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Short Communication

Productivity and nutrient content of greengram (*Vigna radiata*) as influenced by rock phosphate enriched compost

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Pulses are an integral part of diets across the globe and they have great potential to improve human health, conserve soils, protect the environment and contribute to global food security. The United Nations, declared 2016 as "International Year of Pulses" (IYP) to heighten public awareness of the nutritional benefits of pulses as part of sustainable food production aimed at food security and nutrition. India is the largest producer, consumer and importer of the pulses in the world and also has the largest area in the world under grain legumes, cultivated in 23.90 million h with a production of 19.27 million tonnes of which greengram [*Vigna radiata* (L.) Wilczek] occupies an area of 3.38 million ha accounting for 14% of total pulses area and 8.3% of total production and is the third most important pulse crop of India in terms of area cultivated and production (GOI 2014). Greengram is cultivated in arid and semi-arid regions and locally known as "moong". The productivity gap analysis revealed that the national average yield of greengram is 474 kg/ha as against 667 kg/ha in Punjab (IIPR 2011). This indicates that there is a wide scope for increasing the productivity of greengram by proper management practices.

Phosphorus (P) is the second limiting nutrient after nitrogen in majority of soils for crop production. It plays a vital functional role in energy transfer and metabolic regulation and it is an important structural component of many molecules. Phosphorus fertilization usually results in enhanced nodule number and mass, as well as greater nitrogen fixation activity per plant as nodules is strong sink for phosphorus, reaching concentrations. Both phosphorus status and P-fixing capacity of soil strongly influences the phosphorus availability (Rana *et al.* 2011). The cost of applying conventional water soluble phosphorus fertilizer is high in India because their manufacture requires importing high-grade rock phosphate (RP) and sulphur. Thus, alternative use of indigenously available low-grade RP is now gaining importance in India. It is estimated that about 260 million tonnes (Mt) of RP deposits are available in India and only a fraction of it (about 5.27 Mt) meets the specification of the fertilizer industry because of their low P content (low-grade) (FAI 2011). In this respect, preparation of rock phosphate enriched compost (RP-compost) using straw and phosphorus solubilizing bacteria a lot of promise in developing countries like India. Considering all these facts, there is a need to develop a cost effective, eco-friendly and sustainable system where the supply of phosphorus to plants can be ensured with locally existing resources. Therefore, the objective of present study was to evaluate the changes in growth, yield and uptake of major nutrient concentration of greengram under application of rock phosphate enriched compost.

The field experiment was conducted during summer season of 2015 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (25°18' N, 83°03' E and 129 m above mean sea level). The eleven treatments comprised with rock phosphate enriched compost and ordinary compost in combination with the levels of fertilizers in randomized block design replicated thrice. Greengram variety HUM 16 was seeded at a uniform row spacing of 30 cm with a seed rate of 20 kg/ha in the first week of April. The doses of N, P and K fertilizers were applied through urea, diammonium phosphate (DAP) and muriate of potash at the time of sowing, taking 20, 60 and 40 kg N, P_2O_5 and K_2O/ha as recommended dose of fertilizer (RDF). The initial soil analyzed using standard methods like available nitrogen (Subbiah and Asija 1956), phosphorus (Olsen *et al*. 1954), potassium (Hanway and Heidal 1952), sulphur (Chesnin and Yien 1950), organic carbon (Walkley and

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Black 1934), soil pH and electrical conductivity (Jackson 1973). The soil of experiment field was a sandy loam in texture (Piper 1966), low in organic carbon (0.28%) and available nitrogen (145.52 kg/ha), moderate in phosphorus (11.62 kg/ha), potassium content (162.65 kg/ha) and sulphur (10.36 kg/ha) with a neutral in soil reaction (pH 7.6) and safe electrical conductivity (0.22 dS/m). Nitrogen in grain and straw was determined by modified Kjeldahl method. Oven dried grain and straw samples were digested in diacid mixture and P, K and S were determined by adopting standard methods (Jackson 1973). In the study, low-grade rock phosphate (RP) was taken from Rajasthan State Mines and Minerals Ltd, Udaipur, Rajasthan. The powdered RP containing 8.84% total P, out of which 1.29% citrate soluble P. Six pits were prepared for composting, it containing 42.5% total C, 0.45% N, 0.06% P, 1.04% K after complete decomposition was used in treated plots. Farmyard manure (FYM) contained 0.78% total N, 0.36% total P, 0.50% total K and 0.18% total sulphur. For preparing compost, the pit size of 4.0×1.5×1.0 m for phosphorus enriched composts (three pits) and ordinary composts (three pits) were prepared. For carbon-rich compost, paddy straw was added with rock phosphate and gypsum in the ratio of 5:1 in layers according to the size of pit separately. Phosphate solubilizing bacteria (PSB) using *Pseudomonas striata* and cow dung concentrated solution were also mixed in the pit of composting mixture to enhance the solubility of phosphorus and decomposition rate of plant materials. The moisture (50-60%) and temperature were maintained by adding water (3-4 days interval) and turning (once in 2 weeks). The final product is dark brown in colour, crumbly and uniform. The matured enriched compost (EC) was characterized as per the standard procedures and possessed pH 6.92 (compost: water 1:4), electrical conductivity (compost : water 1:4) 3.18 dS/m, total organic C 28.3%, total N 2.24%, total P 2.58%, total K 1.44% and S 1.21% .

It is evident from Table 1 that combined use of enriched compost and fertilizers significantly enhanced growth and yield parameters of greengram, viz. plant height, no. of grains/pod, grain yield, straw yield, harvest index and weight of 1000-grains. The treatment of 75% RDF + 6 t/ha enriched compost (T_7) achieved the highest value of all the growth and yield attributing parameters like plant height (66.03), number of grains/pod (11.67) and test weight (37.79g) which was 37, 46 and 35%, respectively higher over control (48.20 cm, 8.0 and 28.05 g) closely followed by treatment T_3 (64.30 cm, 11.33, 36.16 g). The highest yield of grain 9.68 and straw 39.23 q/ha and harvest index (19.79%) were recorded in treatment T_7 followed by T_3 (9.31, 38.03 q/ha) which was around 46% higher over control (6.52, 26.91 q/ha) in both observations. However, effect of treatments on harvest index was found non-significant. Phosphorus is important for early root development, manufacture and translocation of food material in plant body which resulted in better uptake of nutrients, and this turn to higher yield of mungbean (Sharma and Prasad 2009). RP-enriched compost enhances P availability to plant and also supply amount of sulphur and micronutrients (Singh *et al*. 2014, Tagore *et al*. 2013).

The critical perusal of data contained in Table 2 showed that nitrogen, phosphorus, potassium and sulphur content in grain and straw increased significantly with applied enriched compost and inorganic fertilizers in greengram.

Table 1 Effect of rock phosphate enriched compost and fertilizers application on plant height, no. of grains/pod, grain yield, straw yield, harvest index and weight of 1000-grains of greengram

Treatment	Plant height (cm)	No. of grains/ pod	Grain yield (q/ha)	Straw yield (q/ha)	Harvest Index (%)	Weight of 1000-grains (g)
T_1-Control	48.20	8.00	6.52	26.91	19.49	28.05
T_2-100 % RDF	63.70	10.67	8.62	37.22	18.81	36.25
T_3-100% RDF+ 20 t/ha FYM	64.30	11.33	9.31	38.03	19.66	36.16
T_4-75% RDF + 4 t/ha OC	55.57	8.67	8.10	32.11	20.15	32.12
T_5 -75% RDF + 6 t/ha OC	56.57	9.00	8.39	32.49	20.52	33.79
T_6-75% RDF + 4 t/ha EC	62.30	10.33	9.19	36.05	20.31	35.34
T_7 -75% RDF + 6 t/ha EC	66.03	11.67	9.68	39.23	19.79	37.79
T_8 - 50% RDF + 4 t/ha OC	54.23	8.67	7.62	30.90	19.77	30.94
T_9- 50% RDF + 6 t/ha OC	55.20	9.00	8.05	31.39	20.41	31.77
T_{10} -50% RDF + 4 t/ha EC	57.63	9.67	8.61	33.80	20.29	33.06
T_{11}-50% RDF + 6 t/ha EC	58.97	9.67	8.95	34.48	20.61	33.97
SEm±	1.76	0.72	0.48	0.77	0.97	1.25
CD (P=0.05)	5.08	2.07	1.40	2.23	NS	3.60

NS: Non-significant

Table 2 Effect of rock phosphate enriched compost and fertilizers application on nitrogen, phosphorus, potassium and sulphur content in grain and straw of greengram

Treatment	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Sulphur (%)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1-Control	2.13	1.84	1.56	0.55	1.56	0.55	0.20	0.12
T_2-100 % RDF	3.49	2.30	1.79	0.68	1.79	0.68	0.22	0.13
T_3-100% RDF+ 20 t/ha FYM	3.55	2.34	1.82	0.70	1.82	0.70	0.22	0.13
T_4-75% RDF + 4 t/ha OC	3.26	2.15	1.71	0.62	1.71	0.62	0.22	0.13
T_5 -75% RDF + 6 t/ha OC	3.34	2.18	1.73	0.64	1.73	0.64	0.23	0.13
T_6-75% RDF + 4 t/ha EC	3.49	2.26	1.78	0.68	1.78	0.68	0.23	0.14
T_7 -75% RDF + 6 t/ha EC	3.52	2.32	1.82	0.71	1.82	0.71	0.24	0.14
T_8 -50% RDF + 4 t/ha OC	3.02	2.12	1.64	0.60	1.64	0.60	0.22	0.13
T_9-50% RDF + 6 t/ha OC	3.14	2.13	1.68	0.59	1.68	0.59	0.22	0.13
T_{10} -50% RDF + 4 t/ha EC	3.39	2.22	1.74	0.65	1.74	0.65	0.23	0.13
T_{11} -50% RDF + 6 t/ha EC	3.42	2.28	1.77	0.68	1.77	0.68	0.23	0.14
SEm±	0.021	0.011	0.009	0.006	0.009	0.006	0.001	0.001
CD (P=0.05)	0.060	0.032	0.026	0.019	0.026	0.019	0.002	0.002

The maximum nitrogen content in grain and straw was recorded in treatment T_3 (3.55 and 2.34%, respectively) followed by T_7 (3.52 and 2.32%) and T_6 (3.49 and 2.26%). In case of phosphorus, the highest value in straw (1.82%) was recorded in treatment T_7 which was at par with treatment T_3. The phosphorus content in straw ranged between 0.55 to 0.71%. The maximum phosphorus content was observed in treatment T_7 which was 50% higher over control. The potassium content in grain ranged between 1.56 to 1.82 %. Maximum value of K was obtained in treatments T_7 and T_3. The potassium content in straw ranged between 0.55 to 0.71%. The maximum S content in grain was recorded in treatment T_7 (0.24 %). The sulphur content in straw ranged between 0.12 to 0.14%. The higher concentration of these nutrients along with higher yield ultimately leads to higher uptake as uptake is derived by multiplication of nutrient concentration in grain and straw with respective yields (Kumar *et al.* 2013). Moreover, these nutrients (NPK and S) are synergistic to each other in nature and uptake of one enhances the uptake of others as well (Ali *et al.* 2014).

SUMMARY

The study revealed that addition of low-grade Indian rock phosphate composted along with paddy straw helped to enhance the mobilization of unavailable P in rock phosphate to available forms of P, which in turn helped in supplying P and NKS to greengram [*Vigna radicata* (L.) Wilczek]. Thus, RP-compost could be an alternative and viable technology to utilize both low-grade rock phosphates and paddy straw efficiently and could be used successfully as a cheaper source of P-fertilizer in place of costly water soluble P like diammonium phosphate in crop production and can be used as dose of 75% RDF + 6 tonnes/ha enriched compost to greengram for achieving higher production.

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