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Effect of Rice Mill Processing Wastes on Soil Quality in Abakaliki, Southeastern Nigeria

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Abstract: *The objective of this study was to determine the effects of rice mill processing wastes on soil quality in Abakaliki. Four replicate soil samples were collected from T_1 = 1 m away from unburnt rice husk disposal site; T_2 = 200 m away from unburnt rice husk disposal site; T_3 = 400 m away from unburnt rice husk disposal site and T_4 = Control (Non-dumpsite). The samples collected were used for the determination of selected soil properties. Data collected were analyzed using analysis of variance and differences between mean dictated using F-LSD. The results showed that rice husk significantly ($p<0.05$) improved soil properties with respect to soil bulk density, total porosity, moisture content, aggregate stability, mean weight diameter, pH, organic C, total N, C/N ratio, available P, exchangeable bases, total exchangeable acidity, effective cation exchange capacity and base saturation in various locations studied. Therefore, incorporating of this waste in agricultural soils will help to increase crop productivity and thereby making our environment to be friendlier since organic waste that could have littered our environment has been recycled.*

Keywords: *Environment, nutrient, recycles and wastes*

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I. Introduction

Rice dust as a solid waste is common in Abakaliki rice mill centre. Hundreds tones (1000) are been produced every day. The rice dusts constitute a very serious problem if not handled and adequately removed. The rice husk is been disposed, to the land very close to the milling centre. These over grown heaps of rice dust always cause environmental nuisance and contribute to the loss of nutrients to runoff water, and this reduces the soil quality since these soil nutrients are not recycled. Most millers do not know how to dispose these wastes apart from using these wastes to liter the nearby environment (Mbah, 2006). There is urgent need to research on the best method of disposing this waste in order to encourage healthy environment to everyone upon which incorporating in the soil will also result to nutrient recycled from soil to plant and vice versa. Njoku and Mbah (2012) showed that despite the numerous of rice mill dust waste that is been generated everyday and there long term effects on the surrounding environment no serious attempts have been made as to regarding the way the rice dust will be disposed safely. Njoku et al. (2011) showed that rice husk dust can improve soil properties and crop yield. Anikwe (2000) has in his work made a suggestion that rice dust with high specific surface area and organic carbon content can be used as a soil amendment to improve the soil productivity. Similarly, rice husk dust contains valuable organic material that can help to improve soil productive capacity. Agricultural production in low-input systems in the tropics relies partly on nutrient cycling and the maintenance of soil fertility through biological processes. Consequently, alternative food production systems that are productive and sustainable are being developed (Okonkwo and Ogu 2002). Organic wastes used as soil amendment included farm wastes, compost manure, green manures and fresh grass. Soil physical properties are the main factors that are affecting the use of soil because for agriculture to succeed or fail it depends on the physical properties of the soil, since physical properties are more difficult to change than chemical properties (Chude *et al.,* 2011). But addition of organic wastes has been shown to play greater role in changing soil physical properties (Njoku et al, 2017). Similarly, Njoku and Ibekwe (2017) has shown that application of organic wastes improved soil chemical properties and crop yield.

Therefore, the objective of this work was to determine the effects of rice processing waste on soil properties in Abakaliki.

II. Materials And Method

2.1 Study Area

Abakaliki, the study area is the capital city of Ebonyi State and is located in the Southeastern Nigeria which lies within latitude $6^0$19'N and longitude 8^0 06'E in the derived savannah of the southeast agro-ecological zone of Nigeria. The rainfall pattern is bimodal (April to July and September to November), with a quick dry spell in August normally referred to as "August Break". It has annual rainfall of 1700 to 2000mm and annual mean of 1800mm. Abakaliki has a high temperature of 27^{o}C and the topmost mean daily temperature of 31^{o}C that is within the year. Humidity is high (80%) during rainy season and low (60%) during dry season. Geologically, the research site is sedimentary rock which is obtained from straight seawater retainer of the cretaceous periods and quaternary periods. As stated by Federal Department of Agriculture and Land Resources (1987), agricultural zone of Abakaliki remains within 'Asu River group' and made up of olive brown sandy shale, small particles of mudstones and sandstone. The soil is not very deep with unconsolidated parent substances within one meter of the sand uppermost layer.

2.2 Field Method

A preliminary survey of the research site was conducted and thus rice mill waste dumpsite located along Ogoja Road Abakaliki, at the back of College of Agriculture Science, Ebonyi State University Abakaliki was selected for the study. Soil samples were collected as follows:
T_1 = 1 meter away from the unburnt rice husk disposal site.
T_2 = 200 meter away from the unburnt rice husk disposal site.
T_3 = 400 meter away from the unbunt rice husk disposal site.
T_4 = control (sample collected in non dump site)

2.3 Soil Sampling and Analysis

Four replicate soil samples were collected in each location at the depths of 0 – 30 cm using soil auger at three months interval in each location. Also undisturbed four replicate core soil samples were also collected from each location using a core of 157.28cm^3 at three months intervals. These soil samples were taken to laboratory for analyses immediately after collection.

2.4 Laboratory Procedure

2.4.1 Physical Properties of the Soil

The following soil physical properties were determined:
Bulk density: The bulk density was determined using the method described by Landon (1991).
Total porosity: Total porosity was determined as describe by Obi (2000).
Moisture content: Moisture content was determined as described by Obi (2000).
Aggregate stability: Aggregate stability was determined by the wet technique for Kemper and Rosenau (1986).
Mean weight diameter: This was calculated thus;
Mean weight diameter (MWD) =

$$\sum_{I=1}^{n} XiWi$$

where;
MWD = mean weight diameter (mm)
Xi = mean diameter of each size fraction (mm)
Wi = proportion of all the sample weight

2.4.2 Chemical Properties of the Soil

Soil pH: Soil pH was determined by using a suspension of soil and distilled water in the ratio of 2:5 – soil: water (Mclean, 1982).
Organic Nitrogen: This was determined by the method of Olsen and Sommers (1982).
Total Nitrogen: Total nitrogen was determined using modified kjeldahl digestion procedure (Bremmer and Mulvaey 1982).
Available phosphorous: Available phosphorous was determined by Bray 11 method (Olsen and Sommers 1982).
Exchangeable base: Exchangeable base was determined by using Chapman method (1982).
Exchangeable acidity: Exchangeable base was determined by the titration method (Jou, 1979).
Effective cation exchangeable capacity: This was determined by the summation and calculation (Njoku and Mbah 2012).
Base saturation: Base saturation was calculated as follows: TEB/ECEC $\times$ 100,

Where;
TEB = Total exchangeable bases,
ECEC = Effective Cation Exchangeable Capacity.

2.6 Data and Analysis

The data obtained from this research was analysed using analysis of variance (ANOVA) based on RCBD and difference between treatment means were dictated using F-LSD at P=0.05 according to the method described by SAS Institute Incoporated (1999).

III. Results

3.1 Effect of the Rice Mill Processing Wastes on Soil Particle Distribution

Table 1 shows the result of particle size distribution of the soil studied. There was non-significant ($P<0.05$) changes in particle size distribution among the different sites studied. However, T_1 recorded the lowest sand content of 536 gkg^{-1}. This sand content observed in T_1 was higher than that of T_2, T_3 and T_4 by 17, 16 and 21%, respectively. The order of increase in silt was $T_1 > T_2 > T_3 = T_4$. T_1 recorded the lowest clay content of 156 gkg^{-1} whereas T_3 recorded the highest clay content of 196gkg^{-1}. The textural classes of the soils studied were loamy soil.

4.2. Effect of the Rice Mill Processing Wastes on Soil Bulk Density, Total Porosity, Moisture Content, Aggregate Stability and Mean Weight Diameter

Soil physical properties studied show significant ($P<0.05$) changes among treatment in the various physical parameters studied with the exception of aggregate stability which is non-significant (Table 2). Lowest and highest bulk density of 1.05gcm^{-3} and 1.40gcm^{-3} were observed in T_3 and T_1, respectively. The order of increase of total porosity was $T_1 > T_2 > T_4 > T_3$. Lowest moisture content of 15.99% was observed in T_3. This lowest moisture content observed in T_3 was lower than that of T_1, T_2 and T_4 by 25, 19 and 6%, respectively. Although, there was non-significant change in aggregate stability, the lowest and highest aggregate stability was observed in T_3 and T_1, respectively. The order of increase in mean weight diameter was $T_1 > T_2 > T_4 > T_3$.

Table 1: Effect of Rice Mill Processing Waste on Soil Texture (gkg^{-1})

Treatment	Sand	Silt	Clay	Texture
T_1	536	308	156	Loamy soil
T_2	646	178	176	Loamy soil
T_3	636	168	196	Loamy soil
T_4	676	168	156	Loamy soil
F – LSD (P < 0.05)	NS	NS	NS	

Where: T_1 = 1 metre away from the unburnt rice husk disposal site; T_2 = 200 metres away from the unburnt rice husk disposal site;
T_3 = 400 metres away from the unburnt rice husk disposal site; T_4 = control (sample collected in non-dumpsite).

Table 2: Effect of the Rice Mill Processing Wastes on Bulk Density, Total Porosity, Moisture Content, Aggregate Stability and Mean Weight Diameter

Treatment	Bd (gcm-^{3})	Tp(%)	Mc(%)	Ags(%)	Mwd(%)
T_1	1.40	41.93	19.99	26.93	2.11
T_2	1.35	41.18	18.99	25.93	2.01
T_3	1.05	38.92	15.99	22.93	1.71
T_4	1.15	39.68	16.99	23.93	1.81
FLSD (P<0.05)	0.07	1.45	2.02	Ns	2.53

Where: T_1 = 1 metre away from the unburnt rice husk disposal site; T_2 = 200 metres away from the unburnt rice husk disposal site;
T_3 = 400 metres away from the unburnt rice husk disposal site; T_4 = control (sample collected in non-dumpsite); Bd = bulk density;
Tp = total porosity; Mc= moisture content; Ags = aggregate stability; Mwd = mean weight diameter

3.3. Effect of the Rice Mill Processing Wastes on Soil pH, Organic C, Total N, and Available P

The result of soil pH, organic C, total N, and available P are as presented on Table 3. There was a significant ($P < 0.05$) change among the treatment studies in soil pH, organic C, total N, and available P. T_1 recorded lowest soil pH value of 5.63 which was lower than pH in T_2, T_3 and T_4 by 7, 4 and 7%, respectively. The order of increase in organic C was $T_1 > T_2 > T_4 > T_3$. Similarly, T_1 had the highest total N of 0.25% while T3 recorded the lowest total N of 0.21% and non-dumpsite had 0.24% total N. The increasing order in C/N ratio was $T_2 > T_1 > T_4 > T_3$. Lowest available P of 63.10 mgkg^{-1} was observed in T_1. This lowest available P in T_1 was lower than available P in T_2, T_3 and T_4 by 1, 5 and 6%, respectively.

Table 3: Effect of Rice Mill Processing Wastes on Soil pH, Organic Carbon, Total Nitrogen, and Available Phosphorous.

Treatment	pH	Organic C (%)	Total N (%)	C/N Ratio	Avail. P ($mgkg^{-1}$)
T_1	5.63	1.78	0.25	7.12	63.10
T_2	6.03	1.68	0.23	7.30	63.93
T_3	5.83	1.16	0.21	5.29	66.53
T_4	6.03	1.48	0.24	6.17	66.78
FLSD (P<0.05)	0.04	0.36	0.05	0.48	4.09

Where: T_1 = 1 metre away from the unburnt rice husk disposal site; T_2 = 200 metres away from the unburnt rice husk disposal site;
T_3 = 400 metres away from the unburnt rice husk disposal site; T_4 = control (sample collected in non-dumpsite).

3.4. Effect of Rice Mill Processing Wastes on Exchangeable Bases

The results of exchangeable bases studied are as presented in Table 4. Table 4 also, shows significant ($P < 0.05$) changes in exchangeable bases among different treatments studied. The order of increase in Ca was $T_2 > T_1 > T_4 > T_3$. Lowest magnesium value of 2.60 Cmol(+)kg^{-1} was observed in T_3. This lowest magnesium value in T_3 was higher than magnesium in T_1, T_2 and T_4 by 15, 12 and 4%, respectively. The increasing of K was $T_1 > T_2 > T_3 = T_3$. On the order hand T_3 recorded the lowest Na value of 0.21 Cmol(+)kg^{-1}. This observed Na in T_3 was lower than Na values in T_1, T_2 and T_4 by 48, 43 and 33, respectively.

3.5: Effect of the Rice Mill Processing Wastes on TEA, TEB, ECEC and BS.

The effect of the rice mill processing wastes on TEA, TEB, ECEC and BS is as shown in Table 5. There was a notable ($p < 0.05$) change among different treatments studied with respect to TEA, TEB, ECEC and BS. The order of increase in TEA was $T_2 > T_1 > T_4 > T_3$. Similarly, T_3 recorded the lowest 1.99 Cmol(+)kg^{-1}. This observed TEB value in T_3 was lower than TEB in T_1, T_2 and T_4 by 44, 40 and 32%, respectively. The order of increase in ECEC was $T_1 > T_2 > T_4 > T_3$. Similarly, T_3 recorded the lowest 1.99 Cmol(+)kg^{-1}. The lowest and highest BS was observed in T_3 and T_1, respectively.

Table 4: Effect of the Rice Mill Processing Wastes on Exchangeable Bases (Cmol(+)kg^{-1})

Treatment		Ca	Mg	K	Na
T_1		6.90	3.00	0.16	0.31
T_2		8.05	2.91	0.15	0.30
T_3		6.50	2.60	0.12	0.21
T_4		6.55	2.70	0.12	0.28
F-LSD (P<0.05)		1.99	3.54	0.004	0.05

Where: T_1 = 1 metre away from the unburnt rice husk disposal site; T_2 = 200 metres away from the unburnt rice husk disposal site;
T_3 = 400 metres away from the unburnt rice husk disposal site; T_4 = control (sample collected in non-dumpsite).

Table 5: Effect of the Rice Mill Processing Wastes on TEA, TEB, ECEC and BS

Treatment	TEA (Cmol(+)kg^{-1})	TEB (Cmol(+)kg^{-}1)	ECEC (Cmol(+)kg^{-1})	BS(%)
T_1	0.09	2.86	12.80	93.75
T_2	1.02	2.79	11.80	92.75
T_3	0.86	1.99	8.80	89.75
T_4	0.87	2.63	9.50	90.05
FLSD (P<0.05)	0.19	0.93	0.001	0.001

Where: T_1 = 1 metre away from the unburnt rice husk disposal site; T_2 = 200 metres away from the unburnt rice husk disposal site;
T_3 = 400 metres away from the unburnt rice husk disposal site; T_4 = control (sample collected in non-dumpsite);
TEA = Total exchangeable acidity; TEB = Total exchangeable bases; ECEC = Effective cation exchange capacity;
BS = Base saturation.

IV. Discussion

4.1 Soil Particle Size Distribution

The result of the soil particle size distribution is as shown in Table 1. According to Njoku et al. (2011) and Anikwe (2000) it takes very large amount of organic wastes and long period of time for particle size distribution to change as a result of application of organic wastes.

4.2 Soil Physical Properties

The consequence of rice dust on soil bulk density and total porosity, moisture content, aggregate stability and mean weight diameter are shown in Table 2. The control had the highest bulk densities value present of 1.40g/cm^3 while the lowest values was 1.05%. This bulk density agreed with the findings of numerous studies (Njoku and Mbah 2012). Total porosity values obtained was 41.93%, with the control having almost the least values and the unburnt rice husk which was collected 1 m away from the disposal site having the highest values. The increase in total porosity can be attributed to the increase in percentage of micro-pores. Njoku and Mbah (2012) showed that soils that has high total porosity and low bulk density contain the required amount of oxygen that are very important for organisms that live in the soil to survive. In water it increases the water movement and source piercing and in the collective feeding area of crops (Nnabude and Mbagwu 1998).

Moisture content shows a relatively high value in the unburnt rice husk which was close to the disposal site. The increase in aggregate stability observed at 1m away from rice husk disposal site was as the result of effects of the organic matter in the soil particles. The soil collected 1m away from the rice husk disposal site has higher value of organic matter than Control. (Table 2) showed a significant increase in mean weight diameter in rice husk waste. Mbagwu *et al.* (1991) observed increase in mean weight diameter of rice husk waste relative to control. The organic carbon, total nitrogen and were low. The exchangeable cations and effective cation exchangeable base were also low as a result of low organic nitrogen and silt content of the soil.

4.3 Soil Chemical Properties

There was an increased in the soil pH when compared with the control. The observed pH ranged from 6.03 to 5.63 in the soil collected very close to the disposal site, respectively. Due to the increase in value of the pH. Odedina *et al.* (2003) observed that organic wastes increased soil pH due to the abundance of alkaline earth materials. Also, Mbah and Onweremadu (2009) observed increase in soil pH in organic wastes. These raise in pH level could be ascribed to the significant improvement in the exchangeable bases of the soil (Nwite *et al.*, 2011). Organic carbon, total nitrogen, available phosphorus, exchangeable base, exchangeable acidity, base saturation and effective cation exchangeable capacity is presented. The organic carbon content with rice husk increased significantly with increase when compared to control, the organic carbon was high. This is in agreement in the research made by Okonkwo *et al.* (2011) who proved that the highest organic nitrogen content was obtained in the unburnt rice husk when compared to the burnt rice husk ash. Studies had shown that organic wastes increased soil organic carbon, total nitrogen, available phosphorus, soil pH and effective cation exchangeable capacity (ECEC) and it reduced soil exchangeable acidity (Adeleye *et al.*, 2010 and Mbah, 2006). The increase in pH level could be attributed to the significant changes in the exchangeable bases of the soil the slight changes in the soil pH by rice husk may have impact on the level of available phosphorus for the reason been that the availability of phosphorus and its solubility is depending on pH (Nwite *et al.*, 2011).

V. Conclusion And Recommendation

Soil is a sink for many beneficial and harmful substances. The organic waste materials has a beneficial effect in soil when dispose in soil since the nutrients absorbed from the soil by plant is then released during decomposition and mineralization. The qualities and productivities of the soil are often affected adversely when soil absorbs contaminants or cultivated continuously without the application of organic fertilizer, and in order to ensure good and conducive environment for increased food production and human health, there is need to reclaim the affected soil by the application of organic waste. Most of the rice dust manufactured from the processing of rice can be burnt or discard as wastes, and this creates great environmental threats to the environment and surrounding areas where it is discarded or disposed. Consequently, in agriculture the use of rice dust as organic manure can be a very big reserve tincture to the disposal complication.

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