Journal of Agriculture and Ecology Research International
5(3): 1-8, 2016; Article no.JAERI.15192
ISSN: 2394-1073

SCIENCEDOMAIN *international*
www.sciencedomain.org

Impact of Organo Minerals and Their Integrated Forms on Soil Fertility and Maize Productivity in Southeastern Nigeria

J. C. Nwite[1*], B. E. Eneruvie[2] and S. O. Nwafor[1]

[1]*Department of Crop Production Technology, Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria.*
[2]*Department of Agricultural Technology, Akanu-Ibiam Federal Polytechnic, Unwana, Afikpo, Ebonyi State, Nigeria.*

Authors' contributions

This work was carried out in collaboration between all authors. Author JCN designed the study, wrote the protocol, and wrote the first draft of the manuscript. Authors BEE and SON managed the literature searches, analyses of the study performed the structural equation modeling and discuss the conclusion. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAERI/2016/15192
Editor(s):
(1) Inz. Krzysztof Skowron, Department of Microbiology, Nicolaus Copernicus University in Toruń, Collegium Medicum of L. Rydygier, Poland.
Reviewers:
(1) Mohamed Abdel-Ghany Aly Bekheta, National Research Centre, Dokki, Egypt.
(2) Vijay Singh Meena, ICAR-Vivekananda Institute of Hill Agriculture Almora, India.
(3) Olawuyi Odunayo, University of Ibadan, Nigeria.
Complete Peer review History: http://sciencedomain.org/review-history/12054

Original Research Article

Received 12th November 2014
Accepted 22nd December 2014
Published 2nd November 2015

ABSTRACT

Agricultural soil quality is drastically affected by modern human activities. This study evaluates sole and combined effect of three agro-wastes namely: - rice husk Ash (RHA), rice husk dust (RHD) and poultry manure (PD) on soil fertility nutrient content and grain yield of maize on an Ultisol in Southeast Nigeria. Single and combined effects of the materials were investigated at application rates of 10t/ha for sole PD and RHD, 5 t/ha for sole RHA, 5 t/ha PD + 5 t/ha RHD, 5 t/ha PD + 2.5 t/ha RHA and 3.33 t/ha PD + 3.33 t/ha RHD + 1.67 t/ha RHA with 0 t/ha(control) giving seven treatments. The soil studied was low in pH, organic carbon (OC), total nitrogen, available phosphorous, exchangeable potassium and cation exchange capacity. The soil parameters studied include soil pH, OC, Total nitrogen, exchangeable bases, CEC, EA and available phosphorous

**Corresponding author: Email: johnwhite4real_2007@yahoo.com, johnsmallpot@gmail.com;*

while the grain yield of maize was also measured after harvest. Results showed that the amendments significantly improved the soil pH, organic carbon, exchangeable Na, K, Ca and Mg, while the total nitrogen was not affected significantly. Exchangeable acidity was drastically reduced by the amendments, while the available phosphorous was significantly increased by the application of treatments. Maize grain yield was also significantly increased by the treatments applications. The integrated application especially at 5 t ha-1 poultry manure and 5 t ha-1 rice husk dust increased maize yield and most soil nutrient elements higher than other combinations in the study.

Keywords: Organo-minerals; amendments; agro-wastes; nutrient leaching; maize grain yield.

1. INTRODUCTION

The need to meet ever increasing nutrition demands of the expanding human populations makes sustainable agriculture and agro-based sectors a front burner of environmental and social development issue in sub-Saharan Africa. Soils are an integral component of agriculture and serve as medium for numerous eco-biological, chemical and physical processes. Over-burdening of the soil as a natural resource capital has always been an issue due to its widely varied applications in the maintenance of human life activities [1]. The need thus to effectively manage soil resources in order to achieve optimum productivity of soils is obvious. The target of soil management is to create a healthy soil environment which may retain balanced nutrient status such that its fertility is maintained over time.

Soils in Africa are typically highly variable in fertility and in how they respond to inputs [2,3].

In Nigeria and other tropical countries, it is the utmost interest of most farmers to produce sustainable high crop yield. However, according to Ayeni et al*.* [4], decrease in soil fertility after few years of cropping is always a major limitation of these tropical soils. The need to improve soil fertility and crop production to support the rapidly growing population has led to a renew interest in the use of organic sources of nutrients and mineral fertilizers for soil fertility maintenance [4]. The use of chemical (inorganic) fertilizer in crop production has not been sustainable due to its high cost and scarcity, soil acidity, increased soil bulk density, low water infiltration rate and nutrient imbalance [5,6]. Thus, the needs to investigate alternative sources of nutrients that will be less damaging to the soil environment become imperative.

Hence, the recent interest in the use of agricultural wastes by the dominant resource poor farmers [7,8]. Wastes such as crop residues and animal excreta are used directly or composted. However due to high quantity needed, adequate quantity of an organic waste may not be obtained, hence the farmers often apply different wastes combined. Since the wastes are of different quantity and nutrient composition, their combined use is expected to have positive cumulative and complementary effects in nutrient supply and improvement of crop yield [7].

Animal manures such as that of poultry (chicken) has received much research attention in crop nutrition and had been found to be effective as source of nutrient for crops [9,10]. Recently, studies also showed that poultry manure increased soil organic matter and nutrient status [10]. However, the huge amount of poultry manure required for field crop production and its handling problems limits its use to distant farmers when it is to be applied singly.

There is also a renewed interest in the use of burnt organic residues from plants as sources of phosphate and potash fertilizers [5,11,7]. These materials are often considered less likely to have detrimental effect on soil physicochemical properties compared with mineral fertilizers. The use of plant residues are also limited by large quantity required to meet crop nutritional needs due to their low nutrient content and time lag to mineralize [7], hence the need for combination of these plant materials and animal excreta for improved soil and crop productivity.

Studies [12] have shown the superior effect of integrated nutrient supply over sole use of organic source in terms of balanced nutrient supply, improved soil fertility and crop yield [13,9,10].

There is need to compare the effectiveness of the three sources of bio-fertilizer and their integrated forms (animal and plant residues) on soil fertility and productivity. Hence, the objective of this study was to compare the immediate effects of rice husk ash, poultry manure and rice husk dust organo minerals on soil chemical properties and yield of maize in southeastern Nigeria.

2. MATERIALS AND METHODS

2.1 Location of Study Site

The experiment was conducted in 2011at the Research Farm of Federal College of Agriculture, Ishiagu. The area lies within latitude 05°56´N and longitude 07°41´E in the Derived Savannah Zone of Southeastern Nigeria. The mean annual rainfall for the area is 1350 mm, spread from April to October with average temperature of29°C. The underlying geological material is Shale formation with sand intrusions locally classified as the 'Asu River' group. The soil is hydromorphic and belongs to the order Ultisol. It has been classified as Typic Haplustult [14].

2.2 Field Study

The field was cleared, ploughed and harrowed by a tractor and later prepared into seed-beds manually. The field experiment was laid out in randomized complete block design with three replications of 3 x 2.5 m plot size with plant spacing of 50 x 25 cm. A bulk (composite) auger sample was collected within 0- 20 cm soil depth before treatment application for initial soil characteristics. At the harvest, another soil sample was collected from all the plots to determine the changes that occurred due to treatment application.

Seven treatments sourced from poultry dropping (PD), rice husk dust (RHD) and rice husk ash (RHA) in their sole and combined forms including the control were applied at the rates of 10t/ha for sole PD, 10 t/ha for RHD, 5 t/ha for sole RHA, 5 t/ha PD + 5 t/ha RHD, 5 t/ha PD + 2.5 t/ha RHA and 3.33 t/ha PD + 3.33 t/ha RHD + 1.67 t/ha RHA with 0 t/ha (control – CT).

2.3 Collection of Soil Samples and Laboratory Methods

Using a composite sample from the top- (0-20 cm) soil region at the study site, the soil was characterized before land preparation. Auger samples were collected at harvest from all the identified sampling points in all the plots from the top (0–20 cm) soil. The auger topsoil samples were air-dried and sieved with 2 mm sieve. Soil fractions less than 2 mm from individual samples were then analyzed using the following methods.

Particle size distribution of less than 2 mm fine earth fractions was measured by the hydrometer method as described by Gee and Bauder [15].

Soil pH was measured in a 1:2.5 soil: 0.1 M KCl suspensions [16]. The soil organic carbon (OC) was determined by the Walkley and Black method described by Nelson and Sommers [17]. Total nitrogen was determined by semi-micro kjeldahl digestion method using sulphuric acid and $CuSO_4$ and Na_2SO_4 catalyst mixture [18]. Sodium (Na) and potassium (K) were determined from ammonium acetate leachate using the auto-electric flame photometer. Calcium (Ca) and magnesium (Mg) were determined using the complexometer titration method as described by Thomas [19]. The cation exchange capacity (CEC) was determined by the method described by Rhoades [20], while exchangeable acidity (EA) was measured using the method of McLean [16]. Available phosphorus was measured by the Bray II method [21].

2.4 Data Analysis

Statistical analysis of all the data was performed using GENSTAT 3 7.2 Edition. Statistical differences among treatment means were estimated and compared using Least Significant Difference (LSD) and all inferences were made at 5% Level of probability. The correlation - regression was performed using SPSS stat. 17.0.

3. RESULTS AND DISCUSSION

3.1 Initial Physical and Chemical Properties of the Studied Soil

The soil used for the study has sandy loam texture with high proportion of total sand (72%). The high proportion of total sand in this soil could affect the yield of the maize crop because of probable low soil moisture that may occur especially at tasselling stage and associated high leaching of the soil nutrients. Hence, relatively poor yield of maize on soil not treated with manures was expected [8]. The OC, N, P, K, Mg status and its acidic nature (Table 1) noted to be low in the soil studied are expected to improve with the application of the amendments with their mixtures (poultry manure and also the plant wastes).

3.2 Effects of Different Organo Mineral Sources on the Soil pH, Organic and Total Nitrogen

Table 2 indicates that application of rice husk ash and its addition to poultry manure significantly ($p < 0.05$) increased soil pH higher than plots treated with rice husk dust and its integration with poultry dropping. This could be attributed to its higher contents of Ca, Mg and K compared to the RHD. It has been shown that the oxides and hydroxides of Ca, Mg and K contained in ash from plant residues makes its mode of actions similar to that of burnt or hydrated lime [22,23]. The values ranged from 4.70 – 6.50 with low coefficient variation of 1.8%.

Table 1. Physical and chemical properties of the studied soil (0 – 20 cm) depth

Soil properties	Values
Clay (%)	9
Silt (%)	19
Total sand (%)	72
Textural class	Sandy loam
Organic carbon (%)	0.30
Total nitrogen (%)	0.058
pH (H_2O)	5.0
Exchangeable bases (cmolkg^{-1})	
Sodium (Na^+)	0.72
Potassium (K^+)	0.42
Calcium (Ca^{2+})	2.0
Magnesium (Mg^{2+})	0.6
Cation exchange capacity (CEC) cmolkg^{-1}	9.60
Exchangeable acidity (EA) cmolkg^{-1}	2.2
Available phosphorous (mg/kg)	10.4

The result therefore showed that all the treated plots improved pH higher than the control. This confirms the findings of Nwite et al., [24] who stated that the use of plant materials as organic manures increases the pH of the soil and hence the performance of a crop.

However, the strongly acidic nature of the untreated soil could be adduced to the coarse nature of the soil which should have enhanced leaching of exchangeable bases and to the cropping history of the site which was heavily cropped with application of various mineral fertilizers especially NPK (Table 2).

The effects of treatments on soil organic and total nitrogen (Table 2) indicates that addition of rice husk dust (RHD) amendment to poultry manure and its sole increased significantly ($p < 0.05$) soil organic matter Compared with control, total nitrogen was increased with addition of 5 ton/ha RHD amendment to 5 t/ha poultry manure. Soil organic carbon varied from 0.147% - 0.473%, while the total nitrogen varied from 0.63% - 0.152%. The results indicated that there were more consistency in the soil organic carbon pool among the treatments than what were obtained in soil total nitrogen (10.9% and 30.8%), respectively (Table 2).

3.3 Effects of Different Organo Mineral Sources on the Soil Exchangeable Bases

There were significant ($P < 0.005$) effects on the exchangeable bases due to the amendments. The results (Table 3) showed that the highest mean value (0.86 cmol kg^{-1}) for exchangeable sodium was obtained from plots treated with PD+RHD+RHA. The treatments means varied from each other by 9.7%, which shows better consistency. It is discernible from Table 3 that exchangeable potassium in the studied soil differed significantly. The exchangeable potassium content was significantly ($p < 0.05$) higher in PD+RHA (0.77 cmol kg^{-1}) treated plots and the minimum (0.40 cmol kg^{-1}) was recorded in the control treatment. The mean values ranged from 0.40 – 77 cmol kg^{-1}with a coefficient variation of 16.4%. This means that there was higher consistency (Table 3) among the treatments performance on soil exchangeable sodium than as obtained in exchangeable potassium. Exchangeable calcium was statistically higher in RHA treated soil compared to other treatments with very low coefficient variation (7.1%), showing better consistency among the treatments than other exchangeable bases. Generally, the treated soils in this studied increased the exchangeable bases significantly higher than the control. However, the decreased exchangeable bases (sodium, potassium and calcium) content in control treatment from its initial value (0.72 cmol kg^{-1}, 0.42 cmol kg^{-1} and 2.0 cmolKg^{-1}) could be due to the high rainfall pattern and the proportion of total sand which might affect nutrient retention capacity and also aid in high leaching of the soil nutrients in the area. Exchangeable bases were more in integrated treatments as compared to sole treatments.

3.4 Effects of Different Organo Mineral Sources on the Soil Cation Exchange Capacity (CEC), Exchangeable Acidity (EA) and Available Phosphorous (Avai. P)

The results (Table 4) indicated that there was a short-term improvement on the CEC by the use of different organo mineral sources. This means that CEC of the soil gradually responds to different organo mineral sources for crop production. The higher significant improvement on the CEC by poultry dropping (24.27 cmol kg^{-1}) attributed to edge-advantage it has in improving the soil fertility status. The result is in agreement with the report of Adeniyan and Ojeniyi, [10] that poultry manure increased soil organic matter and other nutrient status. The essence of integrating PD with other organo minerals is to reduce the huge amount of poultry manure required for field crop production and its handling problems which do limits its use to distant farmers when it is to be applied sole.

The exchangeable acidity of the soil decreased significantly with the application of amendments (Table 4). The overall drop in the mean EA values in the treated plots was considered to be attributing of the organic manures nature which has successfully increased the soil pH statistically.

It is depicted (Table 4) that available phosphorus in soil in different treatments differed significantly. The available phosphorus content was maximum (26.0 mg/Kg) in PD treated plots and the minimum (8.1 mg/Kg) was recorded in control treatment. Available phosphorus content in control treatment decreased from its initial value (10.4 mg/Kg) whereas the available phosphorus in rest of the treatments increased from its initial levels. The coefficient variation was very high (25.2%), meaning that there were inconsistency among the treatments in their effects on the available phosphorous.

The maize yield (Table 4) showed significant increase among the treatments with integrated forms of plant wastes (RHD and RHA) with the animal manure (poultry dropping) performing significantly higher than their sole application. The result indicates that the highest significant increase in maize grain yield was obtained from plots amended with sole poultry dropping. However, all the treated plots improved the maize grain yield significantly ($p < 0.05$) higher than the control. It was observed that the yield was moderately stable and consistent among the treatments with coefficient variation (CV %) of 10.0% (Table 4). The yield obtained in this study with organo minerals and their integrated forms were higher than yield recorded by Ayeni and Adetunji [8] with integration of poultry manure and mineral fertilizer at different rate of application where the highest yield recorded was 4.50 t/ha.

Table 2. Effects of amendments on soil pH, organic carbon and total nitrogen

Treatments	pH	Organic carbon (%)	Total nitrogen (%)
PD	6.03	0.360	0.125
RHD	5.83	0.473	0.115
RHA	6.50	0.200	0.080
PD+RHA	6.13	0.387	0.112
PD+RHD	5.73	0.433	0.152
PD+RHD+RHA	5.83	0.437	0.132
CT	4.70	0.147	0.063
$LSD_{0.05}$	**0.1908**	**0.06768**	**NS**
CV %	**1.8**	**10.9**	**30.8**

PD = poultry dropping, RHD = rice husk dust, RHA = rice husk ash, CT = control, NS = not significant

Table 3. Effects of amendments on soil exchangeable bases ($cmol_cKg^{-1}$)

Treatments	Exch. Na	Exch. K	Exch. Ca	Exch. Mg
PD	0.84	0.65	4.00	1.47
RHD	0.51	0.54	3.60	1.10
RHA	0.80	0.70	4.07	1.73
PD+RHA	0.82	0.77	3.73	1.90
PD+RHD	0.81	0.66	3.00	1.43
PD+RHD+RHA	0.86	0.59	3.33	1.60
CT	0.33	0.40	1.37	0.87
$LSD_{0.05}$	0.1220	0.1796	0.4193	0.5116
CV %	9.7	16.4	7.1	19.9

3.5 Important Relationships among the Soil Properties and Maize Grain Yield

Table 5 showed the correlation coefficients among the soil properties and maize grain yield. It was obtained that there was no significant correlations between the total sand percent rest of other soil parameters studied including the grain yield of maize. The soil pH indicated positive significant ($p < 0.05$) correlation coefficient r (0.783*, 0.866*, 0.964** and 0.825*) with all the exchangeable bases (exchangeable sodium, potassium, calcium and magnesium), respectively. It was observed that among the exchangeable bases, the pH gave a stronger significant correlation coefficient r (0.964**) with the exchangeable calcium at both 5 and 1 % ($p < 0.05$ and 0.01) probability levels. The positive correlations of the pH with the exchangeable bases is a prove that liming and application of organic manures to tropical soils improves the soil pH and exchangeable bases, agreeing with the submissions of Lickazz, [22] and Nwite et al*.* [23] that ash from plant residues makes its mode of actions similar to that of burnt or hydrated lime. Nwite et al. [24] stated that the use of plant materials as organic manures increases the pH of the soil and hence the performance of a crop. On the other hand, the soil pH negatively correlated (r = -968**) significantly ($p < 0.05$ and 0.01) with exchangeable acidity in study. This negative correlation implies that as the soil exchangeable acidity increases, the pH decreases. It is therefore important to adopt agricultural practices that will keep the EA at a minimal level as save and sustain our soil resources. It was obtained that there was a positive significant ($p < 0.05$ and $p < 0.01$) correlation coefficient r (0.881**) between soil organic carbon and total nitrogen. An increase in soil organic carbon might lead to an increase in the total nitrogen percent of the soil and vise-versa. Table 5 indicates that soil total nitrogen correlated positively ($p < 0.05$) with the grain yield with a correlation coefficient r (0.832*). The exchangeable sodium shows a significant ($p < 0.05$) correlation coefficient r (0.852*, 0.882**, 0.781*, 0.767* and 0.870*) with exchangeable potassium and magnesium, CEC, available phosphorous and maize grain yield. The study (Table 5) indicated positive significant correlation ($p < 0.05$) with exchangeable calcium and the maize yield (r = 0.797* and 0.771*), respectively. It was shown also that exchangeable K gave a stronger significant ($p <$ 0.05 and 0.01) correlation coefficient r (0.934**) with exchangeable Mg. However, there was a very high negative significant ($p < 0.05$ and 0.01) correlation (r = -0.899**) of the exchangeable K with exchangeable EA. It was obtained that exchangeable calcium and magnesium also strongly significantly ($p < 0.05$ and 0.01) correlated (r = -0.996** and -0.793*) with the EA. Exchangeable Ca gave positive ($p < 0.05$) correlation coefficient r (0.773* and 0.766*) with CEC and available P, respectively. An increase in CEC of the soil has resulted to an increase in the soil available phosphorous and maize grain yield, as it gave very high strong positive significant ($p < 0.05$ and 0.01) correlation coefficient r (0.957** and 0.939**) for avail. P and grain yield of maize, respectively.

Generally, the results showed that maize yield increases with possible increase in the soil total nitrogen, exchangeable sodium and potassium, cation exchange capacity and available phosphorous of the soil. Therefore, any agricultural practice(s) that may lead to improved availability of these above mentioned soil elements, that are environmental friendly and socially acceptable should be encouraged among the rural farmers in their cropping systems to increase soil and crop productivity.

Table 4. Effects of amendments on soil cation exchange capacity – CEC ($cmol_c Kg^{-1}$), exchangeable acidity – EA ($cmol_c Kg^{-1}$) and available phosphorous – mg/Kg (Avail. P)

Treatments	CEC	Exch. Acidity	Avail. P	Maize yield (t/ha)
PD	24.27	1.47	26.0	5.87
RHD	17.13	1.60	18.1	4.17
RHA	16.73	1.27	18.5	4.07
PD+RHA	17.40	1.27	20.2	5.27
PD+RHD	19.73	1.73	23.5	5.37
PD+RHD+RHA	18.03	1.87	16.6	4.90
CT	9.27	2.87	8.1	2.17
$LSD_{0.05}$	6.136	0.4931	8.39	0.8055
CV %	19.7	16.1	25.2	10.0

Table 5. Matrix of correlation coefficients for total sand percent of the soil and other soil chemical properties including the maize grain yield of the studied site

	TS	pH	OC	TN	Na	K	Ca	Mg	CEC	EA	P	Yield
TS	_											
pH	-.372	_										
OC	-.605	.318	_									
TN	-.496	.318	.881**	_								
Na	-.155	.783*	.424	.632	_							
K	-.338	.866*	.323	.424	.852*	_						
Ca	-.343	.964**	.448	.403	.746	.797*	_					
Mg	-.134	.825*	.226	.319	.882**	.934**	.729	_				
CEC	-.215	.662	.605	.751	.781*	.633	.773*	.504	_			
EA	.465	-.968**	-.447	-.417	-.752	-.899**	-.966**	-.793*	-.719	_		
P	-.368	.695	.569	.734	.767*	.742	.766*	.549	.957**	-.782*	_	
Yield	-.292	.671	.697	.832*	.870*	.771*	.745	.670	.939**	-.753	.935**	_

** Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).*
TS = Percent total sand, OC = organic carbon, TN = total nitrogen, Na = exchangeable sodium, K = exchangeable potassium, Ca = exchangeable calcium, Mg = exchangeable magnesium, CEC = cation exchange capacity, EA = exchangeable acidity, P = available phosphorous.

4. CONCLUSION

The Study revealed that there was a short-term improvement on the soil fertility status and maize grain yield by the use of different organo mineral sources. It was noted the superiority of sole poultry dropping and its mixtures with the plant materials on the improvement of chemical properties of the soil studied. These improvements have led to a significant increase in the maize grain yield. It is therefore concluded that the integrated application of these materials at reduced levels were more effective in improving the soil nutrient status and maize yield than sole application of any of these plant materials.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Omotayo OE, Chukwuka KS. Soil fertility restoration techniques in sub-Saharan Africa using organic resources. African Journal of Agricultural Research. 2009;4(3):144-150.
   Available:http://www.academicjournals.org/AJAR ISSN 1991-637X © 2009 Academic Journals.
2. Hossner LR, Juo ASR. Soil nutrient management for sustained food crop production in upland farming systems in the tropics. Juo Soil and Crop Sciences Department College Station Tennessee 77843, USA; 1999.
   Available: http//www.agnet.org
3. AGRA. Alliance for a Green Revolution in Africa: AGRA at work; 2007.
   Available:www.agra-alliance.org/work/ (Retrieved 13th March, 2008)
4. Ayeni LS, Adeleye EO, Oso OP. Residual effect of cocoa pod ash, poultry manure and NPK 20:10:10 fertilizer on soil nutrients, nutrient uptake and yield of maize (*Zea mays*). J. Soil. Nature. 2009;3(2):04-09.
5. Ojeniyi SO. That our soil may not die. 10th Inaugural Lecture of Federal University of Technology, Akure. 1995;5-10.
6. Nottidge DO, Ojeniyi SO, Asawalam DO. Comparative effect of plant residue and NPK fertilizer on nutrient status and yield of maize in a humid ultisol. Nigerian Journal of Soil Science. 2005;15:1–8.
7. Ayeni LS, Adetunji MT, Ojeniyi SO, Ewulo BS, Adeyemo AJ. Comparative and cumulative effect of cocoa pod husk ash and poultry manure on soil and maize nutrient contents and yield. Am.-Eurasian J. Sustain. Agric. 2008;2(1):92-97.
8. Ayeni LS, Adetunji MT. Integrated application of poultry manure and mineral fertilizer on soil chemical properties, nutrient uptake, yield and growth components of maize. Nature and Science. 2010;8(1):60-67. (ISSN: 1545-0740).
9. Adeniyan ON, Ojeniyi SO. Effect of poultry manure, NPK 15 – 15- 15 fertilizer and

combinations of their reduced levels on maize growth and their chemical properties. SSSN. 2005;15:34-41.
10. Adeniyan ON, Ojeniyi SO. Comparative effectiveness of different levels of poultry manure with NPK fertilizer on residual soil fertility, nutrient uptake and yield of maize. Moor Journal of Agricultural Research. 2006;4:194-197.
11. Ayeni LS. Integrated application of cocoa pod ash and NPK fertilizer on soil chemical properties and yield of tomato. American – Eurasian Journal of Sustainable Agriculture. 2008;2(3):333–339.
12. Uyovbisere EO, Elemo KA. Effect of inorganic fertilizer and foliage *Azadriachta* and *Parkia* species on the productivity of early maize. Nigeria Journal of Soil R. 2000;1:17–22.
13. Awodun MA, Ojeniyi SO, Adesoye A, Odedina SA. Effect of oil palm bunch refuse ash on soil and plant nutrient composition and yield of maize. American-Eurasian Journal of Sustainable Agriculture. 2007;1(1):50-54.
14. FDALR. Reconnaissance soil survey of Anambra state-Nigeria, (1:250,000). Federal Department of Agric. and Land Res. (FDALR). Soil report FDALR, Kaduna. In: FAO, (ed.) 1985. Tropical forestry action plan. FAO, Rome; 1985.
15. Gee GW, Bauder JW. Particle-size analysis. In: Klute A, Ed. Methods of Soil Analysis, Part 1, American Society of Agronomy, Madison. 1986;91–100.
16. McLean EO. Soil pH and lime requirement. In: Page AL, Miller RH, Keeny DR, (eds.). Methods of Soil Analysis, Part 2. Am. Soc. Agron., Madison. 1982;199–224.
17. Nelson DW, Sommers LE. Total carbon, total organic carbon and organic matter. In: Sparks DL (ed) Methods of soil analysis, part 3: Chemical methods. Agronomy Monograph No 9. American Society of Agronomy, Madison. 1996;961–1010.
18. Bremner JM, Mulvancy CS. Total nitrogen. In: Page AL, et al. (eds.). Methods of Soil Analysis. No.9; part 2, Amer. Soc. Of Agron. Inc, Madison, Wisconsin, USA. 1982;595–624.
19. Thomas GW. Exchangeable cations. In: Page AL, Miller RH, Keeny DR, (eds.), Methods of Soil Analysis, Part 2. Am. Soc. Agron. Monogr. Madison. 1982;159–165.
20. Rhoades JD. Cation exchange capacity. In: Page AL, Miller RH, Keeney DR, (eds). Methods of Soil analysis. Part 2. Agron A. Madison W.I. P. 1982;149-157.
21. Bray RH, Kurtz LT. Determination of total organic carbon and available forms of phosphorous in soils. Soil Sci. J. 1945;59: 39–43.
22. Lickazz J. Wood ash: An alternative liming material for agricultural soils. Alberta J. Agriculture, Feed and Rural Development; 2002.
Available:www. agric. gov.ab.cal/department/dept.docs.nsf
23. Nwite JC, Obalum SE, Igwe CA, Wakatsuki T. Properties and potential of selected ash sources for improving soil condition and rice yields in a degraded Inland Valley in Southeastern Nigeria. World Journal of Agricultural Sciences. 2011;7(3):304-310.
24. Nwite JC, Essien BA, Anaele MU, Obalum SE, Keke CI, Igwe CA. Supplementary use of poultry droppings and rice-husk waste as organic amendments in Southeastern Nigeria. 1: Soil Chemical Properties and Maize Yield. Libyan Agriculture Research Center Journal International 2012;3(2):90-97. ISSN 2219-4304, © IDOSI Publications, 2012.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/12054