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Research Article

EFFECT OF CURED RUMINANT INTESTINAL TRACT ORGANIC WASTES ON SOIL CHEMICAL PROPERTIES AND THE YIELD OF MAIZE (*ZEA MAYS* .L.) IN ABAKALIKI

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ABSTRACT
Inorganic fertilizers are expensive and scarce, modern farming places emphasis on organic farming because organic wastes can supply virtually all the nutrients required by plants for effective growth and yield through improved chemical properties for sustainable crop production and environmental hygiene .It was based on the above that a study was conducted at the Teaching and Research Farm of the Faculty of Agriculture and Natural Resources Management to study the effect of cured Ruminant intestinal tract organic waste (CRITOW) on soil chemical properties and the yield of maize during the 2011 planting seasons. The treatments used were different rates of cured Ruminant intestinal tract organic waste at 0, 3, 6 and 9 t.ha^{-1} treatment levels. The experiment was laid out in a Randomized Complete Block Design (RCBD) with five replications and four treatments. The chemical properties analyzed were soil pH, available phosphorus, %total nitrogen, exchangeable base (Ca, Ma, K and Na), exchangeable acidity, base saturation, zinc, iron, copper, chromium, lead and cadmium. While the yield parameter of maize measured were weights of cub, line of cub, length of cub, and diameter of cub and grain yield. The results revealed that the low pH of 5.49, lowest organic matter content of 1.88% and, the lowest total nitrogen and available phosphorus were observed in the control, While the highest pH, Organic matter content and available phosphorus was observed in 9t/ha Ruminant intestinal tract waste treated plots. Exchangeable acidity, ECEC and base saturation were all significantly affected by the treatments. Zinc, iron, copper, chromium, lead, cadmium was also significantly affected by the treatments. There was significant difference in the diameter of cub while the other measured crop parameters showed no significant difference.

Key Words: *Maize Yield, Chemical Properties, Heavy Metals, Abakaliki, Southeast*

INTRODUCTION
Soil fertility is the bedrock for bumper harvest, food security and economic empowerment of farmers. In the past, soil fertility was maintained in Southern eastern Nigeria through prolonged bush fallowing of 5 to 10years (Unamma *et al.*, 1985). However, increase in population and food insecurity has removed fallow in most places while it resulted in reduced fallow periods in places like Ekoli Edda southeast Nigeria.
Continuous cropping on a piece of land without adequate use of chemical fertilizers or organic manures lowers oil fertility and crop yield (Agboola and Odeyemi, 1972). Inorganic fertilizers are expensive and scarce, modern farming places emphasis on organic farming because organic wastes can supply virtually all the nutrients required by plants for effective growth and yield through improved soil physical, chemical and biological properties for sustainable crop production and environmental hygiene (FAO, 1976).
Continued cultivation of farmland can gradually decrease the organic matter content of the soil, soil macro and micro nutrients, and soil water and soil structure. The deterioration of these properties can decrease soil fertility and invariably affect crop yield negatively. Deteriorated soil can be returned to a productive state by the application of adequate organic and/or inorganic fertilizers to argument the loss in fertility of the soil. It is as a result of these that the need for the use of cured Ruminant Intestinal Tract

Organic Waste (CRITOW) called rumen digesta was explored as a credible alternative to the costly and not readily available chemical fertilizers.

Maize is ranked third after wheat and rice in the world production of cereal crop (Onwueme and Sinha, 1991) and a common crop in the tropics being able to tolerate draught conditions. It is because of the above good attitudes of maize that it is used as a test crop in an experiment to determine the effect of cured ruminant intestinal tract organic wastes on soil chemical properties and its effect on maize yield.

MATERIALS AND METHODS

Site Description

The research was carried out at the Teaching and Research Farm of the Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki. The State is located within latitude $06^{0}4^{1}$N and longitude 08^{0} $6S^{1}$ E of South East derived savannah zone of Nigeria. The rainfall pattern is bimodal spreading between April and November with peaks in July and September.

Total annual mean rainfall was 1750mm while the annual minimum and maximum rainfall range from 17000mm to 18000mm. The temperature ranged from 27^{0}C to 31^{0}C for night and day temperatures respectively during the period. Relative humidity was high at 80% during rainy season and declines during the dry season to less than 65% (Ofomata, 1975). The soil is a product of successive marine deposits from ASU River belonging to the order ultisol classified as typic haplustult (FDALR, 1985).

Field layout and Treatment Allocation

The experimental field measured 14m wide and 9.5m long giving a total land area of $123.5m^{2}$. Raised bed was used and manually tilled using hand hoe. The experimental field was divided into five main blocks with 1m alley between the blocks. Each of the five blocks was further divided into four equal parts with 0.5m alley between each plot along the block. Each plot measured 2 x 2m. Each treatment was replicated 5 times to give a total plot number of 20. Cured Ruminant Intestinal Tract Organic Waste (CRITOW) at 0, 3, 6 and 9 $t.ha^{-1}$ rates were incorporated into treatment plots and left for one week to stabilize. The treatments were applied to the plots randomly using random numbers.

Planting

The maize variety Oba Super 2 was used as the test crop .Planting was done by direct seeding on the marked beds, at a plant spacing of 50cm x 50cm. Three (3) seeds were sown per hole at a depth of 1.5 to 2.0cm which was later thinned down to 2 stands per hole at 2 weeks after planting to give a total of 80,000 stands per hectare. Weeding was done by handpicking and the use of Atrazine herbicide for the control of weeds. Zero point two five grams (0.25g) of furan 3G was used at 49 days after germination to control steam borer, leafhopper and other diseases.

Harvesting

Harvesting was done at brown maturity of the undehusked cubs Harvesting was by hand picking from the tagged plant. Harvested cobs were dehusked and stabilized at a moisture content of 12%.The following yield parameters were determined: Weight of cub was recorded using measuring scale; the length and diameter of the cub were recorded using measuring tape; number of line on the cub was counted from the cub.

Soil Sampling

A composite soil sample was collected from the site at a depth of 0-30cm with soil auger attached to a core sampler, before planting and after harvesting the crop. These were used for analysis of the chemical and heavy metal concentrations of the soil. The samples were collected randomly to ensure uniform representativeness of the composite sample. The auger samples were analyzed to determine the following soil chemical properties. Soil pH was determined using 1:25ml soil water solution (Maclean, 1982). Total nitrogen was determined by Kjeldahl digestion and distillation method described by Bremner and Mulvaney (1982). Organic matter was determined by the multiplication of 1.724 with organic carbon. Phosphorus was determined by Bray and Kurtz No ii method. Exchangeable captions (Ca, Mg, K, and Na) was extracted with ammonium acetate (NH_4OAC (pH7) and the filtrate was determined by Perkin

Elmer absorption spectrometer (IITA, 1979). The Effective cation exchange capacity (ECEC) was obtained by summation of total exchangeable (AI^{+}+ H^{+}) acidity and total exchangeable bases (TEB). Base saturation was obtained by calculation. Heavy metals (Zn, Fe, Cu, Cr, Pb, and Cd) were determined using atomic adsorption spectrophotometer (AAS) according to IITA (1979).

Experimental Design and Data Analysis

The experiment was laid out in Randomized Complete Block Design (RCBD) with 4 treatments and 5 replications. Data collected from the field was analyzed using analysis of variance (ANOVA). Treatment means was tested for significance using fishers least significance difference (F-LSD) as recommended by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The pre-planting chemical properties of the experimental soil sample are presented in table 1.

Table 1: Pre-planting soil results

Parameters	Units	Value
pH		5.4
P	Mg/kg	27.00
N	%	0.11
OM	%	1.89
Ca	$Cmol.kg^{-1}$	4.20
Mg	$Cmol.kg^{-1}$	2.01
K	$Cmol.kg^{-1}$	0.11
Na	$Cmol.kg^{-1}$	0.02
ECEC	$Cmol.kg^{-1}$	2.19
BS	%	8.35
Zn	$Cmol.kg^{-1}$	21.96
Fe	$Cmol.kg^{-1}$	16.40
Cu	$Cmol.kg^{-1}$	3.96
Cr	$Cmol.kg^{-1}$	0.61
Pb	$Cmol.kg^{-1}$	3.01
Cd	$Cmol.kg^{-1}$	0.89

Table 1 showed that the soil pH was 5.4, the phosphorus concentration in the soil is medium, the nitrogen in the soil is low, the % organic carbon is 1.09 with % organic matter 1.89 which is low, which means the organic carbon in the soil low. All these are being rated using (Landon, 1991) rating for chemical properties of the soil.

According to Landon (1991) ratings for different exchangeable cations, Calcium with mean value of 4.20 shows that it is low, Magnesium with mean value 2.01 is moderate, potassium is very low, sodium is very low. The exchangeable acidity of the soil which is the aluminum and hydrogen ion concentration in the soil is 2.19 and considered acidic.

The ECEC of the soil has a mean value of 8.35. The micronutrient and heavy metals in the soil are as follows all within permissible limit: The results (Table 1) showed that the soil needs to be amended in order to improve its fertility status for a better productivity.

Effect of RITOW on Soil Chemical Properties

Effect of cured ruminant intestinal tract organic waste (CRITOW) on soil pH, %organic matter, total nitrogen and available phosphorus is presented in table 2.There was improvement in the soil pH when the result of the control was compared with the treatments, and when T2 was compared with T4. There was no significant difference when T2 was compared with T3 and when T3 was compared with T4. Soil acidity was 0.29, 0.23 and 0.14 units lower in T2, T3 and T4 respectively when compared with T1 and 0.15 units lower in T4 when compared with T2. The

Cured ruminant intestinal tract organic waste in decomposition may have released exchangeable cations in to the soil. The released ions at the exchange site will replace hydrogen and aluminum ions thereby lowering the acidity of the soil. The acidity when 9t/ha was applied falls within soil pH range for the cultivation of arable crop such as maize.

Table 2: Effects of cured ruminant intestinal tract organic waste (CRITOW) on Soil PH, %organic Matter available phosphorus and total Nitrogen

Treatment	pH in H_2O	% Organic matter	Total Nitrogen %	Available Phosphorus $Cmol.kg^{-1}$
Control	4.49	1.88	0.13	23.51
3t/ha	5.20	2.22	0.11	25.48
6t/ha	5.26	3.11	0.13	27.62
9t/ha	6.35	3.70	0.27	29.51
f-LSD(P =0.O5)	0.12	0.20	NS	3.48

Percent Organic Matter

There was high improvement in soil % organic matter when the result of the control was compared with the plots that relieved CRITOW treatment. There were also significant differences in the percent organic matter content among the plots treated with the cured Ruminant Intestinal Tract Organic Waste (CRITOW). There was 34, 128, 182% more organic matter in T2, T3 and T4 respectively when compared with the control. Furthermore there were 89 and 148% increases in organic matter content when T3 and T4 were compared with T2 respectively. Treatment 4 produced 59% more organic matter then T3. This trend in organic matter build up is understandable. This is because the more organic matter that is added to the soil all things been equal the more it is expected to be found in the soil.

Available Phosphorus

The soil available phosphorus improved significantly when the control treatment was compared with the CRITOW treatment at the different levels. The Cured Ruminant Intestinal Tract Organic Waste (CRITOW) treatment levels did not show significant differences at all levels. Cured ruminant intestinal tract organic waste at 3 and 6t/ha did not difference from the control significantly; and T2 did not difference from T3 and T3 did not difference from T4 significantly. The application of cured ruminant intestinal tract organic waste at 9 $t.ha^{-1}$ increased soil available phosphorus by 6 $Cmol.Kg^{-1}$ when compared with the control plot which did not receive any cured ruminant intestinal tract organic waste treatment. Again there was 4.03 $Cmol.kg^{-1}$ higher content of available phosphorus in the plots treated with 9t/ha CRITOW when compared with 3t/ha rate of application. This result agrees with the result Ekpe, 2011 when fresh rumen digesta was used to improve on the chemical properties of an acid soil. The trend of improvement is consistent in this result. The decomposition of organic compounds in the soil is slow but steady when the right environmental conditions and the right C/N ration are guaranteed.

Effect of Rumen Digesta on Soil Exchangeable Bases

Effect of cured ruminant intestinal tract organic waste treatment on soil exchangeable bases is presented in table 3.

Table 3: Effect of cured Ruminant intestinal tract organic waste (CRITOW) on Calcium, Magnesium, Potassium and Sodium

Treatment	Calcium Cmol.kg^{-1}	Magnesium Cmol.kg^{-1}	Potassium Cmol.kg^{-1}	Sodium Cmol.kg^{-1}
Control	2.35	2.03	0.13	0.07
3t/ha	4.07	2.11	0.14	0.14
6t/ha	4.64	3.19	0.14	0.15
9t/ha	4.95	4.10	0.24	0.16
F-LSD(p=0.05)	0.24	0.34	NS	NS

Calcium

There was statistically positive significant improvement in soil exchangeable calcium (Ca) when the result of the control was compared with the treatments and when the different treatment levels were compared with one another. There was 1.72, 2.29 and 2.6 Cmol.kg^{-1}more in soils treated with 3, 6 and 9 t.ha^{-1} CRITOW respectively than the control plots. There was also 0.57 and 0.88 Cmol.kg^{-1}more Ca in 6 and 9 t.ha^{-1} treated soil than 3 t.ha^{-1} treated soils. Cured ruminant intestinal tract organic waste at 9 t.ha^{-1} produced 0.31 Cmol.kg^{-1}more calcium than 6t/ha treatment level. The structural stability of hay and grasses grazed by animals is dependent on the quantity of calcium content of the soil and easy of uptake. The high and positive significant values of the cured ruminant intestinal tract organic waste on calcium content is a clear indication that when cured ruminant intestinal tract organic waste is incorporated into the soil, the organic matter is capable of enriching the soil with exchangeable calcium and so has the capacity to lower pH for improved mineralization and utilization of the plant nutrient.

Magnesium

Cured Ruminant Intestinal Tract Organic Waste (CRITOW) improved the exchangeable magnesium (Mg) content of the soil when compared with the untreated soil. There was also positive significant difference when the different treatment levels were compared with one another. Nevertheless, there was no significant difference in Mg content when the control was compared with 3 t.ha^{-1} treatment level. But 6 t.ha^{-1} and 9t/ha received 116 and 2.07 Cmol.kg^{-1} more Mg respectively than the control plot. Cured Ruminant Intestinal Tract Organic Waste (CRITOW) at 3t/ha produced 1.08 and 1.99 Cmol.kg^{-1} less than 6 and 9t/ha. Furthermore 9t.ha^{-1} produced 0.91 Cmol.kg^{-1} more exchangeable Mg than 6 t.ha^{-1} cured ruminant intestinal tract organic waste treatment level.

Potassium and Sodium

There was no significant difference in the soil exchangeable potassium (K) and sodium (Na) when the control plot was compared with the difference treatment levels. Although minor variations were recorded, this may be as a result of the embedded position in the internal structure of the plants where potassium and sodium are involved in construction of the structural frame work of the plant. It may have to take longer period of decomposition for the K and Na in the intestinal tract organic waste to be decomposed and released into the soil for plant use.

Effect of CRITOW on Soil EA, ECEC and Base Saturation

Effect of Cured ruminant intestinal tract organic waste on Soil EA, ECEC and Base Saturation is presented in table 4.

Effective Cation Exchange Capacity

The effective cation exchange capacity of the soil was significantly improved when the control was compared with the different levels of the cured ruminant intestinal tract organic waste. Specifically, there was 1.95, 3.0 and 3.08 Cmol.kg^{-1} more ECEC in 3, 6 and 9t/ha respectively treated plots when compared with the control. The variations dropped as the different treatment levels were compared with one another. Six tons per hectare (6t.ha^{-1}) of cured ruminant intestinal tract organic waste produced 1.05 Cmol.kg^{-1} more ECEC than 3t.ha^{-1}, but 9t.ha^{-1} had 1.13 Cmol.kg^{-1} more ECEC than 3t.ha^{-1}. There was no statistically significant effect of the treatment when 6 t.ha^{-1} treatments were compared with 9 t.ha^{-1} CRITOW treatments.

Table 4: Effect of cured Ruminant intestinal tract organic waste (CRITOW) on Exchangeable Acidity, Effective Cation Exchange Capacity (ECE), Base Saturation

Treatment	EA Cmol.kg^{-1}	ECEC Cmol.kg^{-1}	% Base Saturation
0t/ha(Control)	2.16	6.69	74.45
3t/ha	2.08	8.64	78.88
6t/ha	1.74	9.69	81.73
9t/ha	1.97	9.77	82.31
F-LSD (P=0.05)	0.14	0.64	4.88

Per Cent Base Saturation

The per cent base saturation of the soil in the control pots differed significantly when compared with the different treatment levels. There was no significant difference when the different treatment levels were compared with one another. There was 5.6% improvement in % base saturation at 3t/ha treatment level when compared with the control. In addition, there were 8.91 and 9.55% more % base saturation in 6t/ha and 9t/ha treatments respectively when compared with the control.

Effect of Cured Rumen Digesta on Soil Heavy Metal

Effect of Cured Ruminant Intestinal Tract Organic Waste (CRITOW) on soil heavy metals are presented in table 5.

Zinc

The zinc content of the soil improved significantly when the control plots were compared with the treatments plots and there was no significant difference the treatments at the different levels were compared with one another. Specifically, only 6 t.ha^{-1} and 9 t.ha^{-1} treatment levels produced significant difference when compared with the control. There was 2.70 and 2.99 Cmol.kg^{-1} more zinc in treatment 3 and 4 respectively when compared with the control.

Iron

There was statistically significant difference when the iron content of the control plots was compared with the treatments levels and when 3 t.ha^{-1} treatment level was compared with 9 t.ha^{-1} treatment level, but there was no significant difference when the control was compared with 3 t.ha^{-1} treatment level and when 3 t.ha^{-1} treatment level was compared with 6 t.ha^{-1} treatment. The treatment levels at 1, 6 and 9 t.ha^{-1} produced 4.05 and 6.69 Cmol.kg^{-1} more Fe respectively than the soil that did not receive any compared with the different levels of cured ruminant intestinal tract organic waste treatments. The differences in iron content of the treated soil most have come from the application of the cured ruminant intestinal tract organic waste. There was also increasing quantity of iron in the soils as the quantity of the Cured Ruminant Intestinal Tract Organic Waste (CRITOW) increased up to the highest level of 9t.ha^{-1}.

Copper

The multiply comparison of the four treatments in this experiment showed that there was significant difference in Cu content of the soil when the control plot was compared with 3, 6 and 9 t.ha^{-1} treatment levels and when 3 t.ha^{-1} was compared with 9 t.ha^{-1}, but there was no significant difference in Cu content of the treated soils when 3 t.ha^{-1} treatment levels was compared with 6 and when 6 t.ha^{-1} was compared with 9 t.ha^{-1} treatment rates. Accumulations of Copper in the soil improved as the quantity of cured ruminant intestinal tract organic waste were increased up to the highest level of 9t.ha^{-1}. There was weak significant difference of 0.9 Cmol.kg^{-1} improvements in copper content when 3 t.ha^{-1} treatment levels were compared with 9 $t.ha^{-1}$ treatment level. Treatment 2 produced 1.2 $Cmol.kg^{-1}$ more Cu than T1 and 6t/ha produced 1.7 $Cmol.kg^{-1}$ more copper when compared with the control. There was high 2.1 $Cmol.kg^{-1}$ addition in the soil by the 9t/ha treatment application when compared with the control. Copper is one of the elements found in high concentration in the hay and grasses used in livestock production.

Table 5: Effect of cured Ruminant intestinal tract organic waste (CRITOW) on Micronutrients and Heavy Metals

Treatment	Zn	Fe	Cu	Cr	Pb	Cd
			$Cmol.kg^{-1}$			
$0t.h^{-1}$ (Control)	22.05	16.76	4.10	0.51	2.88	0.74
3 $t.ha^{-1}$	23.49	18.67	5.30	1.57	4.93	1.06
6 $t.ha^{-1}$	24.75	20.81	5.80	1.88	5.63	1.29
9 $t.ha^{-1}$	25.04	23.45	6.20	1.86	5.98	1.35
f-LSD (P=0.05)	1.69	2.19	0.73	0.14	0.42	0.11

Chromium

Chromium (Cr) accumulation increased significantly when the control plot was compared with the treatment rates and when the treatments were compared with one another. There was no significant difference when $6t.ha^{-1}$ was compared with 9 $t.ha^{-1}$ treatment level. There was 1.06 $Cmol.kg^{-1}$higher Cr in the soils treated with $3t.ha^{-1}$ than the soils of the control plots. Again there was 1.37 and 1.35 $Cmol.kg^{-1}$accumulation resulting from 6 $t.ha^{-1}$ and 9 $t.ha^{-1}$ treatment rates when compared with the control. Accordingly there were 0.31 and 0.29 $Cmol.kg^{-1}$more Cr in soils treated with 6 $t.ha^{-1}$ and 9t/ha respectively when compared with 3 $t.ha^{-1}$ treatment levels. There was more accumulation of Cr in the soil treated with 6 $t.ha^{-1}$ than in the soil treated with 9 $t.ha^{-1}$. May be the soil there had better soil condition for mineralization than the other plots. Otherwise it is expected that Cr accumulation should follow the same trend as in the other elements.

Cadium

There was statistically significant difference in Cd content of the soil when the control was compared with the treatments and when T2 was compared with T3 and T4. But there was no significant difference when T3 was compared with T4. Generally the accumulation of the element was not very high following the general Cd content of CRITOW. There was about 0.32 $Cmol.kg^{-1}$ more Cd in the soils treated with 3t/ha CRITOW than the control and 0.55 and 0.61 $Cmol.kg^{-1}$ more in soils treated with 6 and 9 $t.ha^{-1}$ CRITOW respectively than the soil that did not receive CRITOW treatments. There was also an increase in Cd in soils treated with 6 and 9t/ha when compared with the control. Six tons per hectare (6 $t.ha^{-1}$) accumulated 0.23 $Cmol.kg^{-1}$more Cd than 3 $t.ha^{-1}$ treated soil and 9t/ha CRITOW treated soil produced 0.29 $Cmol.kg^{-1}$ more Cd than 3t/ha CRITOW treated soil.

Effect of Different Rate of cured ruminant intestinal tract organic waste (CRITOW) on Grain Characteristics and Grain Yield of Maize

Effect of different rates of cured ruminant intestinal tract organic waste on grain characteristics of maize is presented in Table 6.

Weight of Cob ($t.ha^{-1}$)

There was improvement in Cob yield from the soils treated with CRITOW over the control. There was Improvement in their cob yield when the treatments were compared with one another. There were largely 1.3 $t.ha^{-1}$ increases in cob yield from the plots treated with $3t.ha^{-1}$ CRITOW when compared with the pots that did not receive any CRITOW treatment. Furthermore, there was also 1.1 and $1.8t.ha^{-1}$ increase in cob yield from the 6 and 9t/ha CRITOW treated soil respectively over the control. But when the treatments were compared with one another the yield difference started reducing.

Table 6: Effect of cured ruminant intestinal tract organic waste on yield and yield Characteristics of maize

Treatment	Weight of cub t.ha-1	Line of cube	Length of cub	Diameter of cub	Grain yield kg/plot
0t.ha^{-1}	2.5	11.40	22.60	12.20	1.7
3 t.ha^{-1}	3.8	12.20	23.60	14.60	2.8
6 t.ha^{-1}	3.6	12.80	24.00	14.80	3.2
9 t.ha^{-1}	4.3	12.20	25.40	15.40	5.4
f-LSD(P=0.05)	0.14	Ns	Ns	1.53	0.36

In the soil treated with 6 and 9 t.ha^{-1} CRITOW, there was only 0.2 and 0.5 t.ha^{-1} more cob yield respectively than from the soils treated with 3 t/ha CRITOW. Again, the soil treated with 9t/ha produced 0.7t.ha^{-1} more cobs than the soil treated with 6t.ha^{-1} CRITOW. There was a trend of the improvement of the cob yield when compared with the control from 3t.ha^{-1} through 6t.ha^{-1} to 9t.ha^{-1}. Nine tons per hectare (9t.ha^{-1}) produced the highest yield difference.

Grain Yield (t.ha^{-1})

There was great improvement in grain yield when the control was compared with the treatment and when the treatments were compared with one another. The greatest yield difference was recorded when the control was compared with 9 t.ha^{-1} CRITOW treatment and the lowest yield difference was revealed when 3 t.ha^{-1} CRITOW treatment was compared with 6 t.ha^{-1} CRITOW treatment. There was 1.1 t.ha^{-1} increases in grain yield from 3 t.ha^{-1} CRITOW treated soils when compared with the control. Also 6 t.ha^{-1} and 9 t.ha^{-1} CRITOW treated soils produced 1.5 and 3.7 t/ha respectively higher grain yield than the soil that did not receive any CRITOWD treatment. The inter treatment comparison also revealed that 6 t/ha and 9 t/ha CRITOW treated soils recorded 0.4 and 2.6 t.ha^{-1} respectively improved grain yield when compared with 3 t.ha^{-1} CRITOW treated soil. There was also 2.2 t.ha^{-1} more grains from the 9 t.ha^{-1} CRITOW treated soil than the 6 t.ha^{-1} CRITOW treated soil. Cured Ruminant Intestinal Tract Organic Waste (CRITOW) has the capacity to improve on the chemical properties of soil. These improvements could have come to bear on the ultimate reason for soil improvement – crop yield. The accumulated effect so far record in Ekpe 2011 has been reported that the waste, water polluting rumen digesta from our abattoirs can be a good source of soil organic matter for increased crop yield while cleaning up the environment.

Conclusion

Cured Ruminant Intestinal Tract Organic Waste (CRITOW) as organic matter was been applied to improve on soil chemical properties and also to increase soil productivity. The incorporation of cured rumen digesta increased the level of organic matter and reduced soil acidity level. Plots treated with 9 t.ha^{-1} cured rumen digesta revealed improved nutrients content in the soil. Application of higher rates of Cured Ruminant Intestinal Tract Organic Waste (CRITOW) has improved useful in increasing the yield of the maize for sustainable crop production in Abakaliki.

REFERENCES

Agboola AA and Odeyemi O (1972). The effect of land use on the Soil organic matter, exchangeable K, Available P, and soil pH in the Rainforest zone of western Nigeria. *Nigerian African Journal* (2)161-168.

Bremner JM and Mulvaney CS (1982). Nitrogen- total in: Page, A.L., Mailer, RH and Reeney, D.R. Methods of soil analysis 2: Chemical and microbiological properties. *Agronomy monograph* No.9 2 Madison, Wisconsin USA: American Society of Agriculture.

Ekpe II (2011). Assessment of Rumen Digesta as a Source of Organic Matter in Abakaliki Southeast Nigeria. *Global Research Journal of Science* (GRJS) 1(1) 37-39.

FAO (1976). Organic materials as fertilizers soils Bulletin 27 F.A.O. Rome.

FDALR (1985). Reconnaissance Soil Survey of Anambara State, Nigeria.

IITA (1979). Some Selected Methods of soil and plant Analysis, Manual No.10, Ibadan Nigeria 80.

Landon JR (1991). Booker Tropical Soil Survey and Agric. Land Graduation in the Tropics and Subtropics, B.T. New York 480.

Ofomata GEK (1975). Nigeria in Maps, Eastern states of Nigeria. Ethiopia Publishing house, Midwest, Benin city 6.

Onweme IC and Sinha TD (1991). Field crop production in tropical Africa, principles and practices. Technical Center for Agricultural and Rural Co-Operation (CTA) 48.

Steel GD and Torrie JH (1980). Principles and Procedures of Statistics. A biometrical approach 2 McGraw-Hill Book Company Inc. New Year 633.

Unamma RPA, Odurukwe SO, Okereke HE, ENE LSO and Okoil OO (1985). Farming Systems in Nigeria. Report of Benchmark Survey of Farming System of Eastern Agricultural Zone of Nigeria AERLS, National Root crops Research Institute, Umudike.