Int.J.Curr.Microbiol.App.Sci (2017) *6*(3): 223-228

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 3 (2017) pp. 223-228**
Journal homepage: http://www.ijcmas.com

Original Research Article

https://doi.org/10.20546/ijcmas.2017.603.023

Effect of Fertility Levels and Biofertilizers on Physical and Chemical Properties of Soil under Blackgram (*Vigna mungo* L.)

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ABSTRACT

Keywords

Black gram, Fertility, Biofertilizers, Seed inoculation, RDF.

Article Info

Accepted:
08 February 2017
Available Online:
10 March 2017

A field experiment was conducted at Institutional Farm, Rajasthan College of Agriculture, Udaipur, (Rajasthan) during *kharif*, 2014 on clay loam soil. The experiment was laid out according to factorial randomized block design with three replications. The experiment comprised four fertility levels of (control, 50% RDF, 75% RDF, and 100 % RDF) and four biofertiliizers levels (control, PSB, *Rhizobium* and *Rhizobium* + PSB) were applied to the black gram var.T-9. The application of 100 % RDF and seed inoculation with *Rhizobium* + PSB or combination significantly increased the organic carbon, available N, P_2O_5, K_2O, Cu, Zn, Fe and Mn content in soil. However, bulk density, particle density, porosity, Ec and pH was found non significant after harvesting of the crop due to above properties don't change in one cropping season.

Introduction

Black gram (*Vigna mungo* L.) originated in India, contains 24 per cent protein, 60 per cent carbohydrate, 1.3 per cent fat and phosphoric acid. Black gram 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 3.07 m ha area with a production of 1.60 million metric ton. In Rajasthan, pulses occupy 32.46 lac ha area with a production of 19.57 lac ton. However, productivity of black gram is low in Rajasthan 575 kg ha^{-1} (Anonymous, 2012). *Rhizobium* plays an important role in increasing the availability of nitrogen to the plants and helps in boosting the production through nitrogen fixation. Similarly, inoculation with Phosphate Solublizing Bacteria (PSB) plays a pivotal role in supplementary phosphorus requirement of crop. PSB brings out more amount of fixed or unavailable native phosphorus into soluble and available form to the plants.

Nitrogen plays important role in synthesis of chlorophyll, amino acids and other organic compounds of physiological significance in plant system. Phosphorus role in root development, nodule formation and plays important role in energy transfer in the living cells by means of high energy phosphate bond of Adenosine Tri Phosphate.

There is evidence of stagnation or low productivity of black gram and other *kharif* pulses even with the application of recommended doses of NPK fertilizers (Athokpam *et al.*, 2009). Due to low and unstable production and increasing population pressure, the per capita availability of pulses has come down from 69 g in 1961 to about 39.4 g in 2011 against the minimum requirement of 80 g capita^{-1} (Anonymous, 2012). In this research work was studied that effect of fertility levels and biofertilizer levels on physical and chemical properties of soil.

Materials and Methods

The experiment was conducted at Institutional Farm Rajasthan College of Agriculture, Udaipur, which is situated at South-Eastern part of Rajasthan at an altitude of 582.17 metre above mean sea level and at 24º 35′ N latitude and 73º 42′ E longitude. The region falls under Agro-climatic Zone IV a (Sub-humid Southern Plain and Aravalli Hills) of Rajasthan. The soil of experimental site was clay loam in texture, slightly alkaline in reaction. The soil was medium in available nitrogen and phosphorus while high in potassium, and sufficient in DTPA extractable micronutrients.

The experiment comprised four fertility levels of (control, 50% RDF, 75% RDF, and 100 % RDF) and four biofertiliizers levels (control, PSB, *Rhizobium* and *Rhizobium* + PSB) were applied to the black gram var.T-9. 30 kg ha^{-1} Phosphorus was applied through DAP and nitrogen at 20 kgha^{-1} was applied through urea after adjusting N supplied through DAP.

To assess the fertility status of soil, the soil sample (0-15 cm depth), from each plot at harvest of crop was taken. The samples were passed through 2 mm plastic sieve to avoid metallic contamination. The soil sample were analysed for Soil texture, EC, pH, Bulk density, Particle density and OC and available NPK and cationic micronutrients (Cu, Zn, Fe, Mn) content (Table 1).

Results and Discussion

Physical properties

A perusal of data (Table 2) revealed that there was no significant variation in bulk density, particle density and porosity of black gram due to different fertility levels and biofertilizers because physical properties do not change significantly in one cropping season.

Chemical properties

The data summarized in (Table 2) revealed that there was no significant variation in pH and EC of black gram due to different fertility levels and biofertilizers because pH and Ec do not change significantly in one cropping season (one reason).

The data presented in table 3 indicate that the application of fertility levels under 50 % RDF, 75 % RDF and 100 % RDF treatments increased the organic carbon in soil after harvest to the extent of 5.89, 22.56 and 25.76 per cent, respectively over control OC (0.60%). Seed inoculation with PSB, *Rhizobium* and *Rhizobium* + PSB increase in organic carbon of soil after harvest was to the extent of 6.29, 7.08 and 10.85 per cent respectively, over control.

Available nitrogen, phosphorus, potassium

Effect of fertility levels

It is evident from the data summarized in table 3 that after harvesting of the crop the available nitrogen in soil the application of fertility levels under control, 50 % RDF, 75 % RDF and 100 % RDF treatments increased the available nitrogen in soil to the extent of 259.46, 271.79, 298.18 and 303.60 kg ha^{-1} respectively. The application of fertility levels under 50 % RDF, 75 % RDF and 100 % RDF treatments after harvest of the crop increased the available phosphorus in soil to the extent of 19.70, 21.87 and 22.33 kg ha^{-1} respectively, over control (19.12 kg ha^{-1}).

Effect of biofertilizers

An examination of data in table 3 revealed that the increase in available nitrogen with *Rhizobium* + PSB was found to be significant over *Rhizobium* as well as PSB inoculations. The increase in available nitrogen in soil with control, PSB, *Rhizobium* and *Rhizobium* + PSB was to the extent of 259.25, 286.16, 287.40 and 300.22 kg ha^{-1} respectively. The increase in available phosphorus in soil with PSB, *Rhizobium* and *Rhizobium* + PSB inoculation was to the extent of 21.10, 21.26 and 22.30 kg ha^{-1}, respectively over control was 18.38 kg ha^{-1}. The beneficial effect of *Rhizobium* on root growth, development and nodulation of black gram which led to more N_2 fixation, black gram being legume crop which absorbed more soil nutrients from subsurface layers to meet their requirement and part of which was left in surface soil with the root residues after harvest of the crop decomposed and improved the soil fertility. There was no significant variation in available potassium of black gram due to different fertility levels and biofertilizers.

Table.1 Methods adopted for soil analysis

S. No.	Determinations	Methods	Reference
(i)	Soil texture	By International Pipette Method	Piper (1960)
(ii)	Soil reaction(pH)	With the help of pH meter in 1:2 soil-water suspension	Piper (1960)
(iii)	Electrical conductivity (EC)	EC of 1:2 soil-water suspension with the help of "solubridge"	Richards (1954)
(iv)	Bulk density	Method No. 38 of USDA Hand Book No. 60	Richards (1954)
(v)	Particle density	Method No. 39 of USDA Hand Book No. 60	Richards (1954)
(vi)	Porosity	Method No. 40 of USDA Hand Book No. 60	Richards (1954)
(vii)	Organic carbon	Determination by rapid titration method	Walkley and Black (1934)
(viii)	Available nitrogen	Estimation by alkaline potassium permanganate method	Subbiah and Asija (1956)
(ix)	Available phosphorus	Olsen's P, 0.5 *M* $NaHCO_3$ method, pH 8.5	Olsen *et al.* (1954)
(x)	Available potassium	Neutral ammonium acetate extraction and Flame photometry method	Richards (1954)
(xi)	Available Zn, Fe, Cu & Mn content	Extraction by 0.005 *M* DTPA + 0.01 *M* $CaCl_2$ + 0.1 *M* triethanolamine at pH 7.3	Lindsay and Norvell (1978)

Table.2 Effect of fertility levels and biofertilizers on physical and chemical properties of soil after crop harvest

Treatments	**Bulk density (Mg/m^3)**	**Particle density (Mg/m^3)**	**Porosity (%)**	**EC (dSm^{-1})**	**pH**
Fertility Levels					
F_0 : Control	1.36	2.65	48.67	0.81	8.13
F_1 : 50 % RDF	1.35	2.65	49.05	0.82	8.21
F_2 : 75 % RDF	1.31	2.65	50.56	0.82	8.32
F_3 : 100 % RDF	1.29	2.63	50.95	0.83	8.50
SEm±	0.04	0.06	0.10	0.002	0.07
C.D. (P= 0.05)	NS	NS	NS	NS	NS
Biofertlizers					
B_0: Control	1.36	2.64	48.48	0.81	8.21
B_1 : PSB	1.36	2.63	48.28	0.82	8.29
B_2:*Rhizobium*	1.35	2.63	48.66	0.82	8.28
B_3:PSB+*Rhizobium*	1.30	2.61	50.19	0.82	8.39
SEm±	0.04	0.06	0.10	0.002	0.07
C.D.(P= 0.05)	NS	NS	NS	NS	NS

Table.3 Effect of fertility levels and biofertilizers on chemical properties of soil after crop harvest

Treatments	**OC (%)**	**Available N (kg ha^{-1})**	**Available P_2O_5 (kg ha^{-1})**	**Available K_2O (kg ha^{-1})**
Fertility Levels				
F_0 : Control	0.60	259.46	19.12	408.20
F_1 : 50 % RDF	0.62	271.79	19.70	412.81
F_2 : 75 % RDF	0.72	298.18	21.87	426.08
F_3 : 100 % RDF	0.74	303.60	22.33	430.90
SEm±	0.006	2.84	0.25	6.94
C.D. (P= 0.05)	0.017	8.20	0.72	NS
Biofertlizers				
B_0: Control	0.63	259.25	18.38	403.42
B_1 : PSB	0.68	286.16	21.10	421.62
B_2 : *Rhizobium*	0.68	287.40	21.26	423.91
B_3:PSB+*Rhizobium*	0.71	300.22	22.30	429.03
SEm±	0.006	2.84	0.25	6.94
C.D. (P= 0.05)	0.017	8.20	0.72	NS

Table.4 Effect of fertility levels and biofertilizers on available micronutrients of soil after crop harvest

Treatments	**Available Zn ($mg\ kg^{-1}$)**	**Available Fe ($mg\ kg^{-1}$)**	**Available Cu ($mg\ kg^{-1}$)**	**Available Mn ($mg\ kg^{-1}$)**
Fertility Levels				
F_0 : Control	1.84	3.51	2.25	3.31
F_1 : 50 % RDF	1.99	3.79	2.36	3.51
F_2 : 75 % RDF	2.06	4.21	2.51	4.05
F_3 : 100 % RDF	2.13	4.33	2.55	4.18
SEm±	0.02	0.09	0.03	0.06
C.D. (P= 0.05)	0.07	0.27	0.08	0.18
Biofertlizers				
B_0: Control	1.85	3.53	2.27	3.30
B_1 : PSB	2.00	3.93	2.39	3.73
B_2 : *Rhizobium*	2.06	4.04	2.47	3.88
B_3:PSB+*Rhizobium*	2.12	4.32	2.53	4.14
SEm±	0.02	0.09	0.03	0.06
C.D. (P= 0.05)	0.07	0.27	0.08	0.18

Available copper, zinc, iron and manganese

Effect of fertility levels

Further analysis of data (Table 4) revealed that the application of fertility levels (Control, 50 % RDF, 75 % RDF and 100 % RDF treatments) after harvesting of the crop increased the available copper (2.25, 2.36, 2.51 and 2.55 mg ha^{-1}), zinc (1.84, 1.99, 2.06 and 2.13 mg ha^{-1}), iron (3.51, 3.79, 4.21 and 4.33 mg ha^{-1}) and manganese (3.31, 3.51, 4.05 and 4.18 mg ha^{-1}) in soil, respectively. The increase in available micronutrient content of soil with 100 % RDF treatment was found to be at par with 75 % RDF treatment. The data (Table 3 and 4) showed that the 100% RDF had profound influence on the organic carbon, available N, P, K, Cu, Zn, Fe and Mn status of soil. All the treatments resulted in increasing available nutrient in soil over control. These results are in agreement with those of Zhao *et al.*, (2009), Yadav and Kumar (2009), and Chesti and Ali (2012)**.**

Effect of biofertilizers

Further examination of data (Table 4) showed that after harvesting of the crop due to inoculation of black gram seed with PSB, *Rhizobium* and *Rhizobium* + PSB significantly increased available copper, zinc, iron and manganese in soil comparison to control. The seed inoculation with control (No seed inoculation), PSB, *Rhizobium* and *Rhizobium* + PSB significantly increase in available copper (2.27, 2.39, 2.47 and 2.53 mg ha^{-1}), zinc (1.85, 2.00, 2.06 and 2.12 mg ha^{-1}), iron (3.53, 3.93, 4.04 and 4.32 mg ha^{-1}) and manganese (3.30, 3.73, 3.88 and 4.14 mg ha^{-1}) in soil, respectively. An examination of data in table 4 revealed that the increase in available copper, zinc, iron and manganese in soil of black gram with *Rhizobium* + PSB was found to be significant over *Rhizobium* as well as PSB inoculations. However, the increase in available copper, zinc, iron and manganese content in soil with inoculation of *Rhizobium* was found to be at par with that of PSB. *Rhizobium* and PSB improve the N and P status of soil. Combined inoculation of N_2 fixers and PSB benefit the plant than either group of organisms alone and may have added advantage in the degraded agro ecosystem. Dual inoculation might have contributed something towards enhanced plant growth and increased the soluble P. Increased nodulation under *Rhizobium* + PSB inoculation might be to due to close association of both the microbial population and their activities resulting in improving soil fertility status. These finding are similar to the results obtained by Singh *et al.*, (2012), Khandelwal *et al.*, (2012) and Kumari *et al.*, (2012).

On the basis of one year field experimentation, it can be concluded that under agro climatic condition of zone IVa (Sub-humid Southern Plain and Aravali Hills) of Rajasthan, application of 100% RDF + *Rhizobium* + PSB (F_3B_3), is the better option for realizing improved fertility status of soil. However the highest available nitrogen, phosphorus, potassium, copper, zinc, iron and manganese status of soil after harvesting of black gram crop were observed under fertility level 100% RDF (F_3) and inoculation of *Rhizobium* + PSB (B_3) treatment as compared to 75% RDF (F_2) and control (B_0) respectively. Adoption of integrated nutrient management involving (Inorganic fertilizers and biofertilizers application) through improves the soil health.

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How to cite this article:

Chetan Kumar Jangir, D.P. Singh, R.H. Meena and Mahendra Yadav. 2017. Effect of Fertility Levels and Biofertilizers on Physical and Chemical Properties of Soil under Blackgram (*Vigna mungo* L.). *Int.J.Curr.Microbiol.App.Sci*. 6(3): 223-228.
doi: https://doi.org/10.20546/ijcmas.2017.603.023