EFFECT OF TILLAGE PRACTICES AND BURNT COCONUT HUSK ON SOIL PHYSICAL PROPERTIES AND YIELD OF MAIZE (*Zea mays L*) IN OBUDU CROSS RIVER STATE, NIGERIA.

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ABSTRACT :
The objective of this study was to find out the effect of tillage practices and burnt coconut husk on soil physical properties and yield of maize. The objective was achieved through a 2023 cropping season field experiment arranged as a split plot in randomized complete block design (RCBD) with six treatments and three replications. The treatments were ; Flat tillage (FT) ,Ridge tillage (RT), Mound Tillage (MT), FT + 10 t ha-^{1} burnt coconut husk ($FTBCH_{10}$), RT + 10 t ha-^{1} burnt coconut husk ($RTBCH_{10}$), MD + 10 t ha-^{1} burnt coconut husk(MTBCH) . Results of the study showed that tillage practices amended with burnt coconut husk significantly (p=0.05) increased soil bulk density relative to tillage practices alone. Soil total porosity and aggregate stability were increased in tillage practices amended with coconut husk . Significantly higher maize grain yield was obtained in burnt coconut husk amended tillage practices relative to the control. Burnt coconut husk improved the soil physical properties which led to increased maize yield.
Keywords: Tillage practices, Physical properties, Maize yield, Seed germination, Burnt coconut husk.

INTRODUCTION

Tillage is the physical manipulation of the soil to create conditions suitable for germination of seed , seedling emergence and root growth to avoid competition from weeds (Prihar et al. 2000). According to Bayer *et al*.(2001) tillage has been part and parcel of crop production system from the beginning of agriculture. Tillage methods have various influences on the physical characteristics of the soils both beneficial and degrading depending on the appropriateness and method used (Kladivko,2009).

Bayer *et al*.(2001) reported that no-till method limits the rate of soil organic matter loses thus improving soil carbon and nitrogen contents. On the otherhand, Strudley *et al*.(2008) observed that deep tillage practices allow for deeper placement of fertilizer, improves aeration/drainage, water infiltration in soil and increase root depth development and proliferation..

Tillage in combination with soil condition has been found to be the most efficient in reducing the impact of tillage operation problems. Klaiz and Hoogmoed (1993) and Nweke *et al*.(2017) reported that when tillage is combined with soil amendment or treatment, soil productivity and crop yield are increased. Nnadi *et al*.(2019) reported increase in soil properties and castor oil seed yield when tillage practices were amended with wood ash. Mbah *et al*.(2010) and Adeleye *et al*.(2015) observed increased soil properties and maize yield when they used woodash as soil amendment. Njoku and Mbah (2012) studied the effect of burnt rice husk dust in a degraded ultisol and reported increased soil properties and maize yield in amended plots relative to control.

In the study area coconut tree abound and shelled coconut husk constitute wastes/environmental problems in many markets and homes. Researches on the use of these shelled coconut husks either in its original or burnt form has not been carried out. The objective of this study was to find out the effect of tillage practices and burnt coconut husk on soil physical properties and yield of maize (*Zea mays L*).

MATERIAL AND METHODS

Study area : The experiment was carried out in 2022 cropping season at the Teaching and Research Farm of School of Secondary Education Vocational , Federal College of Education, Obudu Cross River state. The area lies approximately within latitude 4^{0} W and latitude $7^{0}20'$ N . The climate of the area is characterized distinctively into wet and dry season. It has annual temperature of between 27-35 ^{o}C with mean annual rainfall of 3000 mm, received between March and November. The soils are formed from different mapping units in the undifferentiated basement complex derived from gneiss, schist and quartz with deep and drained typic dystrudepts, Hapludults and Hapludults (FDALR,1985)

Land Preparation : Land area of 32 m by 17 was used for the study.. The dorminant vegetation (panicum maxinum, pennisetum purperium etc) were cleared with cutlass and the debris removed. The tillage operation was done using traditional hoe. The mounds were prepared to a height and width of 14-18 cm and 19-22 cm ,respectively while the ridges were prepared to heights measuring 16-23 cm high and 82-100 cm wide .

Experiment Design and Treatment Application

The experiment was laid out as a split plot in Randomized Complete Block Design (RCBD) .The area was divided into 3 blocks with each block separated by 1 m guard row.. A total of 6 experimental units measuring 3 m x 3 m each were in each block., Plots were separated by buffer of 0.5 m and each

replicate 1 m apart. . The treatments were ; Flat tillage (FT), Ridge tillage (RT), Mound tillage (MT), FT + 10 t ha-^{1} burnt coconut husk ($FTBCH_{10}$), RT + 10 t ha-^{1} burnt rice coconut dust ($RTBCH_{10}$), and MT + 10 t ha-^{1} burnt coconut husk dust (MTBCH)
.. The treatments were spread uniformly and incorporated into their respective plots during cultivation. The main plot treatment was the tillage practices while the subplot treatment was the application of the burnt coconut husk . . .

Data collection.

Initial soil sample collection : Soil samples were collected from 6 points (at a depth of 20 cm) in the entire plot before the experiment started in April 2022. The samples were composited, air dried and analysed for particle size, exchangeable bases (Ca, Na, Mg, K,), pH, organic carbon, total N, and available P. At 45 and 90 days after planting (DAP) undisturbed core samples were collected from each of the plot and used to determine the bulk density. Soil samples were collected with auger at 30 and 60 DAP and used to determine soil aggregate stability. Burnt coconut husk (BCH) were collected from its disposal site in the market while maize grain was purchased from Ebonyi state agricultural development programme (EBADEP),Abakaliki.

Laboratory methods.

Soil bulk density was determined according to the procedure outlined by Blake and Hartge (1986). Particle size was determined by the hydrometer method (Gee and Or, 2002). Total porosity (Tp) was determined from bulk density value with assumed particle density (dp) of 2.70 Mg cm-^{3} as follows;

Tp =100 [1-db/pd] --------equation 1 .

where Tp= Total porosity, dp = bulk density, pd= particle density. Aggregate stability was determined by the wet-sieving method as described by Kemper and Rosenau (1986).

Yield determination

At maturity six maize plants were selected from each plot and tagged. Maize cobs from the tagged plants were harvested, shelled, air dried and the yield measured.

2.4. Data Analysis

Data collected from the study was analyzed using the general linear model of SAS software for Randomized Complete Block Design (SAS institute inc 1999).

RESULTS AND DISCUSSIONS

Initial properties of the soil and burnt cocnut husk .

Analysis of initial soil sample showed that the texture was sandy clay (Table 1). The soil available P mg kg-^{1}, K cmolkg-^{1} , total Na and organic carbon (%) values were 4.6, 0.23, 0.14 and 1.00, respectively while burnt coconut husk (BCH) had 50.1 mg kg-^{1} available P, 0.16% total N, 3.41 cmolkg-^{I} K, and 14.65% organic carbon. Table 1 also showed pH of 3.80 and 8.25, respectively for soil and burnt coconut husk. According to the table burnt coconut husk had higher nutrient content compared to the soil.

Effect tillage practices and burnt coconut husk on soil bulk density (Mgm-^{3})

Application of burnt coconut husk on tillage practices significantly decreased soil bulk density at 45 days after planting (DAP) relative to tillage practices alone . At 45 DAP bulk density ranged between 1.38 and 1.40 Mgm-^{3} in tillage practices alone and 1.36-1.37 in burnt coconut husk amended tillage practices plots . The order of increase in bd was FT>RT>MT>RTBCH=FTBCH >MTBCH. At 90 DAP tillage practices amended with burnt coconut husk had no significant effect on soil bd. Bulk density is a physical property of soil used to quantify soil compactness. High bulk density limits plant root growth. Mbah *et al*. (2023) reported decreased bulk density in plots amended with burnt rice husk dust compared to the control. Anikwe (2000) observed decreased soil bulk density in plots amended with 4.5 and 6 t ha-^{1} of rice husk dust relative to the control. Observed bulk density values at 45 DAP were lower than those at 90 DAP. The difference in bd could be attributed to such factors as organic matter content, natural process of settling and structural collapse due to impact of rainfall in line with the observation of Mbagwu (1992). The result of this study corroborated those of Njoku and Mbah (2012) and Nnadi et al.(2019) when they used organic wastes as soil amendment.

Effect tillage practices and burnt coconut husk on soil total porosity (Tp%)

At 45 DAP amendment of tillage practices with coconut husk significantly increased the soil tp% relative to tillage practices alone (Table 3). The order of increase in tp at 45 DAP was $FT<RT<MT<FTBCH_{10}=RTBCH_{10}<MTBCH_{10}$. The highest value of 49-6% was observed in $MBCH_{10}$ amended plots. Application of BCH on tillage practices did not produce significant effect on Tp at 90 DAP. Higher Tp values were observed at 45 compared to 90 DAP and could be attributed to reduced soil compaction as a result of reduced bulk density (Table 2).According to Njoku and Mbah (2012) organic materials have low densities and can improve soil porosity and make it less dense. Alburquerque *et al*.(2014) reported increase soil tp in amended plots compared to the control when they used organic wastes as soil amendment. In a study on changes in the properties of an ultisol amended with cow dung and its effect on okra yield , Egwu *et al*. (.2023) reported increased soil tp in cow dung amended plots relative to unamended plots. The result of this study is in line with those of Uguru *et al* . (2015) when they studied the effect of organic wastes on soil properties and castor oil yield in Abakaliki southeast Nigeria.

Effect tillage practices and burnt coconut husk on soil aggregate stability (AS %)

Result of the study on table 4 showed that addition of burnt coconut husk significantly increased soil aggregate stability compared to tillage practices alone at both 30 and 60 DAP. The highest AS value of 57 % at 35 DAP was observed in MBCH10 . The value 57 was 16%, 27%,33%, 4% and 8% higher than the AS values for M,R,F, RBCH and FBCH, respectively. Aggregate stability was also significantly affected at 60 DAP in BCH tillage amended plots compared to tillage practices alone. However, higher AS values were obtained at 45 compared to 60 DAP. The order of increase in AS at 60 DAP was MTBCH>RTBCH>FBCH>MT>RT>FT. Soil organic matter is a soil physical property used to measure the ability of soil aggregates to resist breaking apart when exposed to external forces such as erosion and tillage.

The higher AS observed in the BCH amended tillage practice plots could be attributed to higher organic matter content of BCH (Table 1). According to Mbagwu *et al*.(1991) organic matter from wastes bound smaller aggregates into larger ones which according to Harries *et al*.(1966) is essential for creation of good tilth.

In a study on the effect of burnt rice dust on soil properties Njoku *et al*. (2015) reported increased AS in amended plots relative to the control. Nnabude and Mbagwu (1998) observed significance increased in AS when they studied the effect of burnt and fresh rice husk dust on soil properties. The result of this study is in consistent with that of Nnadi *et al*.(2019) when they studied the effect of tillage and burnt rice husk on soil properties and yield of castor oil in Abakaliki south eastern Nigeria,

Effect tillage practices and burny coconut husk on yield of maize (Mgha^{-1})

Table 5 showed significant increase in maize grain yield in tillage practices amended with BCH compared to tillage practices alone. The highest maize grain yield (2.02 Mgha^{-1}) was obtained in $MTBCH_{10}$ while the lowest yield (1.12 Mgha^{-1}) was observed in FT. The value 2.02 Mgha^{-1} was 20, 38, 51, 5 and 15% higher than maize grain yields in MT, RT, FT, $RTBCH_{10}$ and $FTBCH_{10}$, respectively. The increase in maize grain yield observed in burnt coconut husk amended tillage practices could be attributed to its higher nutrient content (Table 1) and its improvement of soil physical properties. In a study on the effects of tillage practices and burnt rice husk Nnadi *et al*.(2019) reported increase castor oil yield in amended plots relative to tillage practices alone. Using cow dung as soil amendment Egwu *et al*.(2023) reported increased okra yield in cow dung amended plots relative to the control. Njoku and Mbah (2012) observed increased maize grain yield in plots amended with burnt rice husk dust relative to the control. The result of this study is in consistent with that of Mbah *et al*.(2024) when they used burnt and decomposed rice husk as soil amendment.

CONCLUSION AND RECOMMENDATION

The result of this study showed that tillage practices amended with burnt coconut husk improved soil physical properties relative to tillage practices alone. The improvement in soil properties in the amended plots led to increased maize grain yield compared to tillage practices alone. Mound tillage amended with burnt coconut husk gave the highest increase in all the parameters studied including maize grain yield. The study recommended the use of mound tillage amended with burnt coconut husk for crop production in the study area.

REFERENCES

Adeleye ,F.O., Adeleye, A.A and Ojeniyi, S.O (2015) . Effect of woodash manure on soil physicochemical properties , leaf nutrient, pH , nutrient status and yield of yam (*Diascorea rotundata*) in the south western Nigeria. Journal of Applied Sci.8(2) ;4719-4777

Alburquerque, J..A.., Calero, J..M., V., .Banon.-Toment, J., delcampillo M. A.,.GallardoA.., Villar, R.(2014). Effects of biochar produced from different feedstocks on soil properties and sunflower growth. Journ.Plant.Nut. Soil. Sci.4(3);161-166.

Bayer,,C., Martin-Neto,L., Mielniczuk.,-Pillon, C.,N and Sangol, L (2001).Changes in soil organic matter factors under subtropical no-till system. Soil Science AM.J.1473-1478.

Egwu,,P.N..,,Edeh, C.S., Mbah,,C.N., Okoro, G., Nwaogbaga,A.,C., Orji J and Mbarh, E.C (2023). Changes in the properties of an ultisol amended with cow dung and its effect on okra yield in Abakaliki southeast Nigeria. Int Journ of Agric and Rural Dev.26(2);6689-6693.

Federal Department of Agriculture and Land Resources (FDALR). (1985).Reconnaisance soil survey of Cross River state of Nigeria. Soil Reports 1985. FDLAR, Lagos-Nigeria.

Gee, W and Or, D (2002).. Particle size analysis.In J.H. Done and G.C Tapp, edition methods of soil analysis. Part 4. Physical methods. SSSA Book Ser. 5. ASA and AAAA, Madison, WI p 55-293.

Harris , F. E.., Chester, G., and Ajjen ,O.N (1966). Dynamics of soil aggregation. Adv. Agron,18;109-169.

Kemper,A and Rosanau K 1986. Aggregate stability and size distribution. In Klute A ednmethds of soal analysis Part1; Agronomy monograph 9 2nd edn Madison, Wisconsin p 425-442.

Klaij , M.C. and Hoogmoed ,W.B (1993). Soil management for crop production in West Africa.Sahel 11;Emergency, Establishment and yield of pearl millet. Soil and Till. Res.25:301-305.

Kladivko, E.J (2009).Earth worm an crop management. Agric guide AY-270 Purue univ copreative extension west Lafayehe.

Mbagwu, J.S.C(1992). Improving the prouctivity of a degraed ultisol in Nigeria using organic and inorganic amendments Part 2;Changes in soil physical properties. Biores Technol; 42(3) 167-175.

Mbagwu, J.S.C., Piccolo, A., Spallaci, P.(1991). Effects of field application of organic wastes from different sources on chemical, rheological and and structural properties of some Italian soils. Biores Technol 37;71-78.

Mbah, C.N**.,** Nwite, J.N., Njoku.Cand Nweke, A.I (2010) Response of Maize (Zea mays L) to Different Rates of wood-ash Application in acid Ultisol in Southeast Nigeria. African Journ. of Agric Research. 5(7) 580-583

Mbah ,C.N and Njoku, C (2023). Yields of cocoyam, heavy metal uptake and soil properties under different tillage practices and application of burnt rice husk dust in south eastern, Nigeria. Biological Agriculture and Horticulture. 39(1); 62-72 .DOI ;10.1080/01448765.2022.2116729.

Mbah, C.N ., Njokc, C ., Igboji, P ., Awere, S. .U, Okechukwu, G.C.E ., Ustu, S and Abam P. (2024). Soluble salt content and properties of a mound tilled degraded ultisol amended with fresh and decomposed rice mill waste and its effect on maize (*Zea maize* L) grain yield in Abakaliki, southeastern Nigeria. Biological Agriculture and Horticulture 40(1); 1-11 https;//doi.org/10.1080/01448765.2023.2220303.

Njoku, C and Mbah, C.N (2012). Effect of burnt and unburrnt rice husk dust on maize yield and soil physicochemical properties of an Ultisol in Nigeria. Biological Agriculture and Horticulture.First 1-12 .

Njoku, C.,Uguru, B and Mbah,C.N (2015). Use of rice husk dust to improve selected soil physical properties of tropical ultisol in Abakaliki Southeastern Nigeria. Advance in Agriculture and Biology, 4(3); 99-105 .

Nnabude PC and Mbagwu JSC 1998. Soil water relation of Nigerian Typic Haplustult amended with fresh and burnt rice mill wastes. Soil Till Research 50;207-214

Nnadi , E.O ., Mbah, C.N ., Nweke, A.I and Njoku, C (2019). Physicochemical properties of an acid ultisol subjected to different tillage practices and woodash amendment; Impact on heavy metal concentration in soil and castor yield. Soil and Tillage Res194;

Nweke, A.I., Mbah ,C..N., Onweremadu E.O.,Dambaba, N,E..,.Orji E.C.,Ekesiobi, A.. and ,Nnabuife, E. L.C(2017). . Soil pH, available P of an ultisol and castor performance as influenced by contrasting tillage methods and woodash. African Journ. of Agric. Res.12(8): 606-616.

Prihar, S.S., Gajiri, P.R and Cheema, H.S (2000). Migration and tillage effects on root development , water use and yield of wheats on coarse textured soil. J. Envirn Issue and Agric in eveloping countries. 1(1 and) 161-168.

SAS Institute Inc. .,1999. SAS/ISTATS user guide version 6. 4 ed SAS,Institute Cary, N.C.

Strudley, M.W., Green, T.R and Ascouf ,J.C (2008) Tillage effects on soil. Soil Till Res. 99;4-8.

Uguru, B..N.., ,Mbah, C..N. and Njoku, C.(2015). Effect of rice husk dust on selected soil physical properties and maize grain yield in Abakalik, South Eastern-Nigeria. Global Adv.Res.Journ of Agric. Sci. 4(12): 878-886

Table 1; Initial properties of the soil and burnt cocnut husk .

Parameter	Unit	Soil	BCHD
Sand	g/kg	746	-
Silt	g/kg	92	
Clay	g/kg	162	
Texture	Sandy clay		
Av.P	mg/kg	4.60	50.10
TN	%	1.23	0.16
OC	%	1.00	14.65
pH		4.83	9.87
Na	$Cmolkg^{-1}$	0.14	0.33
Ca	$Cmolkg^{-1}$	4.80	8.60
K	$Cmolkg^{-1}$	0.23	3.41
Mg	$Cmolkg^{-1}$	2.80	5.10

Table 2: Effect tillage practices and coconut husk on soil bulk density (Mgm-^{3})

	2023 cropping Season	
Treatment	45	90
MT	1.38	1.50
RT	1.39	1.50
FT	1.40	1.50
$MTBCH_{10}$	1.36	1.49
$RTBCH_{10}$	1.37	1.49
$FTBCH_{10}$	1.37	1.49
FLSD(0.05)		
Amendment(A)	021	NS
Tillage(T)	0.01	NS
TXA	0.002	NS

Table 3: Effect tillage practices and burnt coconut husk on soil total porosity (Tp%)

	2023 cropping Season	
Treatment	45	90
MT	48.8	44.4
RT	48.5	44.4
FT	48.1	44.4
$MTBCH_{10}$	49.6	44.8
$RTBCH_{10}$	49.2	44.8
$FTBCH_{10}$	49.2	44.8
FLSD(0.05)		
Amendment(A)	0.11	NS
Tillage(T)	0.03	NS
TXA	0.03	NS

Table 4: Effect tillage practices and burnt coconut husk on soil Aggregate stability (AS %)

	2023 cropping Season	
Treatment	30	60
MT	49	34
RT	45	37
FT	43	38
$MTBCH_{10}$	57	43
$RTBCH_{10}$	55	42
$FTBCH_{10}$	53	40
FLSD(0.05)		
Amendment(A)	1,21	NS
Tillage(T)	0.92	NS
TXA	0.11	NS

Table 5: Effect tillage practices and burnt coconut husk on grain yield of maize (Mgha^{-1})

Treatment	Yield
MT	1.68
RT	1.46
FT	1.34
$MTBCH_{10}$	2,02
$RTBCH_{10}$	1.92
$FTBCH_{10}$	1.76
FLSD(0.05)	
Amendment(A)	0.32
Tillage(T)	0.02
TXA	0.01