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Influence of integrated phosphorus management on the growth, yield and quality of lentil (*Lens culinaris* L. Medik.)

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Abstract
A field experiment was carried out at the College of Agriculture, CAU, Imphal, Manipur during the *rabi* season of 2019-2020. The experiment was laid out in Randomized Block Design with three replications. There were nine treatments which consisted of different sole and combined application of phosphorus, organic manure and Biophos. The result indicated that application of 75% RDP + FYM @ 5 t/ha + Biophos @ 20 ml/kg seed (T_4) recorded significantly higher growth parameters over all the other treatments in terms of plant height (28.17 cm), number of branches per plant (8.23), fresh and dry weight of plant (14.60 g and 6.26 g) and also the yield attributes such as number of pods per plant (164.30), number of seeds per pod (2.57) besides higher seed and stover yield (15.50 and 19.03 q/ha) as well as crude protein content (23.28%) and crude protein yield (367.83 kg/ha) of the crop. The treatment T_4 was closely followed by T_5 (75% RDP + Vermicompost @ 2 t/ha + Biophos @ 20 ml/kg seed) in respect of seed yield and crude protein content.

Keywords: lentil, phosphorus, organic manure, biofertilizer, yield, quality

Introduction

Lentil (*Lens culinaris* L.Medik.) is a member of the leguminaceae family recognised as the most nutritious amongst the rabi pulses and ranks next only to chickpea. It is cultivated in an area of about 2.22 million hectares with an average productivity of 7312 kg/ha (FAOSTAT, 2018) [7]. The seed of lentil contains about 24% - 26% protein, 1.3% fat, 2.1% minerals, 3.2% fibre and 57% carbohydrate (Ali *et al*., 2012 and Singh *et al*., 2013) [1, 14].

Low productivity of lentil may result from inadequate and imbalanced fertilization and prevalence of suboptimum soil moisture condition. The lentil crop shows good response to phosphorus fertilization (Muhammad *et al*., 2002) [11]. Rhizobium and phosphate solubilizing bacteria are known to enhance the productivity of the crop as they increase the availability of soil nitrogen and phosphorus (El Sayed, 1999) [6]. Phosphorus is one of the macronutrients required for biological growth and development. Among the major nutrients phosphorus is considered to be one of the major limiting nutrient elements in pulse production in India, particularly in acid soils of North Eastern India, including Manipur. Phosphorus plays a vital role in cultivation of legumes as it directly enhances grain formation, stimulates early formation and growth of roots, improves nodulation, seed yield and seed crude protein content (Singh *et al.*,2014) [15].

Only a minute portion of the phosphorus added through synthetic or chemical fertilizer is utilized by the plants and a large quantity of it is transformed into insoluble fixed forms, rendering them unavailable for crop uptake. Phosphorus recovery efficiency by crops is only about 10-30% (Swarup, 2002) [17]. However, biofertilizer like phosphate solubilising bacteria (PSB) can transform fixed or unavailable phosphorus into available form through the process of mineralization thereby supplying it to plants in the required form for growth and development of the crop (Khan *et al*., 2007) [8] . With the increase in available phosphorus, the overall growth and yield of the crop can be increased.

Fertilizers are becoming costlier and the resource poor farmers cannot afford to apply the recommended dose of fertilizers. Further, it is now well realized that to protect the soil health, use of judicious combination of organic and inorganic sources of nutrients is essential. Vermicompost is one good form of organic manure which contains relatively higher amount of plant nutrients compared to other conventional organic manures.

However, non-judicious use of chemical fertilizer as well as reduction in the use of organic manures has resulted in the deterioration of soil physical and chemical properties and its productivity. Use of farm yard manure and vermicompost are some of the best options for maintaining of soil health as well as productivity and replacement of mineral fertilizers.

No one source of fertilizer is entirely adequate to fulfil the nutrient requirement of a crop and one does not serve as a substitute for another, but they complement each other. Therefore, the combination of chemical fertilizer, farmyard manure, vermicompost and biophos in the right dosage will not only prove efficient but also improve the health of the soil which plays a vital role in nutrient and moisture retention **(**Venkateswarlu and Wani, 1999) [19]. Therefore, the present investigation was carried out with the objectives to find out the best integrated phosphorus management practices for lentil.

Materials and Methods

The experiment was conducted at the Agronomy field, College of Agriculture, Central Agricultural University, Imphal during the *rabi* season of 2019-2020. The soil of the experimental field was clay in texture having pH of 5.54, medium in available nitrogen (262.3 kg/ha) and potassium (243.7 kg/ha), low in available phosphorus (18.45 kg/ha) and organic carbon content (0.8%). The minimum and maximum temperatures recorded during the period under review were 10.3 and 24.5 ^{o}C with a total rainfall of 246.4 mm and average sunshine of 8.6 hours respectively.

The experiment was laid out in Randomized Block Design (RBD) with three replications. There were nine treatments which consisted of 100% RDP (40 kg P_2O_5/ha) (T_1), 75% RDP + FYM @ 5 t/ha (T_2), 75% RDP + Vermicompost @ 2 t/ha (T_3), 75% RDP + FYM @ 5 t/ha + Biophos @ 20 ml/kg seed (T_4), 75% RDP + Vermicompost @ 2 t/ha + Biophos @ 20 ml/kg seed (T_5), FYM @ 5 t/ha (T_6), Vermicompost @ 2 t/ha (T_7), Biophos @ 20 ml/kg seed (T_8) and Control (T_9). A uniform dose of 20 kg/ha each of nitrogen and potash were applied to all the plots in furrows a day before sowing was done. The lentil variety used for the study was HUL-57. Phosphorus was applied through single superphosphate (SSP) while organic manures were supplied through farm yard manure (FYM) and vermicompost (VC) and phosphate solublising bacteria through biophos. The nitrogen was supplied through urea and potash through muriate of potash (MOP).

The nitrogen content in the seed was estimated by the modified Kjeldahl's method as proposed by Campbell and Hanna (1937**)** [2]. The protein percentage was then calculated by multiplying the per cent nitrogen with 6.25 while crude protein yield was calculated by multiplying the seed yield with the corresponding protein content and divided by 100.

Results and Discussion

Growth parameters

The results shown in Table 1 revealed that different phosphorus management significantly influenced the growth of the crop at all stages of observation. An analysis of the plant height data showed that the application of 75% RDP + FYM at 5 t/ha + Biophos at 20 ml/kg seed (T_4) resulted in significantly taller plant (12.47, 26.50 and 28.17 cm), number of branches per plant (4.70, 8.23 and 8.20), fresh and dry weight of the plant at 60, 90 DAS and at harvest. This was followed by the application of 75% RDP + vermicompost at 2 t/ha + Biophos at 20 ml/kg seed (T_5) and it was significantly higher as compared to other treatments. The improvement in the growth parameters considered could be attributed to balance nutrition from both inorganic fertilizer and organic manure besides from biofertilizer. Apart from supplying both macro and micronutrients, organic manures improve the physical structure of the soil by improving soil water holding capacity and creating a suitable environment for survival and growth of beneficial soil microbes. This must have triggered optimum growth of the crop. Increased in plant height and number of branches per plant with the integrated application of chemical phosphatic fertilizer and FYM was also observed in earlier study (Dashrath and Singh (2014) [3]. The benefit of phosphorus and phosphate solubising bacteria on growth was reported by Kumari *et al.* (2009) [9] and Singh *et al*. (2014) [15].

Yield attributes and yield

The number of pods per plant and seeds per pod was significantly increased with different phosphorus management practices either sole or in combinations with organic manure and biofertilizer as compared to control (Table 2). Treatment receiving 75% RDP + FYM at 5 t/ha + Biophos at 20 ml/kg seed (T_4) recorded the maximum number of pods per plant (164.30) and seeds per pod (2.57) which remained at par to 75% RDP + VC at 2 t/ha + Biophos at 20 ml/kg seed (T_5) in respect of pods per plant only but significantly higher to all the rest of the treatments for this two yield attributing characters. This might be due to supply of adequate dose of phosphorus through chemical fertilizer and organic manure as well as biofertilizer which led to development of more number of pods and development of more seeds per pod as phosphorus encourages flowering and fruiting in lentil. Kumawat *et al.* (2010) [10] also reported increase in yield attributes of mung bean with the application of organic manures, PSB and phosphorus fertilization. The treatment with phosphate solubilising bacteria (PSB) was found to be most effective as it enhanced the number of pods per plant and seeds per pod (Tagore *et al.* 2013) [18]. Though variation in test weight of the seed was recorded among the integrated phosphorus management practices but the differences were found to be not significant. This finding is in agreement with those of Deol *et al.* (2005) [4] and Dashrath and Singh (2014) [3].

The significantly highest seed yield (15.80 q/ha) and stover yield (19.03 q/ha) was recorded through the application of 75% RDP + FYM at 5 t/ha + Biophos at 20 ml/kg seed (T_4) followed by 75% RDP + VC at 2 t/ha + Biophos at 20 ml/kg seed (T_5). Further integration of 75% RDP + organic manures (T_2 and T_3) also recorded significantly higher seed yield than that of sole application of 100% RDP, FYM, VC and biophos. Such increment in yield may be due to increase in photosynthesis and translocation of assimilates or photosynthates to different plant parts as observed in improvement of growth parameters like plant height, number of branches per plant, plant fresh and dry weight and nodulation resulting in increased number of pods per plant and seeds per pod that were recorded through application of 75% RDP + FYM at 5 t/ha + Biophos at 20 ml/kg seed (T_4). In addition balanced phosphorus nutrition from both organic and inorganic source leads to improved seed yield of lentil as it influences early flowering and pod formation as well as regulation of many plant metabolic activities. The continuous and slow release of nutrients to the crop through integration of organic manures and chemical fertilizer also ensured that optimum yield potential of the crop is expressed. Such impact of balanced integrated phosphorus nutrition on yield has also been reported by Saket *et al.* (2014) [13] and Singh *et al.* (2018) [16]. The lowest seed yield (3.93 q/ha) was recorded in the control.

Harvest index is a measure of the physiological potential of a crop regarding its ability to convert photosynthates into economically relevant parts. According to the findings of the present research displayed in Table 2, the highest harvest index (0.46) was associated with application of 75% RDP + FYM at 5 t/ha + Biophos at 20 ml/kg seed (T_4) and the lowest (0.40) was recorded in the control. This shows that T_4 has more physiological efficiency and it might be a result of the synergistic benefits from chemical fertilizer, organic manures and biofertilizer. The finding of Zike *et al.* (2017) [20] is also in agreement with this study.

Quality

Analysis of the data on crude protein content of lentil seed recorded during this study shows that there was significant effect of the different phosphorus treatments on the crude protein content in the seed of the crop (Table 2). The maximum crude protein content (23.28%) was recorded through the application of 75% RDP + FYM at 5 t/ha + Biophos at 20 ml/kg seed (T_4) which was followed by addition of 75% RDP + VC at 2 t/ha + Biophos at 20 ml/kg seed (T_5) with the lowest (21.70%) recorded in the control. Phosphorus plays an important role in the synthesis of protein and due to the optimum integrated application of inorganic, organic manure and biofertilizers, an ideal or balanced nutrition was achieved which might have led to more synthesis of protein. Also, maximum nodulation was recorded in this treatment and this might have contributed to more nitrogen fixation, hence increased seed crude protein content. This finding is in conformity with those reported by Deshmukh and Jain (2014) [5] and Sahu *et al.* (2017) [12]. The highest crude protein yield of the crop (367.83 kg/ha) was recorded through integrated application of 75% RDP + FYM at 5 t/ha + Biophos at 20 ml/kg seed (T_4). Such increase in the crude protein yield of the crop could be due to accumulation of higher crude protein content of the seed coupled with higher seed yield. Combine application of fertilizer and biofertilizer increase the crude protein yield in lentil as per the report of Sahu *et al.* (2017) [12].

Table 1: Growth parameters of lentil as influenced by integrated phosphorus management

treatment	60 das				90 das				harvest			
	Plant height (cm)	**Branches /plant**	**Plant fresh wt. (g)**	**Plant dry wt. (g)**	**Plant height (cm)**	**Branches /plant**	**Plant fresh wt. (g)**	**Plant dry wt. (g)**	**Plant height (cm)**	**Branches /plant**	**Plant fresh wt. (g)**	**Plant dry wt. (g)**
T_1:100% RDP (40 kg P_2O_5)	10.23	3.50	2.50	1.37	20.20	6.37	8.53	3.35	22.60	6.33	10.30	4.88
T_2:75% RDP + FYM @ 5 t/ha	10.47	3.73	2.60	1.55	21.10	7.03	9.32	3.51	23.67	7.00	11.04	5.26
T_3:75% RDP + VC @ 2 t/ha	10.33	3.53	2.55	1.45	20.60	6.50	9.16	3.44	23.23	6.50	10.61	5.15
T_4:75% RDP + FYM @ 5 t/ha + Biophos @ 20 ml/kg seed	12.47	4.70	3.50	2.05	26.50	8.23	12.82	5.02	28.17	8.20	14.60	6.24
T_5:75% RDP + VC @ 2 t/ha + Biophos @ 20 ml/kg seed	11.67	4.43	3.33	1.74	23.33	7.67	11.28	4.47	25.67	7.63	13.88	6.00
T_6:FYM @ 5 t/ha	10.17	3.40	2.48	1.23	19.47	6.20	8.20	3.29	22.03	6.17	9.53	4.48
T_7: VC @ 2 t/ha	9.80	3.37	2.37	1.16	19.27	5.93	8.18	3.19	21.13	5.90	9.39	4.40
T_8: Biophos @ 20 ml/kg seed	8.80	3.10	2.16	1.01	18.13	5.03	7.03	2.80	19.93	5.00	8.72	4.19
T_9: Control (No P applied)	7.87	2.27	1.15	0.47	16.67	4.40	5.69	2.43	18.13	4.37	6.89	3.28
SE d(±)	0.28	0.19	0.16	0.08	0.67	0.23	0.51	0.11	0.48	0.21	0.37	0.23
CD (P = 0.05)	0.59	0.40	0.35	0.18	1.43	0.49	1.20	0.23	1.03	0.45	0.79	0.50

Table 2: Yield attributes and yield and quality of lentil as influenced by integrated phosphorus management

Treatment	Yield attributes and yield						Quality	
	Pods per plant	**Seeds per pod**	**Test weight (g)**	**Seed yield (q/ha)**	**Stover yield (q/ha)**	**Harvest index**	**Crude protein yield (kg/ha)**	**Crude protein yield (kg/ha)**
T_1:100% RDP (40 kg P_2O_5)	106.20	1.87	18.25	11.43	13.43	0.45	22.40	256.03
T_2:75% RDP + FYM @ 5 t/ha	129.87	1.90	18.31	12.77	15.33	0.45	22.75	290.53
T_3:75% RDP + VC @ 2 t/ha	117.94	1.88	18.29	12.23	14.77	0.45	22.58	276.15
T_4:75% RDP + FYM @ 5 t/ha + Biophos @ 20 ml/kg seed	164.30	2.57	18.56	15.80	19.03	0.46	23.28	367.83
T_5:75% RDP + VC @ 2 t/ha + Biophos @ 20 ml/kg seed	158.93	2.27	18.33	13.80	17.97	0.43	23.10	318.77
T_6:FYM @ 5 t/ha	87.84	1.83	18.23	8.77	10.23	0.45	22.05	193.37
T_7: VC @ 2 t/ha	85.47	1.80	18.23	7.80	9.17	0.44	22.05	171.97
T_8: Biophos @ 20 ml/kg seed	77.06	1.78	18.20	5.60	8.03	0.41	22.05	123.47
T_9: Control (No P applied)	60.87	1.48	17.78	3.93	5.77	0.40	21.70	85.30
SE d(±)	2.70	0.12	0.49	0.37	0.61	0.02	0.05	0.37
CD (P = 0.05)	5.72	0.26	NS	0.79	1.29	0.04	0.11	0.78

References

1. Ali MO, Zuberi MI, Sarker A. Lentil relay cropping in the rice-based cropping system: An innovative technology for lentil production, sustainability and nutritional security in changing climate of Bangladesh. J Food Sci. Engineering, 2012;2(9):52.
2. Campbell WR, Hanna MI. The determination of nitrogen by modified Kjeldahl methods. J Biol. Chem 1937;119:1-7.
3. Dashrath S, Singh RP. Effect of integrated nutrient management on growth, physiological parameters and productivity of lentil (*Lens culinaris* Medik.). Int. J Agric. Sci 2014;10(1):175-178.
4. Deol MS, Kahlon CS, Kaur K. Effect of phosphate solubilizing bacteria, farmyard manure and phosphorous on growth and yield of lentil (*Lens culinaris* Medik.). Dept. Agron., GB Pant Univ. Agri. and Tech. Pantnagar 2005;5:78.
5. Deshmukh C, Jain A. Effect of integrated nutrient management on protein content of lentil seeds under rainfed condition. Int. J Pl. Sci., 2014;9(1):193-195.
6. El Sayed SAM. Influence of *Rhizobium* and phosphate solubilizing bacteria on nutrient uptake and yield of lentil in the New Valley (Egypt). Egyptian J Soil Sci 1999;39(2):175-186.
7. FAOSTAT. Agricultural Data: Agriculture and Food Trade. Rome, Italy: FAO 2018. Available at http://faostat.fao.org (Accessed 18 July 2020).
8. Khan MS, Zaidi A, Wani PA. Role of phosphate – solubilising microorganisms in sustainable agriculture- A Review. Agron. sustainable Dev 2007;27:29-43.
9. Kumari M, Vasu D, Ul-Hasan Z, Dhurwe UK. Effects of PSB (Phosphate Solubilizing Bacteria) on morphological characters of Lens culinaris Medic. Biol. Forum 2009;1(2):5-7.
10. Kumawat N, Sharma OP, Kumar R, Kumari A. Yield and yield attributes of mung bean (*Vigna radiata* L. Wilczek) as affected by organic manures, PSB and phosphorus fertilization. Environ. Ecol 2010;28(1A):332-335.
11. Muhammad H, Shah SH, Nazir SM. Differential genotypic response to phosphorus application in lentil (*Lens culinaris* Medik). Int. J Agri. Bio., 2002;4(1):61-63.
12. Sahu G, Chatterjee N, Ghosh GK. Integrated nutrient management in lentil (*Lens culinaris* Medikus) in red and lateritic soils of West Bengal. Bull. Env. Pharmacol. Life Sci 2017;6(4):55-62.
13. Saket S, Singh SB, Namdeo KN, Parihar SS. Effect of organic and inorganic fertilizers on yield, quality and nutrients uptake of lentil Ann. Pl. Soil Res 2014;16(3):238-241.
14. Singh AK, Bhatt BP, Singh KM, Upadhyaya A. An Analysis of Oilseeds and Pulses Scenario in Eastern India during 2050-51. J Agril. Sci 2013;5(1):241-249.
15. Singh S, Singh H, Singh J, Sharma VK. Effect of integrated use of rock phosphate, molybdenum and phosphate solubilizing bacteria on lentil (*Lens culinaris* Medik) in an alluvial soil. Indian J Agron 2014;59(3):433-438.
16. Singh SR, Kundu DK, Dey P, Singh P, Mahapatra BS. Effect of balanced fertilizers on soil quality and lentil yield in Gangetic alluvial soils of India. J Agril. Sci 2018;156(2):225-240.
17. Swarup A. Lessons from long term fertilizer experiments in improving fertilizer use efficiency and crop yields. Fertilizer news 2002;47(12):59-73.
18. Tagore GS, Namdeo SL, Sharma SK, Kumar N. Effect of Rhizobium and phosphate solubilizing bacterial inoculants on symbiotic traits, nodule leghemoglobin, and yield of chickpea genotypes. Int. J Agron 2013. http://dx.doi.org/10.1155/2013/581627
19. Venkateswarlu B, Wani SP. Bio-fertilizers: An important component of integrated plant nutrient supply (IPNS) in dry lands. Fifty years Dryland Agril. Res. India, CRIDA, Hyderabad, 1999, 379-394.
20. Zike T, Abera T, Hamza I. Response of Improved Lentil (*Lens culinaris* L. Medik.) Varieties to Phosphorus Nutrition on Vertisols of West Showa, Central Highlands of Ethiopia. Adv. Crop Sci. Tech 2017;5:315. doi:10.4172/23298863.1000315