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Effect of Rhizobium and PSB in Combination with Phosphorus on the Enrichment of Soil Fertility and its Effect on Yield of Green Gram (*Vigna radiata* L.)

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A B S T R A C T

The field experiments were conducted during kharif season for the two consecutive years at the crop research farm, Department of soil science, RRS Wadura, Sopore, SKUAST-K to study the effect of PSB, Rhizobium and different levels of phosphorus on growth, nutrient uptake, yield of green gram (*Vigna radiata* L) and soil properties. Different levels of phosphorus (30, 60 and 90 kg/ha) as per treatment and bio-fertilizers (Rhizobium and PSB) were applied. The combined application of phosphorus @ 60 kg/ha and Rhizobium resulted in significant higher plant height (cm), no of branches, no of leaves, no of nodules, available N, P and K in soil. It gave highest yield (14.39 q/ha).

Introduction

Legume is widely recognized to be a symbol of agricultural economy, being a major source of protein for vegetarian human diet and improve the soil fertility by their nitrogen fixing capability. Pulses contain a higher percentage of quality protein nearly three times as much as cereals, thus they are a cheaper source to overcome protein malnutrition among human being. It is generally believed that a starter dose of nitrogen enhances the yield of crop. The continuous drain upon the nitrogen resources of the soil and the necessity for higher crop yield has led to an ever increasing emphasis on the means of covering the limited supply of element. As a major single supplier of biologically fixed nitrogen legume – Rhizobium symbiosis is at the foremost. In this regard the use of biological nitrogen fixation (BNF) technology in grain legumes can be an alternative to expensive urea fertilizer, particularly for improving the production of food legume. Inoculation with efficient *Rhizobium* culture to different legumes is a common agronomic practice for enhancing pulse production (Bhatt *et al.*, 2014). Bio-fertilizers such as (PSB) solubilise insoluble soil phosphates like tri-calcium

phosphates and produce plant growth substances in soil. Among various bio-fertilizers Rhizobium is of paramount importance. Rhizobium fixes atmospheric nitrogen in symbiosis with legumes. Phosphorus plays a key role in various physiological processes concerning root and dry matter production, nodulation and N_2 fixation and also in metabolic activities especially in protein synthesis (Bhatt *et al.*, 2013) reported same. The study was therefore undertaken to find out the effect of different levels of phosphorus and bio-fertilizers on soil fertility and yield of green gram.

Materials and Methods

A plot experiment was undertaken at SKUAST K RRS/FOA wadura, Sopore, during kharif season for the two consecutive years. Composite soil sample collected from the field to a depth of 0-15 cm were air dried, grinded and passed through 2mm sieve for physical and chemical analysis. The soil used for cultivation of the crop was clay loam in texture, with ph of 7.2, O.C 0.6mg/kg and CEC of 14.7c mol (P^{-1}) kg. The experiments were laid out in factorial randomized block design with three replications. The variety tested was (Shalimar moong-1). Different levels of phosphorus 30, 60 and 90kg/ha as per treatments and bio-fertilizers (Rhizobium and PSB) were applied. Green gram seeds were inoculated with bio-fertilizers three hours before sowing. The control plot was supplied with basal dose of NPK only. In other plots N & K were supplied as basal but P was applied @ 30, 60 and 90kg/ha.

Results and Discussion

The data presented in the Table 1a, b and c clearly shows that the treatments had significant effect on plant height (cm), No of branches/plant, No of leaves/plant and No of nodules/plant. The treatments comprising of bio-fertilizer Rhizobium with Phosphorus @ 60kg/ha showed the best results. The greater plant height was recorded due to the treatment (comprising of Rhizobium + phosphorus @ 60kg/ha) while the minimum plant height was associated with the control plot. The increase in such case may be due to increased cell division and elongation on one hand and also the genetic character of variety, thus, lending further advantage to the height of plant. Our results confirm the findings of Prasad, S. K. *et al.*, 2014). Maximum no. of branches/plant were obtained with the treatment (Rhizobium+phosphorus@60kg/ha). This was also observed by Tiwari *et al.*, (2015). Rhizobium inoculation with added P@60kg/ha recorded the maximum number of leaves/plant which was found to be significantly higher than the remaining treatment combinations. It was also been reported by Majengo *et al.*, (2011). The no of nodule/plant was significantly increased with the application of Rhizobium and P@60kg/ha which was also reported by Solaiman *et al.*, (2003) and Das *et al.*, (1997). This might be due to presence of adequate population to Rhizobium and equally benefited by Rhizobium inoculation. The results are in accordance with the studies conducted by Prasad, S. K. *et al.*, (2014).

Data presented in Table 2a, b and c showed that % organic carbon was influenced by rhizobium inoculation alone while there was less impact of the treatment rhizobium in combination with phosphorus levels. Our results are same with the findings of Tiwari (2015). The available nitrogen & potassium significantly increased with the increasing levels of phosphorus levels of phosphorus and with rhizobium inoculation while as the available phosphorus increased with the levels of phosphorus & PSB inoculation. This was also observed by Rathour *et al.*, (2015).

T_1 (a) Effect of phosphorus levels on growth and yield of green gram

Parameters	Phosphorus levels											
	I st year						2nd year					
	P_0	P_{30}	P_{60}	P_{90}	Sem	CD 5%	P_0	P_{30}	P_{60}	P_{90}	SEM	CD 5 %
Plant height (cm)	57.50	58.73	60.10	60.07	0.33	0.68	57.96	59.20	61.18	61.18	0.30	0.63
No of Branches	24.73	6.50	7.97	8.40	0.23	0.97	7.00	7.77	10.11	10.33	0.20	0.42
No of leaves	6.40	27.81	35.08	34.95	0.95	1.47	25.55	28.78	38.55	38.22	1.22	2.52
Nodules/plant	7.10	8.10	9.20	9.10	0.17	0.35	8.55	13.77	13.89	13.77	0.70	1.45
Seed yield (q/ha)	10.68	11.89	12.14	12.22	0.17	0.35	10.14	11.40	11.47	11.42	0.22	

T_1 (b) Effect of bio-fertilizers on growth and yield of green gram

Parameters	Phosphorus levels									
	I st year					2nd year				
	B_0	B_{RH}	B_{PSB}	Sem	CD 5%	B_0	B_{RH}	B_{PSB}	SEM	CD 5%
Plant height (cm)	57.50	60.23	59.80	0.26	0.54	57.96	63.03	59.66	0.28	0.59
No of Branches	6.40	9.55	10.20	0.20	0.41	7.10	11.63	7.44	0.20	0.42
No of leaves	24.73	36.33	25.84	0.82	1.71	25.55	34.57	23.55	1.05	2.18
Nodules/plant	7.10	19.44	7.20	0.15	0.30	16.66	10.00	16.66	0.60	1.25
Seed yield (q/ha)	10.68	12.62	12.37	0.19	0.40	12.43	12.78	12.43	0.15	0.30

T_1 (c) Effect of phosphorus levels and bio-fertilizers on growth and yield of green gram

Parameters	Year	Interaction of bio-fertilizers with Phosphorus levels							
		$B_{RH}P_{30}$	$B_{RH}P_{60}$	$B_{RH}P_{90}$	$B_{PSB}P_{30}$	$B_{PSB}P_{60}$	$B_{PSB}P_{90}$	SEM	CD5%
Plant height (cm)	I st	60.83	62.00	63.03	60.07	60.20	60.60	0.52	1.08
	2nd	63.45	65.44	65.75	63.03	63.49	63.45	0.57	1.18
No of Branches	I st	12.07	12.50	12.23	11.47	11.90	11.77	0.39	0.81
	2nd	10.33	12.22	11.22	9.44	11.33	11.11	0.40	0.83
No of leaves	I st	41.07	44.15	43.02	28.21	29.51	29.53	1.65	3.42
	2nd	43.67	45.22	45.22	34.66	39.11	39.33	2.11	4.37
Nodules/plant	I st	10.33	10.67	11.10	8.00	9.00	9.33	0.29	0.61
	2nd	21.22	24.89	24.89	18.44	21.22	21.11	NS	NS
Seed yield(qt/ha)	I st	12.95	14.62	14.45	12.48	13.80	13.73	0.38	0.79
	2nd	12.32	14.17	14.15	12.46	13.46	13.45	0.29	0.11

T_2 (a) Effect of phosphorus levels on %organic carbon and available nutrient in soil

Parameters	Phosphorus levels											
	I st year						2nd year					
	P_0	P_{30}	P_{60}	P_{90}	Sem	CD 5%	P_0	P_{30}	P_{60}	P_{90}	SEM	CD 5%
%Organic carbon	0.56	0.51	0.55	0.56	0.01	0.02	0.57	0.53	0.54	0.56	0.01	0.02
Available (N)	198	199	201	211	1.52	3.14	196	197	203	213	2.17	4.51
Available (P)	20	20.1	21	21.94	0.15	0.32	20.6	21.1	21.6	21.9	0.09	0.19
Available (K)	243	1 243	243.67	243	0.26	0.54	0 253	1 252	1 255	0 253	0.78	1.62

T_2 (b) Effect of bio-fertilizers on %organic carbon and available nutrient in soil

Parameters	Bio-fertilizer Levels									
	I st year					2nd year				
	B_0	B_{RH}	B_{PSB}	Sem	CD 5%	B_0	B_{RH}	B_{PSB}	SEM	CD 5%
%Organic carbon	0.56	0.62	0.54	0.01	0.02	0.57	0.58	0.54	0.01	0.01
Available (N)	198	236	199	1.31	2.72	196	227	192	1.88	3.90
Available (P)	20	21.33	23.00	0.13	0.28	20.60	20.90	21.33	0.08	0.17
Available (K)	243	245	242	0.22	0.46	253	256	258	0.68	1.41

T_2 (c) Effect of phosphorus levels and bio-fertilizers on %organic carbon and available nutrient in soil

Parameters	Year	Interaction of bio-fertilizers with Phosphorus levels							
		$B_{RH}P_{30}$	$B_{RH}P_{60}$	$B_{RH}P_{90}$	$B_{PSB}P_{30}$	$B_{PSB}P_{60}$	$B_{PSB}P_{90}$	SEM	CD5%
%Organic carbon	I st	0.67	0.66	0.67	0.55	0.56	0.56	0.02	0.04
	2nd	0.60	0.64	0.68	0.56	0.50	0.56	0.01	0.03
Available (N)	I st	237	239	237	199	198	198	2.63	5.45
	2nd	238	239	236	198	197	196	3.77	7.81
Available (P)	I st	21	21	21.67	22.32	22.35	23.10	0.27	0.55
	2nd	21	21.64	22.11	22.22	22.34	23.35	0.16	0.33
Available (K)	I st	244	245	248	242.67	242	242	0.45	0.93
	2nd	256.57	257	256.33	251	254.33	251	1.36	2.88

Highest yield was observed by the treatment combination comprising of (Rhizobium + P_2O_5 @60kg/ha).Influence of Rhizobium might have helped in better nodulation and subsequently helped in increasing availability of nitrogen, an important nutrient to have influenced the yield. Vanitha, M., *et al.*, (2014) reported the same.

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