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Influence of City Waste Manure and Different Levels of Inorganic Fertilizers on Soil Health Parameter, Growth and Yield Attributes of Black Gram (*Vigna mungo L.)* in Inceptisols

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The objective of the experiment was to evaluate the Influence of city waste manure and different levels of inorganic fertilizers on soil health of black gram. The design applied was FRBD. The study consisted of 16 combination of treatments in which was replicated thrice. The lowest bulk

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density and particle density recorded in NPK 80% and it was observed that treatment NPK 80% improved the soil WHC, OC, available N, P and K due to effect of fertilizer levels. Due to effect of city waste manure lowest value of bulk density and particle density of soil was recorded in treatment CWM 7.5 tha^{-1} and it was observed that treatment NPK 80% improved the soil WHC, OC, available N, P and K. The various level of NPK and City Waste Manure with different soil health parameter used from in the experiment, Economically the treatment combination T_{10} (RDF NPK @ 80% + City Waste manure @ 2.5t ha^{-1}) was found to be the best treatment for Black gram (Vigna mungo L.) Var. Shekhar- 2.

Keywords: City waste manure; inorganic fertilizer; soil health; black gram.

1. INTRODUCTION

Soil plays a crucial role in supporting plant growth, providing habitats for numerous organisms, filtering water, and storing and cycling nutrients. Soil is a natural resource that forms the uppermost layer of the Earth's crust. It is a complex mixture of minerals, organic matter, water, air, and various organisms. Organic matter in the soil comes from decomposed plants, animals, and microorganisms.

Black gram (*Vigna mungo* L), also known as urad dal or black lentil, is a warm-season legume crop that is widely cultivated for its nutritious seeds. It is primarily grown in India, Pakistan, Nepal, and other Asian countries. Black gram is a versatile crop used for various culinary purposes, including making dal, soups, curries, and sweets. It is well adapted to tropical and subtropical climates. It thrives in warm weather with temperatures ranging between 25°C to 35°C (77°F to 95°F). The crop requires a frost-free growing season. It can tolerate a wide range of rainfall, but a well-distributed rainfall of 600 to 800 mm (24 to 32 inches) is ideal.

City waste manure, is a waste type consisting of everyday items that are discarded by the public. "Garbage" can also refer specifically to food waste, as in a garbage disposal; the two are sometimes collected separately. Although the waste may originate from a number of sources that has nothing to do with a municipality, the traditional role of municipalities in collecting and managing these kinds of waste have produced the particular etymology 'municipal. The application of City Waste Manure led to increased crop yields in various crops, including rice, wheat, and vegetables. The nutrient-rich composition of the manure contributed to improved plant nutrition and growth, translating into higher yields [1,2,3].

Nitrogen plays a crucial role in the growth and development of black gram plants [4]. It is an essential nutrient that is required in relatively large quantities by plants, and its availability directly influences the yield and quality of black gram crops [5].

Phosphorus plays a vital role in the growth and development of black gram plants. It is one of the essential macronutrients required by plants, and its availability directly impacts the yield and quality of black gram crops. Here are the key roles of phosphorus in black gram cultivation like Energy transfer and storage, Root development and nutrient uptake, Photosynthesis and carbohydrate metabolism, Protein synthesis and nucleic acid formation, Flowering and reproduction [6,7-9].

Potassium is one of the seventeen elements which are essential for growth and development of plants. Potassium is required for improving the yield and quality of different crops because of its effect on photosynthesis, water use efficiency and plant tolerance to diseases, drought and cold as well for making the balance between protein and carbohydrates [10].

2. METHODOLOGY

The present experiment was conducted during winter season (2022-2023) at Department of Soil Science and Agricultural Chemistry Crop Research Farm of the Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh. Prayagraj is located at $25^{0}47'69"$ N latitude and $81^{0}85'74"$ E longitude at an elevation of 98 m from the mean sea level. This region has a sub-tropical climate prevailing in the South-East part of UP. The soil of the experimental site is alluvial and falls under Inceptisol order. The soil samples were randomly collected from five different sites in the experimental plot prior to tillage operation from a depth of 0-15 cm (furrow slice layer). The soil sample will be reduced in volume by quartering and canning the composites. The soil sample will

then be air dried and run through a 2 mm sieve in order to prepare it for chemical analysis (pH, EC, organic carbon, available nitrogen, phosphorus, and potassium, as well as physical analysis (bulk density, particle density, pore space%, water holding capacity %).

3. RESULTS AND DISCUSSION

3.1 Bulk Density (Mg m^{-3})

The results presented in Table 2 depict the influence of city waste manure and levels of inorganic fertilizers on bulk density (Mg m-3) of soil after crop harvest at 0–15 and 15 – 30 cm depth. The influence of city waste manure (cwm) on bulk density (Mg m-3) of soil at 0-15 cm depth was found. The minimum bulk density 1.27 Mg m-3 was found in 7.5 t ha-1 of CWM and maximum bulk density 1.32 Mg m-3 was recorded in 0 t ha-1 of CWM. The influence of NPK and interaction effect of NPK and CWM was found non-significant. It means it may be due to application of city waste manure which increases the pore space and decreased bulk density. However similar results were reported by Sharma et. [11], Kansotia et al. [12], and Jat et al. [13].

3.2 Particle Density (Mg m^{-3})

The results presented in Table 2 depict the influence of city waste manure and levels of inorganic fertilizers on particle density (Mg m-3) of soil after crop harvest at 0–15 and 15–30 cm depth. The influence of city waste manure (cwm) on particle density (Mg m-3) of soil at 0-15 cm depth was found. The minimum particle density 2.61 Mg m-3 was found in 7.5 t ha-1 of CWM and maximum particle density 2.63 Mg m-3 was recorded in 0 t ha-1 of CWM. The influence of NPK and interaction effect of NPK and CWM was found non-significant. Similar results were also reported by Abadi et al. [14], Sharma et al. [11] and Jat et al. [13].

3.3 Pore space (%)

The results presented in Table 2 depict the influence of city waste manure and levels of inorganic fertilizers on pore space (%) of soil after crop harvest at 0–15 and 15 – 30 cm depth. The influence of city waste manure (CWM) on pore space (%) of soil at 0-15 cm depth was found. The minimum pore space 47.72 % was found in 0 t ha-1 of CWM and maximum pore space 48.96 % was recorded in 7.5 t ha-1 of CWM. The influence of NPK and interaction effect of NPK and CWM was found non-significant. The lowering of bulk density of the soil at harvest of the crop due to the application of city waste is light in weight and less dense which may reduce soil bulk density enhance the pore space of then soil. Similar results were also reported by Abadi et al. [14] and Sharma et al. [11].

3.4 Water Holding Capacity (%)

The results presented in Table 2 depict the influence of city waste manure and levels of inorganic fertilizers on water holding capacity (%) of soil after crop harvest at 0–15 and 15 – 30 cm depth. The influence of city waste manure (CWM) on water holding capacity (%) of soil

Table 1. Treatment combinations

Treatment Combination	Treatment
T1	NPK@0% + City Waste @ 0 t ha^{-1}
T2	NPK@0% + City Waste @ 2.5 t ha^{-1}
T3	NPK@0% + City Waste @ 5.0 t ha^{-1}
T4	NPK@0% + City Waste @ 7.5 t ha^{-1}
T5	NPK@40% + City Waste @ 0 t ha^{-1}
T6	NPK@40% + City Waste @ 2.5 t ha^{-1}
T7	NPK@40% + City Waste @ 5.0 t ha^{-1}
T8	NPK@40% + City Waste @ 7.5 t ha^{-1}
T9	NPK@80% + City Waste @ 0 t ha^{-1}
T10	NPK@80% + City Waste @ 2.5 t ha^{-1}
T11	NPK@80% + City Waste @ 5.0 t ha^{-1}
T12	NPK@80% + City Waste @ 7.5 t ha^{-1}
T13	NPK@120% + City Waste @ 0 t ha^{-1}
T14	NPK@120% + City Waste @ 2.5 t ha^{-1}
T15	NPK@120% + City Waste @ 5.0 t ha^{-1}
T16	NPK@120% + City Waste @ 7.5 t ha^{-1}

Table 2. Influence of City waste manure and levels of Inorganic Fertilizers on Physical parameters of soil

Treatment	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
NPK								
NPK 0 %	1.29	1.31	2.64	2.65	47.73	46.94	44.49	42.49
NPK 40 %	1.31	1.31	2.63	2.65	48.09	46.90	44.77	43.02
NPK 80 %	1.27	1.32	2.58	2.66	48.16	47.19	44.97	43.97
NPK 120 %	1.28	1.32	2.63	2.65	48.11	46.96	45.74	44.16
C.D. at 5%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S.E(d)±	0.019	0.015	0.031	0.028	0.448	0.508	0.566	0.505
F-Test	NS	NS	NS	NS	NS	NS	NS	NS
CWM								
CWM 0 tha^{-1}	1.32	1.32	2.63	2.66	47.72	46.86	44.69	43.19
CWM 2.5 tha^{-1}	1.29	1.31	2.62	2.66	47.94	46.94	44.95	43.45
CWM 5 tha_{-1}	1.28	1.31	2.62	2.66	48.48	47.06	45.16	43.32
CWM 7.5 tha^{-1}	1.27	1.30	2.61	2.66	48.96	47.14	45.18	43.66
C.D. at 5%	0.022	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S.E(d)±	0.019	0.015	0.031	0.028	0.448	0.508	0.566	0.505
F-Test	S	NS	NS	NS	NS	NS	NS	NS
Interaction (NPK X CWM)								
C.D. at 5%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S.E(d)±	0.03	0.03	0.06	0.05	0.89	1.01	1.13	1.01
F-Test	NS	NS	NS	NS	NS	NS	NS	NS

at 0-15 cm depth was found. The minimum water holding capacity 44.69 % was found in 0 t ha-1 of CWM and maximum water holding capacity 45.18 % was recorded in 7.5 t ha-1 of CWM. The influence of NPK and interaction effect of NPK and CWM was found non-significant. Water use by crops largely depends on pore size and particle-size distribution, which was governed by soil structure, texture, bulk density, OC content and crop cultivated but city waste as organic source application has improved soil water holding capacity due to very high hygroscopic nature of city waste as organic source and its decomposed materials so increased soil water retention. It could be due to the granulation effect of organic materials, which led to an increase in micropore space and thus, a reduction in water movement through the soil. Our results were in agreement with earlier findings of Sharma et al. [11].

4. CONCLUSION

The treatment combination T_{10} (RDF NPK @ 80% + City Waste manure @ 2.5t ha^{-1}) was determined to be the optimum treatment for Black gram (*Vigna mungo L.*), despite the varying levels of NPK and City Waste Manure utilized in the experiment with diverse soil health parameters. Treatments with municipal waste manure are superior in terms of soil health and black gram yield. The optimum treatment combination for yield was T_{12} -RDF NPK @ 80% + City Waste manure @ 7.5 t ha^{-1}. Any additional organic manure should be put in addition to the treatment combination indicated above in order to increase its feasibility and make it more physico-chemically and economically optimal for the soil.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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