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Influence of FYM, vermicompost and neem cake on soil health, growth and yield attributes of black gram (*Vigna mungo* L.)

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Abstract
There was an experiment carried out in the Zaid season (April 2023-July 2023) at Sam Higginbottom University of Agriculture, Technology, and Sciences. primary research farm in Prayagraj. The design of the experiment was randomized block design with RDF and three levels FYM (0% FYM, 50% FYM and 100% FYM), and three level of Vermicompost (0% VC, 50% VC and 100% VC), and three level of Neem Cake (0% NC, 50% NC and 100% NC). The result shows that adding different amounts of organic fertilizers improved the soil's chemical properties, increased growth, and increased the amount of black gram generated. The use of RDF, FYM, VC, and NC in treatment T_9 [RDF + FYM @ 100% + VC @ 100% + NC @ 100] was observed. Maximum bulk densities were 1.279 and 1.287 mg/m^3 at 0 and 15 cm, respectively, and particle densities of 2.510 and 2.516 mg/m^3 at 0 and 15 cm, as well as percentages of pore space of 46.37% at 0 and 46.67% at 15 and 30 cm, pH 7.04 at 0-15 cm and 7.17 at 15-30 cm, EC 0.45 dS m^{-1} at 0-15 cm and 0.47 dS m^{-1} at 15-30 cm, organic carbon 0.409% at 0-15 cm and 0.399% at 15-30 cm, and water holding capacity 43.19% at 0-15 cm and 45.32% at 15-30 cm Accessible nitrogen at 0-15 cm and 15-30 cm, 285.32 kg ha^{-1} and 280.17 kg ha^{-1}, Accessible In all treatments, available potassium was found to be 203.97 kg ha^{-1} at 0-15 cm and 202.98 kg ha^{-1} at 15-30 cm, whereas phosphorus was found to be 20.89 kg ha^{-1} at 0-15 cm and 18.97 kg ha^{-1} at 15-30 cm.

Keywords: Black gram, FYM, vermicompost and neem cake, growth and yield, etc.

Introduction
Black gram (*Vigna mungo* L.), also referred to as "urd bean," is one of the most highly prized, high-protein pulse crops and is cultivated in almost every part of India during both the kharif and zaid seasons. It is a leguminous crop with a short lifespan that self-pollinates and is a member of the Leguminosae family. Black grains are a staple of Indian cooking because of their vegetable protein content and capacity to supplement a diet high in cereals. Protein makes up about 26% of it, about three times more than cereal and other vitamins and minerals put together.

The black gram seed contains the following nutrients: 24% protein, 60% carbohydrates, 1.4% fat, 3.2% minerals, 0.9% fiber, 154 mg calcium, 385 mg phosphorus, 9.1% mg iron, and a minimal amount of B complex vitamins. Being a short-duration crop, it performs well in a range of multiple and intercropping systems. After the pods are harvested, the plant can be used as premium dry or green manure or green feed. (Source: Anonymous, 2016) [1].

The decomposing mixture of farm animal pee and excrement, litter, and residual elements from roughages or cow feed is referred to as "farmyard manure". According to Jangir *et al*. (2014) [7], well-decomposed farmyard manure normally comprises 0.5% N, 0.25% P_2O_5, and 0.5% K_2O.

Neem cake has shown great promise as a potential fertilizer. Cakes and neem leaves might be used for this. Neem cakes seem to have exceptional potential as fertilizer. Growing popularity as a potential source of organic manure is neem cake, which has two uses: as a fertilizer and as a pest repellent. Murugan (2011) [11] said. Neem cake is made up of 5.2% N, 1.0% P, and 1.4% K. Nitrification is lowered by neem cake's inhibition of nitrogen. It supplies the soil with nitrogen that is readily available for a long time.

Applying biofertilizers is a more environmentally responsible practice. Biofertilizers increase soil fertility and enrich it; they can be very effective in fixing atmospheric nitrogen. The most significant of these biofertilizers in India are vermicompost inoculants designed for particular leguminous crops. The symbiosis between legumes and vermicompost species provides the majority of the biological nitrogen fixation contribution to agriculture (Meena *et al*., 2016) [12].

Nitrogen (N)-rich fertilizer is essential for improving soil fertility and increasing crop yield. Nitrogen-rich fertilizer increases crop biomass and grain yield. It adds 18-34% more nitrogen to the soil than it does now. The addition of sole residue or its combination with N fertilizer has a good effect on the physico-chemical properties of the soil as well as plant development and production. Nitrogen is one of the most vital nutrients that plants require. This accelerates the growth and development of all biological tissues and increases the protein content of pulses. (Ghosh and others, 2022) [6].

Of the three main macronutrients that plants need for optimal growth and development, phosphorus (P) is an essential nutrient element. Phosphorus is essential for root growth, respiration, energy storage, photosynthesis, cell elongation, and the enhancement of crops. Plants that are deficient may have spindly, upright, and thin stems, and their leaves will turn bluish green in color. (2022, Ghosh *et al*.) [6] The most prevalent inorganic cation is potassium, which is necessary for healthy plant growth (Gayathri *et al*., 2009) [5]. Furthermore, cell growth—a crucial process for the health and development of plants— requires it. (Charel, 2006) [3]

Materials and Methods

In the Soil Science Research Farm at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, a field experiment titled "Influence of FYM, Vermicompost and Neem Cake on Soil Health, Growth and Yield Attributes of Black Gram (*Vigna mungo* L.)" was conducted in the Zaid season of 2023. Applied with RDF and three levels of FYM (0%, 50%, and 100%), three levels of Vermicompost (0%, 50%, and 100% VC), and three levels of Neem Cake (0%, 50%, and 100% NC). The experiment's goal is to keep an eye on the physical and chemical properties.

(Muthuvel *et al*., 1992) [14] used a 100 ml graduated measuring cylinder method and process to assess physical parameters such water-holding capacity, bulk density, particle density, and pore space.

In chemical parameters tested by-

a) Soil pH-by Jackson, M. L. 1958 [9]
b) Soil EC (dS m^{-1})-by Wilcox, 1950 [21]
c) Organic Carbon (%)-by Walkley and Black, 1947 [19]
d) Available Nitrogen (kg ha^{-1})-by Subbiah and Asija, 1956 [22]
e) Available Phosphorus (kg ha^{-1}) by Olsen *et al*., 1954 [15]
f) Available Potassium (kg ha^{-1})-by Toth and Prince, 1949 [18]

Result and Discussion

1. Physical Properties of Soil Bulk density (Mg m-3)

The soil's response bulk density was discovered to be non-significant in relation to the effects of VC, FYM, and neem cake. T_9 (RDF @ + FYM @ 100% + VC @ 100% + NC @ 100%) recorded the highest bulk density of soil at 1.279 Mg m-3 and 1.287 Mg m-3 at 0-15 cm and 15-30 cm, respectively, while treatment T_1 (Absolute Control) recorded the minimum bulk density at 1.231 Mg m-3 and 1.237 Mg m-3 at 0-15 cm and 15-30 cm. Kumar *et al*. (2008) [10] and Reddy *et al*. (2005) [16] reported similar results.

Particle density (Mg m-3)

The maximum and minimum soil particle densities were 2.510 mg m-3 and 2.516 mg m-3 at 0-15 cm and 15-30 cm, respectively, and treatment T_9 (RDF @ + FYM @ 100% + VC @ 100% + NC @ 100%). Treatment T_1 (Absolute Control) recorded the lowest particle densities, 2.467 mg m- and 2.484 mg m at 0-15 cm and 15-30 cm, respectively. Kumar *et al*. (2008) [10] and Reddy *et al*. (2005) [16] reported similar results.

Pore space (%)

Influence of FYM, VC, and Neem Cake showed a noteworthy response in the soil's pore space. The results indicate that treatment T_9 (RDF @ + FYM @ 100% + VC @ 100% + NC @ 100%) had the greatest pore space of 48.37% and 46.67% at 0-15 cm and 15-30 cm, respectively, while treatment T_1 (Absolute Control) had the minimum pore space of 41.66% and 38.12% at 0-15 cm and 15-30 cm, respectively. Kumar *et al*. (2008) [10] and Reddy *et al*. (2005) [16] reported similar results.

Water holding capacity (%)

It was discovered that the influence of FYM, VC, and neem cake significantly affected the soil's responsive water holding capacity. The soil's maximum water-holding capacity was measured at 43.19 percent and 45.32 percent at 0-15 cm and 15-30 cm in treatment T_9 (RFF @ + FYM @ 100% + VC @ 100% + NC @ 100%), respectively, and the minimum was measured at 36.29 percent and 37.08 percent at 0-15 cm and 15-30 cm in treatment T_1 (Absolute Control). Reddy *et al*. have reported similar results (2005) [16].

2. Chemical Properties of Soil pH (1:2.5) w/v

It was discovered that the pH response of the soil was not significantly affected by FYM, VC, or neem cake. In treatment T_9, the highest pH of the soil was 7.04 and 7.17 at 0-15 cm and 15-30 cm, respectively. Treatment T_1 (Absolute Control) recorded minimum 6.52 and 6.55 at 0-15 cm and 15-30 cm, respectively, and RDF @ + FYM @ 100% + VC @ 100% + NC @ 100%. Jayaprakash *et al*. (2003) [8] reported a comparable outcome.

Soil EC (dS m^{-1})

It was discovered that the reaction EC of soil to the influence of VC, FYM, and neem cake was not significant. The lowest reported EC of soil was 0.34 dS m^{-1} and 0.36 dS m^{-1} at 0-15 cm and 15-30 cm, respectively, in treatment T_1 (Absolute Control), whereas the maximum was 0.45 dS m^{-1} and 0.47 dS m^{-1} at 0-15 cm and 15-30 cm in treatment T_9 (RDF @ + FYM @ 100% + VC @ 100% + NC @ 100%). Wyngaard *et al*. (2012) [20] reported a similar outcome.

Organic carbon (%)

It was discovered that the reaction of soil organic carbon under the influence of FYM, VC, and neem cake was

substantial. The highest percentage of organic carbon (OC) in the soil was observed at 0-15 cm and 15-30 cm in treatment T_9 (RDF @ + FYM @ 100% + VC @ 100% + NC @ 100%), whereas the lowest percentage was recorded at 0-15 cm and 15-30 cm in treatment T_1 (Absolute Control). Wyngaard *et al*. (2012) [20] reported a similar outcome.

Available nitrogen (kg ha^{-1})

The available nitrogen response of the soil was shown to be significantly impacted by FYM, VC, and neem cake. The treatment T_9 (RDF @ + FYM @ 100% + VC @ 100% + NC @ 100%) recorded the maximum available nitrogen of soil at 285.32 kg ha^{-1} and 280.17 kg ha^{-1} at 0-15 cm and 15-30 cm, respectively, while treatment T_1 (Absolute Control) recorded the minimum available nitrogen at 275.76 kg ha^{-1} and 270.43 kg ha^{-1} at 0-15 cm and 15-30 cm, respectively. Wyngaard *et al*. (2012) [20] reported a similar outcome.

Available phosphorus (kg ha^{-1})

It was discovered that the phosphorus content of the soil significantly influenced the effects of FYM, VC, and neem cake. At 0-15 cm and 15-30 cm, the maximum accessible phosphorus in the soil was measured at 20.89 kg ha^{-1} and 18.97 kg ha^{-1} in treatment T_9 (RFF @ + FYM @ 100% + VC @ 100% + NC @ 100%). Treatment T_1 (Absolute Control) observed a minimum of 15.31 kg ha^{-1} and 14.31 kg ha^{-1} at 0-15 cm and 15-30 cm, respectively. Singh *et al*. (2013) [17] reported a similar outcome.

Available potassium (kg ha^{-1})

It was discovered that the soil's reaction to potassium that was accessible had a major impact on FYM, VC, and neem cake. The treatment T_9 (RDF @ + FYM @ 100% + VC @ 100% + NC @ 100%) recorded the maximum available potassium of the soil at 203.97 kg ha^{-1} and 202.98 kg ha^{-1} at 0-15 cm and 15-30 cm, respectively, while treatment T_1 (Absolute Control) recorded the minimum available potassium at 186.02 kg ha^{-1} and 180.56 kg ha^{-1} at 0-15 cm and 15-30 cm, respectively. Singh *et al*. (2013) [17] reported a similar outcome.

Table 1: Influence of FYM, Vermicompost and Neem Cake on bulk density (Mg m-3), particle density (Mg m-3), pore space (%) and water holding capacity (%) of soil after crop harvest

Treatments		Bulk density (Mg m-3)		Particle density (Mg m-3)		Pore space (%)		Water holding capacity (%)	
		0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	Absolute control	1.231	1.237	2.467	2.484	41.66	38.42	36.29	37.08
T_2	RDF@ + FYM @ 0% + VC @ 50% + NC @ 50%	1.239	1.242	2.472	2.486	41.92	38.59	36.92	36.92
T_3	RDF@ + FYM @ 0% + VC @ 100% + NC @ 100%	1.245	1.248	2.479	2.488	42.16	39.18	35.10	37.10
T_4	RDF@ + FYM @ 50% + VC @ 0% + NC @ 0%	1.251	1.253	2.483	2.490	43.09	40.61	36.99	38.42
T_5	RDF@ + FYM @ 50% + VC @ 50% + NC @ 50%	1.257	1.265	2.488	2.495	44.35	41.65	37.02	40.00
T_6	RDF@ + FYM @ 50% + VC @ 100% + NC @ 100%	1.263	1.273	2.496	2.501	45.67	42.89	38.21	40.38
T_7	RDF@ + FYM @ 100% + VC @ 0% + NC @ 0%	1.267	1.277	2.498	2.504	46.89	44.79	37.92	41.93
T_8	RDF@ + FYM @ 100% + VC @ 50% + NC @ 50%	1.271	1.284	2.503	2.509	47.89	45.66	40.00	41.77
T_9	RDF@ + FYM @ 100% + VC @ 100% + NC @ 100%	1.279	1.287	2.510	2.516	48.37	46.67	43.19	45.32
	F-Test	NS	NS	NS	NS	S	S	S	S
	S.EM. (±)	-	-	-	-	0.61	0.55	0.43	0.47
	C.D. at 0.5%	-	-	-	-	1.83	1.66	1.44	1.52

Table 2: Influence of FYM, Vermicompost and Neem Cake on pH (1:2.5) w/v, EC (dS m^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) of soil after crop harvest

Treatments		Soil pH (1:2.5) w/v		EC (dS m^{-1})		Organic carbon (%)		Available nitrogen (kg ha^{-1})		Available phosphorus (kg ha^{-1})		Available potassium (kg ha^{-1})	
		0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	Absolute control	6.52	6.55	0.34	0.36	0.376	0.365	275.76	270.43	15.31	14.31	186.02	180.56
T_2	RDF@ + FYM @ 0% + VC @ 50% + NC @ 50%	6.58	6.61	0.35	0.37	0.381	0.374	276.45	271.67	16.50	15.02	187.86	183.70
T_3	RDF@ + FYM @ 0% + VC @ 100% + NC @ 100%	6.63	6.73	0.37	0.39	0.385	0.378	277.55	272.84	17.17	15.61	189.06	185.37
T_4	RDF@ + FYM @ 50% + VC @ 0% + NC @ 0%	6.68	6.77	0.38	0.40	0.390	0.382	279.38	274.16	17.65	16.10	190.10	187.47
T_5	RDF@ + FYM @ 50% + VC @ 50% + NC @ 50%	6.72	6.84	0.39	0.41	0.393	0.387	280.44	275.89	18.09	17.23	195.42	189.55
T_6	RDF@ + FYM @ 50% + VC @ 100% + NC @ 100%	6.78	6.89	0.41	0.43	0.396	0.391	281.97	276.32	18.88	17.91	197.61	191.79
T_7	RDF@ + FYM @ 100% + VC @ 0% + NC @ 0%	6.85	6.93	0.42	0.44	0.399	0.394	282.87	277.91	19.43	18.03	199.67	195.11
T_8	RDF@ + FYM @ 100% + VC @ 50% + NC @ 50%	6.97	7.03	0.43	0.45	0.406	0.397	284.89	278.57	20.57	18.41	201.83	197.27
T_9	RDF@ + FYM @ 100% + VC @ 100% + NC @ 100%	7.04	7.17	0.45	0.47	0.409	0.399	285.32	280.17	20.89	18.97	203.97	202.98
	F-Test	NS	NS	NS	NS	S	S	S	S	S	S	S	S
	S.EM. (±)	-	-	-	-	0.01	0.01	1.48	1.73	0.32	0.23	3.70	1.87
	C.D. at 0.5%	-	-	-	-	0.02	0.02	4.43	5.20	0.96	0.69	11.10	5.59

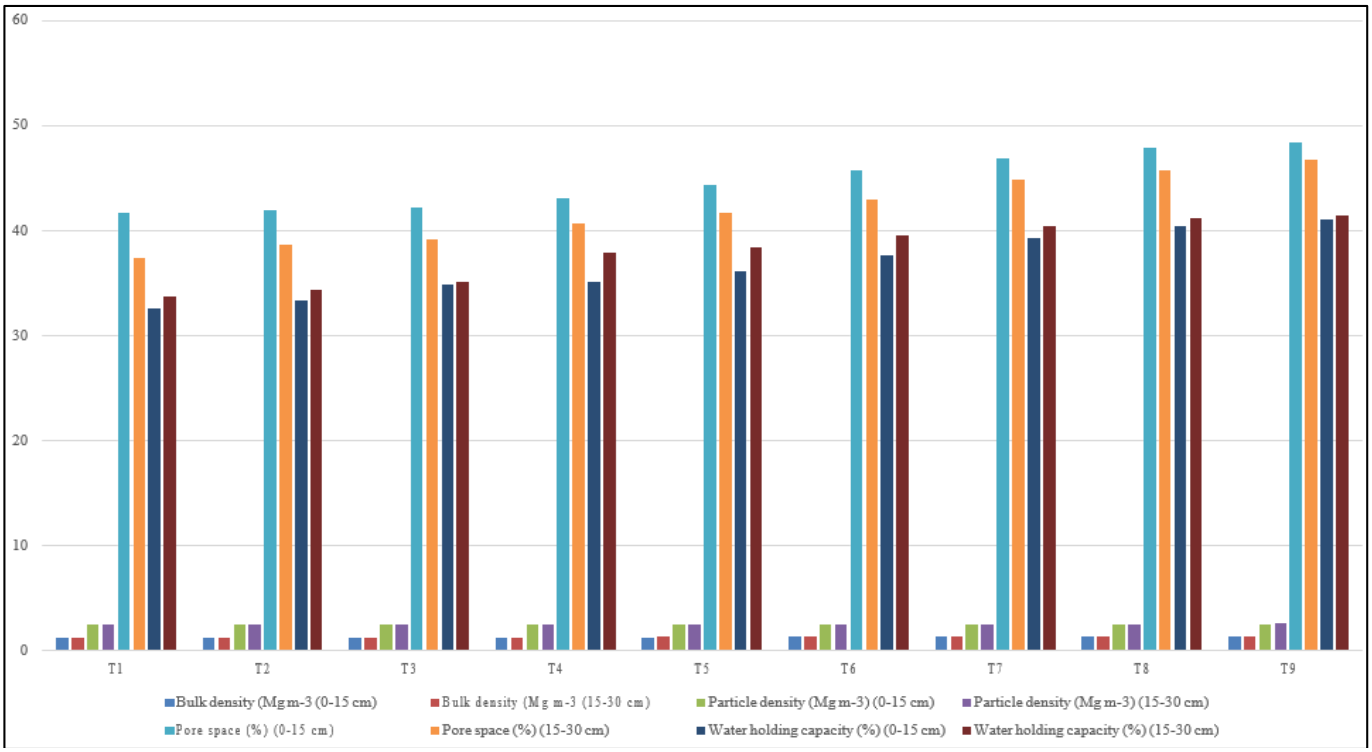

Fig 1: Influence of FYM, Vermicompost and Neem Cake on bulk density (Mg m-3), particle density (Mg m-3), pore space (%) and water holding capacity (%) of soil after crop harvest

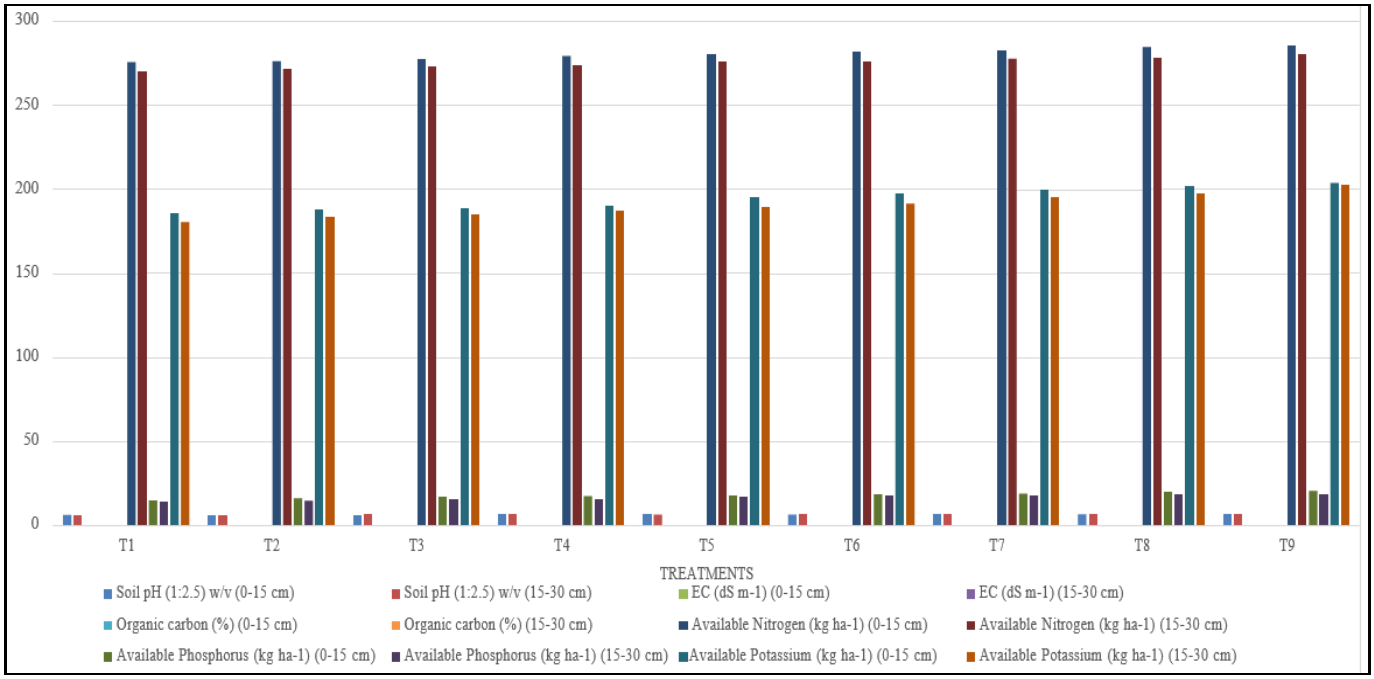

Fig 2: Influence of FYM, Vermicompost and Neem Cake on pH (1:2.5) w/v, EC (dS m^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) of soil after crop harvest

Conclusion

Black gram crop production can be increased in the field by using FYM, vermicompost, and neem cake to improve soil characteristics. The greatest treatment for significantly improving the physical and chemical qualities of soil is T_9 (RDF @ + FYM @ 100% + VC @ 100% + NC @ 100%). Additionally, it aids in the management of soil resources and fertility.

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