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Effect of Spacing and Phosphorus Levels on Growth and Yield of Lentil (*Lens culinaris* Medikus)

Anpur Saikiran Goud[1], Rajesh Singh[2] and Punnam Chhetri[3]

[1]M.Sc. Scholar, Department of Agronomy, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.
[2]Assistant Professor, Department of Agronomy, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.
[3]Ph.D. Scholar, Department of Agronomy, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.

(Corresponding author: Anpur Saikiran Goud)*
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ABSTRACT: A field experiment was carried out during *Rabi season in* 2020 at the Crop Research Farm (CRF), Department of Agronomy, Naini Agricultural Institute (NAI), SHUATS, Prayagraj, Uttar Pradesh. The soil of the experiment field is sandy-loamy texture. The organic carbon content is low and nitrogen, phosphorus is available in medium level and potassium is low. The treatments consisted of Spacing viz., 25 cm × 10 cm, 30 cm × 10 cm and 35 cm × 10 cm and Phosphorus levels viz., 40 kg P/ha, 50 kg P/ha and 60 kg P/ ha, whose effect is observed in lentil (K-75). The experiment was planned in a RBD (Randomized Block Design) with nine treatments replicated three times. The result showed that the treatment with 35 cm × 10 cm + P with 60 kg/ha application recorded significantly higher plant height (32.58 cm), number of branches/plant (8.60), number of nodules/plant (10.33), Dry weight of the plant (12.73 g/plant), number of pods/plant (112.00), number of seeds/pod (1.47), test weight (32.85) and harvest index (32.82 %). The maximum grain yield (1519.75 kg/ha), Stover yield (3241.65 kg/ha), gross returns (79128.25 Rs./ha), net returns (53153.25 Rs./ha) and B: C (2.05) were higher in the treatment of 30 cm × 10 cm + P at 60 kg/ha.

Keywords: Lentil, Spacing, Phosphorus levels and Grain yield.

INTRODUCTION

Lentil (*Lens culinaris* Medikus) is one of the major cold season winter legume crops in India, which is the second major legume sown in winter after chickpea. Lentil is an essential food legume grown during the winter season across the Indian continent under many agroecological conditions, soil types and cropping systems, in areas with extremely cold winters. It is considered the meat of the poor and the cheapest source of protein for a group of disadvantaged people who cannot afford animal protein (Gowda and Kaul, 1982). The product obtained from cultivated lentils is the seed, which is a valuable food for humans containing an excessive amount of protein (22,034.5%), carbohydrates (65%) and various minerals and vitamins (Yadav *et al.,* 2007). The seeds are commonly eaten as dal in soups and the flour can be combined with cereal flour and used in cakes, breads and some baby foods (Muehlbauer *et al.,* 1995).

Spacing is one of the essential traits that can be manipulated to harvest the maximum production per unit area. With increased spacing the total population decreases, but with more nutrients the plant grows better and produces more vice versa. On the other hand, even a very small population can decrease the yield (Pookpakdi and Pataradilok, 1993). Proper spacing ensures much less competition for sunlight, space, water and nutrients, and provides additional yield under favorable moisture conditions. Through ideal spacing efficient utilization of solar radiation and vitamins takes place and promotes the growth of plants both in their aerial and underground parts and thus increase grain yield (Miah *et al.,* 1990).

Phosphorus is an essential macro-element for the growth of legumes. Phosphorus is essential in plant metabolism which plays an important role in many plant functions including energy storage and transfer, photosynthesis, transformation of sugars and starches, movement of nutrients in the plant and the transfer of genetic traits from one generation to another. Phosphorus is a constituent of ATP, nucleic acid, phospholipids, ADP, sugar phosphate, phytin, proteins and many coenzymes. Phosphorus increases root proliferation, nodulation and nitrogen fixation in legumes, increases dry matter production and seed yield (Sepetoglu, 2002; Sharma and Sharma, 2004; Balyan and Singh, 2005). This will increase the hardness of the crop and also improve the quality of the crop and improve the resistance of the crop to disease (Mann, 1968).

MATERIALS AND METHODS

The experiment was carried out during the *Rabi* season, in 2020 at the Crop Research Farm (CRF), Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh. CRF is located on the correct side of the Yamuna River and across the city of Prayagraj. This area is located at latitude 25°57 ′N, longitude 87°19'E and at an elevation of 98 m above mean sea level. All the facilities needed for cultivation were available. The experiment was laid in Randomized Block Design with nine treatments replicated three times. The treatments consisted of spacings, 25cm × 10cm, 30cm × 10cm and 35cm × 10cm and phosphorus levels 40 kg P/ha, 50 kg P/ha and 60 kg P/ha, the effect of which is observed kg/ha, (T2) 25 cm × 10 cm + Phosphorus 50 kg/ha, (T3) 25 cm × 10 cm + Phosphorus 60 kg in lentil (K-75). The treatment combinations are as follows (T1) 25 cm × 10 cm + Phosphorus 40/ha, (T4) 30 cm × 10 cm + Phosphorus 40 kg/ha, (T5) 30 cm × 10 cm + Phosphorus 50 kg/ha, (T6) 30 cm × 10 cm + Phosphorus 60 kg/ha, (T7) 35 cm × 10 cm + Phosphorus 40 kg/ha, (T8) 35 cm × 10 cm + Phosphorus 50 kg/ha, (T9) 35 cm × 10 cm + Phosphorus 60 kg/ha. The Recommended dose of fertilizer is 20:40:20kg/ha NPK. The fertilizer was applied in the form of Urea, Single super phosphate and Muriate of potash at the time of sowing. The growth parameters were recorded at periodic intervals of 20, 40, 60, 80,100 DAS and at harvest plants selected at random in each treatment.

RESULT AND DICUSSION

The present investigation was carried out at the crop Research Farm, SHUATS to assess the effect of Spacing and Phosphorus levels on growth and yield of Lentil (*Lens culinaris* Medikus)

Growth Parameters: Data present in the present Table 1. The results of the present investigation revealed that T_9 (35 cm × 10 cm + P at 60 kg/ha) significantly increased the plant height (32.58 cm) at harvest stage as compared to all treatments which was significantly at par with T_8 (35 cm × 10 cm + P at 50 kg/ha)30.83 cm and T_6 (30 cm × 10 cm + P at 60 kg/ha) 30.61 cm. Plant height was increased due to application of phosphorus in the soil, which increases the availability of plant nutrients might have increased photosynthetic capacity and the translocation of metabolites in different parts which ultimately increased the root and shoot development of the crop. These findings corroborate the results of Yumnam *et al.,* (2018); Singh and Singh (2014) in lentil.

At harvest the maximum number of branches per plant were observed in T_9 (35 cm × 10 cm + P at 60 kg/ha) (8.60). However, 7.47 was recorded in T_8 (35 cm × 10 cm + P at 50 kg/ha), 7.33 was recorded in T_3 (25 cm × 10 cm + P at 60 kg/ha) and 7.20 was recorded in T_6 (30 cm × 10 cm + P at 60 kg/ha) which were statistically at par with T_9 (35 cm × 10 cm + P at 60 kg/ha). Number of branches per plant was influenced significantly by different spacing and phosphorus levels. Number of branches per plant was increased due to more horizontal growth and plant canopy area under wider spacing. Due to less plant density and competition, plant get sufficient light, air and nutrition for better growth and development under wider spacing as compared to those in closer spacing (Bahadur and Singh, 2005); (Tungoe *et al*., 2018). The potential of lentil to produce more branches per plant can be increased with the increases Each in the level of phosphorus (Rasheed *et al*., 2010).

At 100DAS the number of nodules per plant was significantly higher in the treatment T9 (35 cm × 10 cm + P at 60 kg/ha) with 18.13 nodules per plant. Treatments T6 (30 cm × 10 cm + P at 60 kg/ha) 16.33 and T8 (35 cm × 10 cm + P at 50 kg/ha) 16.80 were statistically at par with T9 (35 cm × 10 cm + P at 60 kg/ha). 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 nodules per plant. These results are confirmed by the results of another researcher, Togay *et al.,* (2008); Patel *et al.,* (2017); Masih *et al.,* (2020).

Table 1: Effect of Spacing and Phosphorus levels on yield attributes and yield of Lentil.

Treatments	Plant height (cm) At harvest	Branches/plant At harvest	Nodules/plant 100 DAS	Dry matter accumulation (g/plant) At harvest
25 cm × 10 cm + P at 40 kg/ha	25.87	5.60	13.53	10.07
25 cm × 10 cm + P at 50 kg/ha	27.89	6.53	14.87	10.24
25 cm × 10 cm + P at 60 kg/ha	28.38	7.33	16.13	10.35
30 cm × 10 cm + P at 40 kg/ha	27.71	6.80	13.53	10.72
30 cm × 10 cm + P at 50 kg/ha	28.95	6.87	14.87	11.56
30 cm × 10 cm + P at 60 kg/ha	30.61	7.20	16.33	11.79
35 cm × 10 cm + P at 40 kg/ha	28.27	6.53	16.27	11.08
35 cm × 10 cm + P at 50 kg/ha	30.83	7.47	16.80	12.24
35 cm × 10 cm + P at 60 kg/ha	32.58	8.60	18.13	12.73
F-Test	S	S	S	S
SEm ±	1.20	0.49	0.61	0.47
CD (P=0.05)	3.59	1.47	1.83	1.41

At harvest the maximum dry weight was observed in T_9 (35 cm × 10 cm + P at 60 kg/ha) (17.69 g). However, 17.01 g was recorded in T_8 (35 cm × 10 cm + P at 50 kg/ha), 16.38 g was recorded in T_6 (30 cm × 10 cm + P at 60 kg/ha) and 16.06 g T_5 (30 cm × 10 cm + P at 50) kg/ha which were statistically at par with T_9 (35 cm × 10 cm + P at 60 kg/ha). Wide row spacing helped in better photosynthetic activity due to greater exposure to light and increased availability of nutrients to plants might have also resulted in higher dry weight of the plant. Results reported by Dutta *et al.,* (2020); Khan *et al.,* (2017); Masih *et al.,* (2020).

Yield attributes: Observations regarding yield attributes are reported in Table 2. The T9 treatment with 35 cm × 10 cm + P at 60 kg/ha recorded the maximum number of pods per plant (112.00), the number of seeds per pod (1.47) and test weight (32.85 grams). Fertilization with phosphorus increases the availability of other plant nutrients which increased the accumulation of carbohydrates and their remobilization to the reproductive parts of the plant, being the nearest sink. Phosphorus is known to encourage flowering and fruiting, which may have stimulated plants to produce more pods per plant and also allows more seeds to develop per pod. Fertilization with phosphorus resulted in much better granulation, enhancement and improvement occurring in 1000 seed weights with increasing doses of phosphorus. Similar results have been reported by Dogan *et al.,* (2014); Abid *et al.,* (2017); Saleh (1976); Yumnam *et al.,* (2018); Shah *et al.,* (2000).

Yield. Observations for grain yield, Stover yield and harvest index are shown in Table 2. The maximum grain yield (1519.75 kg/ha) was observed in the T6 treatment (30 cm × 10 cm + P at 60 kg/ha). However, 1450.69 kg/ha were recorded in the T9 treatment (35 cm × 10 cm + P at 60 kg/ha) and 1353.23 kg/ha were recorded in the T3 treatment (25 cm × 10 cm + P at 60 kg/ha) statistically at par with T6 (30 cm × 10 cm + P at 60 kg/ha). The maximum yield of Stover (3241.65 kg/ha) was observed in the T6 treatment (30 cm × 10 cm + P at 60 kg/ha); however, 3017.94 kg/ha was recorded in the T9 treatment (35 cm × 10 cm + P at 60 kg/ha) which was statistically at par with T6 treatment (30 cm × 10 cm + P at 60 kg/ha). Whereas a spacing of 30 × 10 cm recorded a significantly higher seed and stover yield than a spacing of 35 × 10 cm. according to the results of Choubey *et al.,* (2013); Singh, *et al.,* (2017), Kalsariaet *et al.,* (2017); Yumnam *et al.,* (2018) in lentil.

Table 2: Effect of Spacing and Phosphorus levels on yield attributes and yield of Lentil.

Treatments	Pods/plant	Seeds/pod	Test weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
25 cm × 10 cm + P at 40 kg/ha	90.20	1.00	28.81	1034.63	2720.40	27.56
25 cm × 10 cm + P at 50 kg/ha	97.73	1.13	29.18	1273.39	2809.20	31.01
25 cm × 10 cm + P at 60 kg/ha	93.80	1.20	30.35	1353.23	2998.33	31.06
30 cm × 10 cm + P at 40 kg/ha	93.00	1.07	29.31	961.59	2836.88	25.23
30 cm × 10 cm + P at 50 kg/ha	101.20	1.27	30.54	1256.05	2964.88	29.48
30 cm × 10 cm + P at 60 kg/ha	108.07	1.33	31.14	1519.75	3241.65	31.91
35 cm × 10 cm + P at 40 kg/ha	100.07	1.20	30.08	1020.31	2810.36	26.36
35 cm × 10 cm + P at 50 kg/ha	109.93	1.40	30.93	1320.08	2861.10	31.20
35 cm × 10 cm + P at 60 kg/ha	112.00	1.47	32.85	1450.69	3017.94	32.82
F-Test	S	NS	S	S	S	S
SEm ±	3.50	0.11	0.64	63.04	74.74	0.40
CD (P=0.05)	10.50	-	1.91	189.00	224.06	1.20

The maximum harvest index (32.82 %) was observed in treatment T_9 (35 cm × 10 cm + P at 60 kg/ha). However, 31.91 % was recorded in treatment T_6 (30 cm × 10 cm + P at 60 kg/ha which was statistically at par with treatment T_9 (35 cm × 10 cm + P at 60 kg/ha). Increase in the level of phosphorus from 25 to 75 kg/ha increased the value of harvest index in lentil (Fatima *et al.*, 2013), however, the low HI at low level of phosphorus due to poor development of plant. Hence, balanced nutrition helps to increase the harvest index Singh *et al.,* (2016).

CONCLUSION

The present study clearly showed that T_6 (30 cm × 10 cm + 60 kg P/ha) has got higher grain yield (1519.75 kg/ha) and Stover yield (3241.65 kg/ha) in Lentil. It can be concluded that for obtaining higher yield of Lentil optimum spacing and phosphorus was found more effective.

FUTURE SCOPE

Since the findings were based on the research work done in one season under agro-ecological conditions of Prayagraj, it may be repeated for confirmation and farmer recommendations.

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Conflict of Interest. None.

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