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Short Communication

EFFECT OF *RHIZOBIUM* INOCULATION AND PHOSPHORUS LEVELS ON YIELD ATTRIBUTES AND YIELD OF SUMMER MUNGBEAN

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Pulses play a very important role in human diet as a source of protein because of their high protein content (20-30 %). Green gram (*Vigna radiata* L.) is an excellent source of high quality protein. Among pulses it occupies prominent place and is growing popularly by virtue of the high nutritional value, short growth period, low cost production and adaptability in the off season. *Rhizobium* inoculation has been proved as cheapest source in place of nitrogen fertilizer input for better crop yield particularly in legumes. Mungbean is capable of fixing atmospheric nitrogen through *Rhizobium* species living in root nodules. In natural ecosystems, phosphorus availability in soil is governed by dynamic equilibrium that exists between solid and solution phage vis-à-vis soil constituents affecting transformation of applied phosphorus. Both phosphorus status and P fixing capacity of soil strongly influences the phosphorus availability (Bhal and Aulakh, 2003). Keeping the above facts in view, the present study was undertaken to furnish the information on response of summer mungbean variety to *Rhizobium* and phosphorus levels on yield and yield attributes.

The present investigation was carried out under field conditions in summer season, 2011 at Student Instructional Farm, Narendra Deva University of Agriculture & Technology, Faizabad (Uttar Pradesh). The experimental field was silt loam in texture, slightly alkaline in reaction (pH 8.15) and low organic carbon (3.8 g kg^{-1}), low available nitrogen (220 kg ha^{-1}) medium in phosphorus (14 kg ha^{-1}) and potassium (260 kg ha^{-1}). The Indian variety of mungbean NDM-1 was taken as a test crop. The eight treatment combinations comprising with 4 levels of phosphorus (0, 20, 40, and 60 kg P_2O_5 ha^{-1}) and with and without *Rhizobium* under randomized block design replicated as thrice. A uniform basal dose of 20 kg N and 40 kg K_2O ha^{-1} was applied through urea and muriate of potash, respectively. The phosphorus (as per treatment) was applied as basal through single super phosphate and *Rhizobium* culture (*Rhizobium leguminoserum*) specific to mungbean was applied by seed treatment. Three irrigations excluding pre sowing irrigation were applied as per need of the crop. The plant height, branches per plant, measured at harvest of the crop. The pods per plant, grain per pod, test weight, grain and straw yield were recorded. Straw yield was obtained by subtracting the seed yield from total biological yield. The chemical properties of soil such as pH, EC, organic carbon, available nitrogen, phosphorus, potassium were determined as per procedures described by Jackson (1973).

Table 1: Effect of *Rhizobium* and phosphorus on yield attributes, yield and economics of mungbean

Treatment	Pods $plant^{-1}$	Grain pod^{-1}	Test weight (g)	Grain yield (qha^{-1})	Straw yield (qha^{-1})	Harvest Index	Net income (₹ ha^{-1})	B:C Ratio
Control (Inoculation)	40.47	10.03	32.16	9.29	30.40	23.40	24362	1:53
Rhizobium	43.15	10.69	34.30	9.89	32.38	23.45	25114	1:57
Sem±	0.60	0.22	0.49	0.18	0.68	0.50	-	-
CD (P=0.05)	1.74	0.63	1.43	0.53	1.97	NS	-	-
Phosphorus (kg ha^{-1})								
0	35.76	8.87	28.40	8.23	26.91	23.31	19908	1:31
20	42.20	10.45	33.55	9.37	30.66	23.41	24299	1:52
40	44.33	10.98	35.23	10.25	33.75	23.30	25934	1:55
60	44.94	11.13	35.74	10.50	34.23	23.47	26124	1:49
Sem±	0.85	0.31	0.70	0.26	0.96	0.71	-	-
CD (P=0.05)	2.47	0.89	2.02	0.75	2.78	NS	-	-

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The data (Table1) clearly indicated that the pods plant^{-1} increased with increasing levels of phosphorus up to 60 kg P_2O_5 ha^{-1}. The maximum number of pods plant^{-1} (44.94) was recorded with 60 kg P_2O_5 ha^{-1} which was significantly superior to 20 kg ha$^{-1.}$ *Rhizobium* inoculation resulted into significant increase in pods plant^{-1} registering an increase of 6.2 % over the un-inoculated. The number of grain per pod also significantly increased with increasing level of phosphorus up to 40 kg P_2O_5 ha^{-1}. The highest number of grain pod^{-1} (11.13) was recorded with 60 kg P_2O_5 ha^{-1} and showed an increase of 20.3 % and 6.1% over control and 20 kg P_2O_5 ha^{-1}, respectively. *Rhizobium* inoculation produced significant difference in number of grains per pod, showing an increase of 6.2 % over un-inoculated. Phosphorus application resulted into significant increase in test weight and highest value (35.7g) was recorded with 60 kg P_2O_5 ha^{-1}. *Rhizobium* inoculation resulted in significant increase in test weight by 6.2% over un-inoculated. Kumpawat (2008) also reported that application of 45 kg P_2O_5 ha^{-1} recorded significantly highest 1000-seed weight.

Table 2: Effect of various treatments on N and P uptake by crop

Treatment	Nitrogen				Phosphorus			
	Seed	Straw	Total	Percent increase	Seed	Straw	Total	Percent increase
Control (Inoculation)	35.5	14.5	50.1	-	9.0	2.7	11.7	-
Rhizobium	39.2	15.5	54.8	9.2	10.1	3.2	13.4	14.3
CD (P=0.05)	3.5	0.91	3.10	-	1.10	0.59	1.72	-
Phosphorus levels (kg ha-^{1})								
0	29.9	11.8	41.8	-	7.0	2.1	9.2	-
20	35.9	14.4	50.3	20.5	9.4	2.7	12.2	32.3
40	41.9	16.5	58.4	39.8	10.9	3.3	14.3	55.4
60	42.9	17.1	60.0	43.7	11.3	3.4	14.7	59.9
CD (P=0.05)	3.10	1.03	4.70	-	0.52	0.13	1.06	-

The application of phosphorus resulted in an increase in grain and straw yield with increasing level of phosphorus up to 40 kg P_2O_5 ha^{-1} but maximum grain and straw yields were recorded with 60 kg P_2O_5 ha^{-1}. *Rhizobium* inoculation increased grain and straw yield significantly over without inoculation. The higher yield components, grain and straw yield was also reported by Ali *et al. (*2010), application of 40 kg P_2O_5 ha-^{1} significantly increased growth and yield attributes and seed yield (802 kg/ha) over control but remained at par with 20 kg P_2O_5 ha-^{1} (Rathour *et al.*, 2015). Nitrogen and phosphorus uptake was significantly influenced by different fertility levels and maximum nitrogen (60.0 kg ha^{-1}) and phosphorus (14.7 kg ha^{-1}) uptake was recorded with 60kg P_2O_5 ha^{-1}. Seed inoculation with *Rhizobium* culture increased significantly the uptake of N and P as compared to control. The treatment, *Rhizobium* +20 kg P_2O_5 produced the maximum net return of ₹. 27629 ha^{-1} closely followed by *Rhizobium* +40 kg P_2O_5 (₹. 26774 ha^{-1}). Return per Rupee invested was maximum (1.67) with *Rhizobium* +20 kg P_2O_5 closely followed by (1.64) *Rhizobium*+40 kg P_2O_5. It was because of higher productivity of mungbean under combined application of *Rhizobium* culture and phosphorus and consequently with a higher market price of the produce.

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