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Growth, nodulation and yield components of mung bean (*Vigna radiata*) as affected by phosphorus in combination with rhizobium inoculation

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Mungbean (*Vigna radiata* L.) is capable of fixing atmospheric nitrogen through bacteria living in its root nodules. To study the influence of phosphorus (P) fertilization and *Rhizobium* inoculation on the nodulation, growth and yield of mungbean (*Vigna radiata*), a pot experiment was conducted in wire house, during spring season of 2010 at University of Agriculture, Faisalabad. A composite soil sample was collected from the research area and analysis of physical and chemical properties of the soil was done. Seeds of mungbean cv, NM-92 were inoculated with *Rhizobium* and sown in pots containing 14 kg soil. Phosphorus was applied at 1.2, 2.4 and 3.6 g per 14 kg soil in each pot alone and along with inoculation of Rhizobium phaseoli except in control pot. The source of P was single super phosphate that was mixed with soil before filling the pots. It was noted that combined use of P and inoculant enhanced the number of nodules per plant. The maximum nodules, 8.67 per plant, were recorded where 3.6 g P along with *Rhizobium* inoculation was applied. Phosphorus application along with *Rhizobium* inoculation increased the plant height significantly (13.2%) over control. Maximum increase in plant height at maturity, total number of pods and number of grains per pod were also recorded where 3.6 g of phosphorus along with *Rhizobium* inoculation was applied.

Key words: Mungbean, growth, nodulation, phosphorus, inoculation.

INTRODUCTION

Mungbean (*Vigna radiate* L), commonly known as green gram, is an important conventional pulse crop of Pakistan. In most of the Asian countries, the diet is cereal based. It is a rich source of protein (23%) (Hussain et al., 2010). It has the ability to fix atmospheric nitrogen (N) through *Rhizobium* species, living in nodules on its roots. The area sown under this crop in the year 2008-2009 was 231.1 thousand hectares with a production of 157.4 thousand tons (Govt. of Pakistan, 2009). The rate of nodulation is very low in most of the mungbean growing

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area of Pakistan. There are numerous reasons but imbalanced nutrition appears to be one of them. Therefore, artificial inoculation of mungbean with effective *Rhizobia* is a useful practice for improving its yield (Guozan et al., 1985). Seed inoculation significantly increased the growth parameters of mungbean (Khan and Kounsar, 2000). Besides this, according to Gowda and Gowda (1978), due to the ability of fixing atmospheric nitrogen, mungbean requires phosphorus to improve the yield and quality of grain. Phosphorus also has favourable effects on the number and weight of effective nodules on the root system of leguminous crops (Brady, 1984). The present study was planned to determine the effect of *Rhizobium* in combination with different levels of P on nodulation, growth and yield of mungbean cultivar NM-92 under irrigated conditions at Faisalabad.

MATERIALS AND METHODS

Pot experiment was conducted during March – May 2010 in wire house of the Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad. Surface soil (15 cm depth) was collected from the research area and air dried, mixed thoroughly and passed through 2 mm sieve. A representative sample was taken for physical and chemical analysis of the soil. Characteristics of experimental soil are given in Table 1.

Seeds of mungbean cv, NM-92 were inoculated with *Rhizobium* phaseoli according to standard methods and sown in pots containing 14 kg soil in each. The inoculum was purchased from Ayub Agriculture Research Institute (AARI), Pakistan. It was sold as Nitorgen Ka Teeka. 10% sugar solution was made and added with the black powder, the material provided in the standard pack, and mixed thoroughly. When the sticky paste or solution was ready it was mixed well with the seed of mungbean and sown according to different treatments immediately after drying for one hour under the shady place. The experiment was laid out in 2 factorial completely randomized design (CRD) consisted of different treatments like P_0 (control treatment that was without P and *Rhizobium* inoculation), $P_{50\%}$ of recommended P (1.2 g P), $P_{100\%}$ of recommended P (2.4 g P), $P_{150\%}$ of recommended P (3.6 g P) per pot, P_0 (*Rhizobium* inoculation without P), $P_{50\%}$ (*Rhizobium* inoculation+1.2 g P), $P_{100\ \%}$ (*Rhizobium* inoculation + 2.4 g P), $P_{150\%}$ (*Rhizobium* inoculation + 3.6 g P). These treatments were replicated three times to minimize error.

Recommended doses of N and K fertilizers were applied at 25 and 62 kg ha^{-1}, by using urea of 38 g per 14 kg soil (w/w) and MOP of 72 g per 14 kg soil (w/w) for the sowing, respectively.

The pots were irrigated with fresh water, using sprinkler bucket in seven days interval. Plant height was recorded after 15 days of germination and at the time of maturity. After harvesting, length of roots, number of nodules per plant, number of pods per plant, number of grains per pod, weight of grains per plant and 1000-grain weight were recorded. NP uptake was determined by the following formulae:

N uptake = {(Conc. of N in grain × Oven dry wt. of grain) + (Conc. of N in straw × Oven dry wt. straw)} / 100

P uptake = {(Conc. of P in grain × Oven dry wt. of grain) + (Conc. of P in straw × Oven dry wt. straw)} / 100

The unit is g $plant^{-1}$, for conversion of g $plant^{-1}$; g $plant^{-1}$ will be multiplied by 1000. The data collected for various characteristics were subjected to the analysis of variance and means were compared by using Duncan's Multiple Range Test (Steel and Torrie, 1997).

RESULTS AND DISCUSSION

Plant height at maturity (cm)

The comparison of inoculated means with uninoculated revealed that average height of inoculated plants was increased by 10.19% as compared to average height of uninoculated plants (Table 1). The overall comparison of means resulted in the increase in plant height by 3.9 to 13.2% over its respective control; the interaction between graded P levels and rhizobium inoculation was significant. The maximum plant height (40.35 cm) was recorded in the inoculated plants when it was supplemented with 150 % of the recommended dose of phosphorus. These results were also supported by Thakur and Panwar (1995) who reported an increase in plant height by seed inoculation and fertilizer application.

Number of nodules $plant^{-1}$

In uninoculated plants, no nodulation was observed (Table 1). The inoculated plants were infected by *Rhizobium* for nodulation and the average number of nodules per plant was 6.0 which further increased aggravately with application of increased P levels. The average number of nodules per plant was 11.96 in case of inoculated compared with uninoculated plants as it was 0.00 nodules $plant^{-1}$.The comparison means of different P levels with *Rhizobium* treatments indicated that all the three levels increased nodulation from 78-190% over their *Rhizobium* inoculation alone. These results were quite in line with those of Bar and Lal (1991).

Number of pods $plant^{-1}$

Rhizobium inoculation along with graded levels of phosphorus significantly affected the pod formation (Table 2). In case of uninoculated plants, maximum number of pods was observed where the highest dose of phosphorus (150%) of the recommended phosphorus) was applied which further increases to 23.5% with combined application of P and rhizobium inoculation. Among the inoculated plants, the maximum pod formation (24.16 pods $plant^{-1}$) was observed in P_{100} which was 42.11% higher over its respective control. Inoculation strongly promoted the average pod formation as compared to uninoculated plants (50.32% higher than uninoculated plants). The comparison of the overall means of different P levels indicated that P rates of recommended and 150% of the recommended were statistically non significant but they were 17.59 and

Table 1. Effect of phosphorus and Rhizobium inoculation on plant height and no. of nodules plant^{-1}.

Phosphorus levels	Plant height (cm)			Number of nodules plant^{-1}		
	Uninoculated	Inoculated	Mean	Uninoculated	Inoculated	Mean
P_0 [no phosphorus(control)]	32.05^{f}	34.71^{d}	33.38^{B}	0.00^{e}	6.00^{d}	3.0^{C}
P_{50} [50% of recommended P(1.2 g)]	33.15^{e} (3.4)*	36.19^{c} (4.3)*	34.67^{B} (3.9)*	0.00^{e}	10.17^{c} (69.5)*	5.1^{B} (78)*
P_{100} [100% of recommended P(2.4 g)]	36.27^{d} (13.2)	39.28^{b} (13.2)	37.78^{A} (13.2)	0.00^{e}	14.33^{b} (138.8)	7.2^{A} (140)
P_{150} [150% of recommended P(3.6 g)]	35.11^{b} (9.5)	40.35^{a} (16.2)	37.73^{A} (13.0)	0.00^{e}	17.33^{a} (188.8)	8.67^{A} (189)
Mean	34.15^{B}	37.63^{A} (10.19)*		0.00^{B}	11.96^{A}	

Table 2. Effect of phosphorus and Rhizobium inoculation on no. of pods plant^{-1} and no. of grains pod^{-1}.

Phosphorus levels	**No. of pods plant^{-1}**			**No. of grains pod^{-1}**		
	Uninoculated	**Inoculated**	**Mean**	**Uninoculated**	**Inoculated**	**Mean**
P_0 [no phosphorus(control)]	12.33f	17.00c	14.66C	4.20b	5.58b	4.89C
P_{50} [50% of recommended P(1.2 g)]	13.66e (10.8)*	19.00d (11.7)*	16.33B (11.4)	5.28b (25.7)*	6.63ab (18.8)*	5.95B (21.7)*
P_{100} [100% of recommended P(2.4 g)]	14.50de (17.6)	24.16a (42.1)	19.33A (31.9)	6.18ab	7.53a (34.9)	6.85A (40.1)
P_{150} [150% of recommended P(3.6 g)]	15.16d (23.0)	23.50a (38.2)	19.33A (31.9)	6.18ab (47.1)	7.14a (28.0)	6.66A (36.2)
Mean	13.91B	20.19A (50.3)*		5.46B	6.72A (23.1)*	

22.95% higher over their respective control. Similar results were recorded by Shukla and Dixit (1996) and Ashraf et al. (2003).

Number of grains pod^{-1}

In uninoculated plants the increasing P levels enhanced the grain formation as compared to control (without phosphorus) and P_{100} and P_{150} were statistically non significant (Table 2). In inoculated plants the P levels increased the grain formation as compared to control and P_{100} and P_{150} were statistically non significant. Overall comparison of means of P level indicated that recommended P enhanced the grain formation which was 40.08% higher than its respective control. The comparison of average of inoculated plants to uninoculated was also highly significant and it was 23.08% higher than uninoculated plants. The interaction of rhizobium inoculation and phosphorus inoculation was found non- significant. Shaheen and Rahmatullah (1996) and Perveen et al. (2002) also observed similar types of results in their findings with different treatments of Phosphorus with Rhizobium.

Weight of grains plant^{-1} (g)

The data (Table 3) regarding the grain weight of mungbean (g plant^{-1}) as affected by various levels of phosphorus alone and in combination with *Rhizobium* were recorded after harvest and analysis of variance indicated the significant difference in grains' weight of mungbean due to different treatments. Among the overall means for different P levels, the maximum grain weight (3.32 g plant^{-1}) was observed in P_{100} and it was statistically non-significant with P_{150}. Average fresh weight of grains in the inoculated plants was 105.23% greater than the average fresh weight of grains of uninoculated plants. The interaction between phosphorus levels treatments and *Rhizobium* inoculation was also highly significant. These results are in accordance with Khan and Kounsar (2000) and Perveen et al. (2002).

1000- Grain weight (gm)

The analysis of variance of the data regarding the effect of phosphorus and *Rhizobium* inoculation on the 1000-grain weight (Table 3) indicated that difference in 1000-grain weight due to different phosphorus levels and inoculated treatments were highly significant but at the same time the interaction of P rates along with Rhizobium inoculums was non significant. Among the overall means for graded P levels, maximum 1000- grain weight (25.6 g) was recorded in case of P_{150} which was 16.89% higher than its respective control. At the same time, this P_{150} was statistically at par with P_{100}. The average mean (24.8 g) for inoculated plants resulted in 5.1% greater than the average mean (26.3 g) in uninoculated plants. Interaction of both graded P levels and *Rhizobium* inoculums was non- significant. Response of mungbean to phosphorus along with *Rhizobium* inoculation was also studied by Singh et al. (1993), Khan and Kounsar (2000) and

Table 3. Effect of P and *Rhizobium* inoculation on weight of grains plant^{-1} and 1000- grain weight.

Phosphorus levels	Weight of grains plant^{-1} (gm)			1000- grain weight (gm)		
	Uninoculated	Inoculated	Mean	Uninoculated	Inoculated	Mean
P_0 [no phosphorus(control)]	1.39 ^{e}	1.92 ^{c}	1.66 ^{C}	21.6^{b}	22.2^{b}	21.9 ^{C}
P_{50} [50% of recommended P(1.2g)]	1.65 ^{d} (18.7)*	2.84 ^{b} (47.9) *	2.25 ^{B} (35.5)*	23.8^{b} (10.2)*	24.5^{ab} (10.4)*	24.2 ^{B} (10.5)*
P_{100} [100% of recommended P(2.4)]	1.93 ^{c} (38.8)	4.72 ^{a} (145.8)	3.32 ^{A} (100.0)	24.5^{ab} (13.4)	26.1^{a} (17.6)	25.3 ^{A} (15.5)
P_{150} [150% of recommended P(3.6)]	1.92 ^{c} (38.1)	4.65 ^{a} (142.1)	3.28 ^{A} (97.6)	24.7^{ab} (14.4)	26.5^{a} (19.4)	25.6 ^{A} (16. 9)
Mean	172 ^{B}	3.93 ^{A} (105.2)*		23.6 ^{B}	24.8 ^{A} (5.1)*	

Table 4. Effect of phosphorus and Rhizobium inoculation on nitrogen and phosphorus uptake by plant.

Phosphorus levels	Nitrogen uptake (mg plant^{-1})		Mean	Phosphorus uptake (mg plant^{-1})		Mean
	Un inoculated	Inoculated		Un inoculated	Inoculated	
P_0 [no phosphorus(control)]	64.85^{g}	97.68^{e}	81.27^{D}	2.43^{f}	3.93^{e}	3.18^{D}
P_{50} [50% of recommended P(1.2g)]	83.27^{f} (28.40)*	152.79^{b} (56.41)*	118.03^{C}(45.23)*	3.65^{e} (50.20)*	6.81^{d} (73.28)*	5.23^{C} (64.46)*
P_{100} [100% of recommended P(2.4)]	112.38^{d} (39.29)	282.09^{a} (188.78)	197.23^{B} (142.19)	7.36^{d} (203.29)	19.47^{b} (395.41)	13.41^{B} (321.69)
P_{150} [150% of recommended P(3.6)]	127.99^{c} (97.36)	290.06^{a} (196.94)	209.02^{A} (157.19	10.98^{c} (351.85)	25.19^{a} (540.96)	18.09^{A} (468.86

Perveen et al. (2002) and they noted the results which are in line with this study

Nitrogen uptake in plant (mg plant^{-1})

In inoculated plants the maximum nitrogen uptake (196.94 % higher than the respective inoculated control) was the highest dose of P (150% of the recommended P). The comparison of over all means of P treatments indicated that maximum uptake of N was at the P levels of 150% of the recommended dose and it was 157.19 % greater than the control where no P was applied. The other rest P levels P_{100} and P_{50} followed the P_{150}.Average N uptake in inoculated plants was significantly higher than the uninoculated plants. It was 111.74% higher than its respective uninoculated plants. The interaction between P rates and rhizobium inoculation was also found highly significant. Shah et al. (1996) and Shaheen and Rahmatullah (1996) also reported that treated plots with rhizobium inoculums improved the N and P uptake by plants.

Phosphorus uptake in plant (mg plant^{-1})

The analysis of variance of the data given in Table 4 showed that in uninoculated plants the highest dose of P increased the P uptake by 351.85 % over its respective control P_0.The other rest two levels of Phosphorus, P100 and P50 followed the P150 in the inoculated plants. The comparisons of overall means of uninoculated and inoculated plants showed that P treatments had significant effect on P uptake and maximum uptake was 18.09 mg plant^{-1}. This was 468.86% higher than its respective control where no P was applied. Inoculation significantly promoted the average P uptake by the plants as compared to uninoculated plants which were 127.04% higher than uninoculated plants. The interaction between P levels and rhizobium inoculation was also highly significant. Bar and Lal (1991) studied the same observations in their experiments.

Conclusion

Phosphorus along with *Rhizobium* inoculation application increased plant height, total number of pods, number of grains per pod, and 1000- grain weight significantly. Maximum increase was noted where 150% of the recommended phosphorus along with *Rhizobium* inoculation was applied but it was statistically at par with the results obtained

by applying 100% of the recommended phosphorus along with *Rhizobium* inoculation. So 100% of the recommended phosphorus along with *Rhizobium* inoculation is the best treatment in the experiment.

REFERENCES

Ashraf M, Mueen-Ud- Din M, Warraich NH (2003). Production efficiency of mung bean as affected by seed inoculation and NPK application. Int. J. Agric. boil 5:179-180.

Bar JS, Lal PB (1991). Effect of rhizobium inoculation, phosphorus and molybdenum on yield and its components in mungbean, Indian Agriculturist, 35:67-69.

Brady NC (1984). The nature and properties of Soils. 8th Ed. Mac Millen publishing Co. INC. New York.

Duncan DB (1995). Multiple range and Multiple F. Test Biometrics, 11:1-42. http://dx.doi.org/10.2307/3001478

Gowda D. Gowda AM. (1978). Effect of Rhizobium and fertilizers on biometric parameters of green gram. Crop Res. Hisar 22:367-369.

Guozan NL, Yuanfan W, Yuying H, Vanling, Daiguan Y (1985). Inoculation of Rhizobium on clover. Chinese Prairie 3:60-63.

Hussain A, Ali A, Akhtar J, Yasin M (2010). Effect of Phosphorus in combination with Rhizobium inoculation on growth and yield parameters of mungbean (*Vigna radiata* L.) .Crop. Environ. 2010, 1(1):53-56.

Khan MR, Kounsar K (2000). Effect of seed treatment with certain bacteria and fungi on the growth of mungbean and reproduction of Meloidogyne incongnita. Nemtatologia-Mediterranea. 28:221-226.

Perveen S, Sagir KM, Zaidi A (2002). Effect of Rhizopheric microorganisms on growth and yield of green gram. Indian J. Agric. Sci. 72:421-423.

Shukla SK, Dixit RS (1996). Effect of Rhizobium inoculation, plant population and phosphorus on growth and yield of summer green gram (Phaseolus radiates). Indian J. Agron. 41:611-615.

Shah NH, Hafez FY, Hussain A, Malik KA (1993). Influence of seasonal variation on the indigenous population of Rhizobium in four Pakisani soils and competitive ability of introduced Rhizobia on field grown lentil. NIBGE. Faisalabad, Pakistan. Submitted to Bilogy and Fertility of Soil. Pak. J. Soil Sci. 2(4):41-46.

Shaheen A, Rahmatullah (1996). Growth and nodulation of groundnut inoculation with Rhizobium strains based on different carriers. Pak. J. Soil Sci. 12:26-28.

Singh AK, Choudhary RK, Sharma RPR (1993). Effect of inoculation and fertilizer level on yield,yield attributes and nutrient uptake of green gram (*Phaseolus radiatus*) and black gram (*P. mungo*). Indian J. Agron. 38:663- 665.

Steel RGD, Torrie JH (1980). Principles and Procedures of Statistics. 2nd Ed. McGraw Hill Book Co, New York, USA.

Thakur AK, Panwar JDS (1995). Effect of rhizobium VAM interactions on growth and yield of mungbean under field conditions. Indian J. Plant Pathol. 38:62-65.