JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL. 7 NO. 2 May 2025
DOI :https://doi.org/10.36378/juatika.v7i2.4791
eissn 2656-1727
pissn 2684-785X
pages : 680 – 686

RESEARCH ARTICLE Open Access

The Effect of Kasgot Fertilizer Application on the Chemical Properties of Soil Planted with Cucumbers (*Cucumis sativus* L.)

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Abstract
Sustainable agriculture requires the prudent management of natural resources, including the judicious use of fertilizers and other inputs. One of the primary challenges faced by farmers is the decline in soil fertility resulting from the prolonged use of chemical fertilizers. This study aims to evaluate the effect of Kasgot fertilizer on soil chemical properties, specifically soil pH, organic carbon content, total nitrogen (N), available phosphorus (P), and available potassium (K), in cucumber cultivation. Soil sampling was conducted using a proportional sampling method, where sample points were selected based on soil availability and were representative of the cucumber cultivation area. The results indicated that, based on the analysis of phosphorus (P) and potassium (K) nutrient content, the treatment with 5 grams per planting hole was most effective in increasing phosphorus availability to 0.2907%, classified as high. Meanwhile, the treatments with 10 grams and 20 grams per planting hole were more effective in increasing soil potassium content to 0.0724% and 0.0708%, respectively, both of which were classified as moderate to high.

Keywords: Chemical Properties, Cucumber, Kasgot Fertilizer, Organic Fertilizer, Soil

1. Introduction

Sustainable agriculture requires prudent management of natural resources, including the use of fertilizers. One of the primary challenges faced by farmers is the decline in soil fertility resulting from the long-term application of chemical fertilizers. Continuous use of these fertilizers leads to soil degradation, environmental pollution, and a reduction in soil microbial activity (Soekamto et al., 2023). Therefore, environmentally friendly alternative fertilizers that can enhance soil fertility are needed, such as Kasgot fertilizer.

Kasgot (Black Soldier Fly larvae excrement) is a byproduct of the bioconversion of organic waste by BSF (Hermetia illucens) larvae. This fertilizer is rich in macronutrients, including nitrogen (N), phosphorus (P), and potassium (K), and contains organic matter that can enhance soil structure and improve its chemical properties. Furthermore, kasgot is also known to increase the population of soil microorganisms, which play a crucial role in decomposition and nutrient availability (Fauzi et al., 2022).

Kasgot, or Black Soldier Fly (BSF) larval excrement, is a byproduct of the bioconversion of organic waste by BSF larvae. Kasgot is rich in macro- and micronutrients, including nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S), all of which are essential for plant growth. Additionally, kasgot contains bioactive compounds, beneficial microorganisms, and high levels of organic matter that can enhance soil structure and stimulate biological activity. Its high organic carbon content makes Kasgot an excellent source of organic matter for sustainably improving soil fertility (Fauzi et al., 2022).

Kasgot offers numerous benefits in plant cultivation, particularly by naturally enhancing plant growth and yield. As an organic fertilizer, Kasgot increases nutrient availability in the soil, improves soil structure, and stimulates soil microbial activity, all of which benefit plant root systems. The use of Kasgot has also been shown to promote vegetative growth, including increased plant height, leaf number, and leaf area. Furthermore, Kasgot is

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environmentally friendly, reduces dependence on chemical fertilizers, and supports organic and sustainable farming practices (Kare et al., 2023).

Cucumber (*Cucumis sativus* L.) is a horticultural commodity with high economic value and is widely cultivated in Indonesia. This plant requires fertile soil with a neutral pH and sufficient nutrient content to support its growth. Therefore, applying fertilizers that can improve soil chemical properties is crucial for increasing cucumber productivity (Mading et al., 2021). According to Purnomo et al. (2013), a real effect is observed due to the combination of organic and inorganic fertilizers on the growth and yield of cucumber plants. The treatment of ½N ½P ½K fertilizer + cow urine fertilizer, with 1 litre of water per plant, applied to cucumber plants, produces cucumber plants with higher fruit weight and total fruit weight than other treatments. The average fruit weight per plant is 269.70 g and the total fruit weight per plant is 3664.78 g. The R/C value and RAE value are the highest among all the treatments tested, namely the R/C value of 1.73 and RAE 125%.

Based on the background above, the researcher will conduct research on the Effect of Kasgot Fertiliser Application on the Chemical Properties of Soil Planted with *Cucumis sativus* L.. This study aims to determine the effect of providing kasgot fertilizer on the chemical properties of the soil, specifically soil pH, organic carbon content, total nitrogen (N), available phosphorus (P), and available potassium (K), in cucumber cultivation.

2. Material and Methods

2.1. Place and Time of Research

This research was conducted in Batu Tunggal Village, NA IX-X District, North Labuhanbatu Regency, with coordinates 2°8′9.600″ N and 99°41′24.000″ E, at an altitude of 53 meters above sea level. The research period will span 2 months, from January to April 2024.

2.2. Tools and materials

The tools used in this study included a soil drill to collect soil samples from polybag planting media, a digital scale to weigh the soil and Kasgot fertilizer precisely, and a soil sieve to filter the samples according to analysis standards. Additionally, a pH meter was used to measure soil acidity, and a moisture meter was used to determine the water content in the soil. Standard laboratory equipment was also used for chemical analysis of the soil. The materials used included Kasgot fertilizer (BSF larval excrement) with different doses, mineral soil planting media, and superior cucumber variety seeds planted in polybags. Chemical reagent solutions were used for laboratory analysis of soil chemical properties.

2.3. Research methods

Soil sampling was conducted using the propositional sampling method, where sample points were selected based on the presence of soil that represents the cucumber cultivation area. Each sample point was randomly selected in the treatment (with matting) and control (without matting) areas to ensure a good representation of variations in soil conditions. The experimental units consisted of control (0 grams/planting hole), 5 grams/planting hole, 10 grams/planting hole, 20 grams/planting hole, with observations made without treatment, as well as for the first and second treatments.

2.4. Research Implementation

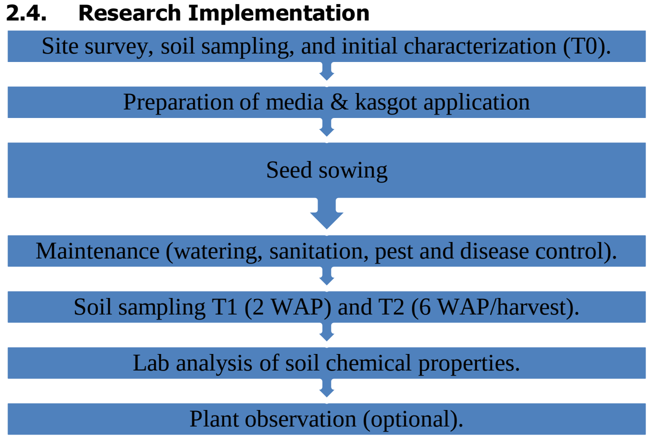

Figure 1. Research flow diagram

2.5. Observation Parameters

The soil chemical parameters observed in this study included soil pH, organic carbon (C), total nitrogen (N), available phosphorus (P), and available potassium (K). Soil pH measurements were performed using a pH meter to determine the level of acidity or alkalinity of the soil due to the kasgot treatment. Organic C content was analyzed using the Walkley-Black method as an indicator of soil fertility. Total nitrogen (total N) was measured using the Kjeldahl method to determine nitrogen availability for plants. Phosphorus availability (available P) was analyzed using the Bray I method, while potassium (available K) was measured using the Systronics Flame Photometer 128 method. To assess the amount of potassium available in the soil.

2.6. Data analysis

Laboratory data were analyzed descriptively by comparing soil chemical parameter values between the Kasgot fertilizer treatments. Average data from each treatment were presented in a criteria table based on the Chemical Analysis of Soil, Plants, Water, and Fertiliser (Suparto, 2005).

3. Results and Discussion

3.1. Germination Power (%)

Based on observations of the analysis results in the PT Socfimdo Bangun Bandar laboratory, Tebing Tinggi

Regency, on soil samples before the application of Kasgot, are presented in Table 1 below.

Table 1. Laboratory Results of Initial Control Soil Samples for the First Application of Kasgot Fertilizer

Parameter	Results	Criteria
pH-H2O	4.96	Sour
P	0.1326	Currently
C-Organic	1.35	Enough
K	0.0712	Low-sufficient
N-Kjeldahl	0.2532	currently

Description based on criteria according to Sulaeman and Suparto (2005)

Based on the analysis of soil chemical properties, it was found that the soil had a pH of 4.96, which is classified as acidic, potentially inhibiting the availability of specific nutrients. The phosphorus (P) content of 0.1326% is in the moderate category, while the nitrogen (N) content of 0.2532% is also moderate, which is sufficient to support early plant growth. The organic carbon content of 1.35% indicates a sufficient level to maintain soil fertility and microbial activity. However, the potassium (K) content of 0.0712% is classified as low-sufficient, indicating that additional fertilization is needed to support fruit formation and plant resilience. This condition aligns with the findings of Olatunji et al. (2015), which showed that although the organic carbon and phosphorus content were in the moderate to high category, potassium levels remained low in most soil samples, indicating a need for additional potassium fertilizer to increase fertility. In addition, Baloch et al. (2020) confirmed that soil pH that is too acidic reduces the availability of important nutrients, such as P, K, and Ca, due to the increased solubility of aluminum and iron, which bind phosphate and interfere with potassium absorption by plant roots.

3.2. Soil pH

The results of the first sample application of Kasgot fertilizer on soil pH parameters are presented in Table 2.

Table 2. Laboratory Results of Soil pH in the First Application of Kasgot Fertilizer Samples

Sample	Results	Criteria
Control	4.96	Sour
5 Grams/Planting Hole	5.02	Sour
10 Grams/Planting Hole	5.06	Sour
20 Grams/Planting Hole	4.89	Sour (more sour)

All treatments showed acidic soil conditions with pH values ranging from 4.89 to 5.06. The 10-gram/planting hole treatment had the highest pH (5.06), but was still in the acidic category, while the 20-gram/planting hole treatment had the lowest pH (4.89), indicating a higher acidity level compared to the other treatments. This relatively high soil acidity can impact the low availability of essential nutrients for plants, so efforts are needed to improve soil pH, such as liming or adding alkaline organic matter, to increase fertility and the efficiency of nutrient absorption by plants. This result is consistent with the findings of research by Hosna et al. (2024) in the Tista floodplain, Bangladesh, which found that lime application significantly increased soil pH and the availability of nutrients such as N, P, and K in acidic soil (initial pH <5), and improved wheat plant growth and yield by increasing fertilizer efficiency. In addition, a study of rice and canola rotation in China by Yan et al. (2019) showed that increasing soil pH through careful application of lime can increase the availability of nitrogen, phosphorus, and potassium, with a pH adjustment duration of up to around 5.0–5.6—significantly increasing element absorption and plant yields at pH levels approaching the ideal category.

The results of the second sample administration of the Kasgot administration treatment on the soil pH parameters are presented in Table 3.

Table 3. Laboratory Results of Soil pH in the Second Application of Kasgot Fertilizer Samples

Sample	Results	Criteria
Control	5.15	Sour
5 Grams/Planting Hole	5.19	Sour
10 Grams/Planting Hole	5.1	Sour
20 Grams/Planting Hole	5.23	Sour (closer to neutral)

Based on the results of pH-H2O measurements on each sample, it was found that all treatments showed acidic soil conditions, with pH values ranging from 5.10 to 5.23. The 10-gram/planting hole sample showed the highest acidity level with a pH of 5.10, while the 20-gram/planting hole sample had the highest pH at 5.23, which was closer to neutral conditions compared to the other treatments. Although all treatments remained in the acidic category, a slight increase in pH at 20 grams/planting hole indicated that the treatment had the potential to neutralize soil acidity gradually. This moderate soil acidity needs to be considered, as it can impact nutrient availability and overall plant growth. A global meta-analysis study by Liu et al. (2024) found that the application of organic amendments consistently increased total microbial biomass and soil biological productivity compared to single chemical fertilizers, especially in land with low organic carbon levels at the beginning of the test. In addition, a long-term study by Yu et al. (2019) showed that organic fertilizer treatment in a greenhouse system for 16 years resulted in significant increases in Soc, Doc, and Mbc, as well as improving soil aggregation and microbial activity at each aggregate size, thereby increasing organic matter stability and overall fertility.

3.3. C Organic

The sample results for the first application of Kasgot fertilizer on the Organic C parameter are presented in Table 4.

Table 4. Organic C Laboratory Results in the First Application of Kasgot Fertilizer Samples

Sample	Results	Criteria
Control	0.77	Low
5 Grams/Planting Hole	1.74	High enough
10 Grams/Planting Hole	1.52	Enough
20 Grams/Planting Hole	0.73	Low

Based on the analysis of soil organic C content, the 5-gram/planting hole and 10-gram/planting hole treatments showed a reasonably good increase in organic matter content, respectively by 1.74% (fair-high) and 1.52% (sufficient). This finding suggests that the treatment can enhance soil quality by increasing organic matter. In contrast, the control treatment (control) and 20 grams per planting hole still showed low Organic C levels, namely 0.77% and 0.73%, which did not support soil microbial activity and nutrient availability. Adequate Organic carbon content is essential to support soil fertility and plant productivity. Studies on barren land, with the application of organic/biochar amendments, have shown an increase in soil organic carbon content of up to 46%, while significantly improving microbial activity and soil health (Hasibuan, 2015). Furthermore, research on alpine meadows has found that the addition of organic amendments increases organic carbon and soil microbial biomass through the formation of better soil aggregates, which contributes to long-term carbon storage (Wang, 2024). The results of the two kasgot fertilizer applications on organic carbon parameters are presented in Table 5.

Table 5. Organic C Laboratory Results for the Second Application of Kasgot Fertilizer Samples

Sample	Results	Criteria
Control	1.58	High enough
5 Grams/Planting Hole	0.71	Low
10 Grams/Planting Hole	1.17	Enough
20 Grams/Planting Hole	1.1	Enough

The results of the organic C content analysis showed that the control treatment had the highest value of 1.58%, which was categorized as quite high. This result was followed by 10 grams/planting hole (1.17%) and 20 grams/planting hole (1.10%), which were categorized as sufficient. Meanwhile, the 5-gram/planting hole treatment showed the lowest value of 0.71% and was categorized as low. A sufficiently high organic carbon content plays a crucial role in enhancing soil fertility, cation exchange capacity, and microbial activity. Therefore, the control treatments, 10 grams/planting hole and 20 grams/planting hole, were considered more effective in improving soil chemical properties than the 5-gram/planting hole treatment. Based on the comparison of the initial results, the first treatment, and the latest results, significant changes were seen in the soil organic C content in each treatment. In the first treatment, 5 grams/planting hole and 10 grams/planting hole showed a good increase in organic c content compared to the initial control (1.35%), with values of 1.74% and 1.52%, respectively, while the control and 20 grams/planting hole were low (0.77% and 0.73%). However, in the latest results, there was a shift, where the control showed a significant increase of up to 1.58% (fair-high category), followed by 10 grams/planting hole (1.17%) and 20 grams/planting hole (1.10%) which were in the sufficient category, while 5 grams/planting hole experienced a sharp decrease to 0.71% (low category). These changes indicate that the effectiveness of kasgot in increasing soil organic c content can vary depending on the application time and decomposition process, and that the control, 10 grams/planting hole, and 20 grams/planting hole treatments are currently better at improving soil chemical properties compared to the initial conditions, while the effectiveness of 5 grams/planting hole tends to decrease over time.

3.4. N-Kjeldahl

The results of the second sample study on the treatment of providing Kasgot fertilizer on the N-Kjeldahl parameters are presented in Table 6.

Based on the analysis of total nitrogen content (N kjeldahl), the 5-gram/planting hole treatment showed the highest value of 0.199%, categorized as medium, indicating the effectiveness of the treatment in increasing nitrogen availability. The 10-gram/planting hole treatment was also categorized as medium, with a content of 0.1718%, while the control had a content of 0.1468%, which was on the border between low and medium. Meanwhile, the 20-gram/planting hole treatment showed the lowest nitrogen content of 0.1273% and was categorized as low. Nitrogen is an important element in plant vegetative growth, so treatments that increase nitrogen content can have a positive impact on plant productivity.

Table 6. N-Kjeldahl Laboratory Results for the First Application of Kasgot Fertilizer Samples

Sample	Results	Criteria
Control	0.1468	Low – Medium
5 Grams/Planting Hole	0.199	Medium (highest)
10 Grams/Planting Hole	0.1718	Currently
20 Grams/Planting Hole	0.1273	Low

A long-term study by Zhang et al. (2022) demonstrated that partial substitution of chemical nitrogen fertilizers with organic fertilizers significantly increased total soil nitrogen, while reducing acidity—especially in acidic soils—which in turn supported corn plant growth and enhanced N use efficiency. In addition, research by Iyengar et al. (2023) on the integrated plant nutrient system (IPNS) that combines biochar, manure, and compost recorded an increase in NH_4^+ -N release in acidic soil, with an increase in total N content on the soil surface by 15–20%, as well as a decrease in N loss through N_2 o emissions. Then, continued with the results of the third sample on the treatment of Kasgot fertilizer on the N kjeldahl parameters presented in Table 7.

Table 7. N-Kjeldahl Laboratory Results for the Second Application of Kasgot Fertilizer Samples

Sample	Results	Criteria
Control	0.1779	Currently
5 Grams/Planting Hole	0.1304	Low
10 Grams/Planting Hole	0.1492	Medium – Low
20 Grams/Planting Hole	0.1607	Currently

The analysis of total nitrogen content (N - Kjeldahl) showed that the control treatment had the highest value of 0.1779% and was classified as medium, followed by 20 grams/planting hole (0.1607%), which was also in the medium category. The 10-gram/planting hole treatment had a content of 0.1492%, which was on the border between medium and low, while the 5-gram/planting hole treatment showed the lowest content of 0.1304% and was classified as low. Adequate nitrogen content is crucial for supporting vegetative plant growth; therefore, the control treatment and 20 grams/planting hole were considered more effective in increasing soil fertility than other treatments. This finding aligns with a review by Aytenew & Wolancho (2020), which states that the application of organic amendments can increase organic nitrogen levels by up to 90% and significantly improve the chemical and biological quality of the soil. Meanwhile, a study by Phillips et al. (2022) on a combined system of inorganic and organic fertilizers showed that the mixed approach can increase nitrogen use efficiency (NUE) by up to two-fold while reducing N losses through runoff, reinforcing the importance of a combination of organic amendments in maintaining adequate N levels in the soil.

3.5. Phosphate

The results of the second sample study on the treatment of providing kasgot fertilizer on the Phosphate parameter are presented in Table 8.

Table 8. Phosphate Laboratory Results for the First Application of Kasgot Fertilizer Samples

Sample	Results	Criteria
Control	0.1122	Currently
5 Grams/Planting Hole	0.1175	Currently
10 Grams/Planting Hole	0.1227	Moderate–Sufficient
20 Grams/Planting Hole	0.128	Enough

Based on the results of the phosphorus (P) content analysis, all treatments showed values in the moderate to sufficient range. The control and 5-gram/planting hole treatments each had a phosphorus content of 0.1122% and 0.1175%, respectively, which is classified as moderate. The 10-gram/planting hole treatment showed an increase with a value of 0.1227%, and is classified as moderate-sufficient. In contrast, the 20-gram/planting hole treatment had the highest content at 0.128%, and is classified as sufficient. Phosphorus is essential for root growth and flower formation, so increasing phosphorus content in the 10-gram/planting hole and 20-gram/planting hole treatments can have a positive impact on plant productivity. These results align with the findings of Chen et al. (2022), who demonstrated that the application of organic fertilizers in conjunction with inorganic fertilizers can enhance P solubility and reduce phosphate fixation in acidic soils by increasing microbial activity and phosphorus-degrading enzymes. In addition, a study by Zhao et al. (2025) revealed that the addition of straw biochar to acidic red soil significantly increased the abundance of readily available phosphorus (P) fractions, as well as enhanced the activity of alkaline phosphatase and P-storing microbes, supporting the improvement of P fertility in low-phosphorus soil conditions. Then, the results of the third sample, which was administered with Kasgot fertilizer, on the Phosphate parameter are presented in Table 9.

Table 9. Phosphate Laboratory Results for the Second Application of Kasgot Fertilizer Samples

Sample	Results	Criteria
Control	0.1902	Enough
5 Grams/Planting Hole	0.2907	Tall
10 Grams/Planting Hole	0.1975	Enough
20 Grams/Planting Hole	0.1519	Moderate – Sufficient

The analysis of phosphorus (P) content revealed that the 5-gram/planting hole treatment had the highest value of 0.2907%, categorized as high, indicating the treatment's effectiveness in increasing phosphorus availability in the soil. The control and 10-gram/planting hole treatments each had a content of 0.1902% and 0.1975%, respectively, which is considered sufficient to support plant growth. Meanwhile, the 20-gram/planting hole treatment showed the lowest value of 0.1519% and was categorized as moderate to sufficient. Phosphorus plays a crucial role in root and flower formation, so the high content in the 5 grams per planting hole treatment provides greater potential for increasing plant growth and productivity. These results align with previous research by Chen et al. (2022), which found that combining organic fertilizers with inorganic fertilizers can enhance phosphorus availability by stimulating microbial activity and dissolving fixed phosphorus compounds. Research by Zhao et al. (2025) also showed that the addition of biochar increases the available phosphorus fraction and supports the activity of P-supplying microbes in acidic soils. In addition, research by Jiao et al. (2021) reported that the combination of organic and biological fertilizers enhances the effectiveness of phosphate fertilizers by increasing the activity of soil phosphatase enzymes and lowering the local pH around the roots, thereby facilitating the more efficient absorption of phosphorus by plants.

3.6. Potassium

The results of the second sample study on the treatment of providing Kasgot fertilizer, focusing on the potassium parameter, are presented in Table 10.

Table 10. Potassium Laboratory Results in the First Application of Kasgot Fertilizer Samples

Sample	Results	Criteria
Control	0.0737	Enough
5 Grams/Planting Hole	0.0526	Low–Fair
10 Grams/Planting Hole	0.0337	Low
20 Grams/Planting Hole	0.0508	Low–Fair

Based on the results of the potassium (K) content analysis, the control treatment showed the highest value of 0.0737%, which was categorized as sufficient, indicating that it sufficiently supported the plant's potassium needs. The 5-gram/planting hole and 20-gram/planting hole treatments each had values of 0.0526% and 0.0508%, respectively, which were categorized as low-sufficient, indicating limited potassium availability. Meanwhile, the 10-gram/planting hole treatment had the lowest content of 0.0337% and was categorized as low, which could impact the decrease in plant physiological efficiency, such as fruit formation and stress resistance. Therefore, increasing potassium needs to be considered in low-rate treatments. These results are in line with the findings of Ghassan et al. (2021), who reported that the application of organic fertilizer consistently increased potassium availability at all stages of corn growth, primarily through the interaction of water and fertilizer—indicating that organic amendments were able to reduce K fixation and significantly increase its release. In addition, Kitagawa et al. (2023) conducted a long-term study. They found that the combination of K fertilizer and straw residue increased the supply of residual K in the soil and plant biomass yield, highlighting the importance of integrating chemical and organic fertilizers to maintain potassium levels within the optimal range. The results of the third sample on the Kasgot fertilizer treatment of potassium parameters are presented in Table 11.

Table 11. Potassium Laboratory Results in the Second Application of Kasgot Fertilizer Samples

Sample	Results	Criteria
Control	0.0522	Low – Fair
5 Grams/Planting Hole	0.0575	Enough
10 Grams/Planting Hole	0.0724	High enough
20 Grams/Planting Hole	0.0708	High enough

Based on the analysis of potassium (K) content, the treatments with 10 grams and 20 grams per planting hole exhibited the highest values, at 0.0724% and 0.0708%, respectively, which are classified as sufficient to high. This result indicates that potassium availability is adequate to support essential plant physiological processes such as fruit formation, enzyme activation, and resistance to environmental stress. The 5-gram per planting hole treatment showed a potassium content of 0.0575%, categorized as sufficient, while the control treatment had the lowest content at 0.0522%, classified as low-sufficient. Therefore, it can be concluded that the 10-gram and 20-gram per planting hole treatments were more effective in increasing soil potassium levels than the other treatments. These findings are supported by research conducted by Dinh et al. (2021), which demonstrated that organic-based fertilization can enhance potassium use efficiency and maintain sustainable soil fertility in tropical regions, particularly when combined with chemical fertilizers in an appropriate manner. Additionally, a study by Okalebo et al. (2020) reported that the application of manure and biowaste significantly increased the available potassium content and potassium uptake in corn plants grown in ultisol soils, confirming that organic inputs play a crucial role in improving soil quality and crop yields. Therefore, the use of organic materials such as compost represents an effective strategy for enhancing soil potassium status, especially within sustainable farming systems.

Figure 2. Soil Sample

4. Conclusion

Based on the analysis of phosphorus (P) and potassium (K) nutrient content, it can be concluded that the treatment of 5 grams per planting hole was the most effective in increasing phosphorus availability, reaching 0.2907%, which falls into the high category. Meanwhile, the treatments of 10 grams and 20 grams per planting hole were more effective in increasing soil potassium content, achieving 0.0724% and 0.0708%, respectively, both of which are classified within the relatively high category.

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