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Response of Integrated Nutrient Management on Soil Physico-chemical Properties of Green Gram (*Vigna radiata* L.) var. Samrat

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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 field experiment was conducted at central research farm Soil Science and Agricultural Chemistry, SHUATS Prayagraj, (U.P.) on sandy loam soil to see response of Integrated nutrient management on soil properties of green gram (*Vigna radiata* L.) var. Samrat during Zaid season of 2022. There are nine treatment combinations were comprised in randomized block design with three replications. The soil samples were taken in two depth (0-15 cm & 15-30 cm) for analysis. The results showed that the application of NPK, Vermicompost and neem cake had a significant and non-significant effect on soil physico-chemical properties. The maximum bulk density 1.53 and 1.52 Mg^{-3}, particle density 2.60 Mg m^{-3} and 2.61 Mg m^{-3}, pH (7.33 and 7.35) and EC 0.33 and 0.32 dS m^{-1} was recorded in T_1 (Absolute control) at 0-15 and 15-30 cm depth respectively. Similarly,

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the maximum percentage pore space 48.82 and 48.16%, water holding capacity 45.20 and 44.75%, percentage organic carbon 0.52 and 0.50%, available nitrogen 286.66 and 285.66 kg ha^{-1}, phosphorus 29.60 and 28.85 kg ha^{-1} and potassium 192.74 and. 191.87 kg ha^{-1} was recorded in T_9 [100 % NPK + 100 % Vermicompost + 100 % NC].

Keywords: Soil parameters; vermicompost; neem cake; green gram.

1. INTRODUCTION

"Soil Health can be defined as the fitness of a specific kind of soil, to function within its capacity and within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation" [1], (Arshad and Martin 2002). "Consideration of soil as a finite and living resource, led to the concept of soil health defined as the continued capacity of soil to function as a vital living system, within eco-system and land-use boundaries, to sustain biological productivity, maintain or enhance the quality of air and water, and promote plant, animal and human health" [2], (Doran and Zeiss 2000). "Though the use of soil health has emerged in recent years, variation in ability of soils to suppress plant diseases is known since many decades" [3].

"Green gram (*Vigna radiata* L.), commonly known as mung bean, is a highly valued legume crop cultivated extensively in India. Its rich protein content, digestibility, and diverse nutritional benefits make green gram a crucial component of the predominantly vegetarian Indian diet. Pulses are generally cultivated on marginal and sub marginal lands of low soil fertility where little attention is paying to adequate fertilization, which has resulted in deterioration of soil health and low crop productivity" [4]. "It is the high time to cultivate pulses crops scientifically with increasing area" [5].

However, achieving optimal yield levels in green gram cultivation remains a challenge due to inadequate nutrient management practices, imbalanced fertilization, and limited utilization of organic resources. The sustainable management of soil fertility plays a vital role in enhancing crop productivity and ensuring long-term agricultural sustainability. Integrated Nutrient Management (INM) is an approach that integrates the use of both organic and inorganic nutrient sources to optimize nutrient availability, promote soil health, and improve crop yields [15-19]. In the case of green gram cultivation, the combination of organic amendments, such as vermicompost and neem cake, along with conventional NPK fertilizers, has the potential to enhance soil properties and contribute to increased crop productivity. Vermicompost, produced through the decomposition of organic waste by earthworms, is a nutrient-rich organic amendment known for its positive effects on soil health and fertility. It improves soil structure, enhances nutrient availability, and promotes beneficial microbial activity, ultimately leading to improved plant growth and productivity [8-11]. Neem cake, derived from the seeds of the neem tree (*Azadirachta indica*), is another organic amendment with significant nutrient content. Neem cake not only enriches the soil with essential nutrients but also exhibits natural pesticide properties, protecting the crop from various soil-borne pathogens and pests. "Nutrient management strategies should be aimed at achieving the twin goals of fertilizer economy and sustainability [12-14]. The negligence to the conservation and use of organic sources for nutrients has not only exhausted soil nutrient reserves, but also resulted in an imbalance among the available nutrients, leading to soil problems. Integration of inorganic and organic sources such as vermicompost, poultry manure, farm yard manure and their efficient management has shown promise in sustaining the productivity and soil health, besides meeting part of crop nutrient requirement" [6].

This research paper aims to investigate the response of integrated nutrient management, incorporating vermicompost, neem cake, and NPK fertilizers, on soil properties of green gram. The study will focus on evaluating the effects of these nutrient sources on soil nutrient content, pH, organic matter content, and soil microbial activity. Additionally, crop performance parameters such as plant height, number of branches, flowering, pod development, and grain yield will be assessed. Field experiments will be conducted in representative green gram-growing regions Uttar Pradesh of India, encompassing diverse agroclimatic conditions. Different combinations and levels of vermicompost, neem cake, and NPK fertilizers will be tested to

determine the most effective and efficient nutrient management practices for maximizing green gram yield while ensuring soil health and sustainability. The outcomes of this research endeavour are expected to provide valuable insights into the potential benefits of integrating vermicompost, neem cake, and NPK fertilizers in green gram cultivation. By elucidating the impacts on soil properties and crop productivity, this study aims to facilitate evidence-based decision-making for farmers, policymakers, and researchers to adopt sustainable and efficient nutrient management strategies, ultimately enhancing the profitability and sustainability of green gram production.

2. MATERIALS AND METHODS

The field experiment was conducted at Research Farm of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. It is situated at $25^0 24' 23''$ N latitude, $81^0 50' 38''$ Longitude and at the altitude of 98 meter above the sea level. There are nine treatment combination were comprised in randomized block design with three replications. Healthy seeds of green gram variety Samrat were sown 30×45 cm spacing in sandy loam soil. The recommended doses of NPK were applied @ 20:40:20 kg $ha^{-1.}$ The graded level of NPK were applied through Urea, Diammonium phosphate and Murate of potash. Half dose of nitrogen and full dose of phosphorus and potassium were applied basally at the time of sowing. The soil samples were collected randomly from the experimental field to ascertain the nutrient status of each plot at 0-15 and 15-30 cm depth. The size of the soil sample was reduced by air-drying and crushing with the wooden hammer and then passed through a 2 mm sieve, conning and quartering to prepare the composite soil sample for physical and chemical analysis.

Table 1. Treatment combination for green gram

Treatment	Treatment Combination
T_1	[Absolute control]
T_2	[RDF @ 0 % + Vermicompost @ 50 % + NC @ 50 %]
T_3	[RDF @ 0% + Vermicompost @ 100 % + NC @ 100 %]
T_4	[RDF @ 50 % + Vermicompost @ 00 % + NC @ 00 %]
T_5	[RDF @ 50 % + Vermicompost @ 50 % + NC @ 50 %]
T_6	[RDF @ 50 % + Vermicompost @ 100 % + NC @ 100 %]
T_7	[RDF @ 100 % + Vermicompost @ 00 % + NC @ 00 %]
T_8	[RDF @ 100 % + Vermicompost @ 50 % + NC @ 50 %]
T_9	[RDF @ 100 % + Vermicompost @ 100 % + NC@ 100 %]

3. RESULTS AND DISCUSSION

3.1 Effect on Soil Physical Properties

Table 2. Influence of NPK, Vermicompost and neem cake on bulk density, particle density, pore space, and water holding capacity of soil

Treatments	BD (Mg m^{-3})		PD (Mg m^{-3})		Pore space (%)		WHC (%)	
	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
T 1	1.53	1.52	2.60	2.61	46.02	45.35	42.02	41.68
T 2	1.48	1.47	2.5	2.54	46.34	45.67	42.44	42.10
T 3	1.44	1.43	2.46	2.47	47.19	46.33	42.76	42.42
T 4	1.37	1.36	2.35	2.36	47.19	46.52	43.41	43.08
T 5	1.36	1.35	2.31	2.33	47.38	46.71	43.83	43.49
T 6	1.29	1.28	2.27	2.29	47.65	46.98	44.123	43.78
T 7	1.25	1.24	2.23	2.26	48.12	47.74	44.46	44.12
T 8	1.21	1.206	2.19	2.23	48.28	47.62	44.87	44.48
T 9	1.17	1.17	2.15	2.19	48.82	48.16	45.20	44.75

BD- Bulk density, PD- Particle density and WHC -Water holding capacity

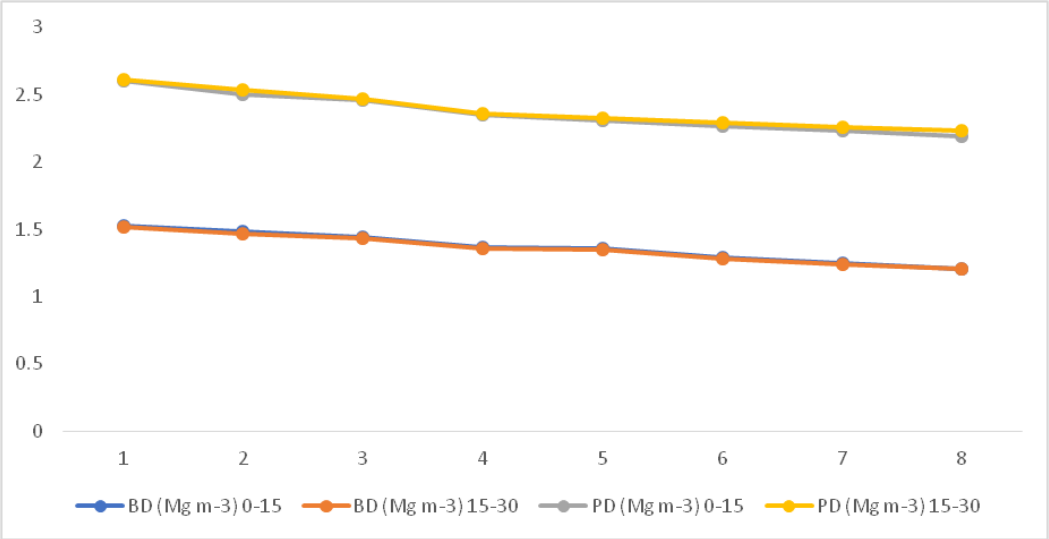

Fig. 1. The influence of NPK, Vermicompost and neem cake on the bulk density and particle density of soil after crop harvest

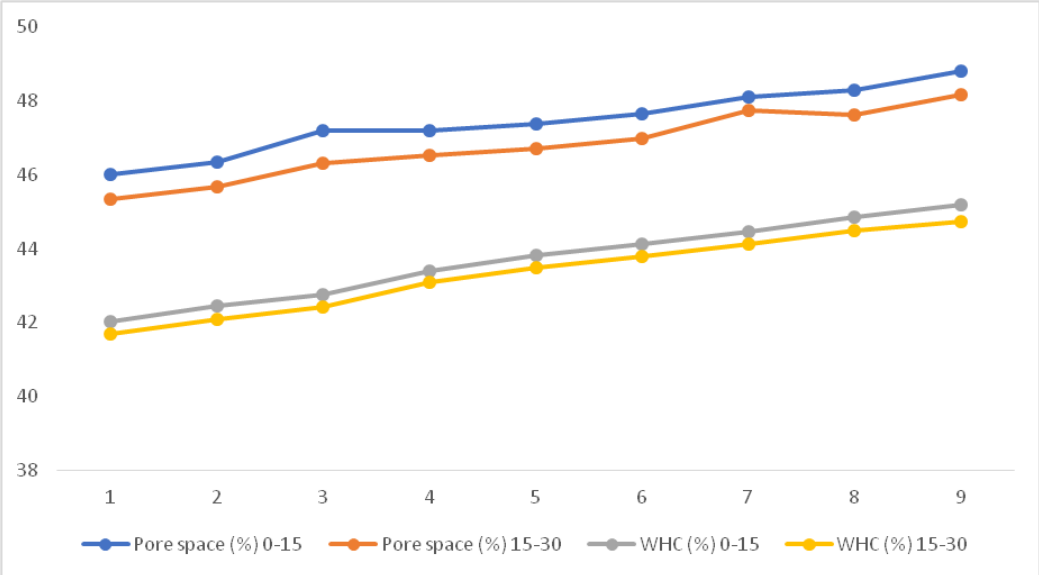

Fig. 2. The influence of NPK, Vermicompost and neem cake on the pore space(%) and water holding capacity of soil after crop harvest

"The interaction effect of NPK, Vermicompost and neem cake on the bulk density of soil after crop harvest was also found significant" [7]. The maximum bulk density 1.53 and 1.52 Mgm^{-3} of soil was revealed at 0-15 and 15-30 cm depth in T1 (0 % NPK + 0 % Vermicompost + 0 % NC) and minimum bulk density 1.17 and 1.17 Mgm^{-3} of soil was found in T9 (100 % NPK + 100 % Vermicompost + 100 % NC). "The interaction effect/response of NPK, Vermicompost and neem cake on the Particle density of soil after crop harvest was found significant. The maximum Particle density 2.60 and 2.61 Mgm^{-3} of soil was revealed at 0-15 and 15-30 cm depth in T1 (0 % NPK + 0 % Vermicompost + 0 % NC) and minimum Particle density 2.15 and 2.19 Mgm^{-3} of soil was found in T9 (100 % NPK + 100 % Vermicompost + 100 % NC). The interaction effect/response of NPK, Vermicompost and neem cake on the Pore space of soil after crop harvest was found significant. The maximum Pore space 48.82 and 48.16% of soil was revealed at 0-15 and 15-30 cm depth in T9 (100 % NPK + 100 % Vermicompost + 100 % NC) and

minimum Pore space 46.02 and 45.35 % of soil was found in T1 (0 % NPK + 0 % Vermicompost + 0 % NC)" [7]. The interaction effect/ response of NPK, Vermicompost and neem cake on the Water Holding Capacity of soil after crop harvest was found significant. The maximum Water Holding Capacity 45.20 and 44.75 % of soil was revealed at 0-15 and 15-30 cm depth in T9 (100 % NPK + 100 % Vermicompost + 100 % NC) and minimum Water Holding Capacity 42.02 and 41.68 % of soil was found in T1 (0 % NPK + 0 % Vermicompost + 0 % NC).

3.2 Effect on Soil Chemical Properties

"The effect/response of NPK, Vermicompost and neem cake on the pH of soil after crop harvest was found significant" [19]. The maximum pH 7.33 and 7.35 of soil was revealed at 0-15 and 15-30 cm depth in T_1 [NPK @ 0 % + Vermicompost @ 0 % + NC @ 0 %] and minimum pH 6.93 and 6.94 of soil was found in T_9 [NPK @ 100 % + Vermicompost @ 100 % + NC @ 100 %]. The effect/response of NPK, Vermicompost and neem cake on the EC (dSm^{-1}) of soil after crop harvest was found significant. The maximum EC 0.33 dS m^{-1} and 0.32 dS m^{-1} of soil was revealed at 0-15 and 15-30 cm depth in T_1 [NPK @ 0% + Vermicompost @ 0 % + NC @ 0 %] and minimum EC 0.24 dS m^{-1} and 0.23 dS m^{-1} of soil was found in T_9 [NPK @ 100 % + Vermicompost @ 100 % + NC @ 100 %]. The effect/response of NPK, Vermicompost and neem cake on the % Organic carbon of soil after crop harvest was found significant. The maximum % Organic carbon 0.52 and 0.50 of soil was revealed at 0-15 and 15-30 cm depth in T_9 [NPK @ 100 % + Vermicompost @ 100 % + NC @ 100 %] and minimum % Organic carbon 0.35 and 0.34 of soil was found in T_1 [NPK @ 0 % + Vermicompost @ 0 % + NC @ 0 %]. The effect/response of NPK, Vermicompost and neem cake on the Nitrogen (Kgha^{-1}) of soil after crop harvest was found significant. The maximum Nitrogen 286.66 Kg ha^{-1} and 285.66 Kg ha^{-1} of soil was revealed at 0-15 and 15-30 cm depth in T_9 [NPK @ 100 % + Vermicompost @ 100 % + NC @ 100 %] and minimum Nitrogen 262.78 Kg ha^{-1} and 261.56 Kg ha^{-1} of soil was found in T_1 [NPK @ 0% + Vermicompost @ 0 % + NC @ 0 %]. The interaction effect/response of NPK, Vermicompost and neem cake on the Phosphorus of soil after crop harvest was found significant. The maximum Phosphorus 29.60 Kg ha^{-1} and 28.85 Kg ha^{-1} of soil was revealed at 0-15 and 15-30 cm depth in T_9 [NPK @ 100 % + Vermicompost @ 100 % + NC @ 100 %] and minimum Phosphorus 21.25 Kg ha^{-1} and 20.12 Kg ha^{-1} of soil was found in T_1 [NPK @ 0% + Vermicompost @ 0 % + NC @ 0 %] The effect/response of NPK, Vermicompost and neem cake on the Potassium (Kg ha^{-1}) of soil after crop harvest was found significant. The maximum Potassium 192.74 Kg ha^{-1} and 191.87 Kg ha^{-1} of soil was revealed at 0-15 and 15-30 cm depth in T_9 [NPK @ 100 % + Vermicompost @ 100 % + NC @ 100 %] and minimum Potassium 176.10 Kg ha^{-1} and 174.41 Kg ha^{-1} of soil was found in T_1 [NPK @ 0% + Vermicompost @ 0 % + NC @ 0%].

Table 3. Influence of NPK vermicompost and neem cake on pH electrical conductivity and organic carbon of soil capacity of post-harvest soil

Treatments	pH		EC (dS m^{-1})		OC (%)	
	0-15	15-30	0-15	15-30	0-15	15-30
T_1	7.33	7.35	0.33	0.32	0.35	0.34
T_2	7.30	7.32	0.32	0.31	0.37	0.35
T_3	7.26	7.28	0.31	0.30	0.4	0.38
T_4	7.25	7.25	0.31	0.30	0.41	0.39
T_5	7.22	7.23	0.29	0.29	0.43	0.41
T_6	7.13	7.15	0.28	0.27	0.46	0.44
T_7	7.05	7.07	0.27	0.26	0.47	0.45
T_8	7.00	7.01	0.26	0.25	0.49	0.47
T_9	6.93	6.94	0.24	0.23	0.52	0.50

EC- electrical conductivity, OC- organic carbon

Table 4. Influence of NPK vermicompost and neem cake on available nitrogen phosphorus and potassium of soil capacity of post-harvest soil

Treatments	N (kg ha^{-1})		P_2O_5 (kg ha^{-1})		K_2O (kg ha^{-1})	
	0-15	15-30	0-15	15-30	0-15	15-30
T_1	262.78	261.56	21.25	20.12	176.10	174.41
T_2	267.66	266.52	23.16	21.95	177.04	175.80
T_3	270.33	269.33	23.70	22.68	179.61	177.48
T_4	277.00	276.00	24.66	23.65	179.726	179.00
T_5	278.33	278.00	25.26	24.09	181.21	180.26
T_6	282.00	281.33	25.81	24.86	183.27	182.52
T_7	283.33	283.00	25.98	25.29	186.07	185.41
T_8	285.33	284.66	28.41	27.18	188.68	187.58
T_9	286.66	285.66	29.60	28.85	192.74	191.87

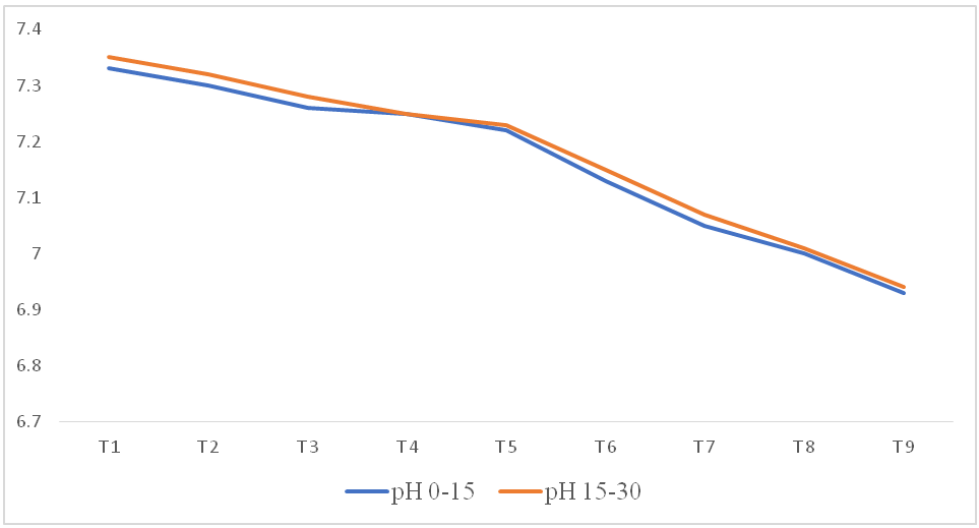

Fig. 3. The influence of NPK vermicompost and neem cake on pH 1:2.5 W/V of post harvest soil

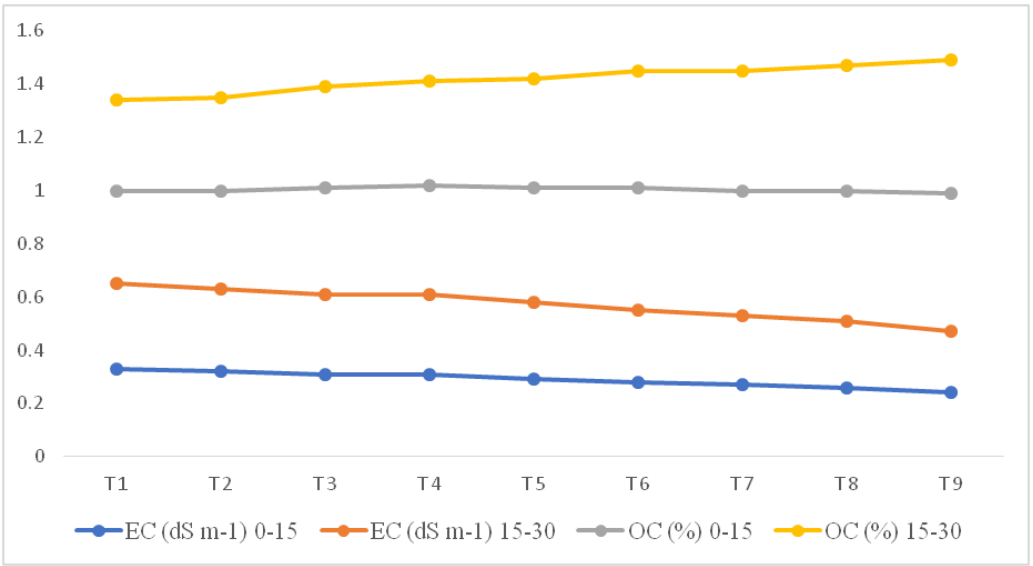

Fig. 4. The effect of NPK vermicompost and neem cake on EC and Organic Carbon of Post-harvest soil

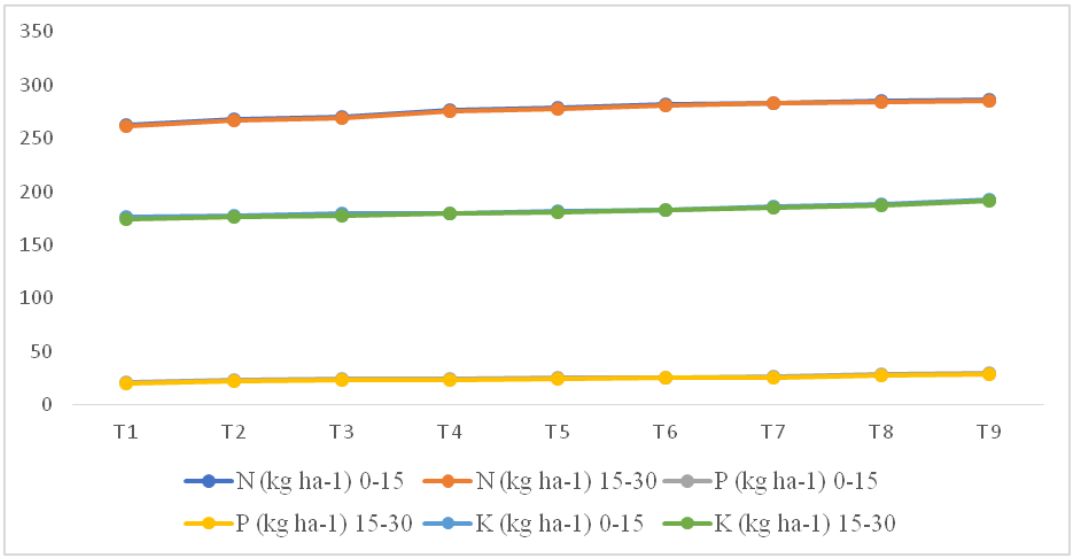

Fig. 5. The effect of NPK vermicompost and neem cake on available NPK of post- harvest soil

4. CONCLUSION

From results it can concluded as the application of NPK, vermicompost and neem cake in treatment T_9 [100 % NPK + 100 % vermicompost +100 % NC] was found sample most effective in improving chemical properties of soil as decrease in pH, and electrical conductivity and increase in organic carbon and available nitrogen, phosphorus and potassium. Similarly, the maximum plant height, nodule per plant, pod per plant, number of branches per plant, grain and straw yield (kg ha^{-1}) and harvesting index was found in treatment T_9 [100 % NPK +100 % vermicompost +100 % NC]. The economically of different treatment concerned, the treatment T_9 [100 % NPK +100 % vermicompost +100 % NC] provides maximum gross return ₹ 124640.00 ha^{-1}, net Return of ₹ 86511.00 ha^{-1} with cost benefit ratio is 1:3.26.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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