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Response of Upland Rice and Soil Chemical Properties to Formulated Organic Manures in Asaba, Delta State, Nigeria

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ABSTRACT
Response of upland rice and soil chemical properties to formulated organic manures evaluated at Teaching and Research Farm, Department of Agronomy, Delta State University, Asaba Campus for two cropping seasons. Five manures (FRH, RHW, RHCDW, RHC and RHCDC were formulated with rice husk and cowdung, and for twelve weeks. Water and cassava mill effluent used were also added during turning at weekly interval and were applied at 5 t ha^{-1}. The experiment was layout in randomized complete block design with four replicates. New rice for Africa was used as test crop, and height, number of leaves, total leaf area, plant girth, dry matter and rice yield were measured while soil pH, organic matter, total N, available P and exchangeable bases were determined after harvest. Data collected were subjected to analysis of variance, mean differences were separated with DMRT at 5% level of probability. The result shows that RHCDC had highest number of leaves and total leaf area while RHCDW had highest plant height, plant girth, dry matter and rice yield. Both were not significantly different, but significantly higher than other manures. All the manures improved soil chemical properties, therefore it can be concluded that RHCDW is more effective in Asaba and its environment.
Key words: Rice husk, organic fertilizer, upland rice, soil chemical properties, cowdung

INTRODUCTION

Rice is the second important cereal in the world after wheat in terms of production (Jones, 1995). West Africa is the leading producer and consumer in Sub-Saharan Africa (WARDA, 1996) while Nigeria is the highest producer and consumer of rice in the Sub-region with figures slightly above 50% (WARDA, 1996). Despised these, the yields have been consistently low on farmers' farms in the face of ever increasing cost of fertilizers, and increase demand of the product. To worsen the problem, inorganic fertilizers are not available and also adulterated products find their way into the market. Farmers now have no option than to source for locally made and easily available material as source of nutrient to sustain crop production. This is important to boost the productivity and quality of rice. Also, this type of fertilizer is environmental friendly and easily affordable unlike the inorganic form. Therefore, the objective of this study is to determine the effects of organic manure formulated differently on rice yield and soil chemical properties.

MATERIALS AND METHODS

The field experiment was conducted at the Teaching and Research Farm, Department of Agronomy Delta State University, Asaba Campus for two cropping seasons (2008 and 2009). The site is situated in the rainforest zone, with longitude 6^0 14^I E and latitude 6^0 14^I N. It has a bi-modal rainfall pattern, the rainy season runs between mid March and mid November while the dry seasons runs from late November to the end of March. The land was previously grown to cassava, maize and yam on a continuous basis and no record of fertilizer application. Rice husk water without cowdung (RHW); Rice husk cassava mill effluent without cowdung (RHC); Rice husk/cowdung/water (RHCDW) and Rice husk/cowdung/ cassava mill effluent (RHCDC). Water and cassava mill effluent were added during turning at weekly interval for twelve weeks. Rice husk fresh (FRH) was applied to compare the effects of composting on the manure. This bring the manure types to five and were applied at 5 t ha^{-1}. The manures were spread and incorporated into the soil with hoe and spade during seed bed preparation two days before sowing. Seven seeds of New Rice for Africa used as test crop were sown and later thinned to four per stands two weeks after sowing. The manures were formulated with rice husk (RH) and cowdung (CD) mixture in ratio 7:3 by weight:

Randomized complete block design (RCBD) was used, the plot measured 23m by 19m with four replicates, each sub-plot size was 3m by 4m and plant spacing of 25 cm by 30 cm was used. Data collection on growth parameters started three weeks after sowing and subsequently on weekly basis while yield parameters were measured after harvest. These includes: plant height (cm), number of leaves, plant girth (cm), total leaf area (cm^2), number of tillers, dry matter and rice yield (t ha^{-1}). Soil sample for pre-planting soil analysis was randomly collected from the experimental plot before seed bed preparation while the soil samples for post planting soil chemical analysis were taken from each sub-plot. The soil samples were air dried at room temperature and sieved with 2mm sieve before analyses. Soil parameters considered were: Soil pH, organic matter, total nitrogen, available phosphorus and exchangeable bases. The soil pH was on a ratio of 1:2 soil/water suspensions (IITA, 1979). Organic carbon was determined using the Walkley Black Method. Exchangeable bases- K, Ca. Mg and Na were extracted by ammonium acetate extraction. The Ca and Mg were determined by Atomic Absorption Spectrophotometer (AAS) while K and Na were read using Flame Photometer. The available P was extracted using Bray-1 extracting solution and further reading was carried out Colormetrically. Total N was determined by the Kjeldhal distillation method. The data obtained were statistically analyzed using the Analysis of Variance. Duncan Multiple Range Test (DMRT) at 5% level of probability was used to separate differences among treatment means.

RESULTS

Particle size distribution and chemical properties of pre-planting soils

The nutrient content of the soil before planting is shown on Table 1, the soil was sandy clay loam, acidic and low in organic matter, total N, and available P. Also, it was low in exchangeable bases except K that was moderate, low effective cation exchange capacity and had high base saturation.

Effects of the manure on growth and yield of rice

Plant Height: Table 2 shows the effects of manure on plant height, there were gradual increases of plant height with increase of weeks after sowing (WAS) in both seasons. No significant differences ($p<0.05$) among the manures at 4 to 7 WAS. Manures treated plots were significantly taller than the control, although the control plant grew taller at the early stage especially in first season. At 4 WAS, RHCDW had the tallest height (25.34 cm), while at 5 and 6 WAS, RHC had the tallest plant (31.16 and 37.14 respectively). The RHCDW type had the tallest plant from 7 to 10 WAS while RHCDW and RHCDC had similar plant height at 11 WAS. In the second season, RHCDW maintained the tallest plant height except at 5 WAS that it was similar to RHCDW. Rice grown with all the manures were significantly taller than the control.

Table 1: **Particle size distribution and chemical properties of pre-planting soils**

Parameter	values
pH (H_2O) 1:2	5.0
Organic matter (gkg^{-1})	1.5
Total Nitrogen (gkg^{-1})	0.6
Available P ($mgkg^{-1}$)	7
Exchangeable bases (cmol kg^{-1})	
K	0.3
Mg	1.3
Ca	1.2
Na	0.1
Exch. Acidity	0.6
ECEC	3.5
BS %	82.9
Particle Size (gkg^{-1})	
Sand	680
Silt	90
Clay	220
Textural Class	**Sandy clay loam**

Table 2: Effects of the organic manures on plants height (cm)

	Weeks after sowing								
Organic manures	3	4	5	6	7	8	9	10	11
2008									
Control	19.3a	24.5a	29.1a	31.5a	35.0a	37.1b	40.4b	43.4b	46.3b
FRH	18.0b	24.8a	28.4a	32.4a	36.9ab	42.0ab	47.2ab	52.0a	56.4a
RHW	18.0b	24.4a	30.5a	35.6a	42.2a	46.8a	51.7a	56.9a	62.0a
RHC	16.9c	23.3a	31.2a	37.1a	41.7a	47.4a	52.2a	56.9a	62.8a
RHCDW	18.6a	25.3a	30.6a	36.1a	42.6a	48.2a	53.0a	58.2a	64.0a
RHCDC	17.6c	24.9a	30.5a	36.2a	40.7ab	46.8a	52.2a	58.1a	64.0a
2009									
Control	20.1c	22.3c	24.2d	28.4d	33.0d	37.2d	40.9d	42.3d	44.1d
FRH	24.7a	30.1a	34.8b	40.2b	46.7b	52.8b	58.3b	64.4b	69.4b

RHW	23.9b	29.4b	34.9b	40.5b	46.5b	52.1b	55.7c	62.3c	67.5c
RHC	23.0b	29.3b	33.0c	40.0b	45.9c	51.4b	57.4b	62.4c	68.4b
RHCDW	24.9a	31.5a	36.1a	44.0a	50.3a	57.0a	63.7a	70.3a	77.6a
RHCDC	24.6a	30.6a	36.1a	38.6c	44.7c	50.0c	57.1c	63.2b	68.3b

Mean within each column with the same letters are not significantly different (P < 0.05) DMRT

Legend
Fresh rice husk (FRH)
Rice husk with water (RHW)
Rice husk + Cow dung with water (RHCDW)
Rice husk with cassava mill effluent (RHC)
Rice husk + cow dung with cassava mill effluent (RHCDC).

Plant girth: Table 3 shows effects of the manures on plant girth from 3 to 11 WAS, it general increased with increase in WAS, except the control that had similar plant girth at both years. Significant differences occur all the weeks (p<0.05) except at 5 and 6 WAS in the first year. Also at 3, 4 and 5 WAS, the control had the highest plant girth while at 6 to 11 WAS, RHCDC had the highest plant girth while the control was 0.24 cm. In the second year, control had the highest plant girth at early stage, RHCDW and RHCDC at 9 and 10 WAS while at 11 WAS, RHCDW had the highest plant girth (0.45 cm).

Total leaf area: Table 4 shows effects of the manures on total leaf area, RHCDC had the largest total leaf area (117.9 cm^2) in the first season. Also, RHCDC had the largest leaf area (120.2 cm^2) at the second season, but it was not significantly different from RHCDW. The least was observed from control treatment (90.7 cm^2)

Table 3: Effects of the organic manure on plants girth (cm)

	Weeks after sowing								
Organic manure	3	4	5	6	7	8	9	10	11
2008									
Control	0.19a	0.23a	0.24a	0.24a	0.24b	0.24c	0.24d	0.24c	0.24d
FRH	0.15b	0.17b	0.20a	0.23a	0.27ab	0.29b	0.31c	0.34b	0.35c
RHW	0.12c	0.14cd	0.19a	0.24a	0.27a	0.29b	0.32bc	0.33b	0.35c
RHC	0.12c	0.13d	0.18a	0.24a	0.28a	0.30ab	0.32bc	0.35ab	0.37bc
RHCDW	0.14b	0.16bc	0.20a	0.25a	0.28a	0.31ab	0.36ab	0.38a	0.40ab
RHCDW	0.15b	0.17b	0.23a	0.26a	0.29a	0.34a	0.37a	0.39a	0.41a
2009									
Control	0.19a	0.21a	0.23a	0.23b	0.23c	0.23c	0.23d	0.23d	0.24d
FRH	0.18b	0.21a	0.22b	0.26a	0.29a	0.32a	0.34b	0.36c	0.38bc
RHW	0.18b	0.20b	0.22b	0.25a	0.28ab	0.31ab	0.33bc	0.36bc	0.39b
RHC	0.18b	0.20b	0.22b	0.25a	0.29a	0.31ab	0.34b	0.37b	0.40b
RHCDW	0.19ab	0.21a	0.23a	0.26a	0.29a	0.32a	0.36a	0.39a	0.45a
RHCDC	0.18b	0.19c	0.22b	0.26a	0.29a	0.32ab	0.36a	0.39a	0.44a

Mean within each column with the same letters are not significantly different.(P < 0.05) DMRT

Table 4: Effects of the organic manure on total leaf area (cm^2)

	Weeks after sowing							
Organic manures	4	5	6	7	8	9	10	11
2008								
Control	32.2c	36.8d	42.1a	52.9b	60.2b	68.6b	78.7b	90.7b
FRH	36.7b	43.5b	52.7a	62.7ab	72.3ab	83.3ab	94.7ab	104.3b
RHW	32.0c	39.4c	48.5a	58.9ab	72.5ab	84.3ab	95.8ab	110.6b
RHC	34.4c	42.3b	53.8a	67.1a	75.5ab	93.9a	105.4a	114.5ab
RHCDW	38.3b	50.0a	54.4a	64.5ab	76.8a	90.9a	102.9a	115.2ab
RHCDC	40.0a	48.5a	54.5a	70.4a	85.2a	96.2a	106.3a	117.9a
2009								
Control	30.1d	33.2c	38.3d	42.5f	48.2d	56.7c	64.1e	68.8e
FRH	39.6a	45.7b	54.8b	63.9d	74.1b	85.3b	96.6d	105.4c
RHW	36.0c	42.4b	48.5c	59.9e	71.5c	84.8b	95.8d	110.6d

RHC	38.4a	44.3b	53.8b	68.1c	77.5b	83.9b	95.4c	109.5b
RHCDW	40.3a	52.0a	64.4a	75.5a	87.8a	96.9a	110.9a	118.6a
RHCDC	41.0a	51.5a	64.5a	72.4a	88.2a	97.2a	106.3b	120.2a

Mean within each column with the same letters are not significantly different (P< 0.05) DMRT

Number of tillers: Effects of the manures on number of tillers per plant are presented on Table 5. First season, the control, FRH and RHW had no tiller while RHC, RHCDW and RHCDC produced one tiller each. Second season, RHCDW and RHCDC had 3 tillers each, RHW had two (2) tillers while FRH and RHC produced 1 tiller each. The control had no tiller development at both years.

Dry matter yield: Table 5 shows effects of the manures on dry matter yield after harvest. There were significant differences among the organic manures which produced significantly higher dry matter yield than the control. First year, the best organic manure (RHW) was only significantly different from FRH and control treatment. It produced 5.07 t ha^{-1} of dry matter while control produced 2.92 t ha^{-1}. No significant differences among RHCDC, RHC and RHW. Second year, RHCDC produced the highest dry matter (6.7 t ha^{-1}), while the least was the control (2.67 t ha^{-1})

Rice yield: Effects of the manures on rice yield after harvest were shown on Table 5. There were significant differences among the manures. All the manures were significantly higher than the control. During first cropping season, RHCDW produced the highest rice yield while the least was control (2.05 and 1.05 t ha^{-1} respectively). The RHCDW treatment was significantly different from FRH, RHC and control. Second cropping season, RHCDW produced the highest rice yield (2.36 t ha^{-1}), while control had the least (0.95 t ha^{-1}).

Table 5: Effects of the organic manure on number of tillers, dry matter and rice yield

		t ha^{-1}	
Organic manures	Num.of tillers/plant	Dry Matter	Rice yield
2008			
Control	0b	2.92c	1.05c
FRH	0b	4.77b	1.73b
RHW	0b	5.03ab	1.80ab
RHC	1a	4.85ab	1.87b
RHCDW	1a	5.07a	2.05a
RHCDC	1a	4.97ab	2.00ab
2009			
Control	0c	2.67d	0.95d
FRH	1c	5.33c	2.03c
RHW	2b	5.31b	2.14b
RHC	1c	5.44b	2.15b
RHCDW	3a	6.56a	2.36a
RHCDC	3a	6.70a	2.34a

Treatments mean within each column with the same letters are not significantly different (P< 0.05) DMRT

<u>Legend</u>
Fresh rice husk (FRH)
Rice husk with water (RHW)
Rice husk + Cow dung with water (RHCDW)
Rice husk with cassava mill effluent (RHC)
Rice husk + cow dung with cassava mill effluent (RHCDC).

Effects of the manures on soil chemical properties after harvest

Soil pH: There were manures effects on soil pH (Table 6). All the manures had higher value of soil pH than the control. At first year, RHCDC and RHCDW had the highest effects while the least was FRH. Second year, though RHCDC and RHCDW were not significantly different but RHCDC had the highest soil pH value (5.8). Both had higher effects on soil pH than RHC, RHC and FRH.

Organic matter: All the manures improved soil organic matter than the control. First year, RHCDW had highest effects on soil organic matter (3.0 gkg^{-1}) while RHC, RHW and FRH had equal organic matter (2.7 gkg^{-1} each). Second year, RHCDW had highest organic matter (11.1 gkg^{-1}) while the least was FRH (10.0 gkg^{-1}).

Total nitrogen: Total nitrogen was not improved after harvest at the first year. The RHCDW treatment had highest total nitrogen (0.7 gkg^{-1}), the other manures had 0.6 gkg^{-1} each while the control was the least (0.5 gkg^{-1}). The second year, RHCDW also had the highest total nitrogen (1.3 gkg^{-1}), it was not significantly higher than the other manure types. The control was the least (0.5 gkg^{-1}).

Available phosphorus: Pronounced differences among the manures were observed and also, all the manure improved available phosphorus than the control (6 $mgkg^{-1}$). The first year, RHCDC had the highest available P (10 $mgkg^{-1}$) while the least was RHW (7 $mgkg^{-1}$). In the second year, significant differences were observed, the manures significantly had higher available phosphorus than the control. The RHCDW treatment had highest available phosphorus (13 $mgkg^{-1}$) while FRH had the least phosphorus among the manure types (10 $mgkg^{-1}$), but it was only significantly higher than control (5 $mgkg^{-1}$).

Exchangeable bases: Exchangeable K content of treated soils were slightly higher than the control in first year. The RHW, RHC and FRH treatments had 0.3 $Cmolkg^{-1}$ each while RHCDC and RHCDW had 0.2 $cmolkg^{-1}$. All the manures were significantly different ($p<0.05$) from the control in second year. The RHW, RHC and FRH had 0.5 $cmolkg^{-1}$, RHCDC and RHCDW treatments had 0.4 $cmolkg^{-1}$ each while the least was control (0.1 $cmolkg^{-1}$).

The manure types were significantly, in first year, FRH had the highest calcium (1.9 $cmolkg^{-1}$) while the least was control 1.1 $cmolkg^{-1}$). The second year, no significant differences ($p<0.05$) among the manure types but all had higher Ca than the control. The RHW and RHCDC had 4.0 $cmolkg^{-1}$ while the control had 1.0 $cmolkg^{-1}$.

In first year, RHCDC, RHCDW and RHC had equal value of exchangeable Mg (2.3 $cmolkg^{-1}$) while FRH and RHW had 2.2 $cmolkg^{-1}$ each. The control had 1.2 $cmolkg^{-1}$. At the second year, RHCDW had the highest exchangeable Mg (3.4 $cmolkg^{-1}$), it was only significantly different ($p<0.05$) from control with value of 1.1 $cmolkg^{-1}$.

The manure types also increased Na in first year, RHC and RHCDC had the highest Na (0.3 $cmolkg^{-1}$) while the lowest among the manure was RHW (0.1 $cmolkg^{-1}$). The control had 0.09 $cmolkg^{-1}$. Second year, there were no significant differences ($p<0.05$) among manures but all the plant grown with the organic manures had significantly higher Na than the control. The RHCDC, RHCDW and RHC treatments had equal exchangeable Na (0.3 $cmolkg^{-1}$) while RHW and FRH also had equal value of 0.2 $cmolkg^{-1}$, the control had 0.08 $cmolkg^{-1}$.

All the manures had higher effective cation exchange capacity than the control. In first year, RHC had highest ECEC (5.3 $cmolkg^{-1}$) while the least was control (3.3 $cmolkg^{-1}$). The second year, RHCDC had the highest value of ECEC (6.7 $cmolkg^{1}$) while the least was the control (3.2 $cmolkg^{-1}$). Percentage base saturation was also high, first year, it ranges from 78.7% to 88.7% while in second year, and it ranges from 76.5% to 92.4%.

Table 6: **Effects of the organic manure on post soil chemical properties**

Organic manures	pH (H_2O)	OM (g/kg^{-1})	N (g/kg^{-1})	P ($mgkg^{-1}$)	K (cmolkg^{-1})	Ca (cmolkg^{-1})	Mg (cmolkg^{-1})	Na (cmolkg^{-1})	Ex A. (cmolkg^{-1})	CEC (cmolkg^{-1})	BS (%)
2008											
Control	5.1c	1.5a	0.5a	6d	0.2a	1.2b	1.2b	0.09c	0.7a	3.3b	78.7c
FRH	5.3a	2.7a	0.6a	8bc	0.3a	1.9a	2.2a	0.2a	0.6a	5.2a	88.5a
RHW	5.4a	2.7a	0.6a	7c	0.3a	1.3b	2.2a	0.1b	0.6a	4.5a	86.7ab
RHC	5.4a	2.9a	0.6a	9b	0.3a	1.8a	2.3a	0.3a	0.6a	5.3a	88.7a
RHCDW	5.5a	3.0a	0.7a	9b	0.2a	1.7a	2.3a	0.2a	0.6a	5.0a	88.0a
RHCDC	5.5a	2.7a	0.6a	10a	0.2a	1.8a	2.3a	0.3a	0.6a	5.2a	88.5a
2009											
Control	4.9c	1.5a	0.5b	5d	0.1b	1.0b	1.1c	0.08b	0.7b	3.0b	76.5c
FRH	5.4b	10.0a	0.9a	10bc	0.5a	2.1a	2.8a	0.2a	0.6a	6.2a	90.3a
RHW	5.4b	10.1a	1.0a	11ab	0.5a	2.2a	3.1a	0.2a	0.5a	6.4a	92.2a
RHC	5.5b	11.4a	1.0a	13a	0.5a	2.1a	3.2a	0.3a	0.5a	6.6a	92.4a
RHCDW	5.7a	11.1a	1.3a	12a	0.4a	2.0a	3.4a	0.3a	0.5a	6.6a	92.4a
RHCDC	5.8a	10.6a	1.2a	11ab	0.4a	2.2a	3.2a	0.3a	0.6a	6.7a	91.0b

Treatments mean within each column with the same letters are not significantly different (P< 0.05) DMRT

Legend
Fresh rice husk (FRH)
Rice husk with water (RHW)

Rice husk + Cow dung with water (RHCDW)
Rice husk with cassava mill effluent (RHC)
Rice husk + cow dung with cassava mill effluent (RHCDC).

DISCUSSION

Fertility level of the study area was low, this resulted in a good response of applied manure. Mixing rice husk with cowdung increased the rate of mineralization with release of nutrient for plant absorption. This finding is in line with work of Adeoye *et al*. (2005) who mixed rice husk, cowdung and poultry droppings separately. There were better performances of plants receiving manure types compared to the control. Rice husk amended with cowdung using either water or cassava mill effluent promoted the growth and yield of rice. At the early growth stage, no significant differences and also the control treatment performed better than all the organic manure types. This could be a result of initial immobilization of nutrient and slow release of nutrient which led to yellowish colouration of leaves. Similar observations were made by Sakala *et al*. (2000) and Adeoye *et al*. (2005). Microorganisms decomposing the organic manure initially take up available soil nutrient (especially N) for their growth, leading to a decreased supply for rice growth during the initial stage of decomposition. This implies that application of organic manure increases the initial need for nutrient but during later stages of rice growth it decreases the need for nutrient (Thur *et al*., 2008). Nutrients are often released from organic sources at time when there is little crop uptake (Bouman *et al*., 2002 and Sharpley *et al*., 1998), and furthermore, Ofosu-Anin and Leitch (2009) observed that the amount of nutrient mineralized from organic sources in the cropping season provides a major portion of the plants nutrient needs. Under optimum temperature and moisture conditions, nutrient immobilization can last about four to six weeks after application (Krishna *et al*., 2004). The yellowish coloration observed was more severe at the first cropping than second season. This could be attributed to the residual effects of the organic manure applied during the first season. Blackmar (1997) reported from his finding that decomposition of organic residues results in a short term depletion of the plant available nutrient supply, and substantial decrease in nutrient availability for the first crop but will increase the nutrient supplying power of the soil in years to come.

The soil was found to be sandy loam, acidic, low organic matter, total N, available P, exchangeable bases and high base saturation, indicating low level of fertility. The low fertility could be attributed to continuous cultivation without accompanied proper soil amendment over the years. The soil pH is within the range for proper rice growth (Kamprath, 1970). It has been reported that decreased soil organic matter and low plant nutrients are the key factors responsible for the observed declining trend in rice-based cropping system (Peddy and Krishnainh, 1999). The poor fertility is a major characteristic of the tropical soil (Tolessa, 1999). Anikwe *et al*. (1999) attributed the poor fertility status of the soil to continuous cropping which makes the soil highly vulnerable to soil degradation. The manure types reduced soil acidity more than the control, they acted as neutralizing agent of acidic soil during and after decomposition. This result was in harmony with the findings of Okonkwo (1991) and Adediran *et al*. (2006), who stated that organic matter after decomposition increase soil pH. The soil organic matter was enhanced significantly the second year, this could be attributable comparatively to high biomass produced due to application of the manure types (Sawar *et al*., 2003 and Singh *et al*., 2001). Also, the manure accumulates in form of humus during and after decomposition. The total nitrogen of all the manure types was generally low the first season, but by second season, it improved. The low level could be as a result of slow release of N from organic material and low nitrogen use efficiency of manure (Cadish and Giller, 1997). The movement of some part of organic nitrogen to organic matter pool could also lead to the poor nitrogen use efficiency while the increase in nutrient elements after the second year could be as a result of slow and gradual decomposition of manure types which serves as readily available nutrients (Tisdale and Nelson, 1975 and Ali *et al*., 2007). Available phosphorus in treated soil was higher than the control, this could be a of result organic acid released during mineralization of phosphorus which prevent P fixation. As mineralization of organic manure occurs, organic acids are released into the soil solution which reduces Al-toxicity (Noble *et al*., 1996). In addition, increase in the quantities of exchangeable bases could be as a result of the decomposed organic manure which serves and as well acting as solubilizing agents for salts in the soil (Ali *et al*., 2006).

In conclusion, all the formulated manure types improved rice yield and soil chemical properties than the control treatment. Though, no significant differences between RHCDC and RHCDW, they were higher significantly than the other treatments. In addition, RHCDW had the highest rice yield, therefore it could be recommended for farmers in Asaba and its environment. But the different levels of the organic manure application should be evaluated.

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