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Efficacy of phosphorus, vermicompost & biofertilizers on soil health and nutrient content & uptake of black gram (*Vigna mungo* L.)

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Abstract
A field experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) in *kharif* 2016 on sandy clay loam soil which is slightly alkaline in nature to asses the effect of phosphorus, vermicopost & biofertilizer on soil health and nutrient content & uptake of black gram. The experiment was laid out in randomized block design with four replications. The experiment comprised of nine treatment combinations. The results of study revealed that application of 40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} + *Rhizobium* + PSB showed significantly higher nutrient content & uptake of black gram and good soil health.

Keywords: phosphorous, vermicompost, biofertilizers, soil health, black gram, nutrient content & uptake

Introduction
Black gram is important pulse crop among the grain legumes grown in India. It contains 24% protein, 60% carbohydrate, 1.3% fat and is richest in phosphoric acid among the pulses being five to ten times richer than in others. It is commonly known as "urd" or "urd bean". Black gram is plays an important role in maintaining and improving the soil fertility through its ability to fix atmospheric nitrogen in the soil through root nodules which possesses *Rhizobium* bacteria.

In India, Black gram is grown on 7.23 million hactare area with a production of 2.89 million metric ton (DES 2016-17). Black gram is a rainfed crop predominantly grown in Kharif in the state of Rajasthan. In Rajasthan, Black gram occupy 2.18 lac hactare area with a production of 1.25 lac ton. However, the productivity of black gram is low in Rajasthan (575 kg ha^{-1}) (DOA 2013) [4]. It is mainly cultivated in arid and semi-arid districts including Chittorgarh, Udaipur, Ajmer, Jhalawar, Kota, Bundi, Baran etc. One of the important reason of low productivity is poor fertility of soil. The problem is compounded by the fact that the majority of farmers in rainfed areas are resource poor with low risk bearing capacity and they generally do not apply recommended dose of fertilizers, either through organic or inorganic sources. Hence, our research efforts should be aimed to remove the constraints which are responsible for its low productivity. Farmers of south and south-eastern Rajasthan grow black gram without applications of fertilizers or use less then recommended dose of nutrients. This imbalanced nutrient supply adversly affects the seed yield of black gram, soil health, and even the profit to the farmers (Laddha *et al*. 2006) [10].

Phosphorus application to legumes plays a key role in the formation of energy rich phosphate bonds, phospholipids and for development of root system (Tisdale *et al*. 1985) [14]. It also improves the crop quality and resistance to diseases. Phosphorus application to legumes not only benefits the particular crop but also improves the soil nitrogen content for the succeeding non-legume crops requiring lower doses of nitrogen application. It is also an essential constituent of majority of enzymes which are of great importance in the transformation of energy, carbohydrate metabolism, fat metabolism and also in respiration (catabolism of carbohydrates) in plants. It is closely related to cell division and development. Phosphorus stimulates seed setting, hastens maturity and enhanced protein content. It plays an important role in the nutrition of legumes and also improves biological nitrogen fixation and quality of grains (Kumar *et al*. 2009) [8]. It gives rapid and vigorous start to plants, strengthens straw and decreases lodging tendency. Vermicompost has been emerging as an important source in supplementing chemical fertilizer in agriculture in view of sustainable development after Rio Conference, vermicompost is a bio fertilizer enriched with all beneficial soil microbes and also contains all the essential plant nutrients like N, P and K. Since vermicompost helps in enhancing the activity of microorganisms in soil which further increase solubiltiy of nutrients and their consequent availability to plants is known to be altered by microrganism by reducing soil pH at microsites, chelating action of organic acids produced by them and intraphyl mobility in the fungal filaments (Parthasarathi *et al*. 2008) [12].

Biofertilizers play a significant role in improving nutrient availability to crop plants. They are recognized as one of the components of integrated plant nutrient supply system. Use of biofertilizers can have a greater importance in increasing fertilizer use efficiency. Indian soils are poor to medium status within available nitrogen and available phosphorus. The seed of pulses is inoculated with *Rhizobium* with an objective of increasing their number in the rhizosphere, so that there is substantial increase in the microbiologically fixed nitrogen for the plant growth. The inoculation of seeds with suitable *Rhizobium* and pulse plants helps in improving fertility of soil and is a cost effective method of nitrogen fertilization in legumes. The productivity of leguminous crop in dry land could be improved by *Rhizobium* inoculation (Abdelgani *et al*. 2003) [1].

Material and Methods

The experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) in *kharif 2016* on sandy clay loam soil which is slightly alkaline in nature consisted of 9 treatments comprising chemical fertilizers, organic manure and biofertilizers, their combinations, *viz*. 20 kg P_2O_5 ha^{-1} (T_2), 40 kg P_2O_5 ha^{-1} (T_3), 20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (T_4), 40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (T_5), 20 kg P_2O_5 ha^{-1} + *Rhizobium* + PSB (T_6), 40 kg P_2O_5 ha^{-1} + *Rhizobium* + PSB (T_7), 20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} + *Rhizobium* + PSB (T_8), 40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} + *Rhizobium* + PSB (T_9) and control (T_1). These treatments were evaluated under randomized block design (RBD) with four replications. Black gram cultivar (T-9) was taken as test crop. Further, treatments were classified (excluding control) into four groups *viz*, G_1 [T_2 & T_3 (chemical fertilizer)], G_2 [T_4 & T_5 (chemical fertilizer + organic manure)], G_3 [T_6 & T_7 (chemical fertilizer + biofertilizer)] and G_4 [T_8 & T_9 (chemical fertilizer + organic manure + biofertilizer)], respectively.

Results and Discussion

Data presented in table 1 and table 2 show that integration of chemical fertilizer with Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (Group G_4) brought about significant improvement in N, P, K content and uptake over unfertilized control. This indicated a favourable soil micro climate régime induced by the incorporation of vermicompos and biofertilizer.

Application of vermicompost reduces P fixation by releasing considerable aborints and variety of organic acids during decomposition and as well as inducing chelating effects on micronutrients which probably enhanced the availability of phosphorus. Applications of vermicompost not only solubilize the availability of micronutrients but also contains significant amount of N, P and K. Thus application of vermicompost has resulted in an overall significant increase in uptake of nutrients at lesser cost but longer in durability or duration.

Biofertilizers like PSB solublizes the unsoluble phosphorus or fixed phosphorus and make it available to the plants in the easily uptakable ionic form. On other hand *Rhizobium* fixes the atmospheric nitrogen which can be utilizes by the plants for their metabolic processes.

Combined use of organic manure, biofertilizers and chemical fertilizer has been found to be providing not only in maintaining higher productivity but also in providing stable crop yields for sustainable crop production through organic manure, biofertilizers and balanced use of chemical fertilizers. These are in confirmation with findings of Chakrabarti *et al,* 2007; Jaga and Sharma, 2015; Mohammad *et al,* 2017 and Singh *et al,* 2017 [2, 5, 11, 13].

Combined application of chemical fertilizer with vermicompost and biofertilizer (Group G_4) significantly increased the status of macro and micro nutrients in soil at harvest of black gram crop over control (Table 3). The increase in available nutrient status of soil might be due to microbial as well as chemical activity in soil.

Results presented in table 3 showed that enhanced application of 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB increased the available nitrogen content in soil at harvest of black gram crop during the year of experimentation. The increase in available nitrogen status of soil could be ascribed to higher dose P with organic manure & biofertilizer and increased organic content of the soil. INM considers the integrated nutrient supply of the soil and productivity targated capable of sustaining higher yields on one hand, and assured restoration of soil fertility on other. An improvement in available nutrient status of the soil with the incorporation of chemical fertilizer, biofertilizer and organic manure could be attributed to conserved soil nitrogen and increased availability of other nutrients as being its constituent as well as mineralize from the native source in soil. The results of present investigation are in line with the finding of Parthasarathi *et al* 2008, Kokani *et al* 2015, Mohammad *et al* 2017 and Jangir *et al* 2017 [12,7, 11, 6].

The application of phosphorus @ 20 kg and 40 kg with vermicompost and biofertilizer resulted in appreciable buildup of available P status of soil in comparison to control (Table 3). As the level of phosphorus increased, its content in soil also increased, probably due to mobilization of native soil phosphorus resulting in increased P availability. Similar results were reported by Parthasarathi *et al* 2008, Kokani *et al* 2015, Mohammad *et al* 2017 and Jangir *et al* 2017 [12, 7, 11, 6].

The availability of potassium was influenced by various nutrient combination and maximum was obtained under INM (40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB) at harvest of black gram crop, similar results were reported by Parthasarathi *et al* 2008, Mohammad *et al* 2017 and Jangir *et al* 2017 [12, 11, 6].

The data presented in table 3 reveals that available micronutrients status of soil at harvest was increased significantly in treatment receiving 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB and conserved soil fertility. The results of present study are in agreement with those reported by Jangir *et al* 2017 [6].

The data presented in table 4 reveals that no significant variation was observed in pH, EC, bulk density and particle density of soil after harvest of black gram crop due to application of various nutrients during the year of investigation. However use of vermicompost decrease the bulk density and particle density of the soil but not significantly.

Combined application of phosphorus through chemical fertilizer with vermicompost and biofertilizers significantly increased organic carbon in soil at harvest of black gram crop over control (Table 4). Organic carbon content is highest (0.73%) in T_9 (40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB) which is significantly higher over control (0.58%).

The favorable effects of phosphorus with vermicompost and biofertilizers, on soil properties may also be due to increased microbial activities which in turn release organic acids to bring down to soil pH to a range where the activities of plant nutrients are maximum. The increase in microbial activity due to the addition of organic manure and biofertilizer, which enhance activity of enzymes that play a key role in transformation, recycling and availability of plant nutrients in soil. Thus, improvement in nutritional status of plant might have resulted in greater synthesis of amino acids and protein and other growth promoting substances. Similar results were reported by Parthasarathi *et al.* 2008, Kumawat *et al.* 2013, Kokani *et al.* 2015, Mohammad *et al.* 2017 and Jangir *et al.* 2017 [12, 7, 11, 6].

Table 1: Effect of treatments and groups on nutrient content (%) in seed and straw of black gram

Treatments/Groups	Nitrogen in seed	Nitrogen in straw	Phosphorus in seed	Phosphorus in straw	Potassium in seed	Potassium in straw
T_1	3.086	1.276	0.300	0.210	1.162	2.038
T_2	3.217	1.345	0.325	0.220	1.212	2.135
T_3	3.242	1.392	0.362	0.228	1.215	2.137
T_4	3.285	1.442	0.332	0.225	1.217	2.140
T_5	3.310	1.480	0.377	0.234	1.220	2.142
T_6	3.395	1.505	0.395	0.239	1.216	2.139
T_7	3.495	1.552	0.422	0.248	1.190	2.141
T_8	3.517	1.585	0.405	0.243	1.227	2.147
T_9	3.620	1.647	0.437	0.256	1.230	2.150
G_1	3.23	1.37	0.34	0.22	1.21	2.14
G_2	3.30	1.46	0.35	0.23	1.22	2.14
G_3	3.45	1.53	0.41	0.24	1.20	2.14
G_4	3.57	1.62	0.42	0.25	1.23	2.15
S Em±	0.043	0.022	0.005	0.003	0.016	0.025
CD (P=0.05)	0.125	0.064	0.014	0.009	0.045	0.074

Table 2: Effect of treatments and groups on nutrient uptake (kg ha^{-1}) by seeds and straw of black gram

Treatments/Groups	Nitrogen by seed	Nitrogen by straw	Phosphorus by seed	Phosphorus by straw	Potassium by seed	Potassium by straw
T_1	20.12	11.48	1.96	1.89	7.58	18.33
T_2	25.48	14.31	2.57	2.34	9.60	22.72
T_3	26.83	15.33	3.00	2.51	10.05	23.54
T_4	30.59	17.33	3.09	2.70	11.33	25.72
T_5	34.32	18.61	3.91	2.94	12.65	26.94
T_6	29.06	17.64	3.38	2.80	10.41	25.08
T_7	33.83	19.05	4.08	3.04	11.52	26.28
T_8	39.89	22.56	4.59	3.47	13.92	30.68
T_9	45.14	23.74	5.45	3.69	15.34	30.99
G_1	26.16	14.82	2.78	2.43	9.83	23.13
G_2	32.46	17.97	3.50	2.82	11.99	26.33
G_3	31.45	18.35	3.73	2.92	10.96	25.68
G_4	42.51	23.15	5.02	3.58	14.63	30.84
SEm±	1.25	0.70	0.14	0.12	0.45	1.14
CD (P=0.05)	3.65	2.05	0.41	0.34	1.32	3.31

Table 3: Effect of treatments and groups on nutrient status of soil after crop harvest

Treatments/Groups	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})	Available Zn (mg kg^{-1})	Available Fe (mg kg^{-1})	Available Cu (mg kg^{-1})	Available Mn (mg kg^{-1})
T_1	244.12	17.91	389.97	1.80	3.46	2.05	3.26
T_2	265.22	19.17	408.72	1.88	3.60	2.25	3.39
T_3	272.82	20.20	412.82	1.91	3.67	2.29	3.45
T_4	277.82	19.19	422.32	2.03	3.98	2.40	3.68
T_5	286.02	20.41	425.76	2.06	4.09	2.44	3.76
T_6	288.30	21.27	420.84	1.95	3.79	2.31	3.54
T_7	292.75	22.15	423.38	2.00	3.87	2.34	3.62
T_8	297.77	21.44	427.90	2.08	4.18	2.48	3.86
T_9	302.30	22.33	431.74	2.09	4.27	2.51	4.01
G_1	269.02	19.69	410.77	1.90	3.64	2.27	3.42
G_2	281.92	19.80	424.04	2.05	4.04	2.42	3.72
G_3	290.52	21.71	422.11	1.98	3.83	2.33	3.58
G_4	300.04	21.88	429.82	2.09	4.23	2.50	3.94
S Em±	4.53	0.39	5.93	0.03	0.04	0.03	0.04
CD (P=0.05)	13.23	1.15	17.32	0.07	0.12	0.08	0.13

Table 4: Effect of treatments and groups on physio-chemical properties of soil after crop harvest

Treatments/Groups	Bulk Density (Mg m^{-3})	Particle Density (Mg m^{-3})	pH	EC (dS m^{-1})	O.C (%)
T_1	1.35	2.65	8.14	0.81	0.58
T_2	1.35	2.64	8.15	0.82	0.61
T_3	1.34	2.65	8.15	0.83	0.62
T_4	1.32	2.63	8.16	0.82	0.67
T_5	1.31	2.65	8.16	0.83	0.68
T_6	1.34	2.64	8.16	0.83	0.64
T_7	1.34	2.64	8.17	0.83	0.66
T_8	1.30	2.64	8.18	0.83	0.70
T_9	1.29	2.64	8.17	0.83	0.73
G_1	1.35	2.65	8.15	0.83	0.62
G_2	1.32	2.64	8.16	0.83	0.68
G_3	1.34	2.64	8.17	0.83	0.65
G_4	1.30	2.64	8.18	0.83	0.72
SEm±	0.02	0.03	0.13	0.01	0.01
CD (P=0.05)	NS	NS	NS	NS	0.03

References

1. Abdelgani ME, Osman AG, Mohamed SS. Restoring soil fertility of desertified lands through biological nitrogen fixation In: Desertification in the third millennium (eds. AS. Sharhan, WW. Wood, AS. Goudie, A. Fowler and EM. Abdellatif). AA. Balkima Publishers. Lisse, Netherlands, 2003, 335-338.
2. Chakrabarti J, Chatterjee NC, Dutta S. Interactive effect of VAM and *Rhizobium* on nutrient uptake and growth of *Vigna mungo*. International journal of Mycopathological Research. 2007; 45(2):289-291.
3. DES. Commodity profit-pulses, Directorate of Economics and Statistics, Department of Agriculture and Co-operation and Department of Commerce, 2nd Advance Estimates (March 2016-April 2017), 2017.
4. DOA. Rajasthan Agricultural Statistics-At a Glance 2013, Directorate of Agriculture, Statistical Cell, Rajasthan, Jaipur, 2013.
5. Jaga PK, Sharma S. Effect of biofertilizers and fertilizers on productivity of soybean. Annals of Plant and Soil Research. 2015; 17(2):171-174.
6. Jangir CK, Singh DP, Meena RH, Yadav M. Effect of fertility levels and biofertilizers on physical and chemical properties of soil under blackgram (*Vigna mungo* L.). International Journal of Current Microbiology and Applied Sciences. 2017; 6(3):223-228.
7. Kokani JM, Shahz KA, Tandelz BM, Bhimani GJ. Effect of FYM, Phosphorus and Sulphur on yield of summer blackgram and post-harvest nutrient status of soil. The Bioscan. 2015; 10(1):379-383.
8. Kumar V, Dwivedi VN, Tiwari DD. Effect of phosphorus and iron on yield and mineral nutrition in chickpea. Annals of Plant and Soil Research. 2009; 11:16-18.
9. Kumawat PK, Tiwari RC, Golada SL, Godara AS, Gharwal RS, Choudhary R. Effect of Phosphorus sources, levels and Biofertilizers on yield attributes, yield and economics of black gram (*Phaseolus mungo* L.). Legume Research. 2013; 36(1):70-73.
10. Laddha KC, Sharma RK, Sharma SK, Jain PM. Integrated nitrogen management in maize and its residual effect on blackgram under dry land conditions. Indian Journal of Dryland Agricultural Research and Development. 2006; 21(2):177-184.
11. Mohammad I, Yadav BL, Ahmad A. Effect of phosphorus and bio-organics on yield and soil fertility status of Mungbean (*Vigna radiata* L. Wilczek) under semi-arid condition of Rajasthan, India. International Journal of Current Microbiology and Applied Sciences. 2017; 6(3):1545-1553.
12. Parthasarathi K, Balamurugan M, Ranganathan LS. Influence of the vermicompost on the physio-chemical and biological properties in different types of soil along with yield and quality of the pulse crop-blackgram. Iranian Journal of Environmental Health Science and Engineering. 2008; 5(1):51-58.
13. Singh Mandhata, Deokaran Mishra JS, Bhatt BP. Effect of integrated nutrient management on production potential and quality of summer Mungbean (*Vigna radiate* L.). Journal of Krishi Vigyan. 2017; 5(2):39-45.
14. Tisdale SL, Nelson WS, Beaton. Soil fertility and fertilizers. McMillan Publishers Company, New York, 1985.