EFFECTS OF SELECTED WASTES ON SOME CHEMICAL PROPERTIES IN AN ALFISOL, DELTA STATE.

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ABSTRACT

This work reported the effects of wastes (food wastes, swine wastes and bat droppings) on chemical properties in an Afisol of Asaba campus, Delta State University. In this work, Randomized Completely Block Design (RCBD) was used as the experimental designed with four treatments, reproduced into three blocks. Chemical properties investigated were soil pH, available phosphorus, total nitrogen, organic carbon and organic matter, exchangeable bases (Calcium, Magnesium, potassium and sodium) exchangeable acidity, effective cation exchange capacity and percentage base saturation. Analysis of Variance (ANOVA) was used to investigate chemical properties while separation of mean was differentiated using Fisher's Least Significant Differences (FLSD). Soil pH, calcium, magnesium, ECEC and %BS showed that the incorporation of bat droppings gave an apex records of 7.10, 12.8cmolkg^{-1}, 6.8cmolkg^{-1}, 20.685cmolkg^{-1} and 97% respectively. Soil total nitrogen, organic carbon, organic matter, K and Na had best values when compared with other chemical properties under plots of swine wastes (T_2) with highest records of 0.303%, 7.98% 13.76% , 0.199 and 0.244 while available phosphorus was highest with 68.10mgkg^{-1} under T3(BD) with non significant difference (P<0.05) among treatments. Exchangeable acidity was highest with 0.96cmolkg^{-1} in plots of treatment zero (T_0).

Keywords: chemical properties, chemistry nutrition, nutrient elements, food wastes, swine wastes, bat droppings.

INTRODUCTION

Organic materials are major sources of nutrients for crops and soils. They also improve the qualities of micro and macro available nutrient elements. Incorporation of organic dung in soils, has positive effect on biochemical variables due to soil organic matter increase (Masto, *et al.*, 2007). Soil chemical fertility maintenance to increase the productivity of crop grain yield, is a `serious concern around the tropical region. When a soil is cultivated continuously, its productivity gradually decreases due to depletion of organic matter believed to be a reservoir of plant chemical nutrients (Eneje and Uzoukwu, 2012). Wastes materials added to the soils with the help of the degrading factors, ensure the sustainability of the land and protect the productivity of crops. Organic wastes is used as regulators to meet the nutrient requirements of the plants as well as many functions of soils (Demir and Culser, 2015; Alabadan *et al.* 2009). Hence, research attention has recently shifted to the recycling of various decomposing materials that are abundantly produced (Nwajiuba and Chimezie, 2000). Efforts should be made to use manure amendments in producing edible roots and green crops in Nigeria. Recycling of these amendments, into value-added products as soil conditioners, can decrease disposal costs and recycle nutrients for maintaining and improving soil quality and crop growth (Nathan *et al.*, 2015). Over the years, peasant farmers indulge in supporting the nutrient status of their farmland with inorganic fertilizers which are sometimes scarce and unavailable. It may also have hazardous residual outcome or changes on soils and its structure. Manures such as food wastes, swine waste and bat droppings are natural fertilizer which are easily available, cheap and within the financial capacity of poor based peasant farmers. Varieties of soil amendments are primarily derived from plant materials, animal manures and litters to agricultural by products (Green, 2015). Even though nutrient status of a soil is an unseen factor during growth process, researchers and producers can remedy soil nutrient reactions by managing and maintaining the soil fertility status through composted manure, animal manure and crop residues (Flynn, *et al.*, 2004). Consequently, soil productivity and capability to produce crops under a well defined management system and environmental conditions, has diminished to an extreme deterioration (Ghosh, 2017). Since soil productivity is a function of SOM management and interaction, it then becomes imperative to evolve sustainable management system of food wastes, swine wastes and bat droppings to elevate the existing low soil nutritional conditions.

MATERIALS AND METHODS

This research was experimented at the Research Farm, Department of Agronomy, Faculty of Agriculture, Delta State University, Asaba Campus. This experimental farm is located at latitude 6º12^{I} N and 6º43 ^{I} E, with annual rainfall between 1500-1850mm. The peak of rainfall is between July and September (Ministry of Aviation, 2016). The temperature is between 27^{0}C - 30^{0}C and humidity ranging between 68-85%.

Analysis of the initial soil samples

Previous to the preparedness of land, collection of soils at different sampling points was done within the depth of 0 - 30cm, using soil augar. Collected samples were bulked together and carefully mixed to form a composite sample. The composite sample was prepared and packaged for the determination of routine analysis in the laboratory.

Field Methods

Preparation of experimental site was done by clearing of the existing bushes and the debris removed and site segregated into 2m by 2m, given $4m^2$ of plot size.

Design of the experiment and details of treatment: The design was in Randomized Completely Block Design (RCBD) with four treatments as treatment zero(T_0), (T_1=10kg of food wastes), (T_2 =10kg of swine wastes) and (T_3 =10kg of bat droppings duplicated three times.

Chemical properties studied:

Soil pH **(**H_2O**)**: Soil pH was examined in soil/water ratio of 1:2.5 using a glass electrode pH meter as explained by Mclean, (1982).

Kjeldah digestion procedure as modified by Bremner and Mulvancy, (1982) investigated and determined TN. Organic carbon (%) was developed by Walkley and Black method as modified by Nelson and Sommers, (1982).

Available phosphorus ($mgkg^{-1}$) was determined using Bray 2 extract as modified by Olsen and Sommers, (1982).

Exchangeable bases **(**$cmolkg^{-1}$) like (Ca, k, and Na) were illustrated by the method developed by Juo, (1999) while Magnesium(Mg) was investigated using a method described by Tel and Rao, (1982).

Total exchangeable acidity (cmol kg^{-1}): This was carried out using a method explicated by Tel and Rao, (1982).

The determination of ECEC was by summation method, that is the sum of exchange bases and total exchange acidity as shown in equation (1)

$ECEC = TEB + TEA$ ………………..(1)

Where

ECEC = Effective cation exchang capacity (cmol kg^{-1}); TEB = Total Exchangeable bases (cmol kg^{-1}); TEA =Total Exchangeable Acidity (cmol kg^{-1})

$\%Base\ saturation = \frac{TEB}{ECEC} \times \frac{100}{1}$……. (2)

Analysis of data

Data collected for chemical properties were evaluated by Analysis of Variance (ANOVA), as developed by Martin, (2008). Means of treatments were separated from each other by the Fisher's Least Significant Differences (FLSD) and significance differences were obtained at $P<0.05$.

RESULTS AND DISCUSSIONS

Pre treatment soil test.

The values of the Pre soil test results as shown in Table 1, revealed that the class of soil was SL (sandy loam) of which sand was 85.2% , silt 8.20% and clay 6.60%. This statement corroborated with Anikwe, (2000). Soil pH was 5.70 (H_2O) indicating slightly acid soil (Landon, 1991). Soil available phosphorous was 40.2 $mgkg^{-1}$ indicating high rating value, according to Enwezor *et al.*,(1989). Recorded total nitrogen (0.250%) was medium and low for organic carbon (1.94) according to rating by Landon, (1991). The values for exchangeable basic cations were low according to the critical limit for agricultural productivity by FAO, (1976) with Ca - Na measuring 7.22, 3.60, 0.122 and 0.151 $cmolkg^{-1}$ respectively. For EA, the recorded value was 0.96 and ECEC was 12.053cmolkg-1 and %BS was 92.0 %.

Table 1: Pre treatment soil properties

Chemical properties	Values	Units
Sand	85.2	%
Silt	8.20	%
Clay	6.60	%
Textural class	Sandy loam	
pH	5.70	H2O
AP	40.2	Mg/kg
N	0.250	%
OC	1.94	%
OM	3.34	%
Ca	7.22	cmolkg-1
Mg	3.60	cmolkg-1
K	0.122	cmolkg-1
Na	0.151	cmolkg-1
EA	0.96	cmolkg-1
ECEC	12.053	cmolkg-1
BS	92	%

Source: Laboratory analysis (2020), AP=Available phosphorus, N=Nitrogen, OC=Organic carbon, OM=Organic matter, Ca=Calcium, Mg=Magnesium, Na=Sodium, K=Potassium, EA=Exchangeable acidity, ECEC=Effective cation exchange capacity, BS=Base saturation

The laboratory analysis of the wastes(Table 2), recorded 5.86, 78 2.02 and 2.0 as highest values recorded for pH OM, K and Mg in swine waste, 10.4 for TN in bat droppings but 5.20 and 1.09 for available phosphorous Calcium in hotel food waste.

Table 2: Chemical compositions of organic materials (food wastes, swine wastes and bat droppings)

Chemical properties	Food wastes	Swine wastes	Bat droppings
pH	5.62	5.86	5.58
Total Nitrogen	9.20	9.60	10.4
Avail Phosphorus	5.20	3.10	3.22
Organic matter	75	78	70
Potassium	2.02	2.08	1.0
Calcium	1.09	1.08	1.0
Magnesium	1.0	2.0	1.0

Source: Laboratory analysis (2020)

Treatment figures recorded for soil pH, AP, TN, SOC and SOM is displayed in Table 3. Out of other properties, only SOC and SOM sported significant differences ($P<0.05$). Soil pH ranged from 5.8 in treatment zero(T_0) as most minimum to 7.10 for T3(BD) as highest. AP, TN, OC and OM were highest with 70.10 mgkg^{-1}, 0.322%, 7.98% and 13.76% respectively for treatment T_2 (SW) whereas treatment zero(T_0) had lowest of 40.90mgkg^{-1}, 0.280%, 1.98% and 3.41% respectively. The increasing array for pH, was that T_3 (BD) > T_1 (FW) > T_2 (SW) > treatment zero(T_0) while avail phosphorus, total nitrogen, organic C and organic M were in similar direction of increase as; T_2(SW)> T_3(BD)> T_1(FW)> treatment zero(T_0) respectively. Treatments on soil pH showed that T_3(BD) increased over treatment zero(T_0) to T_2(SW) by 10.1 -1.43% for avail phosphorus, T_2(SW) enhanced over treatment zero(T_0), T_1(FW) and T_3 (BD) by 1.44% - 26.3% and for total nitrogen, was higher by 6.04% - 6.98% while, for organic C and organic M, T_2(SW) was increased by 46.54% - 60.3% than other treatments. Improvement on the nutritional status of the organic amendments, implies that food wastes, swine wastes and bat droppings could function as soil management and sustainable products for crop growth. In support of this study, Saluko, (2008) explained that poultry manure improved surface phosphorus, total nitrogen, soil pH and organic carbon in amended plots than in treatment zero(T_0) soils. Recorded rates of exchangeable bases(Table 4), represented none significance between treatments. Calcium and Magnesium were recorded highest as 12.80 and 6.80 cmolkg^{-1} under plots of bat droppings (T_3 (BD) while lowest occurred under treatment zero(T_0) as 7.24 and 3.66 cmolkg^{-1}. Potassium and sodium values recorded were 0.199 and 0.244cmolkg^{-1} under plots of swine wastes (T_2) as highest, while lowest values occurred under treatment zero(T_0). Calcium and Magnesium values were not different in the trend of increase (T_3 (BD) >T_2(SW)> T_1(FW)> treatment zero(T_0) whereas K and Na were exactly similar in the sequence increase as T_2(SW)> T_3(BD)> T_1(FW)> treatment zero(T_0) respectively. However, plot amended with T_3 (BD) on calcium increased over treatment zero(T_0), T_1(FW) and T_2(SW) by 27.74%, 20.76% and 12.3%. Also, under magnesium, T_3(BD) increased over treatment zero(T_0), T_1(FW) and T_2(SW) by 30.02%, 1.5% and 9.7% respectively. For potassium and sodium, plots of T_2 (SW) rated better than treatment zero(T_0), T_1 (FW) and T_3 (BD) by 22.5%, 9.94%, 5.3% and 21.7%, 19.32% and 3.82% respectively. Generally, it was observed that plots of amendments, recorded higher values over treatment zero(T_0). Remarkably exchangeable cations recorded, were improved in the plots with amendments than the treatment zero(T_0). This was an indication that these wastes applied contributed positively to the increase on Ca, Mg, and Na relative to treatment zero(T_0). According to results, Adenawoola and Adejoro, (2005) had similar report that, the increase in soil fertility depends on the usage of manures as soil amendments and other wastes which can increase and improve soil organic matter, total nitrogen phosphorus, Ca, Mg, K and Na content. The effects of food wastes, swine wastes and bat droppings on EA, ECEC and %BS are recorded in Table 5. Values of exchange acidity ranged from 0.68 – 0.96 cmolkg^{-1}, for ECEC, values ranged from 12.143 – 20.685 cmolkg^{-1} and grades for base saturation ranged from 92.1 – 97.0 cmolkg^{-1} that is from treatment zero(T_0) to T_3(BD) respectively. There was similar trend of increase for both ECEC and %BS as ; T_3(BD)> T_2(SW)> T_1(FW)> treatment zero(T_0) but exchangeable acidity had its increment as follows; treatment zero(T_0)> T_1(FW)> T_3 (BD)>T_2(SW). It was observed that effective cation, exchange capacity and base saturation under T_3(BD) was greater than T_2(SW) – T_0(control) by 8.15 – 26.04% for Effective cation exchangeable capacity, was greater over T_1(FW) and T_0(control) by 1.04% and 2.59% and for base saturation, T_3(BD) and T_2(SW) were at zero statistical differences. Also, treatment zero(T_0) was raised above T_1(FW) – T_3(BD) by 9.1%, 17.1% and 5.5% for EA. Applied food wastes, swine wastes and bad droppings on soil effective cation, exchange capacity and percentage base saturation, was noticed to have increased in soils with amendments but decreased exchangeable acidity. Similar work to this present study was highlighted by Soremi *et al.,* (2017) that the concentrations of ECEC and %BS were significantly increased in soils amended with poultry manure relative to the treatment zero(T_0) while exchangeable acidity was lowered in the amended plots but increased treatment zero(T_0) soils.

Table 3: Effects of food wastes, swine wastes and bat droppings on soil pH, Available phosphorus to nitrogen, organic carbon and organic matter

Chemical Properties	Soil pH (H_2O)	Avail phosphorus (mgkg-1)	Total nitrogen (%)	Organic carbon (%)	Organic matter (%)
Treatments					
zero(T_0)	5.80	40.90	0.280	1.98	3.41
T_1 (FW)	6.90	65.20	0.294	2.76	4.76
T_2 (SW)	6.80	70.10	0.322	7.98	13.76
T_3 (BD)	7.10	68.10	0.303	2.91	5.02
FLSD	NS	NS	NS	1.19	1.16

(FW)=Food wastes, (SW) =Swine wastes, (BD)= Bat droppings

Source: Laboratory analysis (2020)

Table 4: Effect of food wastes, Swine wastes and Bat droppings on Calcium (Ca), Magnesium (Mg), Potassium (K) and Sodium (Na) cmolkg^{-1}.

Chemical Properties	Calcium (Ca2+) Cmolkg-1	Magnesium (Mg2+) Cmolkg-1	Potassium (K+) Cmolkg-1	Sodium (Na+) Cmolkg-1
Treatments				
zero(T_0)	7.24	3.66	0.126	0.157
T_1(FW)	8.40	6.60	0.163	0.165
T_2(SW)	10.00	5.60	0.199	0.244
T_3(BD)	12.80	6.80	0.179	0.226
FLSP	NS	NS	NS	NS

(FW)=Food wastes, (SW)=Swine wastes, (BD)= Bat droppings

Source: Laboratory analysis (2020)

Table 5: Effect of food wastes, swine wastes and Bat droppings on exchangeable acidity, effective cation exchange capacity (cmolkg^{-1}) and percentage base saturation (%)

Chemical properties	Exchangeable acidity (EA) (cmolkg^{-1})	Effective cation exchange capacity (ECEC) (cmolkg^{-1})	Percentage (% BS) Saturation (%)
Treatments			
zero(T_0)	0.96	12.143	92.1
T_1 (FW)	0.80	16.128	95.0
T_2 (SW)	0.68	17.723	95.9
T_3 (BD)	0.86	20.685	97.0
FLSD	NS	NS	NS

(FW)=Food wastes, (SW)=Swine wastes, (BD)= Bat droppings

Source: Laboratory analysis (2020)

CONCLUSION

Incorporation of food wastes, swine wastes and bat droppings on chemical properties were generally considered desirable for the production of maize because it was observed that the results recorded, were more than 50% positive increase due to balanced chemical nutrients. Though, swine wastes and bat droppings were the only treatments ranking highest in company of others. It is therefore recommended that both swine wastes and bat droppings should be use to improve and raise the soil available nutrients and maize cultivation. The reasons for this, is that both treatments have the ability to improve and increase soil organic matter and soil nutrient elements.

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