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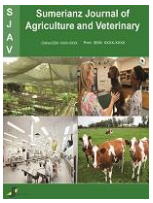

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Improvement of Soil Nutrient and Yield of Maize Through the Application of Different Rates of Sawdust - Piggery Compost Fortified With Urea

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Abstract

Fortification of compost with inorganic fertilizer is necessary to compliment for some deficient nutrient in organic manure to improve soil fertility and crop yield. This experiment was carried out at Ambrose Alli University Teaching and Research Farm, Ekpoma, Nigeria and it was fitted in a Randomized Complete Block Design (RCBD) with seven treatments replicated thrice. The treatments were; Control, 2 tonnes of saw dust piggery compost + 75Kg/ha of urea, 4 tonnes of sawdust piggery compost + 75kg of urea, 6 tonnes of sawdust piggery compost + 75kg of urea (75kg Urea +6 SPC), 8 and 10 tonnes of compost, 150kg/ha of urea. Data collected were analysed using ANOVA and LSD was used to separate means. It was observed from the initial soil test that the soil nutrients status was below critical levels and this necessitate the application of the fertilizer to improve the fertility status of the soil. The application of 75kg Urea + 6 SPC significantly ($p \leq 0.05$) increased the soil nutrient status compared to other treatments. The growth, cobs weight, dry matter and grain yield of maize were significantly ($p \leq 0.05$) higher with application of 75kg Urea +6 SPC compared to other treatments. Also, the nutrient uptake of maize was significantly ($p \leq 0.05$) higher with application of 75kg Urea + 6 SPC. In conclusion, the application of 75kg Urea +6 SPC significantly ($p \leq 0.05$) increased the soil nutrient status, growth and the yield of maize.

Keywords: Fortification; Growth; Maize; Nutrient status; Uptake; Yield.

1. Introduction

Soil degradation is the decline in soil quality due to excessive human pressure and poor management of the land. Over the years, grain yields have drastically reduced due to degrading nature of the soils and poor fertility management. It was therefore necessary to ameliorate the decline soil quality through the application of organic base fertilizer which could be derived from farm or municipal waste.

In many countries, a considerable proportion of farm or municipal waste are not properly disposed constituting a potential environmental threat due to the presence of pathogens and toxic pollutant. These wastes can be harnessed into useful products such as compost for the improvement of soil quality [1]. Compost is a stable aerobically decomposed organic matter resulting from micro-organism breakdown and transforms organic material into a range of increasingly complex organic substances, which has beneficial effects when added to the soil as fertilizer [2].

Composting reduces the rate of waste disposal and environmental pollution. Efficient and optimal use of compost depends on a better understanding of the relationship between compost property and their effects on soils.

The application of mineral fertilizers alone cannot improve the organic matter content of soil also with the sole application of compost; it will be required in very large quantities also deficient in some mineral elements. To improve soil fertility and make up for some nutrient deficiencies in organic manure there is need to fortify organic fertilizer with mineral fertilizer. Compost also has the ability to improve physical, chemical and biological the properties of the soil and it combination with urea will improve soil quality and crop yield. In the humid region, the growth of maize is highly affected by low fertility status arising from erosion and leaching. The integrated use of compost and urea will boost the yield of maize which is an important source of food and replenish the soil organic matter.

The loss of organic matter is one of the most essential threats of soil functions in agricultural lands and these could be solved by the integrated application of compost and urea. The combined application have been reported to increased the yield of maize significantly and sustain the soil nutrients [3]. A lot of researches have been carried out on poultry compost but researches on piggery compost are rare. Therefore, it is the objective of this study to evaluate the integrated application of sawdust-piggery compost and urea on the yield of maize and soil properties.

2. Materials and Method

2.1. Description of Experimental Site

The experiment was carried out at the Teaching and Research Farm of Ambrose Alli University Ekpoma, Nigeria. The location lied between Latitude 6^{o} 42' N and Longitude 6^{o}8' E, with an annual average rainfall of 1500 mm and temperature between 15^{o}C – 34^{o}C.

2.2. Collection of Samples

The top soil (0-15cm), were collected from the experimental site prior to the experiment with the aid of soil auger. The soil was dried, sieved and the samples were analysed for both chemical and physical properties. Particle size analysis was carried out using hydrometer method [4]. The pH was determined in water (ratio 1:1; Soil : water) [5]. Organic carbon was determined by wet dichromate method [5] and available P in the soil was determined using Bray -1 extraction method [6]. Total nitrogen was determined by Kjeidhal method [7]. For exchangeable cations (K, Ca, Na and Mg), K was determined using atomic absorption spectrophotometer [5]. Effective cation exchange capacity was determined by the summation of the total exchangeable bases and exchangeable acidity.

2.3. Plant Sample Analyses

A measure of 1g of the plant material was put into ashing crucible, placed in a muffle furnace, switched on and allows standing at the prescribed temperature for 3hours. Then switched off and allowed to cool down just enough to touch, recovered from the furnace, add 10ml and 20% nitric acid and filter into 100ml standard flask, make up to volume with distilled water and determine K with flame photometer through 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 by blue ammonium molybdate method (standard method). Nitrogen (N) was determined using macro Kjedhal method where 0.1g of plant samples was accurately weighed into digestion tube, 2ml of concentrated sulphuric acid and 1 tablet of Selenium catalyst was added and digested on the hot plate until the solution becomes clear and allows to cool down and filtered into 100ml standard flask, make to volume with distill water and determine the nitrogen content with its standard method.

2.4. Experimental Design

The experiment was laid in a Randomized Completely Block Design (RCBD) with seven treatment replicated thrice; Suwan 1 SR maize variety was planted. The treatment were; Control; 2 tonnes of saw dust piggery compost + 75Kg/ha of urea (75kg Urea + 2 SPC), 4 tonnes of sawdust piggery compost + 75kg of urea (75kg Urea + 4 SPC) , 6 tonnes of sawdust piggery compost + 75kg of urea (75kg Urea + 6 SPC), 8 tonnes of compost, 10 tonnes of compost, 150kg/ha of urea (total of 21 plots).

2.5. Land Preparation and Management Operation

Land preparation (Clearing, packing and mapping) was done manually. Planting area was 16m X 16m. Trial was laid in 21 plots, each plot measuring 1.8m X 1.8m. Planting was done at the rate of three seeds per stand and later thin to one seedling per stand; planting distance was 75cm x 25cm within and between rows. Weeding was done manually at 4 and 8 weeks after planning. The cobs, grain yield and above ground biomass were determined

2.6. Compost

The baskets method was used and the compost was cured after three months. The compost was air-dried for 2 weeks before application. The compost was applied three week after planting using ring method of application.

2.7. Data Collection

Plant height (cm), stem girth (mm), and leaf area (cm^2), were measured at 4, 6, and 8 weeks after planting. Measuring tape was used to measure the plant height and leaf area while Vanier caliper was used to measure the stem girth.

Leaf Area = L X W X 0.75 [8].

Nutrient uptake = Dry Matter yield (Kg) x Nutrient content (%)

Data collected on growth, yield and yield components were analysed statistically using Analysis of Variance (ANOVA) and the means were separated using the Least Significant Difference (LSD).

3. Result and Conclusion

3.1. Soil Analysis

Soil nutrient depletion as a result of continuous cultivation of soil without adequate addition of extra inputs is a major constraint for higher crop production. Organic matter plays a crucial role in improving physical, chemical and biological properties. Compost does not only act as a source of nutrient, but also improve soil characteristics.

The physical and chemical properties of soil on which the experiment was conducted are presented in Table 1. The pH range from 5.4 to 6.6 with application of 8 and 10 tonnes/hectare of sawdust piggery compost. The initial pH value of soil sample was slightly acidic (5.9) while the control was acidic (5.4). The varying pH at different level of compost application is attributed to the ability of compost to reduce acidity [9].

The total organic carborn content increased from 15.64 in control to 27.70 in soil amended with 10 tonnes/hectare of sawdust piggery compost. The application of organic manure increased the organic carbon as observed in the experiment, which confirms the earlier work of Leifeld, *et al.* [10]. They reported that the incorporation of compost derived from waste increases soil organic matter. Available phosphorus ranges from 12.26mg/kg in control to 40.44mg/kg in soil amended with 10 tonnes/hectare of sawdust piggery compost. Calcium level ranged from 2.18 in control to 3.63 in soil amended with 75kgurea+2 tonnes/hectare of sawdust piggery compost. The initial soil sample had the lowest level of sodium (Na) compared with soils amended with organic manure, but they are all below the critical level of 10cmol/kg. The critical level for magnesium was 2.00cmol/kg, the initial soil sample and soil amended with 75kgurea+4 tonnes/hectare of sawdust piggery compost had magnesium content lower than the critical level and this confirms the report of Isitekhale, *et al.* [11]. The particle size distribution of soil before and after application of organic manure was sandy loam.

After the first cropping season, the application of 10 tonnes/hectare of sawdust piggery compost had the highest nitrogen content. The incorporation of 10 tonnes/hectare of sawdust piggery compost increased the ECEC of the soil than other treatments.

Table-1. Physical and Chemical properties of the soil and compost fortified with urea fertilizer

Treatments	g/kg **O.C**	**pH**	g/kg **N**	Mg/kg **P**	Coml./kg									SAND	SILT g/kg	CLAY	TEXTURAL CLASS
					Ca	Mg	Na	K	CEC	ECEC	Al^{3+}	H^{+}	EA				
Initial soil sample	16.0	5.9	1.34	15.21	2.32	1.59	0.71	0.07	4.60	5.20	0.09	0.51	0.60	820	30	150	Sandy loam
Control	15.64	5.4	1.28	12.26	2.18	1.12	1.03	0.03	4.36	4.96	0.07	0.53	0.60	840	10	150	Sandy loam
75kg Urea + 2 SPC	17.99	6.1	6.42	28.69	2.29	1.61	1.17	0.04	5.11	5.31	0.04	0.16	0.20	850	10	140	Sandy loam
75kg Urea + 4 SPC	18.59	6.3	6.75	25.34	2.55	1.70	1.17	0.03	5.45	5.75	0.04	0.26	0.30	800	30	170	Sandy loam
75kg Urea +6 SPC	18.96	6.4	7.29	28.78	2.84	1.89	1.69	0.04	6.46	6.76	0.03	0.27	0.30	820	30	150	Sandy loam
8 SPC	24.99	6.6	6.41	26.88	3.06	2.04	1.25	0.02	6.68	6.78	0.04	0.36	0.40	820	30	150	Sandy loam
10 SPC	27.70	6.6	6.88	28.44	3.06	2.04	1.56	0.02	6.68	7.08	0.03	0.37	0.40	830	10	160	Sandy loam
150kg Urea	15.92	5.7	7.37	21.40	2.84	1.89	1.56	0.05	6.29	6.79	0.07	0.43	0.50	810	30	160	Sandy loam
OMF	21.18	8.18	4.16	28.373	8.86	5.45	19.62	13.33	47.26	56.46	5.00	4.20	9.20				

SPC= sawdust piggery compost
OMF= organomineral fertilizer

3.2. Growth Parameters

No significant different was observed on the height of maize at four weeks after planting at 6 and 8 weeks after planting, the application of 75kg urea+ 6 tonnes/ hectare of sawdust piggery compost increased the height of maize compare to other treatments except for 8 tonnes, 10 tonnes of compost and 150kg ha^{-1} of urea (Table 2). These increases in plant growth confirms the earlier work of Oworu, *et al.* [12], they reported that compost + mineral fertilizer application can stimulate plant growth and root development. It was also reported that manure application positively influence the growth of maize [13]. Ayoola and Makinde [14] reported increase in the height of maize from the combined application of inorganic and organic manure.

There was no significant ($P \leq 0.05$) different in stem girth among treatment at four weeks after planting (Table 3). At Six and eight weeks after planting, the stem girth was significantly ($P \leq 0.05$) increased with the application of 75kg urea+ 6 tonnes/ hectare of sawdust piggery compost compare other treatments except for 8 tonnes, 10 tonnes of compost and 150kg ha^{-1} of urea. It has been reported by Aziz, *et al.* [15] that maize stem girth and other vegetative growth of maize were positively influenced by the application of fertilizer and it confirmed the results obtained from this experiment.

The application of 75kg urea + 6 tonnes/ hectare of sawdust piggery compost significantly ($P \leq 0.05$) increased the leaf area of maize throughout the growth season compared to other treatments (Table 2). The application of fertilizer either sole or combination of compost and mineral fertilizer results in the increase of plant growth and this increase are attributed to the high amount of nutrient in the fertilizer [16]. Compost can be used as a potential resource of essential nutrition for crop production, its application can provide sufficient nutrient for plant growth

[17]. According to the earlier work of [17], combined application of organic and inorganic fertilizer increased stem girth, leaf area of maize than single fertilizer application. According to Zandonadi, *et al.* [18] that humic substance, the major component of soil organic matter in compost can increase shoot biomass through hormonal effect on the root elongation and plant development.

Table-4. Effect of different rate of sawdust piggery compost fortified with urea on the growth parameters of maize.

Treatments	Height (cm)			Stem girth	(mm)		Leaf area (cm^2)		
	Wk 4	Wk6	Wk8	Wk4	Wk6	Wk8	wk4	Wk6	Wk8
	8.73	18.87b	38.90c	7.76	13.93d	25.37d	256.70c	520.06c	758.41e
	9.33	29.53a	46.50ab	8.04	15.97c	28.67c	269.60c	588.16bc	876.14d
Control	8.73	18.87b	38.90c	7.76	13.93d	25.37d	256.70c	520.06c	758.41e
75kgurea+ 2tha^{-1} c	9.33	29.53a	46.50ab	8.04	15.97c	28.67c	269.60c	588.16bc	876.14d
75kgurea+4t ha^{-1} c	11.20	32.57a	48.82ab	8.40	20.00b	33.80b	264.30c	620.86bc	908.46d
75kgurea+6tha^{-1}c	10.94	32.56a	49.06a	8.56	23.87a	49.00a	385.09a	776.67a	1281.64a
8tha^{-1}	10.94	28.17a	51.66a	8.01	24.16a	43.01a	293.41b	686.98b	1006.46c
10tha^{-1}	10.06	29.87a	53.44a	8.22	24.18a	46.01a	294.01b	702.65b	1106.81b
150$kgha^{-1}$ urea	10.80	32.06a	54.16a	8.16	24.60a	48.03a	292.01b	714.09b	1001.46c
LSD	NS	6.30	6.30	NS	2.01	3.04	21.72	66.02	96.46

The mean values with the same letter in the vertical column are not significantly (P≤0.05) different using LSD Legend

75kgurea+2 t/C – 75 kg urea +2 tonnes of compost
75kgurea+4 t/C -75 kg urea +4 tonnes of compost
75kgurea+6 t/C -75 kg urea +6 tonnes of compost
8 t/C - 8 tonnes of compost
10 t/C - 10 tonnes of compost

3.3. Yield Parameter

The cob weight of maize was significantly (P≤0.05) increased with the application of fertilizer compared to control. However, the application of 75kgurea+6 tonnes/hectare of sawdust piggery compost had the highest cob weight compared to other treatments. It was observed that the grain yield of maize was significantly (P≤0.05) increased with the application of 75kgurea+6 tonnes/hectare of sawdust piggery compost compared to treatments. The cob, grain and dry matter weight were significantly (P≤0.05) increased with the application of 75kgurea+6 tonnes/hectare of sawdust piggery compost with the values of 16.34 tonnes / hectares, 4.05 tonnes / hectares and 7.37 tonnes / hectares respectively. According to Daina and Fagbola [19] combined application of compost and mineral fertilizer significantly (P≤0.05) increased the yield of maize in degraded soil. Application of ten tones of compost per hectares was not significantly (P≤0.05) different from that of 150 kg per hectare of urea fertilizer. It showed that the application of ten tonnes was equivalent in yield to that 150 kg of urea. The dry matter yield of maize was significantly (P≤0.05) increased with the application of 75kgurea+6 tonnes/hectare of sawdust piggery compost. Akanbi [20] reported that availability of essential nutrient in adequate quantity and form enhanced protoplasmic development and cell proliferation which enhanced crop yield. Makinde, *et al.* [21] reported significant increase in maize yield from the combine application of mineral fertilizer and organic manure. The increase in yield could be due to the synergetic effects of compost and mineral fertilizer.

Nutrient uptake was significantly (P≤0.05) increased with the application of (P≤0.05) increased with the application of 75kgurea+6 tonnes/hectare of sawdust piggery compost; with ease in nitrogen, phosphorus and potassium. The application of 4 tonnes of sawdust piggery compost + 75kg of urea, 8 tonnes, 10 tonnes of compost and 150kg/ha of urea did not showed significant difference in nitrogen, phosphorus and potassium, however, the treatments were significantly higher in nitrogen, phosphorus and potassium compared to control and 2 tonnes of sawdust piggery compost + 75kg of urea. Also according to Tulsiram and Mohan [22], the integrated application of organic and inorganic fertilizer significantly (p≤0.05) enhanced the uptake of nitrogen, phosphorus and potassium in maize. According to Ogungbe and Fagbola [23] the application of fertilizer significantly (p≤0.05) increased the nutrient uptake of maize and the finding corroborate with the results obtained from this experiment.

Table-5. Effect of different rate of sawdust piggery compost fortified with urea on the cob weight, grain yield, dry matter yield and nutrient uptake of maize

	t/ha			Nutrient uptake (t/ha)		
Treatments	Cob wt.	Grain yield	Dry matter yield	N	P	K
Control	10.45c	2.11c	3.50d	0.67e	0.78e	0.70c
75kgurea+2 t/C	14.49ab	3.13b	4.48c	0.93e	1.22d	0.85c
75kgurea+4 t/C	12.68b	3.47b	5.94b	2.68b	3.17b	1.42b
75kgurea+6 t/C	16.34a	4.42a	7.37a	3.73a	3.69a	1.94a
8 t/C	13.80ab	3.31b	6.24b	2.66b	3.19b	1.93a
10 t/C	15.11a	3.56b	6.24b	2.80b	3.20b	1.41b
150kg urea	14.22ab	3.48b	6.37b	2.56c	3.13b	1.45b
LSD	2.89	0.51	0.49	0.30	0.30	0.29

The mean values with the same letter in the vertical column are not significantly (P≤0.05) different using LSD Legend

75kgurea+2 t/C – 75 kg urea +2 tonnes of compost
75kgurea+4 t/C -75 kg urea +4 tonnes of compost
75kgurea+6 t/C -75 kg urea +6 tonnes of compost
8 t/C - 8 tonnes of compost
10 t/C - 10 tonnes of compost

4. Summary and Conclusion

An experiment was carried out at the Teaching and Research Farm of Ambrose Alli University Ekpoma, Edo State, to assess the effect of different rate of sawdust piggery compost fortified with Urea on the growth, yield of maize and soil properties on degraded soil. The result of soil analyses revealed that the application of 10 tonnes of compost and75kgurea+6 tonnes/hectare of sawdust piggery compost significantly ($P \leq 0.5$) improved the soil fertility status. Sole compost 10 tonnes / hectares and combined application of Urea at 75kgurea+6 tonnes/hectare of sawdust piggery compost significantly ($P \leq 0.5$) increased the growth of maize compared to other treatments. The application of 75kgurea+6 tonnes/hectare of sawdust piggery compost had the highest grain yield with the value 4.42 tonnes/hectare. Farmers can be advised to apply 75kgurea+6 tonner/hectare of sawdust piggery compost to avoid wastage of Urea and organic manure for effective crop production.

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