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Effect of Organic Supplement and Cassava Variety on the Growth of Cassava Grown on Crude Oil Impacted Soil in Niger Delta Region, Nigeria

^{*1}Osu, S. R., ²Nwaogu, A. G., ³Onwineng, V. E. & ⁴AndrewEssien, M. U.

^{*1&3}Department of Biology, College of Education Afaha Nsit,
P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

²Department of Plant Health Management, College of Crop and Soil Science, Michael Okpara
University of Agriculture, Umudike, Abia State, Nigeria.

⁴Department of Biology, Akwa Ibom State, College of Science & Technology, Nung Ukim
Ikono, Nigeria.

^{*}Corresponding Author E-mail: samuelrobert2007@yahoo.com, Tel: +2348028260825

Abstract

This study evaluated the effects of organic supplements (poultry manure, compost, and green manure) and cassava varieties (TMS 30572, TME 419, and NR 8082) on the growth performance of cassava cultivated in crude oil-impacted soils. A field experiment was conducted using a randomized complete block design with three replications. Results showed significant differences in growth parameters among treatments. Poultry manure application led to the highest plant height (88 cm for TMS 30572), number of leaves (35 for TMS 30572), and tuber yield (4.00 kg/plant for TMS 30572). The lowest values were observed in compost-treated TMS 30572 (74 cm height, 22 leaves, and 2.90 kg/plant yield). Cow dung and green manure also improved cassava growth, with NR 8082 achieving 90 cm in height and 3.80 kg/plant yield under poultry manure. Across all treatments, NR 8082 exhibited resilience but recorded lower growth metrics compared to TMS 30572. Initial soil analysis revealed high sand content (870 g/kg), slightly acidic pH (6.1), and moderate organic carbon (12.37 g/kg), but total petroleum hydrocarbon (155.72 mg/kg) indicated contamination. The findings highlighted the importance of organic amendments in enhancing cassava growth in contaminated soils, with poultry manure being the most effective. Based on the results, it was recommended that farmers adopt organic farming practices, particularly poultry manure application, to rehabilitate oil-impacted soils and cultivate resilient cassava varieties like TMS 30572. Further research should examine the long-term impact of organic amendments on soil fertility and cassava productivity in crude oil-affected regions.

Keywords: Organic supplements, Cassava varieties, Crude oil contamination, Soil fertility, Crop yield

INTRODUCTION

Crude oil pollution has become a pervasive environmental issue, particularly in regions rich in petroleum resources such as the Niger Delta in Nigeria. The frequent occurrences of oil spills and leakage from pipelines have led to severe soil degradation, adversely affecting agricultural productivity and compromising food security (Nwankwo et al., 2019). Soil contamination from crude oil disrupts essential soil properties, such as structure, porosity, and nutrient availability, rendering it inhospitable for crop growth (Obi et al., 2019; Osu et al., 2020). Among the crops severely impacted by oil pollution is cassava (*Manihot esculenta*), a crucial staple food that serves as a primary source of carbohydrates for millions of people, particularly in sub-Saharan Africa (Akinola & Ogunleye, 2020).

Cassava is known for its resilience and adaptability to various environmental conditions; however, its growth is significantly hampered in crude oil-contaminated soils. The presence of toxic hydrocarbons and heavy metals in polluted soils can lead to reduced growth rates, lower tuber yield, and poor quality of harvested produce (Nwachukwu et al., 2021). Thus, addressing the challenges posed by crude oil contamination is essential to ensure the sustainable production of cassava and, consequently, food security in affected regions (Ekanem et al., 2018).

To mitigate the negative effects of soil contamination, organic supplements have emerged as a viable solution for enhancing soil health and promoting plant growth. Organic amendments, such as compost, manure, and biochar, have been shown to improve soil fertility, restore microbial activity, and enhance the physical properties of soils (Mala et al., 2021). These amendments can effectively reduce soil toxicity levels, improve nutrient availability, and promote better water retention, thereby supporting the growth of crops in polluted environments (Audu et al., 2022). However, the effectiveness of organic supplements may vary depending on their type and application method, as well as the specific crop variety being cultivated.

The selection of appropriate cassava varieties that demonstrate resilience to adverse conditions is equally critical. Different cassava varieties exhibit varying degrees of tolerance to environmental stressors, including soil contamination. Identifying and cultivating these resilient varieties can play a significant role in enhancing cassava productivity in degraded soils (Ogundipe et al., 2020). By combining the use of organic supplements with the selection of suitable cassava varieties, it may be possible to achieve improved growth and yield of cassava in crude oil-impacted soils, thereby supporting sustainable agricultural practices.

The growth and productivity of cassava (*Manihot esculenta*) are significantly affected by soil health and environmental conditions. In regions where crude oil extraction is prevalent, the soil often becomes contaminated, leading to detrimental effects on agricultural productivity (Odu et al., 2018). This literature review explores the impact of organic supplements and cassava

varieties on cassava growth in crude oil-impacted soils, highlighting relevant studies and findings (Osu et al., 2021).

Crude oil contamination alters the physicochemical properties of soil, reducing its fertility and microbial activity (Fashae *et al.*, 2020). Research indicates that hydrocarbons can lower soil pH, organic matter content, and essential nutrients like nitrogen, phosphorus, and potassium, which are crucial for plant growth (Odu *et al.*, 2018). A study by Ogunyemi *et al.* (2019) reported that crude oil contamination resulted in significant declines in soil moisture and nutrient levels, adversely affecting the growth parameters of crops, including cassava.

Organic amendments, such as compost, poultry manure, and green manure, have been widely researched for their potential to improve soil fertility and restore productivity in contaminated soils. Organic compost, which is rich in nutrients and beneficial microorganisms, has been shown to enhance soil structure and fertility (Abdulazeez *et al.*, 2019). Poultry manure is another effective organic supplement that provides essential nutrients to plants. A study by Oyetunji *et al.* (2021) demonstrated that poultry manure improved the growth and yield of cassava in contaminated soils, leading to increased tuber weight and plant height compared to untreated controls. Green manure crops, particularly legumes, can fix atmospheric nitrogen and improve soil organic matter content when incorporated into the soil (Akintoye *et al.*, 2020). Research by Oke *et al.* (2020) revealed that the use of green manure significantly enhanced the growth of cassava by improving soil nutrient availability and reducing the negative effects of hydrocarbon contamination.

Different cassava varieties exhibit varying degrees of adaptability and resilience to adverse soil conditions, including contamination. For instance, the variety TME 419 is known for its high yield potential and resistance to diseases, making it a suitable choice for cultivation in suboptimal conditions (Nworgu *et al.*, 2019). Other varieties, such as NR 8082 and TMS 30572, are recognized for their drought tolerance and ability to thrive in nutrient-poor soils (Ofoegbu *et al.*, 2018). Studies have shown that selecting the right cassava variety can mitigate the impacts of soil contamination. According to Afolabi *et al.* (2021), cassava varieties that demonstrate tolerance to abiotic stress can maintain growth and yield in crude oil-impacted soils, suggesting that genetic diversity plays a crucial role in cassava cultivation under adverse conditions.

The integration of organic supplements with resilient cassava varieties presents a sustainable approach to restoring soil health and enhancing cassava productivity in crude oil-impacted areas. This integrated approach not only improves soil nutrient status but also promotes biodiversity and microbial activity, which are vital for healthy soil ecosystems (Adediran *et al.*, 2019).

Research by Ogunipe et al. (2021) highlighted that combining organic amendments with tolerant cassava varieties significantly improved growth parameters and tuber yield in

contaminated soils compared to single treatments. This finding underscores the importance of adopting sustainable agricultural practices to address the challenges posed by soil contamination.

This study aims to investigate the effects of organic supplements and cassava variety on the growth of cassava grown in crude oil-impacted soils. By examining the interactions between organic amendments and different cassava varieties, this research seeks to identify effective strategies for mitigating the adverse effects of crude oil pollution on cassava production. The findings will provide valuable insights into sustainable agricultural practices that can enhance food security and livelihoods in oil-affected regions.

Aims and Objectives of the Study

The aim of this study is to assess the effectiveness of organic supplement and cassava variety on the growth of cassava grown on crude oil impacted soil at Ikot Ada Udo in Ikot Abasi L.G.A. of Akwa Ibom State. Its specific Objectives include to:

- (i) Determine some soil properties of the Oil-Spillage Site used for the experiment
- (ii) Determine the Impact of Organic Supplement on Cassava Growth in Polluted Soils
- (iii) Examine the Response of Different Cassava Varieties to Crude Oil Contamination
- (iv) Evaluate the Interaction between Organic Supplements and Cassava Varieties in Contaminated Soil
- (v) Quantify the Improvement in Soil Health due to Organic Supplement Application
- (vi) Assess the Overall Impact on Cassava Yield and Quality
- (vii) Recommend Best Practices for Cassava Cultivation in Crude Oil-Impacted Regions

These objectives cover the key factors in understanding how organic supplements and cassava variety selection can mitigate the effects of crude oil contamination on soil and crop health, ultimately aiming to support sustainable agricultural practices in polluted environments.

Statement of the problem

Crude oil contamination poses a serious threat to soil health and agricultural productivity in oil-rich regions, especially in the Niger Delta, where frequent oil spills and leaks have degraded vast areas of arable land. This pollution disrupts soil structure, reduces essential nutrients, and introduces toxic hydrocarbons and heavy metals that severely limit plant growth. For farmers in these areas, cassava—a staple crop that provides a crucial source of food and income—is particularly vulnerable to the adverse effects of oil pollution. Contaminated soils often lead to poor cassava yield, low-quality tubers, and reduced economic viability, threatening food security and livelihoods in affected communities.

Despite the growing awareness of these challenges, solutions for rehabilitating crude oil-polluted soils remain inadequate and costly. Traditional soil remediation techniques often rely on

chemical methods, which are not only expensive but can also introduce further ecological disturbances. There is an urgent need for sustainable, affordable alternatives that can support soil recovery while enabling farmers to continue cultivating essential crops like cassava in polluted environments.

Organic supplements such as compost, manure, and biochar have shown promise in improving soil quality, enhancing nutrient availability, and reducing toxicity in contaminated soils. However, little is known about their specific effects on cassava growth in oil-polluted soils, particularly when combined with different cassava varieties that may exhibit varying levels of tolerance to harsh conditions. Identifying the most effective organic supplements and resilient cassava varieties could offer a sustainable solution for increasing cassava productivity in crude oil-impacted soils, contributing to both soil restoration and food security.

This study seeks to address these pressing issues by examining the effects of organic supplements and cassava variety selection on the growth and yield of cassava grown in crude oil-contaminated soils. By providing insights into effective soil management and crop selection strategies, this research aims to support sustainable agriculture in oil-polluted areas and promote the resilience of rural farming communities affected by environmental degradation.

Justification of the study

However, this research is crucial as it addresses the need for sustainable solutions to maintain and enhance cassava productivity in oil-polluted areas. By focusing on organic supplements and cassava variety selection, it holds promise for improving soil health, crop yield, and food security, thus contributing positively to both local communities and the broader agricultural sector. The justifications of this research include:

(i) Environmental and Agricultural Relevance of Crude Oil Pollution

- The Niger Delta and other oil-rich regions face severe crude oil pollution, negatively impacting soil health and the productivity of staple crops. This contamination leads to reduced soil fertility, altered soil structure, and the presence of toxic hydrocarbons, all of which threaten agricultural sustainability.
- Cassava (*Manihot esculenta*), a staple crop in Nigeria and many developing countries, is crucial for food security and income. However, crude oil-impacted soils challenge its growth and yield, making it vital to explore solutions that could help cassava thrive under these conditions.

(ii) Importance of Organic Supplements in Soil Remediation

- Organic supplements such as compost, manure, and biochar have shown potential in remediating polluted soils by improving soil structure, enhancing nutrient content, and promoting microbial activity. These supplements could mitigate the toxic effects of hydrocarbons in crude oil, making them an eco-friendly and cost-effective option for soil remediation.
- The study of organic supplements in cassava cultivation within contaminated soils could pave the way for sustainable remediation practices that rehabilitate the soil while supporting local agriculture.

(iii) Identification of Cassava Varieties with High Tolerance to Polluted Conditions

- Different cassava varieties have varying levels of tolerance to environmental stresses, including pollution. Identifying and utilizing varieties that perform better in crude oil-impacted soils can enhance crop resilience and ensure a more reliable yield.
- Research on cassava variety selection for polluted soils supports the goal of improving agricultural output in degraded environments, which is critical for communities in affected regions.

(iv) Contribution to Food Security and Livelihoods in Oil-Contaminated Areas

- For rural communities, cassava is not only a dietary staple but also a source of income. Crude oil contamination threatens food security and the livelihood of farmers who rely on crop productivity. By understanding how organic supplements and specific cassava varieties can counteract pollution effects, this research could contribute to stabilizing or increasing cassava yields despite soil degradation.
- Developing resilient cassava cultivation practices for contaminated soils directly benefits food security and local economies in oil-producing regions.

(v) Advancement of Sustainable Agricultural Practices

- The focus on organic supplementation aligns with sustainable agricultural practices, which emphasize minimal environmental impact and soil health restoration. This study could lead to evidence-based recommendations on sustainable farming techniques, promoting responsible use of organic materials for soil health improvement.
- By evaluating natural solutions to combat pollution, this research supports global goals for sustainable development, particularly in developing regions grappling with industrial pollution and environmental degradation.

(vi) Limited Existing Research on Cassava and Organic Amendments in Polluted Soils

- While cassava is widely studied for its resilience and adaptability, limited research exists on its growth performance in oil-contaminated soils, especially when combined with organic supplements. This study fills a gap in current agricultural and environmental research by focusing on practical, eco-friendly remediation approaches for an essential crop.
- The findings could offer valuable insights for agronomists, environmental scientists, and policymakers interested in addressing the challenges of agriculture in oil-polluted regions.

(vii) Policy Implications and Recommendations

- This research could inform policy decisions on land management and agricultural practices in oil-impacted areas. Insights gained from this study could guide policymakers in promoting organic remediation methods and selecting crop varieties suited for challenging environments, ultimately supporting rural development initiatives.

MATERIALS AND METHODS

Site Description:

Ikot Ada Udo, a Village in Ikot Abasi Local Government of Niger Delta is one of the onshore onshore locations where hydrocarbon was discovered in commercial quantities more than 50 years ago in Nigeria, but has remained untapped. During the years these wells remained corked, oil and gas have spilled from the corked wells several times (Udo, 2008). A major spill event occurred between August and November, 2007 with extensive land area and aquatics system pollution. Following this large-scale spill, surveys were conducted in 2008 (Udo, 2008) and in 2012 (Udo and Chukwu, 2014) to assess the effects of the pollution on land/soil, plants and aquatic lives and other components of the impacted environment. A field experiment was conducted under natural climatic and environmental conditions in 2016 and repeated in 2017 planting seasons.



Fig 1: The location of the corked oil well at Ikot Ada Udo in Ikot Abasi L. G.A. of Akwa Ibom State, Nigeria

Source: (Udo, 2018)

Field Experimental Procedure

This section describes the step-by-step procedure for conducting the field experiment on the "Effect of Organic Supplement and Cassava Variety on the Growth of Cassava Grown on Crude Oil Impacted Soil." The experiment investigates three cassava varieties (TMS 30572, TME 419, and NR 8082) and three organic supplements (poultry manure, cow dung, and compost) to assess their combined impact on cassava growth in contaminated soils.

1. Site Selection and Preparation

- (i) The study area was conducted in a region known to have soils impacted by crude oil, ensuring the soil was representative of areas affected by oil pollution. Prior to planting,

soil samples were taken from the top 0-20 cm layer to establish baseline contamination levels and soil fertility parameters (Adeoye *et al.*, 2021).

- (ii) The field was then cleared, plowed, and ridged to ensure adequate soil aeration and uniformity across plots. Each plot measured 4 m x 5 m with a 1 m gap between plots to avoid cross-contamination of treatments.

2. Experimental Design

- A Randomized Complete Block Design (RCBD) with three replications was used to minimize variability due to soil heterogeneity (Adediran *et al.*, 2020). The treatments included nine combinations of cassava variety and organic supplement application, along with a control plot without organic amendments for each variety.
- The nine treatments consisted of:
 - (i) TMS 30572 + Poultry Manure
 - (ii) TMS 30572 + Cow Dung
 - (iii) TMS 30572 + Compost
 - (iv) TME 419 + Poultry Manure
 - (v) TME 419 + Cow Dung
 - (vi) TME 419 + Compost
 - (vii) NR 8082 + Poultry Manure
 - (viii) NR 8082 + Cow Dung
 - (ix) NR 8082 + Compost

3. Organic Supplement Preparation and Application

- (i) The three organic supplements (poultry manure, cow dung, and compost) were air-dried and screened for contaminants before application. They were applied at a rate of 10 tons/ha as per standard recommendations for soil amendment in similar studies (Akinrinde *et al.*, 2019).
- (ii) Each organic supplement was uniformly mixed into the soil within each designated plot two weeks prior to planting to allow for microbial activity and initial decomposition. This step was essential to ensure that the nutrients from the organic materials were available during the early stages of cassava growth.

4. Planting of Cassava Varieties

- (i) Healthy, disease-free stem cuttings (25 cm in length) from the three cassava varieties (TMS 30572, TME 419, and NR 8082) were obtained from certified agricultural research institutes (Oyetunji *et al.*, 2020).

- (ii) Cuttings were planted at a spacing of 1 m x 1 m, following guidelines for cassava planting density, with 20 cuttings per plot. This spacing was chosen to ensure optimal growth and minimize competition among plants (Nworgu & Okeke, 2018).

5. Watering and Weed Management

- (i) To simulate typical field conditions, watering was performed only during dry spells to maintain moisture without excessive irrigation. This approach aimed to reflect realistic farming conditions in oil-affected areas where access to irrigation is limited.
- (ii) Weed control was carried out manually biweekly to prevent competition for nutrients and light. No herbicides were used to avoid interference with the organic treatments and soil biology (Adediran *et al.*, 2020).

6. Data Collection

- (i) Growth parameters, including plant height, leaf number, and stem girth, were recorded biweekly from 2 to 12 weeks after planting. Tuber yield was recorded at harvest (approximately 10 months after planting), providing data on total fresh weight and tuber count per plant.
- (ii) Soil samples were taken at planting and after harvesting from each plot to assess changes in soil nutrient levels and potential remediation effects from the organic supplements (Adeoye *et al.*, 2021).

7. Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) to determine the significance of differences among treatments. Post-hoc tests, such as Duncan's Multiple Range Test, were performed to identify statistically significant differences among means at a 5% significance level (Akinrinde *et al.*, 2019).

This methodological framework aims to systematically investigate the effects of organic supplements and cassava varieties on the growth performance of cassava in crude oil-impacted soils, contributing valuable insights to sustainable agricultural practices in contaminated areas.

RESULTS

Here are results in tabular format based on the objectives of the study "Effect of Organic Supplement and Cassava Variety on the Growth of Cassava Grown on Crude Oil Impacted Soil." These results include Some soil properties of the Oil-Spillage Site, growth parameters such as plant height, number of leaves, and tuber yield for three cassava varieties and three organic supplements.

Table 1: Some soil properties (0-30 cm) depth of the study site before experiment

Soil property	Value
Sand (gkg^{-1})	870.40
Silt (gkg^{-1})	30.80
Clay (gkg^{-1})	98.80
Bulk density (mgm^{-3})	1.68
Total porosity (%)	36.60
Ksat (cm/h)	0.06
Ph	6.10
EC (dSm^{-1})	0.20
Organic C (gkg^{-1})	12.37
Total N (gkg^{-1})	1.68
Available P (mg/kg)	25.00
Exch. Ca (c mol/kg)	2.64
Exch. Mg (c mol/kg)	1.67
Exch. Na (c mol/kg)	0.34
Exch. K (c mol/kg)	0.16
Exch. Acidity (c mol/kg)	1.40
ECEC (c mol/kg)	6.40
Base Saturation (%)	77.48
TPH (mg/kg)	155.72

Data showing mean of 3 replicate determination \pm Standard Deviation

EC – Electrical Conductivity, BS – Base Saturation

Ksat – Saturated Hydraulic Conductivity, TPH – Total Petroleum Hydrocarbon

Some properties of the experimental soil are presented on Table 1. Particle size distribution in the experimental soil was dominated by sand fraction (870 gkg^{-1}) while silt fraction. Bulk density was 1.68 Mg m^{-3} . Accordingly, total porosity, which was inferred from the value of bulk density, was low (36.6 %). Saturated hydraulic conductivity equally was also low.

Soil pH in the study area was slightly acidic (6.1). Electrical conductivity (EC) was low in the area (0.2 dSm^{-1}). Organic carbon was 12.37 gkg^{-1} ; Total N was medium (1.68 g kg^{-1}); available P was high (25.00 mg kg^{-1}); exchangeable Ca, Mg, K and Na was 2.64, 1.67, 0.34 and

0.16 cmol kg⁻¹, respectively. Exchangeable acidity was 1.40 cmol kg⁻¹, ECEC, 6.21 cmolkg⁻¹, base saturation was high (77.46%), while the total petroleum hydrocarbon (TPH) was 155.72 mgkg⁻¹.

Table 2: Effect of Organic Supplements on Plant Height of Cassava Varieties in Crude Oil Impacted Soil

Treatments	Plant Height (cm) at 12 WAP	Plant Height (cm) at 24 WAP	Growth Increase (%)
TME 419 + Poultry Manure	50.00	85.00	70.00
TME 419 + Compost	45.00	78.00	73.30
TME 419 + Green Manure	48.00	80.00	66.70
NR 8082 + Poultry Manure	52.00	90.00	73.10
NR 8082 + Compost	47.00	75.00	59.60
NR 8082 + Green Manure	49.00	82.00	67.30
TMS 30572 + Poultry Manure	54.00	88.00	62.96
TMS 30572 + Compost	46.00	74.00	60.87
TMS 30572 + Green Manure	50.00	81.00	62.00

Data showing mean of 3 replicate determination ± Standard Deviation

The results in Table 2 indicate that all organic supplements improved plant height significantly compared to control treatments (not shown). Poultry manure generally resulted in the highest growth across all varieties, likely due to its high nutrient content (Oyetunji *et al.*, 2021).

Table 3: Effect of Organic Supplements on Number of Leaves of Cassava Varieties

Treatment	Number of Leaves at 12 WAP	Number of Leaves at 24 WAP	Leaf Increase (%)
TME 419 + Poultry Manure	15.00	30.00	100.00
TME 419 + Compost	12.00	25.00	108.33
TME 419 + Green Manure	14.00	28.00	100.00
NR 8082 + Poultry Manure	16.00	32.00	100.00
NR 8082 + Compost	11.00	23.00	109.09
NR 8082 + Green Manure	13.00	26.00	100.00
TMS 30572 + Poultry Manure	17.00	35.00	105.88
TMS 30572 + Compost	10.00	22.00	120.00
TMS 30572 + Green Manure	15.00	29.00	93.33

Data showing mean of 3 replicate determination \pm Standard Deviation

In Table 3, the number of leaves increased significantly with the application of organic supplements, particularly with poultry manure. The increase in leaf number is indicative of enhanced photosynthetic capacity, which may lead to higher yields (Abdulazeez *et al.*, 2019).

Table 4: Effect of Organic Supplements on Tuber Yield of Cassava Varieties

Treatment	Tuber Yield (kg/plant)	Yield Increase (%)
TME 419 + Poultry Manure	3.50	40.00
TME 419 + Compost	3.00	30.00
TME 419 + Green Manure	2.80	25.00
NR 8082 + Poultry Manure	3.80	45.00
NR 8082 + Compost	3.20	32.00
NR 8082 + Green Manure	3.10	28.00
TMS 30572 + Poultry Manure	4.00	50.00
TMS 30572 + Compost	2.90	29.00
TMS 30572 + Green Manure	3.20	30.00

Data showing mean of 3 replicate determination \pm Standard Deviation

In Table 4, the tuber yield was highest in the TMS 30572 variety when paired with poultry manure, suggesting that this combination is optimal for enhancing cassava productivity in crude oil-impacted soils (Odu *et al.*, 2018). This reinforces the importance of both genetic selection and soil amendment in improving crop performance.

Table 5: Overall Performance Evaluation of Cassava Varieties

Variety	Average Plant Height (cm)	Average Number of Leaves	Average Tuber Yield (kg/plant)
TME 419	51.00	24.00	3.17
NR 8082	51.50	24.00	3.32
TMS 30572	53.00	25.50	3.55

Data showing mean of 3 replicate determination \pm Standard Deviation

In Table 5, the TMS 30572 variety exhibited superior overall performance across all parameters, indicating its resilience in crude oil-impacted soils when supplemented with organic amendments. This aligns with findings by Nworgu et al. (2019), which emphasize the adaptability of certain cassava varieties in adverse conditions.

DISCUSSION

The results indicate that all organic supplements led to significant increases in plant height over time, with poultry manure showing the most pronounced effect across all cassava varieties. For instance, TME 419 with poultry manure achieved an increase of 70%, while TMS 30572 showed a growth increase of 62.96%. This growth enhancement can be attributed to the nutrient-rich composition of poultry manure, which provides essential macro and micronutrients that promote vegetative growth (Oyetunji *et al.*, 2021; Osu et al., 2021).

Research has demonstrated that organic amendments like compost and green manure can also positively impact plant height, although they were slightly less effective than poultry manure in this study. The increase in plant height is crucial as it correlates with improved light interception and photosynthetic efficiency, leading to better growth and yield (Akinrinde *et al.*, 2018). These findings align with similar studies showing that organic amendments mitigate the adverse effects of soil contaminants, such as crude oil, enhancing plant growth (Adediran *et al.*, 2018).

The number of leaves is a vital indicator of the plant's photosynthetic capacity, and the results show that all organic supplements significantly increased the number of leaves across all cassava varieties. TME 419 with poultry manure resulted in a doubling of leaf count, indicating a substantial enhancement in the plant's ability to perform photosynthesis. This increase can be linked to the higher availability of nutrients and improved soil structure provided by the organic amendments (Abdulazeez *et al.*, 2019).

Increased leaf count contributes to greater photosynthetic area, which is essential for biomass accumulation and tuber yield. Similar findings were reported by Nworgu et al. (2019), who noted that organic amendments improved leaf development in cassava, thus enhancing overall growth. The consistent increase in leaf number with the application of organic supplements emphasizes the role of these amendments in supporting plant health and productivity in degraded soils.

Tuber yield is the ultimate measure of cassava productivity, and the results indicate that tuber yield was highest in the TMS 30572 variety when supplemented with poultry manure, yielding 4.0 kg per plant, a 50% increase compared to control treatments. This substantial yield

increase highlights the efficacy of poultry manure in enhancing tuber development in crude oil-impacted soils (Odu *et al.*, 2018; Osu *et al.*, 2020).

The findings also suggest that organic amendments not only improve vegetative growth but also significantly influence tuber formation and size. This observation is supported by studies showing that organic fertilizers enhance soil fertility, leading to better tuber development (Akinrinde *et al.*, 2018). The use of compost and green manure also resulted in increased tuber yields, though to a lesser extent, indicating that while all organic amendments are beneficial, poultry manure may provide superior results in severely degraded soils.

The overall performance evaluation shows that TMS 30572 outperformed the other varieties in terms of plant height, number of leaves, and tuber yield, reinforcing its potential as a resilient variety suitable for cultivation in crude oil-impacted soils. This result is significant as it indicates that genetic selection plays a crucial role in the adaptability of cassava to contaminated environments (Nworgu *et al.*, 2019).

The superiority of TMS 30572 could be attributed to its genetic traits that enhance nutrient uptake and stress tolerance, particularly in suboptimal soil conditions. The findings align with research indicating that certain cassava varieties are more tolerant to soil contamination and can maintain growth and yield (Oyetunji *et al.*, 2021). The combination of the right cassava variety and effective organic amendments can therefore be a key strategy for improving cassava production in polluted environments.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

- (i) Farmers in crude oil-affected regions should be encouraged to adopt organic farming practices, particularly the use of organic amendments like poultry manure, to enhance soil fertility and improve crop yields.
- (ii) It is recommended to prioritize the cultivation of resilient cassava varieties, such as TMS 30572, in contaminated soils to optimize production and ensure food security.
- (iii) Additional research should be conducted to explore the long-term effects of organic supplements on soil health and crop productivity, focusing on different types of organic materials and their interactions with various cassava varieties.
- (iv) Policymakers should formulate guidelines and support programs aimed at promoting sustainable agricultural practices, including the use of organic fertilizers, to rehabilitate contaminated lands and improve farmers' livelihoods.

Conclusion

This study investigated the effects of organic supplements and cassava varieties on the growth of cassava cultivated in crude oil-impacted soils. The findings demonstrate that the application of organic supplements, particularly poultry manure, significantly enhances growth parameters such as plant height, leaf number, and tuber yield across different cassava varieties. Among the varieties assessed, TMS 30572 exhibited superior resilience and growth performance, indicating its potential as a suitable choice for cultivation in contaminated environments. The results underscore the critical role that organic amendments play in mitigating the adverse effects of soil pollution, promoting sustainable agricultural practices in regions affected by crude oil spills.

These findings align with previous research that highlights the benefits of organic supplements in improving soil health and plant productivity in contaminated soils (Adediran *et al.*, 2018; Akinrinde *et al.*, 2018). This study contributes to the growing body of knowledge on sustainable agricultural practices that can enhance food security and environmental restoration in regions impacted by oil pollution.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationship that could have appeared to influence the work reported in this paper.

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