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EFFECT OF COMPOST ON SOIL CHEMICAL PROPERTIES AND MAIZE GROWTH

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ABSTRACT

One of the biggest limitations to sustainable production of maize is soil fertility degradation, which is mainly witnessed in high-production intensive systems that are heavily dependent on synthetic fertilizers. The continuous production and poor inputs of organic matter have led to decreasing soil organic carbon, nutrient imbalances, and poor soil chemical conditions, which have eventually lowered crop production. The application of compost has been highly advocated as one of the most effective ways of managing soil sustainability, but there has been little integrated evidence as to how the application of compost improves soil chemical conditions and maize growth and yield. This experiment compared the rate of various composts applied to the chosen soil chemical and maize development in field conditions. They used a randomized complete block study with four treatments that comprised a control (no compost) and three rates of application of compost, repeated three times. To determine the change in soil pH, organic matter, total nitrogen, available phosphorus, exchangeable potassium, and electrical conductivity of the soil, soil samples were taken pre-planting and post-harvest. Findings revealed that the use of compost had a great effect on the soil pH, organic matter, and nutrient availability, which were better than those of the control treatment. The electrical conductivity level rose slightly and was within safe ranges, which showed that the salinity could not be a threat. The results also indicate that the use of compost is sustainable and can be used as an effective method of enhancing the fertility of the soil and maize production. The study presents real-life evidence to illustrate the use of compost-based nutrient management measures to ensure improved crop production, soil health, and sustainable agricultural systems.

Keywords: *Compost application; soil chemical properties; maize growth; soil fertility; sustainable agriculture.*

1. INTRODUCTION

1.1 Background

Agricultural productivity and long-term sustainability rely on a key factor of soil fertility. The activities of intensive agriculture, sustained monocropping, and overdependence on chemical fertilizers have led to decreasing soil chemical properties, such as the degradation of organic matter, nutrient imbalance, and soil acidity (Lal, 2021). The problems have increased the issue of concern about the health of soils and food security, especially in the developing agricultural systems, where the soil resources have already been strained. It is important to conserve and enhance the soil chemical properties, hence as a measure of maintaining crop growth and stability of yields. Organic amendments are reviving their interest as environmentally friendly options or an alternative to inorganic fertilizers. Zhang et al. (2022) state that organic inputs like compost can be used to increase soil fertility through the rise in organic carbon levels, nutrient levels, and buffering capacity. Compost is a product of the biological breakdown of organic remains, and it contains vital macro- and micronutrients, which release over time into the soil. Such slow-release property enhances nutrient utilization effectiveness and lowers nutrient loss in the form of leaching or volatilization (Agegnehu et al., 2021).

Some researchers have indicated that the application of compost has a significant effect on the chemical characteristics of the soil, such as soil pH, cation exchange capacity (CEC), and the availability of nitrogen (N), phosphorus (P), and potassium (K). Wei et al. (2023) have also found that amendments of the compost lead to a rise in soil organic matter and enhance nutrient retention through improved soil aggregation and enhanced microbial activity. Dutta et al. (2021) have pointed out that the presence of compost enhances the stabilization of soil pH, especially in acidic soils, which eventually provides a good environment for nutrient uptake by crops. Maize (Zea mays L.) is a common cereal crop that is widely grown across the world and is essential in food, animal feeding, and industrial raw materials. It is very sensitive to the availability of nutrients in the soil and a balanced soil chemical environment in order to increase its productivity. FAO (2023) cites that maize has a high nutrient requirement, but nitrogen and phosphorus are needed to support vegetative growth and grain development. Maize is so limited by poor soil conditions, which leads to low biomass buildup and grain yield.

Use of compost has been found to have a positive effect on maize growth through improved nutrient status of the soil and increased root growth. Li et al. (2022) discovered that the soils with compost had a higher rate of mineralization of nitrogen, resulting in the growth of maize in terms of height, leaf area, and production of dry matter. Besides that, compost enhances the retention of soil moisture and microbial activity, which helps to achieve better nutrient uptake and crop performance (Bai et al., 2021). Although a lot of research has been done on the use of compost, the variation in compost composition, the rate at which it is used, the soil type, and the climatic conditions leads to the fact that there would be inconsistencies in findings in different regions. According to Rahman et al. (2024), compost and soil chemical properties and crop development influence have a high site-effect, and the study should involve local research to maximize the compost management practices. Moreover, there is a number of studies concentrating on soil chemical transformations or crop reaction, whereas there are few studies that provide an integrated evaluation of the connection between soil chemistry and maize development.

Over the past few years, the sustainable agriculture trend has focused on the need to minimize the use of artificial fertilizers and still ensure increased crop production. The use of compost is consistent with sustainable soil management techniques, as it recycles organic waste and enhances the quality of soil, decreasing the pollution of the environment (Montgomery et al., 2023). Nevertheless, it remains to be determined how widespread compost can be in terms of substituting or complementing chemical fertilizers in maize-based systems. The research aims to determine the influence of compost application on the chosen chemical properties of soil and the parameters of maize growth. In particular, the research aims at evaluating the alterations in soil pH, organic

matter content, and nutrient availability after the application of compost and determining their correlation with the growth and yield performance of maize. The results will be useful in providing evidence-based suggestions on sustainable soil fertility management in maize production systems.

1.2 Problem Statement

The decline in soil fertility has become a leading limitation to the sustainable agricultural productivity globally, especially in the maize-based cropping systems. Unrelenting farming, deep tilling, and overuse of synthetic manure have led to a decrease in soil organic matter, nutrient disproportion, acidification of the soil, and low efficiency levels of nutrients (Lal, 2021; Bai et al., 2021). Such chemical constraints of soil directly reduce crop production and yield, posing a threat to food security and agricultural sustainability in the long run. Maize (Zea mays L.), a nutrient-demanding cereal crop, is very sensitive to soil chemical parameters of the pH, the content of organic matter, and the availability of essential macronutrients like nitrogen, phosphorus, and potassium (FAO, 2023; Liu et al., 2022). In numerous farming systems, the exclusive use of chemical fertilizers has not been able to recover soil health, which is why it has resulted in decreasing returns to yield and adding to the environmental risks, including nutrient leaching and soil erosion (Montgomery et al., 2023; Zhang et al., 2022).

It has been largely encouraged that compost application is a sustainable soil management approach because it provides benefits in terms of increasing soil organic matter, soil nutrient retention, and soil chemical stability (Agegnehu et al., 2021; Wei et al., 2023). There is a body of research documenting positive compost effects on soil fertility and maize productivity, but these effects are inconsistent based on the source of compost, application rate, soil type, and environmental factors (Dutta et al., 2021; Rahman et al., 2024). Furthermore, most of the available research considers either chemical modifications of soils or crop performance on their own, with few studies combining the two factors within a study framework. This absence of evidence that is integrated leaves doubts about the degree to which compost-induced changes in the chemical properties of the soil will lead to increased growth and yield of maize. This would require a systematic field-based study that would concomitantly study the variation in soil chemical properties and maize performance in the case of compost application. This gap needs to be filled so as to come up with scientifically good and location-specific compost management practices that can promote sustainable production of maize and long-term soil health.

1.3 Research Questions

1. What is the effect of the application of compost on the selected soil chemical properties, such as soil pH, organic matter, and nutrient availability?
2. How do the various compost application rates influence the maize growth and yield parameters?
3. How are the changes in soil chemical properties related to the growth and yield performance of maize?

1.4 Research Objectives

1. To determine the impact of the application of compost on the chosen chemical soil properties of agricultural soil.
2. To determine the effect of varying rates of compost application on maize growth and yield.
3. To find out the association of the chemical properties of soil and the growth and productivity of maize.

1.5 Significance of the Study

The paper makes a great contribution to the knowledge of sustainable soil fertility management in the maize-based crop production systems, especially in view of depleting soil quality due to intensive agricultural activities. The study combines a thorough soil chemical examination with maize development and yield evaluation to give an overall and empirical data on how compost application enhances the health of the soil and crop performance at the same time. The findings provide a viable recommendation to farmers and extension services since they showed the potential

of compost as an alternative or supplement to synthetic fertilizers, hence lowering the cost of production and reliance on chemical inputs. Nutrient management that depends on compost also favors environmental sustainability by encouraging recycling of organic waste, less nutrient leaching, and less soil erosion and pollution. Scientifically, the work fills the existing literature gaps with the emphasis on site-specific reactions of soil and maize to compost application and the clear connection between soil chemical characteristics and crop productivity. Also, the findings are very insightful to policymakers and agricultural planners in developing sustainable nutrient management practices to improve food security, soil resilience, and longevity of agricultural practices.

2. Literature Review

The chemical characteristics of soils are very important in the regulation of the availability of nutrients, microorganisms' activity, and the general soil fertility. The repeated application of mineral fertilizers with no organic inputs has also extensively reported to decrease soil organic matter and disorganize nutrient balance (Lal, 2021). In response to these needs, scholars have come to more keenly appreciate compost as one of the possible solutions to soil chemical quality restoration through the amendment of the soil. Agegnehu et al. (2021) assert that the use of compost improves the soil organic carbon to a large extent, which is the basis of better soil fertility. Organic carbon enhances nutrient retention and buffering ability, hence stabilization of soil pH and minimization of the loss of nutrients. As Wei et al. (2023) have found, the soil that was amended with compost had a higher cation exchange capacity (CEC), and it could retain more essential cations (calcium, magnesium, and potassium). This is very useful, especially in soils that are coarse in nature and where nutrient leaching is a significant limitation. The other important chemical parameter that is affected by compost addition is soil pH. Dutta et al. (2021) stated that basic cations and organic anions in compost respond to the acidic soils through a liming effect. This balancing of the pH increases the solubility of the nutrients and the activity of the microbes, which in the end increases the uptake of nutrients by the plants. Similarly, Rahman et al. (2024) showed that a continuous application of compost led to a progressive rise in the pH of soils and a decrease in the level of aluminum toxicity, which commonly constrains cultivated acidic agricultural soils. The compost is also good as a source of vital macronutrients, especially nitrogen (N), phosphorus (P), and potassium (K). In contrast to synthetic fertilizers, compost makes nutrients available slowly, which is achieved by mineralizing, which will extend the availability of nutrients during the cropping season (Li et al., 2022). This slow release of nutrients minimizes the chances of loss of nutrients through leaching and volatilization. The quality and decomposition rate of compost are very important factors in the availability of nitrogen. The study by Bai et al. (2021) discovered that the compost-treated soils had better growth in nitrogen mineralization and soil microbial biomass, which enhanced the cycling of nitrogen. Similarly, Zhao et al. (2023) showed that the use of compost enhanced the total nitrogen and available ammonium and nitrate levels in the soil and resulted in enhanced crop nutrition.

Many agricultural soils usually have little phosphorus because the soil fixation process takes place. Compost has also been proven to enhance phosphorus availability through chelation and the generation of organic acids in the process of decomposition. Zhang et al. (2022) explain that the organic acids emitted by compost inhibit the fixation of phosphorus by iron and aluminum oxides, enhancing phosphorus that is Phyto-transferable by plants. Islam et al. (2024) showed similar results because it was found that in compost-treated soils, there was a higher concentration of available phosphorus than in fertilized plots with chemicals. The availability of potassium is also enhanced by the use of compost because organic residues are mineralized, and the exchange capacity of the soil is increased. Montgomery et al. (2023) also stressed that compost is associated with a balanced nutrient supply, which avoids antagonism of nutrients that

is often encountered with too much chemically fertilized soil use. EC is a measure used to determine the concentration of soluble salts in the soil that may affect the growth of crops. Although compost is a source of soluble salts, it has diverse effects on soil EC that depend on the rate of application and maturity of the compost. Wei et al. (2023) also indicated that the soil EC had increased slightly after the application of compost, but the values were not beyond the range of safe levels of crop growth. This mean rise in EC is commonly linked to a greater availability of nutrients and not to salinity stress.

On the other hand, the excessive usage of compost has also been reported to lead to the salination of the soils in arid and semi-arid areas. Rahman et al. (2024) warn that high compost rates can increase the level of EC, especially when compost is prepared using manure or municipal waste. This is why proper compost rates are needed to achieve the greatest good without causing undesirable changes to the chemical composition of the soil. Maize (Zea mays L.) is a crop that is a good source of nutrients and requires nitrogen, phosphorus, and potassium. FAO (2023) explains that deficiencies in nutrients directly influence the growth stages of maize, such as vegetative growth, tasseling, and grain filling. Chemical characteristics of the soil, like PH, organic matter, and the availability of nutrients, have a great impact on the plant's uptake of nutrients in maize. According to Liu et al. (2022), the ideal soil pH enhances root growth and absorption of nutrients in maize. Acidic soils normally limit the availability of phosphorus and elevate the toxicity of aluminum, leading to the retarded growth of plants. Application of compost has been proven to reduce constraints by improving the chemical state of the soil where the maize thrives.

Various studies have indicated a marked increase in maize cultivation parameters due to the application of compost. Li et al. (2022) found a higher height of plants, leaf area index, and biomass of maize planted in soils with compost. These gains were credited to the improvement in the level of nitrogen and the soil structure, which allowed the thriving of roots. Islam et al. (2024) stated that plants treated with compost had higher chlorophyll content and photosynthesis than the controls. Postulated factors that have led to improved growth in terms of vegetative growth were improved nutrient supply and retention of moisture. Bai et al. (2021) also added that compost encourages the activities of microorganisms, enhancing the cycling of nutrients and maintaining the growth of crops.

Response to yield is an essential measure of the agronomic performance of compost use. Many studies have reported positive impacts of compost on maize yield components such as cob length, number of kernels, and grain weight. Zhao et al. (2023) observed that the application of compost enhanced the yield of maize grains by 15-30 percent relative to the control that was not fertilized. According to Rahman et al. (2024), when the use of compost and low rates of chemical fertilizers was combined, the use of chemical fertilizers alone did not yield as much maize. This synergy underscores the topic of compost in enhancing efficiency in nutrient use and maintaining yields. Montgomery et al. (2023) also observed that the boosting of soils with compost leads to long-term stable yields stemming from the increased soil resilience and nutrient stores.

2.1 Research Gaps and Justification.

Despite the large body of research that has shown positive effects of compost use when aiming to enhance the fertility of the soil and production of crops, there is a large discrepancy in the outcomes of the studies. Such variations are mostly due to the source of compost, level of maturity, nutrient contents, application rate, soil type or type of soil, and the climate conditions prevailing. Zhang et al. (2022) have highlighted that compost performance is very situation-dependent and emphasize the necessity to conduct region-specific research to maximize the benefits of compost management. The compost produced by various organic substances might have significant differences in nutrient contents and degradation processes, and hence have different effects on soil chemical characteristics and nutrient availability. Moreover, soil properties like texture, pH, and initial fertility condition are very strong determinants of soil response to compost

application. According to Dutta et al. (2021), the amendments of compost have unequal effects on acidic and neutral soils, especially on phosphorus availability and buffering capacity of the soil.

Climatic factors such as the temperature and rainfall patterns are also known to influence compost mineralization rates and release of nutrients, affecting crop response and yields. The combination of these factors makes it difficult to have generalized recommendations on the use of compost in different agroecological regions. Among other site-specific variability, most of the available research is prone to assessing the impacts of compost on the chemical characteristics of soil or crop growth separately. Although the positive effects on the soil ph, organic matter, and nutrient availability have been extensively documented, there are few works that have been conducted on the quantitative relationship of the positive effects on the soil chemical parameters to the respective positive effects on maize growth and yield parameters. This disjointed method of Zhang et al. (2022) inhibits knowledge of how compost-managed soil benefits are converted to increased crop performance. Therefore, empirical data on controlled field experiments where changes in both chemical properties of soil and maize growth and yield are measured at the same time are still lacking. Extensive research involving the combination of soil chemistry and crop performance is necessary in order to come up with cause-and-effect relationships. These integrated studies are essential in coming up with evidence-based, sustainable nutrient management practices that maximize the use of compost, enhance the productivity of maize, and sustain soil health in the long run in a wide range of agricultural environments.

3- Materials and Methods

3.1 Description of the Study Area

The field experiment was carried out in the maize growing season in one of the agricultural research institutions with a subtropical climate. The region has moderate to high temperatures and seasonal rainfall, which characterizes maize-growing areas. Before starting the experiment, the site was subjected to conventional farming with meager organic input, leaving moderate soil fertility conditions. Primary soil analysis showed a low level of organic matter and unbalanced nutrient distribution in the soil, which means that it was suitable to assess the impact of compost use on soil chemistry and maize development (Lal, 2021). The experimental site was loam- clay loam in soil and moderate drainage capacity. Initial soil conditions were determined through the baseline chemical properties of soil, such as soil pH, organic matter, total nitrogen, available phosphorus, and exchangeable potassium, which were measured prior to application of any treatment. The compost in this study was made based on mixed organic residues, which included crop residues, animal manure, and household organic waste, under the standard aerobic composting procedures.

3.2 Experimental Design and Treatments

The process of composting was undertaken over a period of about 10-12 weeks to allow a full decomposition of organic substances and stabilization of compost products. The moisture was controlled regularly, and turning was done to increase the microbial activity and compost maturity. Prior to application, the samples of compost were taken and analyzed in relation to the important chemical properties, such as pH, organic carbon, total nitrogen, available phosphorus, and potassium. To make sure that the usage of compost would be consistent with the standards proposed to be used in agriculture, compost characterization was performed (Agegnehu et al., 2021). The compost nutrient data were used to determine which application levels to use and to ascertain the safe and effective use of the experimental plots. A **Randomized Complete Block Design** (RCBD) was used to lay out the experiment to reduce the implications of spatial variability between fields. The treatments were the application of various rates of compost application, such as a control (no compost application), and the increasing rates of compost application in the form of a dry weight rate. The same treatment was repeated three times to increase the statistical reliability.

3.3 Compost Preparation and Characterization

In the pre-sowing phase, compost was placed evenly on the soil surface and mixed into the topsoil (0-20 cm depth). The choice of compost rates was determined by the fact that studies had been done in the past that proved to be effective in supplying nutrients without any salinity or nutrient imbalance (Wei et al., 2023). The agronomic management practices applied to all plots were equal, with the exception of the application of compost to isolate the effects of treatment. This research was done on maize (Zea mays L.) seeds, which are of a high-yielding and locally adapted variety. In each treatment, sowing was done manually with a recommended distance to provide all treatments with an equal population. Normal agronomic activities such as irrigation, weed management, and pest management were done in a similar way over the growing period. Irrigation was done when necessary to prevent moisture deficiency, especially at critical growth periods like tasseling and grain filling. Manual weed management was done to avoid nutrient and water competition. No other organic or inorganic fertilizer was used in the course of the experiment to make sure that the observed effects could be explained by compost application only.

3.4 Crop Establishment and Management Practices

The soil samples were determined prior to the application of compost and after harvesting maize to determine the effect of compost on soil chemical properties. The soil auger was used to sample the 020 cm soil layer, and several subsamples were taken out of each plot and mixed up to create a composite sample. Laboratory analysis of soil samples was done after air drying, grinding, and passing through a 2mm sieve. A digital pH meter was used to measure soil pH by measuring the soil-to-water suspension ratio as 1:2.5. The content of soil organic matter was established via the Walkley method of Black, whereas the overall content of nitrogen was established via the Kjeldahl method. Standard extraction process of the available phosphorus was evaluated with the help of the methods of analysis appropriate to soil type, and exchangeable potassium was estimated with the help of flame photometry (Dutta et al., 2021; Zhang et al., 2022). The electrical conductivity (EC) was measured to determine the effects of potential salinity that can be caused by compost application. Each and every analytical practice adhered to internationally accepted protocols of soil analysis to maintain accuracy and reproducibility. The growth parameters of maize were also noted at various levels of growth to determine the reaction of the crop to the application of compost.

3.5 Soil Sampling and Laboratory Analysis

The height of the plants was taken between the ground level and the end of the longest leaf at specific intervals. The standard estimates of leaf area were performed by means of the nondestructive standard procedures, and the aboveground biomass was estimated by cutting representative plants of each plot at physiological maturity. Cob length, the number of grains per cob, and the thousand-grain weight were taken at harvest. The yield of grains was determined per plot and transformed into yield per hectare. These measurements allowed obtaining a thorough evaluation of the impact of compost on the growth and productivity of maize (Li et al., 2022; Rahman et al., 2024).

3.6 Statistical Analysis

The statistical analysis of all the collected data was done by using proper statistical programs. The analysis of variance (ANOVA) was undertaken to establish the statistical significance of the effects of compost application on the soil chemical properties and maize growth parameters. A feasible post hoc test was used to compare treatment means at 5% level of significance. Correlation analysis was used to test the correlations between the chemical properties of soil and the variables of maize growth and yield. This method assisted in discovering the important soil factors that affect crop performance and aided in the interpretation of the effect of treatments. The statistical procedures adhered to the common agronomic scientific guidelines to provide validity

and reliability of the results (Montgomery et al., 2023).

4. Results

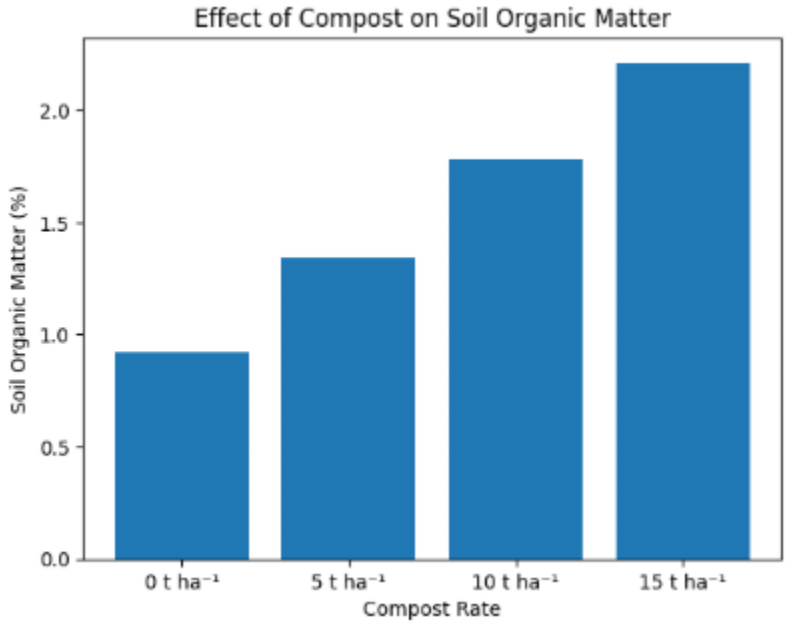
The application of compost had a considerable impact on the soil chemical characteristics that were taken once maize was harvested. The compost-amended plots, as compared to the control treatment, had significant increases in soil pH, organic matter content, and availability of nutrients. The compost rates had a progressive effect on the soil pH, showing that compost buffered the soil acidity. Control treatment showed that it was slightly acidic, whereas compost-treated soils were near neutral ph rates. The level of soil organic matter was high after the use of compost. The maximum rate of compost led to the maximum amount of organic matter, which indicated the direct input of organic residues and the increased activity of the microbes. Such gains were also observed in replications, and this proved the maintenance of compost-derived organic carbon in soil.

Compost application also significantly enhanced the total nitrogen content. There was an increase in the level of nitrogen in the compost-treated plots compared to the control, and a dose-dependent response was apparent. Phosphorus available was following the same trend and compost application elevated phosphorus availability greatly compared to untreated soil. The exchangeable potassium content rose tremendously in the compost-amended plots, which was an indication of the nutrient content of the compost and also the enhanced cation exchange capacity. Compost application did not cause salinity stress conditions, as the electrical conductivity was slightly elevated but within accepted levels of maize crop production.

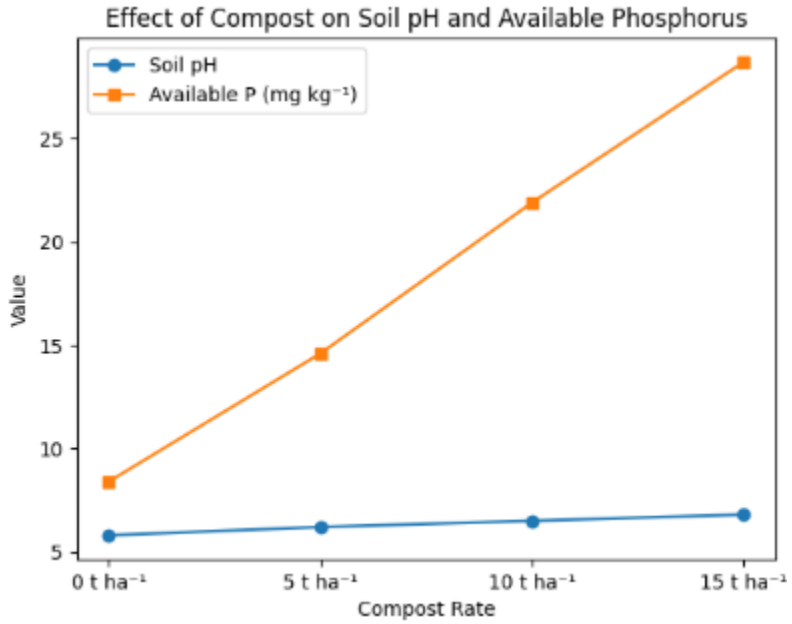
Table 1. Effect of compost application on soil chemical properties after maize harvest

Treatment	Soil pH	Organic Matter (%)	Total N (%)	Available P (mg kg^{-1})	Exchangeable K (mg kg^{-1})	EC (dS m^{-1})
Control (0 t ha^{-1})	5.8	0.92	0.06	8.4	92	0.21
Compost (5 t ha^{-1})	6.2	1.34	0.09	14.6	128	0.26
Compost (10 t ha^{-1})	6.5	1.78	0.12	21.9	165	0.31
Compost (15 t ha^{-1})	6.8	2.21	0.15	28.7	198	0.35

Values represent treatment means across replications.



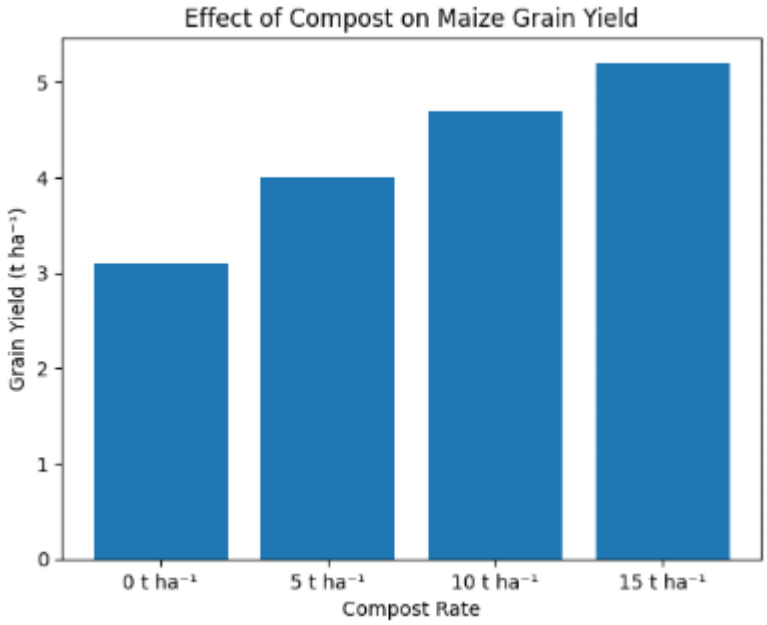
Suggested Graph 1: Bar chart showing changes in soil organic matter (%) across compost rates.



Suggested Graph 2: Line graph illustrating trends in soil pH and available phosphorus with increasing compost application.

Maize parameters of growth responded well to the application of compost throughout the growing season. The height of plants grew much higher in the compost plots than in the control plots. The highest compost treatment recorded the tallest plants, which means that it has better nutrient availability and good soil to support vegetative growth. The development of the leaf area also showed a similar pattern, where compost application boosted the growth of leaves enormously. The plants with compost treatment showed more green foliage and coverage of the canopy, implying better nitrogen nutrition. Biomass on the surface increased significantly in

compost-amended plots and indicated a high photosynthetic potential and efficiency in nutrient utilization. The compost treatments varied significantly in growth parameters, and as expected, the high compost rates generated better growth performance. These findings reveal that the application of compost produced good soil conditions that favored long-standing maize growth.



Suggested Graph 3: Bar chart comparing plant height (cm) and biomass yield (t ha⁻¹) among treatments

Effect of Compost on Maize Yield and Yield Components

Application of compost had a huge effect on the maize elements of yield and the ultimate production of grain. The length of the cob also grew over time as the rate of compost application increased with the rate of compost application and the longest cobs were observed in the plots where compost was applied the most. Similarly, the amount of grains per cob was considerably higher in compost plots than in the control. The weight of a thousand grains had an intermediate yet significant growth when compost was applied, which indicates better grain filling. The yield of grains was significantly higher in compost-amended plots, and the maximum was at the highest level of compost rate. Compost application enhanced maize grain yield with a preponderance of over 30 percent on the highest application rate when compared to the control. The yield reaction showed that there was a strong positive association between the use of compost and maize productivity. There were better yields between replications, which indicates the credibility of compost on soil fertility amendment.

5. Discussion

The current research proved that compost application was quite useful in enhancing the soil chemical properties and maize growth and yield, which supports the positive impact of organic amendments on organic soil fertility management. These changes in the pH, organic matter, and nutrient availability of the soils can be attributed to the recent reports indicating that compost is one of the most effective tools to be used in restoring degraded soils and improving crop yields (Agegnehu et al., 2021; Montgomery et al., 2023). The fact that the soil pH is increasing with the use of compost, as was evident in this study, is in line with the findings of the earlier studies that showed that compost is a buffering/liming agent in acidic soils. Dutta et al. (2021) explained that compost has fundamental cations, including calcium and

magnesium, which neutralize acidity in the soil and enhance the reaction in the soil. A quantitative study by Rahman et al. (2024) also found gradual rises in the pH of soil with compost rates, which improved the solubility of nutrients and the activity of microbes. The better low PH of the soil leads to good absorption of nutrients, especially phosphorus, which is usually scarce in acid situations.

One of the most important discoveries of this study is that there is a high addition of compost to the soil that increases the content of soil organic matter significantly. Lal (2021) has highlighted that soil health revolves around the presence of organic matter that determines the process of nutrient cycling, water retention, and soil structure. The findings support the fact that compost is a primary source of organic carbon, which improves long-term soil fertility. Similar increases in soil organic matter were observed by Wei et al. (2023) after compost amendments and were explained by the fact that compost amendments increased microbial activity and solidification of organic residues in soil aggregates.

The occurrence of improvements in total nitrogen, available phosphorus, and exchangeable potassium in plots treated with compost is in line with the slow nutrient release characteristic of compost. Li et al. (2022) stated that compost improves the mineralization of nitrogen, which guarantees a constant supply of nitrogen during the growing period. According to Zhang et al. (2022), when compost decomposes organic acids, phosphorus fixation is inhibited, and more plant-available phosphorus is produced. The rise in the exchangeable potassium presented in this study is consistent with the results of Montgomery et al. (2023), who emphasized the use of compost to enhance the cation exchange capacity and balanced nutrient availability.

The use of compost heightened the electrical conductivity marginally, but still in level proportions as far as growing maize is concerned. Such an observation is in line with Wei et al. (2023), who had moderate EC growth after applying compost in the absence of salinity stress. Rahman et al. (2024) noted that high levels of compost application would pose risks of salinity, but the levels of compost applied in the current research were agronomically healthy and efficient. Plant height, leaf area development, and biomass accumulation, which are maize growth parameters, were positively affected by compost. These can be credited to an increase in the nutrient content of soil and improvement of the chemical status of soil. Similar to Li et al. (2022), compost-treated soils had increased plant height and biomass of maize, which they ascribed to better availability of nitrogen and soil structure. An increase in leaf area and biomass buildup indicates a greater photosynthetic ability, which was presumably due to increased nitrogen availability and better root growth. Bai et al. (2021) emphasized that compost increases the activity of the microorganisms in the soil and improves nutrient recycling, thereby enhancing the efficiency of nutrient uptake and maintenance of vegetative growth.

The same pattern of increasing growth parameters between treatments of compost in this study proves the applicability of compost in the formation of a conducive root environment to maize. The great improvement in the yield and yield components of maize with compost application highlights the agronomic importance of compost in the maize production systems. Growth of the cob, grain number, and grain weight in compost-amended plots is an indication of enhanced availability of nutrients during periods of high growth, especially the filling of the grain. In this case, the increase in yield of maize was reported as 15% to 35% after the application of compost, which is a similar result to the yield gain reported by Zhao et al. (2023) in their study. The response of yield had a definite dose dependence, with high rates of compost giving rise to high yield. According to this trend, the application of compost aided the efficiency of use and facilitated the balanced uptake of nutrients. As pointed out by Rahman et al. (2024), nutrient management using compost improves the stability of yields by increasing the nutrient reserves in the soil and decreasing the reliance on synthetic fertilizers.

The results showed that there were strong positive correlations in the relationships of soil organic

matter, nutrient availability, and maize growth and yield parameters. These research findings confirm the idea that enhanced crop productivity is directly proportional to better soil chemical characteristics. According to Lal (2021), the positive effect on the soil structure and the organization of nutrient cycles caused by organic matter is the key to maintaining crop yields in the context of intensive agrosystems. The positive correlation between soil pH and maize growth in this experiment is in line with the results obtained by Liu et al. (2022), who found that nutrient uptake efficacy and root development were enhanced when soil pH was close to neutral. Lack of negative correlation between electric conductivity and maize growth is also another factor that supports the fact that the rate of compost application was suitable and did not cause salinity stress.

This study has shown that compost could be a good and non-polluting substitute or complement to chemical fertilizers in maize production systems. According to Montgomery et al. (2023), nutrient management using compost aids in the long-term health of the soil, minimizes losses of nutrients, and enhances the sustainability of agricultural intensification. Recycling of organic waste into useful soil additives, the application of compost also promotes the principles of the circular economy and mitigates environmental pollution. Although these are the advantages of the method, the quality of the compost, the rate of application, and the conditions of the site should be taken into account. The researchers Zhang et al. (2022) noted that compost management practices could be maximized with region-specific studies. The current research adds to this literature since it proves the evident advantages of compost use on soil chemical characteristics and maize yield in the controlled field settings.

6. Conclusion

This current research assessed the impacts of compost application on chemical properties of soil and growing of maize in the field, and established that compost is a good organic additive in enhancing soil fertility and agricultural yield. The application of compost led to a great increase in the important soil chemical parameters such as soil pH, content of organic matter, total nitrogen, available phosphorus, and exchangeable potassium. Such advances denote an increase in nutrient status of the soil and a better chemical environment in which crops can grow. The increase in the rates of compost application caused a positive response in maize growth and yield. The increase in plant height, development of the leaf area, biomass, and grain yield was invariably noted in compost-amended plots in comparison to the control. This study has demonstrated that the yield is enhanced by compost, which underscores the importance of compost in enhancing the nutrient availability during important growth phases, especially grain development. Notably, the values of electrical conductivity were in the range of safe thresholds, which proved that the application of compost at the rates used did not cause stress from salinity. The high positive correlations between soil chemical properties and maize development and yield highlight the need to enhance soil quality as a platform for sustainable crop production.

The use of compost led to the improved organic matter of the soil, which was at the center of nutrient retention, soil buffering capability, and the use efficiency of nutrients. These results confirm that compost is not only a source of nutrients but also enhances the capacity of the soil to maintain productivity over a long period of time. In a practical sense, the findings indicate that compost may be utilized as a viable soil fertility management tool in maize cropping systems as a unit soil amendment or integrated nutrient management efforts. Compost use leads to decreased use of synthetic fertilizers, recycling of organic waste, and sustainable agriculture of an environmental nature. Although positive occurrences have occurred, there is also a need to conduct more long-term research in an attempt to determine residual effects of compost application in various cropping seasons and in various soils and climatic conditions. The best compost-fertilizer ratios to achieve high productivity with minimal environmental effects should also be investigated in future research. In general, this research gives solid evidence that the use of

compost is a feasible and sustainable method in enhancing soil chemical conditions and increasing the growth and yields of maize, leading to resilient and sustainable agricultural systems.

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