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RESPONSE OF *RHIZOBIUM* INOCULATION AND PHOSPHORUS LEVELS ON MUNGBEAN (*VIGNA RADIATA*) UNDER GUAVA-BASED AGRI-HORTI SYSTEM

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ABSTRACT

In present investigation an attempt has been made to integration of crops in orchards to meet the fruit and grain demand with sustaining soil health. In this regard, a field experiment was conducted during *kharif*, 2010 to evaluate the effect of *rhizobium* inoculations and phosphorus levels on performance of mungbean under guava-based agri-horti system. Among the treatments, *rhizobium* inoculation + 60 kg P_2O_5/ha had significant influence on growth and yield attributing characters and consequently the significant increased yield (1011 kg/ha) with *rhizobium* inoculation(*R*I) + 60 kg P_2O_5/ha of mungbean under agri-horti system. The significant positive improvement of nodule number (42/plant) under *R*I + 60 kg P_2O_5/ha was recorded which was at par with *R*I + 80 kg P_2O_5/ha. The N and P content and uptake were also significantly increased with the treatment *Rhizobium* inoculation + 60 kg P_2O_5/ ha. N_2-fixation capacity and yield components of mungbean were enhanced by application of phosphorus fertilizer. So, combined application of *Rhizobium* inoculants along with phosphorous fertilizer was considered to be the suitable combination of increasing mungbean production under agri-horti system.

INTRODUCTION

Due to shrinking land resources coupled with burgeoning population enforce us to search out new vistas to meet the food grain requirement of nation. Agri-horti system is an excellent approach to increasing the food grain production by exploiting the interspaces of the fruit trees during the initial 5-6 years (Gill and Bisaria, 1995) which markedly increase the return per unit area per unit time. Gill and Gangwar (1992) also stated that interspaces of custard apple and aonla orchards can be exploited by intercropping grain and fodder crops during initial years of establishment of fruit trees.

Mungbean due to its ecological versatility it is widely cultivated in various climate and geographical regions of India (Tripathi *et al.,* 2012) found to be most feasible crop to be introduced under agri-horti system.

Mungbean (*Vigna radiata* L. Wilczek) is well suited to a large number of cropping system and a popular cereal-based diets due to easily digestible, rich in protein (25-28%), oil (1.0-1.5%), fiber (3.5-4.5%), ash (4.5-5.5%) and carbohydrates (62-65%) on dry weight basis (Singh *et al*., 2010). India is the largest producer of mungbean, where it is the third most important pulse crop shares 15% (3.5 Mha) of the national pulse crop area and 8.5% (1.2 million ton) of the total pulse production in the country (IIPR, 2011). Mungbean is more palatable, nutritive, digestible and non-flatulent than other pulses (Anjum *et al*., 2006). It not only plays an important role in human diet but also in improving the soil fertility by fixing the atmospheric nitrogen (Muhammad *et al*., 2004).

Inadequate nutrient status of soil is a particular problem for small landholders of the developing countries, where much grain-legume production occurs (Peter and Vance, 2003). *Rhizobium* (BNF) is an efficient source of nitrogen (Peoples *et al*., 1995) considered to be the ecologically viable source of nitrogen in agricultural system that provide half of the biological source of fixed nitrogen (Tate, 1995). *Rhizobium* estimated to globally produce as much nitrogen as fixed by commercial fertilizer production (Gordon *et al.,* 2001). It has been reported that the net benefits of legumes are often equivalent to the addition of 50-100 kg N/ha as fertilizer (Herridge *et al*., 1993). The N fixation process is influenced by many factors, and P availability is one of them (Awomi *et al.,* 2012). Phosphorus plays a vital functional role in energy transfer and metabolic regulation and it is an important structural component of many molecules (Kaur *et al.,* 1999). Application of P along with rhizobium inoculants has been reported to influence nodulation, N_2 fixation, and specific nodule activity (Zahran, 2000). On the other hand, P fertilization usually result in enhanced nodule number and mass, as well as greater N_2 fixation activity per plant (Seraj and Gyamfi, 2004) as nodules are strong sink for P, reaching concentrations three fold higher than in other organs (Vadez *et al.,* 1999). However, meager information is available on the sole and combined effect of *rhizobium* and phosphorus in mungbean [*Vigna radiata* (L.) Wilczek] under agri-horti system for maintaining higher productivity and soil fertility. Thus keeping the importance of *rhizobium* and phosphorus the present study was designed to evaluate the effect of *rhizobium* inoculation

Table 1: Effect of *rhizobium* inoculation and phosphorus levels on growth attributes of mungbean under guava-based agri-horti system

Treatments	Plant height (cm)	Number of branches/ plant	Plant dry weight(g/plant)	Number of nodule/ plant[a]
Control[b]	24.97	3.50	8.50	23.30
Rhizobium inoculation (*R*I)	32.70	3.80	8.87	27.90
*R*I + 20 kg P_2O_5/ha	45.77	4.60	11.17	33.00
*R*I + 40 kg P_2O_5/ha	53.00	5.20	13.00	37.20
*R*I + 60 kg P_2O_5/ha	60.27	5.90	15.80	42.00
*R*I + 80 kg P_2O_5/ha	55.17	5.83	14.27	39.80
20 kg P_2O_5/ha	39.10	4.20	9.47	31.20
40 kg P_2O_5/ha	45.73	4.90	11.83	34.40
60 kg P_2O_5/ha	50.77	5.70	13.93	37.10
80 kg P_2O_5/ha	47.37	5.10	12.73	35.50
SEm ±	2.44	0.25	0.55	1.60
CD $(P=0.05)$	7.27	0.76	1.63	4.76

[a] Recorded at 50 days after sowing; [b] without *rhizobium* and phosphorus

Table 2: Effect of rhizobium inoculation and phosphorus levels on yield attributes and yield of mungbean under guava-based agri-horti system

Treatments	No. of pod/ plant	Pod length (cm)	No. of seed/ pod	Test weight (g)	Harvest index	Seed yield (kg/ha)	Straw yield
Control[b]	8.00	4.23	8.00	35.00	25.05	414.67	1240.60
Rhizobium inoculation (*R*I)	8.20	4.87	8.23	35.10	25.36	423.33	1245.90
*R*I + 20 kg P_2O_5/ha	10.50	5.62	9.00	38.50	27.22	790.00	2112.00
*R*I + 40 kg P_2O_5/ha	12.00	5.71	9.50	40.00	27.95	898.33	2314.40
*R*I + 60 kg P_2O_5/ha	14.00	6.05	10.50	42.00	28.54	1011.00	2530.80
*R*I + 80 kg P_2O_5/ha	13.20	6.00	9.77	41.03	28.05	932.33	2390.00
20 kg P_2O_5/ha	9.00	5.03	8.60	36.30	26.31	671.67	1878.80
40 kg P_2O_5/ha	11.00	5.23	9.20	38.17	27.02	774.00	2089.80
60 kg P_2O_5/ha	13.00	5.51	9.80	40.00	28.00	875.00	2250.00
80 kg P_2O_5/ha	12.40	5.41	9.40	39.17	27.19	810.00	2168.00
S.Em ±	0.67	0.26	0.48	1.51	0.71	39.89	89.56
CD $(P=0.05)$	2.00	0.77	1.44	4.49	2.13	118.53	266.10

[b]without *rhizobium* and phosphorus

alone and in combination with phosphorus on mungbean production under guava based agri-horti system.

MATERIALS AND METHODS

An experiment was conducted at Agronomy farm of Rajiv Gandhi South Campus (BHU), Brakachha, Mirzapur during *kharif* season of 2010. The experiment was laid out in a randomized complete block design with 10- treatments *viz.* control (without *rhizobium* inoculation (*R*I) and phosphorus), 20, 40, 60 and 80 kg P_2O_5/ha with and without- *R*I and each treatment was replicated thrice. Recommended dose of N (20 kg/ha) and K (20 kg/ha) were applied through urea and MoP, respectively whereas, phosphorus was applied as per treatment. Mungbean variety HUM-2 was sown @ 15 kg/ha at row spacing of 30x10 cm, in between the alleys of guava tree spaced at 7x7 m. A composite soil sample (0-15 cm depth) was taken with the help of soil auger representing the whole field and the physical and chemical properties were determined (before sowing & fertilizer application). The soil samples were analyzed for physicochemical properties *viz.* texture (Day, 1965), available N (Subbiah and Asija, 1956), available P (Bray and Kurtz, 1945) and available K (Jackson, 1973). The soil of experimental field was sandy loam in texture and has invariably poor fertility *viz.* N (187.72 kg/ha), P (9.01 kg/ha) and K (113.31 kg/ha). Seed was inoculated with local *rhizobium* strain MO 5 obtained from Department of Genetics and Plant Breeding, Banaras Hindu University, Varanasi. For inoculation, the required quantity of the cultures (200 g culture per 10 kg seed) was prepared with 10% sugar solution to form slurry. The slurry was sprinkled on seeds and mixed with hand to make a uniform coating over the seeds. Then, the inoculated seed were dried under shed (to avoid direct sun rays) and was sown immediately. Growth parameters (plant height, branch/plant, plant dry weight), yield attributes (pod/ plant, pod length, seed/pod, test weight, harvest index) and yield (grain and straw) of each plot was recorded at harvest whereas, number of nodule/plant was recorded at 50 days after sowing. Yield obtained from each plot was converted to kg/ ha. A separate sample of 5 plants from each replicate was excavated for nodule count. The whole plant was carefully placed in a plastic bag. The samples were carefully washed in the laboratory under running tap water above a sieve to catch detached nodules and then number of nodules per plant was counted. After harvest of crop the grain and straw samples were analysed for total P (Prasad *et al.,* 2006) and total nitrogen content (Bremner,1965). Data collected were subjected to statistical analysis as per the methodology described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Maximum plant height, number of branches and plant dry weight was recorded with *R*I + 60 kg P_2O_5/ha which was statistically at par with *R*I + 40 kg P_2O_5/ha and *R*I + 80 kg P_2O_5/ha (Table 1). The improvement of dry weight due to phosphorus and *Rhizobium* inoculation was also reported by Hussain *et al.* (2010). The maximum number of nodules

Table 3: Effect of rhizobium inoculation and phosphorus levels on N and P content and uptake of mungbean under guava-based agri-horti system

Treatment	Nitrogen Content(%)		Uptake(kg/ha)		Phosphorus Content(%)		Uptake(kg/ha)	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Control[b]	2.91	1.11	12.06	13.77	0.35	0.16	1.12	1.96
Rhizobium inoculation (*R*I)	3.17	1.26	13.41	15.69	0.36	0.17	1.52	2.08
*R*I + 20 kg P_2O_5/ha	3.35	1.35	26.46	28.51	0.39	0.18	3.08	3.95
*R*I + 40 kg P_2O_5/ha	3.61	1.51	32.42	34.94	0.41	0.19	3.72	4.53
*R*I + 60 kg P_2O_5/ha	3.98	1.65	40.23	41.75	0.45	0.21	4.49	5.39
*R*I + 80 kg P_2O_5/ha	3.82	1.59	35.61	37.25	0.42	0.20	3.97	4.82
20 kg P_2O_5/ha	3.25	1.30	21.82	24.42	0.37	0.17	2.49	3.17
40 kg P_2O_5/ha	3.46	1.42	26.78	29.67	0.39	0.18	3.05	3.84
60 kg P_2O_5/ha	3.76	1.55	32.20	35.77	0.42	0.20	3.72	4.43
80 kg P_2O_5/ha	3.55	1.50	28.75	32.52	0.41	0.19	3.30	1.96
S Em±	0.15	0.06	1.21	1.27	0.01	0.008	0.13	0.16
CD *(P=0.05)*	0.47	0.18	3.60	3.80	0.05	0.02	0.39	0.47

[b]without *rhizobium* and phosphorus

recorded under *R*I + 60 kg P_2O_5/ha and was at par with *R*I + 80 kg P_2O_5/ha. While, the lowest values of plant height, number of branches, plant dry weight and nodule number were recorded under control plots. The positive improvement of growth parameter and nodule number might be due to increased *rhizobium* activity under presence of phosphorus. Since, phosphorus has a specific role in nodule formation and microbial activities in the soil, the adequate supply of this nutrient might have increased growth attributes (Kumawat *et al.,* 2010).

Yield attributes *viz.* number of pod per plant, pod length, number of seed per pod and test weight was significantly higher under *R*I + 60 kg P_2O_5/ha and was statistically at par with *R*I + 40 kg P_2O_5/ha and *R*I + 80 kg P_2O_5/ha as well as sole phosphorus levels *i.e.* 60 and 80 kg P_2O_5/ha (Table 2). The improvement in yield attributing character might be attributed to the fact that rhizobium inoculation along with phosphorus increased the nodulation and thus enhanced the utilization of atmospheric nitrogen and availability of phosphorus. Similar finding was also reported by Pramanik and Singh (2003). Higher grain and straw yield recorded under *R*I + 60 kg P_2O_5/ha and was at par to *rhizobium* inoculation in combination with 40 and 80 kg P_2O_5/ha and was also with sole application of 60 kg P_2O_5/ha. Significant increase in grain and straw yield due to *rhizobium* inoculation along with P levels was also reported by Hussain *et al.* (2010). The enhancement in mungbean yield with combined application of *rhizobium* and phosphorus might be due to increase in phosphorus availability that lead to better translocation of photosynthates towards sink with consequent improvement in yield attributes. Similar findings were also reported by Naik and Rajput (2003). Maximum harvest index was recorded with *R*I + 60 kg P_2O_5/ha and was statistically at par with all the treatment expect control as well as sole *rhizobium* inoculation and phosphorus level at 20 kg P_2O_5/ha.

The N and P content and uptake in grain and straw were significantly recorded with inoculation and P application. The maximum N and P contents and uptake was recorded with *R*I + 60 kg P_2O_5/ha (Table 3). The ample availability of phosphorus and the nitrogen due to nitrogen fixation at rhizosphere might be increased its content in grain. The uptake of nutrient is a function of their content and yield. Increase in seed and straw yield along with higher content of N and P might have resulted in higher uptake of these nutrients by the crop. Similar finding were reported by Hussain *et al.* (2012).

From the above experiment it was concluded that rhizobium inoculation + 60 kg P_2O_5/ha had significant influence on growth and yield attributing characters and consequently the significant increased yield of mungbean under agri-horti system. The N and P content, uptake and number of nodules per plant were also significantly increased with the treatment *Rhizobium* inoculation+60 kg P_2O_5/ ha. N_2-fixation capacity and yield components of mungbean were enhanced by application of phosphorus fertilizer.

REFERENCES

Anjum, M. S., Ahmed, Z. I. and Rauf, C. A. 2006. Effect of *Rhizobium* inoculation and nitrogen fertilizer on yield and yield components of mungbean. *Int. J. Agri. Biol.* **8:** 238-240.

Awomi, T. A, Singh, A. K., Manoj-Kumar and Bordoloi, L. J. 2012. Effect of Phosphorus, Molybdenum and Cobalt Nutrition on Yield and Quality of Mungbean (*Vigna radiata* L.) in Acidic Soil of Northeast India. *IJHF.* **25(2):** 22-26.

Day, P. R. 1965. Particle fractionation and particle-size analysis. In: Black C. A. (ed) Methods of Soil Analysis. Part 1. Physical and mineralogical properties, including statistics of measurement and sampling 9.1. *American Society of Agronomy, Inc., Madison, Wisconsin USA.* pp. 545-567

Bray, R. H. and Kurtz, L. T. 1945. Determination of total, organic and available forms of phosphorus in soils. *Soil Sci.* **59**: 39-45.

Bremner, J. M. 1965. Total nitrogen. In: Black C. A. (ed) Methods of soil analysis Part 2. Chemical and microbiological properties. American Society of Agronomy, Inc., *Madison, Wisconsin USA.* pp. 1149-1165.

Gill, A. S. and Bisaria, A. K. 1995. Agricultural system for forage production. *In: New Vista in Forage Production. Hazra, C.R. and Misri, B. (Eds.). AICRP (Fe), IGFRI, Jhansi.* pp.

Gill, A. S. and Gangwar, K.S. 1992. Investigation on the integration of fodder and food crops as intercrops with fruit trees. *Agr. Sci. Digest.* **12(1)**: 15-16.

Gomez, K. A. and Gomez, A. A. 1984. Statistical procedures for agricultural research Edn. 2nd *J. Wiley and Sons,* New York, p. 680.

Gordon, A. J., Lea, P. J., Rosenberg, C. and Trinchant, J. C. 2001.

Nodule formation and function. In: Plant nitrogen. P. J. Lea and J.-F. Morot-Gaudry (Eds.), *Berlin, Germany: Springer.* pp.101-146.

Herridge, D. F., Rupela, O. P., Sarraj, R. and Beck, D. P. 1993. Screening techniques and improved biological nitrogen fixation in cool season legumes. *Euphytica*. **1:** 1-14.

Hussain, A., Ali, A. and Noorka, I. R. 2012. Effect of phosphorus with and without *rhizobium* inoculation on nitrogen and phosphorus concentration and uptake by mungbean (*Vigna radiata* L.) *J. Agric. Res.* **50(1)**: 49-57.

Hussain, A., Ali, A., Akhtar, J. and Yasin, M. 2010. Effects of phosphorus in combination with rhizobium inoculation on growth and yield parameters of mungbean. *Crop Environ.* **1(1)**: 53-56.

IIPR. 2011. Indian Institute of Pulses Research Vision-2030. Gupta S. (Ed.). Indian Institute of Pulses Research (ICAR), Kanpur. p. 42.

Jackson, M. L. 1973. Soil chemical analysis. *Prentice Hall of India Pvt. Ltd., New Delhi.*

Kaur, V., Kaur, N. and Gupta, A. K. 1999. Phosphatase activity and phosphorus partitioning in nodules of developing mungbean**.** *Acta Physiol. Plant.* **21(3):** 215-220.

Kumawat, A., Pareek, B. L. and Yadav, R. S. 2010. Response of greengram (*Vigna radiata*) to biofertilizers under different fertility levels. *Indian J. Agr. Sci.* **80(7)**: 655-657.

Muhammad, A. N., Rashid, A. and Ahmad, M. S. 2004. Effect of seed inoculation and different fertilizer levels on the growth and yield of mungbean (*Vigna radiata* L.). *J. Agron.* **3**: 40-42.

Naik, K. R. and Rajput, A. S. 2003. Effect of biofertilisers on seed production of summer green gram (*Phaseolus radiatus*). *Agron. Digest.* **3:** 38-39.

Peoples, M. B., Herridge, D. F. and Ladha, J. K. 1995. Biological nitrogen fixation: an efficient source of nitrogen for sustainable agricultural production. *Plant Soil.* **174**: 3-28.

Peter, H. G. and Vance, C. P. 2003. Legumes: importance and constraints to greater use. *Plant Physiol*. **131:** 872-877.

Pramanik, K. and Singh, R. K. 2003. Effect of phosphorus and bio-fertilizers on growth, yield attributes, yield and nutrient uptake of green gram (*P. radiatus*). *Agron. Digest.* **3:** 35-36.

Prasad, R., Shivay, Y. S., Kumar, D. and Sharma, S. N. 2006. Learning by doing exercises in soil fertility. A practical manual for soil fertility. Division of Agronomy, Indian Agricultural Research Institute, New Delhi, p. 68.

Serraj, R. and Gyamfi, J. A. 2004. Role of symbiotic nitrogen fixation in the improvement of legume productivity under stressed environments. *West African J. Appl. Ecol.* **6:** 95-109.

Singh, B. B., Dixit, G. P. and Katiyar, P. K. 2010. *Vigna* research in India (25 Years of research achievements). *All India Coordinated Research Project on MULLaRP, IIPR, Kanpur.* p. 1.

Subbiah, B. V. and Asija, G. L. 1956. A rapid procedure for the determination of available nitrogen in soils. *Curr. Sci.* **25**: 259-260.

Tate, R. L. 1995. Soil microbiology (symbiotic nitrogen fixation). J. Wiley and Sons Inc., New York. pp. 307-333.

Tripathi, P. K., Singh, M. K., Singh, J. P. and Singh, O. N. 2012. Effect of *rhizobial* strains and sulphur nutrition on mungbean (*Vigna radiata* (l.) wilczek) cultivars under dryland agro-ecosystem of Indo-Gangetic plain. *Afr. J. Agr. Res.* **7(1):** 34-42.

Vadez, V., Lasso, J. H., Beck, D. P. and Drevon, J. J. 1999. Variability of N_2-fixation in common bean (*Phaseolus vulgaris*) L.) under P deficiency is related to P use efficiency. *Euphytica*. **106:** 231-242.

Zahran, H. H. 2000. *Rhizobium*-legume symbiosis and nitrogen fixation under severe conditions and in an arid climate. *Microbiol. Mol. Biol. Rev*. **63(4)**:968-989.