Journal of Sustainable Agriculture And the Environment

E-mail: jsae@mouau.edu.ng. Website: www.mouau.edu.ng.

Effects of Poultry Manure and Rice Mill Waste on Some Physical Properties, pH and Organic Matter Content of Soils Under Three Land Use Types in Owerri North LGA, Imo State

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Abstract

Changes in land use induce alterations in soil properties over time. A study was conducted in Owerri North Local Government Area of Imo State, Southeast Nigeria to assess changes in aggregate stability, water retention characteristics, bulk density (BD), organic matter (OM) and acidity (pH) of soils from different land use types amended with organic materials. The experiment was a 3x3 factorial laid out in a completely randomized design replicated thrice. The factors were oil palm plantation (PP), rubber plantation (RP) and arable land (AL) as factor A, and poultry manure (PM), rice mill waste (RMW) and a control (CT) as factor B. Analysis of variance (ANOVA) was performed and F-$LSD_{0.05}$ was used to compare the means. Rubber plantation (RP) recorded the highest mean weight diameter (MWD) in all treatments across land use, 3.00 mm in (CT), 4.93 mm in RMW, and 4.43 mm in PM) while AL recorded the lowest as observed in CT (1.60 mm), RMW (3.03 mm) and PM (2.53 mm). Arable land (AL) was most dispersed having clay dispersion index (CDI) of 53.90% (CT), 47.13% (RMW) and 45.77% (PM). Rice mill waste was better in reducing BD than PM and had the best reducing effect in AL (29.44%) than in PP (26.42%) and RP (11.11%). Field capacity (FC) increased by 15.24% when AL was amended with RMW and by 5.93% when amended with PM. Rice mill waste reduced acidity by increasing pH from 5.10 to 5.43 in PP, 5.40 to 5.66 in RP and 4.90 to 5.43 in AL. Organic matter (OM) was increased by 28.13%, 15.39% and 36.90% in PP, RP and AL, respectively, with application of RMW. The results indicated that the soil properties varied under the different land use types and they improved in response to the organic amendments. Therefore, the organic materials were effective in ameliorating the studied soils.

Key words: organic materials, land use, aggregate stability, water retention, acidity.

Introduction

Land use types entail the modifications and arrangements, activities and inputs undertaken in some land cover types to change or maintain such lands (Neris *et al*, 2012). Alterations in land use induce changes in soil properties over time (Braimoh and Vlek, 2004). Some land use types include livestock ranching and forestry (Barlow, 2007), plantation cropping, arable cropping, bush fallowing (Agoume and Birang, 2009), etc.

Soil physical properties deteriorate with changes in land use, especially from forest to arable land. Under natural conditions, such as forestation, soil physical properties do not easily degrade. Arable cropping of the continuous cultivation type negatively affects soil structural parameters. With continuous arable farming, soil physical properties commonly decline due to decrease in organic matter content and soil pH. Intensive cultivation disintegrates surface soils owing to decrease in organic matter (Kutilek, 2005). However, Mbagwu *et al.* (1994) have shown that stability of soil increased with increase in organic matter content.

Tropical soils, exposed to torrential rainfall, are generally low in organic matter contents. Low organic matter contents of soils result to increased bulk density, low total porosity, low water transmission rates and retention (Mbah and Mbagwu, 2003; Onwuka, 2003).

Use of inorganic fertilizers to improve yield of tropical soils could exacerbate problems associated with soil acidity. However, use of organic materials on soils increases soil organic matter which buffers the soil and improves aggregate stability and water retention capacity (Spaccini *et al*, 2002). Organic matter of animal origin is laborious and expensive to use due to the treatment and dehydration processes required before its use as soil amendment (Oguike and Onyeukwu, 2012). Comparatively, rice mill waste (RMW) is easy to use. It is light, easily dehydrated by air drying before application. Due to the residual value of rice mill waste (RMW), it does not require repeated application as it is slowly degraded by decomposing microorganisms, being a high C:N ratio organic material (Oguike and Onyeukwu, 2012).

The use of soil amendments improves soil composition, fertility, and soil fauna which in the long run have a beneficial effect on crop production (Ayeni *et al.*, 2008). Studies have shown that rice mill waste and poultry manure as amendments increased soil organic matter, total nitrogen, phosphorus, pH and cation exchange capacity (CEC) and reduced soil exchangeable acidity (Adeleye *et al.*, 2010; Ayeni *et al.*, 2008; Mbah, 2006). The positive effects of rice mil waste and poultry manure as soil amendments on soil productivity have been reported by several works (Njoku and Mba, 2012; Mbah and Onweremadu, 2009). Rice mill waste and poultry manure are valuable for their roles in increasing soil fertility, substituting for inorganic fertilizer, and improving soil characteristics by their addition of organic matter to the soil (Njoku *et al.*, 2011).

Rice husk removal during rice refining, creates disposal problem due to less commercial interest. Also, handling and transportation of rice husk is problematic due to its low density (Kumar *et al.*, 2012).

Much of the husk produced from processing of rice is either burnt or dumped as waste creating great environmental threat to surrounding area where it is dumped. Therefore, it is important to know the effects of rice mill waste and poultry manure on selected physical properties, pH and organic matter content within the soil matrix under various land use types. The objective of the study was to investigate the variations in the selected soil properties as affected by rice mill waste and poultry manure amendments under different land use types.

Materials and methods

Study area

The study was carried out in Owerri North LGA of Imo State, Southeast Nigeria. The area is located within latitudes 5° 14‘ N to 5° 16’ N and longitudes 7° 6’ E to 7° 8’ E. The mean annual rainfall in this area is 2202 mm, starting in March and ending in October with peaks in July and September (NIMET, 2015). The dry season starts in November and ends in February. Uniform mean temperature ranges between 29° - 35°C throughout the year. Within the location, oil palm plantation, rubber plantation and arable land were investigated.

The oil palm plantation (PP) was established 31years ago and covering an area of 6,000 m^2 (0.6 ha). The geographical coordinates are 5°24’13”N and 7°7’9”E, with altitude of 82.9 m above sea level (ASL) (Hand held GPS).

Rubber plantation (RP) established over 52 years ago, covers an area of about 4,000 m^2 (0.4 ha). The geographical coordinates are 5°24’24”N and 7°7’13”E with altitude of 80.4 m (ASL) (Handheld GPS).

Arable land (AL), continuously sown to cassava, maize and melon intercrop, covers about 4,000 m^2 (0.4 ha). The geographical coordinates are 5°24’51”N and 7°6’51”E with altitude of 73.3m (ASL).

Organic manure collection

The poultry manure (PM) was collected from Michael Okpara University of Agriculture, Umudike (MOUAU) poultry farm while rice mill waste (RMW) was collected from Bende in Bende Local Government Area of Abia State.

Table 1: Chemical composition of organic materials used

Property	PM	RMW
pH	7.20	7.90
Organic matter (g kg^{-1})	58.80	55.36
Nitrogen (g kg^{-1})	43.10	20.00
Phosphorus (mg kg^{-1})	14.20	5.50
Ca (mg kg^{-1})	1360.00	1620.00
Mg (mg kg^{-1})	512.40	1122.40
K (mg kg^{-1})	1521.00	3120.00
Na (mg kg^{-1})	483.00	246.10

Soil sample collection

Auger samples were collected at 0 – 20 cm depth from the three land use types. Within each land use type, the auger samples were randomly collected from three positions. At each position, five auger points were bulked together to form a composite sample. The samples from the three positions were mixed together to constitute sample from one land use type.

Core samples (inner diameter: 4 cm and length: 5cm) were also collected from the three land use types in triplicates.

Sample Preparation and incubation

The auger samples and the poultry manure were air-dried before sieving with 2mm sieve. The rice mill waste was also air dried and ground to floury texture. The poultry manure and rice mill waste were separately mixed with 6 kg of the soils from each of the three land use types in an 8 liter capacity plastic buckets perforated at the bottom. The organic materials were mixed with the soil samples at the rate of 5 t ha^{-1} which was calculated to be 10 kg/ 6kg soil. The mixture was moistened at intervals all through the incubation period of 60 days.

The base of the core samples was covered with a cheese cloth and saturated in water for determination of selected soil physical properties.

Experimental design

The layout of the experiment was a 3x3 factorial in a completely randomized design with each treatment replicated three times. The factors are: A - three land use types namely oil palm plantation, rubber plantation and arable land and B - organic materials namely poultry manure, rice mill waste and the control, all replicated three times, giving rise to 3x3 factorial and 27 observational units.

Laboratory analysis

The laboratory analyses included pH in 1:2.5 soil/water ratios. Organic carbon (OC) was measured by the Walkley and Black method as outlined by Nelson and Sommers (1982) and converted to organic matter (OM) by multiplying by 1.724. Particle size distribution was determined by the Bouyoucos hydrometer method as outlined by Kettler *et al*, (2001). For the determination of clay dispersion index (CDI), particle size distribution was repeated using water as dispersant and then computed using values of clay in the water – dispersed and calgon – dispersed samples as shown in equation (1).

$$CDI = \frac{\%\ clay\ (H_2O)}{\%\ clay\ (calgon)} \times 100 \quad \ldots\ldots\ldots (1)$$

Water retention (field capacity (FC) and permanent wilting point (PWP)) was estimated by the method of Mbagwu (1991) whereas available water content (AWC) was deduced from the difference between FC and PWP. Bulk density was by the method described by Blake (2003) while mean weight diameter was by the method of Kemper and Rosenau (1986).

Data analyses

The measured data were analyzed according to the procedure for a 3x3 factorial in a completely randomized design using SPSS and R-Statistics 251.0 versions. Analysis of variance (ANOVA) was performed and $F.LSD_{(0.05)}$ was used to compare the means.

Results and discussion

Aggregate stability

Table 2 shows the changes in aggregate stability of soils of different land use types in response to poultry manure (PM) and rice mill waste (RMW) amendments. The result showed that rubber plantation (RP) recorded the highest mean weight diameter in all the treatments as follows: 3.00 mm (control), 4.93 mm (RMW) and 4.43 mm (PM). The lowest mean weight diameter was recorded under arable land (AL) as observed in control (1.60 mm), RMW (3.03 mm) and PM (2.53 mm) amendments. Mean weight diameter increased more in soils amended with RMW than PM amendments. With reference to the control, arable land (AL) recorded the highest percentage increase (89.58 and 58.30 %) in mean weight diameter upon amendment with RMW and PM, respectively. Oil palm plantation (PP) had the lowest percentage increase under RMW (36.78 %) and PM (32.00 %) amendments. There was a significant ($p<0.05$) increase in the mean weight diameter of the soils with the application of the organic amendments. Comparing the land use types AL was more dispersed than PP and RP. The CDI for AL was 53.90% (control), 47.13% (RMW) and 45.77% (PM). The least dispersed was RP, with CDI of 34.60% (control), 32.80% (RMW) and 31.77% (PM). Amendment with poultry manure reduced clay dispersion more than the amendment with rice mill waste. Arable land (AL) had the highest percentage decrease in clay dispersion index with values of 12.56 and 15.08 % under RMW and PM, respectively. This result suggested that the reducing effects of the RMW and PM on clay dispersibility were more on the AL which was structurally unstable compared to RP and PP (Table 2).

However, the application of rice mill waste to the soil under oil palm plantation increased the CDI by 1.39%. The application of rice mill waste and poultry manure to the soils significantly ($p<0.05$) decreased their clay dispersion index. The low MWD observed in AL may be attributed to frequent tillage, clean weeding, together with reduced organic matter (Oguike and Mbagwu, 2009). Cultivation breaks up soil aggregates and exposes previously inaccessible organic matter to microbial attack thereby accelerating their decomposition and mineralization. (Shepherd *et al*., 2001; Musah, 2013). The higher value of MWD observed under PP and RP than AL may be attributed to the high organic matter contents inherent in the soils. This can be associated with increase in binding materials (polysaccharides, humic acid and humin) available in the organic materials enabling soil particles to aggregate with each other (Eneje and Lemoha, 2012; Turgut and Kose, 2015).

The highest CDI observed in AL may be attributed to the colloidal nature of clay which could promote the poor aggregation in soils (Ghezzi, 2010). The highest percentage reduction observed in AL when the organic amendments were applied suggested that arable land may have been deprived of organic matter due to continuous cultivation of the land. This may have reduced the soil structural stability. However, as organic amendments were applied to the soil under AL, the aggregate stability improved.

Table 2: Aggregate stability of soils studied

Land use	MWD (mm)	CDI (%)
	Control	
PP	2.90	43.30
RP	3.00	34.60
AL	1.60	53.90
Mean	*2.50*	*43.93*
	Rice mill waste	
PP	3.97 (36.78 %)	43.90(1.39 %)
RP	4.93 (64.33 %)	32.80(5.20 %)
AL	3.03 (89.38 %)	47.13(12.56 %)
Mean	*3.98*	*41.28*
	Poultry manure	
PP	3.83 (32.00 %)	40.30(6.92 %)
RP	4.43(47.67 %)	31.77(8.18 %)
AL	2.53(58.30 %)	45.77(15.08 %)
Mean	*3.60*	*39.28*
$LSD_{0.05}$		
Land use (L)	0.33	1.11
Amend.(A)	0.80	0.91
L × A	0.39	1.31

MWD = mean weight diameter, CDI = clay dispersion index,
PP = oil palm plantation, RP = rubber plantation, AL = Arable land,
L × A = Interaction of land use × amendments.
Values in bracket denote percentage change.

The improvement in aggregate stability with rice mill waste and poultry manure treatments obtained from this study is similar to the work of Njoku *et al.* (2017) and Hernández Rodríguez *et al.* (2017). They reported that application of the organic wastes increased soil aggregate stability. Arshad and Gill (1996) made similar findings and reported that rice mill waste lowered the wet aggregate stability of soil. Ardeshir *et al.* (2010) observed that broiler litter applications linearly increased soil aggregate stability.

Bulk density and porosity

The changes in bulk density and total porosity of soils of different land use types in response to poultry manure (PM) and rice mill waste (RMW) amendments are shown in Table 3. The rubber plantation (RP) recorded the lowest bulk density in all the treatments thus: control (0.90 Mg m^{-3}), rice mill waste (0.80 Mg m^{-3}) and poultry manure amendment (0.80 Mg m^{-3}). The highest bulk density was recorded under arable land (AL) as observed in control (1.80 Mg m^{-3}), rice mill waste (1.27 Mg m^{-3}) and poultry manure (1.50 Mg m^{-3}). Bulk density decreased more in soils amended with RMW than PM (Table 3). Application of rice mill waste caused decrease in soil bulk density from 1.40 Mg m^{-3} (control) to 1.03 Mg m^{-3} in PP; 0.90 Mg m^{-3} (control) to 0.80 Mg m^{-3} in RP; and 1.80 Mg m^{-3}(control) to 1.27 Mg m^{-3} in AL. The amendment with rice mill waste had about 26.42 % decrease in bulk density over the control in PP, 11.11 % decrease over control in RP and 29.44 % decrease over control in AL. Application of poultry manure caused decrease in soil bulk density from 1.40 Mg m^{-3} (control) to 1.20 Mg m^{-3} in PP, 0.90 Mg m^{-3} (control) to 0.80 Mg m^{-3} in RP, and 1.80 Mg m^{-3} (control) to 1.50 Mg m^{-3} in AL. The amendment of poultry manure caused about 14.29 % decrease in bulk density over the control in PP, 11.11 % decrease over control in RP; and 16.67 % decrease over control in AL.

With reference to soil total porosity (Table 3), rubber plantation (RP) recorded the highest total porosity in control (65.40 %), rice mill waste (69.23) and poultry manure (69.20%) amendments. The lowest total porosity was recorded under arable land (AL) as observed in control (30.80 %), rice mill waste (51.27 %) and poultry manure (42.30 %) amendments. Total porosity increased more in the soils amended with RMW than PM amendments.

Table 3: Bulk density and total porosity of soils studied

Land use	Soil Properties	
	BD (Mg m^{-3})	Tp (%)
	Control	
PP	1.40	46.20
RP	0.90	65.40
AL	1.80	30.80
Mean	*1.37*	*47.47*
	Rice mill waste	
PP	1.03 (26.42 %)	60.23 (30.45 %)
RP	0.80 (11.11 %)	69.23 (5.86 %)
AL	1.27 (29.44 %)	51.27 (66.45 %)
Mean	*1.03*	*60.24*
	Poultry manure	
PP	1.20 (14.29 %)	53.83 (16.52 %)
RP	0.80 (11.11 %)	69.20 (5.81 %)
AL	1.50 (16.67 %)	42.30 (37.34 %)
Mean	*1.17*	*55.11*
$LSD_{0.05}$		
Land use	0.21	2.16
Amend.	0.10	1.96
L × A	0.19	1.31

BD = bulk density, Tp = total porosity, PP = oil palm plantation, RP = rubber plantation, AL = Arable land, L × A = Interaction of land use × amendments. Values in bracket denote percentage change

Application of rice mill waste caused increase in soil total porosity from 46.20 % (control) to 60.23 % in PP; 65.40 % (control) to 69.23 % in RP; and 30.80 % (control) to 51.27 % in AL. The amendment with rice mill waste caused about 30.45 % increase in total porosity over the control in PP, 5.86 % increase over control in RP and 66.45 % increase over the control in AL. Application of poultry manure caused increase in soil total porosity from 46.20 % (control) to 53.83 % in PP, 65.40 % (control) to 69.20 % in RP and 30.80 % (control) to 42.30 % in AL. The amendment with poultry manure had about 16.52 % increase in total porosity over the control in PP, 5.81 % increase over control in RP and 37.34 % increase over control in AL.

There was a significant ($p<0.05$) decrease in the bulk density of the soils upon application of the organic amendments. The application of rice mill waste and poultry manure to the soil significantly ($p<0.05$) increased the total porosity of the soils under the land use types. These observations reflected the influence of organic matter on the parameters. With increased organic matter content, bulk density decreased while total porosity increased resulting in an increase in aggregate stability (Baunhardt and Lascano, 1996).

The variation in bulk density may be attributed to the level of organic matter in the soil (Oguike *et al.*, 2018). The higher bulk density and lower total porosity observed under arable land than the other land use types may be attributed to the mechanical disruption of the pore arrangements by frequent tillage (Celik, 2005). The low bulk densities of PP and RP may be attributed to their high organic matter contents (Oguike *et al.*, 2006; Oguike and Mbagwu, 2009). Oguike *et al.*, (2018) observed that soil organic matter reduced bulk density. The reduction in bulk density and increase in total porosity observed after application of the amendments may be attributed to the role of rice mill waste as bulking agent (Bernal *et al.* (2008). Werner (1997) reported increase in total porosity as a result of low bulk density. As sources of organic matter, the RMW and PM used as amendments promote soil faunal activity and play a major role in the build-up and stabilization of soil structure (Anikwe, 2000). The significant decrease in soil bulk density could be attributed to the direct effect of soil organic matter (SOM) levels (Okolo *et al.*, 2013). Indirectly, the decrease is as a result of improved structure as is partly substantiated by increased porosity.

Water retention characteristics

Table 4 shows the changes in water retention properties of soils of different land use types in response to poultry manure (PM) and rice mill waste (RMW) amendments. The soil under rubber plantation (RP) retained the highest amount of moisture at field capacity both in the control (33.70 %) and with poultry manure amendment (34.10 %). Arable land retained the highest (36.30 %) with rice mill waste amendment. The lowest soil moisture retained at field capacity was recorded in the arable land (AL) as observed in control (31.50 %) and when poultry manure was applied (33.37 %). With rice mill waste amendment, oil palm plantation retained the lowest (34.60 %). With reference to permanent wilting point, arable land recorded the highest in control (20.10 %), rice mill waste (23.60 %) and poultry manure (21.27 %) amendments, while rubber plantation had the lowest in control (19.60 %) and poultry manure (19.43 %) amendments. However, oil palm plantation was observed to have the lowest amount of moisture at permanent wilting point (20.03 %) when treated with rice mill waste. For available water content, rubber plantation (RP) recorded the highest in control (14.40 %), rice mill waste (15.00 %) and poultry manure amendments (14.67 %). The lowest available water content was recorded under arable land (AL) soil as observed in control (11.40 % %), rice mill waste (12.70 %) and poultry manure (12.07 %) amendments.

Soil moisture retained at field capacity and the available water content increased more in soils amended with RMW than with PM. Moisture at permanent wilting point (PWP) increased in all the land use types with rice mill waste amendment, and also in arable land when poultry manure was applied. However, it decreased in PP and RP with poultry manure amendment. Compared to the control, field capacity under AL had the highest percentage increase, 15.24 and 5.93 % upon amendment with RMW and PM, respectively. Oil palm plantation (PP) had the lowest percentage increase with RMW (3.28 %) and PM (1.10 %) amendments.

Table 4: Water retention characteristics of soils studied

Land use	Soil Properties		
	FC	PWP (%)	AWC
		Control	
PP	33.50	19.90	13.60
RP	33.70	19.60	14.10
AL	31.50	20.10	11.40
Mean	*32.90*	*19.87*	*13.03*
Rice mill waste			
PP	34.60 (3.28 %)	20.03 (0.65 %)	14.57 (7.12 %)
RP	35.30 (4.75 %)	20.30 (3.57 %)	15.00 (6.38 %)
AL	36.30 (15.24 %)	23.60 (17.41 %)	12.70 (11.40 %)
Mean	*35.40*	*21.31*	*14.09*
		Poultry manure	
PP	33.87 (1.10 %)	19.87 (0.15 %)	14.00 (2.94 %)
RP	34.10 (1.19 %)	19.43 (0.87 %)	14.67 (4.02 %)
AL	33.37 (5.93 %)	21.27 (5.80 %)	12.07 (5.85 %)
Mean	*33.78*	*20.19*	*13.58*
$LSD_{0.05}$			
Land use	0.12	0.98	0.06
Amend.	0.09	0.80	0.03
L × A	0.16	0.93	0.31

FC = field capacity, PWP = permanent wilting point,
AWC = available water content, PP = oil palm plantation,
RP = rubber plantation, AL =
Arable land, L × A = Interaction of land use × amendments.
Values in bracket denote percentage change

The amendment with rice mill waste resulted to 0.65 % increase in permanent wilting point (PWP) over the control in the PP, 3.57 % in RP and 17.41 % in AL. With poultry manure amendment, there was 0.15 % increase in PWP over the control in PP, 0.87 % decrease in RP and 5.80 % increase in AL. With reference to the control, AL recorded the highest percentage increase (11.40 and 5.85 %) in available water content upon amendment with RMW and PM, respectively. Rubber plantation (RP) had the lowest percentage increase under RMW (6.38 %) while oil palm plantation had the lowest under PM (2.94 %) amendment.

The application of rice mill waste amendment had a greater increased effect on soil water retention characteristics than the amendment with poultry manure. The higher field capacities recorded under PP and RP soils than in AL maybe attributed to the high organic matter which provided large surface area required for the absorption and retention of water molecules (Materechera and Mkhabela, 2001). The high water retention capacity of soils under PP and RP is similar to the findings of Ayoubi *et al*. (2011). The lower available water content of soils under AL may be attributed to their low structural stability. Yihenew and Ayanna (2013) who made similar observation reported that land under continuous cultivation deteriorated soil structure aggregates, reducing their available water contents.

pH and organic matter

The changes in soil pH and organic matter content of three land use types in response to poultry manure (PM) and rice mill waste (RMW) amendments are shown in Table 5. Rubber plantation (RP) recorded the highest soil pH in control (5.40), rice mill waste (5.60) and poultry manure (5.50) amendments. The lowest soil pH was recorded under arable land (AL) as observed in control (4.90), rice mill waste (5.43) and poultry manure (5.03). The application of RMW reduced acidity more than with application of PM. Application of rice mill waste caused increase in soil pH from 5.10 (control) to 5.43 in PP; 5.40 (control) to 5.60 in RP; and 4.90 to 5.43 in AL. The amendment with rice mill waste resulted in 6.54 % increase in soil pH over the control in PP: 3.70 % RP; and 10.88 % in AL. Application of poultry manure caused increase in soil pH from 5.10 (control) to 5.27 in PP, 5.40 (control) to 5.50 in RP and 4.90 (control) to 5.03 in AL. The amendment with poultry manure increased soil pH by 3.26 % in PP, 1.85 % in RP and 2.72 % in AL. The increase in pH was due to the application of the organic materials which resulted in increased organic matter content that possibly helped to bind tightly with aluminium ions thereby reducing their activity in the soil solution and raised soil pH, hence reducing acidity (Nega and Heluf, 2013).

With reference to soil organic matter content, the rubber plantation (RP) recorded the highest as follows: 39.00 g kg^{-1} (control), 45.00 g kg^{-1} (RMW) and 42.67 g kg^{-1} (PM). The lowest organic matter content was recorded under arable land (AL) as observed in control (28.00 g kg^{-1}), rice mill waste (38.33 g kg^{-1}) and poultry manure (34.33 g kg^{-1}). Soil organic matter content increased more in soils amended with RMW than with PM amendment.

Application of rice mill waste caused increase in soil organic matter from 32.00 g kg^{-1} in the control to 41.00 g kg^{-1} under PP, 39.00 g kg^{-1} (control) to 45.00 g kg^{-1} under RP and 28.00 g kg^{-1} (control) to 38.33 g kg^{-1} under AL. The amendment of oil palm plantation soil with rice mill waste resulted in 28.13 % increase in organic matter content while 15.38 % increase was observed in RP. The highest increase of 36.90 % was recorded in AL. Application of poultry manure caused increase in soil organic matter from 32.00 g kg^{-1} (control) to 39.00 g kg^{-1} in PP, 39.00 g kg^{-1} (control) to 42.67 g kg^{-1} in RP and 28.00 g kg^{-1} to 34.33 g kg^{-1} in AL. The amendment with poultry manure resulted in 21.88 % increase in organic matter content in PP, 9.40 % increase in RP and 22.62 % increase in AL.

The lower organic matter content under arable land than in the PP and RP may be attributed to the continuous decomposition and oxidation of organic matter (Oguike and Onwuka, 2017) and rapid intake of organic inputs in the soil by plants (Nega and Heluf, 2013). The increase in decomposition of organic matter may be due to enhanced biological activity as a result of soil mixing due to tillage and higher temperatures from increased soil exposure (Rab, 2003). The higher organic matter under PP and RP than AL may be attributed to the continuous input and decomposition of litter falls and roots (Kleber *et al*., 2011; Wu *et al*., 2011). This corroborates the findings of Urisotle *et al*. (2006) who stated that the roots of grasses and trees and the fungal hyphae under plantation land use probably were responsible for the high organic matter. The result showed that the application of rice mill waste and poultry manure positively influenced the soil pH and organic matter. Relative to control, there was increase in pH when the soil was amended with rice mill waste and poultry manure. This finding is in agreement with the reports of Onwuka *et al*. (2007) and Eneje and Azu, (2009) who reported improvement on soil pH when amended with organic manure.

Table 5: pH and organic matter of soils studied

Land use	Soil Properties	
	pH	OM (g kg^{-1})
	Control	
PP	5.10	32.00
RP	5.40	39.00
AL	4.90	28.00
Mean	*5.13*	*33.00*
	Rice mill waste	
PP	5.43 (6.54 %)	41.00(28.13 %)
RP	5.60 (3.70 %)	45.00(15.38 %)
AL	5.43 (10.88 %)	38.33(36.90 %)
Mean	*5.49*	*41.44*
	Poultry manure	
PP	5.27(3.26 %)	39.00(21.88 %)
RP	5.50(1.85 %)	42.67(9.40 %)
AL	5.03(2.72 %)	34.33(22.62 %)
Mean	*5.27*	*38.67*
$LSD_{0.05}$		
Land use	0.13	2.01
Amend.	0.04	2.11
L × A	0.10	1.32

PP = oil palm plantation, RP = rubber plantation, AL = Arable land, L × A = Interaction of land use × amendments.

Conclusion

The results showed that the soil properties varied with different land use types and in response to the organic amendments. The soils became more structurally stable with the organic amendments. Higher total porosity and low bulk density were observed in oil palm and rubber plantations than in arable land. Organic amendments increased the total porosity and reduced the bulk density of the soils. Higher soil moisture was retained in the oil palm and rubber plantations than in arable land. The organic amendments increased the soil moisture retained at field capacity and the available water for plant uptake. The pH of the soils studied ranged from strongly acidic to moderately acidic. Organic matter was generally low in arable land but high in oil palm and rubber plantations. The highest percentage change observed in arable land when the organic amendments were applied suggested that arable land may have been deprived of organic matter due to continuous cultivation on the land. This may have reduced the soil structural stability. However, as organic amendments were applied to the soil under AL, the aggregate stability changed more than the soils of PP and RP which had little or no human disturbance. Rice mill waste was observed to contribute more to improvements in the physical properties of the soils studied. The problem of soil degradation arises from increased pressure on the land due to improper management and use. This problem, if not properly handled, will cause destruction of valuable agricultural soils leading to food insecurity and environmental problems. However, improving the organic matter content in soils through amendments with organic materials will be effective in tackling the degradation of the soils.

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