Influence of Different Levels ofOrganic Manuresand InorganicFertilizersin Potato (*Solanumtuberosum*L.) cultivationon
Soil Physical and Chemical Properties

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 Randomized 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 objective of the study was to gauge the impact of these treatments on the physico-chemical properties of the soil. Upon comprehensive analysis of the results, 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, Uttar Pradesh, India.

Keywords: Vermicompost, 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). Potatoes is a staple vegetable, either boiled potato is consumed directly or processed into various products like chips, French fries, mashed potatoes and canned potato, to mention a few. Given the increasing global population and the consequent increasing 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 its use but also enhances the income of farmers, fosters value-added exports, and generates additional employment opportunities (Hussain, 2016). Area of potato cultivation in Uttar Pradesh in2020-'21 was 620.44 thousand hectares yielding a total of 15,811.31 thousand tons of potatoes (Department of Agriculture and Farmers Welfare, GoI).

However, the world's population is on the rise, demand of crops is also rising but soil fertility is diminishing due to the imbalanced use of fertilizers, which poses detrimental effects on the soil environment and crop production. 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). 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 inputs to farmland can boost microbial activity, improve soil fertility and lead to higher crop yields. Many research studies over the years have emphasized the crucial role of organic manures in cultivating different crops including potato for promoting growth and tuber yield. 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 a period of time 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). In this backdrop the main objective of this study was 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.

MATERIALSANDMETHODS

Field experiments were conducted at the Research Farm of SHUATS-Prayagraj during two consecutive winter-seasons of 2020 and 2021. The research farm is situated at a latitude of 25^{o}.57' N, 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 summer and relatively chilly winters. The maximum temperature in this locale can soar to as high as 46-48 °C during the peak summer, while rarely descending below 4°C to 5°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-'21 and 2021-'22, the experiments were conducted using 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): No use of Fertilizer, Verrmicompost and Neem cake;**T_2**: NPK - nil+ Vermicompost @ 3t ha^{-1} + Neem cake @0.6t ha^{-1};**T_3**: NPK - nil + Verrmicompost @ 6t ha^{-1} + Neem cake @ 1.2t ha^{-1};**T_4**: NPK @ 50% of Recommended Dose of Fertilizer (RDF) + No Vermicompost and Neem cake; **T_5**: NPK @ 50% of RDF + 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% of RDF + NoVermicompost and Neem cake; **T_8**: NPK @ 100% of RDF + Vermicompost @ 3t ha^{-1} + No Neem cake;**T_9** : NPK @ 100% of RDF + Vermicompost @ 6t ha^{-1} + Neem cake @ 1.2t ha^{-1}respectively.(Which fertilizers were used to supply required NPK? Soil samples were collected from which depths? In case of Treatments T8 and T9 100 percent NPK have been applied along with vermicompost and Neem cake which also supply nutrients. That has not been taken into consideration.)

RESULTS AND DISCUSSIONS:

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

The data presented in Table 2 provide insights into the impact of varying levels of Vermicompost, Neem cake, and fertilizers on bulk density (g cm^{-3}) and particle density (g cm^{-3}) of soil and it was observed that the effects were not statistically significant.Bulk density of soil exhibited the highest valuesat soil depths of 0-15 cm and 15-30 cm in treatment T7 (1.28, 1.26 and 1.29, 1.28) followed by the 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 earlier works of Sinha *et al.* (2006) who reported similar observations regarding the influence of organic amendments on soil properties.(Bulk Density may be changed due to addition of bulky organic manure but Particle density does not change with addition of organic matter).

Pore Space (%)

Upon careful examination of the data concerning soil porosity at depths of 0-15 cm and 15-30 cm, as detailed in Table 2, it is evident that the influence of varying levels of vermicompost, neem cake and fertilizers on pore space percentage was indeed significant throughout the experiment. Notably, the highest pore space wasobserved 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 0-15 cm depth. 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 work.

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 3, 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) in two years respectively.

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 waterholding capacity of the soil. This positive influence may be attributed to the addition of bulky organic materials to the soil 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.

Organic carbon (%)

The data presented in Table 3 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 by the treatment 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% respectively in 2021 and 2022. 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 electrical conductivity of saturation extract were found to be statistically significant. Similar results were reported by Gabr*et. al,* (2007), Gopinath and Mina (2011), Ojha *et al.*(2009) and Ghulam *et al.* (2016). Solid-liquid wastes including organic amendments like vermicompost and neem cake increase the organic carbon content in the soil.A higher percentage of organic carbon in sewage sludge increased the organic matter content in the soil (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.

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 7.42followed 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 observed in the control treatment T1 at 6.64 and 6.84 in two experimental 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 variation in pH levels was likely to be 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 may be attributed to various processes, including the oxidation of different organic compounds, nitrification of ammonia and production of organic acids resulting from anaerobic decomposition of organic matter (Vig*et al.*, 2003).

Electrical Conductivity (dSm^{-1})

The data presented in Table 3 illustrates the substantial impact of different levels of vermicompost, neem cake, and fertilizers on the electrical conductivity of soil. In the topsoil layer (0-15 cm), the highest electrical conductivity was recorded in treatment T9 reaching 0.42 and 0.46 dS m^{-1}followed by T8 (0.41 and 0.44 dS m^{-1}), while the lowest values were observed in the control treatment T1 measuring 0.34 and 0.38 dS m^{-1} respectively in the two 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 found in the control treatment T1 at 0.36 and 0.40 dS m^{-1} in two years. It is noteworthy that the mean value of soil electrical conductivity was found to be statistically significant. This is corroborated by 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. 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 underline the importance of carefully managing fertilizer application to regulate soil electrical conductivity levels for optimal crop growth and overall soil health.

Available Nitrogen (kg ha^{-1})

The data illustrated in Table 4 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 as 242.16 and 246.49 kg ha^{-1} followed by T8 (238.31 and 242.65 kg ha^{-1}) while the lowest levels were recorded in the control treatment T1, measuring 212.53 and 219.27 kg ha^{-1}, respectively, in both years. Similar trend was also observed at a greater depth of 15-30 cm 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 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 significantaffirming the substantial impact of vermicompost, neem cake, and fertilizers on nitrogen availability. These findings are in line with the previous findings of Islam *et al.* (2013), Ojha *et al.* (2009) and Ghulam *et al.* (2016). 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.

Available Phosphorus (kg ha^{-1})

The data presented in Table 4 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 as 25.47 and 27.23 (0-15 cm) and 24.13 and 26.20kg ha^{-1} (15-30 cm) followed by T8 as 23.75 and 25.08kg ha^{-1} (0-15 cm) and 22.42 and 24.38kg ha^{-1} (15-30 cm) and T6 as 22.37 and 24.45 (0-15 cm) and 21.37 and 21.77kg ha^{-1} (15-30 cm), while the lowest levels were recorded in the control treatment T1 measuring 16.96 and 18.96 (0-15 cm) and 16.29 and 17.62kg ha^{-1} (15-30 cm), respectively in two years. This underscores the significant impact of vermicompost, neem cake, and fertilizers on enhancing the availability of phosphorus in soil. The addition of these organic materials along with fertilizers positively influences the phosphorus content of soil. Similar observations have been reported by other researchers (Kumar *et al.*, 2013; Ojha *et al.*, 2009; Suh *et al.*, 2015 and Ghulam *et al.*, 2016)who observed 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. These findings emphasize the importance of nutrient management practices in enhancing soil nutrient content, a crucial factor in achieving optimal crop growth and yield.

Available Potassium (kg ha^{-1})

The data presented in Table 4 clearly demonstrate that the availability of potassium in the soil was significantly influenced by varying levels of vermicompost, neem cake, and fertilizers, both at depths of 0-15 cm and 15-30 cm. The highest levels of available potassium were consistently observed in treatment T9 as 217.37 and 224.70 kg ha^{-1}(0-15 cm) and 214.03 and 216.20kg ha^{-1} (15-30 cm) followed by T8 as 214.51 and 220.84kg ha^{-1} (0-15 cm) and 211.17 and 212.97kg ha^{-1} (15-30 cm)), T7 as 210.30 and 216.63kg ha^{-1} (0-15 cm)), and T6 as 204.75 and 211.08kg ha^{-1} (0-15 cm)), while the lowest levels were recorded in the control treatment T1 measuring 186.30 and 192.64 kg ha^{-1}(0-15 cm) and 184.64 and 188.97kg ha^{-1} (15-30 cm) respectively in two 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),Ojha *et al.* (2009) and Ghulam *et al.* (2016) 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 soilsupporting the positive effect of nutrient management practices on soil nutrient content including potassium which is vital for optimal crop growth and yield.

Table 1: Analysis of soil properties

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
Water Holding Capacity(%)	37.12	37.92
pH	6.54	6.77
ECe (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

Treat-ments	Bulk Density (Mg m^{-1})				Particle Density (Mg m^{-1})				Porosity (%)				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

Treatments	pH				ECe (dSm^{-1})				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

Treat-ments	Available Nitrogen (kg^{-1} soil)				Available Phosphorus (kg^{-1} soil)				Available Potassium (kg^{-1} soil)			
	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 of potato. 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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