Original research article

Influence of Phosphorus and Iron on growth and yield of Lentil(*Lens culinaris* L.)

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 andyield 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 + FeSO4 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), Test weight (31.20 g), seed yield (1.25 kg/ha), Stover yield (2.07 kg/ha), harvest index (37.67 %), compared to other treatments.

Keywords: *Phosphorus, Iron, Growth, Yield.*

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” **(Singh *et al.*, 2005)**. 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 **(Erskine *et al.*, 1993).** The yield losses of the vulnerable genotypes ranged from 18 to 25%. According to **Sakal *et al*. (1984)**, the Fe^{2+} 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 **(Brar and Sidhu, 1992)**. According to **Lindsay and Norwell (1969)**, 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.)”**

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 growth parameters and yield, production was recorded at harvest from randomly selected plants in each plot. The data was computed and analysed by following statistical method of **Gomez and Gomez (1984)**.

RESULT AND DISSCUSSION

Growth parameters

"Significantly higher plant height (26.03 cm), dry weight (11.61 g) are observed in treatment 9 with combined application of Phosphorus at 50 kg/ha and $FeSO_4$ 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" **(Datta *et al.*, 2013)**. "Several studies reported that plant height increases with increment in phosphorus dose, the maximum plant height was obtained at 60 kg/ha compared to 30 kg/ha" **(Togay *et al,* 2008). "**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.*,2011).** 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". [**Kuldeep *et al.,* (2018)].**

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 $FeSO_4$ at 20kg/ha. It might be the reason of moderate plant nutrients availability due to which the plant produce morepods plant^{-1} as compare to other treatments and also phosphorus strongly increases the reproduction of the plants i.e. flowering and fruiting **(Ali *et al.*, 2017)**. These results were similarwith that of **Saleh, 1976 and Jayapaul *et al.*, 1990.** 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 effecton lentil. Similar observations were found by **Landge *et al.* (2002) and Tahir *et al*. (2011)** 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" **(Chaubey *et al.*, 1999 andSingh *et al.*, 1999). "**The increase in seed yield by application of 60 kg P_2O_5 /fed might be associated with high number of pods /plant, 1000 seed weight and seed yield /plant" **(Zeidan, 2007).** Similar results were reported by **Chaubey *et al.*, 1999 and Singh *et al.*, 1999** and they found that phosphorus fertilization at 50kg/P_2O_5/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_2 fixation" **(Nasar *et al.*, 2017).**

These findings are supported by **Sharief and Said (1998)** 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 (2007) 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". [Goud et al., 2021]. "This might be due to increased availability of physiologically active iron (Fe^{2+}) 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" **(Meena *et al.*, 2013). "**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". [**Prajapatiet al. 2013].**

Table 1: Influence of Phosphorus and Iron on Growth attributes on Lentil.

Sl No.	Treatments	Plant height (cm)	Plant dry weight (g/plant)	CGR (g/m^2 /day)	RGR (g/g/day)
1	Phosphorus at 20 kg/ha + $FeSO_4$ at 5 kg/ha	22.83	4.40	11.28	0.047
2	Phosphorus at 20 kg/ha + $FeSO_4$ at 10 kg/ha	23.03	4.47	11.28	0.046
3	Phosphorus at 20 kg/ha + $FeSO_4$ at 20 kg/ha	23.23	4.53	11.17	0.045
4	Phosphorus at 30 kg/ha + $FeSO_4$ at 5 kg/ha	24.20	4.67	11.00	0.044
5	Phosphorus at 30 kg/ha + $FeSO_4$ at 10 kg/ha	24.53	4.83	10.78	0.042
6	Phosphorus at 30 kg/ha + $FeSO_4$ at 20 kg/ha	24.77	4.93	10.67	0.042
7	Phosphorus at 50 kg/ha + $FeSO_4$ at 5 kg/ha	24.97	4.80	10.78	0.043
8	Phosphorus at 50 kg/ha + $FeSO_4$ at 10 kg/ha	25.30	4.97	10.72	0.042
9	Phosphorus at 50 kg/ha + $FeSO_4$ 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 + $FeSO_4$ at 5 kg/ha	94.80	1.13	27.67	900.00	1533.33	37.02
2	Phosphorus at 20 kg/ha + $FeSO_4$ at 10 kg/ha	97.47	1.33	27.73	910.00	1596.67	36.34
3	Phosphorus at 20 kg/ha + $FeSO_4$ at 20 kg/ha	97.80	1.47	27.73	936.67	1706.67	35.46
4	Phosphorus at 30 kg/ha + $FeSO_4$ at 5 kg/ha	98.67	1.53	27.80	996.67	1793.33	35.73
5	Phosphorus at 30 kg/ha + $FeSO_4$ at 10 kg/ha	99.67	1.53	29.40	1033.33	1853.33	35.79
6	Phosphorus at 30 kg/ha + $FeSO_4$ at 20 kg/ha	104.47	1.53	29.73	1036.67	1856.67	35.81
7	Phosphorus at 50 kg/ha + $FeSO_4$ at 5 kg/ha	109.33	1.53	30.40	1110.00	1930.00	36.50
8	Phosphorus at 50 kg/ha + $FeSO_4$ at 10 kg/ha	110.00	1.80	30.47	1153.33	1973.33	36.87
9	Phosphorus at 50 kg/ha + $FeSO_4$ 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	-

CONCLUSION

It was concluded that application of 50 kg/ha Phosphorus with 20 kg/ha Iron (treatment 9) recorded higher seed yield and maximum net returns and benefit cost ratio in lentil crop.

REFERENCES

1. **Ali, A., Ahmad, B., Hussain, I., Ali, A., Shah, F. A. 2017.** Effect of phosphorus and zinc on yield of lentil. *Pure and Applied. Biology.,* **6**(4):1397-1402.

2. **Brar, J. S. and Sidhu A S. (1992).** Effect of Rhizobium Inoculation under Different Levels of Phosphorus and Molybdenum on N, P, and Mo contents of straw and Seeds of Moong (*Phaseolus aureus* Roxb.).

3. **Chaubey AK, Kushik MK & Singh SB (1999)**. Response of lentil to phosphorus and zinc sulphate nutrition. *Crop Res Hasar* **17**: 309-12.

4. **Datta, S.K., Sarkar, M.A.R. and Uddin, F.M.J. (2013).** Effect of variety and level of phosphorus on the yield and yield components of lentil. *International Journal of Agricultural Research Innovation Techology*. **3:** 78-82.

5. **Erskine, W., Saxena, N. P. and Saxena, M. C. (1993).** Iron deficiency in lentil: Yield loss and geographic distribution in a germplasm collection. *Plant Soil* **151:** 249-254.

6. **Fatima, K., Hussain, N., Pir, F.A. and Mehdi, M. (2013).** Effect of nitrogen and phosphorus on growth and yield of lentil (*Lens culnaris*). *Elixir Applied Botany* **57:** 14323-14325.

7. **Goud AS, Singh R, Chhetri P. (2021)** Effect of Spacing and Phosphorus Levels on Growth and Yield of Lentil (Lens culinaris Medikus). *Biological Forum – An International Journal*. **13**(4):181-184.

8. **Jayapaul P & Ganesaraja V (1990).** Studies on response of soybean varieties to nitrogen and phosphorus. *Indian Journal Agriculture* **35**: 329-330.

9. **Kuldeep, Kumawat, P. D., Bhadu, V., Sumeriya, H. K. and Kumar, V. (2018).** Effect of iron and zinc nutrition on growth attributes and yield of chickpea (*Cicer arietinum* L.) *International Journal of current Microbiology and Applied Sciences,* 7(8): 2837-2841.

10. **Landge, S. K., S. U. Kakade, P. D. Thakare., A. P. Karunakar and D. J. Jiotode. (2002).** Response of soybean to nitrogen and phosphorus. *Paistan. journal Genotypes Sciences.* **3**(3): 653-655.

11. **Lindsay, W.L. and Norwell, W.A. (1969).** Development of a DTPA micronutrient soil test. *Soil Science Annual. Procedures* **35**(1): 600-602.

12. **Meena, K. K., Meena, R. S., Kumawat, S. M. 2013**, Effect of sulphur and iron fertilization on yield attributes, yield and nutrient uptake of mungbean (*Vigna radiata) Indian Journal of Agricultural Sciences* **83** (4): 472–6.

13. **Nasar, J., Shah, Z. 2017.** Effect of iron and molybdenum on yield and nodulation of lentil. *ARPN Journal of Agricultural and Biological Science* **12 (**11).

14. **Prasad, U. K., Prasad, T. N., Mishra, R. B. 1995**. Effect of irrigation and phosphorus on yield, moisture use and phosphorus uptake of late-sown lentil (lens culinaris) in calcareous soil. *Indian Journal f Agricultural Scieces* **65** (3): 178-81.

15. **Prajapati JP, Santosh Kumar, Singh RP, Kushwaha IK, Yadav PK. (2013).** Effect of Phosphorus and Sulfur on Growth, Yield Attributes and Yield of Green Gram (Vigna radiata L.). *Environment and Ecology*. **31**(4A):1977—1979.

16. **Rasheed, M., Jilani, G., Shah, I.A., Najeeb, U. and Iqbal, T. (2010).** Improved lentil production by utilizing genetic variability in response to phosphorus fertilization. *Soil and Plant Sciences.* **60:** 485-493.

17. **Sakal, R., Singh, B.P. and Singh, A.P. (1984)** Determination of threshold value of iron in soils and plants for the response of rice and lentil to iron application in calcareous soil. *Plant and Soil* **82**: 141–148.

18. **Saleh SA (1976).** Response of six soybean varieties to phosphorus fertilizer at wadi Jizan region, Saudi Arabia. *Annals Agricultural Sciences Moshtohor* **5**: 3-10.

19. **Sharief A. E and Said El. M. 1998**. Response of lentil productivity to phosphorous fertilizer levels and some micronutrients. Proc. 8th Conf. Agron., *Suez Canal University*., Ismailia, Egypt, 28-29, November. pp. 326-34.

20. **Singh OB, Shama HB & Singh VK (1999).** Effect of nitrogen, phosphorus and rhizobium culture on yield and yield attributes of lentil under dry land conditions. DeptAgron G.B Pant University Agri & Tech Pantnagar Distt. Udham Singh Nagar 263145, India. *Ind J Pulses Research* **12**: 260-2.

21. **Singh, K.K., Srinivasarao, Ch. and Ali, M. (2005).** Root growth, nodulation, grain yield, and phosphorous use efficiency of lentil as influenced by phosphorus, irrigation, and inoculation. Commun. *Soil Science and Plant Anal*. **36:** 1919-1929.

22. **Tahir, M., A. Ali, N. Aabidin, M. Yaseen and H. Rehman. (2011).** Effect of molybdenum and seed inoculation on growth, yield and quality of mungbean. *Genotypes and Environment.* **2**(2): 37-40.

23. **Togay, Y., Togay, N., Dogan, Y. (2008)** Research on the effect of phosphorus and molybdenum applications on the yield and yield parameters in lentil (*Lens culinaris* Medic.) *African Journal of Biotechnology* **7** (9): 1256-1260.

24. **Trivedi, A. K., Hemantaranjan, A. and Pandey, S. K. 2011**. Iron application may improve growth and yield of soybean. *Indian Journal of plant Physiology*, 16(3/4): 309-313.

25. **Zeidan, M.S. 2007**, Effect of Organic manure and Phosphorus Fertilizers on Growth, Yield and Quality of Lentil Plants in Sandy Soil. *Research Journal of Agriculture and Biological Sciences*, **3**(6): 748-752.