UNDER PEER REVIEW

Role of fermented organic manure and mycorrhiza on physio-chemical properties of soil and growth of green gram (*Vigna radiata* L.) var. PDM-139.

ABSTRACT

The integrated use of fermented organic manure and mycorrhiza has been employed to enhance crop productivity and maintain soil health and fertility. The research titled "Role of Fermented Organic Manure and Mycorrhiza on Soil Health Properties, Growth, and Yield of Green Gram (Vigna radiata L.) var. PDM-139" was conducted during the Zaid season of 2023 at the Central Research Farm, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj, Uttar Pradesh, India. The plot was designed in 3X3 R.B.D. having 3 levels of fermented organic manure @ 0, 50, 100 %, Mycorrhiza @ 0, 50, 100 % and N, P, K at R.D.F respectively. The Variety selected was PDM-139 released by SVRC, Uttar Pradesh in the year 1974. The average yield recorded was 6-9 q ha^{-1}. Results indicated non-significant with the highest values observed in the control treatment in case of bulk density (Mg m^{-3}) and particle density (Mg m^{-3}) of soil was recorded maximum in T_1 (Absolute control) and minimum was recorded at T_9 (NPK@RDF + M_2@ 10Kg ha^{-1} 50% + F_2@ 50 l ha^{-1} 100%). The maximum Pore space (%) and Water holding capacity (%) of soil was recorded at T_9 (NPK@RDF + M_2@ 10Kg ha^{-1} 50% + F_2@ 50 l ha^{-1} 100%) and the minimum was found in T_1 (control). The slight decrease of pH and EC was observed on application of the treatments, the maximum pH of soil was recorded at T_9 (NPK@RDF + M_2@ 10Kg ha^{-1} 50% + F_2@ 50 l ha^{-1} 100%) and the minimum in T_1 (Absolute control) .The maximum Organic Carbon (%) and increase of N, P, K of soil was recorded at T_9 (NPK@RDF + M_2@ 10Kg ha^{-1} 50% + F_2@ 50 l ha^{-1} 100%) and the minimum was found in T_1 (Absolute control).

Keywords: Fermented organic manures, Mycorrhiza, Green gram, Soil health, Yield, etc.

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INTRODUCTION

Soil is generally defined as the fine earth that covers the land surface, formed through various weathering processes either in place or by the accumulation of materials transported by wind, water, or ice. A distinctive feature of soil is the addition of organic material to this weathered substance. This organic matter can be both living and dead. Therefore, soil can be described as a mixture of mineral material and organic matter, which imparts its unique characteristics **(Nortcilff *et al*., 2006).** Agricultural soil is a type of soil that is used for productive activities of various crops, considered of great importance in terms of environmental decontamination since plants apart from absorbing nutrients such as CO_2, also absorb different polluting compounds from soil.

Pulses are the main source of protein particularly for vegetarians and contribute about 14 % of the total protein content of average Indian diet. Production of pulses in the county is far below the requirement to meet even the minimum level per capita consumption. The per capita availability of pulses in India has been continuously decreasing which is 32.52 g day^{-1} against the minimum requirement of 80 g day^{-1} per capita prescribed by Indian Council of Medical Research (ICMR). Therefore, it is necessary for agricultural scientists to evolve strategy to increasing production of pulses to meet the protein requirements of increasing population of the country. **Anonymous (2009).**

India is the major producer of green gram in the world and grown in almost all States. It is grown in about 36 lakh hectares with total production of about 17 lakh tonnes of grain with a productivity of about 500 kg ha^{-1}. The important green gram growing states in the country are Orissa, Maharashtra, Andhra Pradesh, Madhya Pradesh, Gujarat, Rajasthan and Bihar. It is the third most important pulses grown and consumed in India and is also an important *Zaid* legume in Uttar Pradesh. It is mainly sown along with onset of summer**.** Green Gram can be cultivated in a wide range of soils, from black cotton soils in North India red laterite soils in South India and sandy loam soils in Uttar Pradesh. For best production of green gram mostly the soil like well-drained loamy to sandy loam soil should be selected. (**Jat *et al.*, 2014).**

The repeated use of chemical fertilizers makes the soil to be unworthy for cultivation of crops as it detoriates the microbial activity by reducing the microbial population. Soil can be turned to fertile by the usage of organic fertilizers. Among the organic fertilizers are one of the important components that make the soil healthy. Among the Biofertilizers AM Fungi is one of the important sources that form association with almost 80 % of plants. Its symbiotic association with plants studied by several researchers **(Rajasekhara and Nagarajan, 2005).**

Fermented organic manure comprises a fermented organic extract rich in nitrogen, phosphorus, potassium, and micronutrients. This composition significantly enhances the soil's organic matter by rapidly increasing the organic carbon content. Consequently, soil degradation and erosion are minimized, and soil aeration is improved. This environment benefits carbon-fixing microbes, enriching soil organic carbon and promoting adequate photosynthesis in plants. The hydrolyzed mass in the N-Carb organic extract facilitates the absorption of essential nutrients through plant roots, even under adverse soil conditions. Additionally, it optimizes soil moisture retention at the root zone, helping plants withstand various biotic and abiotic stresses, including salinity, drought, and nutrient deficiency, making it suitable for both organic and conventional agriculture. **(Dutta and Tambat, 2022).**

MATERIALS AND METHODS

The field trial was conducted during the Zaid season of 2023 at the Central Research Farm of the Department of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture, Technology and Sciences (U.P.), located at 25°24’30’’ N latitude, 81°51’10’’ E longitude, and 98m above mean sea level. This location is part of the Agro-Ecological Sub Region [North Alluvium Plain Zone (0-1% slope)] and the Agro-Climatic Zone (Upper Gangetic Plain Region). Agro-climatically, Prayagraj District falls within the subtropical belt of Southeast Uttar Pradesh, experiencing extremely hot summers and fairly cold winters. The maximum temperature ranges up to 46°C, rarely dropping below 4-5°C, with relative humidity between 20-94%. The area receives an average annual rainfall of about 1100mm, primarily from July to the end of September, though occasional winter precipitation is not uncommon. During the crop season, temperatures ranged from a minimum of 21.38℃ to a maximum of 37.82℃, while humidity varied from 46.42% to 96.85%

The experimental design was a 3x3 Randomized Block Design with three levels of fermented organic manure (0, 50, 100%), mycorrhiza (0, 50, 100%), and NPK at recommended doses (RDF). Each plot measured 2m x 2m, and the green gram variety used was PDM-139, aimed at evaluating soil properties and health.

The soil in the experimental area was primarily sandy loam, classified as Inceptisol and part of the alluvium soil near the Ganga-Yamuna Basin. Before tillage operations, soil samples were collected randomly from five distinct locations within the experimental plot at a depth of 0-15cm. These samples were prepared for physical and chemical analysis by air-drying, coning and quartering, sieving through a 2mm sieve, and storing in polythene bags. Post-harvest, soil samples were again collected according to different treatment combinations and analysed for various parameters. The recorded parameters included bulk density, particle density, water holding capacity, and pore space (as per Muthuval et al., 1992), and chemical parameters such as pH (M.L. Jackson, 1958), electrical conductivity (E.C.) (Wilcox, 1950),

organic carbon (Walkley and Black, 1947), available nitrogen (Subbiah and Asija, 1956), available phosphorus (Olsen et al., 1954), and available potassium (Toth and Prince, 1959).

The detailed about treatment combination of the conducted research wise given in Table 1.

Table 1. Treatment combination of green gram

Treatments	Treatment Combination	Symbol
T_1	**Absolute control**	$L_0M_0F_0$
T_2	**NPK@RDF + M_0 + F_1 @ 50%**	LM_0F_1
T_3	**NPK@RDF + M_0 + F_2 @ 100%**	LM_0F_2
T_4	**NPK@RDF + M_1@ 50% + F_0**	LM_1F_0
T_5	**NPK@RDF + M_1@ 50% + F_1@ 50%**	LM_1F_1
T_6	**NPK@RDF + M_1@ 50% + F_2@ 100%**	LM_1F_2
T_7	**NPK@RDF + M_2@ 100% + F_0**	LM_2F_0
T_8	**NPK@RDF + M_2@ 100% + F_1@ 50%**	LM_2F_1
T_9	**NPK@RDF + M_2@ 100% + F_2@ 100%**	LM_2F_2

Note: RDF = Recommended dose of fertilizer, M= Mycorrhiza and F= Fermented organic manure.

RESULT AND DISCUSSIONS

The study found that using fermented organic manure and mycorrhiza significantly enhances various soil physical parameters, such as particle density, water holding capacity, and porosity, thereby maintaining good soil health. Additionally, soil chemical properties improved with increased nutrient levels, including soil electrical conductivity (EC), organic carbon, available nitrogen, phosphorus, and potassium. The field experiment revealed that soil bulk density and pH decreased with higher levels of fermented organic manure and mycorrhiza The maximum bulk density (1.341 Mg m^{-3}) and pH (7.06) were observed in the control treatment T_1[Absolute control], while the minimum pH (6.95) and bulk density (1.224 Mg m^{-3}) were found in the T_{9-} [NPK@RDF + M_2@ 10Kg ha^{-1} 100% + F_2@ 50 l ha^{-1} 100%].

The T_{9-} [NPK@RDF + M_2@ 10Kg ha^{-1} 100% + F_2@ 50 l ha^{-1} 100%] treatment also resulted in the highest values for electrical conductivity (0.42 dS m^{-1}), particle density (2.41), pore space (48.72 %), water holding capacity (48.53 %), organic carbon (0.65 %), available nitrogen (297.67 kg ha^{-1}), available phosphorus (26.03 kg ha^{-1}), available potassium (211.07 kg ha^{-1}). In contrast, the control treatment T_1[Absolute control] had the lowest values for these parameters: minimum electrical conductivity (0.30 dS m^{-1}), pore space (45.43 %), water holding capacity (43.42 %), organic carbon (0.45 %), available nitrogen (274.67 kg ha^{-1}), available phosphorus (18.83 kg ha^{-1}), available potassium (178.30 kg ha^{-1}). This indicates that the T9 treatment has the greatest potential to improve soil health and productivity.

Table 2. Effect of different levels of NPK fermented organic manure and mycorrhizal inoculation on bulk density (Mg m^{-3}), particle density (Mg m^{-3}) water holding capacity (%) and pore space (%)

Treatments	Bulk Density (Mg m^{-3})	Particle Density (Mg m^{-3})	Water Holding Capacity (%)	Pore Space (%)
	0-15 cm	0-15 cm	0-15 cm	0-15 cm
T_1	1.341	2.424	43.52	44.68
T_2	1.334	2.434	44.79	45.20
T_3	1.325	2.446	45.20	45.83
T_4	1.294	2.449	45.47	47.17
T_5	1.281	2.490	46.12	48.56
T_6	1.271	2.513	46.56	49.43
T_7	1.261	2.514	47.52	49.85
T_8	1.244	2.564	47.95	51.49
T_9	1.224	2.597	48.53	52.87
F-Test	NS	NS	S	S
S.Em. (±)	0.02	0.02	0.21	0.14
C.D.@5%	0.05	0.05	0.45	0.29

Table 3. Effect of different levels of NPK fermented organic manure and mycorrhizal inoculation on pH, EC, organic carbon, Av. Nitrogen, Av. Phosphorus and Av. Potassium (kg ha^{-1})

Treatments	pH	EC (dSm^{-1})	OC (%)	Av. Nitrogen (kg ha^{-1})	Av. P_2O_5 (kg ha^{-1})	Av. K_2O (kg ha^{-1})
	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm
T_1	7.06	0.30	0.45	274.67	18.83	178.30
T_2	7.05	0.32	0.46	276.33	19.60	181.52
T_3	7.04	0.34	0.51	279.33	20.88	187.12
T_4	7.05	0.34	0.53	283.33	21.48	192.18
T_5	7.03	0.36	0.58	286.00	22.60	191.87
T_6	7.01	0.38	0.60	289.33	23.56	193.91
T_7	7.02	0.40	0.61	292.67	24.60	202.80
T_8	6.99	0.41	0.63	296.33	25.08	207.68
T_9	6.95	0.42	0.65	297.67	26.03	211.65
F-Test	**S**	**S**	**S**	**S**	**S**	**S**
S.Em. (±)	**0.08**	**0.02**	**0.03**	**0.54**	**0.16**	**0.85**
C.D.@5%	**0.21**	**0.03**	**0.05**	**1.15**	**0.35**	**1.80**

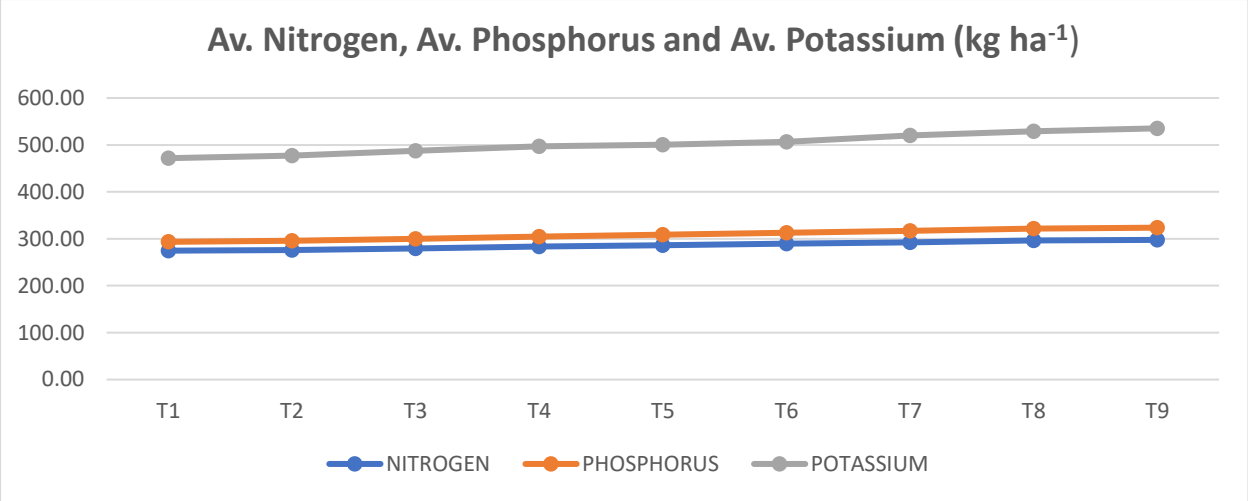

Fig 1. Graphical Representation of Av. Nitrogen, Av. Phosphorus and Av. Potassium vs Treatment Combination

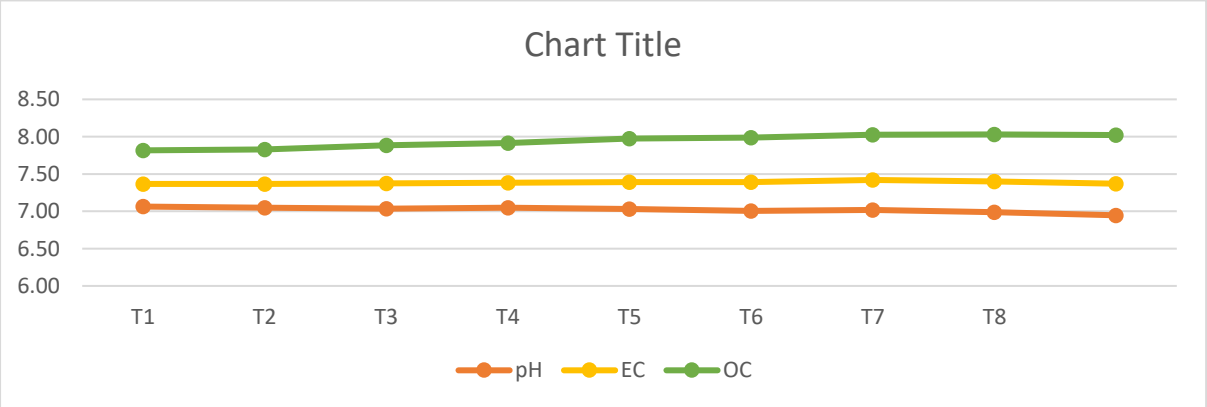

Fig 2. Graphical representation of treatment combination vs EC, pH and OC(%)

Conclusion

It is revealed from trial that the various level of NPK fermented organic manure and mycorrhizal inoculation used from in the experiment, the treatment combination T_9 – [NPK@RDF + M_2@ 10Kg ha^{-1} 50% + F_2@ 50 l ha^{-1} 100%] for green gram it could be recommended for profitable production of Green gram (*Vigna radiata* L.) var. PDM-139 and treatment T_9 is best in terms of soil physical and chemical properties. Further it increased soil fertility and nutrient uptake by the plant. The major challenges faced during the research trial was infestation of white flies and yellow mosaic virus attack due to dry condition around the field. Overall, it proved to be beneficial both respect to soil health properties and economically by application of fermented organic manures and inoculation of mycorrhiza in cultivation and growth of green gram.

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