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Effect of phosphorus and date of sowing on growth and yield of lentils (*Lens culinaris*)

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Abstract

A field experiment was conducted during Rabi 2024 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), medium in organic carbon (0.53 %), low in available N (165.48 kg/ha), medium in available P (27.52 kg/ha) and high in available K (212.36 kg/ha). The treatment consists of three levels of phosphorus and three different dates of sowing. The experiment was laid out in randomized block design consisting of 9 treatments replicated thrice. Significantly higher plant height (42.12 cm), number of nodules/plant (42.56), maximum plant dry weight (18.09 g/plant), number of pods/plant (50.71), test weight (37.12 g), seed yield (1749.56 t/ha) and stover yield (3886.67 t/ha) were recorded in Treatment 9 (Phosphorus 60kg/ha + 21st December).

Keywords: Planting Dates, Phosphorus, Stover yield and Economics

Introduction

Lentil (*Lens culinaris* M.) is one of the man's oldest food crops. It is an old-world grain legume food crop that was domesticated in the near East arc along with other pulses such as pea, chickpea in early Neolithic times. Lentil seed is a rich source of protein, minerals (K, P, Fe, Zn) and vitamins for human nutrition, flour is used to make soups and mixed with cereals to make bread and cakes. Furthermore, because of its high lysine and tryptophane content, its consumption with wheat or rice provides a balance in essential amino acids for human nutrition. Lentil straw is also a valued animal feed. Lentil is an important food legume grown during winter season throughout Indian continent under varied agro-ecological conditions, soil types and cropping system, in areas where winters are extremely cold. It is better preferred over chickpea and pea owing to its tolerance to frost. A major proportion of lentil crop (*Lens culinaris* Medikus) is not planted until after the harvest of rice in December. The need for raising the productivity of such crops resulted in the development of concept of late-sown lentil. The development of short-duration genotypes having lesser sensitivity to environment has provided good scope to raise a successful late-sown crop with proper agronomic management. Lentil is usually grown as a winter crop, on marginal lands where rainfall is low and soil is poor. The area planted to lentil in Jordan has decreased by more than 50 % in the last 10 years and production has also significantly decreased. At the same time, imports have been growing rapidly (Singh *et al.*, 2016) [2].

Phosphorus is a non-renewable and second most important macronutrient which is required for young tissues and performs several functions related to growth, development, and metabolism of the plant and also regulates many metabolic activities of the plant life. Phosphorus increases the hardiness of the crop and an adequate supply of phosphorus results in rapid growth. Phosphorus is the key element for successful pulse production because it is involved in root development, stalk and stem strength, flower and seed formation, crop maturity and production, N-fixation, crop quality and resistance to plant diseases by enhancing the physiological functions. It plays an important role to stimulate biological activities like nodulation, nitrogen fixation, and nutrient uptake in soil and rhizosphere environment resulting in a higher yield of legume crops. Higher phosphorus application stimulates the plant to increase the main root as well as lateral root

length which enables the plant to take large volume of water from deeper soil layers. The symbiotic parameters i.e. nodulation, nodule dry weight and leghaemoglobin content are positively influenced by phosphorus application. Proper supply of phosphorus lengthens the lentil phenology i.e. maturity period, moreover it also influences the physiological parameters i.e. harvest index, leaf area index, net assimilation rate and crop growth rate. The optimum phosphorus application enhances the yield attributes such as number of pods per plant, grains per pod and 1000-grain weight, resulting in high production. Phosphorus application makes the plant resistant against diseases i.e. root rot, collar rot and wilt by morphological and physiological changes. (Pandey *et al.*, 2015)^[1].

Planting time is familiar to influence in lentil improvement as well as progress that had impact on ultimate productivity. Planting mid-July decrease productivity and the time to physical growth has stopped. Compare with the biological clock of a Lentil plant during rainy season is one of key features that can make suitable condition to innovative district. Planting date is the most important factor affecting the yield due to change in environment and by thermo-and photosensitive effects on growth and development of lentil. Varietal responses to planting dates will be of great importance as varieties differ in their growth and development behavior under different agro-ecological situation. Most of the lentil sowings in India get deferred because of the delayed harvest of the preceding crop, which quite often happens to be paddy. So, growing of this crop after preceding rice in kharif season, farmer may not be able to sow summer crop in due time. Also, the crop suffers around the seed-filling stage due to the rising high temperatures in most of its cultivated areas. Since the growing time, thus, gets squeezed, it is imperative that early maturing varieties will be more suitable in India. Extra early varieties of lentil thus may pave the way of growing another crop in subsequent season and its potential yield is concerned. (Singh *et al.*, 2014)^[3].

Materials and Method

The experiment was conducted during the *Rabi* season 2024, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 25° 30' 42''N latitude, 81° 60' 56'' E longitude and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the *Yamuna* River by the side of Prayagraj-Rewa Road about 12 km from the city. The experiment was conducted in Randomized Block Design with 9 treatments each replicated thrice. The plot size of each treatment was 3m x 3m. The factors are Phosphorus (40kg/ha, 50 kg/ha, 60 kg/ha) and Date of Sowing (1st Sowing on 7th Nov, 2nd Sowing on 14th Nov, 3rd Sowing on 21st Nov). Lentil variety Masur BL -4 was selected for sowing. Seeds were sown in line manually. Seeds were covered with the soil immediately after sowing. The Lentil crop was sown on 7 Nov 2024, 14 Nov 2024 and 21 Nov 2024 respectively. Harvesting was done by taking 1m² area from each plot and from it five plants were randomly selected for recording growth and yield parameters. The observations were recorded for plant height, number of nodules/plants, dry weight, crop growth rate, number of pods/plants, test weight, seed yield, stover yield. The data was subjected to statistical analysis by analysis of variance method.

Result and Discussion

1. Growth parameters

Plant height (cm): At 60 DAS, a significantly higher plant

height (42.12 cm) was observed in Treatment 9 (Phosphorus 60kg/ha + 21st December). Further, Treatment 7 (Phosphorus 60kg/ha + 7th December) and Treatment 8 (Phosphorus 60kg/ha + 14th December) with plant height of (39.16 cm) and (39.77 cm) was found to be statistically at par with Treatment 9 (Phosphorus 60kg/ha + 21st December).

Number of nodules/plants: At 60 DAS, a significantly highest nodule (42.56) was observed in Treatment 9 (Phosphorus 60kg/ha + 21st December). Further, Treatment 8 (Phosphorus 60kg/ha + 14th December) (39.54) was found to be statistically at par with Treatment 9 (Phosphorus 60kg/ha + 21st December).

Dry weight (g): At 60 DAS, the highest plant dry weight (18.09 g) was recorded with Treatment 9 (Phosphorus 60kg/ha + 21st December). However, Treatment 8 (Phosphorus 60kg/ha + 14th December) (17.17 g) was found to be statistically at par with Treatment 9 (Phosphorus 60kg/ha + 21st December).

Crop Growth Rate (g/m²/day): At 45-60 DAS, a significantly higher crop growth rate (20.20 g/m²/day) was observed in Treatment 9 (Phosphorus 60kg/ha + 21st December). Furthermore, Treatment 8 (17.32 g/m²/day) (Phosphorus 60kg/ha + 7th December) was found to be statistically at par with Treatment 9 (Phosphorus 60kg/ha + 21st December).

Relative Growth Rate (g/g/day): At 45-60 DAS, a significantly higher relative growth rate (0.2031 g/g/day) was observed in Treatment 9 (Phosphorus 60kg/ha + 21st December). Moreover, Treatment 8 (Phosphorus 60kg/ha + 14th December) (0.1922 g/g/day) was found to be statistically at par with Treatment 9 (Phosphorus 60kg/ha + 21st December).

2. Yield Attributes

Number of pods/plants: The data shown that there was a significant effect among the treatments. The highest number of pods (50.71 pods) was recorded with Treatment 9 (Phosphorus 60kg/ha + 21st December). However, Treatment 7 (Phosphorus 60kg/ha + 7th December) (49.59 pods) was found to be statistically at par with Treatment 9 (Phosphorus 60kg/ha + 21st December). The lowest number of pods was recorded with Treatment 4 (Phosphorus 50kg/ha + 7th December) with (43.20 pods)

Test weight (g/plant): The data shown that there was a significant effect among the treatments. The highest test weight was recorded at Treatment 9 (Phosphorus 60kg/ha + 21st December) (37.12 g). However, Treatment 7 (Phosphorus 60kg/ha + 7th December) (35.64 g) and Treatment 8 (Phosphorus 60kg/ha + 14th December) (36.21 g) was found to be statistically at par with Treatment 9 (Phosphorus 60kg/ha + 21st December) although these was found no significant difference with all treatments.

Seed Yield (t/ha): The data shown that there was a significant effect among the treatments. The highest seed yield was recorded at Treatment 9 (Phosphorus 60kg/ha + 21st December) (1749.56 t/ha). However, Treatment 8 (Phosphorus 60kg/ha + 14th December) (1673.36 t/ha) was found to be statistically at par with Treatment 9 (Phosphorus 60kg/ha + 21st December).

Stover Yield (t/ha): The data shown that there was a significant effect among the treatments. The highest stover yield was

recorded with (3886.67 t/ha) Treatment 9 (Phosphorus 60kg/ha + 21st December). However, Treatment 8 (Phosphorus 60kg/ha + 14th December) (3713.33 t/ha) was found to be statistically at par with Treatment 9 (Phosphorus 60kg/ha + 21st December). The lowest number of pods was recorded with Treatment 1 (Phosphorus 40kg/ha + 7th December) with (2140.00 t/ha).

Harvest Index (%): The data shown that there was a significant effect among the treatments. The highest Harvest Index was recorded with (36.51%) Treatment 9 (Phosphorus 60kg/ha + 21st December). However, Treatment 8 (Phosphorus 60kg/ha + 14th December) (36.11%) was found to be statistically at par with Treatment 9 (Phosphorus 60kg/ha + 21st December).

3. Economics

Gross Returns (INR/ha): The highest gross returns (76785.36

INR/ha) were recorded in Treatment 9 (Phosphorus 60kg/ha + 21st December) and the lowest gross returns (69080.21 INR/ha) was recorded in Treatment 1 (Phosphorus 40kg/ha + 7th December).

Net Returns (INR/ha): The highest net returns (42605.36 INR/ha) were recorded in Treatment 9 (Phosphorus 60kg/ha + 21st December) and the lowest net returns (35170.2 INR/ha) was recorded in Treatment 1 (Phosphorus 40kg/ha + 7th December).

Benefit Cost Ratio (B: C): The highest benefit-cost ratio (1.25) was recorded in Treatment 9 (Phosphorus 60kg/ha + 21st December) and the lowest benefit-cost ratio (1.04) was recorded in Treatment 1 (Phosphorus 40kg/ha + 7th December).

Table 1: Effect of Phosphorus and Date of Sowing on Yield Attributes of Lentils cultivation

S. No. of Test	No. Treatment Combinations	Pods/plant weight	Seed yield	Stover yield	Harvest Index	
		(g/plant)	(kg/ha)	(kg/ha)	(%)	
	Phosphorus 40kg/ha + 7th December	44.31	31.20	1209.78	2140.00	28.39
	Phosphorus 40kg/ha + 14th December	43.60	32.16	1353.85	2353.33	29.94
	Phosphorus 40kg/ha + 21st December	45.24	32.56	1351.11	2733.33	31.14
	Phosphorus 50kg/ha + 7th December	43.20	32.80	1256.36	3100.00	31.28
	Phosphorus 50kg/ha + 14th December	44.73	33.12	1449.36	3253.33	31.25
	Phosphorus 50kg/ha + 21st December	47.61	34.02	1357.67	3423.33	33.32
	Phosphorus 60kg/ha + 7th December	49.59	35.64	1560.67	3433.33	33.07
	Phosphorus 60kg/ha + 14th December	48.39	36.21	1673.36	3713.33	36.11
	Phosphorus 60kg/ha + 21st December	50.71	37.12	1749.56	3886.67	36.51
	F-test	S	S	S	S	NS
	SEm(±)	1.15	1.17	0.53	271.9	1.28
	CD (p=0.05)	-	3.48	1.59	808.1	3.54

Table 2: Effect of Phosphorus and Date of Sowing on Economics of Lentils cultivation

S. No.	Treatment Combinations	Cost of Cultivation	Gross Returns (INR/ha)	Net Returns (INR/ha)	Benefit Cost Ratio (B:C)
	Phosphorus 40kg/ha + 7th	33910	69080.21	35170.21	1.04
	Phosphorus 40kg/ha + 14th	33920	72003.82	38083.82	1.12
	Phosphorus 40kg/ha + 21st	33930	71615.12	37685.12	1.11
	Phosphorus 50kg/ha + 7th	34050	72458.74	38408.74	1.13
	Phosphorus 50kg/ha + 14th	34080	71074.21	36994.21	1.09
	Phosphorus 50kg/ha + 21st	34060	70451.24	36391.24	1.07
	Phosphorus 60kg/ha + 7th	34150	71546.95	37396.95	1.10
	Phosphorus 60kg/ha + 14th	34210	73221.25	39011.25	1.14
	Phosphorus 60kg/ha + 21st	34180 December	76785.36	42605.36	1.25

Discussion

Late sowing date of 21st December and application of Phosphorus 60 kg/ha generally leads to higher yield attributes like plant height, number of pods and seed yield compared normal sowing and applications. One possible explanation for these enhancements is the delay of sowing time affected grain yield, plant height, primary branches per plant and the number of pods per plant. The cause of plant height reduction might be happened due to rapid increase in temperature as well as reduction of soil moisture {Tawaha *et al.*, (2002) [4]}.

Conclusion

It was concluded that application of 60 kg/ha of Phosphorus and 21st December recorded highest yield attributes and economics in Lentils.

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