Influence of N, P, K, Rhizobium and Vermicompost on Soil Health Parameters and Yield of Green Gram (*Vigna radiata* L.) *var.* Samrat

ABSTRACT

An experiment was conducted on "Influence of N, P, K, Rhizobium and Vermicompost on Soil Health Parameters and Yield of Green Gram (*Vigna radiata* L.) *var.* Samrat". during *zaid* season 2023-2024 at the central research farm, department research farm of Soil Science and Agricultural Chemistry, The design applied was 3x3 RBD having three levels each of vermicompost and N.P.K *i.e.,* 0, 50, and 100% respectively and three levels of rhizobium treated seed @ 0, 50, 100%. The result obtained in treatment T_9 ($N_{25}P_{50}K_{25}$ kg ha^{-1} + vermicompost @ 5 t ha^{-1} and rhizobium @ 200g 10 kg^{-1}) has showed a slight change in soil pH *i.e.,* 6.79 and EC *i.e.,* 0.208 dS m^{-1}. The post-harvest soil samples have showed significant increase in pore space, water holding capacity and organic carbon *i.e.,* about 49.20 %, 47.59 % and 0.49 % respectively. Whereas available N, P and K found to be 334.12 kg ha^{-1}, 34.36 kg ha^{-1}, and 204.28 kg ha^{-1} respectively. The increase in NPK (kg ha^{-1}) was found to be significant among all treatments in green gram cultivation and soil quality improvement. The best results among all treatment combination with respect to plant height (65.76 cm), number of leaves $plant^{-1}$ (44.34), number of branches $plant^{-1}$ (14.58), number of grain pod^{-1} (14.28), number of pod $plant^{-1}$ (42.11) and seed yield q ha^{-1} (16.67) were found in treatment combination T_9 ($N_{25}P_{50}K_{25}$ kg ha^{-1} + vermicompost @ 5 t ha^{-1} and Rhizobium @ 200g 10 kg^{-1}. T_9 gave the highest gross return with ₹ 1,49,030 and the benefit of ₹ 29,849.13 with highest cost benefit ratio *i.e.,* 1:1.38. vermicompost along with other combinations has showed improvement in soil health as well as in crop development and yield. Study has also revealed that the application of N, P, and K with vermicompost was an excellent source for fertilization than sole fertilizers.

Keywords: *Soil Health, Green gram, Vermicompost, Rhizobium, NPK, Yield etc.*

INTRODUCTION

The term "soil health" describes the capability of soil to function. Profitability of farms, sustainable crop production, water and nutrient cycling, and climate regulation all depend on healthy soil. Evaluation of soil quality in relation to land production and management sustainability within the framework of soil functions are the two main goals of soil health assessment. A number of characteristics of soil have been found to be markers of soil health. Researchers have been assessing the health of the soil in research plots using a variety of soil health management techniques.

Green gram is popularly known as “Moong Dal.” “It is widely cultivated throughout Asia, including India. Pulses are the main source of protein particularly for vegetarians and contribute about 14 % of the total protein of average Indian diet”. “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, agricultural scientists must to evolve strategy to increase production of pulses to meet the protein requirements of increasing population of the country.”

Vermicompost is relatively resistant to microbial degradation. However, it is essential for establishing and maintaining the optimum soil physical condition for plant growth. It is a good source of N for sustainable crop production, but its availability remains an important issue due to its bulky nature, while inorganic fertilizer is no longer affordable to poor farmers due to its high cost. Vermicompost contains nutrients especially nitrogen, phosphorous, potassium that are easily taken up by plants for fast growth. These composts provide a source of all necessary macro and micro-nutrients in available forms, thereby improving the physical and biological properties of the soil.

Nitrogen can be fixed by Green Gram from the atmosphere; it reacts to a tiny initial dose of nitrogenous fertilizers. The best results have been obtained when applying 15–25 kg N ha^{-1}. Increasing the nitrogen dose could potentially hinder nitrogen fixation capacity by diminishing nodule formation and growth. Nitrogen is indispensable for all crops, playing a crucial role in enhancing protein content and overall nutritional yield. Inadequate nutrient levels can result in stunted growth and a yellowish-green hue in plants. Moreover, nitrogen accelerates the growth and development of living tissues, particularly boosting tiller count in cereals and enhancing the photosynthetic activity of green plants.

Phosphorus plays a crucial role in boosting pulse productivity. It exerts a notably beneficial influence on the formation of nodules, root development, and nitrogen fixation in legume crops. The fixation process in legume crops, reliant on atmospheric nitrogen, demands considerable energy, with phosphorus being essential to fulfill its ATP (adenosine triphosphate) requirements **Sipai and colleagues (2016)**.

It is better for the environment to use biofertilizers. Biofertilizers can be highly useful in fixing atmospheric nitrogen since they enhance and boost soil fertility. In India, the most important type of bio-fertilizers are rhizobium inoculants that are specifically made for leguminous crops. **Goel *et al.* (1999)** found that most of the agricultural contribution of biological nitrogen fixation comes from the symbiotic connection between legumes and rhizobium species.

METHODOLOGY

The detailed treatment combination is showed in table 1. and field experiment had been conducted during the Zaid season 2022 central research farm of department of Soil Science and Agricultural Chemistry, located at 25°24'30'' North latitude 81°51'10'' East longitude and 98m above mean sea level. Representing the Agro-ecological sub region [North Alluvium plain zone (0- 1% slope)] and Agro-climatic zone (Upper Gangetic plain region). "Argo climatically, The maximum temperature of the location ranges between 46°C and seldom falls below 4°C-5°C. The relative humidity ranges between 20-94%. The average rainfall of this area is around 1100mm annually". The soil samples were randomly collected from one site in the experiment plot prior to tillage operation from a depth of 0-15 cm. The volume of the soil sample then reduced by conning and quartering the composites soil samples. Following this, they underwent air drying and were sieved through a 2 mm mesh, preparing them for both physical and chemical analysis. Soil physical analysis was conducted after post-harvest operations. After 60 days crop harvest soil sample was collected from field. Physical properties textural class, soil colour, bulk density Mg m^{-3}, particle density Mg m^{-3}, pore space %, water holding capacity % were analyzed. Soil chemical analysis is done after post-harvest operations were following, pH, EC dS m^{-1}, organic carbon %, available N kg ha^{-1}, P kg ha^{-1}, K kg ha^{-1}. The trial was laid out in a randomized block design with three replications; plot size was 2 x 2 m for crop seed rate is 20 kg ha^{-1} moong.

Table 1. Treatment combination of green gram

S. No.	Treatment combination	Symbol
T_1	(@$N_0P_0K_0$ kg ha^{-1} +Vermicompost @ 0 t ha^{-1} and Rhizobium @ 0g 10 kg^{-1} Seed)	$I_1V_1R_1$
T_2	(@$N_0P_0K_0$ kg ha^{-1} +Vermicompost @ 2.5t ha^{-1} and Rhizobium @ 100g 10 kg^{-1} Seed)	$I_1V_2R_2$
T_3	(@$N_0P_0K_0$ kg ha^{-1} +Vermicomposte @ 5 t ha^{-1} and Rhizobium @ 200g 10 kg^{-1} Seed)	$I_1V_3R_3$
T_4	(@$N_{12.5}P_{25}K_{12.5}$ kg ha^{-1} +Vermicompost@ 0 t ha^{-1} and Rhizobium @ 0g 10 kg^{-1} Seed)	$I_2V_1R_1$
T_5	(@$N_{12.5}P_{25}K_{12.5}$ Kg ha^{-1} +Vermicompost @ 2.5 t ha^{-1} and Rhizobium @ 100g 10 kg^{-1} Seed),	$I_2V_2R_2$
T_6	(@$N_{12.5}P_{25}K_{12.5}$ kg ha^{-1} +Vermicompost @ 5 t ha^{-1} and Rhizobium @ 200g 10 kg^{-1} Seed),	$I_2V_3R_3$
T_7	(@$N_{25}P_{50}K_{25}$ kg ha^{-1} +Vermicompost@ 0 t ha^{-1} and Rhizobium @ 0g 10 kg^{-1} Seed)	$I_3V_1R_1$
T_8	(@$N_{25}P_{50}K_{25}$ kg ha^{-1} +Vermicompost @ 2.5 t ha^{-1} and Rhizobium @ 100g 10 kg^{-1} Seed),	$I_3V_2R_2$
T_9	(@$N_{25}P_{50}K_{25}$ kg ha^{-1} +Vermicompost @ 5 t ha^{-1} and Rhizobium @ 200g 10 kg^{-1} Seed).	$I_3V_3R_3$

RESULTS AND DISCUSSION

Soil parameters

The composition of N, P, K and vermicompost have significant increasement on the soil parameters. The increasement of pore space %, water holding capacity %, organic carbon, available nitrogen, phosphorus, potassium, with the improvement of soil parameters, table2. Revealed that application of different level s of vermicompost and N, P, K have following roll, on soil. In treatment T_1 lowest data observed particle density 2.25 and 2.26 Mg m^{-3}, pore space 42.31 and 40.30%, water holding capacity 41.15 and 40.45% and T_9 shows the highest particle density 2.64 and 2.66 Mg m^{-3}, pore space 49.20% and 49.21%, water holding capacity 47.59% and 47.65% at 0-15cm and 15- 30cm depth of soil respectively. Also, in table 2. Shown bulk density with highest in T_1 is 1.31 and 1.32 with lowest in T_9 1.18 and 1.20 respectively in 0-15cm and 15-30 cm depth of soil. Table3. shown that in Treatment T_1 have highest pH 7.24 and 7.34 , EC 0.28 and 0.29 dS m^{-1}, organic carbon 0.37 and 0.33%, nitrogen 296.5 and 288.5 kg ha^{-1}, phosphorus 23.32 and 23.33 kg ha^{-1}, Potassium 134.81 and 132.41 kg h^{-1} and T_9 have lowest pH 6.79 and 6.82, EC 0.19 and 0.20 dS m^{-1}, organic carbon 0.50% and 0.49% , nitrogen 334.12 and 326.12 kg ha^{-1}, Phosphorus 34.36 and 34.89 kg ha^{-1}, potassium 204.28 and 200.61 kg ha^{-1} respectively in 0-15cm and 15-30cm depth of soil. The T_9 treatment is found to be best, followed by T_8 and T_7, as depicted by their respective physical and chemical properties. The application of N, P, K, vermicompost, and rhizobium eventually proves to have a positive impact on the soil, helping to maintain its fertility. T_1 demonstrates the least effect on soil parameters among the treatments.

Table 2. Effect of different levels of N, P, K, Vermicompost and Rhizobium on physical properties of soil

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	1.31	1.32	2.25	2.26	42.31	42.30	41.15	40.45
T_2	1.29	1.30	2.28	2.28	43.70	43.69	40.91	41.22
T_3	1.19	1.21	2.28	2.28	44.12	44.18	42.08	42.74
T_4	1.26	1.27	2.24	2.25	45.89	45.87	43.48	44.63
T_5	1.23	1.26	2.31	2.31	46.65	46.66	44.01	44.78
T_6	1.23	1.25	2.33	2.33	46.12	46.13	44.42	45.63
T_7	1.22	1.25	2.36	2.36	46.31	46.31	45.06	46.27
T_8	1.30	1.31	2.39	2.39	48.65	48.66	46.28	47.15
T_9	1.18	1.20	2.39	2.39	49.20	49.21	47.59	47.65
F-test	S	S	S	S	S	S	S	S
S. Em. (±)	0.05	0.05	0.03	0.03	0.03	0.03	0.8	1.25

C.D.@5 %	0.02	0.02	0.01	0.01	0.14	0.14	0.38	0.59

Table 3. Effect of different levels of N, P, K, Vermicompost and Rhizobium on chemical properties of soil

Treatments	**pH**		**EC (dS m^{-1})**		**Organic Carbon (%)**		**Nitrogen (kg ha^{-1})**		**Phosphorus (kg ha^{-1})**		**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**
T1	7.24	7.34	0.28	0.29	0.37	0.33	296.50	288.50	23.32	23.33	134.81	132.41
T2	7.40	7.50	0.27	0.28	0.40	0.35	301.45	295.45	25.36	25.17	149.38	148.01
T3	7.42	7.52	0.25	0.26	0.42	0.36	306.14	296.14	26.04	25.58	154.73	154.39
T4	7.28	7.38	0.22	0.23	0.45	0.39	314.67	307.00	27.24	27.31	155.94	155.87
T5	7.05	7.11	0.23	0.24	0.44	0.39	314.51	309.84	28.42	28.56	165.24	162.24
T6	7.02	7.08	0.23	0.24	0.48	0.43	318.45	316.49	30.30	29.71	173.45	168.78
T7	6.91	7.01	0.22	0.23	0.46	0.43	320.20	319.50	31.15	31.40	186.65	179.65
T8	6.89	6.92	0.21	0.22	0.48	0.46	325.07	316.07	33.75	33.01	196.98	186.98
T9	6.79	6.82	0.19	0.20	0.50	0.49	334.12	326.12	34.36	33.89	204.28	200.61
F-test	S	S	S	S	S	S	S	S	S	S	S	S
S. Em. (±)	0.33	0.36	0.02	0.01	0.03	0.05	3.07	3.07	0.91	1	4.35	4.38
C.D.@ 5%	0.16	0.17	0.01	0.02	0.06	0.02	1.45	1.45	0.43	0.47	2.05	2.07

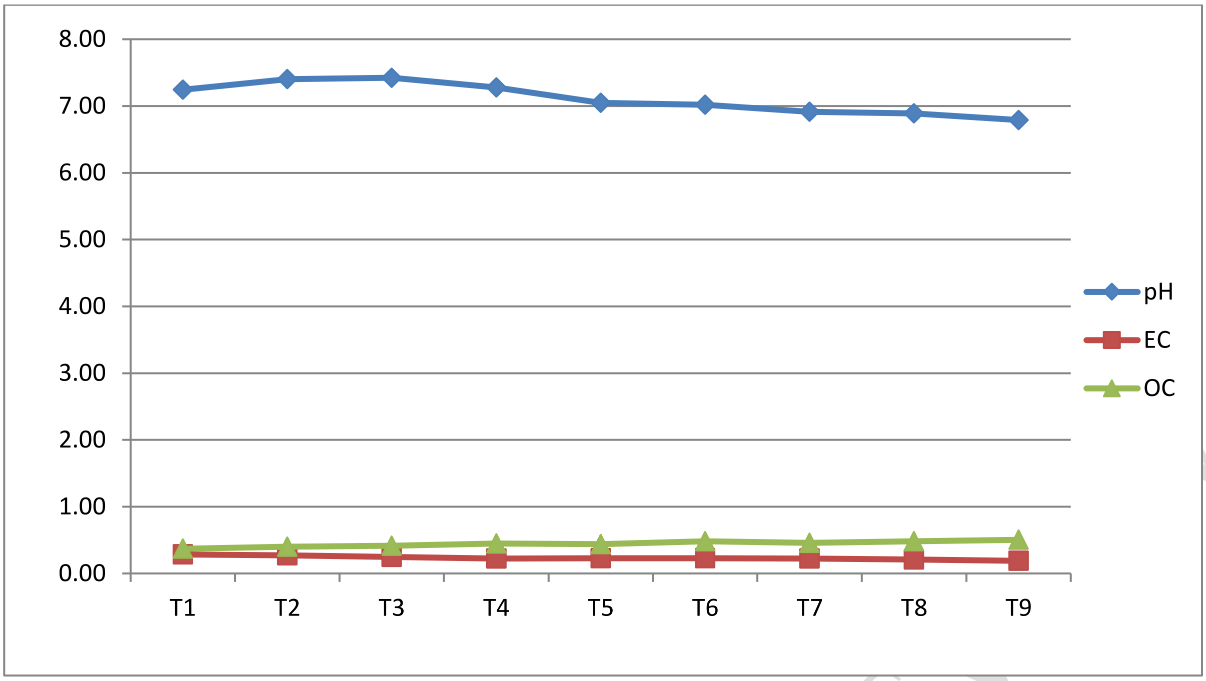

Fig:1 Graphical representation of Treatment Combination VS pH, EC(dS m^{-1}), Organic Carbon(%)

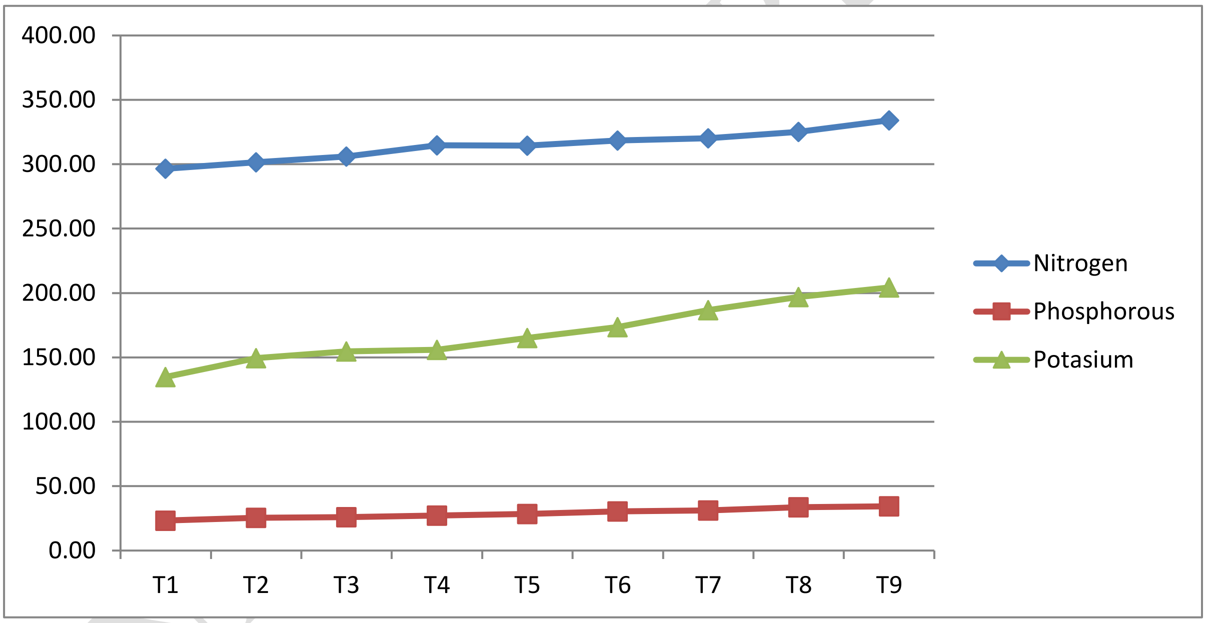

Fig 2. Effect of different levels of Nitrogen(kg ha^{-1}), Phosphorous(kg ha^{-1}) and Potassium(kg ha^{-1}) in soil

Economy of Green Gram crop

According to following table 4. The economy of different treatment concerned, the treatment T_9 provides highest net profit of ₹29849.13 with cost benefit ratio1:1.34 however, the minimum net profit of ₹10095was recorded in the treatment T_1 with cost benefit ratio is 1:1.8.

Table 4. Effect of different treatment combination on cost benefit ratio (C: B) of green gram

Treatment	Yield (q ha^{-1})	Selling price (₹ q^{-1})	Gross return (₹ ha^{-1})	Total cost of cultivation (₹ ha^{-1})	Net Profit (₹ ha^{-1})	Cost Benefit ratio (C:B)
T_1	7.33	9000	65970	55875.00	10095	1:1.18
T_2	7.67	9000	69030	56275.00	12755	1:1.22
T_3	9.33	9000	83970	66275.00	17695	1:1.26
T_4	11.33	9000	101970	88727.97	13242.03	1:1.14
T_5	11.67	9000	105030	88727.97	16302.03	1:1.18
T_6	12.67	9000	114030	99954.40	14075.6	1:1.14
T_7	13.33	9000	119970	99954.40	20015.6	1:1.20
T_8	14.00	9000	126000	101180.87	24819.13	1:1.24
T_9	16.67	9000	149030	111180.87	29849.13	1:1.34

CONCLUSION

It revealed from trial that the various level of N,P,K, vermicompost and rhizobium seed treatment used in the experiment, the treatment combination T_9 [$N_{25}P_{50}K_{25}$ kg ha^{-1} +Vermicompost @ 5 t ha^{-1} and Rhizobium @ 200g 10 kg^{-1} Seed] was found to be the best treatment with highest gross return of ₹ 149030 which gave benefit of ₹29849.13 with highest cost benefit ratio 1:3.4 for green gram. Therefore, T_9 can be recommended for profitable production of green gram (*Vigna radiata* L.) *var.* Samrat and it is also found that treatment T_9 has shown significance results over soil physical and chemical properties. Therefore, Combination of N, P, K, vermicompost and rhizobium treated seed is found to be better among all treatments for both soil health and green gram production.

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