Original Research Article

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

ABSTRACT

A field experiment was conducted during *Rabi* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) on the topic "Influence of Phosphorus and Iron on Yield and Economics 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 + $FeSO_4$ at 20 kg/ha) recorded significantly 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 %), gross returns (1,00,266.67 INR/ha), net returns (66,866.71 INR/ha) and B:C ratio (2.00) as compared to other treatments.

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

Introduction

The family Leguminasae includes lentils (*Lens culinaris* Medic). Legumes like lentils are a healthy food source. It is one of the oldest annual grains and legumes that is grown and consumed the most in the world, and is primarily eaten as dhal. As early as 6000 B.C., lentil was grown in South Western Asia. In addition to having a high concentration of the important amino acids isoleucine and lysine, lentils also include other nutrients such nutritive fibre, folate, vitamin B_1, and minerals **(Rozan *et al*., 2001)**. Because it contains a high amount of protein, lentil is also referred to as "poor man's meat." Lentils are also enjoyed equally by all socioeconomic strata in South East Asia **(Bhatty, 1988)**. As a thick soup made from whole grains or split pulses known as "dhal," lentils are frequently consumed. Its seeds can be fried and eaten, while lentil flour is excellent for soups, stew purées, bread and pastries made with cereal, as well as for adding softness to cuisine **(Williams and Singh, 1988).**

The Indus subcontinent, which includes Pakistan, the Middle East, and many other nations, uses lentil as a main course, a side dish, or in salads. It is used as a substitute for meat in vegetarian diets in some places. South East Asia is where lentils are most frequently cultivated. The most well-known nations for the production and cultivation of lentil include India, Canada, Turkey, Bangladesh, Iran, China, Nepal, and Syria, among many more countries. On an area of 19.6 thousand hectares, lentils are grown in Pakistan during the winter as the second-most important pulse crop, after chickpea, with an annual production of 9.7 thousand tonnes and an average grain yield of 541 kg ha-1 **(GOP, 2013)**, which is a very low yield and cannot satisfy the demands of the growing population. Due to the spread of various illnesses and weed infestations, the area used to cultivate lentils is gradually decreasing.

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

YIELD PARAMETERS

Number of pods/plant

Treatment 9 with (Phosphorus at 50 kg/ha + $FeSO_4$ at 20kg/ha) recorded significantly highest Number of pods per plant (113.07). However, treatments with (Phosphorus at 50 kg/ha + $FeSO_4$ at 10kg/ha) and (Phosphorus at 50 kg/ha + $FeSO_4$ at 20kg/ha) were statistically at par with the (Phosphorus at 50 kg/ha + $FeSO_4$ at 20kg/ha).

It might be the reason of moderate plant nutrients availability due to which the plant produce more pods 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 similar with that of (**Saleh, 1976) and (Jayapaul *et al.* 1990).**

Number of seeds/pod

Treatment 9 with (Phosphorus at 50 kg/ha + $FeSO_4$ at 20kg/ha) recorded significantly highest Number of seeds per pods (1.93). However, treatments with (Phosphorus at 50 kg/ha + $FeSO_4$ at 10kg/ha), (Phosphorus at 50 kg/ha + $FeSO_4$ at 5 kg/ha), (Phosphorus at 30 kg/ha + $FeSO_4$ at 20 kg/ha), (Phosphorus at 30 kg/ha + $FeSO_4$ at 5 kg/ha), (Phosphorus at 30 kg/ha + FeSO4 at 10 kg/ha). (Phosphorus at 30 kg/ha + $FeSO_4$ at 20 kg/ha), and (Phosphorus at 20 kg/ha + $FeSO_4$ at 20 kg/ha) were statistically at par with the (Phosphorus at 50 kg/ha + $FeSO_4$ at 20kg/ha).

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.* (2002) and Tahir *et al.* (2011)** in chick pea.

Test weight (g):

Highest test weight (31.20 g) was recorded in Treatment 9 with application of (Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha), though there was significant difference among the treatments.

The possible reason for thousand grain weight could be the effect of cell division, phosphorus contents present inside the seed as well as the formation of albumin and fats **(Ali *et al.*, 2017).**

Seed Yield (kg/ha):

Treatment 9 with (Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha) recorded the highest seed yield (1253.33 kg/ha). However, treatment with Phosphorus at 50 kg/ha + $FeSO_4$ at 10kg/ha was statistically at par with the (Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha).

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) and (Singh *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 N2 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.

Stover yield (kg/ha)

Treatment 9 with (Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha) recorded the highest stover yield (2073.33 kg/ha). However, treatments with Phosphorus at 50 kg/ha + $FeSO_4$ at 10kg/ha and Phosphorus at 50 kg/ha + $FeSO_4$ at 5kg/ha were statistically at par with the (Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha).

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) and (Zeidan, 2007) and Rasool and Singh (2016)** in lentil. 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).**

Harvest Index (%)

Treatment 9 with (Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha) recorded the highest harvest index (37.67 %).

Each increment of P from (25 to 75 kg ha^{-1}) gave superior HI value of lentil **(Fatima *et al.*, 2013),** however, the low HI at low level of P might be due to poor development of plant.

ECONOMICS

Cost of cultivation varied due to Phosphorus and different levels of Iron. Highest cost of cultivation was seen in treatment 9 with Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha (31,649.96 INR/ha) and lowest was seen in the control (28,549.96 INR/ha).

Gross returns varied due to Phosphorus and different levels of Iron on Yield and Yield components of Lentil. Highest Gross returns were seen in treatment 9 with Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha (1,00,266.67 INR/ha) and lowest Gross returns were seen in the treatment control (70,400.00 INR/ha)

Net Returns varied due to Phosphorus and different levels of Iron on Yield and Yield components of Lentil. Highest Net returns were seen in the treatment 9 with Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha (66,618.71 INR/ha) and lowest Gross returns were seen in the treatment control (41,850.04 INR/ha)

Highest B: C Ratio was recorded with the treatment 9, Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha (2.17) and lowest B: C Ratio was seen in the treatment Phosphorus at 20 kg/ha + $FeSO_4$ at 20 kg/ha (1.39).

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

Sl No.	Treatments	Number of pods/plant	Number 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	-

Table 2: Influence of Phosphorus and Iron on Economics of Lentil.

Sl No.	Treatments	Total cost of cultivation (INR/ha)	Gross Returns (INR/ha)	Net Returns (INR/ha)	B:C ratio
1	Phosphorus at 20 kg/ha + $FeSO_4$ at 5 kg/ha	29099.96	72000.00	42900.04	1.47
2	Phosphorus at 20 kg/ha + $FeSO_4$ at 10 kg/ha	29849.96	72800.00	42950.04	1.44
3	Phosphorus at 20 kg/ha + $FeSO_4$ at 20 kg/ha	31349.96	74933.33	43583.37	1.39
4	Phosphorus at 30 kg/ha + $FeSO_4$ at 5 kg/ha	29199.96	79733.33	50533.37	1.73
5	Phosphorus at 30 kg/ha + $FeSO_4$ at 10 kg/ha	29949.96	82666.67	52716.71	1.76
6	Phosphorus at 30 kg/ha + $FeSO_4$ at 20 kg/ha	31449.96	82933.33	51483.37	1.64
7	Phosphorus at 50 kg/ha + $FeSO_4$ at 5 kg/ha	29399.96	88800.00	59400.04	2.02
8	Phosphorus at 50 kg/ha + $FeSO_4$ at 10 kg/ha	30149.96	92266.67	62116.71	2.06
9	Phosphorus at 50 kg/ha + $FeSO_4$ at 20 kg/ha	31649.96	100266.67	68616.71	2.17
10	Control (RDF 20-40-20 NPK/ha)	28549.96	70400.00	41850.04	1.47

CONCLUSION

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

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