

# Impact of Composts Based on Poultry Droppings and Phosphate Waste from Togo on Corn Yield (*Zea mays*) and on the Physicochemical Characteristics of the Soil

Ablam Lazare Afanou<sup>1</sup>, Bassaï Magnoudéwa Bodjona<sup>1</sup>, Kolani N'Djoibini Tchanaté<sup>1</sup>, Essodjolon Prospère Kanabiya<sup>2</sup>, Gado Tchangbedji<sup>1</sup>

<sup>1</sup>Laboratoire de Gestion, Traitement et Valorisation des Déchets (GTVD), Université de Lomé, Lomé, Togo

<sup>2</sup>Laboratoire de Génie des Procédés et des Ressources Naturelles (LAGEPREN), Université de Lomé, Lomé, Togo

Email: [ablamlazare@gmail.com](mailto:ablamlazare@gmail.com)

**How to cite this paper:** Afanou, A.L., Bodjona, B.M., Tchanaté, K.N., Kanabiya, E.P. and Tchangbedji, G. (2025) Impact of Composts Based on Poultry Droppings and Phosphate Waste from Togo on Corn Yield (*Zea mays*) and on the Physicochemical Characteristics of the Soil. *Open Journal of Applied Sciences*, 15, 747-760.

<https://doi.org/10.4236/ojapps.2025.153049>

**Received:** December 5, 2024

**Accepted:** March 23, 2025

**Published:** March 26, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

Poultry droppings and phosphate waste from Togo (phosphate sludge and sieve rejects) were used to produce four types of composts: compost A (170 kg of poultry droppings and 85 kg of phosphate sludge), compost B (170 kg of poultry droppings and 85 kg of sieve rejects), compost C (170 kg of poultry droppings, 42.5 kg of phosphate sludge and 42.5 kg of sieve rejects), and compost D (255 kg of poultry droppings). This study aims to evaluate the impact of these composts on maize yield and on the physicochemical characteristics of the soil. Each compost was applied at a rate of 10 t/ha on agricultural plots, in comparison with a control soil receiving no compost. The highest corn grain yield ( $4.05 \pm 0.57$  t/ha), as well as the highest concentrations of available phosphorus (45.33 mg/kg), total nitrogen (0.071%) and total organic carbon (0.80%), were observed on plots amended with compost D. The soil amended with compost A had the highest clay content (%Clay = 8%). Composts made from poultry droppings and phosphate waste can therefore contribute to improving the physicochemical parameters of the soil.

## Keywords

Composts, Phosphate Waste, Poultry Droppings, Corn

## 1. Introduction

Overexploitation of agricultural land, exacerbated by the population explosion, leads to its depletion of nutrients. This phenomenon pushes farmers to resort to

chemical inputs, particularly chemical fertilizers. However, the high cost of these chemical fertilizers makes them almost inaccessible to smallholders [1]. In addition, the excessive use of chemical fertilizers presents economic but also environmental problems: it pollutes groundwater, increases soil acidity, degrades its physical structure and reduces organic matter [2]. A decrease in crop yields is also observed a few years after the application of chemical fertilizers. Faced with this situation, the use of organic fertilizers, such as compost, becomes essential. In Togo, compost is the most accessible and least expensive organic fertilizer for smallholders. Several studies ([2]-[5]) have demonstrated that this material constitutes a biofertilizer rich in organic matter (OM), nitrogen (N), phosphorus ( $P_2O_5$ ) and potassium ( $K_2O$ ). Composts modify the physicochemical parameters of the soil and their repeated applications increase the organic matter content of the soil [6]-[9]. Iglesias-Jimenez and Alvarez suggest that plants can obtain a high contribution of nitrogen compounds through compost [10]. Improvements in pH have been observed in Kolwezi (DR Congo) after the application of different levels of composts from household waste to acid soils [11]. In this study, it is a question of studying, from agronomic trials, the impacts of four (4) composts developed from poultry droppings and phosphate waste on corn yield (*Zea mays L.*) and on some physicochemical parameters of the soil.

## 2. Material and Methods

### 2.1. Material

#### 2.1.1. The Tools Used

The field tools used during the agronomic trials were: hoes for weeding, planters for making holes, a lopper for cutting shrubs, plastic ropes for making holes in straight lines.

#### 2.1.2. Fertilizers Used during Agronomic Trials

Four composts (A, B, C and D) (**Figure 1**), made from poultry droppings and phosphate waste (phosphate sludge and sieve rejects) from Togo were used as organic fertilizers during the agronomic trials. The poultry droppings came from the Regional Center of Excellence on Avian Sciences (CERSA) of the University of Lomé while the phosphate waste (phosphate sludge and sieve rejects) came from the Société Nouvelle des Phosphates du Togo (SNPT) which is the natural phosphate washing plant of Togo located in Kpémé (**Figure 2**). The substrate composition of each compost is mentioned in **Table 1** and their physicochemical characteristics are listed in **Table 2** [12]. In order to assess the maturity of these composts, the germination rates of corn seeds (**Table 3**) were studied with these clearly showing their non-phytotoxicity according to the work of abad Berjon *et al.* [13] which stipulate that when the germination rates of species are greater than 50%, then the composts are considered non-phytotoxic for this species. Chemical fertilizers (NPK and urea) purchased on the market were also used as mineral fertilizers for comparison in these trials.



Figure 1. Appearance of the different composts obtained after 120 days of the process.

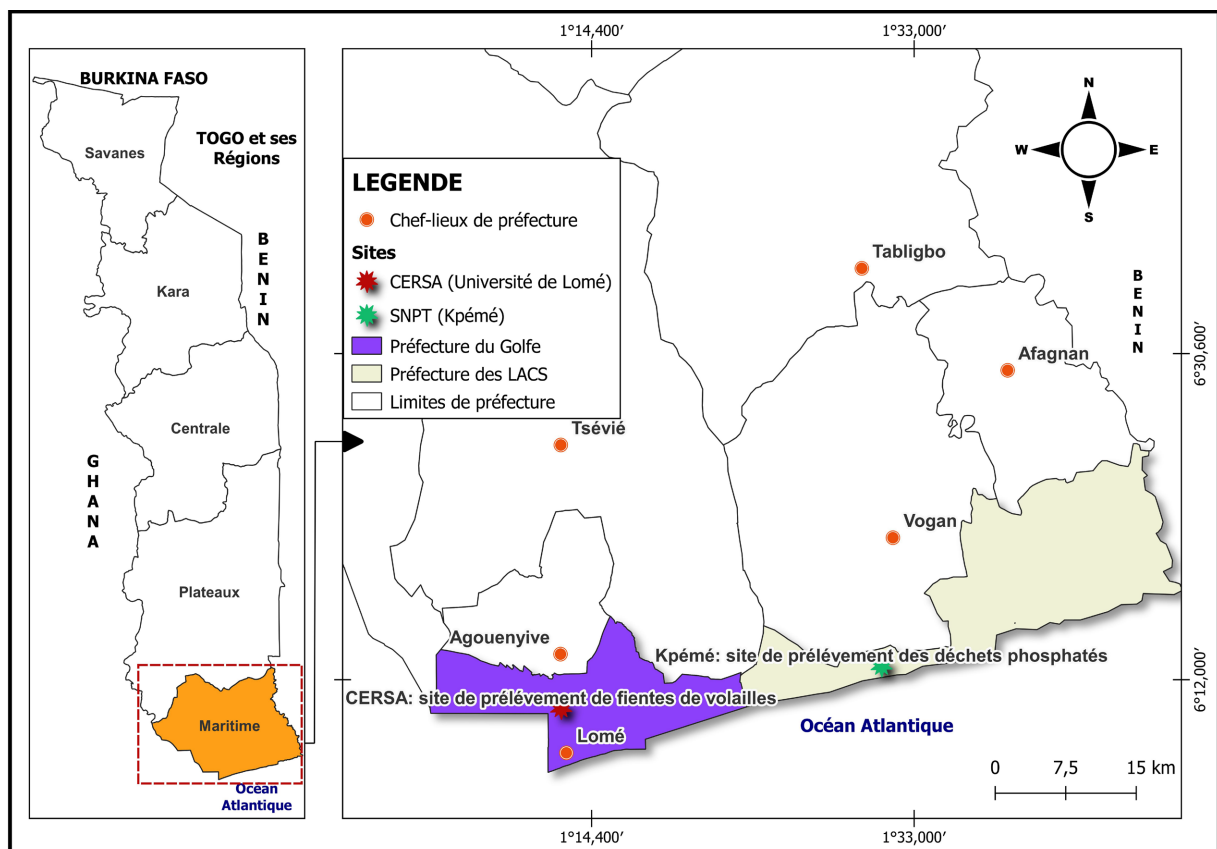


Figure 2. Map showing the collection locations of composting raw materials.

Table 1. Substrate composition of different composts [12].

| Swath | Poultry droppings (FV) |       | Phosphate mud (BP) |       | Screen Refusal (RC) |       |
|-------|------------------------|-------|--------------------|-------|---------------------|-------|
|       | m (kg)                 | P (%) | m (kg)             | P (%) | m (kg)              | P (%) |
| HAS   | 170                    | 66.7  | 85                 | 33.3  | 0                   | 0     |
| B     | 170                    | 66.7  | 0                  | 0     | 85                  | 33.3  |
| C     | 170                    | 66.7  | 42.5               | 16.7  | 42.5                | 16.7  |
| D     | 255                    | 100   | 0                  | 0     | 0                   | 0     |

m = mass of raw materials and P = percentage relative to the total mass of the pile.

**Table 2.** Physicochemical characteristics of the composts used [12].

| Settings                 | Compost A | Compost B | Compost C | Compost D |
|--------------------------|-----------|-----------|-----------|-----------|
| pH                       | 8.8       | 9.1       | 8.2       | 9.7       |
| %MO                      | 20.00     | 19.00     | 18.00     | 39.51     |
| %COT                     | 12.10     | 11.02     | 10.44     | 22.92     |
| %N                       | 1.20      | 1.27      | 1.45      | 2.02      |
| C/N                      | 9.9       | 8.68      | 7.20      | 11.34     |
| P <sub>tot</sub> (mg/g)  | 32.40     | 61.44     | 39.96     | 15.02     |
| P <sub>ass</sub> (mg/kg) | 112.37    | 113.46    | 110.53    | 136.86    |
| Ca (mg/g)                | 51.12     | 52.26     | 50.44     | 39.50     |
| Mg (mg/g)                | 7.90      | 9.34      | 9.01      | 9.91      |
| K (mg/g)                 | 12.58     | 10.50     | 13.58     | 30.67     |
| Na (mg/g)                | 17.79     | 11.21     | 14.07     | 14.13     |
| CEC (Cmol /kg)           | 78.10     | 69.94     | 73.50     | 80.49     |

P<sub>tot</sub> = total phosphorus, P<sub>ass</sub> = available phosphorus, CEC = cation exchange capacity, COT = total organic carbon.

**Table 3.** Evolution of corn germination rate as a function of compost and doses.

| 100% sand  | 75% sand + 25%<br>compost | 50% sand + 50%<br>compost | 25% sand + 75%<br>compost | 100% compost |
|--|---------------------------|---------------------------|---------------------------|--------------|
| Germination rate (%) of corn seeds for compost A |                           |                           |                           |              |
| 100  | 100                       | 87.5                      | 87.5                      | 75           |
| Germination rate (%) of corn seeds for compost B |                           |                           |                           |              |
| 100  | 100                       | 100                       | 87.5                      | 87.5         |
| Germination rate (%) of corn seeds for compost C |                           |                           |                           |              |
| 100  | 100                       | 87.5                      | 75                        | 75           |
| Germination rate (%) of corn seeds for compost C |                           |                           |                           |              |
| 100  | 87.5                      | 75                        | 75                        | 62.5         |

### 2.1.3. Reproduction Material Used

Corn (*Zea mays L.*, variety *TZEE*) was the only crop tested in these agronomic trials, due to its importance as a major food crop in Togo. According to Adewi *et al.* [14], maize cultivation faces challenges such as soil degradation and unforeseen seasonal variations, which can significantly reduce yields.

## 2.2. Methods

### 2.2.1. Period of Agronomic Trials and Test Soil

The agronomic trials were carried out from August to December 2022 on a plot located at the University of Lomé (Togo), at the following geographical coordinates: 6° 10.30'N, 1° 12.70'E, at an altitude of 20 meters. The soil used for this study had been left fallow for more than six years, meaning that this soil had not been subject to any organic or chemical amendment during this time.

### 2.2.2. Analysis of the Physicochemical Parameters of the Experimental Soil

Before soil amendment with different composts and chemical fertilizers, soil samples were taken from the 0 to 20 cm layer horizons [15] to determine the following physicochemical parameters: particle size, pH, total organic carbon content (% TOC), total nitrogen content (% N), C/N ratio, total phosphorus ( $P_{tot}$ ), available phosphorus ( $P_{ass}$ ), as well as potassium (K), sodium (Na), calcium (Ca), and magnesium (Mg) contents.

### 2.2.3. Soil Preparation and Sowing of Corn

On the study soil, a device comprising 18 elementary plots of 2.80 m<sup>2</sup> each (2.8 m long by 1 m wide), separated by 0.7 m wide alleys was created (Figure 3). Six treatments were applied on these plots: ST0 (control soil without compost or chemical fertilizers), STA (soil amended with compost A at 10 t/ha), STB (soil amended with compost B at 10 t/ha), STC (soil amended with compost C at 10 t/ha), STD (soil amended with compost D at 10 t/ha) and STEC (soil amended with chemical fertilizers at 200 kg/ha). The composts were applied 3 days before sowing and the chemical fertilizers were applied on the 16th day (NPK) and on the 45th day (Urea) after sowing. Each treatment was repeated three times randomly. Plots were prepared one week before sowing and watered for three days before sowing. Sowing was carried out at a spacing of 60 cm × 40 cm, placing four seeds per pocket. Two weeks after sowing, thinning was carried out to maintain two plants per pocket. Regular weeding was carried out throughout the trial. The crops were watered every two days with 30 litres per plot, or by natural rainfall, until 60 days after sowing, thus ensuring a good water regime.

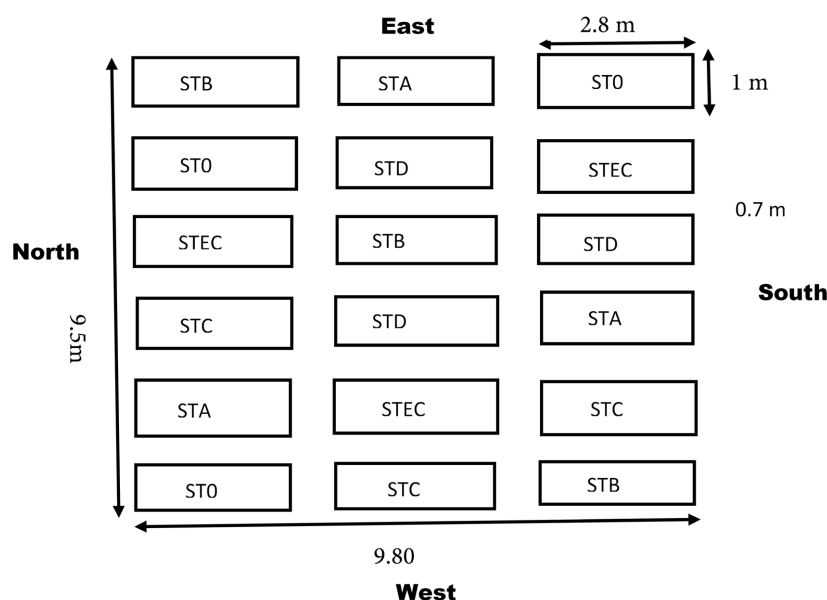


Figure 3. Corn sowing plan during agronomic trials.

### 2.2.4. Harvest and Evaluation

Harvesting took place 110 days after sowing. Grain yield and 1000-grain weight

for each treatment were measured. Formula was used to calculate the grain yield of each elementary plot.

$$Y_{id} = \frac{100 - H_c}{100 - H_s} \times M : \text{Formula}$$

$Y_{id}$ : yield (in tonnes per hectare);

$M$ : mass of harvested seeds (in tonnes per hectare);

$H_s$ : standard humidity (14% humidity recommended for good seed conservation);

$H_c$ : humidity of seeds at the time of harvest.

### 2.2.5. Post-Test Analysis

After the agronomic trials, *i.e.* six months after the application of the different composts, soil samples (depth of 0 to 20 cm) were taken from each elementary plot for analysis. The main physicochemical parameters analyzed on these samples are: particle size, pH, total organic carbon content, fertilizing elements (Ca, Mg, Na, K), total phosphorus and assimilable phosphorus, as well as cation exchange capacity (CEC).

### 2.2.6. Protocols for Analysis of Physicochemical Parameters

#### a) Soil granulometry

The particle size was determined with a BETTERSIZER ultrasonic granulometer. Indeed, 1 to 10 g of the soil under study is introduced into an ultrasonic bath containing distilled water and homogenized using a stirrer. After homogenization, the wet sample is conveyed to a reading tank equipped with a screen on which the percentage of each texture is read according to its size.

#### b) Potential of hydrogen (pH)

The pH is measured on aqueous suspensions according to the AFNOR NF ISO 10-390 standard of November 1994.

#### c) Total nitrogen (NTK)

Total nitrogen (NTK) which is the sum of ammoniacal nitrogen and organic nitrogen is determined according to the AFNOR ISO 11261 standard of June 1995, as described by Biekre *et al.* [4].

#### d) Total phosphorus ( $P_{tot}$ )

Total phosphorus ( $P_{tot}$ ) is determined in two steps according to the method of Bustamante *et al.* [16]. Indeed, ten (10) grams of sample are digested in an acid medium (converting all the phosphorus into orthophosphate), followed by the spectroscopic determination of orthophosphate ions at 660 nm.

#### e) Total organic carbon (TOC)

Total organic carbon (TOC) was measured following the method of Walkley and Black [17].

#### f) Fertilizing elements (Ca, Mg, Na, K)

These elements were determined by atomic absorption spectrometry (AAS) after mineralization of the samples with aqua regia, in accordance with the standard method NF ISO 11466.

**g) Assimilable phosphorus ( $P_{\text{ass}}$ )**

Available phosphorus ( $P_{\text{ass}}$ ) was measured by the Olsen method. One gram of soil was stirred in 20 ml of 0.5 M sodium bicarbonate for one hour, then filtered and assayed with a UV-visible spectroscope at 660 nm.

**h) Cation exchange capacity (CEC)**

This parameter was determined according to the Metson method [18].

**3. Results and Discussion****3.1. Physicochemical Characteristics of the Experimental Soil**

The physicochemical characteristics of the experimental soil before the start of the agronomic trials are presented in **Table 4**. The analysis reveals that the soil has an acidic pH, less than 7 (pH = 5.50), indicating moderate acidity. This acidity may require adjustment to optimize crop growing conditions. The contents of total organic carbon (TOC) (%TOC = 0.48), total nitrogen (%N = 0.04), total phosphorus ( $P_{\text{tot}}$  = 77.55 mg/kg), and available phosphorus ( $P_{\text{ass}}$  = 2.78 mg/kg) are all relatively low, suggesting that the soil is poor in essential plant nutrients. These results are corroborated by similar studies showing that nutrient-poor soils can limit agricultural productivity [19].

**Table 4.** Physicochemical parameters of the experimental soil.

| Physicochemical parameters                          | Measured contents Gomgnimbou <i>et al.</i> [15] |       |
|---|---|-------|
| pH  | 5.50  | 3.95  |
| % Total organic carbon (TOC)                        | 0.48  | 0.38  |
| % Total nitrogen (N)                                | 0.04  | 0.034 |
| C/N ratio   | 14  | 11    |
| Total phosphorus ( $P_{\text{tot}}$ ) (mg/kg)       | 77.55   | 80    |
| Phosphorus assimilable ( $P_{\text{ass}}$ ) (mg/kg) | 2.78  | 2.72  |
| Calcium (Ca) (mg/kg)                                | 136.91  | -     |
| Magnesium (Mg) (mg/kg)                              | 183.89  | -     |
| Potassium (K) (mg/kg)                               | 126.91  | 1348  |
| Sodium (Na) (mg/kg)                                 | 345.00  | -     |
| Cation exchange capacity (CEC) (Cmol/kg)            | 2.93  | 1.98  |
| Sand (% sand)                                       | 91.98   | -     |
| Silt (% silt)                                       | 6.99  | -     |
| Clay (% clay)                                       | 1.02  | -     |

$P_{\text{tot}}$  = total phosphorus,  $P_{\text{ass}}$  = available phosphorus, CEC = cation exchange capacity, COT = total organic carbon.

The content of nutrient elements, such as calcium (Ca = 136.91 mg/kg), magnesium (Mg = 183.89 mg/kg), potassium (K = 126.91 mg/kg) and sodium (Na = 345.00 mg/kg), is also low. This deficiency of essential plant nutrients is consistent

with observations from recent studies, which highlight the importance of proper nutrient management to maintain soil fertility and support crop yields [20]. The soil particle size distribution indicates that it is predominantly sandy (%sand = 91.98). Sandy soils, although well drained, often have limitations in terms of water and nutrient retention. This characteristic is well documented in the literature, which highlights the challenges associated with the management of sandy soils, including their low water-holding capacity and their need for fertilization to improve their productivity [21] [22].

In conclusion, the experimental soil presents characteristics indicating low fertility and potentially problematic acidity. The application of composts as amendments can help to improve these conditions, as previous research has shown [23] [24]. Acidity correction and nutrient enrichment are essential to improve soil fertility and support sustainable agricultural production.

### 3.2. Influence of Composts on the Chemical Properties of the Soil

**Table 5** shows the new physicochemical parameters of the different amended soils.

**Table 5.** Physicochemical parameters of the treated plots.

| Settings                 | STA                  | STB                 | STC                  | STD                 | ST0                 | STEC                |
|--------------------------|----------------------|---------------------|----------------------|---------------------|---------------------|---------------------|
| pH                       | 7.30 <sup>a</sup>    | 7.14 <sup>a</sup>   | 7.02 <sup>a</sup>    | 7.53 <sup>a</sup>   | 6.05 <sup>a</sup>   | 6.51 <sup>a</sup>   |
| %COT                     | 0.66 <sup>a</sup>    | 0.72 <sup>a</sup>   | 0.78 <sup>a</sup>    | 0.80 <sup>a</sup>   | 0.50 <sup>a</sup>   | 0.54 <sup>a</sup>   |
| %N                       | 0.062 <sup>a</sup>   | 0.059 <sup>a</sup>  | 0.058 <sup>a</sup>   | 0.071 <sup>a</sup>  | 0.035 <sup>a</sup>  | 0.062 <sup>a</sup>  |
| Ca (mg/kg)               | 1643.02 <sup>a</sup> | 703.45 <sup>b</sup> | 1361.49 <sup>c</sup> | 756.20 <sup>d</sup> | 139.69 <sup>e</sup> | 155.76 <sup>f</sup> |
| Mg (mg/kg)               | 583.07 <sup>a</sup>  | 230.92 <sup>b</sup> | 393.05 <sup>c</sup>  | 158.97 <sup>d</sup> | 190.42 <sup>e</sup> | 125.45 <sup>f</sup> |
| K (mg/kg)                | 143.84 <sup>a</sup>  | 130.49 <sup>b</sup> | 147.76 <sup>c</sup>  | 158.97 <sup>c</sup> | 125.23 <sup>d</sup> | 141.91 <sup>f</sup> |
| P <sub>tot</sub> (mg/kg) | 802.78 <sup>a</sup>  | 686.67 <sup>b</sup> | 732.14 <sup>c</sup>  | 526.23 <sup>d</sup> | 111.39 <sup>e</sup> | 116.10 <sup>f</sup> |
| P <sub>ass</sub> (mg/kg) | 35.30 <sup>a</sup>   | 24.15 <sup>b</sup>  | 34.48 <sup>a</sup>   | 45.33 <sup>c</sup>  | 2.42 <sup>d</sup>   | 38.22 <sup>f</sup>  |
| CEC (cmol/kg)            | 3.36 <sup>a</sup>    | 4.61 <sup>a</sup>   | 4.03 <sup>a</sup>    | 4.90 <sup>a</sup>   | 2.56 <sup>a</sup>   | 3.35 <sup>a</sup>   |

Note: Values with different letters on the same line are significantly different at the 5% probability level. P<sub>tot</sub> = total phosphorus, P<sub>ass</sub> = available phosphorus, CEC = cation exchange capacity, COT = total organic carbon.

Before compost application, the soil pH was 5.5, indicating moderate acidity. After amendment, the pH of soils treated with these composts approached neutrality, ranging from 7.02 to 7.53, while those of the control soil (ST0) and the soil amended with chemicals (STEC), which were 6.05 and 6.51, respectively, were slightly acidic. This trend towards a more neutral pH for soils amended with the different composts can be attributed to the basicity of the composts used, whose pH ranged from 8.2 to 9.7. Nyembo *et al.* confirmed that the application of composts can effectively restore the pH of an acidic soil by increasing its buffering capacity [25]. The highest levels of total organic carbon (%TOC = 0.80%) and total

nitrogen (%N = 0.07%) were observed in soil amended with compost D (STD). Poultry droppings, used to produce this compost, are known to be rich in easily decomposable organic matter, which promotes the release of nutrients into the soil. Dean *et al.* [26] observed that poultry droppings effectively increased total soil nitrogen levels in the short to medium term. Composts enriched with organic matter, such as poultry droppings, improve soil fertility by increasing carbon and nitrogen content, which is crucial for crop growth. Soil amended with compost D (STD) also recorded the highest cation exchange capacity (CEC) at 4.90 cmol/kg. This increase in CEC is thought to be due to the rich organic matter content of the composts, which improves soil structure and its ability to retain cations. Higher CEC allows the soil to retain essential plant nutrients more efficiently. The best levels of total phosphorus (802.78 mg/kg) and available phosphorus (45.33 mg/kg) were observed in soils amended with compost A (STA) and compost D (STD), respectively. Useni *et al.* found that composts could improve the levels of available phosphorus in soil, which is crucial for the development of maize plants [11]. The amended soils showed an increase in the levels of calcium (Ca), magnesium (Mg), and potassium (K) compared to the control soil. The soil amended with compost A (STA) recorded the best contents of calcium (1643.02 mg/kg) and magnesium (583.07 mg/kg), while compost D (STD) provided the best contents of potassium (158.97 mg/kg) and available phosphorus (45.33 mg/kg). Composts, rich in nutrients, enrich the soil with these essential nutrients.

### 3.3. Influence of Composts on the Granulometry of Different Amended Soils

**Table 6** illustrates the particle size distribution of the plots amended with the composts (STA, STB, STC, and STD). Although the general texture of the study soil, initially sandy, was not significantly modified, variations in the proportions of sand, silt, and clay were observed. The proportions of sand in the plots treated with the composts varied from 83% to 88.79%. The soil amended with compost A (STA) showed the lowest percentage of sand (83%) and the highest percentage of clay (%Clay = 8%). Furthermore, the proportions of silt in the amended plots (STA, STB, STC, and STD) varied between 8% and 10.08%, while the control plot (ST0) showed a silt percentage of 6.08%. This increase is probably due to the contribution of organic matter by composts, which enrich the soil with fine particles and promote the formation of silt. The results obtained are in agreement with those of Bouajila and Sanaa [27] who noted an improvement in soil structure after application of manure composts. These changes are beneficial for overall soil structure, as an increase in silt and clay can improve soil stability and its ability to retain water and nutrients. These contributions of silt and clay by the different composts are beneficial to the soil. Indeed, for kantone and Liechtenstein [28], clays and silts constitute formidable reservoirs of water and vital elements for vegetation. In conclusion, although the overall texture of the study soil remained sandy, the composts had a significant impact on the distribution of particles in the

soil. The addition of composts, especially those containing phosphate mud, led to an increase in the proportion of clay and silt, which improved the soil texture and its water retention properties.

**Table 6.** Soil granulometry.

| Different amended soil | %sand | %silt | %clay |
|------------------------|-------|-------|-------|
| ST <sub>A</sub>        | 83    | 9     | 8     |
| ST <sub>B</sub>        | 88    | 8     | 4     |
| ST <sub>C</sub>        | 85    | 8.52  | 6.48  |
| ST <sub>D</sub>        | 88.79 | 10.08 | 1.19  |
| ST <sub>EC</sub>       | 90.58 | 5.58  | 3.84  |
| ST <sub>0</sub>        | 92.26 | 6.08  | 1.66  |

### 3.4. Influences of Composts on Corn Grain Yield

**Table 7** presents the corn grain yields obtained with the different compost treatments. Although the differences are not significant at the 5% level, the plots amended with the composts (ST<sub>A</sub>, ST<sub>B</sub>, ST<sub>C</sub>, ST<sub>D</sub>) show higher yields than the control plot, with values ranging from 2.53 t/ha to 4.05 t/ha, compared to 1.8 t/ha for the unamended soil. This improvement in yield can be attributed to the richness of the composts in essential nutrients such as carbon, nitrogen, phosphorus, calcium and potassium. Compost D (ST<sub>D</sub>), in particular, produced the highest yield (4.05 t/ha). This superior performance is probably due to the high organic matter content of compost D, which provides a gradual and continuous release of nutrients necessary for corn growth. For Kitabala *et al.*, the contribution of doses of compost to the soil improves its fertility and consequently crops yields [29]. Our results are in agreement with those obtained by Tamakloe *et al.*, who reported a yield of 2.40 t/ha for maize on soil amended with household waste composts [30]. However, the yield observed in our study is significantly higher, which can be explained by the higher nutrient composition of our composts. The work of Mrabet *et al.* [31] has clearly demonstrated that the presence of compost in the soil significantly influences corn yield in terms of weight. Compost D, with its high organic matter concentration and high nutrient levels, is consistent with these observations, highlighting the importance of balanced compost composition to optimize corn yields. Furthermore, the results of this study are also supported by the work of N'dayegamiye *et al.* [32], who noted significant increases in corn yields after amending soils with composts rich in potassium, nitrogen, phosphorus, and then organic matter.

Ultimately, although the yield differences between treatments were not statistically significant, the addition of composts appeared to improve corn grain yield compared to unamended soil. The variations observed between the different composts highlight the importance of the nutritional quality of composts in optimizing agricultural yields.

**Table 7.** Corn grain yield according to treatments.

| Treated soils | Yield (t/ha)             |
|---------------|--------------------------|
| STA           | 3.70 ± 0.51 <sup>a</sup> |
| STB           | 2.53 ± 0.34 <sup>a</sup> |
| STC           | 3.93 ± 0.29 <sup>a</sup> |
| STD           | 4.05 ± 0.57 <sup>a</sup> |
| ST0           | 1.82 ± 0.26 <sup>a</sup> |
| STEC          | 4.01 ± 0.22 <sup>a</sup> |

**Note:** Values assigned the same letters in the same column are not significantly different at the 5% probability threshold.

### 3.5. Influence of Composts on the Weight of 1000 Corn Grains

**Table 8** presents the weights of 1000 corn grains obtained with the different compost treatments. The results show that the weight of 1000 grains varies between  $221.95 \pm 2.62$  g and  $240.10 \pm 13.10$  g for the amended soils, while the control soil has a weight of  $217.85 \pm 3.15$  g; the soil amended with chemical fertilizers has a weight of  $235.26 \pm 9.32$  g. The composts used in this study contain various essential nutrients, such as organic matter and mineral salts, which are beneficial for the growth of corn plants. The values observed for the weights of 1000 grains are higher than those reported by Zoumboudré *et al.* who found an average weight of 172 g for corn grains grown with pruning manures [33]. This improvement in nutrient availability leads to heavier grains, as shown in our study. These results highlight the importance of composts in optimizing corn production.

**Table 8.** Weight of 1000 corn grains according to treatments.

| Treated soils | Weight of 1000 grains (g)   |
|---------------|-----------------------------|
| STA           | 221.95 ± 2.62 <sup>a</sup>  |
| STB           | 228.90 ± 16.83 <sup>a</sup> |
| STC           | 228.10 ± 13.10 <sup>a</sup> |
| STD           | 240.10 ± 13.44 <sup>a</sup> |
| ST0           | 217.85 ± 3.15 <sup>a</sup>  |
| STEC          | 235.26 ± 9.32 <sup>a</sup>  |

**Note:** Values assigned different letters in the same column are significantly different at the 5% probability level.

## 4. Conclusion

This study investigated the short-term impacts of composts made from poultry manure and phosphate waste from Togo on soil physicochemical properties and maize yield. The results show that compost treatments improved soil parameters, including increasing pH and cation exchange capacity, total organic carbon (TOC), and total nitrogen (NTK) compared to those of the control soil (ST0). The

best corn seed yield ( $4.05 \pm 0.57$  t/ha) and the highest 1000 grain weight ( $240.10 \pm 13.44$  g/1000 grains) came from the treatment with compost D (STD). The soil amended with compost A showed a notable increase in the proportion of clay. Ultimately, in view of the analyses, it can be said in general that the composts produced are of good quality and can validly replace chemical fertilizers if their production is done in large quantities.

### Conflicts of Interest

The authors declare that they have no conflicts of interest in relation to this publication. None of the authors have any financial, professional or personal relationships that could influence the integrity of the results and conclusions of this study.

### References

- [1] Useni, S.Y., Chukiyabo, K.M., Tshomba, K.J., Muyambo, M.E., Ntumba, N.F., Kasangij, K.P., Kyungu, K.A., Baboy, L.L., Nyembo, K.L. and Mpundu, M.M. (2013) Utilisation des déchets humains recyclés pour l'augmentation de la production du maïs (*Zea mays* L.) sur un ferralsol du sud-est de la RD Congo. *Journal of Applied Biosciences*, **66**, 5070-5081. <https://doi.org/10.4314/jab.v66i0.95005>
- [2] Konate, Z., N'ganzoua, K. R., Sanogo, S. and Camara, M. (2020) Effet des durées de compostage de la fiente de poulet sur la fertilité physico-chimique des composts produits. *International Journal of Innovation and Applied Studies*, **29**, 1233-1241. <http://www.ijias.issr-journals.org/>
- [3] Sema, A.M., Koledzi, E.K., Krou, N.M. and Tcha-Thom, M. (2021) Etude comparée de la ventilation naturelle et automatique à l'aide de tuyaux perforés et du procédé classique de retournements des andains en compostage. *International Journal of Biological and Chemical Sciences*, **15**, 354-366. <https://doi.org/10.4314/ijbcs.v15i1.30>
- [4] Biekre, A.H.T., Tie, B.T. and Dogbo, D.O. (2018) Caractéristiques physico-chimiques des composts à base de sous-produits de ferme de Songon en Côte d'Ivoire. *International Journal of Biological and Chemical Sciences*, **12**, 596-609. <https://doi.org/10.4314/ijbcs.v12i1.45>
- [5] Tchegueni, S., Kili, K., Bodjona, M., Koriko, M., Hafidi, M., Baba, G., et al. (2012) Effets des composts à base de déchets d'agrumes et du tourteau de karité sur la disponibilité du phosphore du sol: Une étude en conditions contrôlées. *International Journal of Biological and Chemical Sciences*, **6**, 1381-1389. <https://doi.org/10.4314/ijbcs.v6i3.39>
- [6] Crecchio, C., Curci, M., Pizzigallo, M.D.R., Ricciuti, P. and Ruggiero, P. (2004) Effects of Municipal Solid Waste Compost Amendments on Soil Enzyme Activities and Bacterial Genetic Diversity. *Soil Biology and Biochemistry*, **36**, 1595-1605. <https://doi.org/10.1016/j.soilbio.2004.07.016>
- [7] García-Gil, J.C., Plaza, C., Soler-Rovira, P. and Polo, A. (2000) Long-Term Effects of Municipal Solid Waste Compost Application on Soil Enzyme Activities and Microbial Biomass. *Soil Biology and Biochemistry*, **32**, 1907-1913. [https://doi.org/10.1016/s0038-0717\(00\)00165-6](https://doi.org/10.1016/s0038-0717(00)00165-6)
- [8] Montemurro, F., Maiorana, M., Convertini, G. and Ferri, D. (2006) Compost Organic Amendments in Fodder Crops: Effects on Yield, Nitrogen Utilization and Soil Characteristics. *Compost Science & Utilization*, **14**, 114-123. <https://doi.org/10.1080/1065657x.2006.10702272>

- [9] Walter, I., Martínez, F. and Cuevas, G. (2006) Plant and Soil Responses to the Application of Composted MSW in a Degraded, Semiarid Shrubland in Central Spain. *Compost Science & Utilization*, **14**, 147-154. <https://doi.org/10.1080/1065657x.2006.10702276>
- [10] Iglesias-Jimenez, E. and Alvarez, C.E. (1993) Apparent Availability of Nitrogen in Composted Municipal Refuse. *Biology and Fertility of Soils*, **16**, 313-318. <https://doi.org/10.1007/bf00369312>
- [11] Tshala, U.J., Kitabal, M.A., Kasongo, M.L.E. and Nyembo, K.L. (2019) Effets des composts ménagers sur les propriétés du sol et sur la productivité des cultures légumières: Cas de la tomate (*Lycopersicon esculentum* Mill). *International Journal of Biological and Chemical Sciences*, **13**, 3411-3428. <https://doi.org/10.4314/ijbcs.v13i7.35>
- [12] Berjón, M.A., Morató, M.D.C., Revuelta, P.A. and Simón, A.C. (1997) The Influence of Solid Urban Waste Compost and Nitrogen-Mineral Fertilizer on Growth and Productivity in Potatoes. *Communications in Soil Science and Plant Analysis*, **28**, 1653-1661. <https://doi.org/10.1080/00103629709369905>
- [13] Afanou, A.L., Bodjona, M.B., Diribissakou, I., Ajavon, A.K., Edoh, K.H. and Tchangbedji, G. (2024) Caractérisation physico-chimique des composts élaborés à base des fientes de volaille et des déchets phosphatés du Togo. *International Journal of Biological and Chemical Sciences*, **17**, 2998-3007. <https://doi.org/10.4314/ijbcs.v17i7.30>
- [14] Adewi, E., Badameli, K.M.S. and Dubreuil, V. (2010) Evolution des saisons des pluies potentiellement utiles au Togo de 1950 à 2000. *Climatologie*, **7**, 89-107. <https://doi.org/10.4267/climatologie.489>
- [15] Gomgnimbou, A.P.K., Bandaogo, A.A., Kalifa, C., Sanon, A., Ouattara, S. and Nacro, H.B. (2019) Effets à court terme de l'application des fientes de volaille sur le rendement du maïs (*Zea mays* L.) et les caractéristiques chimiques d'un sol ferrallitique dans la zone sud-soudanienne du Burkina Faso. *International Journal of Biological and Chemical Sciences*, **13**, 2041-2052. <https://doi.org/10.4314/ijbcs.v13i4.11>
- [16] Bustamante, M.A., Paredes, C., Marhuenda-Egea, F.C., Pérez-Espinoza, A., Bernal, M.P. and Moral, R. (2008) Co-Composting of Distillery Wastes with Animal Manures: Carbon and Nitrogen Transformations in the Evaluation of Compost Stability. *Chemosphere*, **72**, 551-557. <https://doi.org/10.1016/j.chemosphere.2008.03.030>
- [17] Walkley, A. and Black, I.A. (1934) An Examination of the Degtjareff Method for Determining Soil Organic Matter, and a Proposed Modification of the Chromic Acid Titration Method. *Soil Science*, **37**, 29-38. <https://doi.org/10.1097/00010694-193401000-00003>
- [18] Metson, A.J. (1956) Methods of Chemical Analysis for Soil Survey Samples. New Zealand Soil Bureau Bulletin No. 12.
- [19] Thevathasan, N.V., Gordon, A.M., Bradley, R., Cogliastro, A., Folkard, P., Grant, R., et al. (2012) Agroforestry Research and Development in Canada: The Way Forward. In: Nair, P.K.R. and Garrity, D., Eds., *Agroforestry— The Future of Global Land Use*, Springer, 247-283. [https://doi.org/10.1007/978-94-007-4676-3\\_15](https://doi.org/10.1007/978-94-007-4676-3_15)
- [20] Shennan, C. (2008) Diversity of Soil Fertility Management in Sustainable Agriculture. *Annual Review of Environmental Resources*, **33**, 159-184.
- [21] Hillel, D. (2004) Introduction to Soil Physics. Academic Press.
- [22] Brady, N.C. and Weil, R.R. (2008) The Nature and Properties of Soils. Pearson.
- [23] Zerssa, G.W., Kim, D., Koal, P. and Eichler-Löbermann, B. (2021) Combination of Compost and Mineral Fertilizers as an Option for Enhancing Maize (*Zea mays* L.)

- Yields and Mitigating Greenhouse Gas Emissions from a Nitisol in Ethiopia. *Agronomy*, **11**, Article 2097. <https://doi.org/10.3390/agronomy11112097>
- [24] Pellejero, G., Palacios, J., Vela, E., Gajardo, O., Albrecht, L., Aschkar, G., *et al.* (2021) Effects of the Application of Compost as an Organic Fertilizer on a Tomato Crop (*Solanum lycopersicum* L.) Produced in the Field in the Lower Valley of the Rio Negro (Argentina). *International Journal of Recycling of Organic Waste in Agriculture*, **10**, 145-155. <https://doi.org/10.30486/IJROWA.2021.1909797.1135>
- [25] Luciens, M., Yannick, U., Dieudonné, C., Dieudonné, K., Yambayamba, K., Michel, M., *et al.* (2014) Amélioration des propriétés physiques et chimiques du sol sous l'apport combiné des biodéchets et des engrais minéraux et influence sur le comportement du maïs (*Zea mays* L. variété Unilu). *Journal of Applied Biosciences*, **74**, 6121-6130. <https://doi.org/10.4314/jab.v74i1.7>
- [26] Steele, D.D., Stegman, E.C. and Knighton, R.E. (2000) Irrigation Management for Corn in the Northern Great Plains, Usa. *Irrigation Science*, **19**, 107-114. <https://doi.org/10.1007/pl00006709>
- [27] Bouajila, K. and Sanaa, M. (2011) Effects of organic Amendements on Soil Physico-chemical and Biological Properties. *Journal of Materials and Environment*, **2**, 485-490.
- [28] Kantone, B. and Liechtenstein, F. (2016) Argiles, limons et satbilisation des sols. c/o CEFOR Lyss Hardernstr. 20. <https://www.fobatec.ch/>
- [29] Kitabala M.A., Tshala U.J., Kalenda, M.A., Tshijika, I.M. and Mufind, K.M. (2016). Effets des différentes doses de composts sur la production et la rentabilité de la tomate (*Lycopersicon esculentum* Mill) dans la ville de Kolwezi, Province du Lualaba (RD Congo). *Journal of Applied Biosciences*, **102**, 9669-9679.
- [30] Tamakloe, J.M., Koledzi, E.K., Aziabile, E. and Krou, N.M. (2021) Impact of Composts Maturity on Growth and Agronomic Parameters of Maize (*Zea mays*). American Journal of Analytical Chemistry Evaluation of the Maturity of the Compost Produced at the Compost Production Site of the NGO ENPRO in Lomé (Togo) Using the UV-Visible Spectroscopy. *Science Journal of Chemistry*, **12**, 29-45. <https://doi.org/10.4236/ajc.2020.122003>
- [31] Mrabet, L., Belghyti, D., Loukili, A. and Attarassi, B. (2011) Etude de l'effet du compost des déchets ménagers sur l'amélioration du rendement de maïs et de la laitue. *Afrique Scince*, **7**, 74-85.
- [32] N'dayegamiye, A., Drapeau, A. and Laverdière, M.R. (2021) Effets des apports de composts de résidus ménagers sur les rendements des cultures et certaines propriétés du sol. *Agrosol*, **16**, 135-144.
- [33] Zomboudré, G., Zombré, G., Ouedraogo, I.N., Guinko, S. and Macauley, H.R. (2005) Réponse physiologique et productivité des cultures dans un système agroforestier traditionnel: Cas du maïs (*Zea mays* L.) associé au karité (*Vitellaria paradoxa* Gaertn.) dans la zone Est du Burkina Faso. *Biotechnology, Agronomy and Society and Environment*, **9**, 75-85. <https://poups.uliege.be/1780-4507/index.phd?id=13880>