



# Influence of Phosphorus and Iron on Growth and Yield of Lentil (*Lens culinaris* L.)

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## 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

A field experiment was conducted during the period of *Rabi* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) on the topic "Effect of phosphorus and iron on growth and yield of lentil (*Lens culinaris* L.)", to study treatments consisting of three levels of Phosphorus viz. 20 kg, 30 kg and 50 kg/ha and three levels of Iron viz. 5, 10 and 20 kg/ha. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.28%), available N (225 kg/ha), available P (19.50 kg/ha) and available K (92 kg/ha). There were 10 treatments each being replicated thrice and laid out in Randomized Block Design. The results revealed that treatment 9 (Phosphorus at 50 kg/ha + FeSO<sub>4</sub> at 20 kg/ha) recorded significantly higher plant height (26.03 cm), plant dry weight (11.61 g), number of pods/plant (113.07), number of seeds/pod (1.93), seed yield (1.25 kg/ha) and Stover yield (2.07 kg/ha compared to other treatments.

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## 1. INTRODUCTION

India is the world's largest vegetarian population and is the biggest producer of pulses. For the people of India, pulses supply a cheap and nutritious source of protein. One of the a few pulse species is lentil (*Lens culinaris* L.). foods that are high in nutrients of the cold seasons, legumes. Lentils have been consumed by humans since the dawn of civilization. As a winter crop, it is commonly grown in temperate, subtropical, and tropical climates. It may be grown on a wide range of soil types from light loams to black cotton soils light loams to black cotton soils, it may be grown on a wide range of soil types. In the Indo-Gangetic Plain (IGP), it is one of the main sources of plant protein. Important nutrients for human nutrition can be found in lentils, include 25% protein, 1.1% fat, and 59% carbohydrates. (www.dpd.gov.in).

Leguminous plant seeds, such as pulses, belong to the Fabaceae family. There are significant part of a vegetarian diet because they serve as a good source of protein and satisfy the majority of physiological requirements. In India, plants make up 88% of all protein consumption. Pulses are also an important source of vitamin B. Pulse seeds that have already germinated include vitamin C. Since they contain 2 to 6% fat, they can deliver the fatty acids that are necessary for survival. They are able to considerably satisfy their own nitrogen needs by employing nitrogen-fixing bacteria found in their nodules to fix atmospheric nitrogen. They are resistant to drought because of their deep roots and the fact that many of them are short-lived crops. These work well for many cropping systems as well. They may greatly satisfy their own nitrogen needs through using nitrogen-fixing bacteria found in their nodules to fix surrounding nitrogen. They are immune to drought because of their deep roots and the fact that many of them are short-lived crops. These are also excellent for intercropping and a wide range of cropping systems Malika et al. (2015).

“Due to its role in root development, stalk and stem strength, flower and seed formation, crop maturity and production, N-fixation, crop quality, and resistance to plant diseases, phosphorus is a crucial component for the successful production of pulses. It is vital to the stimulation of biological processes such Legume yield is increased via nodulation, nitrogen fixation, and nutrient uptake in the rhizosphere environment.

Application of phosphorus reduces the negative effects of drought on physiological parameters and can increase yield in water situations of stress” [1]. The majority of soils used for producing lentils have low to medium levels of phosphorus that are readily available, therefore they respond well to the suggested quantity of phosphorus fertilizers. Pulses' increased yield is a result of phosphorus application, which also improves the soil's nitrogen content for subsequent non- legume crops that require less nitrogen. However, high rates of phosphorus application cause P fixation because they chelate with iron and aluminium in acidic soils and calcium in alkaline soils, making them unavailable to plants. So, to get the ideal lentil yield, phosphorus needs to be applied in the proper amount. Therefore, phosphorus must be applied in the proper amount to produce the highest possible yield of lentils.

In several crops, including lentil, iron (Fe) insufficiency is a prevalent nutritional problem [2]. The yield losses of the vulnerable genotypes ranged from 18 to 25%. According to Sakal et al. [3], the Fe<sup>2+</sup> concentration of the leaf tissue, as compared to the total iron content, was closely correlated with the symptoms of Fe lack and was determined to be a good index to identify soil where response to Fe attitudes can be expected. Leghemoglobin, ferredoxin, and nitrogenase are all made up of iron. During the process of fixing nitrogen, bacteria have used this element. Some legumes have low nitrogen concentrations in their shoots as a result of iron deficiency, which typically reduces nodule formation, leghaemoglobin production, and Nitrogenase activity. The nitrogen fixation processes have been shown to benefit from iron and molybdenum fertilisation, increasing lentil yield and nitrogen status. The ability to actively fix nitrogen depends on the crop's health and an appropriate supply of nutrients, as is well established [4]. According to Lindsay and Norwell [5], the essential level of iron is 4.5 ppm.

Keeping in view the above facts, the present experiment was undertaken to find out “Influence of phosphorus and iron on growth and yield of lentil (*Lens culinaris* L.)”

## 2. MATERIALS AND METHODS

The experiment was conducted during *rabi* season of 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj

(U.P). The soil of the field constituting a part of central gangetic alluvium is neutral and deep. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.28%), available N (225 kg/ha), available P (19.50 kg/ha) and available K (92 kg/ha). The treatment consists of Phosphorus @ 20 kg, 30 kg and 50 kg/ha and Iron consists 5 kg, 10 kg and 20 kg/ha. The experiment was laid out in RBD with 10 treatments each replicated thrice. The treatment combinations are T1- Phosphorus at 20 kg/ha + Iron at 5 kg/ha, T2- Phosphorus at 20 kg/ha + Iron at 10 kg/ha, T3 - Phosphorus at 20 kg/ha + Iron at 20 kg/ha, T4 - Phosphorus at 30 kg/ha + Iron at 5 kg/ha, T5 - Phosphorus at 30 kg/ha + Iron at 10 kg/ha, T6 - Phosphorus at 30 kg/ha + Iron at 20 kg/ha, T7 - Phosphorus at 50 kg/ha + Iron at 5 kg/ha, T8 - Phosphorus at 50 kg/ha + Iron at 10 kg/ha, T9- Phosphorus at 50 kg/ha + Iron at 20 kg/ha, T10- Control N:P:K (20:40:20kg/ha). The field was levelled properly and the sowing was done on 1<sup>st</sup> December, 2022 with seed rate 40-45 kg/ha and 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. The observations for growth parameters were recorded at 20, 40, 60, 80 DAS and at harvest. Yield attributes and yield were recorded at harvest from five randomly selected plants in each plot. The data was computed and analysed by following statistical method of Gomez and Gomez (1984).

### 3. RESULTS AND DISCUSSION

#### 3.1 Growth Parameters

At 60 DAS, significantly higher plant height (26.03 cm), dry weight (5.00 g) are observed in treatment 9 with combined application of Phosphorus at 50 kg/ha and FeSO<sub>4</sub> at 20 kg/ha. The higher P fertilization improves the plant height of lentil which might be due to stimulation of biological activities in the presence of balanced supply of phosphorus" [6]. "Several studies reported that plant height increase with increment in phosphorus dose, the maximum plant height was obtained at 60 kg/ha compared to 30 kg/ha" [7]. "The increase in the availability of iron to plant might have stimulated the metabolic and enzymatic activities thereby increasing the growth of the plant reported" by Trivedi et al. [8]. Increase in growth parameters 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 greater uptake 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 Zafar et al., (2003), Pandey et al., (2016) and Singh et al., (2016) in lentil. "The increase in the availability of iron to plant might have stimulated the metabolic and enzymatic activities thereby increasing the growth of the crop" [9].

#### 3.2 Yield Parameters and Yield

According to yield attributes data that was collected and analyzed at harvest, significantly higher number of pods/plant (113.07), number of seeds/pod (1.93) were recorded in Treatment 9 with combined application of Phosphorus at 50 kg/ha and FeSO<sub>4</sub> at 20kg/ha. It might be the reason of moderate plant nutrients availability due to which the plant produce more pods/plant as compare to other treatments and also phosphorus strongly increases the reproduction of the plants i.e, flowering and fruiting [10]. These results were similar with that of Saleh, [11] and Jayapaul et al. [12]. The increase in number of seeds/pod by the application of molybdenum along with iron may be due to the fact that molybdenum and iron may fixed that much amount of nitrogen which was required by the plant to show better performance as molybdenum is related directly to nitrogen fixation by legumes. Result also showed that the molybdenum and iron nutrition had similar effect on lentil. Similar observations were found by Landge et al. [13] and Tahir et al. [14] in case of chick pea. "The reason for increasing grain yield is the balance nutrient supply and timely application of the nutrients which enhances the plant growth and the grain yield will be increased. Similar results support that increasing phosphorus level, the grain yield increased too" [15,16]. "The increase in seed yield by application of 60 kg P<sub>2</sub>O<sub>5</sub> /fed might be associated with high number of pods/plant, 1000 seed weight and seed yield /plant" [17]. Similar results were reported by Chaubey et al. [15] and Singh et al. [16] and they found that phosphorus fertilization at 50kg/P<sub>2</sub>O<sub>5</sub>/ha increased seed yield as compared with control. "It is widely known that Fe helps improve the chlorophyll content necessary for photosynthetic activities. Moreover, Fe and Mo are integral components of nitrogenase enzyme which are essential for symbiotic N<sub>2</sub> fixation" [18].

**Table 1. Influence of phosphorus and iron on growth attributes on lentil**

S. No.	Treatments	Plant height (cm)	Plant dry weight (g/plant)	CGR (g/m <sup>2</sup> /day)	RGR (g/g/day)
1	Phosphorus at 20 kg/ha + FeSO <sub>4</sub> at 5 kg/ha	22.83	4.40	11.28	0.047
2	Phosphorus at 20 kg/ha + FeSO <sub>4</sub> at 10 kg/ha	23.03	4.47	11.28	0.046
3	Phosphorus at 20 kg/ha + FeSO <sub>4</sub> at 20 kg/ha	23.23	4.53	11.17	0.045
4	Phosphorus at 30 kg/ha + FeSO <sub>4</sub> at 5 kg/ha	24.20	4.67	11.00	0.044
5	Phosphorus at 30 kg/ha + FeSO <sub>4</sub> at 10 kg/ha	24.53	4.83	10.78	0.042
6	Phosphorus at 30 kg/ha + FeSO <sub>4</sub> at 20 kg/ha	24.77	4.93	10.67	0.042
7	Phosphorus at 50 kg/ha + FeSO <sub>4</sub> at 5 kg/ha	24.97	4.80	10.78	0.043
8	Phosphorus at 50 kg/ha + FeSO <sub>4</sub> at 10 kg/ha	25.30	4.97	10.72	0.042
9	Phosphorus at 50 kg/ha + FeSO <sub>4</sub> at 20 kg/ha	26.03	5.00	10.72	0.041
10	Control (RDF 20-40-20 NPK/ha)	22.07	3.90	12.00	0.052
	F-Test	S	S	S	S
	SEm(±)	0.25	0.06	0.11	0.001
	CD (p=0.05)	0.76	0.17	0.33	0.002

**Table 2. Influences of phosphorus and iron on yield attributes and yield of lentil**

Sl No.	Treatments	No. of pods /plant	No. of Seeds /Pod	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
1	Phosphorus at 20 kg/ha + FeSO <sub>4</sub> at 5 kg/ha	94.80	1.13	27.67	900.00	1533.33	37.02
2	Phosphorus at 20 kg/ha + FeSO <sub>4</sub> at 10 kg/ha	97.47	1.33	27.73	910.00	1596.67	36.34
3	Phosphorus at 20 kg/ha + FeSO <sub>4</sub> at 20 kg/ha	97.80	1.47	27.73	936.67	1706.67	35.46
4	Phosphorus at 30 kg/ha + FeSO <sub>4</sub> at 5 kg/ha	98.67	1.53	27.80	996.67	1793.33	35.73
5	Phosphorus at 30 kg/ha + FeSO <sub>4</sub> at 10 kg/ha	99.67	1.53	29.40	1033.33	1853.33	35.79
6	Phosphorus at 30 kg/ha + FeSO <sub>4</sub> at 20 kg/ha	104.47	1.53	29.73	1036.67	1856.67	35.81
7	Phosphorus at 50 kg/ha + FeSO <sub>4</sub> at 5 kg/ha	109.33	1.53	30.40	1110.00	1930.00	36.50
8	Phosphorus at 50 kg/ha + FeSO <sub>4</sub> at 10 kg/ha	110.00	1.80	30.47	1153.33	1973.33	36.87
9	Phosphorus at 50 kg/ha + FeSO <sub>4</sub> at 20 kg/ha	113.07	1.93	31.20	1253.33	2073.33	37.67
10	Control (RDF 20-40-20 NPK/ha)	91.47	1.07	27.60	880.00	1470.00	37.47
	F-Test	S	S	NS	S	S	NS
	SEm(±)	1.74	0.16	1.10	42.26	62.86	1.42
	CD (p=0.05)	5.17	0.46	-	125.55	186.76	-

These findings are supported by Sharief and Said [19] found that “foliar application of micronutrients either separately or in combination significantly improved the grain yield of lentil”. The higher stover yield with suitable dose of phosphorus might be contributed by better growth of the plant as expressed in terms of plant height, number of branches per plant, fresh and dry weight of the plant as a result of improved nutrient uptake. These findings were supported by Choubey et al., (2013), Zeidan [17] and Rasool and Singh (2016) in lentil. “Phosphorus helps in utilizing nutrient efficiency, resulting in better canopy and a further increase in radiant energy uptake and utilization with a greater effective and total number of pods per plant” [20]. “This might be due to increased availability of physiologically active iron (Fe<sup>2+</sup>) in the plant system which in turns affects various physiological functions of plants favourably. Translocation of the same to reproductive structures. Since uptake is the function of seed and straw yield and their nutrient concentration, there was significant improvement in concentration of these nutrients coupled with seed and straw yield” [21]. “Phosphorus increases the production of plant biomass, nodule number and weight and chlorophyll content in leaf exhibited significant positive correlation with grain and straw yield” [22-25].

#### 4. CONCLUSION

It was concluded that application of 50 kg/ha Phosphorus with 20 kg/ha Iron (treatment 9) recorded higher growth parameters, yield attributes and yield in lentil crop. 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.

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