EFFECT OF TILLAGE PRACTICES AMENDED WITH BURNT COCONNUT HUSK ON CHEMICAL PROPERTIES OF A DEGRADED TYPIC HAPLUDULT AND ITS IMPACT ON SOIL HEAVY METAL CONTENT AND ROOT DRY MATTER YIELD OF MAIZE (Zea Mays L) IN OBUDU-CROOS RIVER STATE NIGERIA.

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ABSTRACT.
This study evaluated the effect of tillage practices amended with burnt coconut husk (BCH) on soil chemical properties, soil heavy metal content and root dry matter yield of maize in 2023 cropping season. The experiment was arranged as a split plot in randomized complete block design (RCBD) with six treatments replicated three times. The treatments were ; Flat tillage (FT), Ridge Tillage (RT), Mound Tillage (MT), FT + 10 t ha-^{1} burnt coconut husk ($FTBCHH_{10}$), RT + 10 t ha-^{1} burnt coconut husk ($RTBCH_{10}$), and MT + 10 t ha-^{1} burnt coconut husk ($MTBCH_{10}$). Results of the study showed that tillage practices amended with burnt coconut husk significantly ($p=0.05$) increased soil chemical properties compared to tillage practices alone. Maize root dry matter yield was significantly ($p<0.05$) higher in burnt coconut husk amended tillage practices compared to the tillage practices alone. Soil heavy metal content was higher in burnt coconut husk amended tillage practices but within tolerable limit . Burnt coconut husk is recommended for use as soil amendment on tillage practices since it improved soil chemical properties , increased root yield and does not constitute hazards in terms of soil deterioration by heavy metals .

Keywords: Heavy metals, Tillage practices , Soil amendment, Heavy metal, Health hazards.

INTRODUCTION.

Organic matter effect crops growth and yield either directly by supplying nutrients or indirectly by modifying soil properties that can improve the root environment and stimulate plant growth

Research results have shown that successive applications of organic residues can cause changes in soil characteristics such as physical properties(Mbah and Njoku, 2023), soil aggregate stability (Nnadi et al., 2019) carbon content (Comin *et al*., 2013), nitrogen (Glacomini *et al*..2013), soil aggregation (Loss *et al.* , 2017) , biological parameter such as biological diversity and microbial activity (Gonzalez-Mancina *et al*.,2013).

According to Prihar et al. (2000) tillage is the physical manipulation of soil performed to create conditions suitable for germination of seeds and seedling emergence, and root growth to reduce competition of weeds. Tillage combined with soil amendments increase soil productivity and crop yield (Klaij and Hoogmood , 1993) . Ustu and Mbah (2024) reported improved soil physical properties and increased maize grain yield in tillage practices amended with burnt coconut husk compared to tillage practices alone. Nweke et al. (2016) and Nnadi et al (2019) observed improved soil properties and increased castor seed yield in tillage practices amended with wood ash relative to tillage practices alone.

Heavy metals such as lead (Pb), Cupper (Cu) and Iron (Fe) are always part of life due to nature and human activities. Metals generally are natural components of earths crust and are therefore major constituents of soil. Heavy metal pollution is not only toxic to plants and deteriorates soils optimal bio-productivity but is a severe threat to human health especially at elevated level (Oti Wilberforce et al, 2013).

Ustu and Mbah (2024) reported that large quantities of burnt and urburnt coconut husk are produced in the markets in Obudu on daily/ yearly basis. The authors noted that these wastes which constitute environmental and health problems have limited research data on their safe disposal or effective utilization in the study area.

The objective of this study was to find out the effect of tillage practices amended with burnt coconut husk on soil chemical properties , soil heavy content and root yield of maize (Zea mays L *)* in a degraded Typic Haplustult in Obudu – Cross River , Nigeria.

MATERIAL AND METHODS

Location of Study: The study was carried out at the Teaching and Research Farm of School of Secondary Education Vocational , Federal College of Education, Obudu Cross River state during the 2023 cropping season. The area which is characterized distinctively into wet and dry season lies approximately within latitude 4^{0} W and latitude $7^{0}20'$ N . The area has annual temperature of between 27-35 ^{o}C with mean annual rainfall of 3000 mm, received between March and November. The soils according to FDALR (1985) were formed from different mapping units in the undifferentiated basement complex derived from gneiss, schist and quartz with deep and drained typic dystrudepts and Hapludults.

Land Preparation :.. Before the start of the experiment in March 2023 the dorminant vegetation (panicum maxinum, pennisetum purperium etc) were cleared with cutlass and the debris removed. A land area measuring 32 m by 17 was mapped out , tilled

and used for the study. 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 prepare to heights measuring 16-23 cm high and 82-100 cm wide .

Design of Experiment and Application of Treatment

Land area measuring 32 m by 17 was used for the experiment which 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 with each 3 m x 3 m were in each block., Each plot was 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 coconut husk ($RTBCH_{10}$), MD + 10 t ha-^{1} burnt coconut husk ($MTBCH_{10}$).

.. 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 dust . .

Collection of data.

Soil sample collection. Before the start of the experiment in March 2023 , composite soil sample were collected from 8 points (at a depth of 20 cm) in the entire plot . The soil samples collected was analysed for particle size, exchangeable bases (Ca, Na, Mg, K,), pH, organic carbon, total N, available P and heavy metals Cu, Zn and Pb. After harvest three soil samples were collected from each plot and composited. The soil samples were air dried and taken to the laboratory for determination of soil chemical properties and heavy metals contents. The chemical properties and heavy metals analysed were same as those determined in the initial soil sample.

Plant sample collection. At maturity 8 maize plants were selected and tagged in each plot. The maize were harvested. After the harvest the shoots were uprooted, air dried for 3 days and the roots cut off from the shoot. The dried shoot was weighed to determine the yield. .

Laboratory Analysis;

The hydrometer method of Gee and Or, (2002) was used to determine particle size while the method of Thomas (1982) was used to determine the soil exchangeable bases (Ca^{2+}, K^{+}, Mg^{2+}, Na^{+}) Soil pH was determined using the method of Peech (1965) while Total nitrogen was measured using the micro-Kjeldhal distillation method of Bremner and Mulvaney (1982). Organic carbon was determined using the method described by Nelson and Somners (1982) whereas Available P was determined by the Bray-2 method as described by (Page, 1982) . .

Determination of heavy metal (Cu, Zn, and Fe,) concentration in maize soil.

The analytical procedure by APHA (American Public Health Association,1998) was used to determine the heavy metal content of the soil . Approximately, 1g of the soil sample was digested with conc HNO_3. And the digests were subsequently subjected to flame absorption spectrophotometer (AAS) according to analytical procedure by APHA to determine the concentrations of heavy metals(Cu, Zn, Fe,).

Analysis of Data.

The general linear model of SAS software for Randomized Complete Block Design (SAS institute inc 1999) was used to analyse the data collected from the study. Treatment means were separated using the Duncans multiple range test.

RESULTS AND DISCUSSIONS

Initial properties of the soil and burnt coconut husk .

Table 1 showed that the texture of the soil was sandy clay. The table also showed that burnt coconut husk contained higher nutrient compared to the soil. Analysis of the soil recorded available P mg kg-^{1}, K cmolkg-^{1} , total N and organic carbon (%) values of 4.6, 0.23, 0.14 and 1.00, respectively while burnt coconut husk recorded 50.1 mg kg-^{1} for available P, 0.16% for total N, 3.41 cmolkg-^{1} for K, and 14.65% for organic carbon. Similarly, the Table also showed higher pH of 3.80 in soil compared to burnt coconut husk with pH of 8.25, Table 1 also showed that the soil contained higher level of Pb and lower levels of Zn and Cu compared to the BCH.

Effect tillage practices and BCH on soil exchangeable bases (Na, Ca, Mg and K –Cmolkg-^{1})

Application of burnt coconut husk on tillage practices significantly increased the soil exchangeable bases (Na, Ca, Mg and K) on BCH amended tillage practices compared to tillage practices alone (Table 2)**.** The highest values of Na, Mg and Ca were observed in $MTBCH_{10}$ amended tillage practices while K was highest in $RTBCH_{10.}$ . .The order **of** increase in Mg content was $MTBCH_{10}$ > $RTBCH_{10}$> $FTBCH_{10}$ > Tt>FT>MT. The observed value of Ca (2.69 Cmolkg-^{1}) in $MTBCH_{10}$ was 3%, 6%, 25%, 26% and 27% higher than those of $FTBCH_{10}$, $RTBCH_{10}$, MT,RT and FT, respectively. The higher values of exchangeable bases in the BCH amended tillage practices could be attributed to higher content of these nutrients in BCH compared to the soil (Table 1). According to Giovanini et al. (1993) addition of ash in one way or another to soil has been done for years through burning of agricultural residues. Mbah et al .(2010) reported improved soil properties in ash amended plots relative to the control when they tested the response of maize (Zea mays L) to different rates of wood-ash application on acid ultisol in south east Nigeria. In a study on the effect of burnt and unburnt rice husk dust Njoku and Mbah (2012) reported increase in soil exchangeable properties in burnt rice husk relative to the control. Research results by

Adetunji (1997) and Owolabi et al.(2003) showed increased nutrient availability in soil of southwest amended with different types ash relative to the control. In a study on the effect of ash from different agricultural wastes on soil properties and grain yield of Maize (Zea Mays L) in a degraded ultisol, Mbah et al.(2021) reported improved soil properties in ash amended plots relative to the control. The result of this study corroborates those of Ojeniyi et al .(2007) and Odiete et al. (2005) when they used ash as soil amendment .

Effect of tillage practices and burnt rice husk dust on soil pH, Total N %, Avail P Mg kg^{-1} and OC%.

The result of the study in Table 3 showed that application of BCH on tillage practices significantly ($p<0.05$) increased soil available P, OC%, Total N and pH compared to tillage practices alone. The highest value of available P was observed in $MTBCH_{10}$ while the order of increase in OC was $MTBCH_{10}$ > $FTBCH_{10}$ > $RTBCH_{10}$ >RT>MT>FT. Total N value was highest in $MTBCH_{10}$ (0.17) and this value was 24%, 41 %, 58%, 71% and 71% higher than the observed Total N values in $RTBCH_{10,}$ $FTBCH_{10}$ M, R and T, respectively. Recorded pH values ranged between 5.51-5.52 in tillage practices alone and 6.60-6.64 in tillage practice amended with burnt coconut husk. Research results have shown improved soil available P, OC, Total N and pH when ash from different sources are used as soil amendment. In a study on the physicochemical properties of an acid ultisol subjected to different tillage practices and wood-ash application, Nnadi et al..(2019) reported .improved Total N, OC, Available P and pH.in tillage practice amended wood-ash compared to tillage practices alone. Nweke et al.(2016) reported improved soil pH and available P when they studied the effect of contrasting tillage practices and wood-ash on soil pH, available P and castor performance in an ultisol. Adetunji (1997) and Owolabi et al . (2003) observed reduced acidity in soils amended with ashes from different sources relative to un-amended plots in line with the result of this study. The result of this study corroborates those of Mbah et al . .(2023) when they studied the effect of tillage practices amended with burnt rice husk dust on chemical properties of a degraded sandy clay loam in Abakaliki southeast Nigeria.

Effect tillage practices and BCH on soil heavy metal contents..

Application of BCH on tillage practices significantly ($p<0.05$) increased soil heavy metal concentrations relative to tillage practices alone (Table 4). The highest concentration of Cu (32.5) was observed in $MTBCH_{10}$. This value 32.5 was 12%, 28%, 83%, 88% and 87% higher the values obtained in $RTBCH_{10,}$ $FTBCH_{10}$, MT, RT and FT , respectively. The order of increase in Pb content of the soil was $FTBCH_{10}$ > $RTBCH_{10}$ > $MTBCH_{10}$ > FT>MT>RT. The observed Zn values ranged from 87.8- 96.8 in tillage practices alone and 139.2-189.6 in tillage practices amended with BCH. Ojenuga et al.(1996) reported that anthropogenic activities enrich soils with heavy metals . Using sewage sludge as soil amendment Brady and Weil (2002) reported increased heavy metal content in amended plots relative to the control. Nnadi et al.(2019) reported increased soil heavy metal content of tillage practices amended with wood-ash compared to tillage practices alone. Mbah et al.(2013) in a study on changes in rheological properties and heavy metal content of an ultisol amended with ash and its effect on maize grain yield reported increased heavy metal content of ash amended plots relative to the control. Heavy metal concentration excess of critical limits in soil could have agronomic and environmental implications. Brown (1977) reported that the normal range of Pb , Zn and Cu in soil is between 2-300 mg kg^{-1} , 1-900 and 2—250 mg kg^{-1} ,respectively.. The observed values of Pb, Zn and Cu in the tillage practices amended with BCH and tillage practices alone are within the acceptable levels in soil.

Effect of tillage practices and burnt coconut husk on Maize (Zea mays L) root yield .

Result of the study on Table 5 showed that application of burnt coconut husk increased root yield of maize in tillage practice amended plot compared to tillage practices alone. The order of increase is $MTBCH_{10}$ > $RTBCH_{10}$ > $FTBCH_{10}$ >MT=RT=FT. Using wood ash as soil amendment Mbah *et al*. (2010) reported increased maize yield compared to the control. Similarly Nnadi *et al.* (2019) showed that tillage practices amended with burnt rice husk dusk produced higher Castor seed yield compared to tillage practices alone. In a study on yields and heavy metal uptake of cocoyam (*Xanthsomonas sagitifolium*) and effects on soil properties of different tillage practices and application of burnt rice husk dust in Abakaliki south-east Nigeria, Mbah and Njoku (2023) reported increased cocoyam tuber yield in tillage practice amended plots relative to tillage practices alone.

CONCLUSION AND RECOMMENDATION.

Application of BCH on tillage practices improved soil chemical properties , increased soil heavy metal content (Pb, Cu, Zn) and maize root yield compared to tillage practices alone. The increased soil heavy metal content was within the tolerable limit. Burnt coconut husk was recommended as soil amendment in tillage practices for production of tuber crops in the study it since increased root yield in tillage practices amended plots compared to tillage practices alone .

REFERENCES

Adetunji, M.T (1997). Organic residue management and nutrient cycling. Agro-ecosyst. 47 ; 81-195**.**

Augelova, V., Ivanova, R., Pevicharova , G and Ivanov, K (2010). Effect of organic amendments on heavy metal uptake of potato plant.19th World congress of soil sciencs

.Soil solution for a changing world.1-6 August 2010, Brisbane Australia.

APHA. (American Public Health Association- (1998). Standard methods of eamination of water and waste water 20th edn.APHA Washington DC,USA p874.

Bremner,J.M and Mulvaney, C.S (1982). Nitrogen Total. In Page et al.(Eds) Methods of soil analysis. Part 2 No 9. Madison, Wisconson.pp 595-824.

Brown H.H.M (1977) Environment chemistry of the elements . Academic Press London.

.

Federal Department of Agricultural Resources (FDALR,1985). Reconnaisnce survey of Anambra stste of Nigeria. Soil Report,1985.Federal Department of Agric and ,Land Resources, Lagos-Nigeria.

Gee, G.W and Bauder, J.W (1986). In : Particle size analysis. Part : Physical and microbiological method 2nd edition. Agronomy series No 9 ASA, ASSA Madison , WI. 1973. Pp 14.

Glacomini, S.J., Aita, C., Pujo, S.B and Mida, E (2013). Transformceasndonnitrogen 10 no scio apos addiode dhectoliquido e cama scicreposta de suinos. Pesquisa Agropecuafia Brasilum 48;211-219.

Giovanini,G., Benvenuti, S., Lucchesi, S and Giachetti, M (1993). Wood reuction by burning straw and stubble in the field; positive response and potential . Journ.of Agric Sci. 2 (4); 11-16.

Gonzalezez-Mancilla, A. , Delcamen Rivera-Cruz, M., Ortiz Garcia, C.F., Almarez-suarez, J.J., Frujivivi-Nacia, A and Crus-Navarro, G (2013). U so de fertilizantes organicos mycrobiologicas dei suelo y dei creamiemto critic citrange troyer. Universidady dencia . 38;123-139.

Klaij M.C.,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.

Loss A, Lourenzi CR, Mergan Junior CA, Santos Junior E, Bendet L, Pereira MG , Picollo MC , Brenetin G , Lovato PE and Comin JJ 2017. Carbon, Nitrogen and Natural abundance of 13C and 15N in biogenic and Phyicogenic aggregates in a soil with 10 years of pig manure application. Soil Tillage Res. 166; 52-58

Mbah ,C.N., Nwite, J..N.., Njoku, C., ,Nweke, A.I.,(2010). Response of maize(Zea mays L) to different rates of woodash application in acid ultisol in south east Nigeria. African.Journ.of Agric.Res.5(7); 580=583.

Mbah,C.N., Oguejiofor, CU.,Idike,FI., Nwovu,IG and Attoe,E (2013) Changes in rheological properties and heavy metal content of an ultisol amended with ash and its effect on maize yield. Nig.Joun. Biotech 25; 53-59.

Mbah ,C.N ., Igboji, P.O., Mbah, E.C., Igberi ,C., Olaolu, M., Orji ,J., Iroegbu,C.,

Abam ,P.,.Awere, S.U., Okechukwu, G.C.E and Ustu, S.U (2023). Effect of Tillage Practices Amended with Burnt Rice Husk Dust on Chemical Properties of Degraded Sandy Clay Loam ; Impact on Soil and Cocoyam (*Xanthosomonas sagittifolium*) in Abakaliki Southeast Nigeria **.** Indian Journ of Ecology 50 (6) ; 1987-1993

Mbah, C .N., Njoku, C., Agba, A. O.,Ede, N.,Okechukwu, G.C and Egwu, P.N (2021) Effect of ash from different agricultural wastes on soil properties and yield of maize (Zea mays L) in a degraded ultisol, Indian journal of Ecology 48 (2) ;592-596

Mbah, C.N and Njoku, C (2023). Yield response 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. https;//doi.org/10.1080/01448765.2022.2116729.

Mbah, C.N., Njoku, C, Ngene, P and Oludare , C.J (2012). Use of ash to improve the nutrient content of of an ultisol and its effect on on maize growth and dry matter yield. Agric. Sci. Res. Journ 2(3); 1-5.

Nelson, D.W and Somners,L.E (1996). Total carbon, organic carbon and organic matter. In methods of soil analysis. Spark DL.,(Eds) Part 3.Chemical methods. No 5 ASA and SSSA Madison WI. Pp 961-1010.

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 28(1) ; 49-60

Nnadi , E.O., Mbah ,. CN. ,Nweke, A.I and Njoku, C (2019).Physicochemical propertie of an acid ultisol subjected to different tillage practices and wood ash amendment; Impact on heavy metal on heavy metal concentrations and castor Plant. Soil& Tillage Research Volume 194, November 2019, 104288.

Nweke, A.I., Mbah ,C..N., Okoli,P.S.O (2016.). Tillage Methods and Woodash effect on soil properties and yield od Castor . Global Journal of Agric..12(8): 606-616.

Odiette, I., Chude, V.O., Ogeniyi,S.O., Okozi,A.A and Assaini,GM.(2005). Response of maize to nitrogen and phosphorus sources in guinea savanna zone of Nigeria. Nig. Journ.of Soil Sci.15; 90-101.

Ogeniyi,SO., Awodun,M.A and Odedina, S (2007). Effect of, animal manure amended spent grain and cocoa husk on nutrient status ,

growth and yield of tomata. Int.Journ.of Agric.Res.2(4); 406-410.

Owolabi,O., Ogeniyi,S.O., Awodu,A.O and Hazzan,K (2003). Response of Okra and tomatoes to saw dust ash manure.Moore J.Agric, Res. 4(2); 178-182.

Oti Wilberforce, J.O and Nwabue, F.L (2013). Heavy metal effect due to contamination of vegetables from Enyigba pb mine in Ebonyi state Nigeria. Environ Pollution 2 (1) ; 19-22.

Page, A (1982). Methods of Soil analysis. Part 2.ch.emical and microbiological

properties. Second edition American Society of Agronomy Inc.Soil Sci.Soc .of America Inc,Madison WI..

Peech, M (1965). Hydrogen ion activity. In C,E Black (eds). Methods of soil analysis. Part 11.Am. Soc. Agron.. 9 ;914-926.

Prihar, S.S., Gagri, R.R,, Benbi, D.K and Aroro, U.K (2000). .Intensive cropping; Efficient use of water, nutrient and tillage., The Haworth Press-Inc Binghamton, N.Y.

Statistical Analysis System –SAS.(1999). Institute Staff 1985 SAS user's guide, 1999 (ed). Statically analysis systems institute inc. Gary N.C

Thomas, G.W (1982.) Exchangeable cations. In A.L.Page, R.H.Miller and R.R.Heeny (EDS) Methods of soil analysis part2 (2ne ed). Agronomy Monograph No 9 ASA and SSSA, Madison.W.I.pp 159-165.

Ustu, S.U and Mbah, C.N (2024). Effect of tillage practices and burnt coconut husk on soil physical properties and yield of maize (Zea mays L) in Obudu Cross River State. International Journal of Agriculture and Rural Dev.27(1); 6946-6951

Table 1; Initial properties of the soil and burnt coconut 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
Mg	Cmolkg-^{1}	2.80	5.10
Na	Cmolkg-^{1}	0.14	0.33
Ca	Cmolkg-^{1}	4.80	8.60
K	Cmolkg-^{1}	0.23	3.41
Zn	Cmolkg-^{1}	110	186
Pb	Cmolkg-^{1}	47	21
Cu	Cmolkg-^{1}	60	146

Table 2: Effect tillage practices and BCH on soil exchangeable bases (Na, Ca, Mg and K- Cmolkg-^{1})

2023 cropping season

Treatment	Na	K	Ca	Mg
MT	0.11h	0.18b	2.00c	0.76s
RT	0.11h	0.19b	1.98c	0.78s
FT	0.10h	0.18b	1.97c	0.77s
$MTBCH_{10}$	0.20a	0.25ac	2.69e	1.45d
$RTBCH_{10}$	0.16ab	0.28ad	2.60d	1.40e
$FTBCH_{10}$	0.13ab	0.23ac	2.54a	1.36a

Note; Means in same column with the same letter donot differ significantly at $p<0.05$
FT=Flat tillage ,RT= Ridge Tillage , MT=Mound Tillage , $FTBCHH_{10}$, = FT + 10 t ha-^{1} burnt coconut husk, $RTBCH_{10}$= RT + 10 t ha-^{1} burnt coconut husk and $MTBCH_{10}$ =MT + 10 t ha-^{1} burnt coconut husk

Table 3: Effect tillage practices and BCH on soil available P mgkg-^{1}, Total N %, Organic C % and pH.

2023 cropping season

Treatment	Avail P	OC	T N	pH
MT	12.8b	0.89d	0.07a	5.52e
RT	13.0b	0.86d	0.05a	5.52e
FT	12.7b	0.88d	0.05a	5.51e
$MTBCH_{10}$	16.7ac	1.57bc	0.17ab	6.64cc
$RTBCH_{10}$	15.9ac	1.47bb	0.13ab	6.62cc
$FFBCH_{10}$	14.6b	1.52ac	0.10be	6.60cc

Note; Means in same column with the same letter donot differ significantly at $p<0.05$
FT=Flat tillage ,RT= Ridge Tillage , MT=Mound Tillage , $FTBCHH_{10}$, = FT + 10 t ha-^{1} burnt coconut husk, $RTBCH_{10}$= RT + 10 t ha-^{1} burnt coconut husk and $MTBCH_{10}$ =MT + 10 t ha-^{1} burnt coconut husk

Table 4: Effect tillage practices and BCH on soil heavy metal content (mg kg-^{1}) **.**

2023 cropping season

Treatment	Pb	Zn	Cu
MT	12.0e	96..8c	4.10d
RT	11.8e	92.5c	3.78d
FT	12.1e	87.8c	4.23d
$MTBCH_{10}$	32.6a	189.6n	32.5dc
$RTBCH_{10}$	46.5ab	156.2es	28.6bb
$FTBCH_{10}$	52.2bc	139.2aa	23.4ad

Note; Means in same column with the same letter donot differ significantly at $p<0.05$
FT=Flat tillage ,RT= Ridge Tillage , MT=Mound Tillage , $FTBCHH_{10}$, = FT + 10 t ha-^{1} burnt coconut husk, $RTBCH_{10}$= RT + 10 t ha-^{1} burnt coconut husk and $MTBCH_{10}$ =MT + 10 t ha-^{1} burnt coconut husk

Table 5: Effect tillage practices and BCH on maize root yield .

2023 cropping season

Treatment	Yield
MT	0.11a
RT	0.10a
FT	0.10a
$MTBCH_{10}$	0.14b
$RTBCH_{10}$	0.14b
$FTBCH_{10}$	0.13b

Means in same column with the same letter donot differ significantly at $p<0.05$
FT=Flat tillage ,RT= Ridge Tillage , MT=Mound Tillage , $FTBCHH_{10}$, = FT + 10 t ha-^{1} burnt coconut husk, $RTBCH_{10}$= RT + 10 t ha-^{1} burnt coconut husk and $MTBCH_{10}$ =MT + 10 t ha-^{1} burnt coconut husk