International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 32-35

Received: 22-03-2018
Accepted: 24-04-2018

G Bhavya
Department of Soil Science and Agricultural Chemistry, Agricultural College, Poalsa, Jagtial Professor Jayashankar Telangana State Agricultural University, Telangana, Hyderabad, India

K Chandra Shaker
Department of Soil Science and Agricultural Chemistry, Agricultural College, Poalsa, Jagtial Professor Jayashankar Telangana State Agricultural University, Telangana, Hyderabad, India

G Jayasree
Department of Soil Science and Agricultural Chemistry, Agricultural College, Poalsa, Jagtial Professor Jayashankar Telangana State Agricultural University, Telangana, Hyderabad, India

M Malla Reddy
Department of Soil Science and Agricultural Chemistry, Agricultural College, Poalsa, Jagtial Professor Jayashankar Telangana State Agricultural University, Telangana, Hyderabad, India

Correspondence
G Bhavya
Department of Soil Science and Agricultural Chemistry, Agricultural College, Poalsa, Jagtial Professor Jayashankar Telangana State Agricultural University, Telangana, Hyderabad, India

Nutrient uptake and yield of green gram (*Vigna radiata* L.) as influenced by phosphorus fertilization, organic manures and biofertilizers

G Bhavya, K Chandra Shaker, G Jayasree and M Malla Reddy

Abstract
Field experiment was conducted during *kharif*, 2016 to study the effects of phosphorus levels, biofertilizers (Phosphate solubilising bacteria) and organic manures (vermicompost) on yield, nutrient concentration and their uptake at flowering and harvest of green gram. The experiment was laid out in randomized block design with three replications having 12 treatment combinations *viz*. 3 levels of phosphorus (0, 75 and 100 % RDP) and its integration with PSB (500 g ha^{-1}seed) and vermicompost (5 t ha^{-1}). Experimental results revealed that grain yield and nutrient uptakes significantly influenced by phosphorus, vermicompost and PSB application. Application of higher dose of phosphorus along with PSB and vermicompost (100 % RDP + Vermicompost+ Phosphate solubilising bacteria) proved to be the best in improving the seed yield (1033.33 kg ha^{-1}). Application of inorganic P fertilizers, organic manures and PSB markedly influenced the nutrient concentration and their uptake. Results showed that application of vermicompost at 5 t ha^{-1}, seed inoculation with PSB and 100% RDP significantly increased the N, P, K and S concentration in grain, haulm and their uptake by greengram.

Keywords: phosphorus, Green gram, PSB, vermicompost, nutrient content, nutrient uptake

Introduction
India is the largest producer of pulses in the world. In India, green gram represents 18% (34.4 lakh hectares) of total pulse area and 11.48 % (514 lakh tonnes) of pulse production (CMIE, 2014-15) [1]. Green gram is the third important pulse crop cultivated through India. Pulses form an integral part of vegetarian diet of large population of India. Besides being rich source of proteins and amino acids, they maintain soil fertility through the process of nitrogen fixation in symbiotic association with Rhizobium bacteria present in their nodules. Thus, they play a vital role as nitrogen fixing manufactories, which help in sustain productivity of agricultural soil (Jat *et al*. 2012) [3].

Phosphorus nutrition has a special significance in green gram production. Besides its role in metabolic process and energy transformations, P considerably influences root proliferation which are seat of biological N fixation and helps plants to draw nutrients from lower layers and consequently thrive under moisture stress conditions (Singh *et al*. 2003) [10]. Phosphorus availability is a limiting factor for plant production in many agricultural soils. A large portion of applied phosphorus fertilizer may be fixed to iron and alluminium oxides and then not available to plant uptake (Kumar *et al*. 2015) [4]. The very high phosphatic fertilizer prices also demand the need for recycling and exploitation of fixed phosphorus to improve crop production. Therefore, the current trend is to explore the possibility of supplementing fertilizers with organic manures and biofertilizers.

The inoculation with phosphate solubilising bacteria (PSB) plays a vital role in solubilisation of various inorganic and organic phosphates added to the soil. PSB may also release soluble phosphate into the soil through the decomposition of phosphate from organic compounds. Since the culture of PSB is very cheap it would prove to be an effective low cost technology to farmer in cutting down the fertilizer expenses.

Organic matter additions were found to mobilize the fixed phosphates in the soil thus increasing the available P to crops (Venkateswarlu, 2000) [13]. Organic manures like vermicompost stimulate the phosphomonoesterase activity in the crop rhizosphere. Production of phosphatases is reduced due to the presence of inorganic phosphorous. Hence, a delicate balance of these two opposing forces decides the activity of the enzyme (Tarafdar, 2008) [11].

Therefore, the present study was made to work out the optimum dose of phosphorus and organic manures with PSB inoculation in green gram.

Material and methods

A field experiment was conducted during *Kharif*, 2016 at College Farm, Agricultural College, Professor Jayashankar Telangana State Agricultural University, Polasa, Jagtial, and Telangana State. The soil of the experimental field was sandy loam in texture and slightly alkaline in reaction (pH 7.84). The soil was low in organic carbon content (0.364%), available nitrogen (157.5 kg ha^{-1}), available P_2O_5 (18.6 kg ha^{-1}) and medium in available K_2O (164.8 kg ha^{-1}), and deficient in available sulphur (19.4 kg 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 are 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 green gram variety used LGG 460 sown with a spacing of 30 cm X 10 cm. The plant samples from individual treatmental plots were collected at flowering and after harvest and analyzed for nutrient concentrations, in order to evaluate the effect of treatments on yield and nutrient concentrations and uptakes.

Results and discussion

Yield of green gram

The grain yield and haulm yield significantly influenced by different phosphorus management practices (Table 1). The seed 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 on 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% (T_{12} on T_1), 11.75% (T_8 on T_5) and 8 % (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 % 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 [8] and Kumar *et al.* 2014 [5]).

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 % RDP along with vermicomost and PSB and it was on par with T_{11} treatments. However, addition of 75 % RDP alone (T_5) significantly increased the haulm yield to 1259.33 kg ha^{-1} over control (T_1). Rathour *et al*. 2014 [9] 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.

Table 1: Yield of green gram as influenced by vermicompost, PSB and phosphorus Fertilization

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
CD at 5%	87.87	56.36
SE(D)	42.37	27.17

Nutrient content

N, P, K and S concentrations as influenced by different combinations were given in Table 2. Among the different combinations, integration of 100 % RDP along with vermicompost and PSB (T_{12}) was significant in increasing the nitrogen content (3.71, 2.40 and 3.92 % at flowering, in haulm and grain respectively) as against control (2.93, 1.60 and 3.17 % at flowering, in haulm and grain respectively).

Among the different phosphorus management practices the highest phosphorus concentration of 0.37 percent was registered in T_{12} treatment (100 % RDP +PSB + vermicomopst) and the lowest P concentration of 0.21 percent recorded under control (without P) at flowering stage of green gram. At harvest, the highest phosphorus concentration of 0.22 and 0.31 percent with T_{12} treatment (100 % RDP + PSB+ vermicomopst) and the lowest P concentrations of 0.10 and 0.18 percent was registered under control (T_1) in haulm and grain respectively. The P concentration in seed was increased by 27.7 and 50.0 percent with the sole application of 75% RDP and 100 % RDP respectively over control. On the whole, application 100 % RDP along with PSB and vermicompost (T_{12}) increased the P concentration by 72 percent over control in grain. At flowering, the highest K concentration of 1.71 percent was registered under T_{12} treatment. At harvest, application of 100 % RDP along with PSB and vermicompost (T_{12}) registered highest K concentration of 1.51 and 1.10 percent and the lowest K concentrations of 1.13 and 0.80 percent in control (T_1) in haulm and grain respectively.

Application of 75 % RDP (T_5) significantly increased the S concentration to 0.22 and 0.26 in haulm and seed percent respectively over control. Application of 100 % RDP (T_9) also significantly increased the S concentration to 0.27 and 0.31 percent in haulm and grain respectively.

Combined application of inorganic P with vermicompost, PSB or both significantly increased the N, P, K and S content in green gram at flowering, in haulms and in seed. This might be due to combined application of organics, inorganic P fertilizers and biofertilizers enhance root growth and cell multiplication leading to more absorption of nutrients from deeper layers of soil ultimately resulting in increased N, P, K And S concentrations. Similar findings was reported by Dhakal *et al*. 2016 [2]; Thenua and Sharma. 2011 [12].

Table 2: Effect of P, PSB and vermicompost on nutrient content of greengram at flowering, in haulm and grain

Treatments	N content (%)			P content (%)			K content (%)			S content (%)		
	At flowering	Haulm	grain	At flowering	haulm	grain	At flowering	haulm	grain	At flowering	Haulm	Grain
T_1	2.93	1.60	3.17	0.21	0.10	0.18	1.25	1.13	0.80	0.17	0.15	0.19
T_2	3.08	1.78	3.23	0.24	0.12	0.20	1.32	1.25	0.81	0.18	0.17	0.21
T_3	3.16	1.83	3.30	0.25	0.13	0.21	1.33	1.31	0.82	0.19	0.18	0.22
T_4	3.22	1.93	3.39	0.26	0.14	0.22	1.34	1.32	0.83	0.20	0.19	0.24
T_5	3.33	2.02	3.51	0.27	0.15	0.23	1.52	1.40	0.85	0.24	0.22	0.26
T_6	3.43	2.08	3.54	0.28	0.16	0.24	1.54	1.42	0.88	0.25	0.24	0.27
T_7	3.46	2.17	3.61	0.29	0.17	0.25	1.57	1.43	0.91	0.26	0.25	0.28
T_8	3.50	2.21	3.68	0.31	0.18	0.26	1.59	1.46	0.93	0.27	0.26	0.29
T_9	3.56	2.27	3.73	0.33	0.18	0.27	1.66	1.46	0.97	0.28	0.27	0.31
T_{10}	3.61	2.30	3.80	0.34	0.19	0.28	1.67	1.47	1.02	0.30	0.28	0.33
T_{11}	3.66	2.37	3.83	0.35	0.20	0.29	1.68	1.49	1.05	0.31	0.29	0.34
T_{12}	3.71	2.40	3.92	0.37	0.22	0.31	1.71	1.51	1.10	0.32	0.30	0.35
CD at 5%	0.398	0.26	0.15	0.06	0.042	0.04	0.15	0.18	0.08	0.025	0.03	0.04
SE(D)	0.192	0.12	0.07	0.027	0.02	0.02	0.07	0.09	0.04	0.012	0.01	0.02

Nutrient uptake

N, P, K and S uptakes as influenced by different combinations were predicted in Table 3. N uptake by green gram at flowering increased significantly from control (without P application) to 75 % RDP (T_5) from a value of 17.63 to 25.84 kg ha^{-1}, which was on par with 100 % RDP (T_9) treatment recorded an uptake of 28.99 kg ha^{-1}. Highest N uptake of 31.44 kg ha^{-1} was observed in the treatment with combined application of 100 % RDP, vermicompost and PSB (T_{12}) while this uptake was comparable with 75% RDP along with PSB and vermicompost (27.85 kg ha^{-1}).

Sole application of 75 % RDP (T_5) and 100 % RDP (T_9) significantly increased the P uptake to 2.07 and 2.66 kg ha^{-1} respectively over the treatment having no P nutrition *i.e.*, control (1.22 kg ha^{-1}). At harvest, the highest P uptake of 3.52 and 3.62 kg ha^{-1} were obtained with the combined application of 100 % RDP with PSB and vermicompost (T_{12}) by haulm and grain respectively and it was on par with T_{10} (100 % RDP + PSB) and T_{11} (100 % RDP + vermicompost) treatments in both the cases. Application of 100 % RDP (T_9) significantly increased the P uptake by 34.4 percent over 75 % RDP (T_5) and application of 75 % RDP significantly increased the P uptake by 57.9 percent over control, this increasing trend was observed in grain. Combined application of 75 % RDP +PSB + vermicompost (T_8) registered statistically comparable P uptake with sole application of 100 % RDP (T_9) in both haulm and grain of green gram.

Integrating 100 % RDP with vermicompost and PSB (T_{12}) registered highest K uptake of 13.65 kg ha^{-1} and the lowest K uptake of 7.53 kg ha^{-1} by green gram at flowering. At harvest the K uptake in the control (T_1) was lowest and the values being 11.33 and 5.64 kg ha^{-1} and was increased significantly to a highest value of 24.47 and 11.32 kg ha^{-1} when 100 % RDP was combindley applied with vermicompost+ PSB (T_{12}) by haulm and grain respectively.

Increase in sole application of inorganic P from 0 to 100 % RDP significantly increased the S uptake by green gram at flowering *i.e.*, from 1.01 kg ha^{-1} in the control to 2.22 kg ha^{-1} in 100 % RDP (T_9). Integrated application of 100 % RDP + PSB + vermicompost (T_{12}) result in significantly highest S uptake of 4.88 and 3.62 kg ha^{-1} by haulm and grain of green gram respectively as against rest of the treatments

Beneficial effects of integration of chemical fertilizers and organic manures along with biofertilizers on nutrients uptake were noticed by Meena *et al.* 2013 [6]. PSB inoculation increased the nutrient uptake. This could be due to increased root nodulation through better root development and more nutrient availability, resulting in better absoption and utilization of all plant nutrients (Rana *et al*, 2013) [7]. Nutrient uptake also increased by increasing inorganic P level might be due to well-developed system, increased N fixation and its availbilty to plants. Similar findings have been reported by Rani *et al*. 2016 [8] and Rathour *et al.* 2014 [9].

Table 3: Effect of P, PSB and vermicompost on nutrient uptake of greengram at flowering, in haulm and grain

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})			S uptake (kg ha^{-1})		
	At flowering	Haulm	grain	At flowering	haulm	grain	At flowering	haulm	grain	At flowering	Haulm	Grain
T_1	17.63	15.88	22.29	1.22	1.03	1.38	7.53	11.33	5.64	1.01	1.51	1.39
T_2	18.92	18.54	23.41	1.48	1.27	1.54	8.10	12.97	5.87	1.08	1.78	1.55
T_3	19.60	19.52	24.73	1.53	1.42	1.67	8.28	13.94	6.15	1.15	1.88	1.67
T_4	20.28	22.37	26.14	1.62	1.66	1.85	8.47	15.32	6.43	1.24	2.20	1.85
T_5	25.84	25.48	29.14	2.07	1.89	2.18	11.83	17.67	7.09	1.84	2.81	2.19
T_6	25.81	26.54	30.22	2.10	2.08	2.30	11.60	18.15	7.51	1.89	3.03	2.30
T_7	27.05	29.89	31.38	2.27	2.34	2.38	12.28	19.73	7.93	2.01	3.39	2.38
T_8	27.85	31.19	34.21	2.46	2.56	2.68	12.61	20.56	8.67	2.11	3.72	2.68
T_9	28.98	33.10	35.65	2.66	2.66	2.93	13.50	21.31	9.25	2.22	3.95	2.93
T_{10}	29.70	34.97	37.46	2.77	2.94	3.32	13.73	22.32	10.05	2.44	4.31	3.32
T_{11}	30.37	37.06	38.17	2.88	3.14	3.39	13.97	23.26	10.49	2.55	4.60	3.39
T_{12}	31.44	39.06	40.49	3.14	3.52	3.62	13.65	24.47	11.32	2.69	4.88	3.62
CD at 5%	3.22	4.00	2.20	0.38	0.65	0.34	2.17	2.30	0.90	0.23	0.38	0.34
SE(D)	1.55	1.93	1.06	0.18	0.31	0.16	1.04	1.11	0.437	0.11	0.189	0.16

References

1. CMIE. Centre for Monitoring Indian Economy. Apple Heritage, Mumbai, 2014-15.
2. Dhakal Y, Meena RS, Kumar S. Effect of INM on nodulation, yield, quality and available nutrient status in soil after harvest of green gram. *Legume Research.* 2016; 39(4):590-594.
3. Jat SL, Prasad K, Parihar CM. Effect of organic manuring on productivity and economics of mungbean (*Vigna radiata* L). Annals of Agricultural Research. 2012; 33(1, 2):17-20.
4. Kumar P, Pandey SK, Kumar P. Effect of different phosphorus levels on nutrient content, uptake and economics of urd bean under custard apple based agri-horti system. Journal of Agri Search. 2015; 2(2):88-93.
5. Kumar S, Tomar S, Tomar TS. Integrated phosphorus management in black gram (V*igna mungo*) in western Uttar Pradesh during summer season. Annals of Agricultural Research. 2014; 35(3):290-297.
6. Meena RS, Ramawatar, Kamalesh, Meena VS, Ram K. Effect of organic and inorganic sources of nutrients on yield, nutrient uptake and nutrient status of soil after harvest of green gram. An Asian Journal of Soil Science. 2013; 8(1):80-83.
7. Rana M, Pathania P, Khaswan SL. Effect of biofertilizers and phosphorus on productivity and nutrient uptake of soyabean (*Glycine max* L.). Annals of Agricultural Research. 2013; 34(3):245-247.
8. Rani M, Prakash V, Khan K. Response of mungbean [*Vigna radiata* (L.) Wilczek] to phosphorus and sulphur and PSB during summer season. Agricultural Science Digest. 2016; 36(2):146-148.
9. Rathour D, Sadhu AC, Suryawanshi PK. Integrated phosphorus management in summer green gram (*Vigna radiata* L.). Advance Research Journal of Crop Improvement. 2014; 5(1):57-59.
10. Singh ON, Sharma M, Dash R. Effect of seed rate, phosphorus and FYM application on growth and yield of bold seeded lentil. Indian Journal of Pulses Research. 2003; 16(2):116-118.
11. Tarafdar JC. Mobilisation of native phosphorus for plant nutrition. Journal of the Indian Society of Soil Science. 2008; 56(4):388-394.
12. Thenua OVS, Sharma RK. Effect of phosphorus, sulphur and phosphate solubilizing bacteria on productivity and nutrient uptake of chickpea. Annals of Agricultural Research. 2011; 32(3, 4):116-119.
13. Venkateswarlu B. configurations and fertilizer management for sustainable groundnut production. *Ph.D. thesis*. Gujarat Agricultural University, Sardar Krishinagar, Gujarat. 2000.