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Influence of Biofertilizers on Yield and Phosphorus Uptake at Various Levels of Phosphorus in Mungbean (*Vigna radiate* L. Wilczek.)

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Abstract

A field experiment was carried out during the summer season of 2004 to study the influence of biofertilizers and phosphorus levels on yield and P uptake of Mung bean. The experiment was laid out in factorial randomized block design. The treatments comprised four phosphorus levels (0, 30, 60 and 90 kg P_2O_5/ha) and three biofertilizers (VAM, PSB and *Rhizobium*). The seed and straw yield increased significantly with the application of biofertilizers and phosphorus levels ; however their interaction had non-significant effect. Quadratic response of mungbean seed yield to biofertilizers was recorded and VAM was found more efficient among biofertilizers with minimum physical, maximum and optimum economic doses ; 60 kg P_2O_5/ha was found optimum along with biofertilizers with respect to yield. Among all the treatments VAM along with 60 kg P_2O_5/ha was found to be better in registering seed yield, straw yield and P uptake.

Key words : Biofertilizers, Yield, Phosphorus uptake, Mungbean.

The year 2007-08 has been a successful year for pulse production in India as for first time it has crossed the mark of 15 million tones which has cemented the country as the largest pulse producer in the world with 25% of share in global production from 32% area (1). Mungbean is an important grain legume throughout south and southeast Asia. It is easily digestible free from flatulence, rich in protein and iron. Besides nourishing its people, the cultivation of mungbean can sustain the soils of Asia by adding nitrogen through rhizobial symbiosis. Mungbean requires less nitrogen but phosphorus is considered important input to get high yield per unit area. Phosphorus is known to encourage the formation of new cells to promote the root and shoot growth and to hasten the flowering, seed formation and maturity. Phosphorus is one of the major nutrients limiting plant growth. Most of the soils throughout the world are P deficient (2), and therefore require P to replenish the P demand by crop plants. To circumvent the P deficiency in soils, P fertilizers are applied. However, after application, a considerable amount of P is rapidly transformed into less available forms by forming a complex with Al or Fe in acid soils (3) or Ca in calcareous soils (4) before plant roots have had a chance to absorb it. The use of biofertilizers not only increases availability of other nutrients but also has been found to increase overall phosphorus use efficiency. Very less literature is available about response of biofertilizers with respect to different phosphorus levels. The potential of regulating the translocation of assimilates by phosphorus and biofertilizers would prove more rewarding by hastening the partitioning of dry matter for yield formation. Taking these under consideration the following experiment was laid out.

Methods

A field experiment was conducted at Agronomy Crop Research Farm, Amer Singh college (Lakhaoti), 28^0 N longitude and 77^0 E latitude and at an altitude of 201.48 m amsl during summer season of 2004. The climate of the experimental site was semi-arid and subtropical with hot dry summer and severe cold winter. The average annual rainfall of this region is 703.75 mm. The soil of the experimental site was sandy loam, neutral (7.5 pH), low in organic carbon (0.47%), available nitrogen (154 kg/ha), available phosphorus (9.20 kg/ha), available potash (203 kg/ha). The experiment was laid out in factorial randomized block design. The treatments comprised four phosphorus levels (0, 30, 60 and 90 kg P_2O_5/ha) and three biofertilizers (VAM,

Table 1. Effect of biofertilizers on seed yield, straw yield and harvest index at various levels of phosphorus in mungbean.

Biofertilizers	Seed yield (q/ha) Rhizobium	PSB	VAM	Mean	Straw yield (q/ha) Rhizobium	PSB	VAM	Mean	Harvest index (%) Rhizobium	PSB	VAM	Mean
Phosphorus Levels (kg/ha)												
0	5.76	5.83	6.05	5.88	18.45	18.58	18.77	18.60	23.63	23.72	24.14	23.83
30	6.75	6.85	7.29	6.96	20.28	20.28	20.60	20.43	24.83	24.92	25.34	25.03
60	6.97	7.05	7.26	7.09	20.58	20.58	20.90	20.73	25.21	25.30	25.72	25.41
90	6.99	7.06	7.28	7.11	20.86	20.86	21.18	21.01	25.0	25.09	25.51	25.20
Mean	6.61	6.74	6.90		20.04	20.04	20.36		24.7	24.75	25.17	

CD (P=0.05) Biofertilizers : 0.0223 Phosphorus levels : 0.025 B × P : NS

PSB and Rhizobium). These comprise 12 treatments which were replicated thrice. Variety Pusa Vishal was selected for the experiment. The observations on seed yield and straw yield were recorded. Phosphorus uptake in seed and straw was recorded as per standard procedures. Response curve of quadratic type of equation $Y = a + bP + cP^2$ was fitted using least square technique as given in Snedecor and Cochran 5. The physical maximum and economic doses were derived by differentiating the above function.

Results and Discussion

Yield and Harvest Index

Seed yield, straw yield and harvest index were significantly influenced with varying type of biofertilizers and phosphorus levels (Table 1), however, interaction of biofertilizers and phosphorus levels was found to have non-significant effect. The non-significant effect of interaction was mainly due to different response of biofertilizers to varying phosphorus levels. A consistent and significant increase in seed yield and straw yield was obtained with increase in phosphorus levels from 0 to 60 kg P_2O_5/ha and further increase did not show any significant increase in yield. In fact 90 kg P_2O_5/ha resulted significant decrease in harvest index. The seed yield of mungbean significantly augmented with the application of phosphorus over control. This may perhaps be due to the reason that phosphorus helped in proliferation of root system and thus resulted in increasing the nutrient absorption by increasing the absorbing surface area which in turn increases yield (6) Among biofertilizers VAM was found to be superior in registering the seed yield and straw yield however in terms of harvest index PSB was found better. The response of mungbean upto 60 kg P_2O_5/ha with the biofertilizers was also reported by Ahmad et al. (7).

P Uptake and P Harvest Index

The P uptake by seed and straw and P harvest index were significantly influenced by application of biofertilizers and phosphorus levels (Table 2). How-

Table 2. Effect of biofertilizers on phosphorus uptake and P-harvest index at varying levels of phosphorus in mungbean.

Biofertilizers	P-Uptake Seed (kg/ha) Rhizobium	PSB	VAM	Mean	Straw (kg/ha) Rhizobium	PSB	VAM	Mean	P-Harvest index (%) Rhizobium	PSB	VAM	Mean
Phosphorus Levels (kg/ha)												
0	2.54	2.61	2.73	2.62	2.41	2.58	2.66	2.55	51.21	50.30	50.59	50.70
30	3.076	3.15	2.27	3.16	2.81	2.98	3.06	2.95	52.28	51.36	51.66	51.77
60	3.24	3.31	3.43	3.33	2.96	3.14	3.21	3.10	52.25	51.34	51.64	51.74
90	3.28	3.35	3.47	3.37	3.0	3.17	3.25	3.14	52.26	51.34	51.65	51.75
Mean	3.03	3.11	3.22		2.79	2.96	3.04		52.0	51.09	51.38	

CD (P = 0.05) Biofertilizers : 0.0134 Phosphorus levels : 0.0116 B × P : NS

Table 3. Response curve of phosphorus levels under the influence of different biofertilizers in green gram.

Biofertilizers	Functions	R^2	Physical optimum dose (kg/ha)	Optimum economic dose
Rhizobium	$578.85 + 3.72\ P - 0.0269\ P^2$	0.98	69.00	65.51
PSB	$586.15 + 3.82\ P - 0.0281\ P^2$	0.98	67.98	64.50
VAM	$611.60 + 4.27\ P - 0.0339\ P^2$	0.92	62.97	60.10

ever, their interaction affected insignificantly to P uptake. The high P uptake by seed (3.47 kg/ha) was obtained with the application 90 kg P_2O_5/ha along with VAM, however it was at par with VAM and 60 kg P_2O_5/ha. Among biofertilizers VAM was found more efficient in increasing phosphorus uptake in seed and straw. The superiority of VAM over PSB and Rhizobium in phosphorus uptake was also reported by Thakur and Panwar (8). P- harvest index was significantly improved with the application of phosphorus at 30 and 60 kg P_2O_5/ha, however at 90 kg P_2O_5/ha it was found to be at par with 60 kg P_2O_5/ha. The insignificant response of P uptake and P harvest index above 60 kg P_2O_5/ha indicates that P applied was sufficient at 60 kg for optimum grain production. Khan et al. (9) also reported at par response of 60 and 90 kg P_2O_5/ha phosphorus levels.

Response Analysis

Application of P induced a linear increase in the beginning but with further increase in levels of P, subsequent increase in yield was at decreasing rate as a result of which green gram seed yield recorded quadratic response to P application (Table 3). The physical optimum level of phosphorus and optimum economic dose of phosphorus were worked out by differentiating the response functions ; it was relatively less in VAM followed by PSB.

However, maximum physical optimum phosphorus dose (69 kg P_2O_5/ha) was observed in Rhizobium inoculated plots. Also less difference between physical optimum and optimum economic doses of phosphorus was seen in VAM. This clearly suggests that the response to applied P in green gram crop gets altered, according to type of biofertilizers inoculated. Further it was observed VAM along with 60 kg P_2O_5/ha was optimum in registering the maximum yield. Thus at very high dose of P, higher yields can be obtained only after genotypically increasing the sink capacity of the crop.

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