EFFECT OF DIFFERENT RATES OF RICE MILL WASTE ON SOIL CHEMICAL PROPERTIES AND GRAIN YIELD OF MAIZE (Zea mays L.)

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ABSTRACT
A field experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Anambra State University, Igbariam Campus, to determine the effect of different rates of rice mill waste (RMW) on the soil chemical properties and grain yield of maize (Zea mays L). The experiment was laid out in Randomized Complete Block Design (RCBD) with five treatments, viz 0 kg/RMW, 6 kg/RMW, 12 kg/RMW, 18 kg/RMW and 24 kg/RMW. The treatments were replicated four(4) times and data collected were subjected to an analysis of variance test based on Randomized Complete Block Design (RCBD), while treatment means were separated using least significant difference (LSD=0.05). The results of the study indicated significant differences between the rates of RMW in soil and agronomic parameters measured. Yield values increased in soil and agronomic parameters assessed with increasing rates of rice mill waste in dosage of application from zero level. The order of increase in soil and agronomic parameters measured was 24 kg RMW > 18 kg RMW > 12 kg RMW > 6 kg RMW > control. Thus 24 kg of RMW recorded the highest value in all the parameters measured in this trial. Therefore, rice mill waste at the rate of 24 kg could be used as soil amendment since it increased the soil chemical parameters, growth and grain yield of maize.
Key words: Amendment, Maize, Rice mill, Soil properties.

INTRODUCTION
The cultivation of crops by farmers is based on the continuous availability of nutrients in the soil with fallow system as one of the major means of replenishing the depleted plant nutrients. Continuous cropping leads to the depletion of soil nutrient with the resultant poor performance of the cultivated crops (Corsky and Ndikawa, 2008). With this trend soil nutrients that will boost crop growth and yield decline progressively unless the nutrients are replenished through the use of organic matter or mineral fertilizers, or partially through the use of crop residues. Fertility can be rebuilt through the use of the traditional fallow system that allows restoration of nutrients and restoration of soil organic matter. Nonetheless, increasing demand for land as a result of population increase, has led to a break down of these soil fertility maintenance strategies with regard to fallow periods (Sanchez et al., 1997). The use of chemical fertilizers to replenish lost nutrients in cultivated soil is negligible because most farmers cannot afford the costs. More so, under intensive agriculture, the use of chemical fertilizers is often associated with reduced yield, soil acidity and nutrients imbalance (Ojeniyi, 2000). There is scarcity of mineral fertilizer in the Southeast of Nigeria and a possible alternative to chemical fertilizer is the use of organic matter to maintain sustainable crop yield and soil productivity. Mutuo et al. (2000) reported that plot that had received organic biomass had a high residual effect and gave 50% yield increase above control plots. Recycling of crop residues has been found useful in improving soil nutrients availability and crop yields (Singh and Singer, 2001), and in improving the overall ecological balance of the crop production (Beri, and Bhat2001). Lal (1998) further observed that crop yield increased on soils incorporated with organic wastes.

Maize is one of the most important staple food crops in the tropics and like other cereals is a heavy user of nutrients. Although it is a surface feeder, the nutrients must be present in available form in the top horizon of the soil. One of the reasons why maize yield remain low in the south east is because most soils used for maize production are no longer virgin, and best, they are from a short period of fallow, and suffer from nutrient exhaustion. For such soils to support a good crop of maize, additional fertility is required in the form of manure. Hence the essence of this study was to investigate the effect of different rates of rice mill organic waste on the soil chemical properties, growth and grain yield of maize.

MATERIALS AND METHODS
The research was carried out in the experimental, Teaching and Research farm of the Department of Crop Science and Horticulture in the Faculty of Agriculture, Anambra State University, Igbariam Campus. The site lies between latitude 060 14^1 N and longitude 060 45^1 E (ANSU met, 2010). The rainfall pattern is bimodal between April and October, with a mean annual rainfall of 1268.4mm. The dry season falls between November and March. The relative humidity (RH) of the study area is moderately high all year round with the highest RH of 85% during the wet season and the lowest (64%) occurring during the dry

season. The soil is of the sandy loam textural class classified as Ultisol (FDALR, 1985).
The experiment was laid out in a randomized complete block design (RCBD), with four replicates to give 20 plots, each measuring 3m x 4m. Plots were separated from each other by 0.5m path and each block was separated by 1m alley. The study area was cleared of the natural Vegetation (Talinum traingulare, Panicum maximum, Aspilia Africana and other weed species) and cultivated using hoe. Treatments consisted of the appropriate rates of rice mill waste were given to the requisite plots and evenly worked into the soil by hoeing. The treatments used are as follows:
RMW 0 kg/plot equivalent to 0 t/ha
RMW 6 kg/plot equivalent to 5 t/ha
RMW 12 kg/plot equivalent to 10 t/ha
RMW 18 kg/plot equivalent to 15 t/ha
RMW 24 kg/plot equivalent to 20 t/ha
Each treatment was replicated four times.
Two maize seeds were planted per hole at the spacing of 75cm by 25cm and at a depth about of 2cm. This was done 7days after the incorporation of the rice mill waste.
The seedlings were thinned down to one plant per stand two weeks after germination. Empty stands were supplied. Weeding was done manually with hoe at 2 weeks interval till harvest.

Soil Sample Collection
Initial soil sample were collected randomly from 0-20cm depth in the study site before treatment application. The sample were mixed together thoroughly to form composite soil samples and used for pre-planting soil analysis. (Table 1), similarly at the end of the study, soil samples were collected from respective plots at depth of 0-20cm, the soil samples were air dried and sieved through 2 mm sieve and used for the determination of the soil chemical parameters. The soil chemical parameters determined was soil pH determined by electrometric method using a soil water ratio of 1:2.5. Total N was determined by macro-kjeldahl method and organic carbon determined by oxidation with sulphuric acid according to Walkley and Black method. Exchangeable cat ions were extracted using 1N NH_4OAC. Potassium and Sodium were determined on flame photometer. Exchangeable Ca and Mg were determined by EDTA titration. Available P was determined by Bray II method.

Table 1 Initial properties of the soil before treatment application

Parameter	Value
Clay	9%
Silt	15%
Find Sand	42%
Coarse Sand	34%
Textural Class	Sandy Loam
pH H_20	5.5
pH KCL	4.6
C	0.62%
OM	1.07%
N	0.08%
Na	0.23 $Cmolkg^{-1}$
K	0.15 $Cmolkg^{-1}$
Ca	0.6 $Cmolkg^{-1}$
Mg^{2+}	1.4 $Cmolkg^{-1}$
Avail P	4.66 $mgkg^{-1}$

Agronomic parameters measured

Agronomic parameters studied were: Plant height (cm): Eight (8) maize plants/plot were measured for height at the end of the study with a meter rule. The plant height was measured from the ground surface to the tip of the tallest leaf.

Leaf are index at 35,65 and 95 days after planting (DAP) was measured and calculated using the length x width x 0.75 formula and summed over all leaves and divided by land area per plant (Watson, 1947).

At maturity the grain yield per plot was measured. Eight plants/plot were selected and tagged the grain yield from the tagged plants were harvested, dried to 14% moisture content. The grain harvested from the tagged plants was weighed to get its yield per plot.

Data Analysis

Data generated were subjected to an analysis of variance test based on Randomized Complete Block Design (RCBD). Statistical significance between treatment means was estimated using Fisher's least significant difference (FLSD=0.05), according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Table 1 show that the soil is acidic and textural class is sandy loam. The soil contains low level of major nutrient elements and low content of organic matter % (1.07) and total N% (0.08), while the available P (mgkg^{-1}) was below the range according to the ratings of Landon (1991). Hence the soils of the experimental site are considered poor in these essential plant nutrient elements.

The analysis of the soil (Table2) show that the application of rice mill waste significantly (P=0.05) increased the values of Ca Cmolkg^{-1} , Mg Cmolkg^{-1} , Na Cmolkg^{-1} , K Cmolkg^{-1} organic carbon %, total N% available P mgkg^{-1} and pH (H_20) relative to control plots. Increasing the rate of application of rice mill waste resulted to an increase in the values obtained with 24kg RMW recording the highest value in all the soil chemical parameters assessed in this trial.

The value of Ca content increase in 24kg RMW was 9.24% higher than 18kg RMW, 28.71% greater than 12kg RMW, 44.44% higher than the values obtained in 6kg RMW and 160% higher than the value of control plot. Similarly the application of RMW raised the Mg level compared to the control plots. The order of increase in the soil Mg was 24kg RMW> 18kg RMW> >12kg RMW> 6kg RMW> Control. However the result of Ca and Mg content of the soil obtained in 18kg RMW and 12kg RMW as well as 12kg RMW and 6kg RMW were not different statistically but significantly better than the control plot. The result of Na and K content of the soil indicated that the RMW positively increased the value of the nutrients (Na, K) and the order of increase followed the trend of Mg. Though statistically the values of Na and K obtained in 24kg RMW and 18kg RMW, 12kg RMW and 6kg RMW, as well as 6kg RMW and Control were similar. The positive contribution of this amendment to exchangeable bases (Ca^{2+}, Mg^{2+}, Na+, K^+) contents relative to control was in agreement with the observation of Nwinyi (1977), who noted that organic wastes serves as a nutrient store from which basic cat ion are slowly released and constitute the soil exchange complex, being negatively charged and retained nutrient cat ions. Also in line with the findings of this study, Adeleye et al. (2010) reported that application of organic amendment increased soil exchangeable Mg, Ca, K, Na, and lowered exchangeable acidity. While Owolabi et al. (2003) showed that. OM tended to buffer soils and causes the release of exchangeable cat ions during mineralization of organic matter.

Table 2. Effect of different rates of rice mill waste on soil chemical properties.

Rates of RMW	Ca	Mg	Na	K	OC	%N	P	$P^H_{H_2O}$
0K	0.5	0.7	0.06	0.05	0.3	0.20	0.80	4.5
6Kg	0.9	1.60	0.13	0.09	0.75	0.50	6.30	5.2
12Kg	1.01	1.85	0.16	0.11	1.0	0.62	8.45	5.5
18Kg	1.19	2.05	0.20	0.14	1.2	0.75	10.40	5.9
24Kg	1.30	2.85	0.25	0.16	2.0	0.91	12.50	6.3
LSD0.05	0.50	0.73	0.08	0.04	0.14	0.22	0.71	0.50

RMW=Rice mill waste

The soil organic carbon (OC) Value obtained in the 24 Kg RMW rate was higher relative to other rates, while the order of increase in total N% was 24 KgRMW > 18 KgRMW > 12 KgRMW > 6

KgRMW > Control. However, statistically there was no significant difference between 24Kg and18Kg rates as well as 12Kg and 6Kg rates of RMW in the value of total N% recorded. The observed improvement in OC and total N in the treated Plots relative to control plots could be attributed to higher level of OC and total N in waste than the soil. The influence of the rice mill waste on the soil available P and soil P^H values varied among the rates and appreciated relative to the control rate. .There was increase in the values of available P and soil P^H following increase in the rate of application of RMW. The value of soil available P recorded among the rates showed that percentage increase in 24 Kg rate was 19.62 % higher than the 18 Kg rate, 47.95 % greater than the 12 Kg rate, 92.31 % higher than the value recorded in 6 kg rate and 1462.5 % higher than the control plot. The order of soil P^H increase was Control < 6 Kg RMW < 12 KgRMW < 18 KgRMW < 24 KgRMW. The higher P^H values observed in rice mill waste amended plots compared to the control might partially be due to the calcium supplied to the soil by the organic waste (Cooper and Warman, 1999). Also, the following authors; Odedina et al, (2003), Munecheru-Muna et al. (2007) and Mbah and Onweremadu (2009) reported increase in soil P^H in plots amended with organic wastes relative to control. Their works agreed with this study. The level of soil available P might have being influenced by the changes in soil P^H brought about by the application of rice mill waste, since the availability of phosphorous and its solubility is P^H dependent. Ozubor and Anoliefo (1999) reported that soils with low P^H value result to reaction of phosphorous with aluminum and iron to form complex compound such as aluminum phosphate (Al_2PO_4) and iron Phosphate (Fe_2 PO_4) which are fixed in the soil and not readily available for plant uptake. So in line with the findings of this study Mbah and Onweremadu (2009) reported significant increase in the soil available P level of the soils amended with organic wastes relative to the control plots. In support of these findings with regard to soil application of rice mill wastes, recent studies had shown that organic wastes increased soil organic matter, N, P^H, P, CEC exchangeable base and reduced soil exchangeable acidity (Adeniyan and Ojeniyi 2003, Ayeni et al 2008, Adeleye, 2010).

Effect of different rates of rice mill waste on maize growth and gain yield.

The rice mill waste was significant (P=0.05) for leave area index measured at 35, 65, and 95 days after planting. The value of leave area index obtained in 65 days in all the rates of RMW applied was highest comparable to the values obtained in 35 and 95 days (Table 3). The plots that received 24kg RMW gave the highest value of leave area index in 35, 65, and 95 DAP. The table equally showed that increasing the rates of application of rice mill waste led to an increase value of the leave area index in all the sampling date (35, 65, and 95 DAP) relative to control.

Table3 Effect of rice mill waste on leaf area index

Rates of RMW	Days after planting 35	65	95
0kg	12.30	21.98	18.60
6kg	16.40	24.76	20.50
12kg	20.58	25.52	22.94
18kg	20.97	26.69	21.33
24kg	21.14	29.44	23.29
LSD 0.05	0.61	1.09	2.80

RMW= Rice Mill Waste

Table 3 showed that increasing the rate of application of rice mill waste resulted to an increase in maize height with 24 kg RMW recording the highest maize height with a value of 168.5 cm. The differences in plant height recorded could be as a result of differences in plant nutrient in the rates of waste applied. This result is supported by the study of Njoku (2011), where rates of application of burnt and un burnt rice mill waste increased plant height relative to control. Increase in plant height following addition of organic amendment was also reported by Mbah et al. (2002), Sharma (2004), Obi and Ebo (1995b).

From the result (Table 4), 24 kg RMW recorded the highest value of grain yield with 5.20 kg. The result indicated that yield increased with increasing rates of rice mill waste. The higher grain yield observed in amended plots than the control could be attributed to higher content of nutrients in the rice mill waste than the soil.

Table 4. Effects of rice mill waste on plant height (cm) and Maize yield kg/ha

Rates of RMW	plant height (cm)	Maize yield kg/ha
0kg	119.8	3.20

6kg	129.3	3.80
12kg	155.8	4.30
18kg	153.8	4.70
24kg	168.5	5.20
LSD 0.05	NS	0.44

RMW=Rice Mill waste
NS=Non Significant

According to Zingore et al. (2003) soil productivity decline overtime due to continuous cultivation of tropical soils leading to mining of the soil nutrients. This might have contributed to the kind of result obtained from the control. Kumar and Mittal (2007) reported that increase in plant grain yield in waste amended plots was as a result of nutrients released by those wastes. Also Agboola (2003) stressing on the value of organic manure reported that it has been used to increase grain and herbage yields. Leng (2006), attributed yield increase resulting from the addition of organic manure to increase in cat ion exchange capacity (CEC) and to increase in water holding capacity which gave increase diffusivity and decreased resistance of soil to root penetration. Rice mill waste mineralized and released their nutrients gradually making them available to crops thereby enhancing their growth and grain production.

Conclusion

This study has shown that rice mill waste can be good amendment to improve soil nutrient status and thereby increase crop yields. The application of rice mill waste significantly increased soil chemical properties and maize grain yield relative to control. Increasing the rates of application of rice mill waste led to an increase in maize yield.

The rice mill waste are very cheap to get in the study area and it will save the farmer the cost of buying fertilizer that is exorbitant in price if found at all.

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