



Effect of Different Rate of Oil Palm – Piggery Waste Compost Application on the Growth, Yield of Maize and Soil Nutrient Status

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Abstract

An experiment was conducted to evaluate the effect of the different rates of oil palm-piggery waste compost on maize growth, yield and soil properties. The experimental design was a Randomized Complete Block Design (RCBD) with seven treatments replicated thrice. The treatments were; control, 2, 4, 6, 8, 10 and 12 tonnes/ha ($t\ ha^{-1}$) of oil palm-piggery compost. The soil was low in nutrient however, the application of 10 and 12 $t\ ha^{-1}$ of compost significantly ($p \leq 0.05$) improved the soil nutrient status. The application of 10 and 12 $t\ ha^{-1}$ of oil palm-piggery waste compost significantly ($p \leq 0.05$) increased maize growth and yield compared to other treatments. The uptake of N, P and K was higher in 12 $t\ ha^{-1}$ of oil palm-piggery waste compost. In conclusion, the application of 10 $t\ ha^{-1}$ of oil palm-piggery waste compost can be adopted by farmers for the improvement of soil nutrients and yield of maize.

Introduction

Waste disposal poses a great problem in third world country mostly in Nigeria where these wastes are improperly deposited. The indiscriminate disposal of these wastes causes pollution and diseases resulting to unhealthy environment. Conversion of agricultural wastes to compost for soil amendment is now gaining attention worldwide as a sustainable crop production system. Compost or organic manure helps in improving soil fertility through the modification of soil physical, chemical and biological properties (Agbede et al., 2017). This in turn leads to the production of high quality crops through improved nutrient use efficiency (Ayoola and Adebayo, 2017). Several research findings have shown that improving plant nutrition through the use of organic amendments for sustainable crop production is a promising approach and have been found to significantly increase the growth of crops (Fahad, 2020).

The process of composting leads to the decomposition of raw materials such as

animal manure, sawdust and green manure and stabilises them under controlled conditions. Stabilizing the material take the nutrient such as nitrogen and ties them up in the compost organic matter. The nutrients are slowly released over time, increasing the opportunity for uptake by the plants and reducing downstream water pollution problems. Compost improves the water-holding capacity, soil structure, porosity and aggregate stability. The incorporation of compost into soil enhance soil nutrient for high crop yield such as maize. Maize (*zea mays*L.) provides food for more than 1.2 billion people in addition to other uses and is the third widely grown cereal crop. It is highly productive, less rigorous to produce, cheap and adapt to a wide range of agro-ecological zones. Many agro-based industries rely on maize as a source of raw materials. But the major constrain to the growth and yield of maize apart from those caused by diseases is low soil fertility resulting from land degradation (Kyawt et al., 2015).

Soil degradation is the decline in the quantity and quality of soil and the factors responsible includes: erosion, the loss of humus and plant/animal life, loss of structure, changes in permeability, acidification and declining fertility, changes in pH, salinization and chemical toxicity. To reduce the risk of soil degradation, extensive management practices such as organic farming, afforestation and application of fertilizer are inevitable. The application of compost increases the growth and yield of maize as reported by Okoko and Makworo, (2017). The utilization of agricultural waste as organic fertilizer mostly piggery-oil palm waste needed more valuable research. It is therefore the objective of this study to evaluate the effects of piggery - oil palm waste on maize yield and soil properties.

Materials and Methods

Experimental Design

The experimental design adopted was the randomized complete block design (RCBD) with seven (7) treatments replicated three times. The treatments applied includes: control, 2, 4, 6, 8, 10 and 12tonnes/ha of oil palm-piggery compost. Maize was planted and all data obtained were analyzed statistically using the analysis of variance (ANOVA) test and means were separated using Least Significance Difference (LSD).

Description of Experimental Site

The experiment was conducted at the Teaching and Research Farm, Faculty of Agriculture, Ambrose Alli University, Emuado Annex, Ekpoma in 2018 planting season. Ekpoma is located at latitude $6^{\circ}42'1''N$ and longitude $6^{\circ}08'1''E$ of the equator, with the mean annual rainfall of 1500mm and temperature that ranges between $15^{\circ}C$ - $34^{\circ}C$.

Soil Analysis

Soil samples were collected at the experimental site at (0-15cm) depth prior to the experiment and post-harvest samples were collected after planting and analyzed for Their physical-chemical properties. Particle size distribution was determined by the hydrometer (Bouyoucos, 1962). The pH was measured in a 1:1 (soil-water mixture) by glass electrode pH meter (Maclean, 1982), organic carbon was done by wet dichromate acid oxidation method (Nelson and Sommers, 1982). Total nitrogen was determined by micro Kjeldahl method (Bremer and Mulvancy, 1982), available phosphorus was determined by Bray-1 extraction method (Bray and Kurtz, 1945). Al^{3+} and H^{+} were extracted with KCl (Thomas, 1982). Calcium (Ca), Magnesium (Mg), Sodium (Na) and Potassium (K) were extracted with NH_4OAC (Ammonium acetate). Potassium (K) and Sodium (Na) were determined with a flame emission photometer while Calcium (Ca) and Magnesium (Mg) were determined by the atomic absorption spectrophotometer (IITA, 1979). ECEC was calculated by summation of exchangeable base and exchangeable acid (Adamson and Ingram, 2003). Compost was analyzed for nutrient content after three months in the laboratory.

Plant Sample Analysis

A sample of 1g was weighed into the ashing crucible, placed in a muffle furnace at aprescribed temperature of 3 hours. The plant sample was recovered from the furnace and allowed to cool, 10 ml of nitric acid (HNO_3) was added and filtered into 100ml standard with distilled water used to make it up to volume. The solution was retained for the determination of potassium (K), hydrogen a set of working standard of the order 0, 2, 4, 6, 8 and 10ppm respectively, to calibrate the equipment

while the phosphorus content was determined by the ammonium molybdate method. Nitrogen was determined by the micro kjedahl method; plant sample of 0.1g was weighed into digestion tube, 2 ml of concentrated sulphuric acid (H_2SO_4) and one tablet of selenium catalyst was added. The mixture was digested on a hot plate and the solution was allowed to cool and filtered into 1000 ml standard flask made up to volume with distilled water from which nitrogen was determined titrimetrically. Nutrient uptake = Dry matter yield (Kg) x Nutrient concentration (%)

Cultivation, Planting and Management Practices

The pre-planting operations were carried out which includes site selection, clearing of vegetation, packing of debris, mapping design and herbicide spray which was done manually. The planting areas was 16m by 16m the trial was laid in 21 plots, each plot size (consisting of flat beds) measured 1.8m by 1.8m. The maize variety used in planting was suwan-1- SR with three seed sown per hole at a spacing distance (standard spacing) of 75cm by 25cm and later thinned to one plant per stand two (2) after emergence producing a stand capacity of 53,333 plants per hectare. Weeding was done manually using cutlass and hoe at 4th and 7th after planting.

Compost Application

The oil palm-piggery wastes were composted for 3 months, dried before application and oil palm-piggery compost was applied two weeks after germination.

Collection of Data

The following parameters were taken; plant height, stem girth and leaf area. The readings were taken four to eight after planting (4-8WAP). Plant height and leaf

area was measured using tape rule, stem girth was measured using Vernier caliper and leaf area was calculated thus; Leaf area = length x width x 0.75, where 0.75 is a constant (Remison and Lucas, 1982). Cobs, grain and dry matter weight were determined.

Results

Soil Analysis

The pH value of the soil before cultivation was slightly acidic (5.60) while the pH of the control after harvest was 5.40 (Table 1). The pH of the soil after application of oil palm-piggery waste compost ranged from 6.0 in 2 t ha⁻¹ to 6.70 in 12 t ha⁻¹ of oil palm-piggery waste compost. The pH was increased to near neutral with the application of compost. The total organic carbon of soil amended with 10 and 12 t ha⁻¹ of oil palm-piggery waste compost was higher compared to other treatments. Total nitrogen was improved with the application of compost, however, the application of 10 t ha⁻¹ of oil palm-piggery waste compost increased the total nitrogen value of 7.99g/kg than other treatments. The nitrogen content of the soil was higher than the critical level of 1.20g/kg. The available phosphorus ranged from 14.80mg/kg to 47.22mg/kg. The soil samples test from various application rates were above the critical level of 15mg/kg except for the control, and from the result it implied that the application of compost improve the phosphorus content of the soil. Calcium level ranges from 2.18 in the control to 3.86 in 12 t ha⁻¹ of oil palm-piggery waste compost and 12 t ha⁻¹ of oil palm-piggery waste compost was higher than the critical level of 3.80cmol/kg. The value of sodium was below the critical level of 10cmol/kg. The critical level of magnesium was 2.00cmol/kg, it was observed that 2 to 6 t

ha⁻¹ of composted oil palm-piggery waste was below the critical level but other treatments applied had value within the critical level of magnesium. The textural classes for the soil treated with the different rate of oil palm-piggery waste compost were sandy loam.

Growth Parameters

The growth and yield of maize was significantly improved with application of compost as observed during the experiment. At four weeks after planting, the height of maize was not significantly different among treatments however, the maize in the plot amended with 10 tonnes of compost were taller (Table 2). The application of 8 – 12 tonnes/hectare of oil palm - piggery waste compost significantly ($p \leq 0.05$) increased the height of maize throughout the growth season.

At four weeks after planting there was no significant difference in stem girth among treatments, the incorporation of 10 t ha⁻¹ compost increased the girth of maize than other treatments. From the experiment, a significant ($p \leq 0.05$) increase in stem girth of maize was observed from the application of 8 – 12 t ha⁻¹ of compost at weeks 6 and 8 after planting

At four weeks after planting the application of 10 t ha⁻¹ of oil palm-piggery waste compost increased the leaf area of maize than other treatments (Table 2). The application of 6 – 12 t ha⁻¹ of compost significantly ($p \leq 0.05$) increased the leaf area of maize compared to other treatments.

Plant Yield and Nutrient Uptake

The application of 10 tonnes/hectare of oil palm-piggery waste compost significantly ($p \leq 0.05$) increased the cob weight of maize compared to other treatments except for 8 and 12 tonnes /

hectares (Table 3). The application of 10 and 12 tonnes/hectare of oil palm-piggery waste compost significantly ($p \leq 0.05$) increased the grain yield of maize compared to other treatments. The application of compost significantly ($p \leq 0.05$) increased the dry matter yield of maize compared to the control. However, 8 tonnes/hectare of oil palm-piggery waste compost application significantly ($p \leq 0.05$) increased the dry matter yield of maize but not significantly different from the application of 4 and 10 tonnes/hectare of oil palm-piggery waste compost application.

Discussion

The soil was moderately acidic with pH 5.60 and the application of compost increased the pH of the soil to near neutral with pH range between 6.00 – 6.70. Compost can be used as liming materials as it has the ability to buffer acidity and this corresponds with the earlier work of Robert (2015). The increase in pH observed due to the application of oil palm-piggery compost agreed with the findings of Whalen (2000), who reported a similar result that organic manure reduces acidity. The organic matter content was improved with incorporation compost to soil and according to Rivero *et al.* (2004), the application of compost significantly improves the quality and quantity of soil organic matter content. Naba *et al.* (2020), reported a significant increase in soil total nitrogen when compost was applied to soil and this corresponded to the result obtained from the experiment. Organic manure is very vital in enhancing the quality of soil and it improves the physical, chemical and biological properties of the soil. Compost contains a significant amount of soil nutrients such as nitrogen, phosphorus, magnesium, potassium, calcium, sulphur and essential

micronutrient, these are very important in soil for plant growth (Agegnehu, 2014). And according to Brown and Cotton (2011), the high nutrient content in compost was significant in improving the fertility of the soil. And according to Tanwar *et al.* (2016) the application of organic base fertilizer significantly ($p \leq 0.05$) increased the organic carbon, nitrogen and phosphorus compared to the application of mineral fertilizer alone and the finding was in agreement with the results obtained from the experiment. The decomposition of organic matter increased microbial activity resulted in the release of more exchangeable bases such as K, Ca, and Mg that reduce the soil acidity near to neutrality. Lee *et al.* (2006), reported that the application of organic materials such as crop residues, green manure, and compost improved soil pH, available nutrients, organic matter content, and reduced exchangeable acidity. Application of organic amendments to soil enhances soil N, P and K concentrations (Hao *et al.*, 2008).

The study further revealed that sole application of oil palm-piggery waste compost improved the soil and consequently, increases the growth of maize. According to Lopez-Buco *et al.* (2003) organic manure positively influences the heights of plants and it has been reported that optimum height has a positive correlation with productivity. The vigorous growth due to organic manure application may be associated with the higher nutrient content in compost released for plant use which is essential for protoplasm formation and its absence can cause stunted growth of the plant (Togun *et al.*, 2002). According to Moyin-Jesu and Adeofun, (2008), the application of organic manure significantly ($p \leq 0.05$) increased the stem girth and growth of maize; this implies that the application of organic manure improved

soil properties which resulted in the growth of maize. The increase in stem girth could be associated with a continuous supply of nutrients by organic manure (Farhad *et al.*, 2009). The positive performance of compost on the leaf area of maize is connected with the facts that it enhanced biological diversity which is responsible for the release of nutrient to the plant (Yakub *et al.*, 2012). According to Amugoyegbe *et al.* (2012), the application of organic manure enhanced leaf area, total chlorophyll contents, carbon content, and water holding capacity and decreases bulk density of soil which culminate and interplay to promote growth and yields. This further confirmed the earlier findings of Akande *et al.* (2010) that the application of organic manure could ameliorate acidic tropical soil to improve crop production. This agreed with the findings of Okoko and Makworo (2017) and Ibeawuchi *et al.* (2007) they reported that high rates of organic manure increase the water-soluble and exchangeable potassium and magnesium which enhances grain yield and dry matter yield of maize. Furthermore, according to Ayoola and Makinde (2006) organic manure increases the grain yield of maize. Organic manure increases the dry matter yield which was confirmed by the earlier work done by Marere *et al.* (2001). The use of organic manure has great potential for improving soil productivity and crop yield through the improvement of physical, chemical and microbiological condition of the soil as well as nutrient supply (Malaiye *et al.*, 2004). Nutrient uptake of soil amended with oil palm-piggery waste compost significantly ($p \leq 0.05$) increased the Nitrogen, Phosphorus and Potassium with 12 tonnes/hectare of oil palm-piggery waste compost having the highest significant ($p \leq 0.05$) value compared with other treatments.



Table 1: Chemical and Physical Properties of the Soil and Compost.

Treatmen ts	g/kg OC	pH	g/kg N	Mg/kg P	←-----→					Cmol/kg CEC	←-----→				Particle size distribution g/kg			Textural Class
					Ca	Mg	Na	K	ECEC		Al ³⁺	H ⁺	EA	Sand	Silt	Clay		
Initial Soil	16.00	5.60	1.34	16.22	2.30	1.09	0.72	0.67	4.79	5.39	0.09	0.51	0.60	820	30	150	Sandy loam	
Control	15.64	5.40	1.28	14.80	2.18	1.12	1.03	0.03	3.36	3.96	0.07	0.53	0.60	840	10	150	Sandy loam	
2tonnes	17.51	6.00	2.02	28.78	2.21	1.48	1.30	0.01	4.99	5.59	0.07	0.53	0.60	820	10	170	Sandy loam	
4tonnes	18.25	6.10	4.57	38.45	2.72	1.82	1.26	0.06	5.85	6.45	0.06	0.54	0.60	850	10	140	Sandy loam	
6tonnes	21.90	6.20	6.06	34.66	2.72	1.82	1.34	0.04	5.91	6.21	0.03	0.27	0.30	860	10	130	Sandy loam	
8tonnes	23.79	6.30	7.21	39.81	3.29	2.20	1.35	0.05	6.88	7.28	0.04	0.36	0.40	850	10	140	Sandy loam	
10tonnes	25.81	6.60	7.99	32.31	3.67	2.46	1.42	0.05	7.58	7.88	0.07	0.23	0.30	850	10	140	Sandy loam	
12tonnes	26.29	6.70	6.06	47.22	3.86	2.57	1.33	0.13	7.89	8.29	0.07	0.33	0.40	820	10	170	Sandy loam	
OPPWC	37.15	8.13	9.08	33.11	12.70	22.84	8.72	11.12	55.41	60.43								

OPPWC – Oil palm piggery waste compost.

Table 2: Evaluation of different rates of sawdust-piggery compost on the growth of weekds after planting.

Treatments	Plant	ht.	(cm)	stem girth (mm)			Leaf Area(cm ²)		
	4	6	8	4	6	8	6	8	
C	14.17	30.22c	61.55d	12.13	21.11d	31.33c	94.91c	386.60c	745.10e
2 t	14.24	34.04b	68.49c	12.26	23.07c	34.34b	95.31c	429.10b	933.20d
4 t	14.46	34.06b	69.40c	12.36	24.99ab	34.86b	113.80b	456.30b	1,206.00c
6 t	14.56	34.26b	73.84b	12.50	25.94ab	35.78b	119.80b	486.04a	1,369.46b
8 t	14.62	35.88a	76.44a	12.67	26.64a	36.50b	128.01a	488.46a	1,386.70b
10 t	14.66	36.48a	77.40a	12.82	26.68a	39.50a	136.21a	491.09a	1,546.30a
12 t	14.39	35.98a	76.57a	12.76	26.58a	38.68a	135.14a	496.80a	1,560.32a
LSD	NS	1.20	2.40	NS	1.40	2.01	12.03	26.60	106.23



Table 3: Effect of Oil Palm Piggery Waste Compost on the cob weight, grain yield, dry matter yield and nutrient uptake.

Treatment	Cob Wt (t/ha)	Grain Yield(t/ha)	Dry matter Yield(t/ha)	Nutrient Uptake(tonnes/ha)		
				N	P	K
Control	12.32d	1.85d	3.70b	0.99d	1.70f	0.41g
2 tonnes	13.61c	2.47c	5.13a	1.42c	2.16e	0.55f
4 tonnes	14.41c	3.06b	5.57a	1.58c	2.37e	0.59e
6 tonnes	15.62b	3.54ab	5.11a	1.96b	2.76d	0.92d
8 tonnes	16.69a	3.89ab	5.41a	2.53a	3.18c	1.23c
10 tonnes	17.67a	4.46a	5.80a	2.72a	3.93b	1.59b
12 tonnes	17.05a	4.36a	5.14a	2.73a	5.03a	2.05a
LSD(0.05)	1.01	0.60	1.04	0.29	0.37	0.15

The mean values with the same letter in the vertical column are not significantly ($p \leq 0.05$) different using LSD.

Lenged

C- control

t-tonnes($p \leq 0.05$)

ht- height

Summary and Conclusion

The experiment conducted at the Teaching and Research Farm of Ambrose Alli University, Ekpoma, Edo State, Nigeria was to assess the effect of the different rates of oil palm-piggery waste compost on the growth and yield of maize. The application of oil palm-piggery waste compost improves soil properties and productivity. The application of 6-12 tonnes/hectare of oil palm piggery compost significantly ($p \leq 0.05$) improved the growth parameters of the maize plant. However, the application of 10 tonnes/hectare of oil palm- piggery waste compost has the highest grain yield. Farmers can be encouraged to apply 10 tonnes/hectare of oil palm piggery compost to avoid wastage of organic manure, effective soil management and high crop production.

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