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Response of varying level of inorganic fertilizers, farm yard manure and rhizobium inoculation on soil health and yield attributes of black gram (*Vigna mungo* L.) var. Shekhar-2

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Abstract
A field trial was carried out during *kharif* season of 2021 to evaluate the "Response of varying level of inorganic fertilizers (N P K, & Zn), farm yard manure and rhizobium inoculation on soil health and yield attributes of black gram (*Vigna mungo* L.) var. Shekhar-2" in sandy loam soil. The experiment was laid down in randomized block design comprised three fertility levels (control, @ 100% RDF, @50% Zn, @ 100 % FYM) and three levels of farm yard manure (control, @ 50% FYM, @ 100% FYM) replicating thrice and rhizobium inoculation. Amongst the fertility levels, the application of @100 % RDF, (20 kg N ha^{-1} 60 kg P_2O_5 ha^{-1} 20 K_2O ha^{-1}), 100% Zn (25 kg Zn ha^{-1}) and 100% (10 t FYM ha^{-1}) significantly increased seed yield of black gram. Although, the seed yield in 100 % RDF, 100 % Zn, 100 % FYM and in 50 % was at par with 100% RDF. Similarly, seed inoculation with Rhizobium significantly increased seed yield over the remaining treatments. The interaction effect of fertility levels and biofertilizer significantly influenced the yield and of black gram maximum being with 100% RDF, Zn, FYM and Rhizobium combination.

Keywords: Soil parameters, inorganic fertilizer, biofertilizer, black gram, FYM and yield

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. In India, black gram is grown on 3.07 m ha. area with a production of 1.60 million metric tonnes, the state Uttar Pradesh covered area 7.01 lakh ha. (DES, 2019). Protein-energy malnutrition as well as micronutrient deficiencies can be reduced by increasing the consumption of pulses which are rich sources of proteins, minerals, iron and fiber Thirty-one per cent of Indians are vegetarian, according to the 2006 the Hindu-CNN-IBN State of the Nation Survey (Yadav and Kumar 2006) [12]. Thus, a large part of their protein requirement could be met by pulses. The daily protein requirement of an average person is 56 g, and 100 g of pulses contain around 25 g of protein. At least half of the daily requirement of protein can be met by including two servings of pulses in the daily diet. Food security stands on the three pillars of availability, access and absorption (nutrition) (UNICEF 2016) [11]. Recently, there has been a paradigmatic shift from food availability to household food insecurity, and from energy intake (input measures) to anthropometric measures (output measures), thereby shifting the focus to proper Nutrition (Dev and Sharma 2010). It also enriches soil by fixing atmospheric Nitrogen. 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. Biofertilizer are organic resources containing a specific micro-organism which is derived either from the nodules of plant or from soil around root zone. Rhizobium has vital role towards increasing the avail ability of Nitrogen to the plants and helps in boosting the production through Nitrogen fixation. Nitrogen is an essential element of all the amino acids in plant structures which are the building blocks of plant proteins, important in the growth and development of vital plant tissues and cells like the cell membranes and chlorophyll. Phosphorus plays a vital role in photosynthesis, respiration, energy storage, cell elongation and improves the quality of crops. Phosphorus is an essential constituent of majority of enzymes, which are of great importance in the transformation of energy, in carbohydrate metabolism, in fat metabolism and also in

respiration of plants. It enhances the activity of Rhizobium and increased the formation of root nodules. Potassium (K) is the most abundant inorganic cation, and it is important for ensuring optimal plant growth. K is an activator of dozens of important enzymes, such as protein synthesis, sugar transport, N and C metabolism, and photosynthesis. Zinc affects plant–pathogen interactions via its key role in the activation/stabilization of metallo enzymes. A common component in the plant responses to stress conditions caused by insufficient Zn availability and/or pathogen attack is the plant's capacity to overcome oxidative stress. (Fones and Preston, 2012) [3]. Farmyard manure refers to the decomposed mixture of dung and urine of farm animals along with litter and left-over material from roughages or fodder fed to the cattle. On an average well decomposed farmyard manure contains 0.5 per cent N, 0.2 per cent $P_2O_5$and .0.5 per cent K_2O. (Jangir *et al.* 2014) [4]. The object of this experiment to study the effect of various treatment on Physico-chemical properties of soil and to assess the effect of different level of inorganic fertilizers, farm yard manure and biofertilizer (*Rhizobium* inoculation) on growth and yield of Black gram.

Materials and Methods

The field experiment was conducted at Research Farm of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. The area situated on the south of Prayagraj on the right side of the river Yamuna on the South of Rewa Road at a distance of about 6 Km from Prayagraj city. It is situated at $25^0 24' 23''$ N latitude, $81^0 50' 38''$ E and at the altitude of 98 meter above the sea level. The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and cold winter. The maximum temperature of the location reaches up to 46 ^{0}C – 48 ^{0}C and seldom falls as low as 4 ^{0}C – 5 ^{0}C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually. Prayagraj has a sub- tropical and semi- arid climate with rain mostly during July- September. The meteorological data including the weekly average of maximum and minimum temperature. The experiment comprised two fertility level of (control, 100 % RDF) and three level of (control, 50% Zn, 100% Zn) and three level of FYM (control, 50% FYM, 100% FYM) two level of biofertilizer (control, 100% Rhizobium) replicating thrice. After crop harvesting the material was threshed manually and winnowed. The clean seed obtained from individual plots was weighed and the weight recorded as seed yield in terms of q ha-1. Straw yield was obtained by subtracting the seed yield from biological yield. The seed recorded under each plot were converted into quintals per hectare. The samples were analyzed for different Physico-chemical properties which is mention below in table 1.

Table 1: Protocol used for Physico-chemical analysis

Analysis	Particulars	Result	Protocol
Physical	Sand (%)	61.71	Bouyoucos, (1927)
	Silt (%)	23.10	
	Clay (%)	14.19	
	Texture	Sandy loam	
	Soil Colour	Pale Brown	Munsell, (1971)
	Particle Density (Mg m^{-3})	2.37	Muthuaval *et al.* (1992)
	Bulk Density (Mg m^{-3})	1.23	Muthuaval *et al.* (1992)
	Pore Space (%)	47.53	Muthuaval *et al.* (1992)
	Water Retaining Capacity (%)	54.20	Muthuaval *et al.* (1992)
Chemical	Soil pH	7.58	Jackson, (1958)
	Electrical Conductivity	0.177	Wilcox, (1950)
	Organic Carbon (%)	0.45	Walkley and Black (1947)
	Available Nitrogen (kg ha^{-1})	238.21	Subbiah and Asija (1956)
	Available Phosphorus (kg ha^{-1})	20.73	Olsen *et al.* (1954)
	Available Potassium (kg ha^{-1})	127.65	Toth and Prince, (1949)
	Zinc, (mg kg^{-1})	0.605	Lindsay and Norvell, (1978)

Results and Discussion

As depicted in table 2 shows that the maximum bulk density of soil (Mg m^{-3}), was found for T_1 (Control) which was 1.25 and minimum was found for T_9 (I_3 RDF @ 100% + Zn @ 100% + F_3 @ 100%) which was 1.09 (Mg m^{-3}). The interaction effect of inorganic fertilizer (N P K & Zn) and FYM on bulk density (Mg m^{-3}) of soil was found non-significant. This is show that the maximum particle density of soil (Mg m^{-3}), was found for T_9 (I_3 RDF @ 100% + Zn @ 100% + F_3 @ 100%) which was 2.62 and minimum was found for T_1 (I_3 RDF @ 0% + Zn @ 0% + F_3 @ 0%) which was 2.28 (Mg m^{-3}). The interaction effect of inorganic fertilizer (N P K & Zn) and FYM on particle density (Mg m^{-3}) of soil was found non-significant. The results show that the maximum pore space (%) of soil, was found for T_9 (I_3 RDF @ 100% + Zn @ 100% + F_3 @ 100%) which was 57.26 and minimum was found for T_1 (I_1 RDF @ 0% + Zn @ 0% + F_1 @ 0%) which was 44.20. The interaction effect of inorganic fertilizer (N P K & Zn) FYM on pore space (%) of soil was found non-significant.

As perusal table 2 shows that the pH and EC of soil in which the maximum pH and EC at 25˚C (dS m^{-1}) was found for T_7 (I_3 RDF @ 100% + Zn @ 100% + F_1@ 0%) which were 7.25 and 0.193 and minimum was found for T_3 (I_1 RDF @ 100 % + Zn @ 0% + F_3 @ 100%]) and T_3 (I_1 RDF @ 100 % + Zn @ 0% + F_3 @ 100%) respectively which were 6.80 and 0.126 respectively. The interaction effect of inorganic fertilizer (N P K & Zn) FYM on pH and EC was found significant. Response of organic carbon (%), available Nitrogen (kg ha^{-1}), Phosphorus (kg ha^{-1}), Potassium (kg ha^{-1}) and Zinc (kg mg^{-1}) of post- harvest soil. The result depicted in table 2 shows that the Maximum Organic carbon (%) in soil were found for T_9 (I_3 RDF @ 100% + Zn @ 100% + F_3 @ 100%) which were 0.469 % and minimum was found for T_1 (I_1 RDF @ 0% + Zn @ 0% + F_1 @ 0%) which were 0.460 %. Maximum available Nitrogen, Phosphorus, Potassium (kg ha^{-1}) and Zinc (kg mg-^{1})

in soil were found for T_9 (I_3 RDF @ 100% + Zn @ 100% + F_3 @ 100%) which were 325.93, 34.86, 208.23 kg ha^{-1}, 1.530 kg mg^{-1} respectively and minimum was found for T_1 (I_1 RDF @ 100 % + Zn @ 0% + F_3 @ 100%) which were 290.50, 24.50,179.63 kg ha^{-1} and 0.607 kg mg^{-1} respectively. The interaction effect of Phosphorus and Zinc on available Nitrogen and Potassium was found significant and the interaction effect of inorganic fertilize (N P K & Zn) FYM on organic carbon (%), available Phosphorus and Zinc was also found significant. Combined application of phosphorus and Zinc were found significant increase in available Nitrogen and available Potassium. The results are similar with the finding of (Amrita *et al.* 2017).

Table 2: Soil Parameter

Treatment	BD (Mg m^{-3})	PD (Mg m^{-3})	Pore space (%)	pH (w/v)	EC (dS m^{-1})	OC (%)	Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})	Potassium (Kg ha^{-1})	Zinc (mg kg^{-1})
T_1	1.25	2.28	44.20	7.05	0.153	0.460	290.50	24.50	179.63	0.607
T_2	1.22	2.24	47.42	7.21	0.169	0.461	301.83	34.82	206.62	1.163
T_3	1.20	2.32	47.37	6.80	0.126	0.461	303.88	34.86	197.74	1.450
T_4	1.19	2.52	52.78	7.06	0.153	0.463	310.22	26.68	180.38	1.230
T_5	1.16	2.52	50.43	7.00	0.159	0.464	314.31	29.38	180.68	1.237
T_6	1.14	2.34	54.40	6.97	0.146	0.466	320.60	30.68	198.24	1.480
T_7	1.12	2.50	52.59	7.25	0.193	0.467	322.65	31.58	204.88	1.503
T_8	1.10	2.38	56.75	6.95	0.149	0.468	235.53	33.54	195.84	1.230
T_9	1.09	2.62	57.26	6.85	0.156	0.469	325.93	35.37	208.23	1.530
F- test	NS	NS	S	S	S	NS	S	S	S	S
S.Em. (±)	0.05	0.33	1.38	0.06	0.005	0.332	3.24	0.56	2.60	0.028
C.D.	0.05	0.69	2.94	0.12	0.015	0.155	6.87	1.18	7.79	0.051

Summary

The effect of fertility levels inorganic fertilizer (N P K & Zn) FYM and biofertilizer on the net yield was found significant. The significantly highest net yield of black gram were obtained with combined use of (I_3 RDF @ 100% + Zn @ 100% + F_3 @ 100%) It is obvious because the seed and straw yield of black gram also increased significantly under this treatment which is main contributor to seed yield and thus resulted in higher net returns under application of (I_3 RDF @ 100% + Zn @ 100% + F_3 @ 100%). It was expected because that all the treatments gave significant increase in seed yield which ultimately gave more net returns over the input cost incurred in these treatments in comparison to others treatments.

Conclusion

On the basis of one year field experimentation, it can be concluded that application of 100% RDF (20 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1}, 20 kg K_2O and 25 kg Zn ha^{-1}) + Rhizobium + FYM, is the better option for realizing higher productivity, content and uptake of nutrients of black gram and is the better option for improved fertility status of soil.

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