FENING, K.O., ADEOLUWA, O.O., OLOGUNDUDU, O.M. (Eds) (2019) Scientific Track Proceedings of the 5th West African Organic Conference."Organic Agriculture: Life for All". November 12-15, 2019, University of Ghana, Legon, Accra

pp.127-133

5TH WEST AFRICAN ORGANIC CONFERENCE
www.waoc.bio

WAfrONet
West Africa Organic Network

EOAP-G

Influence of Source and Rates of Organic Residues Application on the Growth and Yield of Maize (*Zea mays* L.) and Soil Chemical Properties in Minna, Nigeria

Tsado, P. A.[1]*, Igwe, C. A.[2], Lawal, B. A.[1], Osunde, A. O.[1], Eze, P. C.[1] and Okolo, C.C.[2]

[1]Department of Soil Science and Land Management, Federal University of Technology, Minna, Nigeria.

[2]Department of Soil Science and Land Management, University of Nigeria, Nsukka, Nigeria.

*Corresponding Author:
E-mail: tsadophilips@yahoo.com
p.tsado@futminna.edu.ng

Keywords:
Organic residues,
Growth, Yield,
Soil properties

Access online at:
www.waoc.bio OR
www.noara.bio

Published by
NOARA
Network of Organic Agriculture Researchers in Africa
RÉSEAU DES CHERCHEURS EN AGRICULTURE BIOLOGIQUE EN AFRIQUE
شبكة الباحثين في الزراعة العضوية بإفريقيا

Abstract

Two season field experiment were conducted at the Teaching and Research Farm of Federal University of Technology Minna, Niger State during 2012 and 2013 cropping season. The experiments were designed to investigate the effect of sources and rates of organic residues on the growth, and yield of maize and on soil chemical properties. The treatments consisted three organic residues (orange waste, tamarind pulp and amaranthus leaves) and five rates of application (0, 2, 4, 6 and 8t ha^{-1}). The treatment combinations were laid in a split plot arrangement using the randomized complete block design with three replicates. Organic residue sources occupied the main plots while their rates of application were assigned to the sub plot. Parameters recorded were : plant height at 2, 4, 6 and 8 weeks after planting (WAP), shoot dry weight at 50% tasseling, dry cob weight, grain yield at harvest and post-harvest soil chemical properties (soil pH, total nitrogen, organic carbon and available phosphorus. The results obtained showed that the treatment had a significant ($p < 0.05$) effects on the plant height at 4, 6 and 8 WAP), cob weight and yield parameters in both seasons. Significant ($p < 0.05$) differences were also observed on the growth and yield among the sources and their rates of application of the organic materials. Similarly, the post soil analysis showed a significant improvement of soil chemical properties (soil pH, total nitrogen, organic carbon and available phosphorus) over the control and initial soil analysis.

Introduction

The key limiting factors in crop growth, development and yield are the essential nutrients (nitrogen, phosphorus, potassium and water). In most cases, maize growers use chemical fertilizers as the major supply of nutrient in order to attain higher growth and yield (Amjad, et al., 2005). Continuous application of chemical fertilizers may lead to soil acidity and human health problem and soil degradation since they release nutrients at faster rates. Moreover, the increasing costs and unavailability in rural areas of inorganic fertilizers have rendered them unaffordable to most resource – poor small scale farmers

Organic residues can serve as substitute or alternatives to the use of inorganic fertilizers. Application of organic residues supplies the required nutrients, improved soil structure, water holding capacity, porosity, microbial population, maintain the quality of crop produced and above all, they are available. Organic manure application is one of the technologies being exploited to restore such low fertility and degraded soils. Organic manures supply nutrients such as N, P,K and essential micronutrients to crop (Agbede and Adekiya, 2015).

The application rates and sources of orange wastes, tamarind pulps and amaranthus leaves for maize has not been documented in this agro-ecological zone. Farmers needs to be given a specific application rates, sources and how these organic materials should be applied. There is dire need to carryout research on the use of different sources of organic material as fertilizer source for growth and yield of maize in this agro-ecology. Hence the objective of this study was to investigate the effect of sources and rates of organic residues on the growth and the yield and soil properties

Materials and Methods

Soil Sampling and Sampling Location

The site was an experimental field (2012 and 2013 cropping season) located at Teaching and Research Farm of the Federal University of Technology, Minna Latitude $9^0$31'N and Longitude $6^0$30'E in the Southern Guinea savanna of Nigeria .The treatment consisted of three organic residue sources (orange waste, tamarind pulp and amaranthus leaves) and five rates of application (0, 2, 4, 6 and 8 t ha-^{1}). The treatment combinations were laid out in a split-plot arrangement using the randomized complete block design with three replicates. Organic residue source occupied the main plot while their rates of application were assigned to the sub-plot. The soil was tentatively classified as Haplic Plinthosol (Typic Plinthustalfs) (FAO, 2006; Lawal *et al.*, 2012).

The soil samples used for pre and post physical and chemical studies were collected before first year planting after second year's harvest in October 2012 and 2013. Ten sub samples were taken from each plot to form a composite for the analysis. The sampling depth was from 0 – 20 cm. Air-dried samples were ground to pass a 2-mm and 0.5-mm sieve for analysis.

Soil Analysis

Soil particle size distribution was determined by the hydrometer method after dispersion with sodium hexametaphosphate according to the procedure described by I.I.T.A. (1976). pH values of the samples were determined in distilled water and 1.0N KCl solution using a soil - solution ratio of 1:2 (McLean, 1982).Total N was determined using the kjeldahl method as described by Bremner (1996). Organic carbon was determined by the Walkley – Black wet oxidation method described by Nelson and Sommers (1982). Olsen P (available P) was determined by the Bray P 1 method (Murphy and Riley, 1962). Total P was determined after digestion with 70% $HClO_4$. Phosphate in the digest was determined colorimetrically with the molybdate – ascorbic acid procedure. Exchangeable Bases: Na and K were determined from ammonium leachate using flame photometer. While, Ca and Mg was determined by using Atomic Adsorption Spectrophotometer (AAS). Exchangeable Acidity (EA) this was determined titrimetrically using 1.0N KCl extract (McLean, 1982).

Field Management

Maize was the test crop used for the purpose of this experiment. The field was cultivated manually using hoe. Prior to the cultivation, these organic materials were crushed, grounded and applied by broadcasting on the field two weeks before sowing for both 2012 and 2013 cropping season. Three seeds/stand (at intra-row spacing of 50cm and inter-row spacing of 75cm) was planted and later thin to two, 2 Weeks After Planting (WAP). Each plot size measured 6m x 5.4m and 1m distance between two plots. At 2 and 6 WAP, 120kg N, 60kg P_2O_5& 60kg K_2O ha^{-1} was applied as basal application using NPK 20:10:10 and urea.

Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) using a statistical package SAS (2002) version. Means with significant differences were separated using the least Significant Difference at 5% level of probability.

Results and Discussion

Characteristics of the Studied Soil

The result obtained for some selected physical and chemical properties of the soils used before the experiments are presented in Table 1. The textural class of soil collected from the studied site was sandy clay loam with a moderately acidic in reaction. Exchangeable acidity ($H^+ + Al^{3+}$) value was also low in the soil (0.62 cmol kg-[1]). These suggest that that the soils have no acidity problem and there will be availability of most nutrients to crop roots. Most plant nutrients are readily available to crop roots at pH range 5.0 to 6.0 (Adeboye *et al*., 2009; Tsado et el., 2015). The low acidity level of the soils may be attributed to accumulation of bases due to low level of leaching. The organic carbon content and the available P content of the soil were low while the soils total N was very low. Jones and Wild (1975) reported low to medium organic carbon rate for savanna soils which was attributed to paucity vegetation cover, rapid mineralization of organic matter, inadequate return of crop residues, bush burning and short fallow periods. Also,the low total N and available P status of the soils may be attributed to low organic matter contents as organic matter is regarded as the major reservoir of soil P and N. The soils of the Nigerian savanna have been reported to be inherently poor in available P (Lombin, 1987). The exchangeable bases was observed to be low and was in the decreasing order Ca > Mg > K > Na.

Effects of Organic Residues on Maize Plant Height and Grain Yield

The significant increase in the plant height of the maize (Table 2 and 3) could be attributed to the effect of rates of application of organic residues. Since these organic residues were applied two weeks to the field prior to the land preparation, the period was sufficient enough and most of the minerals on these organic materials were readily available for the plant uptake. The result is in support of Ishanular and Ahmed (2013) and Tsado et al (2015). They reported that application of organic acids before planting will provide better soil condition for plant growth and development. The increase in growth characteristics is attributed to the stronger role of N and P in cell division, cell expansion and enlargement which ultimately influenced the vegetative growth of maize (Mohsin Zafar *et al*., 2011)

The results of the yield and cob weight of maize for both seasons (Table 4) showed that the maize yield and weight responded positively to the application of the organic residues. There was a yield increment during 2013 over 2012 cropping session. This could probably be attributed to the residual benefits of the previous year as a result of residual accumulation of organic matter (Tsado et al., 2014).

Effects of Organic Residues on Soil Chemical Properties

The result of some selected soil chemical properties of the studied revealed that their concentrations (except pH) were significantly increased by the additions of organic residue sources and their rates of application (Table 5). The significant improvement on the chemical properties of the soil due to the application of these organic wastes could be attributed to practical implication of the results of this study has indicated that low molecular weight organic acids have the potentials to increase the availability of both applied and native P in the soil. Organic residues such as animal manures, composted wastes, grasses and other crop residues are usually readily available to farmers in large quantities. In practice, application of these organic inputs should be done prior to planting and P fertilization and it suggested that sufficient time be allowed for the sorption of the applied organic materials before the application of the P fertilizer.

Based on the results of the experiment obtained, application of 8 tones / ha of the three organic residues applied was significantly more effective in mobilizing both organic and inorganic forms of P and also produced the highest yield in the two locations where the studied was carried out. Therefore, it is recommended that higher rates of above 8 tones / ha be applied especially Minna location so as to improve the Olsen –

Table1: Some Initial Physical and Chemical Properties of the Soils of the Experimental Sites

Soil Properties	Values
Particle size distribution (g kg^{-1})	
Sand	640
Silt	100
Clay	260
Textural class	Sandy Clay Loam
pH: 0.01M $CaCl_2$	5.21
H_20	6.07
Org. C. (g kg^{-1})	8.91
Total N. (g kg^{-1})	0.51
Available P. (mg kg^{-1})	4.21
Exchangeable bases (cmol kg^{-1})	
Ca	2.82
Mg	1.63
.K	0.76
.Na	0.26
Exch.acidity (cmol kg^{-1})	0.62
ECEC	6.09
BS (%)	89.82

Table 2: Plant Height (cm plant^{-1}) of 2 and 4WAP of 2012 and 2013 Cropping Seasons as Affected by Organic Residue Source and their Rates of Application

	2WAP		4WAP	
Treatments	**2012**	**2013**	**2012**	**2013**
Organic residue source (OR)				
Orange waste	45.27	58.09	55.33	59.22
Tamarind pulp	49.17	51.48	54.20	59.52
Amaranthus leaves	48.66	49.45	55.39	59.37
LSD (0.05)	NS	NS	0.82	0.83
Rates (t ha^{-1})				
0	43.87	44.07	45.68	48.11
2	45.28	48.61	46.62	49.98
4	44.73	43.13	50.11	54.94
6	46.13	46.32	54.77	49.04
8	48.87	45.57	56.72	58.43
LSD (0.05)				
Rates	NS	NS	1.06	1.08
OR * Rates	NS	NS	NS	NS

NS = Not Significant (P <0.05)

Table 3: Plant Height (cm plan^{t-1}) of 6 and 8WAP of 2012 and 2013 Cropping Seasons as Affected by Organic Residue Source and their Rates of Application

	6WAP		**8WAP**	
Treatments	**2012**	**2013**	**2012**	**2013**
Organic Residue Source (OR)				
Orange waste	64.27	78.09	85.33	92.22
Tamarind pulp	63.17	71.48	84.20	89.52
Amaranthus leaves	61.66	70.45	83.39	89.37
LSD (0.05)	0.58	0.67	0.82	0.83
Rates (t ha^{-1})				
0	51.87	54.07	55.68	68.11
2	55.28	58.61	55.62	69.98
4	59.73	63.13	60.11	74.94
6	66.13	69.32	64.77	79.04
8	68.87	71.57	66.72	81.43
LSD (0.05)				
Rates	0.78	0.88	1.06	1.08
OR * Rates	NS	NS	NS	NS

NS = Not Significant (P< 0.05)

Table 4: Maize Yield (t h^{a-1}) and Cob Weight (g plat^{-1}) of 2012 and 2013 Cropping Seasons as Affected by Organic Residue Source and their Rates of Application.

	Yield		**Cob weight**	
Treatments	**2012**	**2013**	**2012**	**2013**
Organic Residue Source (OR)				
Orange waste	4.27	4.49	115.33	119.22
Tamarind pulp	4.17	4.48	114.20	119.52
Amaranthus leaves	3.66	3.85	112.39	119.37
LSD (0.05)	0.58	0.67	0.82	0.83
Rates (t ha^{-1})				
0	1.87	2.97	105.68	108.11
2	3.28	3.61	107.62	110.98
4	3.73	4.13	109.11	110.94
6	4.13	4.32	109.77	111.04
8	4.87	4.57	110.72	110.43
LSD (0.05)				
Rates	0.78	0.88	1.06	1.08
OR * Rates	NS	NS	NS	NS

NS = Not Significant (P< 0.05)

Table 5: Some Selected Post Harvest Soil Chemical Properties after 2013 Cropping Seasons as Affected by Organic Residue Source and their Rates of Application

Treatments	pH	OC	TN	AP	CEC
Organic Residue Source (OR)					
Orange waste	6.25	12.58	1.24	7,47	8.75
Tamarind pulp	6.22	10.44	0.99	7.65	9.22
Amaranthus leaves	5.98	10.33	0.77	6.55	8.23
LSD (0.05)	NS	0.89	0.32	0.70	0.88
Rates (t ha^{-1})					
0	5.98	9.50	0.62	5.98	7.30
2	6.08	9.55	0.82	6.77	8.22
4	6.10	10.00	1.33	6.87	8.24
6	6.09	11.23	1.43	7.86	9.33
8	5.99	12.65	1.32	7.49	9.52
LSD (0.05)					
Rates	NS	1.22	0.88	0.76	0.85
OR * Rates	NS	NS	NS	NS	NS

NS = Not Significant (P< 0.05)

References

Agbede, T. M and Adekiya A, O.(2015). Effect of poultry manure and NPK fertilizer on soil physical properties, growth and yield of carrot (Daucus carota L).Proceedings of the 39th annual conference of the Soil Science Society of Nigeria, March 9th – 13th 2015 held at Landmark University, Omu-aran, Kwara State.

Adeboye, M. K. A., Osunde, A. O., Ezenwa, M. I. S., Odofin, A. J. and Bala, A. (2009). Evaluation of the fertility status and suitability of some soils of arable cropping in the southern guinea savanna of Nigeria. *Nig. J. Soil Sci.* 19(2): 115 - 120.

Amad, M., Nza., S and Ali, S. (2005).Growth and seed yield of carrot as influenced by different regimes of nitrogen and potassium. Journal of Research Science 16(2) :73 - 78

FAO (2006). Guidelines for soil description: Genetics and Systemic interpretations. Food and Agricultural Organization of the United Nations p. 67.

IITA. 1976. Selected methods for soil and plant analysis. IITA, Ibadan – Nigeria. Manual series No 1. Pp 70.

Jones, M.J. and A.Wild. (1975). Soil of West Africa Savanna. Commonwealth Agricultural Bureaux, Harpenden.U.K. pp.24.

Ishanular, D. and Ahmed, A. B. (2013). Effect of humic acid on growth and quality of maize fodder production. *Pakistan J. Bot.* 45(1) : 21 - 25.

Lawal, B. A., Adeboye, M. K. A., Tsado, P. A., Elebiyo, M. G. and Nwajoku, C. R. (2012). Properties, classifications and agricultural potentials of lateritic soils of Minna in sub-humid agro-ecology zone, Nigeria.*Int. J.Dev.sust*. Vol.1, No.3, (in press).

Lombin, G. (1987). Soil and climate constraints to the crop production in the Nigeria savanna region. *Proceedings of the 15th Annual Conf. Soil Sci. Soc. Nig*. 21 – 24 September, 1987 p 6 - 9.

McLean, E. O. 1982. Soil pH and lime requirement. In: A. L. Page et. al. (eds), Methods of soil analyses (No. 9, part 2), 199 – 224. *Am. Soc. of Agron,; Soil Sci. Soc. Am;* Inc. Madison, Wisconsin, U.S.A.

Mohsin, Z., Abassi, M, Khaliq, A. and Zahid, R. (2011). Effect of combining organic