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Influence of Sulphur and Foliar Application of Iron on Growth and Yield of Lentil (*Lens culinaris* L.)

Doney Pragna [a++*], Rajesh Singh [a#] and Thakur Indu [a†]

[a] Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Lentil (*Lens culinaris* L.) is typically cultivated in marginal soil with low fertility status. It is an important rabi season pulse crop in North India. The crop responds well to exogenous application of Sulphur and Iron. Considering the above, a field experiment was conducted during *Rabi* 2022 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 influence of Sulphur and foliar application of Iron on Growth and Yield of Lentil. The experiment was laid out in Randomized Block Design comprising of two factors *viz*., Sulphur (20, 30, 40 kg/ha), Iron (control, 0.3%, 0.5%) and Control (20-40-20 NPK kg/ha). There were 10 treatments each replicated thrice. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.9), organic carbon (0.112%), available N (278.93 kg/ha), available P (10.8 kg/ha), and available K (206.4 kg/ha). Application of Sulphur and foliar application of Iron significantly influenced the growth parameters, yield attributes and yield over control. Results revealed that at 60DAS the higher plant

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[++] *M.Sc Scholar;*
[#] *Associate Professor;*
[†] *Ph.D Scholar;*
**Corresponding author: E-mail: dpragna342@gmail.com;*

height (26.5 cm), more number of nodules per plant (26.7), maximum plant dry weight (7.31 g/plant), maximum crop growth rate (9.88 g/m^2/day), more no of pods per plant (162.40), more no of seeds per pod (2.53), higher seed yield (1556.19 kg/ha) and higher stover yield (2868.3 kg/ha) were recorded with application of Sulphur 40 kg/ha + Iron 0.5% in lentil.

Keywords: Lentil; sulphur; iron; growth parameters; yield attributes and yield.

1. INTRODUCTION

Lentil (*Lens culinaris* L.), a significant annual leguminous crop known for its lens shaped seeds and is referred to as "*Masoor*" locally. It belongs to Leguminosae family. It is grown for grains, throughout northern and central India. Whole or dehulled grains are also used in preparations of dal [1]. It is also used in bakeries and in other foods for softness. Vegetable protein makes up a sizable portion of the average human diet. Lentils contain protein, carbohydrates, oils and ash at the rate of 23.25%, 59%, 1.8% and 0.2% respectively along with magnesium, calcium, phosphorus, iron. Lentil additionally contains a substantial amount of vitamins A and B [2]. The majority of the world's output of food crops—64% of the total—comes from Canada and India. In fact, India was the world's top producer of lentils until Canada recently overtook it, dropping India to second. The country's average area planted with lentils was 14.24 lakh ha, and it produced 12.17 lakh tonnes at an average productivity of 855 kg/ha.

Sulphur significantly affects the production of pulse-specific protein, which is primarily stored in globulins and is a component of some amino acids, including methionine, cystein, and cystine, and it encourages nodulation in legume crops [3]. Sulphur is an enzyme activator, a vital component for boosting the yield of legume crops, and a constituent of several vitamins like vitamin A, biotin, and thiamine. Additionally, S plays a crucial role in the synthesis of chlorophyll and the activation of enzymes [4,5]. According to Chaudhary et al. [6], sulphur is related to crop production for higher nutritional and market grade products.

Because it is crucial for metabolic processes like DNA synthesis, respiration, and photosynthesis, iron is an important micronutrient. It typically contributes to the synthesis of chlorophyll and maintaining of chloroplast structure. According to Kerkeb and Conolly [7], Iron (Fe) is involved in the breakdown of hormones as well as other chemical processes occurring in plants. According to Rout and Sahoo [8], Iron (Fe) is crucial for a variety of plant biochemical pathways. It aids in the activation of plant enzymatic processes such the formation of ferredoxin, nitrogenase, and haemoglobin.

Keeping in view the above facts, the present experiment was undertaken to find out "Influence of Sulphur and Foliar application of Iron on Growth and Yield of Lentil (*Lens culinaris* L.)".

2. MATERIALS AND METHODS

A field experiment was conducted during *Rabi* season 2022 at the Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, SHUATS, Prayagraj (U.P.), India. The farm is located at 25.57° N latitude, 87.19° E longitude and at an altitude of 98m above mean sea level. The soil of experimental plot was sandy loam texture, nearly neutral in soil reaction (pH 6.9), organic carbon (0.112%), available N (278.93 kg/ha), available P (10.8 kg/ha), and available K (206.4 kg/ha). The experiment was laid out in Randomized Block Design comprising of two factors *viz*., Sulphur (20, 30, 40 kg/ha), Iron (control, 0.3%, 0.5%) and Control (20-40-20 NPK kg/ha). There were 10 treatments each replicated thrice. The treatments consist of T_1-Sulphur 20 kg/ha + Control, T_2-Sulphur 20 kg/ha + Iron 0.3%, T_3-Sulphur 20 kg/ha + Iron 0.5%, T_4-Sulphur 30 kg/ha + Control, T_5-Sulphur 30 kg/ha + Iron 0.3%, T_6-Sulphur 30 kg/ha + Iron 0.5%, T_7-Sulphur 40 kg/ha + Control, T_8-Sulphur 40 kg/ha + Iron 0.3%, T_9-Sulphur 40 kg/ha + Iron 0.5% and T_{10}-Control (20-40-20 NPK kg/ha). The field was levelled properly and the seeds are sown at the spacing of 30 cm x 10 cm in line sowing. The lentil variety taken to carry out the experiment was PL-406. Recommended dose of fertilizers 20-40-20 NPK kg/ha were applied as basal dose and Sulphur was added to soil just before sowing. Foliar application of Iron was done at pre-flowering and pod formation stage. Thinning and gap filling operations were done at 10 days after sowing. The experimental plots were kept weed free throughout the crop growing period. 5 plants were randomly selected and tagged for recording observations. The observations were recorded at 20, 40, 60, 80 Days after sowing and at harvest for plant height (cm), number of nodules, dry weight (g/plant), Crop growth rate (g/m^2/day) and Relative growth rate (g/g/day). However number of pods per plant, number of seeds per pod, test weight (g), seed yield (kg/ha), stover yield (kg/ha) and harvest index (%) were recorded at harvest. The data were subjected to statistical analysis by analysis of variance method [9].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height (cm)

The data revealed that at 60 DAS the significantly higher plant height (26.5 cm) was observed in treatment T_9 [Sulphur 40 kg/ha + Iron 0.5%], however treatment T_8 [Sulphur 40 kg/ha + Iron 0.3%] was found to be statistically at par with treatment T_9.

This enhancement in plant organs might be due to the consequence of cell proliferation, enlargement, and elongation that occurs as a result of faster crop growth with Sulphur application. Similar outcomes were reported by Saini et al. [10]. Iron application, which is crucial for the synthesis of chlorophyll, photosynthesis, and a plant growth regulator, may be the cause of further plant height development. Similar results were also reported by Jin et al. [11].

3.1.2 Number of nodules per plant

The data revealed that at 60 DAS significantly more number of nodules per plant (26.7) was observed in treatment T_9 [Sulphur 40 kg/ha + Iron 0.5%], however treatment T_8 [Sulphur 40 kg/ha + Iron 0.3%] was found to be statistically at par with treatment T_9.

Increased supply of Sulphur to plants markedly increases nodulation and symbiotic nitrogen fixation. These findings are familiar with those of Varin et al. [12] Increased infection and rhizobial colonisation in the rhizosphere may be the reason of the rise in nodule count due to the increased availability of micronutrient. Similar outcomes were reported by B.K. Patel et al. [13]. The number of nodules increases as plant grows and reaches maximum at flowering stage.

3.1.3 Dry weight (g/plant)

The data revealed that at 60 DAS significantly maximum dry weight (7.31 g/plant) was observed in treatment T_9 [Sulphur 40 kg/ha + Iron 0.5%], however treatment T_8 [Sulphur 40 kg/ha + Iron 0.3%] was found to be statistically at par with treatment T_9.

Increase in dry weight of plant might be due to positive effect of Sulphur which enhances the plant growth and canopy. Similar results were found by Bohra [14]. Further increase in dry weight might be due to iron involved in various physiological process such as enzyme activation, chlorophyll formation, electron transport and stomata regulation. Similar findings were observed by Kavya et al. [15].

3.1.4 Crop growth rate (g/m^2/day)

The data revealed that during 40-60 DAS significantly maximum crop growth rate (9.88 g/m2/day) was observed in treatment T_9 [Sulphur 40 kg/ha + Iron 0.5%]. However, treatment T_3 [Sulphur 20 kg/ha+ Iron 0.5%], treatment T_5 [Sulphur 30 kg/ha + Iron 0.3%], treatment T_7 [Sulphur 40 kg/ha + Control] was statistically at par with the application of Sulphur 40 kg/ha+ Iron 0.5%.

3.1.5 Relative growth rate (g/g/day)

The data revealed that during 40-60 DAS lentil crop fertilized with recommended dose of fertilizers (20-40-20 NPK Kg/ha) resulted in significant increase in Relative growth rate (0.0483 g/g/day). However, treatment T_1 [Sulphur 20 kg/ha + Control], treatment T_4 [Sulphur 30 kg/ha + Control], treatment T_7 [Sulphur 40 kg/ha + Control] was found to be statistically at par with treatment T_9.

3.2 Yield Attributes and Yield

3.2.1 Number of pods per plant

The data revealed that significantly more number of pods per plant (162.40) were recorded in treatment T_9 [Sulphur 40 kg/ha + Iron 0.5%], however treatment T_8 [Sulphur 40 kg/ha + Iron 0.3%] was found to be statistically at par with treatment T_9.

Sulphur was found to boost yield attributes when balanced nutrients were applied because the element is known to help plants to form reproductive organs, which result in the development of pods and seeds. Sulphur application led to an increase in yield attributing parameters in lentil. Similar results were

Table 1. Influence of sulphur and foliar application of Iron on Growth attributes of Lentil

S. No.	Treatment combinations	Plant height (cm)	No. of nodules per plant	Dry weight (g/plant)	Crop growth rate (g/m^2/day)	Relative growth rate (g/g/day)
1	Sulphur 20kg/ha + Control	23.7	24.1	6.29	9.43	0.0477
2	Sulphur 20kg/ha + Iron 0.3%	24.8	25.2	6.26	9.46	0.0417
3	Sulphur 20kg/ha + Iron 0.5%	25.2	25.4	6.75	9.69	0.0423
4	Sulphur 30kg/ha + Control	24.2	24.4	6.38	9.51	0.0480
5	Sulphur 30kg/ha + Iron 0.3%	25.5	25.7	6.82	9.66	0.0420
6	Sulphur 30kg/ha + Iron 0.5%	25.9	26.1	6.96	9.37	0.0407
7	Sulphur 40kg/ha + Control	24.4	24.9	6.49	9.75	0.0460
8	Sulphur 40kg/ha + Iron 0.3%	26.1	26.4	7.20	9.08	0.0390
9	Sulphur 40kg/ha + Iron 0.5%	26.5	26.7	7.31	9.88	0.0390
10	Control (20-40-20 NPK kg/ha)	23.4	23.4	6.08	9.42	0.0483
	F-test	S	S	S	S	S
	SEm (±)	0.13	0.13	0.10	0.11	0.0014
	CD (p=0.05)	0.39	0.40	0.33	0.34	0.004

Table 2. Influence of sulphur and foliar application of Iron on yield attributes and yield of Lentil

S. No.	Treatment combinations	No. of Pods/plant	No. of Seeds/pod	Test weight(g)	Seed Yield(Kg/ha)	Stover Yield(Kg/ha)	Harvest Index (%)
1	Sulphur 20kg/ha + Control	155.47	1.20	17.85	1018.89	1861.9	35.37
2	Sulphur 20kg/ha + Iron 0.3%	158.13	1.73	20.35	1159.63	2170.3	34.83
3	Sulphur 20kg/ha + Iron 0.5%	159.27	1.93	20.46	1266.90	2314.6	35.41
4	Sulphur 30kg/ha + Control	156.80	1.33	18.13	1047.80	1955.1	34.88
5	Sulphur 30kg/ha + Iron 0.3%	159.53	2.00	20.78	1361.79	2455.8	35.68
6	Sulphur 30kg/ha + Iron 0.5%	160.87	2.07	20.85	1434.81	2599.3	35.57
7	Sulphur 40kg/ha + Control	157.40	1.53	20.16	1136.40	2032.7	35.87
8	Sulphur 40kg/ha + Iron 0.3%	161.80	2.33	20.99	1515.27	2755.5	35.50
9	Sulphur 40kg/ha + Iron 0.5%	162.40	2.53	21.07	1556.19	2868.3	35.17
10	Control (20-40-20 NPK Kg/ha)	151.33	1.07	17.52	966.85	1753.0	35.55
	F-test	S	S	NS	S	S	NS
	SEm (±)	0.32	0.08	0.97	14.39	39.84	0.44
	CD (p=0.05)	0.94	0.25	-	42.78	118.40	-

previously reported by Sahu et al. [16]. Further increase could be as a result of foliar application of iron during the flowering and pod-formation stages, which is in charge of efficient photosynthate transfer from source to sink and results in a higher number of pods and seeds per pod. Similar results were previously reported by Barla et al. [17].

3.2.2 Number of seeds per pod

The data revealed that significantly more number of seeds per pods (2.53) were recorded in treatment T_9 [Sulphur 40 kg/ha + Iron 0.5%], however treatment T_8 [Sulphur 40 kg/ha + Iron 0.3%] was found to be statistically at par with treatment T_9.

3.2.3 Test weight (g)

The data revealed that there was no significant difference between treatments. However maximum test weight (21.07 g) was recorded in treatment T_9 [Sulphur 40 kg/ha + Iron 0.5%] whereas, minimum test weight (20.99 g) was recorded in treatment T_2 [Sulphur 20 kg/ha + Iron 0.3%].

3.2.4 Seed yield (kg/ha)

The data revealed that significantly higher seed yield (1556.19 kg/ha) was recorded in treatment T_9 [Sulphur 40 kg/ha + Iron 0.5%], however treatment T_8 [Sulphur 40 kg/ha + Iron 0.3%] was found to be statistically at par with treatment T_9.

Increase in yield owing to Sulphur application may be ascribed to improved growth and yield attributes and yield is directly related to these attributes. Similar findings were reported by Singh et al. [18]. Further increase might be due to application of Iron which helps in photosynthesis, assimilates transportation to sink and increase in carbohydrate synthesis finally increases seed yield and stover yield. Similar findings were reported by Anitha et al. (2005) [19].

3.2.5 Stover yield (kg/ha)

The data revealed that significantly higher stover yield (2868.3 kg/ha) was recorded in treatment T_9 [Sulphur 40 kg/ha + Iron 0.5%], however treatment T_8 [Sulphur 40 kg/ha + Iron 0.3%] was found to be statistically at par with treatment T_9.

3.2.6 Harvest index (%)

The data revealed that there was no significant difference between treatments. However higher harvest index (35.87%) was recorded in treatment T_7 [Sulphur 40 kg/ha + Control] whereas, lesser harvest index (34.88%) was recorded in treatment T_4 [Sulphur 30 kg/ha + Control].

4. CONCLUSION

This study concluded that application of Sulphur 40 kg/ha in combination with Iron 0.5% as foliar spray was found to be more productive in terms of growth parameters and yield attributes and yield of lentil and also proven profitable. Since the findings are based on one season, further trails are needed to confirm the results.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ali RI, Awan TH, Ahmad MM, Saleem U, Akhtar M. Diversification of rice based cropping system to improve soil fertility sustainable productivity and economics. Journal of Animal and Plant Sciences. 2012;22(1):108-12.
2. Zafar M, Maqsood M, Anser MR, Ali Z. Growth and yield of lentil as affected by phosphorus. International Journal of Agriculture and Biology. 2003;5(1):98-100.
3. Becan M, Winekoop S, Matamoros MA. Sulphur transport and metabolism in legume root nodules. Frontiers in Plant Science. 2018;10. DOI:10.3389/fpls.2018.01434.
4. Tiwari BK, Singh N. Pulse chemistry and technology. Cambridge: Royal Society of Chemistry. 2012;1-10.

5. Singh DP. Effect of potassium and sulphur on performance of green gram (*Vigna radiata*) in alluvial soil. Annals of Plant and Soil Research. 2017;19(2):223-226.
6. Chaudhary NN, Khaif HR, Raj AD, Yadav V, Yadav P. Effect of nutrients (K and S) on growth yield and economics of pearl millet [*Pennisetum glaucum* (L.)]. International Journal of Forestry and Crop Improvements. 2014;5(1):9-12.
7. Kerkeb L, Connolly EL. Iron transport and metabolism in plants. Genetic Engineering Springer. 2006;119-140.
8. Rout RG, Sahoo S. Role of iron in plant growth and metabolism. Reviews in Agricultural Science. 2015;3:1-24.
9. Gomez KA, Gomez AA. Three or more factor experiment. (In:) Statistical procedure for Agricultural Research. 2nd ed. 1976;139-141.
10. Saini AK. Effect of Iron and Sulphur fertilization on growth and yield of green gram (*Vigna radiata* L.). Journal of Pharmacognosy and Phytochemistry. 2017;6(4):1358-1361.
11. Jin Z, Wang M, Wu L, Wu J, Shi C. Impacts of combination of foliar iron and boron application on iron biofortification and nutritional quality of rice grain. Journal of Plant Nutrition. 2008;. 31:1599-1611.
12. Varin S, Cliquet J. B, Personeni E, Avice JC, Lemauviel-Lavenant S. How does sulphur availability modify N acquisition of white clover (*Trifolium repens* L.)? Journal of Experimental Botany. 2010;61:225–234.
DOI:10.1093/jxb/erp303
13. Patel BK, Patel HK, Makwana SN, Shival VN, Chotaliya RL. Effect of various sources of nitrogen and phosphorus on growth yield and economics of summer green. International Journal of Current Microbiology and Applied Sciences. 2010;11:745-752.
14. Bohra RK. Effect of N P K S and Zn application growth yield economics and quality of chickpea. Archives of Agronomy and Soil Science. 2014;60:1193-1206.
15. Kavya P, Singh S, Hinduja N, Tiwari D, Sruthi S. Effect of foliar application of micronutrients on growth and yield of green gram (*Vigna radiata* L.). Legume Research-An International Journal; 2020.
16. Sahu S, Shankar T, Maitra S, Adhikary R, Mondal T, Duvvada SK. Impact of phosphorus and sulphur on the growth and productivity of green gram *(Vigna radiata*). Research on Crops. 2021;22(4):785-791.
17. Barla S, Sahoo HK, Patra BP, Biswasi S, Kumari K, Ojha RK. Effect of zinc and iron on growth and productivity of summer mung bean. International Journal of Environment and Climate Change. 2022; 12(4):119-124.
18. Singh P, Yadav K. K, Meena F, Singh B, Singh R. Effect of phosphorus and sulphur on yield attributes yield and nutrient uptake of mung bean (*Vigna radiata* L.) in central plain zone of Punjab India. Plant Archives. 2017;17:1756-760.
19. Anitha S, Sreenivasan, Purushothaman SM. Response of Cowpea [*Vigna ungiculata* L. Walp] to foliar nutrition of Zinc and Iron in the oxisols of Kerala. *Legume Research*. 2005;28(4): 294-296.

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