Influence of Different Levels Organic and InorganicFertilizer on Soil Health after Potato (*Solanumtuberosum*L.) cultivation.

Comment [AM1]: *Solanum tuberosum*L.

Abstract

The degradation of soil, characterized by the decline in soil organic matter, nutrient exhaustion, and the subsequent diminishment of soil fertility, stands as a prominent factor contributing to the subpar levels of agricultural productivity. Organic amendments (OAs) present a promising avenue for rectifying this degradation, exerting their potential by enacting improvements in both the physical and chemical attributes of the soil. This, in turn, leads to a marked enhancement in the growth and yield performance of crops. An experimental endeavor was meticulously undertaken, employing the Randomised Block Design (RBD) framework, and encompassing three replicates for each treatment. Within this ambit, nine distinct nutrient management practices were evaluated, which included the application of organic manures, namely vermicompost (VC) and neem cake (NC), alongside their amalgamations with inorganic fertilizers. The overarching objective was to gauge the ensuing impact on the physico-chemical facets of the soil. Upon a comprehensive analysis of the aforementioned research endeavor, it emerges as a discernible conclusion that the treatment combination denoted as T9 [RDF @ 100% + Vermicompost @ 6 t ha-1 + Neem cake @ 1.2 t ha-1] emerged as notably advantageous. This treatment not only exhibited a discernible positive effect but also led to a significant amelioration in the physico-chemical attributes of the soil. Consequently, it is prudent to advocate this particular treatment combination to farmers, as it not only augments the yield of potatoes but also serves to uphold the overall health and vitality of the soil, particularly under the specific agro-climatic conditions of Prayagraj.

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Keywords: Vermcompost, Neem cake, NPK, Soil properties, and soil health.

Introduction:

Potato (Solanum tuberosum L.), a tuber crop belonging to the Solanaceae family, holds a position of great significance in global agriculture, being cultivated in over 125 countries and serving as a staple food for more than a billion individuals worldwide (Sanwen Huang et al., 2011). It ranks as the fourth most crucial food crop globally, following rice, wheat, and maize, concerning human consumption (Kandil et al., 2011; Devaux et al., 2014). Potatoes are a valuable non-grain alternative, contributing substantially to the global food supply while also standing as one of the world's primary vegetable crops. Additionally, they are an economical source of essential nutrients such as carbohydrates, proteins, fats, vitamins (including A, B, and C), minerals, and antioxidants, boasting a high biological value (Hale et al., 2008). In the state of Uttar Pradesh, India, potatoes are an esteemed vegetable, either consumed directly or processed into various products like chips, French fries, mashed potatoes, and canned potatoes, among others. Given the increasing global population and the consequent heightened demand for food, coupled with diminishing cultivable land, potatoes are poised to play a pivotal role in the future of food security. The value addition of potatoes not only diversifies crops but also enhances the income of farmers, fosters value-added

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exports, and generates additional employment opportunities (Hussain, 2016). As of the 2020-2021 agricultural year, Uttar Pradesh cultivated potatoes on approximately 620.44 thousand hectares of land, yielding a total of 15811.31 thousand tons of potatoes (Department of Agriculture and Farmers Welfare).

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However, the world's population is on the rise, and soil fertility is diminishing due to the imbalanced use of fertilizers, which poses detrimental effects on the environment. Balanced fertilizer usage, in combination with organic manure, can enhance crop yields, whereas imbalanced use can disrupt the natural soil processes and negatively impact ecosystem services (Timsina, 2018). Improperly using chemical fertilizers without incorporating organic manures has resulted in negative consequences in agriculture. This includes problems like soil fertility decline, nutrient depletion, and a decrease in organic matter content. Organic manures, like poultry and cattle waste, along with compost, are not only eco-friendly but also easily accessible. Applying these to farmland can boost microbial activity, improve soil fertility, and lead to higher crop yields. This has made the use of organic manures widely accepted in sustainable agriculture. Many research studies in recent decades have emphasized the crucial role of organic manures in cultivating potatoes for promoting growth and tuber yield. Thus, this study was conducted to compare the effects of different types of organic manures combined with chemical fertilizers on the growth, yield, and nutritional quality of potatoes. It's well known that using organic manure can enhance soil structure, creating optimal conditions for plant growth. This research primarily focuses on managing soil fertility by using a combination of organic manure and synthetic fertilizers to find the most effective rates for achieving maximum potato yield. According to Monirul et al. (2013), organic manure releases nutrients gradually over an extended period, allowing plants to benefit from sustained nourishment and improved growth. This finding has been supported by the studies of Hossain et al. (2017), Jahiruddin et al. (2012), Haliru et al. (2015), and Mondal (2016). Therefore, the main goal of this study is to investigate the primary effects of applying solid waste along with various combinations of synthetic NPK fertilizers and how they interact with potato growth, yield, yield components, and the chemical composition of potato plants.

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MATERIALSANDMETHODS

Two consecutive winter-season field experiments were conducted at the Research Farm of SHUATS-Prayagraj. The research farm is situated at a latitude of 25^{o}.57' N, a longitude of 81^{o}.57' E, and an elevation of approximately 98 meters above mean sea level. The Allahabad district, where these experiments took place, embodies the subtropical region of South East Uttar Pradesh, characterized by scorching summers and relatively chilly winters. The maximum temperature in this locale can soar to heights between 46 ^{o}C and 48 ^{o}C during the peak of summer, while rarely descending below 4^{o}C to 5^{o}C in winter. Relative humidity varies from 20% to 94%, and the area receives an average annual rainfall of approximately 1100 mm. For the winter seasons of 2020-2021 and 2021-2022, the experiments followed a Randomized Block Design with three replications for nine treatments. The nine treatment combinations were meticulously structured to assess their impact on potato cultivation in this unique agroclimatic condition. The treatment combination was laid out as T_1- (Control)-NPK

Comment [AM14]: Randomized Complete Block Design

0% Recommended Dose of Fertilizer (RDF) + Verrmicompost t@ 0t ha^{-1} + Neem cake @ 0t ha^{-1},T_2- NPK 0% RDF+ Vermicompost @ 3t ha^{-1} + Neem cake @0.6t ha^{-1}, T_3-NPK 0% RDF + Verrmicompost @ 6t ha^{-1} + Neem cake @ 1.2t ha^{-1}, T_4-NPK 50% RDF + Vermicompost @ 0t ha^{-1} + Neem cake @ 0t ha^{-1},T_5-NPK 50% + Vermicompost @ 3t ha^{-1} + Neem cake @ 0.6 t ha^{-1},T_{6-} NPK 50% RDF + Vermicompost @ 6t ha^{-1} + Neem cake @ 1.2t ha^{-1}, T_7-NPK 100% RDF + Vermicompost @ 0t ha^{-1} + Neem cake @ 0t ha^{-1},T_8-NPK 100%RDF + Vermicompost @ 3t ha^{-1} + Neem cake @ 0.6t ha^{-1}, T_9-NPK 100% RDF + Vermicompost @ 6t ha^{-1} + Neem cake @ 1.2t ha^{-1}respectively.

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2. Where is statistical analysis?

Result and Discussions

Bulk Density (g cm^{-3}) and Particle density (gcm^{-3})

The data presented in Table 1 provide insights into the impact of varying levels of Vermicompost, Neem cake, and fertilizers on bulk density (Mg m-3) and particle density (Mg m-3) in the soil, and it is noteworthy that the observed effects were not statistically significant across both years. In the years 2021 and 2022, at soil depths of 0-15 cm and 15-30 cm, the soil bulk density exhibited the highest values in treatment T7 (1.28, 1.26 and 1.29, 1.28), closely followed by treatment T4 (1.26, 1.24 and 1.27, 1.26), while the lowest values were recorded in treatment T3 (1.21, 1.20 and 1.22, 1.21) for both depth ranges in both years. On the other hand, particle density reached its maximum in treatment T7 (2.56, 2.57 and 2.56, 2.57), followed by treatment T9 (2.55, 2.55 and 2.55, 2.56), with the minimum value recorded in treatment T1 (2.44, 2.44 and 2.45, 2.55) during both years. It's worth noting that the variations in different levels of Vermicompost, Neem cake, and fertilizers appeared to have a negative impact on bulk density and particle density, potentially attributed to the addition of bulky materials to the soil. These findings align with prior research, as Sinha et al. (2006) also reported similar observations regarding the influence of organic amendments on soil properties.

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Pore Space (%)

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Upon careful examination of the data concerning soil porosity at depths of 0-15 cm and 15-30 cm, as detailed in Table 3, it is evident that the influence of varying levels of vermicompost, neem cake, and fertilizers on pore space percentage was indeed significant throughout both years. Notably, the highest pore space percentages were registered in treatment T9 (51.81 and 52.47), closely followed by treatment T6 (50.61 and 51.28), while the lowest pore space percentages were observed in treatment T1 (46.66 and 48.55) at the 0-15 cm depth in both years. At the 15-30 cm depth, a similar trend was observed, with the effects of different levels of vermicompost, neem cake, and fertilizers significantly influencing porosity during both years. Here again, treatment T9 exhibited the highest soil pore space percentages (50.47 and 51.94), followed by treatment T6 (49.61 and 48.51), while the lowest porosity values were noted in treatment T1 (44.66 and 46.99) at the 0-15 cm depth in both years. It's important to note that the variations in the application of different doses of fertilizer positively impacted porosity, likely due to the addition of bulky materials to the soil composition. These findings align with those reported by Ghulam et al. (2016), who also observed similar trends in their research.

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Water holding capacity(%)

An in-depth analysis of the data pertaining to soil water holding capacity at depths of 0-15 cm and 15-30 cm, as presented in Table 1, reveals a significant influence of varying levels of vermicompost, neem cake, and fertilizers on this crucial soil parameter throughout both years. Notably, the treatment combinations exhibited distinct effects on the water-holding capacity of the soil. Treatment T9 consistently displayed the highest water-holding capacity values (43.72 and 45.79 at 0-15 cm; 42.72 and 43.82 at 15-30 cm), closely followed by treatment T6 (43.27 and 44.07 at 0-15 cm; 42.31 and 43.41 at 15-30 cm). In contrast, the lowest water-holding capacity values were consistently observed in treatment T1 (37.12 and 37.92 at 0-15 cm; 37.04 and 37.92 at 15-30 cm) during both years.

It is important to highlight that the variations in the application of different doses of vermicompost and neem cake had a positive impact on the water-holding capacity of the soil. This positive influence is likely attributed to the addition of bulky organic materials to the soil composition, which can enhance the soil's ability to retain water. Consequently, these findings underscore the importance of organic amendments in soil management practices aimed at improving water retention, which is crucial for sustaining crop growth and overall soil health.

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Organic carbon (%)

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The data presented in Table 1 shed light on the response of soil organic carbon content, which was notably influenced by different levels of vermicompost, neem cake, and fertilizers, with significant effects observed in both years. Within the top 0-15 cm soil layer, the highest organic carbon content was recorded in treatment T9, reaching 0.51% and 0.53%, followed closely by T8 (0.48% and 0.51%), while the lowest organic carbon content was consistently observed in the control treatment T1, registering 0.38% and 0.40% in both years. At a greater depth of 15-30 cm, the trend continued, with the maximum organic carbon content recorded in treatment T9 at 0.48% and 0.50%, followed by T8, while the minimum organic carbon content was consistently found in the control treatment T1 at 0.36% and 0.40% in both years. Moreover, the mean values of soil electrical conductivity were found to be statistically significant. These findings are in line with prior research, as similar results were reported by researchers such as Gabr, S. M., Elkhatib and El-Keriawy, 2007), Gopinath, and Mina, 2011, Ojha et al. 2009, and Ghulam et al. 2016. These studies collectively suggest that as the dose of solid-liquid waste, including organic amendments like vermicompost and neem cake, increases, the organic carbon content in the soil also tends to rise. Furthermore, it's worth noting that a higher percentage of organic carbon in sewage sludge has been linked to increased organic matter content in the soil, as reported by Singh and Agrawal (2010). This underscores the significance of organic amendments in enriching soil organic carbon content, which can have positive implications for soil health and agricultural productivity.

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Soil pH

The pH levels of the soil displayed significant responses to the application of different levels of vermicompost, neem cake, and fertilizers. Within the top 0-15 cm soil layer, the maximum pH values were consistently observed in treatment T9, reaching 7.15 and 7.42, closely followed by T8 (7.09 and 7.30), while the minimum pH values of the soil were consistently recorded in the control treatment T1, measuring 6.54 and 6.77, respectively, in both years. At a greater depth of 15-30 cm, the trend continued, with the highest pH values recorded in treatment T9 at 7.31 and 7.53, followed by T8 (7.23 and 7.39), while the lowest pH values were consistently observed in the control treatment T1 at 6.64 and 6.84 in both years. It's important to note that the mean value of soil pH was found to be non-significant with regard to the application of vermicompost, neem cake, and fertilizers. This suggests that, overall, the pH of the soil did not exhibit a significant change due to these factors, and any variations in pH levels were likely influenced by other factors such as crop stage and the application of solid-liquid waste. Soil pH tended to change from neutral to slightly acidic in nature, possibly as a result of increased application of solid-liquid waste and other agricultural practices. These changes in pH could be attributed to various processes, including the oxidation of different organic compounds, nitrification of ammonia, and the production of organic acids resulting from anaerobic decomposition of organic matter, as documented in studies like Vig et al. (2003).

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Electrical Conductivity (dSm^{-1})

The data presented in Table 1 illustrates the substantial impact of different levels of vermicompost, neem cake, and fertilizers on the electrical conductivity of the soil. In the topsoil layer (0-15 cm), the highest electrical conductivity was consistently recorded in treatment T9, reaching 0.42 and 0.46 dS m-1, closely followed by T8 (0.41 and 0.44 dS m-1), while the lowest electrical conductivity values were consistently observed in the control treatment T1, measuring 0.34 and 0.38 dS m-1, respectively, in both years. At a greater depth of 15-30 cm, a similar trend was observed, with the highest electrical conductivity values recorded in treatment T9 at 0.44 and 0.47 dS m-1, followed by T8 (0.42 and 0.45 dS m-1), while the lowest electrical conductivity values were consistently found in the control treatment T1 at 0.36 and 0.40 dS m-1 in both years. It is noteworthy that the mean value of soil electrical conductivity was found to be statistically significant. This aligns with the findings of Ghulam et al. (2016) and Esawy et al. (2009), who also reported significant variations in electrical conductivity in response to different doses of inorganic and organic fertilizers. Their observations are in line with the present study, reinforcing the influence of fertilizer application on soil electrical conductivity. Similarly, studies conducted by Islam et al. (2013) and Ojha et al. (2009) also support these findings, indicating that the electrical conductivity of soil is responsive to fertilizer application practices. These collective observations underscore the importance of carefully managing fertilizer application to regulate soil electrical conductivity levels for optimal crop growth and overall soil health.

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Available Nitrogen (kg ha^{-1})

The data illustrated in Table 1 clearly demonstrate that the availability of nitrogen in the soil was markedly influenced by varying levels of vermicompost, neem cake, and fertilizers across both years and at different depths. Notably, the highest levels of available nitrogen were consistently observed in treatment T9, reaching 242.16 and 246.49 kg ha-1, closely followed by T8 (238.31 and 242.65 kg ha-1), while the lowest levels were consistently recorded in the control treatment T1, measuring 212.53 and 219.27 kg ha-1, respectively, in both years. At a greater depth of 15-30 cm, a similar trend was observed, with the highest available nitrogen levels recorded in treatment T9 at 238.83 and 243.49 kg ha-1, followed by T8 (234.98 and 239.98 kg ha-1), while the lowest levels were consistently found in the control treatment T1 at 209.21 and 215.87 kg ha-1 in both years. Importantly, the mean value of available nitrogen in the soil was found to be statistically significant, further affirming the substantial impact of vermicompost, neem cake, and fertilizers on nitrogen availability. These findings align with previous research conducted by Islam et al. (2013), Ojha et al. (2009), and Ghulam et al. (2016), all of which have reported similar trends in soil nitrogen availability in response to varying fertilizer and organic matter applications. These collective observations highlight the critical role of nutrient management practices in influencing the nitrogen content of the soil, which is pivotal for achieving optimal crop growth and productivity.

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Available Phosphorus (kg ha^{-1})

The data presented in Table 1 provides clear evidence of the significant influence of varying levels of vermicompost, neem cake, and fertilizers on the availability of phosphorus in the soil, both at depths of 0-15 cm and 15-30 cm. Notably, the highest levels of available phosphorus were consistently observed in treatment T9, reaching 25.47 and 27.23(0-15 cm) and 24.13 and 26.20(15-30 cm), closely followed by T8 (23.75 and 25.08 (0-15 cm) and 22.42 and 24.38(15-30 cm)) and T6 (22.37 and 24.45(0-15 cm) and 21.37 and 21.77(15-30 cm)), while the lowest levels were consistently recorded in the control treatment T1, measuring 16.96 and 18.96(0-15 cm) and 16.29 and 17.62(15-30 cm), respectively, in both years. This data underscores the significant impact of vermicompost, neem cake, and fertilizers on enhancing the availability of phosphorus in the soil. The addition of these organic materials, along with fertilizers, positively influences the soil's phosphorus content. This effect is attributed to the incorporation of bulky materials and the nutrient-rich composition of the applied fertilizers. Similar observations have been reported by other researchers. For instance, Kumar et al. (2013) noted that the amendment of solid-liquid waste into soil led to increased availability of nitrogen, largely due to the higher organic matter content, which in turn enhanced the cation exchange capacity, affecting the solubility and availability of elements in the soil. This study aligns with findings by Ojha et al. (2009), Suh et al. (2015), and Ghulam et al. (2016), all of which reported an increase in available phosphorus with the application of organic amendments and fertilizers. These findings collectively emphasize the importance of nutrient management practices in enhancing soil nutrient content, a crucial factor in achieving optimal crop growth and yield. Available phosphorus of soil at 0-15 cm and 15-30 cm presented in table 1 reveals that effect of different level of vermicompost, neem cake and fertilizers on available phosphorus of soil was significant during the both year. Relatively maximum available phosphorus of soil was recorded in treatment T9 (25.47 and 27.23) followed by T8 (23.75 and 25.08.07) and T6 (22.37and 24.45) , while minimum available phosphorus of soil was recorded in T1 (16.96 and 18.96) at 0-15 cm in the both year.At 15-30 cm depth, the effect of different level of vermicompost, neem cake and fertilizers on available phosphorus of soil was significant during the both year. Maximum available phosphorus of soil was recorded in treatment T9 (24.13 and 26.20) followed by T8 (22.42 and 24.38) and T6(21.37 and 21.77) ,however minimum available phosphorus of soil was recorded in T1 (16.29 and 17.62) at 15-30 cm in the both year. The variation in different doses of vermicompost and neem cake and fertiliser affects available phosphorus of soil positively due to addition of bulky materials and fertilizer in soil composition. Similar findings also have been reported by.Amendment of solid liquid waste on soil increases more available Nitrogen relatively high percentage of organic matter increased the cationexchange capacity and it affect the solubility and availability of element to soil (Kumar et al., 2013). The increase in available P have also been reported by Ojhaet al.,(2009), Suhet al.,(2015)and Ghulamet al. (2016).

Available Potassium (kg ha^{-1})

The data presented in Table 1 clearly demonstrate that the availability of potassium in the soil was significantly influenced by varying levels of vermicompost, neem cake, and

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fertilizers, both at depths of 0-15 cm and 15-30 cm. Notably, the highest levels of available potassium were consistently observed in treatment T9, reaching 217.37 and 224.70(0-15 cm) and 214.03 and 216.20(15-30 cm), closely followed by T8 (214.51 and 220.84(0-15 cm) and 211.17 and 212.97(15-30 cm)), T7 (210.30 and 216.63(0-15 cm)), and T6 (204.75 and 211.08(0-15 cm)), while the lowest levels were consistently recorded in the control treatment T1, measuring 186.30 and 192.64(0-15 cm) and 184.64 and 188.97(15-30 cm), respectively, in both years.This data highlights the significant impact of vermicompost, neem cake, and fertilizers on enhancing the availability of potassium in the soil. The addition of these organic materials, in combination with fertilizers, positively influences the soil's potassium content. This effect is attributed to the incorporation of both organic and inorganic fertilizers, which collectively contribute to the increased availability of potassium in the soil. This is consistent with findings by Kumar et al. (2013), who noted that the amendment of solid-liquid waste into the soil resulted in increased nitrogen availability due to higher organic matter content, enhancing the cation exchange capacity and ultimately influencing the solubility and availability of elements in the soil. These findings align with previous research by Ojha et al. (2009) and Ghulam et al. (2016), further supporting the positive effect of nutrient management practices on soil nutrient content, including potassium, which is vital for optimal crop growth and yield.

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Table 1: Analysis of soil pre-sowing of Potato

Parameters	2020	2021
Sand (%)	64.80	64.79
Silt (%)	21.94	21.95
Clay (%)	13.26	13.26
Texture of Soil	Sandy Loam	Sandy Loam
Bulk density (g cm^{-3})	1.24	1.23
Particle density (g cm^{-3})	2.44	2.45
Pore space (%)	46.66	47.33
WHC(%)	37.12	37.92
pH	6.54	6.77
EC (dSm^{-1})	0.34	0.38
OC (%)	0.38	0.40
Available Nitrogen ($kgha^{-1}$)	112.53	119.87
Available Phosphorus ($kgha^{-1}$)	16.96	18.96
Available Potassium ($kgha^{-1}$)	186.30	192.64

Table 2: Effect of vermicompost and neem cake and fertilizer on soil physico-chemical propertiesafter harvest of Potato

Bulk Density(Mg m^{-1})	Particle Density(Mg m^{-1})	Porocity(%)	Water Holding capacity (%)

	2020-21		2021-22		2020-21		2021-22		2020-21		2021-22		2020-21		2021-22	
	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	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	1.24	1.25	1.22	1.23	2.44	2.44	2.45	2.45	46.66	44.66	47.33	46.99	37.12	37.04	37.92	37.92
T_2	1.23	1.24	1.21	1.22	2.46	2.47	2.47	2.48	47.87	45.87	48.54	47.20	38.04	37.45	40.37	39.71
T_3	1.22	1.23	1.20	1.21	2.45	2.46	2.46	2.47	48.41	47.07	49.07	48.08	41.11	40.59	42.85	42.58
T_4	1.26	1.27	1.24	1.25	2.45	2.45	2.45	2.46	47.73	45.73	48.40	47.06	39.25	38.88	41.32	40.65
T_5	1.25	1.26	1.23	1.24	2.45	2.45	2.46	2.46	48.34	47.34	48.67	48.00	40.54	40.11	42.58	41.94
T_6	1.24	1.25	1.22	1.23	2.53	2.53	2.54	2.54	50.61	49.61	51.28	48.51	43.27	42.31	44.07	43.41
T_7	1.28	1.29	1.26	1.27	2.56	2.56	2.57	2.57	49.09	46.76	49.76	49.95	40.61	40.27	41.61	41.85
T_8	1.25	1.26	1.23	1.24	2.47	2.48	2.48	2.48	49.25	48.59	50.25	49.59	42.31	42.25	43.61	42.31
T_9	1.23	1.24	1.21	1.22	2.55	2.55	2.55	2.56	51.81	50.47	52.47	51.94	43.72	42.72	45.79	43.82
F - test	NS	NS	NS	NS	NS	NS	NS	NS	**S**	**S**	**S**	**S**	S	S	S	S
C.D. @ 5%	-	-	-	-	-	-	-	-	2.69	3.73	1.90	1.93	4.17	3.81	3.59	3.20
S. Ed. (±)	-	-	-	-	-	-	-	-	1.26	1.27	0.89	0.90	1.96	1.79	1.68	1.50

Table 3: Effect of vermicompost and neem cake and fertilizeron soil Physico-chemical properties after harvest of Potato

	pH				Ec (%)				OC(%)			
	2020-21		2021-22		2020-21		2021-22		2020-21		2021-22	
	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	6.54	6.64	6.77	6.84	0.34	0.36	0.38	0.40	0.38	0.34	0.40	0.37
T_2	6.63	6.75	6.89	6.96	0.37	0.39	0.40	0.41	0.39	0.35	0.41	0.38
T_3	7.09	7.19	7.24	7.31	0.40	0.41	0.43	0.44	0.40	0.38	0.42	0.39
T_4	6.84	6.94	7.07	7.13	0.38	0.39	0.41	0.42	0.41	0.40	0.43	0.42
T_5	6.74	6.84	6.91	6.97	0.36	0.38	0.39	0.40	0.43	0.41	0.45	0.44
T_6	7.02	7.12	7.2	7.33	0.37	0.40	0.41	0.42	0.46	0.44	0.48	0.45
T_7	6.95	7.02	7.14	7.21	0.39	0.41	0.43	0.44	0.44	0.42	0.46	0.43
T_8	7.09	7.23	7.3	7.39	0.41	0.42	0.44	0.45	0.48	0.46	0.51	0.49
T_9	7.15	7.31	7.42	7.53	0.42	0.44	0.46	0.47	0.51	0.48	0.53	0.50
F - test	NS	NS	NS	NS	S	S	S	S	S	S	S	S
C.D. @ 5%	-	-	-	-	0.04	0.03	0.03	0.03	0.06	0.05	0.06	0.03
S. Ed. (±)	-	-	-	-	0.02	0.01	0.01	0.01	0.03	0.02	0.02	0.01

Table 4: Effect of vermicompost and neem cake and fertilizeron soil chemical properties after harvest of Potato

	Available Nitrogen (kg $^{-1}$)		Available Phosphorus(kg $^{-1}$)		Available Potassium(kg $^{-1}$)	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22

	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	212.53	209.21	219.87	215.87	16.96	16.29	18.96	17.62	186.30	184.64	192.64	188.97
T_2	222.06	218.73	228.73	224.40	17.31	16.65	19.31	18.38	190.84	187.51	197.17	192.31
T_3	217.29	211.96	221.62	215.96	19.16	18.49	21.16	20.23	193.14	189.81	199.14	187.48
T_4	221.07	217.74	228.74	220.08	18.07	17.74	20.74	19.50	195.69	193.35	202.02	194.02
T_5	223.42	220.09	230.09	226.76	20.22	19.55	22.55	20.89	199.89	196.23	206.56	198.36
T_6	231.98	228.65	238.65	233.65	22.37	21.37	24.45	21.77	204.75	201.42	211.08	203.55
T_7	228.25	224.92	231.59	226.59	21.56	20.23	24.23	23.66	210.30	206.97	216.63	208.40
T_8	238.31	234.98	242.65	239.98	23.75	22.42	25.08	24.38	214.51	211.17	220.84	212.97
T_9	242.16	238.83	246.49	243.49	25.47	24.13	27.23	26.20	217.37	214.03	224.70	216.20
F - test	S	S	S	S	S	S	S	S	S	S	S	S
C.D. @ 5%	13.26	10.18	10.08	10.90	2.83	2.92	4.03	3.84	13.28	12.65	9.44	9.92
S. Ed. (±)	6.23	4.78	4.73	5.12	1.32	1.37	1.89	1.80	6.24	5.94	4.43	4.66

Conclusions

The findings of the experiment provide valuable insights into the potential benefits of organic amendments (OAs) in enhancing the physical and chemical properties of soil, leading to improved crop growth and yield, particularly for potatoes. Through this study, it has become evident that the incorporation of organic materials such as vermicompost and neem cake, in combination with inorganic fertilizers, can have a significant positive impact on soil quality. Among the various treatment combinations evaluated, T9 [RDF @ 100% + Vermicompost @ 6 t ha-1 + Neem cake @ 1.2 t ha-1] emerged as the most effective in improving the physical and chemical properties of the soil. This treatment not only demonstrates its potential to boost potato yields but also contributes to the overall health and sustainability of the soil in the Prayagraj region. Therefore, based on these findings, it is strongly recommended that farmers consider adopting this recommended treatment to enhance potato production and maintain soil quality in the Prayagraj area, ultimately promoting sustainable and productive agriculture.

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