

Original Research Article

Productivity of Lentil (*Lens culinaris* L.) as influenced by different biofertilizers and phosphorus regimes.

ABSTRACT

A field experiment was conducted during winter season of 2012-2013 at Agronomy Research Farm, CSKHPKV, Palampur, HP to evaluate the effect of biofertilizers and phosphorus levels on lentil. The experiment consisted of 16 treatments comprising of four levels each of biofertilizer (UI, In_{Rh}, In_{PSB} & In_{Rh + PSB}) and phosphorus (0, 20, 40 & 60 kg P₂O₅/ha). Seed and straw yield of lentil was significantly influenced by the different treatments. Significantly higher yield of lentil was obtained in the plots sown with inoculated seed over uninoculated seed (UI). Higher seed as well as straw yield was recorded in the plots treated with phosphorus application over control (Po). The highest yield was recorded in the plots received phosphorus @ 60 kg P₂O₅ per hectare but the maximum response (kg seed/ kg P₂O₅) was at P₄₀. Interaction between biofertilizers and phosphorus levels was also significant in respect of seed as well as straw yield. The maximum yield was recorded in the plots sown with inoculated seed with both biofertilizers and applied 60 kg P₂O₅ per ha (In_{Rh+PSB} + P₆₀).

Key words: Lentil, seed and straw yield, phosphorus, rhizobium, phosphate solubilizing bacteria

INTRODUCTION

Lentil (*Lens culinaris* L.) is an important winter pulse crop grown in Indian sub-continent. In Himachal Pradesh, lentil is the second important rabi pulse crop after chickpea. The area under lentil in H.P. is 600 ha and its productivity is about 667 kg/ha which is low as compared to the national average (Anonymous, 2007-08). Lentil like other pulse crops has been given the secondary importance and is grown on marginal lands with low fertility and receives sub-optimal fertilizer application. It has shown good response to the application of phosphorus as reported by Chaubey *et al* (1990) and Muhammad *et al* (2012). Rhizobium and phosphate solubilizing bacteria are known to benefit the crop by increasing the availability of soil nitrogen and phosphorus (El Sayed, 1999). The present investigation was carried out to evaluate the effect of biofertilizers and phosphorus levels on lentil production.

MATERIAL AND METHODS

A field experiment was conducted during winter season of 2012-13 at Agronomy Research Farm, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh. The experimental site was silty clay loam in texture and acidic in reaction. The fertility status of the soil was low in available nitrogen medium in both phosphorus and potassium. There are 16 treatments comprising of four levels each of phosphorus and biofertilizer and tested in randomized block design (RBD) with three replications having plot size of 3.1 x 3.3m. The field experiment sown with variety HPL-5 in early December, 2003. Row to row spacing was 30 cm. Phosphorus was given through single super phosphate (16% P₂O₅). The crop was also given 10 kg/ha basal dose of nitrogen through urea. The healthy seeds of lentil were inoculated with rhizobium and phosphate solubilizing bacteria cultures before sowing.

RESULTS AND DISCUSSION

Effect of rhizobium

Seed inoculation with rhizobium (In_{Rh}) significantly increased (11%) the seed yield over the uninoculated seed treatment (Table 1). It may be due to increase in the availability of soil nitrogen to the plants for increased growth and development as rhizobium present in root nodules of lentil fix atmospheric nitrogen. Kantar *et al* (1994) and Selim (1995) also reported the similar findings.

Effect of phosphate solubilizing bacteria

Seed inoculated with phosphate solubilizing bacteria produced significantly higher seed as well as straw yield. Seed yield recorded in the plots sown with seed inoculated with PSB was 7% and 9% higher as compared to seed inoculated with rhizobium and uninoculated seed, respectively (Table 1). The phosphate solubilizing bacteria help to release unavailable soil phosphorus and may increase the efficiency of applied phosphatic fertilizers. Similar results have also been reported by Gaur (1990).

Combined effect of rhizobium and phosphate solubilizing bacteria

Combined inoculation with rhizobium and phosphate solubilizing bacteria produced the highest seed and straw yield (Table). Increase of 29% in seed yield and 17% in straw yield was recorded in the plots treated with both rhizobium and phosphate solubilizing bacteria. This may be due to the increased availability of nitrogen and phosphorus to the plants which in turn results into enhanced absorption of nutrients. El Sayed (1999) also observed the same effect.

Effect of phosphorus

Phosphorus application significantly increased both the seed and straw yield of lentil (Table). The highest seed yield was produced with 60 kg P_2O_5 /ha but the maximum response (kg seed/ kg P_2O_5) was with 40 kg P_2O_5 /ha. Phosphorus @ 60 kg P_2O_5 /ha gave 61%, 57% and 11% higher seed yield over P_0 (control), P_{20} and P_{40} , respectively. It may be due to the favourable effect of phosphorus on root and root nodulation development at initial stages and on yield components at later stages. The present results corroborate to the findings of Khare *et al* (1988).

Interaction effect of biofertilizers and phosphorus levels

Seed inoculation with both rhizobium and phosphate solubilizing bacteria in combination with phosphorus @ 60 kg P_2O_5 /ha significantly increased the seed and straw yield of lentil. The higher seed and straw yield was recorded in the plots treated with both rhizobium and phosphate solubilizing bacteria combined with application of phosphorus @ 60 kg P_2O_5 /ha. These results are in conformity with those of Azad *et al* (1991).

CONCLUSIONS

It can be concluded that lentil responded to phosphorus application upto 60 kg P_2O_5 /ha but the maximum response, kg seed per kg P_2O_5 was with 40 kg P_2O_5 /ha. Seed inoculated with rhizobium and phosphate solubilizing bacteria in combination was proved to be superior over inoculation with either of biofertilizers. Interaction among rhizobium, phosphate solubilizing bacteria and phosphorus application was significant.

REFERENCES

1. Anonymous. Fertilizer Statistics 2008-09.
2. Azad AS, Gill AA, Dhaliwal HS. Response of phosphorus and *Rhizobium* culture on grain yield of lentil. *Lens*. 1991; 18(1-2):14-19.
3. Chaubey AK, Kuashik MK, Singh SB. Response of lentil to phosphorus and zinc sulphate nutrition. *Crop Research Hisar* .1999; 17(3): 309-312.
4. El Sayed SAM. Influence of *Rhizobium* and phosphate solubilizing bacteria on nutrient uptake and yield of lentil in the New Valley (Egypt). *Egyptian Journal of Soil Science*. 1999; 39(2):175-186.
5. Gaur AC. Phosphate solubilizing micro-organisms as biofertilizers. Omega Scientific Publishers New Delhi pp. 176. 1990
6. Kantar F, Kiziloglu T, Caglar O, Akten S. Lentil yield in relation to *rhizobium leguminosarum* inoculations in eastern Anatolia. *Lens Newsletter*. 1994; 21(2):36-40.
7. Khare JP, Tomar GS, Tiwari UK, Sharma HL. Response of lentil to nitrogen and phosphorus levels under rainfed conditions in central India. *Lens Newsletter*. 1998; 15(2):12-14.
8. Muhammad H, Shah SH, Nazir SM. Differential genotypic response to phosphorus application in lentil (*Lens culinaris medic*). *International Journal of Agriculture and Biology*. 2012; 4(1):61-63.
9. Selim MM. . Rhizobial inoculation and fertilization on lentil grown under new reclaimed sandy soil conditions. *Egyptian Journal of Agronomy*. 1995; 20(1-2): 137-151.

Table 1 Effect of biofertilizers and phosphorus levels on the growth of lentil

Treatment	No. of plants/m ²		Plant height (cm)			Dry matter accumulation			No. of nodules/Plant	
	90 DAS	120 DAS	90 DAS	120 DAS	At Harvest	90 DAS	120 DAS	At Harvest	90 DAS	120 DAS
P₀	58	50	11.75	21.83	24.83	24.33	52.88	130.18	4.00	6.16
P₂₀	75	71	12.41	23.41	27.00	28.53	62.36	146.19	4.25	6.83
P₄₀	87	83	41.08	26.66	29.41	33.00	70.04	185.97	4.75	8.00
P₆₀	96	93	15.08	27.41	29.91	36.29	78.73	201.70	6.00	8.75
C.D. at 5%	11.98	9.37	1.16	2.28	2.10	1.87	7.76	20.47	0.73	1.14
UI	73	70	12.66	23.25	26.16	29.69	60.30	154.94	4.08	6.74
In_{Rh}	76	74	13.16	24.58	27.66	29.61	64.62	159.63	4.91	7.41
In_{PSB}	79	75	13.16	25.41	27.91	29.69	63.85	163.92	4.66	7.24
In_{Rh+PSB}	88	84	14.33	26.08	29.41	33.16	75.24	185.54	5.33	8.33
C.D at 5%	NS	9.37	1.16	NS	2.10	1.87	7.76	20.47	0.73	NS

Table 2 Effect of biofertilizers and phosphorus levels on yield attributes and yield of lentil

Treatment	No. of plants/m ² (At harvest)	No. of primary branches/plant	No. of pods/plant	No. of seeds/pod	Test weight (g)	Biological yield kg/ha	Seed yield kg/ha	Straw yield kg/ha	Harvest index (%)
P₀	57	3.83	49.91	1.68	2.40	139.4	492	902	35
P₂₀	68	4.33	54.91	1.71	2.41	1480	506	974	34
P₄₀	82	5.08	70.33	1.79	2.57	2012	713	1299	35
P₆₀	88	5.33	78.41	1.80	2.561	2192	794	1377	36
C.D. at 5%	5.78	0.61	4.61	0.02	0.14	83.49	26.68	75.01	NS

UI	64	4.25	54.16	1.72	2.48	1612	544.8 0	106 7	34
In_{Rh}	74	4.67	62.41	1.75	2.50	1737	605.1 5	113 2	35
In_{PSB}	74	4.58	66.16	1.74	2.45	1770	649.0 0	112 1	36
In_{Rh+PSB}	79	5.08	70.83	1.77	2.57	1959	706.4 8	125 3	35
C.D at 5%	5.78	0.61	4.61	0.02	NS	83.49	26.68	75.0 1	1.6

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142 **Table 3 Effect of biofertilizers and phosphorus levels on nutrient content,**
143 **uptake of lentil**

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Treatmen t	Nitrogen content (%)		Phosphorus content (%)		Protei n conten t (%)	Nitrogen uptake kg/ha		Phosphorus uptake kg/ha		Availabl e N kg/ha	Availabl e P kg/ha
	See d	Stra w	Seed	Stra w		Seed	Stra w	See d	Stra w		
P₀	3.57	2.48	0.37	0.30	22.35	17.61	22.53	1.84	2.79	190.76	12.39
P₂₀	3.62	2.51	0.47	0.36	22.65	18.34	24.47	2.40	3.56	220.08	15.75
P₄₀	3.66	2.54	0.59	0.39	22.91	26.01	33.10	4.24	5.07	238.04	20.55
P₆₀	3.77	2.54	0.62	0.40	23.60	30.03	35.55	4.99	5.61	257.60	25.64
C.D. at 5%	NS	0.02	0.02	0.02	NS	2.70	1.71	0.20	0.35	3.99	1.40
UI	3.60	2.46	0.48	0.34	22.49	19.66	26.29	2.70	3.70	190.08	14.64
In_{Rh}	3.67	2.51	0.48	0.35	22.96	22.31	28.58	3.09	4.04	237.05	16.31
In_{PSB}	3.65	2.54	0.53	0.38	22.85	23.70	28.59	3.60	4.34	217.81	21.19
In_{Rh+PSB}	3.71	2.55	0.55	0.39	23.21	26.32	32.19	4.08	4.95	261.55	22.19
C.D at 5%	NS	0.02	0.02	0.02	NS	2.70	1.71	0.20	0.35	3.99	1.40

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