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Comparative Effects of Sawdust-Piggery Compost and NPK on the Growth and Yield of Maize in a Degraded Ultisol

Dr. Dania Stephen Okhumata
Project Supervisor, Department of Soil Science, Ambrose Alli University, Ekpoma, Nigeria
Oshidi Ayodele Francis
Project Student, Department of Soil Science, Ambrose Alli University, Ekpoma, Nigeria

Abstract
The rate of land degradation in the tropics necessitates the use of fertilizer to improve soil quality for enhancement of plant growth and yield. Two season experiments were carried out to investigate the comparative effects of different composts and NPK on the growth and yield of maize in a degraded soil was conducted at the Teaching and Research Farm of Ambrose Alli University, Ekpoma, Edo State, Nigeria. The experiment was fitted in a Randomized Compete Block Design (RCBD) with five treatments (control, composted piggery manure, piggery-sawdust, sawdust and NPK fertilizer) replicated three times. The soil samples were anaylsed before planting and after harvesting for both physical and chemical properties. The compost was applied at 15 tonnes per hectare before planting while NPK at 300 kg ha^{-1} was applied two weeks after planting. From the result, the application of organic manure reduced soil acidity, increased soil organic matter (SOM) and nutrient content of the soil, thereby increased the growth and yield of maize. The growth rate of maize was significantly ($P\leq0.05$) higher with the application of piggery manure compared to other treatments. The application of piggery manure at 15 t ha^{-1} significantly ($P\leq0.5$) increased the grain and dry matter yield to the values of 3.97t ha^{-1} and 7.30t ha^{-1} respectively compared to other treatments. The yield of maize obtained from sawdust- piggery compost was not significantly different from that of NPK fertilizer. The grain and dry matter yield were significantly ($P\leq0.05$) lower in composted sawdust with the values of 0.67t ha^{-1} and 1.46t ha^{-1} respectively. The order of significance of grain yield was: piggery compost > Sawdust-piggery compost and NPK > control > composted sawdust. In conclusion, pig composted manure significantly ($P\leq0.05$) increased the growth, grain dry matter yield of maize compared to other treatments while the yield of maize from the application of Sawdust-piggery compost and NPK(15 15 15) were not significantly different from each other.

Keywords: *Compost, piggery, growth, maize, nutrient depletion, yield*

1. Introduction

A large proportion of municipal wastes generated are not properly disposed thereby causing environmental pollution because of the presence of pathogens and other toxic substances (Darby *et al*., 2006; De Araujo *et al*., 2009). Apart from the negative effects of these municipal wastes (sawdust, woods halves, animal dungs) as an environmental pollutant, however, there are other benefits which can be derived from these wastes. These wastes can compost into organic manures. Composting can help to manage the waste, reduce environmental pollution and the products can be useful in soil fertility management. It is obvious that compost have various benefits on soil mostly in ameliorating soil degradation and increase of organic matter.

Soil degradation results to the decline in soil quality which is a major problem in agriculture as it adversely affects the growth and yield of crops. It is a serious global environmental problem as soils host the majority of the world's biodiversity. The use of fertilizer is necessary to improve fertility and sustainability of the soil. The use of synthetic fertilizers to sustain crop production is very important but not on a long-term, also, these fertilizers are not readily available. However, organic fertilizers are affordably cheap but bulky. Organic manure is preferred to synthetic fertilizer as it improves the nutrient content, nutrient recycling, activates the microbial biomass and help in improving soil structure and tilt (Mbagwu and Ekwealor, 1990).

Application of compost help to build organic carbon stock in the soil and research have proven higher grain yield of maize using compost, an average of 4.06 t ha^{-1} was reported by Ayoola and Makinde (2009). According to Ogbonna *et al*. (2012), compost application increased the growth and yield of maize significantly compost compared to inorganic fertilizer on the long run. Much work has been done using poultry manure but research on pig dungs as compost are rear. Hence, this research was focused on the comparative effects of piggery - sawdust compost and inorganic fertilizer (NPK) on the growth and yield of maize in a nutrient depleted soil.

2. Materials and Methods

The experiment was carried out at the teaching and research farm of Ambrose Alli University, Emaudo Annex, Ekpoma. Ekpoma is in the humid rainforest vegetation belt of Nigeria, lying between latitude $6^0$42' North and longitude $6^0$8' East, with an average rainfall of 1,750mm and temperature between 15^0C-34^0C.

3. Sample Collection and Analysis

Composite surface soil (0-15cm), were collected from the experimental plot before planting and after harvesting for physical and chemical properties. The treatments were; composted sawdust (15 tonnes ha^{-1}), piggery waste compost (15 tonnes ha^{-1}), sawdust-piggery compost (15 tonnes ha^{-1}), NPK (300 kg ha^{-1}) and control; five treatments replicated three times. The experiment was fitted in a Randomized Compete Block Design (RCBD). Swan-1 variety of maize was planted, three seeds per hole and later thinned to one stand three weeks after planting. Plant height, stem girth and leaf area were measured at fourth, fifth, sixth, seventh and eight weeks after panting. Grain and dry matter were determined. The data were analyzed using Analysis of Variance (ANOVA) and least significant difference (LSD) at 5% probability was used to separate means. Particle size analysis was carried out on soil sample using hydrometer method, (Bouyoucos, 1965). The pH was determined in water (ratio 1:1, soil: water) (IITA 1979). Organic carbon was determined according to the methods of Walkley and Black (1934). Available phosphorous was determined using Bray-P extraction method (Bray and Kurtz, 1945). Total Nitrogen was determined by Kjeldahl method (Bremner and Mulvaney, 1982). Potassium and sodium were determined using the flame photometer, calcium and magnesium was determined using atomic absorption spectrophotometer (IITA, 1979). Effective cation exchange capacity was determined by the summation of the total exchangeable bases and acids.

4. Results and Discussions

Soil degradation results in decline of organic matter and soil nutrient and thereby causing significant reduction in crop yield. It is therefore necessary to improve the soil quality using organic fertilizer. The pH ranges from 5.70 in control to 7.10 in piggery – sawdust compost. According to Johnson *et al*. (2006), addition of organic fertilizer increases the pH to near neutral or alkaline. Hence, organic manure has the ability to reduce soil acidity. The organic fertilizer contributed higher organic carbon to the soil than the control and NPK (Table 1). Piggery - Sawdust compost had the highest organic carbon and matter content with the values of 23.10 g kg^{-1} and 39.90 g kg^{-1}, therefore, organic manure has the ability to improve and sustain the organic matter content of the soil (Loveland and Webb, 2003). The total N and phosphorous were lowest in the composted sawdust with the values 1.40g/kg and 1.20mg/kg respectively. Sawdust was very low in Nitrogen content because of the high carbon to nitrogen ratio (C: N; 300:1). Addition of piggery manure and piggery – sawdust compost to the soil increased the nutrient content of the soil. According to Poll *et al*. (2008) and Soumare *et al*. (2003), application of manure increased the soil nutrient concentration.

Al^{3+} and H^+ was highest in the control and reduced in treatment with organic fertilizers, Al^{3+} and H^+ are responsible for soil acidity and the application of organic manure reduces acidity in soil and this confirm the work of Pitram and Singh (1993), that the application of agricultural wastes (manures) to an acid soils reduce the acid content of the soil. Piggery manure had the highest CEC and the highest ECEC value of 36.23 and 38.43 respectively. It has been reported that piggery manure had the highest cation exchange capacity and can therefore increase soil ECEC when incorporated into soil (Pedra *et al*., 2008).

Treatments	pH	OC g/kg	OM g/kg	N g/kg	P Mg/kg	K+ Cmol/kg	Mg^{2+} Cmol/kg	Ca^{2+} Cmol/kg	Na+ Cmol/kg	$A1^{3+}$ Cmol/kg	H+ Cmol/kg	Acidity Meg/100g	CEC	ECEC	Particle Size (g/kg) Sand	Silt	Clay	Textural class
Control	5.70	10.30	17.70	0.87	7.51	0.15	2.27	3.40	0.37	0.41	2.98	3.40	6.19	9.58	840	10	150	Sandy loam
Sawdust	5.90	21.50	37.10	0.40	1.21	0.04	1.88	1.80	0.15	0.39	1.01	1.40	5.86	7.26				
SPC	7.10	23.10	39.90	4.20	29.02	0.42	10.52	15.76	0.10	0.19	1.91	2.10	24.89	28.90				
Pig manure	6.80	21.80	37.70	4.50	53.12	0.54	14.15	21.21	0.33	0.17	2.03	2.20	36.23	38.43				

Table 1: Chemical and Physical Properties of Soil and Organic Fertilizers before Application
SPC = SAWDUST – PIGGERY COMPOST

4.1. Growth Parameters

The application of piggery manure significantly (P ≤0.05) increased the height of maize at fifth to eight weeks after planting compared to other treatments (Table 2). The stem girth of maize at four weeks after planting was highest in plots with the application of piggery manure but not significantly (P≤0.05) higher when compared to other treatments. At five to eight weeks after planting, pig manure significantly (P≤0.05) increased the stem girth and leaf area of maize compared to other treatments (Table 3). This increase in the growth parameter has been reported and according to Dania and Fagbola (2013), the application of organic base fertilizer significantly (P ≤0.05) increased the growth of the vegetative traits and yield of maize. The grain yield of maize was significantly (P≤0.05) increased with the application of pig manure when compared to other treatments while sawdust had the lowest grain yield. The yield of maize in soil with the application of composted pig manure was 40% and 62.4% higher than the control and the application of sawdust respectively. This confirmed the earlier work of Mallory and Griffin, (2007) and Lima *et al.* (2009), they reported that manure can have positive long-term effects on maize yield. Kihanda *et al*. (2006) reported that when organic manure was applied, crop yields increased and stabilized. The dry matter yield of the above ground biomass of maize was significantly (P≤0.05) increased with the application of pig manure. The yield of maize obtained from the application of sawdust – piggery compost was not significantly (p≤0.05) different from that of NPK mineral fertilizer. It is obvious that farmers will obtain equivalent yield of maize with the application of 15 tonnes per hectare of sawdust – piggery compost and 300 kg per hectare of NPK. The compost materials can be source locally and produced by famers, this is an added advantage of compost over mineral fertilizers which are not readily available.

Treatment	**4**	**5**	**6**	**7**	**8**
Control	22.97^{a}	34.07^{b}	58.12^{bc}	72.08^{ab}	82.09^{b}
Pig manure	25.23^{a}	59.65^{a}	85.36^{a}	106.12^{a}	131.61^{a}
Sawdust-piggery compost	24.09^{a}	44.32^{ab}	62.03^{b}	80.62^{ab}	103.36^{ab}
NPK	22.83^{a}	47.52^{ab}	69.93^{b}	90.84^{ab}	119.62^{a}
Composted Sawdust	14.25^{a}	32.63^{b}	40.67^{c}	66.40^{b}	73.84^{b}
LSD	2.43	17.28	17.85	27.10	29.61

Table 2: Effect of Sawdust-Piggery Compost on the Height of Maize (Cm) Weeks after Planting the Mean Value with the Same Letter in the Vertical Column Is Not Significantly (P≤0.05) Different Using LSD

Treatment	4	5	6	7	8
Control	8.82	10.67^{bc}	12.67^{ab}	10.67^{c}	10.89^{c}
Pig manure	11.35	13.22^{a}	14.44^{a}	16.11^{a}	17.44^{a}
Sawdust-piggery compost	9.47	10.55^{bc}	13.22^{ab}	15.56^{a}	16.55^{ab}
NPK	10.11	11.33^{b}	13.44^{a}	14.11^{ab}	16.44^{ab}
Sawdust	7.40	9.44^{c}	10.89^{b}	10.33^{c}	11.22^{c}
LSD	Ns	0.98	2.20	2.24	1.25

Table 3: Effect of Sawdust-Piggery Compost on the Stem Girth of Maize (Mm) Weeks after Planting

The mean value with the same letter in the vertical column is not significantly (P≤0.05) different using LSD.

Treatment	**4**	**5**	**6**	**7**	**8**
Control	140.54	183.39^{b}	239.75^{b}	253.21^{c}	326.23^{c}
Pig manure	164.07	318.40^{a}	451.21^{a}	531.80^{a}	614.72^{a}
Sawdust-piggery compost	148.11	181.00^{b}	295.45^{b}	371.74^{b}	470.65^{b}
NPK	159.25	209.44^{b}	307.08^{b}	368.65^{b}	478.46^{b}
Sawdust	137.70	175.71^{b}	183.94^{b}	208.86^{c}	326.54^{c}
LSD	NS	95.5	151.8	100.6	131.1

Table 4: Effect of Sawdust-Piggery Compost on the Leaf Area of Maize (Cm^2) Weeks after Planting

The mean value with the same letter in the vertical column is not significantly (P≤0.05) different using LSD

Treatment	**Grain Yield**	**Dry Matter Yield**
Control	1.26^{c}	2.14^{bc}
Pig manure	3.94^{a}	7.30^{a}
Sawdust-piggery compost	2.76^{b}	5.53^{a}
NPK	2.78^{b}	6.17^{a}
Sawdust	0.67^{d}	1.46^{c}
LSD	0.48	1.95

Table 5: Grain and Dry Matter Yield of Maize (T Ha^{-1})

The mean value with the same letter in the vertical column is not significantly (P≤0.05) different using LSD.

5. Summary and Conclusion

The experiment was carried out at the Teaching and Research Farm, Ambrose Alli University, Ekpoma, Edo State, Nigeria to investigate the comparative effects of piggery - sawdust compost and NPK fertilizer on the growth and yield of maize in degraded soil. The application of composted piggery manure and sawdust – piggery increased the nutrient content of the soil.

The application of composted pig manure has significant positive influence on the growth and yield of maize. Pig manure at the rate of 15 tonnes per hectare significantly ($P \leq 0.05$) increased the growth and yield of maize compared to other treatments. From the experiment, farmers can be encouraged to incorporate pig manures for effective soil management. It is evident that pig manure when properly applied increased the growth, yield of maize as well as the soil nutrient content.

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