Original Research Article

Influence of Different Sources of Phosphorus on productivity and profitability on Greengram (*Vigna radiata* 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^{-1} (31.53), no. of grains pod^{-1} (12.8), test weight (44 g), grain yield (1496.77 kg ha^{-1}), Stover yield (2920 kg ha^{-1}) 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^{-1}), net returns (Rs 47002.17 ha^{-1}) 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.

Comment [U1]: Keywords

INTRODUCTION:

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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.

Comment [U3]: Show the meaning at first mention.

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 (Awomi *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, 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

Comment [U4]: Materials and Records

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^{o}N latitude, 81.54^{o}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).

Comment [U5]: ?

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

Comment [U6]: pH?

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^{-1}. The different nutrient sources like urea, Single super phosphate (SSP), Udaipur rock phosphate (URP) and muriate of potash (MOP) were 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 time of sowing. The crop was managed as per regional recommendations of SHITS Allahabad (U.P.).

Comment [U7]: That is,

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 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 (SEm±) and the CD value were indicated in the tables to compare the difference between the mean values.

Results and discussion

Comment [U8]: Results and Discussion

Yield attributes

Comment [U9]: Subsection number!!

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 $plant^{-1}$), number of grains (12.80 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 happen due to fact that Phosphorus play a primary role in photosynthesis by way of energy transfer and thereby increase photosynthetic efficiency resulting in increased availability of photosynthetes. 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 kg ha^{-1}) and stover yield (2920 kg ha^{-1}) which might be due to overall increment in seed yield by phosphorus application which increases yield attributes and finally contributes in seed yield. Further, the increase of seed yield may be due to increase in P availability through solubilization of phosphate rich compound. 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 Rathour *et 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 *et al.*, 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 (Chen *et al.*, 2006)

Table 2. Response of different sources of phosphorus on yield attributes of Greegram

Treatments	**No. of Pods plant^{-1}**	**No. of Grains pod^{-1}**	**Test Weight (g)**	**Seed yield (kg ha^{-1})**	**Stover Yield (kg ha^{-1})**
Control (No Phosphorus)	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
S Ed (±)	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

Comment [U10]:

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^{-1}), net returns (Rs 47002.17 ha^{-1}) 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 Rathour *et al.*(2015).

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

Treatments	Cost of Cultivation(Rsha^{-1})	Gross Return (Rs/ha^{-1})	Net return (Rs/ha^{-1})	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^{-1},no. of grains pod^{-1}, 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.

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Comment [U11]: Use journal format for reference listing