

## Original Research Article

### EFFECT OF PHOSPHORUS AND SULPHUR ON GROWTH AND YIELD OF LENTIL

(*Lens culinaris medic.*)

#### ABSTRACT

A field experiment was conducted during *Rabi* season of 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 Response of Nitrogen and Boron on growth and yield of Lentil. The treatments consist of Phosphorus 20, 30, 40 kg/ha and Sulphur 10, 20, 30 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 (39.81 cm), higher number of nodules (6.07), higher plant dry weight (14.40 g/plant), higher number of pods/plant (158.77), higher number of seeds/pod (1.94), higher 1000 seed weight (24.94 gm), higher seed yield (1.1 t/67 ha) and higher stover yield (2.92 t/ha) were significantly influenced with application of Phosphorus 40 kg/ha + Sulphur 30 kg/ha. Higher gross return (INR 1,00,200/ha), higher net return (INR 68,600/ha) and higher B:C ratio (2.17) were also recorded in treatment-9 (Phosphorus 40 kg/ha + Sulphur 30 kg/ha).

**Keywords:** *Lentil, Phosphorus, Sulphur, growth parameters, yield attributes and Economics*

**Comment [RY1]:** Needs to add short background the important of lentil so that this study is indeed needed

## INTRODUCTION

Lentil has been one of the world's oldest agricultural crop resistant to drought and *Lensis* Latin word that describes exactly the shape of these seed of a cultivated legume now known as *Lens culinaris* a name given by the German botanist Medikus in **Cubero (1787)**. Locally called as Masoor belongs to the family Fabaceae. Lentil is a cool season pulse crop and is also relatively to **lerant** to drought. It is a valuable human food, consists of vegetable protein in good amount. Lentil contains protein, carbohydrates, oils and ash at the rate of 23.25%, 59%, 1.8% and 0.2%, respectively along with iron, calcium, phosphorus and magnesium. A significant amount of vitamin A and B is also provided by lentil”.

Comment [RY2]: Typeo?

Plant nutrition is an important factor in increasing lentil crop productivity. Phosphorus (P), the second-most significant macronutrient and a non-renewable resource, is needed for developing cells and serves a variety of purposes for plant growth, development, and metabolism. Because it controls numerous biochemical processes in plant life, it is also known as "the secret to life." Phosphorus makes crops more resilient, and a sufficient amount of phosphorus causes crops to develop quickly. For vegetation to be healthy and vigorous, phosphorus is necessary. It promotes more uniform floral development and early fruit maturity. helps plants grow throughout their full life span and also provides disease resistance (**Singh et al. 2016**).

Sulphur is an important secondary plant nutrient, playing a vital role in various physiological processes in the plant including the formation of amino acid (methionine, cysteine, and cystine), synthesis of proteins and chlorophyll. It activates enzymes and involves in the metabolic activities of vitamins (biotin and thiamine) and part of co-enzyme A and pyrophosphate. Sulphur deficiency can be responsible for poor flowering, fruiting and stunted growth. Pulses are reported to be second after oil seeds in requirement of sulphur **Parashar A, and Tripathi (2020)**.

Keeping these points in view, the present study entitled “**Effect of Phosphorus and Sulphur on Growth and Yield of Lentil (*Lens culinaris* Medik.)**” 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* season of 2022-23.

## Materials and Methods

The experiment was conducted during *Rabi* of 2022, Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, Uttar Pradesh. Which is located at 25.24° 42' N latitude, 81° 50' 56" E longitude and 98m altitude above the mean sea level (SL). The experiment was conducted in Randomized Block Design with 10 treatments each replicated thrice. The plot size of each treatment was 3m x 3m. Factors are three levels of phosphorus (20, 30 and 40 kg/ha) and three levels of Sulphur (10, 20 and 30 kg/ha). The P and S were supplied, both are applied as basal at the time of sowing. The lentil variety KLS-0903 was sown on 26 November 2022 by maintaining a spacing of 30cm x 10cm. Harvesting was done taking 1m<sup>2</sup> area from each plot. And from it three plants were randomly selected for recording growth and yield parameters. The treatment details are as follows, T<sub>1</sub> -(RDP 20 kg/ha+ Sulphur 10 kg/ha), T<sub>2</sub> -(RDP 20 kg/ha+ Sulphur 20 kg/ha), T<sub>3</sub> -(RDP 20 kg/ha+ Sulphur 30 kg/ha), T<sub>4</sub> -(RDP 30 kg/ha+ Sulphur 10 kg/ha), T<sub>5</sub> -(RDP 30 kg/ha+ Sulphur 20 kg/ha), T<sub>6</sub> -(RDP 30 kg/ha+ Sulphur 30 kg/ha), T<sub>7</sub> -(RDP 40 kg/ha+ Sulphur 10 kg/ha), T<sub>8</sub> -(RDP 40 kg/ha+ Sulphur 20 kg/ha), T<sub>9</sub> -(RDP 40 kg/ha+ Sulphur 30 kg/ha), T<sub>10</sub> -(N 20 Kg/ha + P 40 kg/ha +k 20 kg/ha) Control. The observations were recorded for plant height, nodules/plant, dry weight, grain yield and stover yield. The data were subjected to statistical analysis by analysis of variance method (Gomez and Gomez, 1976).

Comment [RY3]: Typo?

Comment [RY4]: deleted

## Results and Discussion

### Growth parameters:

**Plant height** – the significantly higher plant height (39.81cm) was observed in treatment-9 (RDP 40 kg/ha+ Sulphur 30 kg/ha). However, treatment-8 (RDP 40 kg/ha+ Sulphur 20 kg/ha) was statistically at par with treatment-9 (RDP 40 kg/ha+ Sulphur 30 kg/ha). Significant and higher number of plant height may be owing to phosphorus application in the soil might be due to increase availability and uptake of soil nutrients by the crop contributed by phosphorus fertilization. The higher availability of nutrients might have increased the photosynthetic ability and translocation of the metabolites to different parts which ultimately increased the root and shoot development of the crop. These findings corroborate the results of **Tophia Yunnam et al. (2018)**, in lentil. And also, with the increased availability of sulphur to plants has helped in better development and thickening of xylem and collenchyma tissue which might have resulted into increased plant height. Similar results are reported with **Mourya Teja et al., (2021)**.

**Nodules/plant** – Significantly higher number of nodules/plant (37.44) was recorded in treatment-9 (Nitrogen 30/ha+ Phosphorus 50kg/ha) [Table 1]. However, treatment-8(Nitrogen30 kg/ha + Phosphorus 40kg/ha) was found to be statistically at par with treatment-9(Nitrogen 30 kg/ha+ Phosphorus 50kg/ha).Significant and higher number of nodules/plant was with application of (Nitrogen 30kg/ha phosphorus 50kg/ha) might helped in efficient utilization of nutrients, which resulted in attaining better crop canopy and further increased absorption and utilization of radiant energy resulting in higher effective and total number of nodules/plants.**Patelet et al.(2017)** in green gramwho reported that application of phosphorus increased the number of nodules/plants. Further, the application of higher dose nitrogen might have favored rapid growth and enlargement of tissues. **Fatimaet al.(2013)**.

**Dry weight/plant-** The significantly higher plant dry weight (14.40 g/plant) was observed in treatment-9(RDP 40 kg/ha+ Sulphur 30 kg/ha). However, treatment-8(RDP 40 kg/ha+ Sulphur 20 kg/ha)wasstatisticallyatparwithtreatment-9(RDP 40 kg/ha+ Sulphur 30 kg/ha).Significant and higher dry weight is observed with the application of phosphorus.Increases in dry weight due to an increase in photosynthetic ability and translocation of metabolites to different parts which ultimately increased the shoot development of the crop similar results conformity with **Unni and Debbarma (2022)**. Sulphur also shown significant improvement in dry weightSulphur plays major role in photosynthetic process which has a direct bearing on plant growth and development, increasing levels of Sulphur application resulted in increment in dry weight of lentil, the results were found to be similar with **Singh et al. (2000)**.

### **YIELD**

**Numberof Pods/plant** - The significant and higher number of pods/plant (158.77) were observed in treatment-9with(RDP 40 kg/ha+ Sulphur 30 kg/ha),whichwassignificantlysuperioroverrestofthetreatments. However, treatment-8 (RDP 40 kg/ha+ Sulphur 20 kg/ha), was found to bestatisticallyat parwith treatment-9 (RDP 40 kg/ha+ Sulphur 30 kg/ha). Significant and higher number of pods/plants was with application of phosphorus also increased the number of pods/plants which might be due to phosphorus strongly increases the reproduction of the plants i.e., flowering and fruiting. These results were similar with that of **Abid et al.(2017)**. Further increase in the number of pods with the application of Sulphur improved availability of Sulphur and favorable nutritional environment might have helped the plants at the peak growth period and flowering stages which ultimately

increased the number of pods per plant similar results have been reported with **Mourya Teja et al., (2021)**.

**Number of seeds/pod** - The significant and higher number of seeds/pod (1.94) were observed in treatment-9 with (RDP 40 kg/ha+ Sulphur 30 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (RDP 40 kg/ha+ Sulphur 20 kg/ha), was found to be statistically at par with treatment-9 (RDP 40 kg/ha+ Sulphur 30 kg/ha). Significant higher number of seed/pod might be due to increase in phosphorus fertilization in ensuring availability of other plant nutrients which increased carbohydrate accumulation and their re-mobilization to reproductive parts of the plant, being the closest sink. Phosphorus is known to encourage flowering and fruiting which might have stimulated the plants to produce more pods per plant and also enables development of a greater number of seeds per pod. Similar findings were reported by **Shah et al. (2000)**.

#### **Test Weight (gm)**

The significant and higher Test Weight (24.94 gm) was observed in treatment-9 with (RDP 40 kg/ha+ Sulphur 30 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (RDP 40 kg/ha+ Sulphur 20 kg/ha), was found to be statistically at par with treatment-9 (RDP 40 kg/ha+ Sulphur 30 kg/ha). Improved availability of Sulphur and favorable nutritional environment might have helped the plants at the peak growth period and flowering stages which ultimately increased the number of pods per plant, number of seeds per pod and test weight. Improved growth characters might have also resulted into the improved source sink relationship and sink size. Similar results have confirmed with **Anil Kumar Singh et al. (2012)**.

**Seed Yield (t/ha)** - The significant and higher seed yield (1.67 t/ha) was observed in treatment-9 with (RDP 40 kg/ha+ Sulphur 30 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (RDP 40 kg/ha+ Sulphur 20 kg/ha), was found to be statistically at par with treatment-9 (RDP 40 kg/ha+ Sulphur 30 kg/ha). The significantly higher seed yield was recorded with the application of Phosphorus it 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/plant and number of seeds/ pods. 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 **Tophia Yumnamet et al. (2018)**. Also, Higher seed

yield under Sulphur application 30 kg/ha might be due to significant expansion in entire yield related traits like number of branches (primary and secondary) and capsules/plant, number of seeds/capsule and test weight (1000-seed weight). The similar results observed by **Prajapati et al. (2013)**.

**Stover Yield (t/ha)** - The significant and higher stover yield (2.92 t/ha) was observed in treatment-9 with (RDP 40 kg/ha+ Sulphur 30 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (RDP 40 kg/ha+ Sulphur 20 kg/ha), was found to be statistically at par with treatment-9 (RDP 40 kg/ha+ Sulphur 30 kg/ha). Significant and 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)**. And also, with the application of sulphur helps in increase in Numerous straw yield was attained by the enlargement of plant in terms of height, more spread number of branches, maximum dry weight of plant was the result of nutrient uptake. These outcomes had been supported by **Singh et al., (2000)**.

#### **Economic Analysis**

**Gross returns (INR/ha)** - Highest gross return (1,00,200.00 INR/ha) was obtained in treatment-9 (RDP 40 kg/ha+ Sulphur 30 kg/ha) as compared to other treatments.

**Net Returns** - Net return (68,600.00 INR /ha) was found to be highest in treatment-9 (RDP 40 kg/ha+ Sulphur 30 kg/ha) as compared to other treatments. With increasing levels of phosphorus, the grain and straw yield increased this attributed to a higher Net return. These results are in conformity with those observed by **Mitra et al. (2006)**.

**Benefit Cost Ratio** - Benefit Cost ratio (2.17) was found to be highest in treatment-9 with (RDP 40 kg/ha+ Sulphur 30 kg/ha) as compared to other treatments. kg/ha) as compared to other treatments [Table 2].

#### **Conclusion:**

It was concluded that with the application of Phosphorus 40 kg/ha along with Sulphur 30 kg/ha (Treatment-9), has performs positively and improves growth and yield parameters. Maximum grain yield, gross returns, net returns and benefit cost ratio were also recorded with application of Phosphorus 40 kg/ha along with Sulphur 30 kg/ha (Treatment-9). These findings are based

on one season therefore; further trials may be required for further confirmation.

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**Table 1. Influence of phosphorus and Sulphur on growth parameters of lentil.**

S. No.	Treatment combinations	Plant height	Number of nodules/plant	Plant Dry weight
1.	RDP 20 kg/ha+ Sulphur 10 kg/ha	35.67	15.65	11.13
2.	RDP 20 kg/ha+ Sulphur 20 kg/ha	35.91	15.78	11.60
3.	RDP 20 kg/ha+ Sulphur 30 kg/ha	36.77	16.47	11.73
4.	RDP 30 kg/ha+ Sulphur 10 kg/ha	37.35	16.81	12.40
5.	RDP 30 kg/ha+ Sulphur 20 kg/ha	37.61	17.89	12.73
6.	RDP 30 kg/ha+ Sulphur 20 kg/ha	38.14	18.63	13.20
7.	RDP 40 kg/ha+ Sulphur 10 kg/ha	37.24	18.47	13.67
8.	RDP 40 kg/ha+ Sulphur 20 kg/ha	38.97	19.44	13.73
9.	RDP 40 kg/ha+ Sulphur 30 kg/ha	39.81	20.83	14.40
10.	Control	35.61	15.90	11.56
	F test	S	S	S
	S Em.(±)	0.36	0.54	0.25
	CD (P=0.05)	1.08	1.59	0.75

**Table 2. Influence of phosphorus and Sulphur on yield attributes of lentil.**

S. No.	Treatment combinations	No. of Pods/Plant	No. of seeds/pods	Test weight	Grain yield	Straw yield	Harvest index
1.	RDP 20 kg/ha+ Sulphur 10 kg/ha	115.17	1.31	19.37	1.10	2.57	29.98
2.	RDP 20 kg/ha+ Sulphur 20 kg/ha	125.60	1.53	20.27	1.23	2.60	32.17
3.	RDP 20 kg/ha+ Sulphur 30 kg/ha	129.97	1.60	20.45	1.26	2.67	32.11
4.	RDP 30 kg/ha+ Sulphur 10 kg/ha	136.83	1.57	21.03	1.33	2.57	34.08
5.	RDP 30 kg/ha+ Sulphur 20 kg/ha	142.21	1.64	22.04	1.37	2.71	33.55
6.	RDP 30 kg/ha+ Sulphur 20 kg/ha	147.60	1.75	22.18	1.49	2.82	34.54
7.	RDP 40 kg/ha+ Sulphur 10 kg/ha	145.83	1.67	20.67	1.52	2.76	35.56
8.	RDP 40 kg/ha+ Sulphur 20 kg/ha	153.54	1.81	23.81	1.61	2.87	35.90
9.	RDP 40 kg/ha+ Sulphur 30 kg/ha	158.77	1.94	24.94	1.67	2.92	36.39
10.	Control	133.73	1.63	19.63	1.19	2.70	30.47
F test		S	S	S	S	S	S
S Em.(±)		3.09	0.05	0.88	0.04	0.05	0.76
CD (P=0.05)		9.19	0.14	2.61	0.12	0.16	2.25

**Table 3. Influence of phosphorus and Sulphur on economic analysis of lentil.**

<b>Treatments</b>	<b>Cost of cultivation (INR/ha)</b>	<b>Gross return (INR/ha)</b>	<b>Net return (INR/ha)</b>	<b>B:C Ratio</b>
RDP 20 kg/ha+ Sulphur 10 kg/ha	29406	66000	36594	1.24
RDP 20 kg/ha+ Sulphur 20 kg/ha	29936	73800	43864	1.47
RDP 20 kg/ha+ Sulphur 30 kg/ha	30456	75780	45324	1.49
RDP 30 kg/ha+ Sulphur 10 kg/ha	29982	79560	49578	1.65
RDP 30 kg/ha+ Sulphur 20 kg/ha	30512	81960	51448	1.69
RDP 30 kg/ha+ Sulphur 30 kg/ha	31032	89160	58128	1.87
RDP 40 kg/ha+ Sulphur 10 kg/ha	30550	91380	60830	1.99
RDP 40 kg/ha+ Sulphur 20 kg/ha	31080	96600	65520	2.11
RDP 40 kg/ha+ Sulphur 30 kg/ha	31600	100200	68600	2.17
CONTROL	30030	71160	41130	1.37

## REFERENCES:

- Ali, Abid, Ahmad, Bashir, Hussain, Iqbal, Ali, Akhtar, Shah and Ali, Fawad (2017). Effect of phosphorous and zinc on yield of lentil. *Pure Applied Biology* 6(4):1397-1402.
- Anil Kumar Singh., Gade, R.M., Bharati, R.C., Santosh Kumar and Pravesh Kumar. 2012. Influence of sulphur and zinc nutrition on incidence of disease and performance of rice. *J. Pl. Dis. Sci.* 7(2): 239-242.
- ArathiUnni aø\* and Victor Debbarma (2022). Response of Nitrogen and Phosphorus on Growth and Yield of Lentil (*Lens culinaris medik.*) *International Journal of Plant & Soil Science* 34(21): 328-334.
- BagadiMourya Teja VS, George SG. Effect of sulphur and zinc on growth and yield of lentil (*Lens culinaris M.*); 2021. \ 10(11):370-372.
- Choubey, S.K., Dwivedi V.P. and Srivastava, N.K (2013). Effect of different levels of phosphorus and sulphur on growth, yield and quality of lentil. *Indian Journal Science and Research* 4(2):149-150.
- Cubero JI. Origin, taxonomy and domestication. In: Webb C, HawtinGC, editors. *Lentils*. Slough, England: Commonwealth Agricultural Bureau; 1981.
- Gomez, K. A and Gomez, A. A (1976). Three or more factor experiment. In: *Statistical Procedure for Agricultural Research* 2nd edition, p. 139 -141.
- Mitra, A.K., Banerjee, K and Pal A.K (2006). Effect of different levels of phosphorus and Sulphur on yield attributes, seed yield, protein content of seed and economics of summer green gram. *Research on crops* 7(2):404-405.
- Prajapati, J. P., Kumar, S., Singh, R. P., Kushwaha, I. K. and Yadav, P. K. 2013. Effect of Phosphorous and Sulphur on growth and yield attributes and yield of green gram (*Vigna radiata L.*). *Environment and Ecology* 31(4); 1977 - 1979.
- Parashar A, Tripathi L. Effect of phosphorus and sulphur on the growth and yield of black gram (*Vigna mungo L.*). *Journal of Pharmacognosy and Phytochemistry*. 2020;9(5):2585-2588.
- Patel HB, Shah KA, Barvalya MM, Patel SA. Response of green gram (*Vigna radiata L.*) to different level of Phosphorus & organic liquid fertilizer. *International Journal of Current Microbiology and Applied Sciences*. 2017;6(10):3443-51.
- Shah, S. H., Mahmood, M.Y. and Zamir, M.S.I. 2000. Qualitative and quantitative response of

three cultivars of lentil (*Lens culinaris* Medic) to phosphorus application. *Int. J. Agri. Biol.*, 2(3): 248-250.

Singh, Nariendar and Singh, Guriqbal, (2016). Response of lentil (*Lens culinaris* Medikus) to phosphorus. *Agricultural Reviews* 37(1):27-34.

Singh, Y. P., Chauhan, C. P. S. and Gupta, R. K. 2000. Effect of Sulphur, Phosphorous and inoculation on growth, yield and Sulphur utilization by lentil (*Lens culinaris*). *Indian Journal of Agricultural Sciences* 70(7); 491-493.

Yumnam, Tophia, Luikham, Edwin, Singh and Herojit, A (2018). Influence of phosphorous on growth and yield of promising varieties of lentil (*Lens Culinaris* L.M). *International Journal of Current Microbiology and Applied Sciences* 7(8):162-170.

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