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# Three Years Influence of Tillage and Wood Ash on Soil Organic Matter Content of a Typic Haplustult and Yield of Castor

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***Abstract:*** *Soil organic matter is made up of dead remains of plant and animal which is at different stages of decomposition, hence the store house of mineral nutrients in soil. Thus a split plot in randomized complete block design with three tillage methods (mound, ridge, flat) and four rates of wood ash (0, 2, 4, and 6tha$^{-1}$) replicated three times was set up to evaluate the influence of tillage and wood ash on soil organic matter (SOM) content of an ultisol and yield of castor for three (3) consecutive years study. The results obtained after three years of study showed that SOM vary among the tillage methods and recorded increased value in 3$^{rd}$ year planting irrespective of the tillage method. Apart from mound that its OM decreased in 2$^{nd}$ year with a value of 1.35gkg$^{-1}$, ridge and flat show increased value as planting year increased. Irrespective of the tillage method studied, the 3$^{rd}$ year results recorded decreased value in stem girth with increased value of pod weight of castor compared to 1$^{st}$ and 2$^{nd}$ year results. The result of ash application indicated that irrespective of the tillage method applied, the control plots (Mdo, Rdo, Fto) recorded the lowest OM concentration, stem girth and pod weight of castor. Evidence that the influence of WA was much on the amended soils compared to the control soils.*

***Keywords:*** *Organic carbon, organic matter, tillage, ash, mound, ridge, flat, castor & stem girth.*

## 1. Introduction

Under natural conditions the grasses and indeed trees, shrubs, plus other native plants annually supply large quantities of organic matter (OM). As these materials are decomposed and digested by the soil organisms of many kinds, they become part of the underlying soil layers by infiltration or by physical incorporation. The higher plant tissue therefore is the sources of soil organic matter (SOM) which is so

essential for soil formation. Soil OM represents an accumulation of partially synthesized plant and animal residues that are at various stages of decomposition. This material is continuously being broken down as a result of the activities of soil micro-organisms. When the SOM is finally degraded by the soil organisms it becomes what is called humus that impacts its colour and mineral components to the soil. The level of impacts however depends on the quantities of residues decomposed and incorporated in the soil. Soil OM influence soil physical, chemical, biological properties and plant growth and yield, SOM is the store house of the plant mineral nutrients and major source of soil mineral elements such as phosphorous, nitrogen and sulphur. The main source of energy for soil organisms, without it biochemical activities in soil would become practically impossible. Studies have shown that a lot of factors influence the quantity and quality of SOM content which invariable affect the yield capacity of soils. Magdoff (1993) observed that the types of crop grown the amount of roots, biomass yield and efficiency of harvest and the management of residues affect SOM. Hence the amount and type of OM is an indicative of soil productivity. Changes in land use management systems have also being found to affect soil OM content (Nweke 2015). When carbon enters the soil through animal manure, ash, charcoal, harvest residues, litter falls or as roots, it is primarily stored as SOM. This adds to soil fertility, water retention capacity, root proliferation, crop production and yield. Hence it becomes paramount important for farmers to recognize the benefits of maintaining and increasing SOM content in agricultural soils. As SOM not only help in soil fertility and formation but also in stabilization of both macro and micro- aggregates (Nweke, 2015). Nweke further reported that finer soil particles retain more water and accumulate more OM than Macro-aggregates.

Tillage an integral part of crop production system since ages in agriculture has been found to influence SOM content of soils. Holland (2004) observed that conservation tillage system decreased contamination of surface waters and the conservation of nutrients and OM, though it help in reduced sedimentation and soil erosion and improved water infiltration. He further stressed that increases in OM depended particularly on soil types, cropping systems, kind of management and climate. Conventional tillage promotes greater aeration of the soil, which increased the breakdown of OM that releases a large quantity of nutrients to support plant growth (Bessam and Marbet, 2003). Tillage temporarily increases the $O_2$ level in the soil which increases the mineralization rate of OM thus enhancing the release of $CO_2$ into the atmosphere (Alvarze et al., 1995). With this there is corresponding oxidation of nutrients contained in the OM, the most being nitrogen. These released chemical nutrients become available for plant uptake that enhance yield. Ash is a term usually applied to the minerals obtained from burning wood, food stuffs, coal, rice husk, or other fuel. Chemical analyses of ashes determine the amount of minerals they contain. These ashes have been found to have positive effect on soil OM content, soil characteristic and crop yield. Owolabi et al. (2003) found out that the OM content increases observed in their studies are attributable to the nutrient supplied by the type of ash used. Applying ash to farmland after recycling can be one of the effective ways to improve the SOM, physical, chemical and microbiological properties of soil as ash is involved in direct release of nutrients and increase soil pH. Soils differ in their response to tillage methods. It is important to investigate more closely the influence of different tillage methods on SOM being important soil characteristics that influence a lot of processes in soils. Similarly the author observed that research information on the influence of tillage practices on OM content of soils of tropical countries like Nigeria is very scarce. Thus this work attempted to develop tillage wood ash package for the production of castor on ultisol in the derived savannah zone of southeast Nigeria. Hence in this study the effect of three tillage methods, wood ash at four different rates and tillage cum ash treatments on SOM, stem girth and castor yield were evaluated after three years of repeated treatments.

## 2. Materials and Methods

### 2.1 Location of Experiment

This study was carried out in three cropping years at Teaching and Research Farm of Faculty of Agriculture and National Resources Management (FARM), Ebonyi State University, Abakaliki. The area of the study is located within latitude $06^{o}19^{1}$ N and Longitude $08^{o}06^{1}$, the rainfall distribution is bimodal from April to July and peak in June and September to November. It has an annual rainfall range of 1700 –

1800 mm. The temperature ranges from 27°C – 31°C, the relative humidity of the study area is between 60 – 80% (Ofomata 1975; FDALR 1985). The soil is Ultisol and classified as Typic Haplustult by FDALR (1985).

**2.2 Land preparation/design and Treatment Application**

A land area measuring 0.0615ha (41m x 15 m) was mapped out and used for the study. The natural vegetation in the experimental site was cleared using cutlass and the debris removed from the site. Tillage methods studied were mound (Md), Ridge (Rd) and Flat (Ft), and wood ash made from Agba plant called *Carpolobea alata* which were applied at different levels 0, 2, 4, 6 $tha^{-1}$ were spread uniformly on the soil surface and incorporated in their respective plots during cultivation. The experiment was laid out as split plot in a randomized complete block design (RCBD), with tillage methods as the main plots and wood ash as the sub-plots, with 12 treatments replicated 3 times to give a total of 36 plots. Each plot measuring 3m x 4m ($12m^2$), a plot was separated by 0.5m alley and each replicate was 1m apart. Two castor seeds per hole were planted at a spacing of 0.9m between rows and 0.45m within rows at a depth of 8cm. There was basal application of NPK fertilizer 15:15:15 at the rate of 0.4kg/plot to all plots two weeks after planting. The seedlings were thinned down to one plant per stand two weeks after germination. Weeding was done manually with hoe at 3-weeks interval till harvest. Harvesting was done when the capsules containing the seed turned brown and this commenced 153 days after planting. It continued for the next 62 days at every 21 days intervals. It is usually done early in the morning before sun set and evening to avoid scratches usually caused by the leaves of the plant if done in the afternoon when the weather is hot. The harvested spikes were dried in the sun 2-3 days and then the pods containing the seeds were weighed and the yield expressed in ton/ha. The same procedure was repeated in the second and third year of the experiment but without application of wood ash in the third year to test the residual effect.

**2.3 Soil Sample Collection**

Auger soil samples were randomly taken from ten (10) different spots in the experimental area at the depth of 0 – 20 cm prior to planting. The Auger soil samples were mixed thoroughly to form a composite soil sample and used for pre-planting soil analysis. Also the wood ash treatment used was analyzed for determination of its chemical composition. At the end of each cropping season that was after crop harvest, auger soil samples were collected from three different spots in each plot, the soil samples were air dried, sieved and used for organic matter content analysis.

**3. Laboratory method**

**3.1 Organic Matter and Organic Carbon**

Carbon occur in the soil in the form of carbonates (mainly $CaCO_3$), elementary carbon (Charcoal), littered plant and animal residues and humus which is the colloidal organic matter of the soil that no longer show the recognizable structure of leaves, wood, animal tissue etc from which it has been derived. The organic carbon determination was done by oxidizing the reducing material in the soil by chromic acid formed by adding Conc. $H_2SO_4$ to potassium dichromate solution. Heat is supplied by the dilution of the $H_2SO_4$ and the remaining chromic acid is then determined by means of standard ferrous sulphate titration. After the soil has been oxidized the mixture was allowed to cool, diluted and directly titrated with ferrous sulphate using an indicator. Thus the organic carbon was analyzed by the method of Nelson and Sommers (1982) and the value for the Organic Matter (OM) was obtained by multiplying the carbon value by the conventional Van Bemmelar factor of 1.724.

**3.2 Stem Girth (cm)**

Ten castor plants per plot were sampled for stem girth. This was taken at the end of the study with a tape.

### 3.3 Pod Yield ($tha^{-1}$)

Ten (10) castor plants per plot were sampled and tagged. The pod yield per plot was measured when the capsule matures and dried. The pods harvested from the tagged plants were weighed to get the yield per plot and then expressed to its hectare equivalent.

### 3.4 Data Analysis

The data generated were subjected to an analysis of variance test based on RCBD using CropStat software version of 7.0, while statistically significant difference among treatment means was estimated using the least significant difference (LSD < 0.05).

## 4. Results

The values of total nitrogen 0.05% (TN), organic carbon 1.09% (OC), and organic matter 1.88% (OM), were generally low (Table1). The soil contains low level of these nutrient elements. Hence the soil of the studied area is considered poor in these essential nutrient elements. Also ash obtained from *Carpolobea alata* contains lower levels of organic matter, organic carbon and total nitrogen (Table 2).

**Table 1: Initial soil parameters before treatment application**

| Test Parameter | Value |
|---|---|
| Total nitrogen | 0.05% |
| Organic carbon | 1.09% |
| Organic matter | 1.88% |

**Table 2: Chemical composition of the wood ash before application**

| Test Parameter | Value |
|---|---|
| Total nitrogen | 0.04% |
| Organic carbon | 0.66% |
| Organic matter | 1.13% |

### 4.1 Effect of tillage and wood ash on soil organic matter content

The organic matter(OM) content result after the 3 years of study presented in Table 3 vary among the tillage methods (TM) and showed significant difference (P < 0.05). Irrespective of the tillage methods (TM) studied OM showed increased value in the 3rd year planting result as against its value obtained in the 1st and 2nd year planting results. Apart from mound method that its OM decreased in 2nd year, ridge and flat method showed increased value of OM as the planting year increased, thus their yield variation were 3rd year value > 2nd year value> 1st year value (for ridge and flat) while mound showed 3rd year value >1st year value >2nd year value. Among the tillage methods, least value of 1.35gkg$^{-1}$ OM was recorded in mound in the 2nd year planting result. In comparison of the TM with regard to cropping years studied the 1st year showed a variation of mound > ridge > flat, 2nd year flat > ridge > mound, while 3rd year result showed a variation of ridge > flat > mound.

The effect of wood ash (WA) application irrespective of the tillage method it was applied showed statistical significant (P < 0.05) difference among the treatment rates and vary in value obtained among the rates. Its application in mound method, showed that OM variation in the 1st planting period were Md4 > Md6 > Md2 > Md0. The 2nd and 3rd year planting results showed Md2 > Md6 > Md4 > Md0. The result of the 3years study on mound showed that lower concentration of OM was recorded in Md0 and the least value of OM for the 3years study was obtained in Md0 of 2nd year planting period. The (WA) on ridge showed that the value of OM concentration recorded in Rd4 (1st year) Rd2 (2nd year and 3rd year) were highest among the rates of WA applied. While the least value of OM concentration among the rates for the 3years of study was obtained in Rd0 of the 1st year planting. The effect of WA in flat method for 1st year planting showed inconsistent in the order of OM variation, the order was Ft6 > Ft2 > Ft4 > Ft0. The 2nd

and 3rd result showed that OM content increased as the rate of WA applied increased, though the Ft0 and Ft2 of the 3rd year result showed similar values in OM concentration.

**Table 3 Effect of tillage and wood ash or soil organic matter gkg$^{-1}$**

| Treatment | 1st year | 2nd year | 3rd year |
|---|---|---|---|
| Md0 | 1.32 | 1.11 | 1.25 |
| Md2 | 1.67 | 1.72 | 3.41 |
| Md4 | 2.09 | 1.18 | 2.23 |
| Md6 | 1.95 | 1.39 | 3.00 |
| Mean | 1.76 | 1.35 | 2.47 |
| Rd0 | 0.94 | 1.46 | 2.07 |
| Rd2 | 1.88 | 2.23 | 3.16 |
| Rd4 | 2.23 | 1.60 | 2.91 |
| Rd6 | 1.74 | 1.67 | 2.99 |
| Mean | 1.71 | 1.74 | 2.78 |
| Ft0 | 1.04 | 1.11 | 2.24 |
| Ft2 | 1.53 | 1.60 | 2.24 |
| Ft4 | 1.25 | 2.30 | 2.60 |
| Ft6 | 1.83 | 2.50 | 3.07 |
| Mean | 1.41 | 1.88 | 2.54 |
| LSD 0.05 | | | |
| TM | 0.28 | 0.34 | 0.53 |
| WA | 0.37 | 0.38 | 0.31 |
| TM X WA | 0.13 | 0.11 | 0.49 |

Md0= Mound without wood ash (WA); Md2= Mound+2t/ha WA; Md4 = Mound+4t/ha WA; Md6 = Mound+6t/ha WA; Rd0 = Ridge without WA ; Rd2 = Ridge+2t/ha WA; Rd4 = Ridge+4t/ha WA; Rd6 = Ridge+6t/ha WA; Ft0 = Flat without WA; Ft2 = Flat+2t/ha WA; Ft4 = Flat+4t/ha WA; Ft6 = Flat+6t/ha WA

The result of OM presented in Table 3 showed that the OM concentration was significantly affected by the TM and rate of WA application. The mean value result of OM showed that the ridge and flat and their rates of WA are relatively alike and higher in value than the mound and its rate of WA especially for 2nd and 3rd year results. The OM concentration for the 3years study showed a result order of 3rd year planting results > 2nd year planting result > 1st year planting result. Generally the result showed lowest OM values in Md0, Rd0 and Ft0 for the 3years of the study.

### 4.2 Effect of tillage methods and wood ash on stem girth and pod weight of castor

The stem girth and pod weight of castor presented in Table 4 showed that tillage methods (TM) significantly ($P < 0.05$) affected the result of the parameters. The 1st year planting result of mound showed that the value of stem girth decreased as the year of planting increased recording the least value in the residual year (3rd year). The weight of the pod decreased in the 2nd year result but increased rapidly in the 3rd year result. The same result scenario obtained in mound was observed in ridge and flat for the two parameters. In comparison of the tillage methods (mound, ridge and flat), the stem girth result obtained in 1st, 2nd and 3rd year showed that value recorded in flat was higher in 1st and 2nd year with least value in this two years obtained from ridge. The 3rd year result however showed a contrary order of least value being observed in flat with highest value recorded in mound. Pod weight result showed order of mound > flat > ridge (1st and 2nd year) while 3rd year showed a result order of mound > ridge > flat.

The rates of wood ash application irrespective of the tillage method applied was significant ($P < 0.05$) for the parameters measured (Table 4). Its effect in mound method showed a result variation of Md4 >

Md6 > Md2 > Md0 (1st and 2nd year) and Md6 > Md4 > Md2 > Md0 (3rd year) for the stem girth result; however pod weight result presented a result order of Md4 > Md6 > Md2 > Md0 for the 3 years of study. The ridge method presented a result order of Rd6 > Rd4 > Rd2 > Rd0 for the 1st and 2nd year result of stem girth. The 3rd year result of stem girth showed an order of Rd2 > Rd6 > Rd4 > Rd0, while the result of the pod weight in ridge showed a decreased value in all the rates in 2nd year but showed rapid increase in pod weight in the 3rd year result. The 3 years study showed that the lowest value (0.77tha$^{-1}$) of pod weight was obtained in Rd0 in the 2nd year planting. The effect of WA application in flat method showed a result variation of Ft4 > Ft6 > Ft2 > Ft0 (1st and 2nd year) and Ft6 > Ft4 > Ft2 > Ft0 (3rd year) for the two parameters studied. For the 3years of study the least values of the parameters were recorded in Ft0 of 3rd year (stem girth) and 2nd year (pod weight).

The result presented in Table 4 showed that the tillage methods and rates of wood ash interaction significantly affected the two parameters for the 3years under study. The values of the parameter (stem girth, and pod weight) obtained from the plots that received 4tha$^{-1}$ WA (Md4, Rd4 and Ft4) was highest among the values of the other rates in 1st and 2nd year planting periods while the rate that gave the highest value of the tested parameters in the 3rd year (residual year) was the plot that received 6tha$^{-1}$ WA (Md6, Rd6 and Ft6). This particular result indicates that 6tha$^{-1}$ have strong residual effect on the parameters assessed more than the other rates. The result presented in Table 4 also showed that the values of parameters were dependent on the quantity of WA applied as their result showed increased value as the rate of WA application increased. Generally the influence of WA was much on the amended soils compared to the control soils as higher values were observed on the amended relative to the control soils.

**Table 4 Effect of tillage and wood ash on stem girth (cm) and pod weight (tha$^{-1}$) of castor**

| Treatment | 1st year Stem girth Cm | Pod weight tha$^{-1}$ | 2nd year Stem girth Cm | Pod weight tha$^{-1}$ | 3rd year Stem girth Cm | Pod weight tha$^{-1}$ |
|---|---|---|---|---|---|---|
| Md0 | 10.20 | 1.01 | 9.70 | 0.89 | 0.14 | 6.30 |
| Md2 | 11.02 | 2.89 | 10.52 | 2.78 | 0.22 | 7.33 |
| Md4 | 12.44 | 4.13 | 11.94 | 4.01 | 0.33 | 8.32 |
| Md6 | 11.78 | 3.41 | 11.28 | 3.30 | 0.34 | 7.94 |
| Mean | 11.36 | 2.86 | 10.86 | 2.75 | 0.26 | 7.47 |
| Rd0 | 9.66 | 0.89 | 9.16 | 0.77 | 0.12 | 7.15 |
| Rd2 | 11.06 | 1.89 | 10.60 | 1.78 | 0.33 | 8.18 |
| Rd4 | 11.32 | 3.15 | 10.84 | 3.04 | 0.25 | 7.53 |
| Rd6 | 12.12 | 3.04 | 11.62 | 2.93 | 0.28 | 7.98 |
| Mean | 11.04 | 2.24 | 10.56 | 2.13 | 0.25 | 7.71 |
| Ft0 | 9.92 | 1.27 | 9.43 | 1.17 | 0.09 | 5.78 |
| Ft2 | 11.52 | 2.36 | 11.02 | 2.25 | 0.13 | 6.52 |
| Ft4 | 12.17 | 3.32 | 11.60 | 3.21 | 0.16 | 6.70 |
| Ft6 | 11.92 | 2.74 | 11.42 | 2.63 | 0.20 | 7.26 |
| Mean | 11.38 | 2.43 | 10.87 | 2.32 | 0.15 | 6.64 |
| LSD 0.05 | | | | | | |
| TM | 1.01 | 1.05 | 1.01 | 1.05 | 0.91 | 0.80 |
| WA | 0.84 | 0.82 | 0.84 | 0.81 | 0.10 | 0.90 |
| TMXWA | 1.60 | 1.51 | 1.60 | 1.51 | 0.16 | 1.45 |

Md0 = Mound without wood ash (WA); Md2= Mound+2t/ha WA;Md4=Mound+4t/ha WA; Md6=Mound+6t/ha WA; Rd0 = Ridge without WA ; Rd2= Ridge+2t/ha WA; Rd4= Ridge+4t/ha WA; Rd6= Ridge+6t/ha WA; Ft0= Flat without WA; Ft2= Flat+2t/ha WA; Ft4= Flat+4t/ha WA; Ft6= Flat+6t/ha WA

## 5. Discussion

### 5.1 Organic matter concentration

The observed increase in SOM content of the 3rd year planting season irrespective of the TM and rates of ash applied can be explained in the light of the residual effects of the 1st year planting coupled with the additional ash application in the 2nd year and rates of degradation. On the contrarily at the end of 1st and 2nd year planting, OM content were found to be low this might be due to low presence of the OM in both the soil (Table 1) and ash (Table 2) before the commencement of the study. This simply suggests the inferiority of ash from *Carpolobea alata* plant as far as improvement of the OM status of the soil through ash addition is concerned. The low content of OM can as well be attributed to high productivity and reduced decomposition. The higher concentration of OM observed in ridge and flat method could be attributed to less soil inversion usually experienced in the two aforementioned methods relative to the mound method less aerobic activity and better physical protection of SOM within the aggregates as Feller and Beare (1997) noted that silt + clay particles protect SOM. This attitude tend to limit rapid OM decomposition and mineralization, hence the nature of result obtained from ridge and flat method. This probable may be the reason why after 3 years of study, the highest OM storage was recorded in ridge of which the order is Rd (2.077gkg$^{-1}$) > Ft (1.943gkg$^{-1}$) > Md (1.860gkg$^{-1}$). This is in live with the work of Khalid et al. (2013) who found that zero tillage stored highest OM content of 7.48gkg$^{-1}$ compared to reduced tillage and conventional of 6.90gkg$^{-1}$ and 6.86gkg$^{-1}$ respectively after 2 years of study. The recorded values of OM concentration however were above the critical level considered by Defoer et al. (2000) for good crop production. The increase in OM content observed in the wood ash (WA) amended plots could be attested to the application of the WA of which did not vary much with the rates applied especially with regard to its application in mound (Md) method. The variation in OM concentration with regard to the rates of WA applied did not follow any particular order in the sense that in some cases irrespective of tillage method it was applied higher values are recorded in 2tha$^{-1}$ rate of WA compared to 4tha$^{-1}$ and 6tha$^{-1}$ rate. This suggest that increase in WA application reduced availability of OM of which relate to drop in soil pH in those plots of 4tha$^{-1}$ and 6tha$^{-1}$ WA in which their OM concentration is less than that obtained from 2tha$^{-1}$ WA (Nweke et al., 2017). The increased OM content observed in the 3rd year planting season visa-vie the 1st and 2nd year planting can be as Buyanosky and Wagner (1998) suggest that increased OM is a function of increased OC content from residue and manure. Ismail et al. (1994) observed an increased SOC during 6 year study with maize. The tillage and wood ash interaction revealed that the three tillage (mound, ridge and flat) methods studied in this work increased SOM with each increment in WA application, however highest SOM of 3.41gkg$^{-1}$ was recorded in Md2. The higher SOM recorded in Md2 could be attributed in part to the variability of silt + clay content of the soil as silt + clay protect OM in soil and to less activity of soil micro-organisms that would have increased the decomposition of the SOM.

From the results of the study in Table 4, it was observed that castor plant development and yield was dependent on the tillage methods studied and rates of WA applied. Soil application of WA affected castor plant physiological development and yield relative to control plots. Increasing the rates of WA application resulted to an increase in stem girth and pod weight of castor. The differences in values recorded could be attributed to differences in plant nutrients in the rates of WA applied and their availability to the crop plant. The 4tha$^{-1}$ rate of WA was found to have recorded the highest value of pod weight in all the TM studied in 1st year and 2year season respectively compared to the other rates of WA. This could be attributed to higher contents of plant nutrients in form required by the plant and probable higher activity of micro-organisms leading to the release of nutrients to the plant. The 3rd year result however showed strong residual effect of 6 tha$^{-1}$ of WA on the castor plant an indication that 6 tha$^{-1}$ WA mineralized and released its nutrients gradually making them available to castor plant thereby enhancing its growth and yield observed in the 3rd year result. The decline in the values obtained from the other rates after two years of application probable may be that most of the nutrients contained in them might have been released, whereas nutrients in 6tha$^{-1}$ rate of WA are still been released and made available for the castor to utilize. The fact that 4tha$^{-1}$ rate WA released its nutrients faster than other rates may have led to higher pod weight

and stem girth recorded in plots amended with the rate in the 1st and 2nd year cropping season. The drastic reduction in the value of stem girth in the 3rd year cropping season irrespective of the TM and rates of WA applied, may be due to non-application of WA in the 3rd year season of which might have reduced the percentage build up of N and other nutrients that would have helped the vegetative development of the castor plant that will lead to an increase yield. Among the tillage methods mound consistently gave the highest pod weight in 1st and 2nd year season and next in rank after ridge method in 3rd year season. This in part may be due to higher soil inversion observed in making of mound compared to other tillage methods studied or probable mound retains much water upon which mineral nutrients dissolved and made available to castor plant. While the least value obtained from flat method may be attributed to non-soil inversion, hard pan limitations in water retention and transmission all acting together might have resulted to the nature of result obtained from flat method.

## 6. Conclusion

This study has shown that WA can be used as organic fertilizer to improve soil nutrients and thereby increase crop yields. The SOM, stem girth and pod weight of castor responded differently to the tillage methods and rates of WA applied. Increasing the rate of WA application led to an increase in OM content and castor yield. Organic matter storage in soil can be influenced by the tillage practices. The findings from the study indicate, that mound tillage may be more productive, though with less sequestering of OM at higher rate of WA than ridge and flat tillage. Thus castor plant can be grown successfully in ultisol in humid tropical climate soil with mound at $4tha^{-1}$ rate of WA but advised to increase the rate to $6tha^{-1}$ if the cropping is to last beyond two seasons due to strong residual impact of $6tha^{-1}$ rate of WA observed from the result of the study. Wood ash apart from increasing OM concentration of the soil as shown in the study which is the store house of mineral nutrients that improve soil productivity, it will save the farmer the cost of buying fertilizer as this waste can be obtained free in the study area.

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