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COMPARATIVE EFFECTS OF PIG SLURRY AND OIL-PALM BUNCH ASH ON SOIL ACIDIFICATION ON TOMATO PLOTS IN OKITIPUPA, SOUTHWEST, NIGERIA.

[*1]Olojugba, M. R., [2]Olajide, A. A. and [3]Adegbola, A.

[1&3]Department of Crop, Soil and Pest Management, Olusegun Agagu University of Science and Technology, Okitipupa, Nigeria.
[2]Caleb University, Imota Lagos, Nigeria
Corresponding Author's Email: mr.olojugba@oaustech.edu.ng
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Abstract

The experiment's goal was to lower the soil's acidity by utilizing oil palm bunch ash and pig slurry in combination. At Olusegun Agagu University of Science and Technology's Teaching and Research Farm screen house in a completely randomized design (CRD) experiment.

Pig slurry and oil palm bunch were added at recommended quantities and rates of 0 g/kg, 500 g/kg, and 1000 g/kg. Nine distinct treatments were developed, along with a control, and each was replicated thrice. Before applying, soil samples from the experimental plots were taken after a 37-day incubation period, and they were examined in a laboratory to assess several indicators of soil fertility. These comprised calcium, magnesium, potassium (K), accessible phosphorus (P), total nitrogen (TN), pH, organic matter content (OM), and cation exchange capacity (CEC). Compared to the control, the experimental results showed a significant difference in the soil fertility indicators due to the addition of organic amendments. The addition of the amendments changed the pH of the soil and increased the concentrations of EC, CEC, Mg, Ca, Na, OM, N, P, and K, all of which indicate increased soil fertility. The results provide credence to the theory that adding these organic amendments to agricultural soils can help with sustainable soil management techniques. More investigation and long-term field-scale trials are necessary to confirm the observed effects and determine the implications of organic amendments on soil health and crop yield under actual agricultural conditions.

Keywords: Soil acidity, Pig slurry, Oil palm bunch ash, Organic matter, Nitrogen, pH, Soil fertility.

Introduction

In many parts of the world, agricultural production is essential to maintaining food security and sustainable development. According to Akintoye *et al.* (2014), agriculture is a major economic driver in sub-Saharan Africa, particularly Nigeria, where it creates jobs and boosts GDP. However, soil fertility and environmental sustainability have suffered as a result of the ongoing usage of traditional synthetic fertilizers (Ojo and Togun, 2017). It is crucial to look into sustainable and alternative ways to increase crop productivity and soil fertility.

Researchers and farmers have been investigating alternate techniques to increase crop output and improve soil fertility in recent years. Applying organic amendments, which are plentiful in Southwestern Nigeria and include pig slurry and oil palm bunch ash

(OPBA), is one method that shows promise to increase crop production and improve soil fertility. In addition to offering vital nutrients, these organic materials help improve the general health of the soil, which promotes better plant growth and higher yields (Amusan and Ipinmoroti, 2017, Fajinmi et al., 2018). A byproduct of the palm oil industry, oil palm bunch ash (OPBA) is high in potassium, phosphorus, calcium, and magnesium, among other important minerals. According to studies, adding OPBA to the soil can improve its structure, increase its ability to store water, and boost the availability of nutrients (Olufayo *et al.,* 2019). Moreover, OPBA's alkaline qualities can aid in reducing soil acidity, a prevalent issue in many agricultural regions. Pig slurry, on the other hand, is an organic fertilizer made of urine and manure that is rich in nutrients. Along with other micronutrients, it has notable concentrations of potassium, phosphorus, and nitrogen. Pig slurry is applied to the soil to increase organic matter content, stimulate microbial activity, and improve soil fertility (Oyedele *et al.*, 2017). Pig slurry also functions as a soil conditioner, enhancing water infiltration and soil structure.

The purpose of the study is to find out how pig slurry and oil palm bunch ash affect soil fertility in southwest Nigeria. Given that it is one of the primary crop-growing regions in Nigeria, the selection of the southwest is noteworthy (Popoola *et al.*, 2015). Through assessing the effects of these organic amendments on fertility, nutrient availability, and soil qualities, this study seeks to offer important insights into sustainable farming methods that nearby farmers might implement.

Materials and Methods

At Olusegun Agagu University of Science and Technology, Okitipupa, the incubation phase was conducted in the screen house of the Department of Crop, Soil, and Pest Management. The Department of Crop, Soil, and Pest Management Research Laboratory at Olusegun Agagu University of Science and Technology, Okitipupa, is where the soil analysis was done. Latitude: 6.45358°N, and longitude: 4.77279°E are the coordinates for the Okitipupa. The region is known for its tropical environment, which has distinct rainy and dry seasons. There are two distinct peak rainfall periods in the region's bimodal rainfall pattern each year. April through July is usually the first wet season, with June seeing the most rainfall.

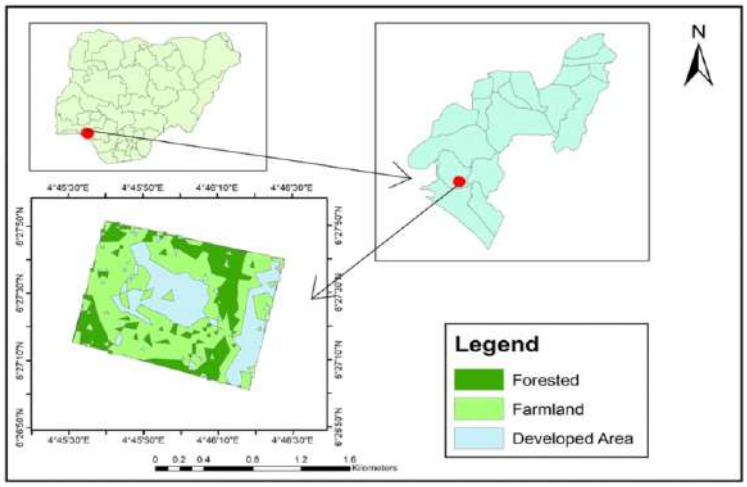

Fig. 1. Map of Study Area

Soil sample collection and site

Core samplers were used in the field to collect soil samples at a depth of 0 to 15 cm. The samples were then transported in plastic bags to the laboratory at the Olusegun Agagu University of Science and Technology, Okitipupa.

Experiment Design

The screen house experiment comprised nine (9) treatments with three replications per treatment (27 samples), arranged as a 3×3 factorial design using a completely randomized design (CRD). The treatments are as follows: pig slurry (PS), oil palm bunch ash (OPB) amendment in three levels (added at 0, 500, and 1000 g.kg-1), and a control (no organic amendment). Water was applied at intervals of five (5) days using 50 cc of water. For twelve weeks the samples were incubated and planted with tomato seedlings in the screen house. During this time, crop yield parameters were recorded, the soil was air-dried, and the samples were sent for laboratory analysis.

Results

Table 1: Physical and Chemical Properties of Experimental Soil

SOIL PROPERTIES	Soil test value (mean + standard deviation)
Sand (%)	40.50±0.70 [a]
Clay (%)	39.50±0.70 [b]
Silt (%)	20.00±0.00 [d]
pH	5.00±0.00 [a]
Total N (%)	0.59±0.57 [a]
Total P	5.26±0.36 [a]
Na	0.61±0.55 [a]
K	0.56±0.62 [a]
Ca^{2+}	1.20±0.28 [a]
Mg^{2+}	0.80±0.28 [a]
CEC	6.15±0.21 [a]
CU	1.12±0.17 [a]
AL	0-.06±0.64 [a]
TOC (%)	0.09±0.14 [a]

The baseline characteristics of the soil prior to the addition of amendments are displayed in Table 1. With a pH of 5.00 (H_20:1), 0.09% organic matter content, soil texture was sandy clay, Phosphorus is 20.70 mg/kg, potassium is 0.56 mg/kg, sodium is 0.61 mg/kg, magnesium is 0.80 mg/kg, calcium is 1.20 mg/kg, and nitrogen is 0.59 %, according to the nutritional levels.

Main effects of pig slurry on soil pH, electrical conductivity (E.C), organic matter, soil available nitrogen, and available phosphorus

The main impact of pig slurry on different soil chemical parameters, such as pH, organic matter (O.M), soil accessible nitrogen (T.N), available phosphorus (P), and cation exchange capacity (CEC), is demonstrated by the results shown in Tables 2a, b, and c. When compared to the control (no pig slurry), the application of pig slurry showed significant difference on the different soil parameters. Pig slurry weighing 1000 g had the greatest mean pH, while soils devoid of pig dung showed significant difference in the mean of pH from those containing 1000 g and

500 g of PS. There was a significant difference in nitrogen (T.N) among the treatments; the highest mean was found in soils with 1000 g PS, followed by 500 g and no PS.

Table 2a: Main effects of pig slurry on soil pH, organic matter, soil available nitrogen, and available phosphorus.

Pig slurry (PS)	pH H20 1:2	O.M %	T.N %	Avail. P mg/kg
No PS	5.64b	0.56b	1.12c	20.73b
PS 500g	6.52a	0.94a	1.24b	21.42a
PS 1000g	6.63a	1.04a	1.68a	21.65a

Means in a column followed by the same letter are not significantly different according to Tukey's LSD (P = 0.05)

Table 2b: Main effects of oil palm bunch ash on soil pH, organic matter, soil available nitrogen, and available phosphorus.

Oil palm bunch	pH H20 1:2	O.M %	T. N %	Avail. P mg/kg
No OPB	4.27b	0.57b	1.24c	20.72a
OPB 500g	5.97a	0.88a	1.42b	20.74a
OPB 1000g	6.27a	0.91a	1.53a	21.23a

Means in a column followed by the same letter are not significantly different according to Tukey's HSD (P = 0.05)

Table 2c Interactive effects of pig slurry and oil palm bunch ash on soil pH, organic matter, soil available nitrogen, and available phosphorus.

Pig slurry (PS)	Oil palm bunch (OPB)	Ph H20 1:2	O.M %	T. N %	Avail. P mg/kg
No PS	No OPB	4.34c	0.87c	1.41c	21.23d
	500g	4.98ab	0.88c	1.41c	54.03b
	1000g	5.03ab	0.86c	1.53b	54.63b
PS 500g	No OPB	5.02ab	2.59a	1.54b	54.45b
	500g	5.59a	2.62ab	1.61a	57.99a
	1000g	5.68a	2.63a	1.62a	58.03a
PS 1000g	No OPB	5.32ab	2.64a	1.60a	59.1a
	500g	5.67a	2.67a	1.64a	58.9a
	1000g	5.69a	2.68a	1.67a	59.1a

Means in a column followed by the same letter are not significantly different according to Tukey's HSD (P = 0.05)

Main effects of pig slurry (PS) on soil calcium, magnesium, sodium, potassium, and cation exchange capacity (CEC)

Information regarding the impact of pig slurry (PS) on soil calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and cation exchange capacity (CEC) is given in Tables 3a, b, and c. The table demonstrates how the concentrations of Ca, Mg, Na, K, and CEC are greatly impacted when pig slurry is added to soil. Between the various PS treatments,

there are notable differences in the mean values for every nutrient. Manure addition significantly increases calcium, magnesium, and CEC as compared to the control (no PS). There were notable variations in sodium and potassium between the PS and no PS, with the greatest mean value found in 1000 g of PS. The outcome demonstrates that adding pig slurry to soil greatly raises the concentration of Ca, Mg, Na, K, and CEC. It also indicates that the best way to increase the chemical characteristics of soil is to add 1000 g of PS.

Table 3a: Main effects of pig slurry on soil calcium, magnesium, sodium, potassium, and CEC

Pig slurry (PS)	Ca cmol/kg	Mg cmol/kg	Na cmol/kg	K cmol/kg	CEC cmol/kg
No PS	1.01c	0.89b	0.41c	0.26c	5.45c
PS 500g	1.35a	1.35a	0.73b	0.47b	6.67b
PS 1000g	1.39a	1.42a	1.00a	0.69a	7.86a

Means in a column followed by the same letter are not significantly different according to Tukey's HSD (P = 0.05)

Table 3b: Main effects of pig slurry on soil calcium, magnesium, sodium, potassium, and CEC

Oil palm bunch (OPB)	Ca cmol/kg	Mg cmol/kg	Na cmol/kg	K cmol/kg	CEC cmol/kg
No OPB	1.20b	0.84b	0.40b	0.24bc	5.44b
OPB 500g	1.42a	1.47a	0.63a	0.48a	7.48a
OPB 1000g	1.53a	1.65a	0.62a	0.56a	7.54a

Means in a column followed by the same letter are not significantly different according to Tukey's HSD (P = 0.05)

Table 3c: Interactive effect of pig slurry and oil palm bunch ash on soil calcium, magnesium, sodium, potassium, and CEC

Pig slurry (PS)	Oil palm bunch (OPB)	Ca cmol/kg	Mg cmol/kg	Na cmol/kg	K cmol/kg	CEC cmol/kg
No PS	No OPB	1.21c	1.07c	0.39c	0.25c	5.44c
	OPB 500g	1.39b	1.20b	0.83b	0.69b	7.46b
	OPB 1000g	1.41b	1.17b	0.88b	0.62b	7.52b
PS 500g	No OPB	1.39b	1.18b	0.94b	0.58b	7.82b
	OPB 500g	1.41b	1.21b	0.89b	0.59b	7.84b
	OPB 1000g	1.56a	1.52a	1.22a	0.97a	8.11a
PS 1000g	No OPB	1.42b	1.27b	0.92b	0.65b	7.91b
	OPB 500g	1.59a	1.56a	0.89b	0.68b	7.97b
	OPB 1000g	1.61a	1.55a	1.31a	1.02a	8.21a

Means in a column followed by the same letter are not significantly different according to Tukey's HSD (P = 0.05)

Main effects of pig slurry on length, diameter, leaf area, leaf area index, chlorophyll and yield of tomatoes

The results shown in Table 4 show how pig slurry (PS) and oil palm bunch (OPB) interact to affect tomato growth in several ways, including length, diameter, leaf area, leaf area index, chlorophyll, and tomato yield. Over the course of four weeks, tomato plants in every treatment group grew longer. The longest tomato plants were consistently produced by the 1000 g of both manure treatment, which was followed by 500 g of both manure and no manure. The length of the plants varies significantly between the treatments. 500 g of both manures and no manure are not significantly different from one another, while 1000 g of both manures is considerably different from the other treatments. In all treatment groups, tomato plant diameter rose during the course of the four weeks.

Table 4: Main effects of pig slurry and oil palm bunch ash on length, diameter, leaf area, leaf area index, chlorophyll and yield of tomatoes

Week (s)	Treatment	Length (cm)	Diameter (cm)	Leaf Area (cm^2)	Leaf area index	Chlorophyll (µg/g)	Tomato Yield (kg)
1	No manure	10.0d	2.01c	920cd	1.53cd	23.06cd	3.53c
1	500 g of both	12.0cd	2.53bc	980c	2.03c	27.02c	4.53b
1	1000 g of both	14.0b	3.04a	1110b	2.53b	31.12bc	5.32ab
2	No manure	11.02cd	2.11c	950c	1.72bc	27.02c	3.72c
2	500 g of both	13.11c	2.73b	1050b	2.23b	32.04bc	4.73b
2	1000 g of both	14.04ab	3.21a	1150ab	2.73ab	36.82b	5.76a
3	No manure	11.53c	2.32c	980c	1.82c	28.03c	3.96c
3	500 g of both	13.54b	2.84b	1080b	2.33b	33.21b	4.94b
3	1000 g of both	15.58a	3.34a	1180a	2.84a	38.02a	5.96a
4	0 g	11.73c	2.42b	1000b	1.95b	28.76c	4.05bc
4	500 g of both	13.67b	2.92ab	1100ab	2.40ab	33.89ab	5.07ab
4	1000 g of both	15.74a	3.42a	1199a	2.93a	40.36a	5.98a

Means in a column followed by the same letter are not significantly different according to Tukey's LSD (P = 0.05)

Discussion

The application of oil palm bunch ash and pig slurry had a significant difference on the pH of the soil, as seen by the results, with the PS-treated treatments showing higher pH values. Pig slurry's alkaline composition, which raises the pH of the soil, is responsible for this result (Khan and Abbasi, 2017). Similarly, EC levels are greatly impacted by the addition of pig slurry, with treatments using pig manure showing greater values. This impact is brought about by the soluble

salts found in manure, which in turn raises the soil's electrical conductivity (Sharma et al., 2017). The addition of manure has a noticeable effect on the amount of organic matter present, especially when pig slurry is used since it increases soil fertility by acting as a source of organic matter (Olufayo *et al.,* 2016). Furthermore, the application of pig dung has a considerable impact on the available phosphorus and nitrogen in the soil, with higher values seen in treatments. This is explained by the fact that manure is a rich supply of phosphate and nitrogen, which enhances the soil's nutritional status (Olufayo *et al.,* 2016). The findings demonstrate that adding manure can improve soil pH, electrical conductivity, and nutrient status efficiently. However, depending on particular soil and crop circumstances, the ideal kind and amount of pig manure may change (Olufayo *et al.,* 2016).

When compared to treatments without oil palm bunch ash, the interaction impact between pig slurry and oil palm bunch ash clearly shows that the application of oil palm bunch ash considerably affects soil pH and electrical conductivity. OPB's liming impact on acidic soils is responsible for the observed increase in pH (Jeffery *et al.,* 2011). The presence of soluble salts in OPB is responsible for the increase in electrical conductivity (Chan *et al.,* 2016). PS application considerably influences organic matter content, especially when 1000 g and 500 g of pig manure were utilized because of their organic matter content, even if no discernible change in organic matter content is seen between treatments with and without OPB (Olufayo *et al.,* 2016). Similar to how manure application affects soil accessible phosphorus and nitrogen, treatments using PS and OPB show greater values because of their rich nutrient content (Olufayo *et al.,* 2016). The combined application of PS and OPB improves soil pH, electrical conductivity, and nutrient status, according to the results of the interaction impact of the two treatments. Depending on the particular soil and crop circumstances, certain combinations of pig slurry and oil palm bunch ash may work better than others (Olufayo *et al.*, 2016).

Depending on the type of manure used, the results regarding the impacts of manure on soil calcium, magnesium, sodium, potassium, and cation exchange capacity indicate notable differences. The largest concentrations of calcium, magnesium, sodium, potassium, and cation exchange capacity are found in pig dung. This result is in line with other research (Wang *et al.,* 2020) that highlighted pig dung as a rich source of nutrients for soil and plants. Moreover, compared to the control treatment without any manure, the application of oil palm bunch ash results in a considerable increase in the capacity for the exchange of calcium, magnesium, sodium, potassium, and cations (Adekunle *et al.,* 2018).

Further evidence that the combined application of these amendments considerably influences the examined soil chemical characteristics, hence reducing the acidity present in the soil, comes from the results of the interaction effect between pig slurry and oil palm bunch ash. Pig slurry and oil palm bunch ash together show a synergistic effect on soil properties; additionally, the addition of oil palm bunch ash alone also significantly affects the levels of calcium, magnesium, sodium, potassium, and cation exchange capacity when compared to the control treatment without any amendment. This outcome is in line with other research that shown that PS and OPB had a synergistic effect on soil characteristics (Adekunle *et al.,* 2018). It has been demonstrated that combining PS with OPB improves plant growth by increasing soil

nutrient availability (Adekunle et al., 2018). It has been discovered that the combination of OPB and pig manure improves soil qualities more than each amendment applied alone (Atkinson *et al.,* 2010; Adebayo *et al.,* 2018). The most successful treatment in this study, however, for lowering soil acidity and enhancing soil elements including calcium, magnesium, sodium, potassium, and cation exchange capacity was a mixture of pig manure and oil palm bunch ash.

Conclusion and Recommendation

The goal of adding oil palm bunch ash and pig slurry together with other organic amendments is to significantly increase soil fertility while lowering soil acidity. An increase in organic matter content resulted in better soil structure and greater nutrient availability. The aforementioned amendment was found to have a good impact on the soil's capacity to retain nutrients and moisture, as evidenced by its increased water-holding capacity and improved cation exchange capacity. Prior to adding organic amendments, it is crucial to do soil tests and analysis. This will direct the proper application rates of organic amendments and assist in identifying any specific nutrient imbalances or deficits in the soil. Optimizing the application according to the needs of the soil will increase its advantages and reduce the possibility of nutrient imbalances or excesses.

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