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Research Article

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Effect of integrated use of phosphorus, biofertilizers and organic manures on soil available nutrient status and yield of greengram (*Vigna radiata* L.)

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Summary

The effect of inorganic phosphorus, phosphate solubilising bacteria and vermicompost on yield of greengram and available nutrient status was studied during *Kharif* 2016 at Agricultural College, Polasa, Jagtial, Telangana state, India. The experiment was conducted with three levels of phosphorus (0, 75 and 100 % RDP), phosphate solubilising bacteria (0 and 2 kg ha^{-1}) and vermicompost (0 and 5 t ha^{-1}). The results revealed that grain and haulm yields were increased with increasing inorganic P levels and when the crop was supplemented with PSB and vermicompost. Significantly higher grain (1033.33 kg ha^{-1}) and haulm yield (1625.66 kg ha^{-1}) were recorded when the crop was integrated with 100 % RDP along with PSB and vermicompost. Results also indicated that there was a significant build-up in available N, P, K and S status with increasing inorganic P levels, seed inoculation with PSB and vermicompost application. Thus, it shows positive influence by the application of phosphatic fertilizers, organic manures and biofertilizers.

Key words : Integrated phosphorus management, Green gram, Yield, Phosphorus levels, PSB, Available nutrients

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Introduction

India is the largest producer of pulses in the world. In India, greengram represents 18 per cent (34.4 lakh hectares) of total pulse area and 11.48 per cent (514 lakh tonnes) of pulse production (CMIE, 2014-15). Green gram is the third important pulse crop cultivated throughout India for its multipurpose use as vegetable, pulse, fodder and green manure crop, as it occupies good position due to its high seed protein content and ability to store the soil fertility through symbiotic nitrogen fixation. Despite occupying a greater position both in respect of area and production, the productivity of greengram is low compared to world average. One reason for this could be the imbalanced nutrient management. Farmers are not applying fertilizers and also cultivating greengram in marginal low fertile soils under rainfed conditions.

Phosphorus plays pivotal structural and regulatory role at the nexus of photosynthesis, root development, energy conservation and transformation, carbon metabolism, enzyme activation and nucleic acid synthesis (Vance *et al.,* 2003). The very high phosphatic fertilizer prices also demand the need for recycling and exploitation of fixed phosphorus to improve crop production. The availability of phosphorus to the crop can be augmented by providing appropriate strains of microbes which are known to solubilise the fixed phosphorus and mobilize the deeply placed phosphorus to root zone by their avctivity. Besides increasing the availability of native P in the soil also help in enhancing the use efficiency of applied phosphorus (Thenua and Sharma, 2011). Organic matter additions were found to mobilize the fixed phosphates in the soil thus, increasing the available P to crops (Venkateswarlu, 2000). This study aimed to enhance greengram production and nutrient status of soil using PSB and vermicompost.

Resource and Research Methods

A field experiment was conducted during *Kharif,* 2016 at College Farm, Agricultural College, Professor Jayashankar Telangana State Agricultural University, Polasa, Jagtial, Telangana State. The soil of the experimental field was sandy loam in texture and slightly alkaline in reaction (pH 7.84) having an organic carbon content of 0.364%, 157.5 kg available nitrogen ha^{-1}, 18.6 kg available P_2O_5 ha^{-1}, 164.8 kg available K_2O ha^{-1} and 19.4 kg available sulphur ha^{-1}. The experiment was laid out in Randomized Block Design with three levels of phosphorus (0, 75 and 100 % RDP) and its integration with biofertilizers (PSB) and organic manures (vermicompost), all together 12 treatments replicated thrice. The various treatments were control (T_1- without any P application), seed inoculation of PSB (T_2), application of vermicompost @ 5 t ha^{-1} (T_3), PSB + vermicompost (T_4), 75 % RDP (T_5), 75 % RDPP + PSB (T_6), 75 % RDP + vermicompost (T_7), 75 % RDP + PSB + vermicompost (T_8), 100 % RDP (T_9), 100 % RDP + PSB (T_{10}), 100% RDP + vermicompost (T_{11}) and 100% RDP + PSB + vermicompost (T_{12}). The plots were uniformly basal dressed with 20 kg urea and 20 kg K_2O ha^{-1} and phosphorus applied as per the treatments. PSB and vermicompost applied as per the treatments. *Rhizobium* seed treatment was given to all the treatments. The greengram variety used LGG 460 sown with a spacing of 30 cm x 10 cm. The soil samples from individual treatmental plot were collected at flowering and after harvest and analyzed for available nitrogen by alkaline permanganate method (Subbiah and Asija, 1956) using Kelplus, available phosphorus by ascorbic acid method (Olsen *et al.*, 1954) using spectrophotometer, available potassium with neutral normal ammonium acetate method (Jackson, 1973) using Flame photometer and available sulphur by turbidimetry method (Chesnin and Yein, 1963) using spectrophotometer.

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Grain and haulm yield :

The grain yield and haulm yield were significantly influenced by different phosphorus management practices (Table 1). The grain yield was the highest when vermicompost and PSB were combinedly applied with inorganic P at 100 % RDP (T_{12}), the yield being 1033.33 kg ha^{-1} and it was found to be at par with T_{11} (996 kg ha^{-1}) and T_{10} (985.00 kg ha^{-1}) treatments. Integrated application of inorganic P along with vermicompost and PSB significantly increased the seed yield by 46.92 per cent (T_{12} on T_1), 11.75 per cent (T_8 on T_5) and 8 per cent (T_{12} on T_9) at P_0. P_{75} and P_{100} levels, respectively over inorganic P application at their respective level. Application of 75 per cent RDP alone (T_5) significantly increased the seed yield to 831.00 kg ha^{-1} over 703.33 kg ha^{-1} in control (T_1). The increased seed yield with P application might be due to increased P availability and uptake resulted profuse nodulation leading to greater symbiotic nitrogen fixation which in turn has positive effect on photosynthesis, then on yield (Rani *et al.,* 2016 and Kumar *et al.*, 2014).

Haulm yield was increased from a value of 993.33 kg ha^{-1} in the control (T_1) to 1625.66 kg ha^{-1} in the treatment (T_{12}) which was receiving 100 per cent RDP along with vermicomost and PSB and it was at par with T_{11} treatments. However, addition of 75 per cent RDP alone (T_5) significantly increased the haulm yield to 1259.33 kg ha^{-1} over control (T_1). Rathour *et al*., 2014 reported that phosphorus involves in cell division, increases various metabolic processes and cell enlargement, application of phosphate solubilising bacteria releases growth promoting substances which improves the haulm yield.

Available nutrients:

The pertaining to available nutrient status of the soil at flowering and harvest stages is presented in Table 2.

Results indicated that the available nitrogen in soil affected significantly by all the treatments and maximum available nitrogen of 220.70 and 200.20 kg ha^{-1} were recorded during flowering and harvest stages, respectively, in T_{12} treatment, where it is receiving 100 per cent RDP along with PSB seed inoculation and vermicompost application. Application of higher level of phosphorus significantly increased the available nitrogen status of soil, this is attributed due to increased phosphorus

Table 1 : Effect of various treatments on haulm and grain yield of greengram

Treatments	Yield (kg ha^{-1})	
	Haulm	Grain
T_1- Control (without application of P)	993.33	703.33
T_2- PSB	1037.33	724.33
T_3-Vermicompost	1066.66	749.67
T_4-PSB + Vermicompost	1157.33	771.33
T_5-75 % RDP ha^{-1}	1259.33	831.00
T_6-T_5+PSB	1275.00	853.00
T_7-T_5+Vermicompost	1379.66	868.67
T_8-T_5+ PSB+ Vermicompost	1411.66	928.67
T_9-100 % RDP ha^{-1}	1456.66	956.67
T_{10}-T_9+PSB	1518.33	985.00
T_{11}-T_9+Vermicompost	1566.00	996.00
T_{12}- T_9+ PSB+ Vermicompost	1625.66	1033.33
C.D. (P=0.05)	87.87	56.36
S.E.±	42.37	27.17

Table 2 : Effect of various treatments on available nutrient status of soil at flowering and after harvest of greengram

Treatments	Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})		Available S (kg ha^{-1})	
	At flowering	At harvest	At flowering	At harvest	At flowering	At harvest	At flowering	At harvest
T_1- Control (without application of P)	180.00	168.67	15.67	13.83	204.10	195.67	15.83	11.10
T_2- PSB	184.33	175.00	16.43	14.90	207.13	198.33	16.00	12.33
T_3-Vermicompost	187.67	177.67	17.50	15.60	208.20	200.33	16.23	12.83
T_4-PSB + Vermicompost	189.67	181.67	18.57	18.20	210.25	203.67	16.47	13.47
T_5-75 % RDP ha^{-1}	195.87	184.00	21.33	19.60	212.00	205.33	16.77	14.00
T_6-T_5+PSB	198.00	186.67	22.67	21.20	215.03	210.67	17.03	14.53
T_7-T_5+Vermicompost	201.00	187.57	24.67	22.87	216.33	212.33	17.27	14.83
T_8-T_5+ PSB+ Vermicompost	205.97	190.53	25.83	23.80	218.33	215.67	17.33	15.33
T_9-100 % RDP ha^{-1}	208.23	191.33	26.17	24.53	221.33	217.67	17.87	16.33
T_{10}-T_9+PSB	216.00	197.67	27.80	25.80	230.00	222.33	18.10	16.67
T_{11}-T_9+Vermicompost	218.20	199.17	29.67	26.63	232.67	224.33	18.84	16.67
T_{12}- T_9+ PSB+ Vermicompost	220.70	200.20	31.03	27.33	237.56	228.67	18.67	17.27
C.D. (P=0.05)	20.64	13.64	2.156	1.958	58.82	22.8	1.62	2.82
S.E.±	9.95	6.58	1.03	0.944	28.36	10.9	0.78	1.36

availability and stimulation of symbiotic N fixation. The above results are in conformity with those reported by Kumar *et al*. (2014) and Khan *et al.* (2013).

At flowering stage, application of 100 % RDP + vermicompost + PSB (T_{12}) resulted in a significantly highest available phosphorus of 31.03 kg ha^{-1}, which was at par with T_{11} (100 % RDP + vermicompost) treatment (29.67 kg ha^{-1}) and significantly superior over the remaining treatments. The lowest available P of 15.67 kg ha^{-1} recorded in control (T_1), which was scheduled without any phosphorus application. At harvest, greater amount of available P (27.33 kg ha^{-1}) was registered in 100 % RDP + vermicompost + PSB (T_{12}) treated plots and comparable available phosphorus of 26.63 and 25.80 kg ha^{-1} were registered in T_{11} (75 % RDP + vermicompost) and T_{10} (75 % RDP + PSB) treatments, respectively. Inoculation with phosphorus solubilizers releases soluble inorganic phosphates into soil through decomposition of phosphate-rich organic compounds and secretion of organic acids, resulting in the effective soulbilization of phosphates (Chesti and Ali, 2012). Application of higher level of phosphorus significantly increased available phosphorus status of soil. This is attributed due to increased the phosphorus availability and stimulation of symbiotic N fixation. The above results are in conformity with those reported by Kumar *et al*. (2014) and Bhatt *et al*. (2013). The beneficiary effect of vermicompost on P availability was reported by Khan *et al*. (2013).

Application of either graded levels of phosphorus or any combination of P with PSB and vermicompost did not show any significant influence on the available K status of soil at flowering stage of greengram. At harvest stage, significant build-up in available potassium was observed with application of graded levels of inorganic *P. plots* receiving 100 per cent RDP along with vermicompost and PSB (T_{12}) registered higher available potassium of 228.67 kg ha^{-1}, which was at par with T_{11}, T_{10},$T_{9,}$ T_8 and T_7 treatments and significant over remaining treatments.

The available S was also significantly influenced by different treatments. T_{12} left significantly maximum available sulphur of 18.67 and 17.27 kg ha^{-1} at flowering and at harvest, respectively. However, the lowest available sulphur of 15.83 kg ha^{-1} was recorded in control treatment at flowering stage of greengram. With increasing inorganic phosphorus level and integration with vermicompost and PSB the available sulphur status was increased at flowering and harvest of the greengram this may attributed due to as P fertilizer is applied in the form of SSP which contains 12 per cent S which is directly added to the field. Phosphorus application might have increased the soil solution sulfates by anion exchange and vermicompost improved the available sulphur status of soil by the mineralization process. Khan *et al.* (2013) also noticed same results.

Thus, the objective of maximizing yields as well as maintaining soil health and productivity can be furnished by a balanced use of inorganic fertilizers conjunctively with biological and organic manure.

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