

## Original Research Article

### Influence of Different Sources of Phosphorus on productivity and profitability on Greengram (*Vignaradiata*L.)

#### ABSTRACT

A field experiment was conducted during the *kharif* season of 2014 at Crop Research Farm, Department of Agronomy, SHIATS, Allahabad, UP to evaluate the influence of different sources of phosphorus on productivity and profitability on Greengram. The experiment was conducted in randomized block design with 9 treatments *viz.* Control (No Phosphorus, 100% P through SSP, 100% P through URP, 50% P through SSP + 50% P through URP, 75% P through SSP + 25% P through URP, 100% P through SSP + PSB inoculation, 100% P through URP + PSB inoculation, 50% P through SSP + 50% P through URP + PSB inoculation, 75% P through SSP + 25% P through URP + PSB inoculation. greengram variety Samrat was sown at a spacing of 30cm x 10 cm and it was fertilized with Phosphorus, SSP, URP, PSB as per the requirement of the treatments. The experimental results revealed that application of 100% P through SSP + PSB seed inoculation produced significantly higher no. of pods plant<sup>-1</sup> (31.53), no. of grains pod<sup>-1</sup> (12.8), test weight (44g), grain yield (1496.77 kg ha<sup>-1</sup>), Stover yield (2920 kg ha<sup>-1</sup>) and protein (24.06%). Further, it was revealed that application of 100% P through SSP + PSB recorded 32.45% higher grain yield as compared to control. Among the economics, application of 100% P through SSP + PSB seed inoculation recorded higher gross return (Rs 71766.82 ha<sup>-1</sup>), net returns (Rs 47002.17 ha<sup>-1</sup>) and Benefit Cost (1.89). Thus, application of 100% P through SSP + PSB seed inoculation was found to be most promising treatment in enhancing the yield in Greengram.

**KEYWORDS:** Single super phosphate, Udaipur rock phosphate, PSB, Green gram.

#### **INTRODUCTION:**

India is the world's largest producer and consumer of pulse crop. It contributes about a quarter to the world's total pulse production. While one-third of world's total acreage under pulses is in India, pulses play a vital role in Indian food chain particularly for vegetarians and contribute about 14 per cent of the total protein of average Indian diet. Production of pulses in the country is far below the requirement to meet even the minimum level per capita consumption. The per capita availability in pulses is low (35.0 g/capita per day) in 2005 as

against the minimum requirement of 84 g per day per capita prescribed by ICMR, which is causing malnutrition among the growing people. To meet this malnutrition, there is need to increase pulse production in India.

Green gram locally called as moong or mung belonging to the family leguminaceae has the capacity to fix atmospheric nitrogen. India alone accounts for 65% of its world average and 54% of the total production. Mungbean is an excellent source of protein (25%) with high quality of lysine (460 mg/ g) and tryptophan (60 mg /g), riboflavin (0.21 mg/ 100 g) and minerals (3.84 g/100 g). However, the low productivity of mungbean may be due to nutritional deficiency in soil and imbalanced external fertilization (Awomiet *et al.*, 2012). It is mostly grown under dry land farming system where erratic rains often fetch the crop under moisture stress (Malik *et al.*, 2006). Further, Indian soils are poor to medium in available phosphorus. Phosphorus fertilization is important for pulse crops. As the concentration of available P in the soil solution is normally insufficient to support the plant growth, continual replacement of soluble P from inorganic and organic sources is necessary to meet the P requirements of crop (Tisdale *et al.*, 2010). P is added extra dose in recommended dose of phosphorus which increase nitrogen fixation and finally improve productivity of green gram (Prasad *et al.*, 2014). It plays an important role in virtually all main metabolic processes in plant including photosynthesis, energy transfer, signal transduction, macromolecular biosynthesis and respiration (Carsky *et al.*, 2001). Phosphorus deficiency can limit nodulation by legumes and P fertilizer application can overcome this deficiency. So to increase the nutrient use efficiency and yield, different phosphorus fertilizers like Single Super Phosphate (SSP), Rock phosphate (RP) were used. These Phosphorus fertilizer efficiency was further enhanced by PSB inoculation due to its capability to solubilize phosphates and then after mobilize phosphorus in plants. Khan and Joergesen, (2009). Phosphorus application mix with phosphate solubilizing bacteria (PSB) and superior phosphorus uptake by plants and yields indicating that the PSB are capable to solubilize phosphates and then after mobilize phosphorus in plants. Similarly Rock phosphate (RP) is a phosphatic fertilizers which is not available as adequate reserves in India and whatever available is of low grade (Rao *et al.*, 2015). Thus, Certain phosphate dissolving microorganisms (PDM) could be used as a means to improve the efficacy of rock phosphate and superphosphate (Hamdali, *et al.*, 2012). These microorganisms, including bacteria and fungi, are able to mobilize phosphorus from sparingly soluble rock phosphates, and they have an enormous potential in providing soil phosphates for plant growth. Phosphate solubilizing bacteria inoculation enhances the mineralization of organic forms of phosphorus and solubilization of inorganic phosphorus,

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improving the availability of native soil phosphorus to plants and thereby resulting to higher grain yield. Gull *et al.*, 2004). Thus, keeping the fact in view, an experiment was conducted to assess the effect of different sources of Phosphorus on productivity and profitability on Greengram.

### Materials and Method

The experiment was carried out during *kharif* season year 2014 at Crop Research Farm, Department of Agronomy, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad (U.P.). The experimental site is located situated at 25.28°N latitude, 81.54°E longitude at the elevation of 98 m above the mean sea level. The climate of this place is typically sub-tropical and semi-arid in nature. The soil of the experimental field was sandy loam in texture, low in organic carbon and medium in available nitrogen, phosphorus and low in potassium with electrical conductivity in the safer range (Table 1).

**Table 1.** Properties of soil

Soil type	Ph	EC (dS /m)	O.C. (g/kg)	Available N (kg/ ha)	Available P (kg/ ha)	Available K (kg/ ha)
Sandy loam	7.5	0.19	4.0	240	22.50	95.00

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The experiment was conducted in randomized block design with 9 treatments, i.e. Control, 100% Phosphorus through SSP, 100% Phosphorus through URP, 50% Phosphorus through SSP + 50% Phosphorus through URP, 75% Phosphorus through SSP + 25% Phosphorus through URP, 100% Phosphorus through SSP + PSB seed inoculation, 100% Phosphorus through URP + PSB inoculation, 50% Phosphorus through SSP + 50% Phosphorus through URP + PSB inoculation, 75% Phosphorus through SSP + 25% Phosphorus through URP + PSB inoculation which were replicated thrice. Mungbean variety 'Samrat' was sown using seed rate of 15 kg ha<sup>-1</sup>. The different nutrient sources like urea, Single superphosphate (SSP), Udaipur rock phosphate (URP) and muriate of potash (MOP) were applied as side placement, for which 4-5 cm deep furrows were made along the seed rows with a *hand hoe*. The recommended dose was applied according to the treatment details as through Urea, SSP, URP and MOP while Whole of nitrogen, phosphorus and potash was applied as basal at the

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time of sowing. The crop was managed as per regional recommendations of SHITS Allahabad (U.P.).

Data pertaining to yield attributes and yield was obtained at harvest. For grain and stover yield, from the individual plot, net plot was harvested and subsequently, the grain and stover yield thus obtained were weighed and expressed in  $\text{kg ha}^{-1}$ . Among economic parameters, net return per ha was calculated by deducting cultivation cost from gross returns. Benefit cost (B:C) ratio was calculated by dividing net returns with total cost of cultivation to evaluate the economic viability of treatments. The data were analyzed following the method described by Gomez and Gomez (1984). Significant difference of sources of variation was tested at the probability level of 0.05. The standard error of the mean ( $\text{SEm} \pm$ ) and the CD value were indicated in the tables to compare the difference between the mean values.

## Results and discussion

### Yield attributes

Data pertaining to yield attributes revealed that the application of 100% P through SSP + PSB seed inoculation recorded significantly higher yield attributes viz. number of pods ( $31.53 \text{ plant}^{-1}$ ), number of grains ( $12.80 \text{ pod}^{-1}$ ), test weight (44 g) which was statistically at par with the application of 100% P through URP + PSB seed inoculation. It was also reported that the application of 100% P through SSP + PSB seed inoculation recorded 54.56% increase in number of pods, 29.69% increase in number of grains and 15.09% increase in test weight as compared to control. (Table 2) which might have happened due to the fact that Phosphorus plays a primary role in photosynthesis by way of energy transfer and thereby increases photosynthetic efficiency resulting in increased availability of photosynthates. These all together resulted in overall increase in yield attributes. These results corroborate with the findings of Pal and Jana (1991), Rajkhowa *et al.* (1992)

Crop yield is the resultant of better growth and development of the plant, higher rate of photosynthesis, better translocation of photosynthates in better source-sink association and better expression of yield attributes. Data presented in Table 2 revealed that the application of 100% P through SSP + PSB seed inoculation recorded significantly higher seed yield ( $1496.67 \text{ kg ha}^{-1}$ ) and stover yield ( $2920 \text{ kg ha}^{-1}$ ) which might be due to overall increment in seed yield by phosphorus application which increases yield attributes and finally contributes to seed yield. Further, the increase in seed yield may be due to an increase in P availability through solubilization of phosphate-rich compounds. The PSB secrete a number of organic

acids which may form chalets resulting in effective solubilization of phosphate, favoured higher nitrogen fixation, dry matter accumulation, rapid growth, higher absorption and utilization of P and other plant nutrients and ultimately positive resultant effect on growth and finely yield attributes and yield,. Similar result phosphorus through SSP with PSB were also reported by Chesti and Ali(2007) and Rathouret *al.*(2015).The better performance of SSP+PSP compared to other sources might be attributed to readily available phosphorus resulting in better absorption and utilization of phosphorus by plant and presence of other important plant nutrients i.e. sulphur. Sulphur, besides increasing phosphorus availability (Sacchidanand*etal.*, 1980) also increases its assimilation rate. Phosphate solubilizing bacteria enhance the phosphorus availability to plants by mineralizing organic P in soil and by solubilizing precipitated phosphate (Chenet *al.*, 2006)

**Table 2. Response of different sources of phosphorus on yield attributes of Greengram**

Treatments	No.of Pods plant <sup>-1</sup>	No.of Grains pod <sup>-1</sup>	Test Weight (g)	Seedyield (kg ha <sup>-1</sup> )	Stover Yield (kg ha <sup>-1</sup> )
Control(NoPhosphorus)	20.40	9.87	38.23	1130.00	2280.00
100% P through SSP	26.40	11.00	41.00	1380.00	2700.00
100% P through URP	25.53	11.00	40.67	1348.67	2500.00
50% P through SSP+50% P through URP	24.00	10.53	40.50	1384.33	2600.00
75% P through SSP+25% P through URP	24.07	11.00	40.83	1376.67	2566.67
100% P through SSP+PSB inoculation	31.53	12.80	44.00	1496.67	2920.00
100% P through URP+PSB inoculation	30.00	12.20	42.90	1433.33	2793.33
50% P through SSP+50% P through URP+PSB inoculation	29.00	11.60	41.23	1403.33	2740.00
75% P through SSP+25% P through URP+PSB inoculation	28.07	11.80	40.90	1401.00	2753.33
SEd(±)	0.42	0.29	0.62	28.47	91.99
CD(P=0.05)	0.89	0.62	1.31	60.36	193.34

### Relative economics

Relative economics of greengram calculated on grain and stover basis presented in Table 3 revealed that the application of 100% P through SSP + PSB seed inoculation resulted in higher cost of cultivation, gross return (Rs 71766.82 ha<sup>-1</sup>), net returns (Rs 47002.17 ha<sup>-1</sup>) and Benefit Cost (1.89) which might have happened due to that due to superiority of PSB over the control in respect of higher pod yield and net return obtained by the application of SSP + PSB

seed inoculation in greengram. Similar results were also reported by Devi *et al.*(2012) and Rathouret *et al.*(2015).

**Table 3. Response of different sources of phosphorus on Economics of Greengram**

Treatments	Cost of Cultivation (Rs/ha <sup>-1</sup> )	Gross Return (Rs/ha <sup>-1</sup> )	Net return (Rs/ha <sup>-1</sup> )	B:C Ratio
Control (No Phosphorus)	22734.65	54260.00	31525.35	1.38
100% P through SSP	24734.65	66180.00	41445.35	1.67
100% P through URP	23793.41	64538.82	40745.41	1.71
50% P through SSP + 50% P through URP	24264.03	66279.18	42015.15	1.73
75% P through SSP + 25% P through URP	24499.34	65893.49	41394.15	1.68
100% P through SSP + PSB inoculation	24764.65	71766.82	47002.17	1.89
100% P through URP + PSB inoculation	23823.41	68726.51	44903.10	1.88
50% P through SSP + 50% P through URP + PSB inoculation	24294.33	67293.18	42998.85	1.76
75% P through SSP + 25% P through URP + PSB inoculation	24529.34	67199.33	42669.99	1.73

## CONCLUSION

It can be concluded that the application of 100% P through SSP + PSB seed inoculation recorded significantly higher higher no. of pods plant<sup>-1</sup>, no. of grains pod<sup>-1</sup>, test weight, grain yield and Stover yield. Further, it was revealed that application of 100% P through SSP + PSB recorded higher net returns and Benefit Cost. Thus, application of 100% P through SSP + PSB seed inoculation) was found to be most promising treatment in enhancing the yield in Greengram.

## References

- Awomi, T.A., Singh, A.K., Manoj, K. and Bordoloi, L. J. 2012. Effect of phosphorus, molybdenum and cobalt nutrition on yield and quality of mungbean (*Vignaradiata* L.) in Acidic Soil of Northeast India. *Indian Journal of Hill Farming*, **25**(2):22-26.
- Malik, A., Hassan, F., Waheed, A., Qadir, G. and Asghar, R. 2006. Interactive effects of irrigation and phosphorus on green gram (*Vignaradiata* L.). *Pakistan Journal of Botany*, **38**(4): 1119-1126.

**Comment [M3]:** References need to be formatted

Tisdale, S. L., Nelson, W. L., Beaton, J. D. and Havlin, J. L. 2010. Soil fertility and fertilizer: An introduction to nutrient management. PHI Learning Pvt.Ltd.,New Delhi. pp. 184.

Prasad, S. K., Singh, M. K. and Singh, J. 2014. Response of rhizobium inoculation and phosphorus levels on mungbean (*Vignaradiata*L.) under guava-based agrihortisystem. *The Bioscan*. **9**(2): 557-560.

**Comment [M4]:** The scientific name is written in italics

Carsky, R.J., Singh, B. B. and Oyewole, R. 2001. Contribution of early-season cowpea to late season maize in the savanna zone of West Africa. *Biological, Agriculture and Horticulture*,**18**:303-315.

Das, P.K., Sahoo, P.N. and Jehna, M.K. 1997. Effect of vasicular arbuscular mycorrhizea and *Rhizobium* inoculation on nutrient uptake, growth, attributes and yield of greengram. *Environment and Ecology*, **15** (4): 830-833.

Gull, F. Y., I. Hafeez, M. Saleem and K. A. Malik. (2004). Phosphorus uptake and growth promotion of chickpea by co-inoculation of mineral phosphate solubilising bacteria and a mixed rhizobial culture. *Australian Journal of Experiment and Agriculture*,**44**: 623-628.

Hamdali, H., Moursalou, K., Tchangbedji, G., Ouhdouch, Y., Mohamed, H. 2012.Isolation and characterization of rock phosphate solubilizing actinobacteria from a Togolese phosphate mine, *African Journal of Biotechnology*, **11**(2): 312-320.

Khan, K. S. and Joergensen, R. G. 2009. Changes in microbial biomass and P fractions in biogenic household waste compost amended with inorganic P fertilizers. *Bioresource Technology*, **100**: 303-309.

Pal, A.K. and Jana, P.K. 1991. Effect of phosphorus, rhizobium inoculation on summer green gram (*Phaseolusradiata* L.). *Indian Journal of Agronomy*,**36**(4): 536-540.

Rajkhowa, D.J., Thakura, K. and Baroova, S.R. 1992. Response of summer green gram (*Phaseolusradiata*L.) varieties to sources and level of phosphorus. *Indian Journal of Agronomy*,**37**(3): 589-590.

**Comment [M5]:** The scientific name is written in italics

Rathore, D.S., Parothit, H.S. and Yadav, B.L. 2010. Integrated phosphorus management on yield and nutrient uptake of urdbean under rainfed conditions of Southern Rajasthan. *Journal of Food Legumes*, **23** : 128-131.

Chesti, M. H. and Ali, T. 2007. Effect of integrated phosphorus management on yield, nutrient availability and phosphorus transformation in green gram. *Journal of Reserach, SKUAST-J*. **6**(2): 232-237

Chen, Y.P., Rekha, P.D., Arunshen, A.B., Lai, W.A. and Young, C. C. 2006. Phosphate solubilizing bacteria from subtropical soil and their tri-calcium phosphate solubilizing abilities. *Applied Soil Ecology*, **34**: 33-41.

Sacchidanand, B., Sawarkar, N.J., Ghurayya, R.S., Shinde, D.A. and Sinha, S. B.1980. Response of soybean (*Glycine max*) to sulphur and phosphorus. *Journal of Indian Society of Soil Science*, **28**(2): 189-192.

Devi, K.N., Singh, L.N.K., Devi, T.S., Devi, H.N., Singh, K. K., Singh, T.B. And Singh, W. M. 2012. Response of Soybean [*Glycine max* (L.) Merrill] to Sources and Levels of Phosphorus. *Journal of Agricultural Science*, 4. (6): 44-53.

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