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Effect of Different Rates of Sawdust-Piggery Compost on Soil Properties and Yield of Maize in Nutrient Depleted Soil

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Key words: Experiment, important, properties, fertilizer, application

Abstract: Compost is an important source of organic fertilizer that can be used to amend degraded soil to improve soil nutrient and crops yield. This experiment to evaluate the effect of sawdust-piggery compost on soil properties, growth and yield of maize was carried out at Ambrose Alli University Teaching and Research Farm, Emaudo, Ekpoma, Edo State. The experiment was fitted in a Randomized Complete Block Design (RCBD) with seven treatments and three replicates. The treatments were; control (0), 2, 4, 6, 8, 10 and 12 tonnes of sawdust-piggery compost per hectares (ha^{-1}). Data collected were analysed using ANOVA and LSD was used to separate means. Soil nutrients were below critical levels and the application of compost improved fertility status of the soil. Growth parameters, dry matter yield, cob weight, grain yield and nutrient uptake were determined. It was observed that application of Sawdust-piggery compost significantly ($p \leq 0.05$) increased the growth of maize compared to control. The application of 8-12 tonnes of sawdust-piggery compost significantly ($p \leq 0.05$) increased the plant height, leaf area and stem girth of maize compared to other treatments. The application of 8-12 tonnes per hectares (ha^{-1}) of sawdust-piggery compost significantly ($p \leq 0.05$) increased the cob weight, grain and dry matter yield of maize compared to other treatments, however, the application of 10 t ha^{-1} of compost to maize increased grain yield of maize than others rate of applications with value of 4.60 t ha^{-1}. The uptake of nitrogen, phosphorus and potassium were higher with application of 12 tonnes of compost. In conclusion, the application rates of 10 t ha^{-1} of sawdust-piggery compost per hectare on nutrient depleted soils will improve the growth and yield of maize.

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INTRODUCTION

The rising issues of improper disposal of sawdust and piggery wastes results to environmental pollution which needs urgent attention. Waste from piggery farms and timber factory often constitute environmental nuisance and it is therefore necessary to minimize such unpleasant environmental pollution. Farm waste can be minimize and utilize by harnessing these wastes into compost to ameliorate nutrient depleted soil. Soil nutrient depletion resulting from degradation reduced the quality of the soil and crop yield, it is important to enhance the fertility of the soil through fertilizer application for higher crop yield. Fertilizers are considered to be a key factor that can improve soil nutrient and thereby increased the yield of crops[1]. The negative impact of soil degradation and agricultural sustainability have kindled interest in the assessment of soil quality which is the capacity of the soil to function as living and dynamic nature.

Inorganic fertilizers offer a more reliable form of plant and soil nourishment because its nutrient levels are considered to be consistent. However, mineral fertilizer does not improve soil organic matter which is the key resource in the soil. Soil organic matter is an extremely important attribute of soil quality since it influences the soil physical, chemical and biological properties and processes. Although, organic and synthetic fertilizer adds the same nutrient to the soil, however, organic fertilizers perform a dual role by providing required nutrients to plant the soil organic matter. Organic manure increase the soil organic carbon pool, soil pH, enhances microbial activities and sustain the ecosystem. Most cultivated soil by tropical farmers lack sustainability due to nutrient losses by soil erosion and unbalanced nutrient mining[2]. Achieving high crop yield requires adequate and balanced supply of plant nutrient as declining soil fertility is a prominent contrast for crop production. Maize is a nutrient demanding crop which require adequate and appropriate application of fertilizer for improve growth and yield[3, 4]. It was therefore the objectives of the study to evaluate the effect of different rate of sawdust-piggery compost on the yield of maize and soil properties.

MATERIALS AND METHODS

Description of experimental site: The experiment was carried out at the Teaching and Research Farm of Ambrose Alli University, Ekpoma, Edo State, Nigeria. Ekpoma is in the humid rainfall vegetation belt of Nigeria, lying between latitude 6°42^1 North and longitude 60°^{1} East, with an average annual rainfall of 1500mm and temperature between 15°-34°C.

Collection of soil for analysis: The top soils (0-15 cm), were collected from the experimental site prior and after the experiment. The soils were air dried, sieved and the samples were analyzed for both chemical and physical properties. Particle size distribution was determined by hydrometer method[5]. The pH was determined in water (ratio 1:1, soil: water). Organic carbon was determined by wet dichromate method[6] and available phosphorus in the soil was determined using Bray-1 extraction method[7]. Total Nitrogen was determined by Kjeldahl method[8]. Exchangeable cations; Calcium (Ca), magnesium (mg), sodium (Na) and potassium (K) were extracted with NH_4OAC pH 7.0 (Ammonium acetate). Potassium and sodium were determined with flame emission photometer while Calcium (Ca) and Magnesium (Mg) were determined by the atomic absorption spectrophotometer[9]. Effective cation exchange capacity was determined by the summation of the total exchangeable bases and exchangeable acidity.

Plant sample pre-treatment: Measure 1 g of the plant material was put into aching crucible, placed in a muffle furnace, switched on and allowed to stand at the prescribed temperature for 3 h. Then switched off and allow to cool down just enough to touch, recovered from the furnace, add 10 mL and 20% Nitric acid and filtered into 100 mL standard flask, make up to volume with distilled water and determine potassium (K) with flame photometer through a set of working standard of the order 0, 2, 4, 6, 8 and 10 ppm, respectively to calibrate the equipment while the phosphorus content was by blue ammonium molybdate method (Standard Method).

Nitrogen (N) was determined by regular macro Kjedahl method where 0.1 g of the plant sample was accurately weighed into digestion tube, 2 mL of concentrated Sulphuric acid and 1 tablet of selenium catalyst was added and digested on the Hot plate until the solution becomes clear and allowed cool down and filtered into 100 mL standard flask, make to volume with distilled water and determined the Nitrogen content with its standard method.

Experimental design and application of compost: The experimental design was Randomized Complete Block Design (RCBD) with seven treatments, replicated three times. The treatments which also represent the rate of application were; control 2, 4, 6, 8, 10 and 12 tonnes of sawdust-piggery compost were applied two weeks after germination.

Land preparation and management operation: Land preparation (clearing, packing and mapping out) was done manually. Planting area was 16×16 m. The trial was laid in 21 plots with each plot measuring 1.8×1.8 m. Planting was done at the rate of three seeds per stand at a planting distance of 75×25 cm within and between rows and later thinned two weeks after planting to one plant per stand with a population of 53,333 plants per hectare. Weeding was done manually, harvesting and above ground biomass was determined.

Data collection: The following data were collected; maize height (cm), Leaf Area (cm^2) = L X WX 0.75, Stem girth (mm) was measured with vernier caliper 4-8 weeks after planting. Cob weight (t ha^{-1}), Grain yield (t ha^{-1}) Dry matter yield (t ha^{-1}). Nutrient uptake = Dry matter yield (kg)×Nutrient content (%). Data collected were analyzed statistically using Analysis of Variance (ANOVA) and means separated using the LSD.

RESULTS AND DISCUSSION

Soil analysis: The initial pH value of soil before planting was 5.7 while after application of sawdust-piggery compost ranged from 6.3 in 2-6.6 in 12 tonnes and these were higher compared to control with pH 5.4. This result corresponds with the earlier work of Robert[10], who reported that organic matter has the ability to buffer acidity and Quedraogo *et al*.[11], they reported an increase to near neutral in pH when soil was amended with compost. The organic carbon in soil amended with sawdust-piggery compost were higher compared to control, it ranges from 16.42 g kg^{-1} in 2 tonnes to 21.70 g kg^{-1} in 10 tonnes of sawdust-piggery compost application. Available phosphorus ranges from 14.8 in control to 40.4 from the application of 10 tonnes of sawdust-piggery compost. Calcium level ranges from 2.18 cmol kg^{-1} in 2 tonnes to 3.45 cmol kg^{-1} in 8 tonnes of sawdust-piggery compost which are all below the critical level of 3.80 cmol kg^{-1}. However, the application of 10 and 12 t ha^{-1} were above the critical value. Sodium content of the initial soil sample was lower compared to soil which were amended with sawdust- piggery compost butwereall below the critical level of 10 cmol kg^{-1}. The critical level of magnesium is 2.00 cmol kg^{-1}, the initial soil sample, control and soil amended with 2 tonnes of sawdust-piggery compost had magnesium content lower that the critical level. Other treatments applied have a higher concentration of magnesium higher than the critical level. The nitrogen content of soil amended with sawdust-piggery compost were higher compared to the initial and the control soil samples. Soil amended with 10 tonnes of sawdust-piggery compost had the highest nitrogen content of 8.08 g kg^{-1} compared to other treatments. The application of 8-12 t ha^{-1} increased the nutrient content of the soil than other treatments. The particle size distribution of soil before and after application of sawdust-piggery compost were sandy loam (Table 1).

Growth parameters: It was observed that the application of sawdust – piggery compost increased the height of maize compared to control (Table 2). The application of eight to twelve tonnes of sawdust-piggery compost significantly ($p\leq 0.05$) increased the height of maize compared to other treatments. According to Adejobi *et al*.[12], the applications of organic manure significantly ($p\leq 0.05$) increased the growth of maize than where there was no application. Also Oyun *et al*.[13] reported that, compost is a rich source of plant nutrient especially nitrogen, phosphorus and sulphur which are necessary nutrients required for healthy plant growth.

The application of Sawdust-piggery compost significantly ($p\leq 0.05$) increased the stem girth of maize at six, seven and eight weeks after planting compared to the control (Table 2). There was no significant ($p\leq 0.05$) difference in girth at fourth weeks after planting. Ogbonna *et al*.[14], reported no significant ($p\leq 0.05$) difference girth after the initial application of organic manure to maize due to slow mineralization. However, the application of eight to twelve tonnes of sawdust-piggery compost significantly ($p\leq 0.05$) increased the stem girth of maize at six to eight weeks after planting. These findings agreed with Benton, etc. that organic fertilizer increases the fertility of soil and improve crop growth due to nutrient availability and release (Table2).

The leaf area of maize were enhanced with the application of sawdust-piggery compost (Table 2). It was observed during the growth, that the leaf area of maize increased on soil amended with sawdust-piggery compost were significantly compared to control. At six to eight weeks after planting, the leaves area were significantly ($p\leq 0.05$) higher with the application of eight to twelve t ha^{-1} of compost compared to other treatments

Table 1: Soil and compost analysis

Treatments	OC g kg^{-1}	pH	N g kg^{-1}	P Mg kg^{-1}	Ca	Mg	Na	K	CEC Cmol kg^{-1}	ECEC	Al	H	EA	Sand	Silt g kg^{-1}	Clay	Soil texture
ISS	1.60	5.7	1.24	16.21	2.32	1.59	0.71	0.07	4.69	5.29	0.08	0.51	0.60	820	30	150	Sandy loam
C	1.24	5.4	1.20	14.80	2.18	1.12	0.63	0.03	4.36	4.96	0.07	0.49	0.60	825	25	150	Sandy loam
2 t	26.42	6.3	5.72	29.50	2.84	1.89	1.32	0.05	6.11	6.61	0.07	0.43	0.50	860	20	120	Sandy loam
4 t	26.53	6.4	7.18	34.91	3.29	2.46	1.34	0.04	7.52	7.92	0.06	0.34	0.40	850	20	130	Sandy loam
6 t	28.96	6.4	7.24	40.01	3.38	2.12	1.21	0.06	6.56	6.96	0.11	0.29	0.40	830	30	140	Sandy loam
8 t	27.99	6.5	7.41	29.91	3.46	2.04	1.25	0.06	6.41	6.81	0.04	0.36	0.40	820	30	150	Sandy loam
10 t	28.70	6.6	8.08	40.41	4.86	2.04	1.56	0.06	7.32	7.72	0.03	0.37	0.40	830	30	140	Sandy loam
12 t	29.36	6.6	7.66	39.20	4.82	2.08	1.63	0.01	6.84	7.04	0.04	0.16	0.20	840	30	130	Sandy loam.
SPC	37.23	8.15	9.12	31.53	10.78	6.37	8.74	8.14	34.03	38.03	2.80	2.20	4.00				

SPC = Sawdust Piggery Compost; ISS = Initial Soil Sample; t = Tonnes

Table 2: Evaluation of different rates of sawdust piggery compost on the growth of maize weeks after planting

	Plant height (cm)			Stem girth (mm)			Leaf area (cm^2)		
Treatment	4	6	8	4	6	8	4	6	8
C	7.97	22.95c	50.39c	10.11	18.59c	24.23c	119.40	576.41c	819.71c
2 t	9.72	25.12ab	55.43b	10.16	21.94b	25.72c	173.60	602.43b	921.34ab
4 t	7.88	25.33ab	59.84a	9.50	22.30b	26.28b	120.60	639.56a	958.63a
6 t	7.20	36.00a	60.70a	10.56	26.00a	30.76a	121.40	685.51a	983.34a
8 t	9.75	35.83a	59.23a	10.56	26.67a	30.06a	128.90	664.81a	988.84a
10 t	9.15	33.45a	60.69a	10.78	25.47a	31.10a	123.60	671.52a	1172.71a
12 t	7.48	34.33a	59.98a	10.11	25.36a	31.20a	123.70	668.82a	1182.81a
LSD	NS	6.33	3.31	NS	NS	3.40	NS	26.73	56.56

Mean values on the vertical column with same letters are not significantly ($p<0.05$) different, means separated by LSD

Table 3: Evaluation of different rates of sawdust - piggery compost on the yield and nutrient uptake of maize (t ha^{-1})

Variables	Cob wt(t ha^{-1})	GY(t ha^{-1})	DMY(t ha^{-1})	N	P	K
Control	11.40c	2.09c	3.01c	0.60d	1.20d	0.30d
2 tonnes	12.70c	3.17b	4.35ab	1.18c	1.91c	0.46c
4 tonnes	12.99c	3.28b	4.46ab	1.46b	1.87c	0.53c
6 tonnes	14.32	c3.63a	4.95c	1.53b	2.28b	0.63b
8 tonnes	17.59b	4.41a	5.14b	1.69b	2.88ab	0.77b
10 tonnes	21.82a	4.60a	5.48b	1.89b	2.92ab	0.76b
12 tonnes	16.87b	3.96a	6.53a	2.29a	3.33a	1.17a
LSD	3.18	1.01	0.93	0.33	0.46	0.17

Means followed by the same letter within vertical column are not significantly ($p\leq 0.05$) different

applied. The results confirms the earlier works of Aziz *et al*.[15], they reported that theleaf area of maize were significantly ($p\leq 0.05$) increased by the application of compost at different levels. It therefore evidence that the application of sawdust-piggery compost significantly improved the leaf area of maize. The application of twelve tonnes of sawdust-piggery compost increased the leaf area of maize than other treatments. The ability of compost to improve water absorption in soil helps plants to absorb nutrients sufficiently for growth and expansion of leaves[16].

Yield parameters: At harvest the cob weight of maize planted on soil amended with Sawdust-Piggery compost were significantly ($p\leq 0.05$) higher compared to control (Table 3). The application of ten t ha^{-1} of sawdust-piggery compost significantly ($p\leq 0.05$) increased the cob weight of maize compared to other treatments. Verma and Verma[17], reported that the incorporation of organic manure improve the yield of maize depending on the rate of application.

The application of 10 tonnes per hectare of sawdust-piggery compost significantly ($p\leq 0.05$) increased the grain yield of maize compared to other treatments (Table 3). It has been reported that the application of compost influence physical, chemical and biological properties of soil and therefore influences growth and yield of crops especially maize[18]. Increase in grain yield of maize can be achieved with the application of compost[19]. Tejada[20], observed that there was significant ($p\leq 0.05$) increase in the yield of maize from the application of manure.

The dry matter yield of maize planted on soil amended with Sawdust-piggery compost were significantly ($p = 0.05$) increased compared to control (Table 3). Verma and Verma[17] reported that the composted piggery manure had higher significant ($p\leq 0.05$) dry matter yield of maize compared to control. The application of twelve tonnes of Sawdust-piggery compost significantly ($p\leq 0.05$) increased the dry matter yield of maize compared to other treatments. This result also confirms the earlier work done by Marere *et al*.[21] they reported increase in dry matter yield of plants when compost was applied at a higher rate. It was also reported by Paulin and O'Malley[22] that the application of compost manure increased the yield of crops.

The nutrients uptake of maize were significantly ($p\leq 0.05$) increased with the application of sawdust-piggery compost compared to the control. Nutrients uptake were significantly ($p\leq 0.05$) higher with the application of 12 tonnes of sawdust-piggery compost compared to other treatments. Uptake of nitrogen, potassium and phosphorus were significantly ($p\leq 0.05$) increased with the application of 12 tonnes of sawdust-piggery compost. According to Ogungbe and Fagbola, fertilizer either inorganic or organic significantly ($p\leq 0.05$) increased the nutrient uptake of maize and their finding corroborate with the results obtained from this experiment. Also according to Tulsiram and Mohan[23], the application of organic fertilizer significantly ($p\leq 0.05$) enhanced the uptake of nitrogen, phosphorus and potassium in maize.

CONCLUSION

The application of sawdust-piggery compost improved the physical and chemical properties of the soils. Application of sawdust-piggery compost also improves nutrient content and nutrient uptake by plants. Application of 8-12 t ha^{-1} of sawdust-piggery compost significantly ($p\leq 0.05$) increase the plants height, leaf area and stem girth of maize compared to other treatments. Ten t ha^{-1} of sawdust-piggery compost significantly ($p\leq 0.05$) increased the cob weight and the grain yield of maize. In Conclusion, application of 10 t ha^{-1} of sawdust-piggery compost can be used to ameliorate degraded soil for improved soil nutrients for effective growth and yield of maize. The composted pig manure and sawdust help to reduce environmental pollution caused by improper waste disposal.

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