attributes, Yield and Economics.

Introduction

The Indian lentil, or "masoor," also known as *Lens culinaris* L., possesses all the necessary characteristics to become the meal of the future. Customers are very interested in the nutritional value of lentils because they are more concerned than ever with their health and wellness.

The nitrogen-fixing, drought-resistant lentil is a wonderfully cheap, delectable, and healthful meal. Because they work with soil microbes and need little water, lentils contribute to bettering soil quality. Healthy soil has the potential to keep carbon out of the atmosphere. where it accumulates heat and quickens the warming process. In systems of cereal-based cropping, lentil is particularly essential due to its high capacity for fixing nitrogen, which results in the addition of 32.8 kg/ha of nitrogen and 4-5 t/ha of organic matter to the soil. 100 g of dried lentil seeds have the following nutritional characteristics and include between 22.0 and 34.6 percent protein.

340–346 kcal, 20.2 g protein, 0.6 g fat, 65.0 g total carbs, around 4 g fibre, 2.1 g ash, 68 mg Ca, 325 mg P, and 7 mg Fe. Furthermore, because of its high lysine and tryptophan content, it provides a balance in amino acid uptake when consumed with wheat or rice, as these amino acids are scarce in cereals **(Deep et al., 2022).**

After nitrogen, phosphorus, and potassium, sulphur is the fourth most important nutrient for plants. Sulphur has a range of roles in plant growth, including influencing several physiological processes, a plant's capacity to endure abiotic stress, and acting as a structural component of large macromolecules. Agriculture has not given sulphur much attention even though it's been known for a while to be a crucial part of nutrition.

As food, fibre, and energy production are intensified to support the expanding human population, a severe problem with Sulphur has just come to light. Additionally, animal output is rising. Sulphur can assist in supplying the rising demand for premium pulse and oilseed crops. Sulphur is a crucial component in raising the calibre of oilseed crop oil extraction. Protein, vitamin, and chlorophyll production are all facilitated by Sulphur. All live cells require Sulphur because it contains 21 amino acids that are important for the synthesis of protein.

The production of food, fibre, and energy is being increased to meet the growing human population, but a serious sulphur problem has just been discovered. Animal production is also increasing. The increased demand for premium pulse and oilseed crops can be met with the help of sulphur. Enhancing the quality of oilseed crop oil extraction requires the use of sulphur. Sulphur promotes the synthesis of proteins, vitamins, and chlorophyll. Because it comprises 21 essential amino acids for the formation of protein, sulphur is necessary for all living organisms. Pulses are particularly susceptible to sulphur deficiency, which lowers yields and quality. Sulphur is only consumed by plants in the form of sulphate (SO42-), which breaks down into sulphate. Sulphur usage enhances nitrogen utilisation. Deficiency in sulphur has a big effect on how well N, P, and K work. In addition to the permitted dosage, the application of 30 and 40 kg S/ha-1 was demonstrated to be effective in pulses. The Role of Sulphur Nutrition in Increasing Oilseed and Pulse Productivity.

For people, animals, and plants, zinc is an essential micronutrient. Numerous enzymes that catalyse various metabolic processes in plants depend on Zn as an essential component. Zinc helps raise the quantities of antioxidant enzymes and chlorophyll in plant tissues, in addition to supporting photosynthesis, cell membrane integrity, protein synthesis, pollen production, and plant immunity against disease.

In **2015, Hussain** Fe and Zn deficiency affects more than 3 billion people globally, with the ailment being especially prevalent in regions where most of the population relies significantly on a diet primarily composed of cereal-based foods. Zinc deficiency has an impact on humans in addition to slowing down plant development and productivity. **2013 Hafeez** Currently, there is a serious Zn deficit in over half of the world's population. The crop's low Zn content and cultivation in Zn-deficient soils are what are really to blame for this.Nearly 50% of India's soils are deficient in zinc, making it the most important nutritional problem affecting the majority of the country's agricultural output. The current study, **"Influence of Sulphur and Zinc on Growth and Yield of Lentil (Lens culinaris L.),"** was carried out at the Crop Research Farm of the Department of Agronomy at the Naini Agriculture Institute of the Sam Higginbottom University of Agriculture Technology and Sciences in Prayagraj, Uttar Pradesh, during the rabi season of 2022–2023.

Materials & Methods

The experiment was conducted at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, during Rabi 2022. which has 98 m of elevation above mean sea level (SL) and is situated at 25.24' 42'' N latitude, 81.50' 56'' E longitude. The experiment was carried out in randomised block design with 10 treatments and each replicated thrice. Each treatment's plot was 3m x 3m. Three Sulphur levels (20, 30 and 40 kg/ha) and three Zinc values (5, 6 and 7 kg/ha) are factors. However, seeds were sown, S and Z were supplied, and both were used as the basal layer. On November 26, 2022, the PL-406 type of lentils was sowed with a 30 cm 10 cm spacing. Each plot was used for 1m2 of the harvest. And three plants at random were chosen from it to record the production and growth parameters. The specifics of the therapy are as follows:

T1 -(Sulphur 20 kg/ha + Zinc 5 kg/ha), T2 -(Sulphur 20 kg/ha + Zinc 6 kg/ha), T3 – (Sulphur 20 kg/ha + Zinc 7 kg/ha), T4 -(Sulphur 30 kg/ha + Zinc 5 kg/ha), T5 -(Sulphur 30 kg/ha + Zinc 6 kg/ha), T6 -(Sulphur 30 kg/ha + Zinc 7 kg/ha), T7 -(Sulphur 40 kg/ha + Zinc 5 kg/ha), T8 -(Sulphur 40 kg/ha + Zinc 6 kg/ha), T9 -(Sulphur 40 kg/ha + Zinc kg/ha), T10-(N 20 Kg/ha + P 40 kg/ha +k 20 kg/ha) Control. Number of pods/plant, number of seeds/pod, 1000 seed weight grain production, and stover yield were all observed and reported. By using the analysis of variance approach, the data were statistically analysed **(Gomez and Gomez, 1976).**

RESULTS & DISCUSSION

YIELD ATTRIBUTES:

Number of pods/plant-Treatment 9 with (Sulphur 40 kg/ha + Zinc 7 kg/ha) recorded highest and significantly more pods per plant (148.77), and it was significantly better than the other treatments. Treatment 8 (Sulphur 40 kg/ha + Zinc 6 kg/ha), however, was discovered to be statistically equivalent to Treatment 9 (Sulphur 40 kg/ha + Zinc 7 kg/ha). When zinc and sulphur were applied, a considerable and larger number of pods per plant (148.77) were observed. In order to produce more pods per plant, the plants may have benefited from enhanced sulphur availability and a nutrient-friendly environment during their peak growth and blooming stages **(Mourya et al., 2021)**. Increased pod production per plant may also be a result of zinc application. Zinc plays a bigger part in the formation of auxin and indole acetic acid, which promotes enhanced plant development and more pods per plant, according to **Upadhyay (2016).**

Number of seeds/pod-Treatment 9 with (Sulphur 40 kg/ha + Zinc 7 kg/ha) had a considerably higher number of seeds per pod (1.80), outperforming the other treatments. Treatment 8 (Sulphur 40 kg/ha + Zinc 6 kg/ha) was discovered to be statistically equivalent to Treatment 9 (Sulphur 40 kg/ha + Zinc 7 kg/ha). With the application of sulphur, the number of seeds per pod increased. This caused a movement of photosynthates from the plant's growth portions to the seeds, giving them a plump and bold appearance. It also affected the size and weight of the seeds. These results were close with **Choubey et al., 2013,** and with the application of zinc has also significant improvement was observed might be due to Zinc improved translocation of photosynthates towards reproductive system and thereby enhancing the yield of the crop. Better photosynthetic activity also may have resulted in better translocation of photosynthates from source to sink due to less crop competition between the plants which might have led to higher yield attributes. These finding are like those reported by **Reddy and Ahlawat (1996).**

Test weight (gm)-Treatment 9 with (Sulphur 40 kg/ha + Zinc 7 kg/ha) had a much higher Test weight (25.27 gm), and it outperformed the other treatments by a significant margin. Treatment 8 (Sulphur 40 kg/ha + Zinc 6 kg/ha), however, was discovered to be statistically equivalent to Treatment 9 (Sulphur 40 kg/ha + Zinc 7 kg/ha).

The use of sulphur greatly enhanced the test weight over the control by up to 40 kg S ha-1. This improvement in the characteristics related to development and yield may have resulted from the soil's physical state being improved and its pH being lowered, which was slightly on the upper side **(Choudhary and Das 1996)**. The outcomes thus obtained are corroborated by those of Deo and **Khaldelwal (2009).**

Seed Yield(t/ha)- Treatment 9 with (Sulphur 40 kg/ha + Zinc 7 kg/ha), which was much better than the other treatments, had a significant and higher seed production (1.78 t/ha). Treatment 8 (sulphur 40 kg/ha plus zinc 6 kg/ha) was discovered to be statistically equivalent to Treatment 9 (sulphur 40 kg/ha plus zinc 7 kg/ha). Sulphur and zinc may have a synergistic effect because they efficiently use large amounts of nutrients through their well-developed nodules and roof systems, which may have led to better plant growth and yields despite the initial low levels of Sulphur and Zinc availability in the experimental soil. Lentil seed yield is a function of test weight, number of pods per plant, and number of seeds per pod. The number of seeds produced by a lentil plant grew as the number of pods and seeds per pod increased. **Teja et al.., (2021)** findings and similar results agree. Increase in these characteristics is brought about by zinc's role in early stages of starch utilisation, enzyme activation, membrane integrity, chlorophyll production, and stomatal balancing, which increased assimilate accumulation in the grains and led to heavier grains. These outcomes support the conclusions made by **Krishna et al. in 2022**.

Stover Yield (t/ha)- Treatment 9 with (Sulphur 40 kg/ha + Zinc 7 kg/ha) showed a considerable and greater stover yield (3.05 t/ha), which was superior to the other treatments. Treatment 8 (sulphur 40 kg/ha plus zinc 6 kg/ha) was discovered to be statistically equivalent to Treatment 9 (sulphur 40 kg/ha plus zinc 7 kg/ha). Its poor availability in test soils may be the cause of the rise in straw production brought on by sulphur application. The synergistic impact of S may be brought about by the efficient utilisation of huge amounts of nutrients by roots that had grown deeply into the soil, which may have improved plant growth and final production despite the initial low availability of sulphur in the experimental soil. **Sahay et al. (2015)** observed similar findings.

Harvest Index (%) - Treatment-8 with (Sulphur 40 kg/ha + Zinc 6 kg/ha) was much better than the other treatments, as evidenced by the significant and higher Harvest Index (37.17%) that was recorded. Treatment 9 (Sulphur 40 kg/ha + Zinc 7 kg/ha), however, was discovered to be kg/ha of sulphur resulted in a considerable and increased Harvest Index (37.17%). Due to improved photosynthetic transfer from growth portions to storage parts, the harvest index has increased, increasing the plant's economic yield. **Shukla et al. (2014) and Chaubey et al. (2019)** both support these findings.

ECONOMIC ANALYSIS:

Gross Returns

The treatment with the highest gross returns (1,06,980 INR/ha) was recorded in treatment 9 (sulphur 40 kg/ha + zinc 7 kg/ha).

Net returns

In comparison to other treatments, treatment 9 (Sulphur 40 kg/ha + Zinc 7 kg/ha) was observes to have the highest net returns (74,445 INR/ha).

Benefit cost ratio

Comparing treatments, it was discovered that treatment-9 with (Sulphur 40 kg/ha + Zinc 7 kg/ha) had the highest benefit-cost ratio (2.29) of all.

CONCLUSION:

It is concluded that with the application of Sulphur 40 kg/ha along with Zinc 7.0 kg/ha (Treatment-9), has performs positively and improves growth and yield parameters.

ACKNOWLEDGEMENT:

I express my gratitude to my advisor Dr. Rajesh Singh for constant support, guidance and for his valuable suggestions for improving the quality of this research wok and to all the faculty members of Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj -211007, Uttar Pradesh. For providing us necessary facilities to undertake the studies.

Table 1. Influence of Sulphur and Zinc on yield attributes of lentil.

Sr. No.	Treatments	Pods/plant	Seeds/pod	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1.	Sulphur 20 kg/ha + Zinc 5kg/ha	106.83	1.29	21.97	1.29	2.55	33.64
2.	Sulphur 20 kg/ha + Zinc 6kg/ha	111.27	1.35	22.18	1.34	2.66	33.56
3.	Sulphur 20 kg/ha + Zinc 7kg/ha	117.30	1.50	23.12	1.42	2.72	34.27
4.	Sulphur 30 kg/ha + Zinc 5kg/ha	121.17	1.53	22.18	1.46	2.72	34.96
5.	Sulphur 30 kg/ha + Zinc 6kg/ha	125.54	1.61	22.71	1.55	2.80	35.70
6.	Sulphur 30 kg/ha + Zinc 7kg/ha	131.60	1.67	24.18	1.64	2.82	36.75
7.	Sulphur 40 kg/ha + Zinc 5kg/ha	136.83	1.64	23.00	1.57	2.69	36.79
8.	Sulphur 40 kg/ha + Zinc 6kg/ha	142.54	1.72	24.21	1.68	2.84	37.17
9.	Sulphur 40 kg/ha + Zinc 7kg/ha	148.77	1.80	25.27	1.78	3.05	36.95
10.	Control (N.P.K 20-40-20 kg/ha)	118.73	1.38	20.63	1.26	2.70	31.87
	F-Test	**S**	**S**	**S**	**S**	**S**	**S**
	SEm(±)	2.19	0.04	0.69	0.03	0.05	0.67
	CD (p=0.05)	6.50	0.11	2.05	0.10	0.15	1.98

Table 2. Influence of Sulphur and Zinc on economic analysis of lentil.

Treatments	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C Ratio
Sulphur 20 kg/ha + Zinc 5kg/ha	31374.72	77580	46205.28	1.47
Sulphur 20 kg/ha + Zinc 6kg/ha	31524.72	80580	49055.28	1.56
Sulphur 20 kg/ha + Zinc 7kg/ha	31674.72	85200	53525.28	1.69
Sulphur 30 kg/ha + Zinc 5kg/ha	31804.82	87600	55795.18	1.75
Sulphur 30 kg/ha + Zinc 6kg/ha	31954.82	93180	61225.18	1.92
Sulphur 30 kg/ha + Zinc 7kg/ha	32104.82	98160	66055.18	2.06
Sulphur 40 kg/ha + Zinc 5kg/ha	32234.93	93960	61725.07	1.91
Sulphur 40 kg/ha + Zinc 6kg/ha	32384.93	100800	68415.07	2.11
Sulphur 40 kg/ha + Zinc 7kg/ha	32534.93	106980	74445.07	2.29
Control (N.P.K 20-40-20 kg/ha)	29914.5	75960	46045.5	1.54

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