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Effect of Tillage Practices Amended with Burnt Rice Husk Dust on Chemical Properties of Degraded Sandy Clay Loam and Impact on Soil and Cocoyam (*Xanthosomonas sagittifolium*) in Abakaliki Southeast Nigeria

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Abstract: The objective of this study was to find out the effect of tillage practices amended with burnt rice husk dust on soil chemical properties, content of carbohydrate, corm nutrient, heavy metal and yield of cocoyam in a degraded sandy clay loam. The field experiment was in split plot in randomized complete block design with six treatments. The treatments were; mound tillage (no treatment), ridge tillage (no treatment) mound + 10 t ha^{-1} burnt rice husk dust ($MBRDH_{10}$), Ridge + 10 t ha^{-1} burnt rice husk dust ($RBRHD_{10}$), mound + 20 t ha^{-1} burnt rice husk dust ($MBRHD_{20}$) + Ridge +20 t ha^{-1} burnt rice husk dust ($RBRHD_{20}$). Tillage practices amended with burnt rice husk dust significantly increased soil chemical properties compared to tillage practices alone. Soil extractable carbohydrate (cold water soluble, hot water soluble, dilute acid soluble) content was increased in tillage practices amended with rice husk dust. Corm nutrient content and shoot heavy metal (Cu, Pb, Zn, Fe) were significantly higher in tillage practices amended with burnt rice husk dust than tillage practices alone. The heavy metal was increased to levels that are non toxic to humans in food crops in the amended plots. The use of burnt rice husk dust as soil amendment could be recommended for reclamation of the productivity of degraded soil of the area and improve in crop quality without increase of heavy metal content of crops to toxic levels.

Keywords: Degraded soil, Heavy metal, Nutrient uptake, Tropical soil, Waste management

In most rural settings all over the world a number of indigenous plant species that serve as food and fight hunger by using underutilized plants (Agulana 2020). Abakaliki the study area has a rich resource of indigenous and underutilized crops such as cocoyam (*Xanthosomonas sagittifolium*) which the corms and shoot (stem and leaves) are consumed as food by the people. The crop possess health or physiological benefits over and above the normal nutritional value they provide. 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 (Prihar et al 2000). Arcangelo (2019) reported that organic wastes used as nutrient source for crops increase nutrient recycling and reduce cost related to acquisition of inorganic fertilizer.

There is a growing demand for environmentally correct foods, such as agroecological and/or organic foods which use large amounts of organic wastes (Dias et al 2016). Successive applications of organic residues can cause changes in soil characteristics such as carbon content (Comin et al 2013), nitrogen (Glacomini et al 2013), soil aggregation (Loss et al 2017) and on biological parameter such as biological diversity and microbial activity (Gonzalez-Mancina et al 2013). Qian (2019) reported increased grain yield of soybean when they studied the effect of biochar on grain yield and leaf photosynthetic physiology of soybean cultivars with different phosphorus efficiencies. Nnadi et al (2019) observed improved soil properties and increased castor seed yield when they used wood ash as soil amendment in different tillage practices. Mbah and Njoku (2012) reported that over 10 million t $year^{-1}$ of burnt and urburnt rice husk dusk are produced in urban and rural areas in Abakaliki on yearly basis. Research data on safe disposal or effective utilization of these wastes which constitute environmental and health problems are limited.

Similarly, the contributions of burnt rice husk dust to soil carbohydrate (CHO) content and their effect on crop nutrient and shoot heavy metal uptake by crops in soils of the study area have not been documented. The objective of this study was to find out the effect of tillage practices amended with burnt rice husk dust on soil chemical properties, carbohydrate content, corm nutrient content and shoot heavy metal uptake of cocoyam (*Xanthosomonas sagittifolium)* in a degraded sandy clay loam in Abakaliki Southeast Nigeria.

MATERIAL AND METHODS

Study area: This study was carried out for two cropping seasons (2016 and 2017) at the Faculty Research Farm of Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki, Nigeria. The area lies within latitude 06° 4'N and longitude 08° 65'E within the derived savannah zone of south east Nigeria. It has annual temperature of between 27-37 °C with mean annual rainfall of 1700 mm, received between April and November. The soil is an ultisol and classified as Typic Haplustult (FDALR 1985).

Land Preparation and application of treatments: The land used for the study measured 11 m by 63.5 m equivalent to 698.5 m^2. The experiment was arranged as a split plot in randomized complete block design. The area was divided into 6 blocks with each block separated by 1 m guard row. A total of 18 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; mound tillage (no treatment=M), ridge tillage (no treatment=R) mound + 10 t ha-1 burnt rice husk dust ($MBRDH_{10}$), ridge + 10 t ha^{-1} burnt rice husk dust ($RBHD_{10}$), mound + 20 t ha^{-1} burnt rice husk dust ($MBRHD_{20}$) + ridge +20 t ha^{-1} burnt rice husk dust ($RBRHD_{20}$).

The burnt rice husk dust were collected from the rice mill site at Abakaliki and sieved with < 2.0 mm sieve. The mounds were prepared to a height and width of 16-20 cm and 20-25 cm respectively, using traditional hoe. Ridges measuring 18-25 cm high and 90-105 cm wide were also prepared using hoe. 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 BRHD.

Corm planting and cultural practices: Cocoyam setts with weights 20-25 g were planted at a depth of 5 cm and 30 cm apart to give a planting population of 40,000 corms/ha. Weeding was carried out manually at interval of 6 weeks with hoe, At maturity (18 months after planting) eight plants from each plot were selected and harvested by shelling up and uprooting the plant. This method brought out the corms while the remains in the soil were dug out. The corms were dried in the sun for 4-5 days. The shoot (stem and leaves) were cut of from the base of the corm, air dried for 3 days. The tillage practices were carried out in the second season and new setts of cocoyam were planted without application of amendments to test their residual effect.

Soil sample: A composite soil sample collected from 8 points (at a depth of 20 cm) in the entire plot before the experiment started in March 2016 was analysed for particle size, exchangeable bases (Ca, Na, Mg, K), pH, organic carbon, total N, and available P. After harvest each year 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 (particle size, exchangeable bases (Ca, Na, Mg, K,), pH, organic carbon, total N, and available Phosphorus).

Plant sample: At maturity eight cocoyam plants per plot were sampled and tagged. The shoot (comprising the stem and the leaves) were cut of from the base of the harvested corms. The shoot samples were air dried for 3 days. The dried shoots were grinded and taken to the laboratory for analysis of heavy metal (Cu, Zn, Fe, Pb). Similarly the corms were dried, grinded and analysed for Ca, Na, Mg and K.

Laboratory methods: The soil exchangeable bases (Ca^{2+}, K^+, Mg^{2+}, Na^+) were determined by the method of Thomas (1982). Particle size was determined hydrometer method (Gee and Bauder 1986). The pH was determined according to the method described by Peech (1965). Total nitrogen was determined using the micro-Kjeldhal distillation method (Bremner and Mulvaney 1982). Available P was determined by the Bray-2 method (Page, 1982) while organic carbon was determined using the method described by Nelson and Somners (1982). The same procedure was used to determine the nutrient content of cocoyam corm.

Determination of soil carbohydrate (CHO) content: The carbohydrate fractions in the soil sample was determined in duplicate in three types of soil extract viz dilute acid soluble, hot water soluble and cold water soluble by method (Adesodun et al. (2001).

Determination of heavy metal (Cu, Zn, Fe, Pb) content of cocoyam shoot: Concentrations of heavy metals (Cu, Zn, Fe, Pb) in cocoyam shoot was carried out using the analytical procedure by APHA (American Public Health Association 1998).

Statistical analysis: Data was analysed using the general linear model of SAS software for randomized complete block design (SAS institute 1999).

RESULTS AND DISCUSSION

Initial properties of the soil and burnt rice husk dust: The texture was sandy clay loam. The soil had low nutrient content compared to the burnt rice husk dust. The available P mg kg^{-1}, K cmol kg^{-1}, total N (%) and organic carbon (%) were

29.6, 0.19, 0.06 and 0.40 respectively while burnt rice husk dust had 52.1 mg kg^{-1} available P, 0.16% total N, 18.9 cmol kg^{-1} K, and 3.06% organic carbon. Higher levels of Cu (41) , Pb (50), Fe(33) and Zn (31) mg kg^{-1} were observed in burnt rice husk dust compared to the soil with 18, 22, 28 and 23 mg kg^{-1} for Fe, Cu, Zn and Pb, respectively. Analysis of the soil and burnt rice husk dust showed pH of 4, 81and 9.87, respectively.

Effect of Tillage Practices and Burnt Rice Husk Dust

Soil Ca, Mg, K, and Na (cmol kg^{-1}): Application of burnt rice husk dusk on tillage practices significantly increased soil Ca, Mg, and K, contents compared to tillage practices alone in the first and second cropping seasons (Table 1). In the first cropping season soil Ca content ranged between 0.17- 0.20 cmol kg^{-1} in tillage practices amended with burnt rice husk dust compared to 0.11 cmol kg^{-1} in tillage practices alone. The order of increase in soil K content in the first and second cropping seasons were mound<ridge<$RBRHD_{10}$ <$MBRHD_{10}$<$RBRHD_{20}$<$MBRHD_{20}$ and mound <ridge< $RBRDH_{10}$ <$RBRHD_{20}$< $MBRHD_{10}$ <$MBRHD_{20}$, respectively. The increase in Ca, K, and Mg observed in tillage practices amended with burnt rice husk dust compared to tillage practices alone could be attributed to higher levels of these nutrients in the burnt rice husk dust. Angelova et al (2013) reported apparent increase in soil exchangeable nutrients of Ca, K, and available P. Similarly, Anna and Sirpa (2001) showed significant increase is soil content of Ca, Mg and K when they studied the effect of wood ash fertilization on forest soil chemical properties. In, An and Park (2021) reported improvement in soil Ca, K and Mg. Mbah et al (2012) observed increase in soil Ca, K and Mg when studied the use of ash to improve the nutrient content of an ultisol and its effect on the growth and dry matter yield of maize. Couch et al (2020) reported no positive difference in soil content of exchangeable cations when they studied the short time effects of wood ash application on soil properties, growth and foliar nutrition of *Picea glauca mariana* and *P. glauca* seedlings

Soil pH, total N (%), Avail P (mg kg^{-1}) and OC (%): The tillage practices amended with burnt rice husk dust significantly increased soil organic carbon , available P , total nitrogen and pH compared to tillage practices alone in both cropping seasons (Table 2). In the first cropping the highest OC value of 80% was observed in $MBRHD_{20}$. This value was 47.5, 46.3, 15, 10 and 2.5% higher than mound tillage, ridge tillage, $MBRHD_{10}$, $RBRHD_{10}$ and $RBRHD_{20}$, respectively. In the second cropping season the order of pH increase was mound =ridge < $MBRHD_{10<}$$RBRHD_{10}$<$RBRHD_{20}$<MBRHD20. The observed increases in the values of these parameters in tillage practice amended plots could be attributed to the higher values of these nutrients in the initial burnt rice husk dust. Anna and Sirpa (2001) observed increased soil

Table 1. Effect of tillage practices and burnt rice husk dust on soil Ca, Mg, K, and Na

Parameter	2016				2017			
	Ca (cmol kg^{-1})	Mg (cmol kg^{-1})	K (cmol kg^{-1})	Na (cmol kg^{-1})	Ca (cmol kg^{-1})	Mg (cmol kg^{-1})	K (cmol kg^{-1})	Na (cmol kg^{-1})
Mound	0.11a	0.21g	0.18bb	0.08ab	0.09ac	0.12ac	0.11ad	0.03c
Ridge	0.11a	0.20g	0.19bb	0..08ab	0.08ac	0.11ac	0.12ad	0.04c
$MBRHD_{10}$	0.17b	0.28h	0.29aa	0.10ab	0.13bb	0.17bd	0.16cc	0.07c
$MBRHD_{20}$	0.20c	0.32n	0.31aa	0.11ab	0.16cd	0.19bd	0.17cc	0.07c
$RBRHD_{10}$	0.16b	0.28h	0.26c	0.10ab	0.12bb	0.16bd	0.15cc	0.05c
$RBRDH_{20}$	0.20c	0.33n	0.30aa	0.10ab	0.13bb	0.16bd	0.15cc	0.05c

Means in the same column with the same letter do not differ significantly (p<0.05).
Mound tillage (no treatment), Ridge tillage (no treatment), $MBRDH_{10}$ = mound + 10 t ha^{-1} burnt rice husk dust, $RBRHD_{10}$, = ridge + 10 t ha^{-1} burnt rice husk dust , $MBRHD_{20}$ =mound + 20 t ha^{-1} burnt rice husk dust, $RBRHD_{20}$= ridge +20 t ha^{-1} burnt rice husk dust

Table 2. Effect of tillage practices and burnt rice husk dust on soil pH, total N, avail P and OC

Parameter	Avail.P Mg kg^{-1}	OC %	pH	Total N %	Avail.P Mg kg^{-1}	OC %	pH	Total N %
	2016				2017			
Mound	0.09bb	0.42a	4.6a	0.06s	0.06d	0.29s	4.4	0.02ar
Ridge	0.10bb	0.43aa	4.6a	0..07s	0.06d	0.30s	4.4	0.02ar
$MBRHD_{10}$	0.19a	0.68be	6.4ac	0.10a.	0.15c	0.43a	5.0	0.08ee
$MBRHD_{20}$	0.23d	0.80cd	6.9xa	0.13cx	0.18x	0.50ee	5.6	0.09ee
$RBRHD_{10}$	0.19a	0.72da	6.4ac	0.10ad	0.13c	0.45a	5.2	0.06as
$RBRDH_{20}$	0.23d	0.78as	6.9xa	0.14cx	0.15a	0.48ee	5.3	0.06as

See Table 1 for details

contents of OC, total N, available P and pH in ash amended soil relative to the control. Nnadi et al (2019) reported increased total N, available P, OC and pH in tillage amended with wood ash relative to unamended tillage practices. Njoku and Mbah (2012) studied the effect of burnt and unburnt rice husk dust on soil properties and reported increase in soil contents of OC, total N, available P and pH. Mbah et al (2012) also observed similar effect of poultry manure and wood ash on soil chemical properties and yield of maize (*Zea mays* L).

Soil carbohydrate content (mg kg^{-1}): Tillage practices amended with burnt rice husk dust significantly increased soil carbohydrate (CHO) content relative to tillage practices alone in the both cropping seasons (Table 3). In the first cropping season cold water soluble, hot water soluble and dilute acid soluble carbohydrates ranged between 42-83, 160-395 and 201-511 mg kg^{-1}, respectively. The order of increase in soil CHO content in the second cropping season was mound < ridge< $RBRHD_{10}$ < $MBRHD_{10}$ < $RBRHD_{20}$ < $MBRHD_{20}$ for cold water stable CHO., mound < ridge< $RBRHD_{10}$ < $MBRHD_{10}$ < $RBHD_{20}$ < $MBRHD_{20}$ for hot water stable CHO and mound < ridge< $RBRHD_{10}$ < $RBRHD_{20}$ $MBRHD_{10}$ < $MBRHD_{20}$ for dilute acid stable CHO. In both cropping seasons dilute acid soluble gave the highest levels of soil CHO. Bonglovanni and Lobertini (2006) observed that the lower contents of CHO extracted by cold and hot water when compared to dilute acid extraction method were due to the fact that dilute acid procedure extracted soluble CHO and also CHO from hemicellulose whereas cold and hot water extraction failed to produce hydrolysis of the hemicellulose. Rene (2016) mentioned that plants got CHO which plays a major role as their structural components and provides a major source of energy for soil microbial process from the soil. Gumina and Kuzyakov (2015) reported soil carbohydrate play essential role in soil by contributing to the maintenance and stimulation of microbial activities and functions. Spaccini et al (2002) mentioned waste management technique in some cases were successful in increasing the CHO content of the soil. Ratnayaka et al (2011) reported that carbohydrates are important parameters in determining soil fertility in different land uses. Mbah et al (2007) reported increased soil CHO contented when they used animal wastes as soil amendment. Similarly, Spaccini et al (2004) observed increased soil CHO in soils amended with organic wastes in Nsukka southeast Nigeria. Adesodun et al (2001) showed increased CHO content of soil amended with organic wastes in study on the structural stability and carbohydrate content of an ultisol under different management systems.

Ca, Mg, K and Na (cmolkg-^{1}) uptake of cocoyam corm: Tillage practices amended with burnt rice husk dust significantly increased cocoyam uptake of Ca, Mg and K compared to tillage practices alone) in the first and second cropping seasons (Table 4). Ca contents Cocoyam corm ranged between 0.18-0.26 and 0.16-0.19 in the first and second cropping seasons, respectively. In the first and second cropping seasons the highest K corm content was observed in $MBRHD_{20}$ amended plots. The increase in Ca, Mg, K and Na contents of cocoyam corm could be attributed to higher level of these nutrients in the burnt rice husk dust. Ojeniyi et al (2013) reported increased nutrient uptake by cocoyam corm in an alfisol in south west Nigeria when they used poultry manure as soil amendment. Hargreaves et al (2008) showed increased nutrient uptake in raspberries amended plots relative to the control. Nwokocha et al (2016) reported increased nutrient up take by maize (*Zea mays* L) when they studied the effects of organic amendments on some soil properties and nutrient uptake by maize in soils of different parent materials. Agegnehu et al (2016) observed that crop yield, plant nutrient uptake and soil physicochemical properties improved under organic soil amendments and nitrogen fertilization on Nitosols.

CU, Zn, Fe an Pb (Mg kg^{-1}) uptake by cocoyam shoot: There was significant increase in cocoyam shoot uptake of Cu, Zn and Fe in tillage practices amended with burnt rice husk dust relative to tillage practices alone (Table 5). Fe, Cu, Zn and Pb in shoot ranged between 0.13-0.23, 0.66-1.20, 36-

Table 3. Effect of tillage practices and burnt rice husk dusk on soil carbohydrate content

Parameter	Cold water stable	Hot water	Dil. acid stable	Cold water	Hot water	Dil. acid stable
		2016			2017	
Mound	42ac	160dd	205e	28ed	38b	184ax
Ridge	41ac	162dd	201e	29ed	38b	180ax
$MBRHD_{10}$	72bb	334bc	400h	58a	289as	251dd
$MBRHD_{20}$	83cx	416ee	483n	75s	310ed	270ef
$RBRHD_{10}$	63de	309dd	311av	55e	230xc	229gg
$RBRDH_{20}$	80cx	398ss	326er	65g	290er	240ss

See Table 1 for details

Table 4. Effect of tillage practices and burnt rice husk dust on corn Ca, Mg, Na and K uptake

Parameter	2016				2017			
	Ca (cmol kg^{-1})	Mg (cmol kg^{-1})	K (cmol kg^{-1})	Na (cmol kg^{-1})	Ca (cmol kg^{-1})	Mg (cmol kg^{-1})	K (cmol kg^{-1})	Na (cmol kg^{-1})
Mound	0.19b	0.96a	0.92d	0.05b	0.12d	0.46g	0.32d	0.04a
Ridge	0.18b	0.94a	0,93d	0.05b	0.12d	0.40g	0.34d	0.04a
$MBRHD_{10}$	0.23az	1.02c	0.99v	0.06b	0.19g	0.60h	0.49e	0.06a
$MBRHD_{20}$	0.26vx	1.10s	1.09e	0.07b	0.18g	0.65a	0.51s	0.05a
$RBRHD_{10}$	0.24vx	1.05e	0.96s	0.07b	0.18g	0.61d	0.50s	0.05a
$RBRDH_{20}$	0.24vx	1.08s	1.03g	0.08b	0.19g	0.62d	0.53g	0.06a

See Table 1 for details

Table 5. Effect of tillage practices and rice husk dust on uptake of Cu, Zn, Pb, and Fe by the cocoyam shoot

Parameter	2016				2017			
	Cu (Mg kg^{-1})	Zn (Mg kg^{-1})	Pb (Mg kg^{-1})	Fe (Mg kg^{-1})	Cu (Mg kg^{-1})	Zn (Mg kg^{-1})	Pb (Mg kg^{-1})	Fe (Mg kg^{-1})
Mound	0.76aa	44ee	0.001bb	0.13ac	0.64d	32aa	0.001as	0.10as
Ridge	0.78aa	56ee	0.001bb	0.15ac	0.68d	29aa	0.002as	0.10as
$MBRHD_{10}$	1.01cc	89abc	0.002bb	0.22ee	0.81b	63cx	0.002as	0.15cv
$MBRHD_{20}$	1.04cc	98ff	0.002bb	0.21ee	0.80b	68ee	0.002as	0.13cv
$RBRHD_{10}$	0.98sa	88abc	0.002bb	0.23ee	0.70.a	67ee	0.002as	0.13cv
$RBRDH_{20}$	0.99sa	95rr	0.002bb	0.21ee	0.81b	68ee	0.002as	0.14cv

See Table 1 for details

101 and 0.001-0.003 Mg kg^{-1}, respectively, in the first cropping season. In the second cropping season the highest values of 63 Mg kg^{-1} for Zn, 81 Mg kg^{-1} for Cu, and 0.15 Mg kg^{-1} for Pb were obtained in $MBRHD_{20}$ amended plots. The higher level of Zn obtained in the tillage practice amended plots relative to tillage alone could be attributed to higher levels of organic matter in the burnt rice husk dust. Dawar et al. (2022) observed that poor organic matter results in lower availability of Zn micronutrient in plants. Oti Wilberforce and Nwabue (2013) reported that Zn is essential for growth and development of foetus and the normal functioning of the brain cells. According to Gibson (2012) Zn deficiency in humans adversely affects the development of the brains, immunity, skin, the brain and reproduction. Demizen and Atkay (2006) reported that the acceptable level for Zn in produce for human consumption according to World Health Organization (WHO) is 150 Mg kg^{-1} (Brown 1977). The level of Zn in cocoyam shoot in this study is within acceptable level. Copper (Cu) is an essential element for humans, animal and plants. Shabir et al (2020) reported that excess Cu induces oxidative stress inside plants through enhanced production of reactive oxygen species. The observed Zu level in cocoyam shoot in this study is within acceptable level. Iron (Fe) is an essential micronutrient for almost all living organisms. The concentration of Fe in cocoyam shoot is within the acceptable limit of 0.3 Mg kg^{-1} (Brown 1977). Lead is a harmful and toxic heavy metal. Lead accumulation in excess according to Collins et al (2022) cause up to 42% reduction in growth of roots. World health organization (WHO 1996) reported that the level of pb acceptable in produce for human consumption is 0.001-0.003 Mg kg^{-1}. Lead level in cocoyam corms were within tolerable limit. Tang et al (2015) showed more levels of pb in root and shoots of plant grown in organic waste amended soil. The results of this study agreed with those of Nnadi et al (2019) and Mbah and Njoku (2023) when the used organic wastes as soil amendments. However, the result differed from those of Augelova et al (2010) who reported lower levels of heavy metals in potato grown in organic waste amended soil relative to the control. The levels observed in pb does not constitute health problems in crops and human food.

CONCLUSION

The tillage practices amended with burnt rice husk dust improved soil chemical properties (Ca, Mg, K, Na, total N, OC, available P an pH). There is higher concentrations of carbohydrate determined as cold water soluble, hot water soluble and dilute acid soluble in burnt rice husk dust (BRHD) amended tillage practices. Higher nutrient (Ca, Mg, K, Na) content by cocoyam corm was observed in tillage practices amended with BRHD compared to tillage practices alone, Application of burnt rice husk dust on tillage practices increased heavy metal (Cu, Mg, Pb, Fe) uptake by cocoyam shoot to non-toxic level for humans. The amendment of tillage practices with burnt rice husk dust was recommended for improvement of fertility of degraded soils and increase in crop performance without problem of heavy metal toxicity in crops and humans.

REFERENCES

Adesodun JK, Mbagwu JSC and Oti NN 2001. Structural stability and carbohydrate contents of an ultisol under different management systems. *Soil and Tillage Research* **60**(3-4): 135-142.

Agegnehu G, Nelson PN and Bird MI 2016. Crop yield, plant nutrient uptake and soil physicochemical properties under organic soil amendments and nitrogen fertilization on Nitosol. *Soil and Tillage Research* **160**: 1-3.

Agulana FT 2020. The role of indigenous and underutilized crops in the enhancement of health and food security in Nigeria. *African Journal of Biomedical Research* **23:** 305-312.

An JY and Park BB 2001. Effect of wood ash and N fertilization on soil chemical properties and growth of Zelkova separate across soil types. *Scientific Reports* **11**(1): 14489.

Angelova V, Akova V, Artinova NS and Ivanov K 2010. The effects of organic amendments on soil chemical characteristics. *Bulgarian Journal of Agricultural Science* **19**(5): 958-971.

Anna SEA and Sirpa P 2001. Effect of woodash and N fertilization on forest soil chemical properties. *Silva Fennica* **35**(3): 355-368.

APHA (American Public Health Association) 1998. *Standard methods of examination of water and waste water 20th edn*. APHA Washington DC, USA p. 874.

Arcangelo L, Rafeal Da R and Gustavo B 2019. Animal manure as fertilizer; Changes in soil attributes, productivity and food composition of soil organic matter. *International Journal of Research -GRANTHAALAYAH* **7**(9): 307-331.

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

Bongiovanni MD and Lobartini JC 2006. Particulate organic matter, carbohydrate, humic acid contents in soil macro and microaggregates as affected by cultivation. *Geodema* **136:** 660-665.

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

Brown HJM 1977. *Environmental chemistry of elements*. London, Academic press.

Comim JJ, Loss A, Verga M and Guardei RG 2013. Physical properties and organic carbon content of a Typic Hapludult soil filled with pig slurry and pig litter in a non-tillage system. *Soil and Tillage Research* **51**: 459-470.

Collins S, Baska A, Geevarghese MN, Ali MNV, Baubalic C, Rajan C, Lvov V, Tovar GI, Senatov F, Koppalla S and Swammiapan S 2022. Bioaccumulation of lead (pb) and its effects in plants: A review. *Journal of Harzadoue Letters* **3** November 2022, 10064.

Couch RL, Lukai N, Dave N and Dicgon A 2000. Short time effects of woodash application on soil properties, growth and folial nutrition of *Picea glauca mariana* and *Picea glauca seedlings Canadian Journal of Soil Science* https.///doi.org/10.1139/CISS 202-0105.

Dawar K, Ali W, Bibih G, Mial AL, Ahmad LMA, Hussian MB, Ali M, Fahad S and Rehman SU 2022. Effects of different levels of Zn and compost on yield and yield components of zinc. *Agronomy* **12:** 1562. https//doi.org/10.3390/agronomy12071562.

Dias VV, Tolammi E, Renllion JPP and Schuster MA 2016. Scale of consumer loyalty for organic food. *British Food Journal of Information* **118**: 697-713.

Demizen D and Aksoy A 2006. Heavy metal levels in vegetables in Turkey are within safe limits for Cu, Zn, Ni and exceeded for Cd and Pb. *Food Quality* **29:** 252-265.

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

Gee GW and Bauder JW 1986. In: *Particle size analysis. Part: Physical and microbiological method 2nd edition*. Agronomy series No 9 ASA, ASSA Madison, WI. 1973. Pp 14.

Gibson RS 2012. Zinc deficiency and human health. Etiology health consequences and future solutions. *Plant Soil* 2010361; 291-299.

Glacomini SJ, Aita C, Pujo SB and Mida E 2013. Transformceasndonnitrogen 10 no scio apos addiode dhectoliquido cama scicreposta de suinos. *Pesquisa Agropecuafia Brasilum* **48**: 211-219.

Gonzalezez-Mancilla A, Delcamen Rivera-cruz M, Ortiz Garcia CF, Almarez-suarez JJ, Frujivivi-Nacia A and Crus-Navarro G 2013. Uso de fertilizantes organicos mycrobiologicas dei suelo y dei creamiemto critic citrange troyer. *Universidady Dencia* **38:** 123-139.

Gumina A and Kuzyakov V 2015. Sugars in soil and sweets for micro-organism: Review of origin, content, composition and fate. *Soil Biology and Biochemistry* **90:** 87-100.

Hargreaves J, Sina MA, Phil W and Vasantha Rupasighe HP 2008. The effects of organic amendments on mineral element uptake and fruit quality of raspberries. *Plant and Soil* **308**(1): 213-226.

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 Research* **166:** 52-58.

Mbah CN, Anikwe MAN, Onweremadu EU and Mbagwu JSC 2007. Soil organic matter and carbohydrate contents of a Dystric leptosol under organic waste management and their role in structural stability of soil aggregates. *International Journal of Soil Science* **2**(4): 268-277.

Mbah CN 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.

Mbah CN, Njoku C, Ngene P and Oludare CJ 2012. Use of ash to improve the nutrient content of an ultisol and its effect on maize growth and dry matter yield. *Agricultural Science Research Journals* **2**(3): 1-5.

Nelson DW and Somners LE 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 CN 2012. Effect of burnt and unburnt rice husk dust on maize yield and soil physicochemical properties of an Ultisol in Nigeria. *Biological Agriculture and Horticulture* **28**(1): 49-60

Nnadi EO, Mbah CN, Nweke AI and Njoku C 2019. Physicochemical properties 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* 194, November 2019, 104288.

Nwokocha AD, Asawalam DO, Akinboye AE and Ade Oluwa AA 2016. The effects of organic amendments on some soil properties and nutrient uptake by Zea mays in soils of different parent materials. *International Journal of Advance Agricultural Research* **4:** 89-93.

Obi IU 1990. *Statistical method of detecting differences between treatment means*. Snaap Press Ltd. Enugu-Nigeria.

Ojeniyi SO, Amusan AO and Adekoya AO 2013. Effect of poultry manure on soil physical properties, nutrient uptake and yield of cocoyam in south wet Nigeria. *American Eurasian Journal of .Environmental Science* **13**(10): 121-125.

Oti Wilberforce JO and Nwabue FL 2013. Heavy metal effect due to contamination of vegetables from Enyigba pb mine in Ebonyi state Nigeria. *Environmental Pollution* **2**(1): 19-22.

Page A 1982. *Methods of Soil analysis*. Part 2. Chemical and microbiological properties. Second edition American Society of Agronomy Inc. Soil Sisco of America Incaution WI..

Peech M 1965. Hydrogen ion activity. In Black C.E. (eds). Methods of soil analysis. Part 11. *American Society of Agronomy* **9:** 914-926.

Prihar SS, Gagri RR, Benbi DK and Aroro UK 2000. *Intensive cropping; efficient use of water, nutrient and tillage.* The Haworth Press-Inc Binghamton, N.Y.

Qian Z, Lian-jian K, Yuzi S, Xing-dong Y, Hui-jun ZX, Futi X and Xue A 2019. Effect of biochar on grain yield and leaf photosynthetic physiology of soybean cultivars with different phosphorus efficiencies. *Journal of Integrate Agriculture* **18**(10): 2242-2254.

Ratnayaka R, Seneviratne G and Kulasoonya S 2011. Effect of land use and management practices on quantitative changes of soil carbohydrates. *Eurasian Soil Science* **46**(5). Doi:10.//34/s1064 229313050177.

Rene FH 2016. *Biological workbook for dummies*. Amazon Press pp1-4.

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

Spaccini R, Piccolo A, Mbagwu JSC, Igwe C and Shale T 2002. Influence of management practices on carbohydrate characteristics and structural stability of some high land soil in Ethiopia. *Soil Use and Management* **18:** 404-411.

Tang X, Li X, Liu X, Muhammedu Z, Hasheem T, Jiaming X and Brookes CP 2015. Effect of inorganic and organic amendments on the uptake of lead and trace elements by *Brrassics chinensis* grown in acid red soil. *Chemosphere* **119:** 177-183.

Thomas GW 1982. Exchangeable cations. In Page AL, Miller RH and Heeny RR (eds) *Methods of soil analysis part2* (2nd ed). Agronomy Monograph No 9 ASA and SSSA, Madison. W.I. pp 159-165.

World Health Organization (WHO) 1996.*Guidelines for drinking quality water*. 2nd Edition. Switzerland. **1**(3): 50-57.

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