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Effect of integrated nutrient management on soil health, growth and yield of black gram (*Vigna mungo* L.) var. Indra Urad-1

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Abstract
The present study was entitled on "Effect of integrated nutrient management on soil health, growth and yield of black gram (*Vigna mungo.* L) var. Indra Urad-1". The field experiment was conducted during kharif season of 2021-22 at the NAI, SHUATS in randomized block design with three replications, nine treatments with control. Based on the mean performances T_9 [Neem cake @ 100% + RDF @ 100%] was found the best for black gram yield attribute and yield. Observations were recorded such as plant height (cm), plant population; number of leaves plant^{-1} and yield attributes number of pods plant^{-1}, pod length and seeds pod^{-1}, biological yields of black gram. With application of recommended dose of fertilizer @ 100% gave maximum plant height 57.37cm at 60 DAS, number of leaves 26.60 plant^{-1} and number of pods plant^{-1}19.54 in treatment T_9 as compared to others. The biological yield was maximum in T_9 of 3498 kg ha^{-1} was recorded significantly. Interaction effect of integrated nutrient management was significant for all characters. Thus, it indicates that the process of integrated nutrient management is the better option for Physio-chemical Analysis of Soil to achieve with growth and yield attributes of black gram.

Keywords: Integrated nutrient, rhizobium, black gram, soil health, grain yield etc.

Introduction
Black gram (*Vigna mungo* L. Hepper) is one of the most important leguminous pulse crops among the various grain legumes. Black gram belongs to *leguminoseae* family and subfamily *papilionaceae*. Blackgram (*Vigna mungo* L.), popularly known as "Urad bean". This is the annual plant and used as the most nutritive fooder crop especially for milch animals. Apart from this it also forms a good silage and green manure crop. Being a crop of tropical region, it requires "hot and humid" climate for the best growth. It has ability to fix about 22.10 kg of atmospheric nitrogen per hectare through its root nodules. In addition, it is shade tolerant and therefore compatible as an intercrop with maize, millet, sorghum, sugarcane and cotton (FAOSTAT, 2012) [5]. The most ideal soil growing of black gram is "loamy soil" with pH of 6.5 to 7.8. Black gram cannot be grown in saline or alkaline soils. Black gram is 4th major pulse crop in India, that contributes 10-13% of total area and production respectively. Mostly sowing is done with onset of monsoon in later part of June or mid of July. Black gram is sown in several cropping pattern situational, mixed, catch and sole crop and for animals whole black gram plant is used as nutritive food (Amruta *et al.*, 2016) [1]. Integrated nutrient management approach is not only a reliable way of obtaining high productivity with substantial fertilizer economy, but also a concept of ecological soundness leading to sustainable agriculture by improving Physico-chemical and biological properties of the soil. The basic concept of integrated plant nutrient system is maintenance and improvement of soil fertility for sustaining crop productivity on long term basis. Application of different organic-cum-inorganic sources of nutrients have been found very effective in realizing higher yield, better economy and improved fertility of the soil (Chaudhary *et al.*, 2011) [4]

Neem cake as organic fertilizer
Indian farmers have traditionally used diploid neem cake as a fertilizer in their fields, to enrich the soil. Neem cake is a by-product of oil production and is used as organic fertilizer (Ketkar and Ketkar, 1995) [6]. Neem cake also reduces the alkalinity in the soil because of the calcium and magnesium present in the neem cake. 100Kg of neem cake contains Nitrogen (3.65%),

Phosphorus (0.83%), Calcium (0.77%), Magnesium (0.75%), Potassium (1.67%) given by (SPS coco peat and organic products, 2013).

Materials and Methods

The field experimental is to be conducted out during the Kharif season (17th July to 15th October) 2021-2022 at the Research farm of Department of Soil Science and Agricultural Chemistry at SHUATS located at $25^0 24'3^0$" N $81^0 51'10$" E and 98m above mean sea level. The experiment was laid out in a randomized block design (RBD) with 9 treatments and 3 replications. The treatment consisted of all combination, three level of N P K, Rhizobium, FYM, Neem cake, and crop residue 50 and 100 Kg ha^{-1}. Experiment was conducted at sandy loam soil. The soil samples will be randomly collected from each plot in the experiment plot. Nitrogen, Phosphorus and Potassium are applied basal dose in to the field. The FYM, rhizobium, crop residue and neem cake were applied at their recommended doses *i.e.*, 10 t ha^{-1}, 2g kg^{-1}, 6t ha^{-1} and 5t ha^{-1} respectively. Table 1 indicates the methods of analysis for the pre and post soil physical and chemical properties.

Table 1: Protocols for Analysis of pre- post soil samples

S. No.	Particulars	Protocols
I	**Physical properties**	
1.	Bulk density (Mg m^{-3})	Muthuval *et al.*, (1992)
2.	Particle density (Mg m^{-3})	Muthuval *et al.*, (1992)
3.	Texture (Sand, Slit, Clay %)	Bouyoucous,(1927)
4.	Water holding capacity (%)	Muthuval *et al.*, (2002)
II	**Chemical properties**	
1.	Soil pH (1:2.5) (W/V)	Jackson, (1958)
2.	Electrical Conductivity (1:2.5) (dSm^{-1})	Wilcox,(1950)
3.	Organic Carbon (Kg ha^{-1}) (%)	Walkley and Black,(1947)
4.	Available Nitrogen (Kg ha^{-1})	Subbiah and Asija, (1956) [14]
5.	Available Phosphorus (Kg ha^{-1})	Olsen *et al.*, (1954) [11]
6.	Available Potassium (Kg ha^{-1})	Toth and prince, (1973)

Results and Discussions

Among these treatments, T_9 (Neem cake @ 100% + NPK @ 100%) was found significantly higher plant height (57.37 cm), Pod length (16.66 cm), No. of Pods $Plant^{-1}$ (19.54). Initial boost of nitrogen which might have helped in higher chlorophyll formation and ultimately higher photosynthesis. Phosphorus is also known to encourage cell division and hence contributed to taller plants (Beg and Singh, 2009) [2]. More number of pods mainly due to more survival of flower under high supply of photosynthetic. Higher photosynthetic produced due to better nitrogen and phosphorus availability, better translocation within plants and favorable sink source ratio of photosynthetic (Badar *et al.*, 2015) [3]. Crucial role of Rhizobium in fixation of atmospheric nitrogen which might have enhanced the supply and translocation of N which influences the development of photosynthetic organs (Silva *et al.*, 2013) [12] Steady and higher availability of major, secondary and micronutrients during the crop growth period which have enhanced the growth and yield attributes and finally augmented to better seed yield (Stamford *et al.*, 2013). The range and mean values of growth parameters like Plant height (cm), No. of pods $plant^{-1}$, Length of pod (cm) and No. of seeds pod^{-1} are given in Table 2.

Table 2: Effect of different levels of N, P, K, Rhizobium, FYM, Crop residue and Neem cake on Growth and Yield attributes of Black Gram

	Growth parameters				
	Treatment	**Plant height (cm) (60 DAS)**	**Number of Pods $plant^{-1}$ (75 DAS)**	**Length of Pod (cm)**	**No. of Seed Pod^{-1}**
T_1	[Farmers practice + 100% RDF]	41.57	5.32	10.27	7.14
T_2	[*Rhizobium* 50% + 100%RDF]	48.00	6.97	11.42	8.30
T_3	[100% *Rhizobium*+100%RDF]	48.90	7.46	11.90	8.81
T_4	[50%FYM+100%RDF]	50.23	8.00	12.82	9.09
T_5	[100%FYM+100%RDF]	52.20	8.46	13.51	9.61
T_6	[50%Crop residue+100%RDF]	53.17	9.24	14.50	10.04
T_7	[100%Crop residue+100%RDF]	55.10	10.07	15.87	10.60
T_8	[50%Neem cake+100%RDF]	57.03	11.73	16.16	11.37
T9	[100%Neem cake+100%RDF]	59.07	14.08	16.66	12.24
	F-test	S	S	S	S
	S.ED. (+-)	0.33	0.41	0.38	0.44
	C.D.(P=0.05)	0.7	0.87	0.82	0.93

Effect on soil properties

Among all treatment T_9 [N P K @ 100% + Neem cake @ 100%] was found significantly best treatment for soil with bulk density (1.21 Mg m^{-3}), pore space (55.07%), pH (7.26), EC (0.317 dS m^{-1}), nitrogen (312.27 kg ha^{-1}), phosphorus (28.29 kg ha^{-1}) and potassium (184 kg ha^{-1}). Addition of organic manures can improve the soil physical properties is a well-documented and scientifically proven fact but any significant changes in the soil physical properties can be recorded when organic manure treatment compared with chemical fertilizer treatment. (Berger *et al.*, 2013). Application of FYM has favorable effect on physical, chemical and biological properties of soil and hence provided better environment for root growth and proliferation thereby

creating maximum absorptive power by crop (Saravanan and Kumar, 2013) [13]. Reduction in pH might be due to production of organic acid by manure on decomposition (Silva *et al.*, 2012) [12]. Organic manure in improving porosity and hydraulic conductivity which might have resulted in enhanced leaching of the salts thereby reducing the EC values (Khandelwal *et al.*, 2012) [7]. Significantly higher O.C attributed to bulk posting of organic matter rich in nitrogen which enhanced microbial activity in the soil and thereby greater conversion of organically bound nitrogen to inorganic form by the activities of microbes (Menon *et al.*, 2010) [8]. The higher available N attributed to higher activity of N- fixing bacteria, thereby making N greatly available in the soil by (Singh and Mukherjee, 2009) [15]. Significantly higher available phosphorus might be due to the lower loss of nutrients due to slow available nutrients in soil (Wagadre *et al.*, 2010) [16]. The range and mean values of bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore space (%), pH, Organic carbon (%), electrical conductivity (dS m^{-1}), available nitrogen (kg ha^{-1}), available phosphorous (kg ha^{-1}), available potassium (kg ha^{-1}) are given in Table 3.

Table 3: Effect of Different Levels of N, P, K, Rhizobium, FYM, Crop residue, and Neem cake on soil properties of Black gram

	Treatment	Db (Mg m^{-3})	Dp (Mg m^3)	Pore space (%)	pH	OC (%)	EC (dS m^{-1})	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
T_1	[Farmers practice + @ 100% RDF]	1.41	2.60	43.50	7.64	0.49	0.357	284.33	21.11	150.37
T_2	[50%*Rhizobium*+100%RDF]	1.37	2.54	46.00	7.50	0.54	0.350	289.43	22.09	158.80
T_3	[100% *Rhizobium*+100%RDF]	1.36	2.56	48.66	7.48	0.55	0.347	292.42	22.96	155.47
T_4	[50%FYM+100%RDF]	1.34	2.48	49.72	7.57	0.57	0.337	294.58	23.55	159.13
T_5	[100%FYM+100%RDF]	1.31	2.42	51.30	7.58	0.59	0.337	297.32	24.54	162.80
T_6	[50%Crop residue+100%RDF]	1.28	2.39	51.08	7.39	0.59	0.330	302.48	25.28	167.10
T_7	[100%Crop residue+100%RDF]	1.21	2.37	53.73	7.37	0.61	0.323	304.21	25.95	171.83
T_8	[50%Neem cake+100%RDF]	1.18	2.38	54.34	7.34	0.64	0.323	308.51	26.32	178.83
T_9	[100%Neem cake+100%RDF]	1.15	2.36	55.07	7.26	0.68	0.317	312.27	28.29	184.00
	F-test	S	S	S	NS	S	S	S	S	S
	S.ED	0.033	0.03	0.63	0.11	0.02	0.004	0.65	0.36	1.72
	C.D.(P=0.05)	0.7	0.06	1.33	0.24	0.04	0.008	1.37	0.77	3.65

Effect of different INM treatments on final yields (kg ha^{-1})

Grain yield ha^{-1} (in kg) All the treatments showed significant increase in grain yield per ha (in kg) over the control. The data on grain yield (in kg) per ha was recorded maximum of (1345) kg in T_9 (100%Neem cake+100%RDF) and (1185) kg in T_7 (100% Crop residue + 100% RDF). Higher Gross return (Rs 78300 ha^{-1}) as compared with other treatments and GR (Rs 48300 ha^{-1}) was recorded lowest under (T_1) Control. However; lowest increase was recorded with Net.

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