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Evaluation of productivity and rates of application of poultry manure for remediation of kerosene oil contaminated soil in Abakaliki, Southeastern Nigeria

Nwite J. N.[1], Aya F. C.[1]* and Okeh C. O.[2]

[1]Department of Soil Science and Environmental Management, Faculty of Agriculture and Natural Resources Management, Ebonyi State University, P. M. B. 053, Abakaliki, Ebonyi State, Nigeria.
[2]Department of Biology, Biotechnology and Microbiology, Federal University Ndufu-Alike, P. M. B. 1010, Abakaliki, Ebonyi State, Nigeria.

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This experiment was carried out in order to evaluate productivity and rates of poultry manure used to amend kerosene oil contaminated soil on 0.18 ha of land. The land area was contaminated with 5% of kerosene oil equivalent to 50,000 mgkg^{-1} and thereafter the field laid out using randomized complete block design (RCBD) with four treatments of 10, 20, 30 tha^{-1} of poultry manure and control which were replicated five times. Maize hybrid (Oba super II) variety was used as an evaluation crop. Results showed except for bulk density, poultry manure amended at 30 tha^{-1} was significantly (P<0.05) higher by 57, 10 and 56% in total porosity, aggregate stability and gravimetric moisture content (GMC) compared to control. Eventhough, there was no significant (P<0.05) treatment effect of poultry manure amendment on chemical properties of studied soil properties except for sodium, Organic carbon, nitrogen, phosphorus, CEC and base saturation were respectively higher by 33, 17, 37, 27 and 24% in plot amended with 30 tha^{-1} of poultry manure than when compared to control. Plant height and grain yields of maize followed the trend obtained in improvements of physicochemical properties of soil as reflected by amendments but significant (P<0.05) tallest maize plant and grain yield of maize were obtained in plot amended with 30tha^{-1} of poultry manure compared to control. Rate of poultry manure is necessary for sustainable productivity of kerosene oil contaminated soil.

Key words: Kerosene oil, maize yield, poultry droppings, productivity, remediation.

INTRODUCTION

The widening gap between food production and population growth rate (Anon, 2016; NPAFS, 2010) globally and in Nigeria in particular demands that there should be paradigm shift from our traditional research approach to critical areas. One of such areas is expanding frontiers of academic studies to include investigation into kerosene oil contaminated soil. Kerosene oil is one of the hydrocarbon products

*Corresponding author. E-mail: ayason4real@yahoo.co.uk Tel: +234(0)8064764659.

extracted from petroleum at 150 and 270°C resulting in a mixture with approximately density of 0.79-0.81 gcm-3. It is composed of aliphatic, aromatic, ring, ketonic and heavy metals (http//en.m.wikipedia.org, 2016) which could contaminate soil and reduce its productive potential through nutrients fixation.

In Nigeria generally and Abakaliki particularly, common sources of soil contamination are through household wastes, agricultural wastes and vandalization of pipelines (Nwite and Alu, 2015). Contamination of soil with kerosene oil is due to its increased demand and usage as source of energy for domestic uses both in urban and rural areas. This has raised number of dealers who are readily found at every nook and cranny of the town. Kerosene oil often leaks out into the soil from tanks, drums and other storage containers resulting in the contamination of soil.

According to Brady and Weil (2002), contamination of a soil with toxic substances can degrade its productive capacity to provide habitat for crops. Consequently, reclamation of soil contaminated with organic chemicals has been advocated (Mbah et al., 2009). Since physical and chemical methods most widely used for the treatment of soil contaminated with hydrocarbon oil waste have been criticized for their inadequacy and gross ineffectiveness (Adesodun, 2004), bioremediation has been recommended for such treatment (Odokuma and Dickson, 2003). Organic wastes provide adequate temperature, optimum nutrients such as nitrogen and phosphorus as well as oxygen (Uheghu et al., 2012) which are needed for degradation of oil based wastes. These are lacking in the former approaches. Bioremediation has been adjudged to be most efficient, environmentally safe and friendly as well as cost – effective treatment of hydrocarbon contaminated soils (Odokuma and Dickson, 2003). The approach involves introduction of nutrients in the form of organic matter such as poultry manure to the contaminated soil. Although reclamation of hydrocarbon oil contaminated soil has increased, little or no study has been carried out to reclaim kerosene oil contaminated soils as well as evaluate rates of treatment application of remediating material in Abakaliki environment. In their studies Mbah et al*.* (2009) noted that different rates of application of woodash had variable effects on soil pH and recommended that higher rates would improve soil pH the most. In the study area which is Izzi in Abakaliki, Ebonyi state of southeastern Nigeria, farmers apply poultry manure on hydrocarbon contaminated soil without scientific approach due to ignorance and lack of proper documentation. This necessitated this study in the agro-ecology of the kerosene contaminated soil and the extent at which poultry manure can change the soil characteristics. This research is therefore to bridge the gap in knowledge and to create awareness to land users, critical stakeholders, farmers and agronomists on effect of kerosene oil contamination of soil and its remediation with poultry manure. The objectives of this study were to evaluate productivity and rates of poultry manure used to amend kerosene oil contaminated soil and make recommendation for sustainable productivity.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at Teaching and Research Farm of the Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki, Nigeria. The site is located by latitude 06° 4' N and longitude 08° 65'E in derived savannah area of the Southeast agro-ecological zone of Nigeria. The area experiences a bimodal pattern of rainfall which is spread from April – July and September – November with a short spell in August which the residents refer to as "August break". The total annual rainfall ranges from 1700 to 2000 mm. The average minimum and maximum temperatures are 27 and 31°C, respectively. Relative humidity is 80% during the rainy season but declines to 60% in the dry season (ODNRI, 1989). The soil is derived from sedimentary rock as the Abakaliki agro-ecological zone lies within "Asu River" group. The soil consists of shale residuum and is unconsolidated up to 1 m depth. It belongs to the order ultisol classified as Typic haplustult (FDALR, 1985). The vegetation of the area is primarily derived savannah with bush regrowth and scanty economic trees. The people are largely farmers with few engaging in civil service jobs as means of livelihood. The site had been under cultivation for the past two years. The common food crops grown are yam (*Dioscorea spp*), cassava (*Mannhot spp*), maize (*Zea mays* L.), cocoyam (*Colocasia spp*) and cowpea (*Vignia unguiculata*).

Land preparation/experimental design and treatment application

The experiment was carried out on land area of approximately 0.18 ha. The site was cleared manually and debris removed. The experimental site was spread uniformly with 5% equivalent to 50,000 mgkg^{-1} of kerosene before cultivation using knapsack sprayer. The soil was allowed undisturbed for two weeks. The experiment was laid out using Randomized Complete Block Design (RCBD). The plots measured 2 m x 2 m and were spaced 0.5 m apart. The treatments were control (C) that is kerosene oil contaminated soil without poultry manure amendment and Poultry manure (PM) applied at10, 20 and 30 tha^{-1} and replicated five times to give a total of twenty experimental plots. The replications were separated by 1 m alley. The poultry droppings were spread on the plots and raked into the soil after seedbed preparation.

Planting/Weeding

Planting of maize seed was carried out in April, 2015 season. A hybrid variety of maize (Oba super II) was used as a test crop. This is because oba superII variety is resistant to disease and pest attack. It can also resist drought.The maize seed was sourced from the Ebonyi State Agricultural Development Programme (EBADEP), Onuebonyi Izzi, Abakaliki. The seeds were planted two per hole and at a depth of 5 cm using spacing distance of 25 x 75 cm in each plot after two weeks of treatment incorporation. Thinning was carried out to leave one plant per hole after two weeks of germination (ATWG). Weak plants were removed and replaced by replanting to give plant population of 24 stands per plot. This gave an approximately 53,000 plants per hectare. Weeds were removed at three weekly intervals till plant maturity and harvest.

Table 1. Properties of soil at initiation of study.

Soil properties	Unit	Value
Sand	gkg^{-1}	730
Silt	gkg^{-1}	120
Clay	gkg^{-1}	150
Textural class		Sandy loam
pH(KCL)		5.20
Organic carbon	%	2.35
Organic matter	%	4.05
Nitrogen	%	0.17
Phosphorus	$mgkg^{-1}$	9.43
Calcium	$cmolkg^{-1}$	7.20
Magnesium	$cmolkg^{-1}$	4.00
Potassium	$cmolkg^{-1}$	0.32
Sodium	$cmolkg^{-1}$	0.13
Cation exchange capacity	$cmolkg^{-1}$	15.00
Base saturation	%	65.00

Soil sampling and agronomic data collection

Initial soil samples were randomly collected with auger from the experimental site at depth of 0-20 cm. The samples were composited for pre-planting soil analysis. Core and auger samples were also collected at three points in each plot and at 0-20 cm depth after plant maturity for post-harvest soil analysis. Plant height was measured at two weekly intervals till crop maturity with a calibrated meter rule. When the maize husks had turned brown, the cobs were harvested, dehusked, shelled and grains further dried. The grain yield was determined at 14% moisture content.

Laboratory methods

Physical and chemical properties

Core samples were used to determine some physical properties of soil. Bulk density was determined with Blake and Hartge (1986) method. Total porosity and gravimetric moisture content determinations were done as described by Obi (2000) method. Aggregate stability was evaluated by the method described by Kemper and Rosenau (1986). Particle size distribution analysis was determined by Gee and Or (2002) procedure. Auger samples were used to determine the chemical properties. The auger samples were air-dried, crushed and then passed through a 2mm sieve and particles <0.2mm in diameter used for determination. Total nitrogen was determined using the micro-kjedhal procedure of Bremner (1996). Phosphorus was determined using the Bray-2 method as described in Page et al (1982). Exchangeable sodium and potassium were determined using flame photometry method as described by Ohiri and Ano (1985) while calcium and magnesium were determined using Mba (2004) method. Cation exchange capacity determination was done using ammonium acetate (NH4OAC) displacement method of Jackson (1958). Base saturation was calculated using the formula:

%BS = (Exchangeable bases / Cation exchangeable capacity × 100/1

where
BS = Base saturation

The kerosene oil and poultry manure were analyzed for its contents with Gram staining reaction method of Stewart and Beswick (1977).

Data analysis

Data obtained from the field and laboratory were analyzed using analysis of variance (ANOVA) for randomized complete block design. Treatment means which were significant were evaluated with Fisher's Least Significant Difference (F-LSD) using Steel and Torrie (1980) procedure. Significant treatment effect was accepted at 5% probability level.

RESULTS AND DISCUSSION

Soil properties at initiation of study

Table 1 shows properties of soil before kerosene oil contamination and cultivation. The results showed that sand fraction was predominant among the particle size distribution. Textural class of the soil is sandy loam. The soil had a pH value of 5.20. The available phosphorus content was 9.43 $mgkg^{-1}$. The percentage nitrogen had low value of 0.17%. Organic carbon and organic matter contents of soil were 2.35 and 4.05% respectively. The values for exchangeable sodium, potassium, magnesium and calcium ranged from 0.13 - 7.20 $cmolkg^{-1}$. Cation exchange capacity and base saturation were 15.00 $cmolkg^{-1}$ and 65.00% respectively.

The result of properties of soil at initiation of study showed that the soil is slightly acidic (*Schoenebager* et al., 2002). Available phosphorus and nitrogen are low but organic carbon as well as organic matter are moderate in the soil and except for calcium, all other exchangeable cations are very low (FARMD, 2002). This could be the reason for low cation exchange capacity (Table 1) and moderate base saturation recorded in the soil (FARMD, 2002). The soil condition before study depicts that of degradation and low fertility trend. This could be attributed to probably because the soil before the study had been under cultivation for the previous years.

Properties of kerosene oil

The properties of kerosene oil used to contaminate the soil are presented in Table 2. The results indicate that organic carbon, available phosphorus and nitrogen are very low according to ratings of FMARD (2002) bench mark for tropical soils. Carbon – Nitrogen ratio is moderate (Biswas and Murkherjee, 2008). Eventhough, Cadmium and Copper dominated other heavy metals in their concentration; generally all of them fall below critical and recommended levels for ecotoxicity (LASEPA, 2002).

Nutrients composition of poultry droppings

Table 3 shows nutrients composition of poultry manure.

Table 2. Properties of kerosene oil.

Kerosene properties	Unit	Value
Zinc	$mgkg^{-1}$	1.15
Copper	$mgkg^{-1}$	1.57
Lead	$mgkg^{-1}$	0.27
Cadmium	$mgkg^{-1}$	1.25
Organic matter	%	0.50
Phosphorus	$mgkg^{-1}$	2.00
Nitrogen	%	0.02
Carbon-nitrogen ratio	%	25

Table 3. Nutrients composition of poultry manure.

Parameters	Unit	Value
pH(KCL)		8.9
Organic carbon	%	29.9
Organic matter	%	51.6
Nitrogen	%	0.50
Phosphorus	$mgkg^{-1}$	1.60
Calcium	$cmolkg^{-1}$	2.50
Magnesium	$cmolkg^{-1}$	3.50
Potassium	$cmolkg^{-1}$	2.50
Sodium	$cmolkg^{-1}$	0.50
Carbon-nitrogen ratio		60

Table 4. Soil physical properties following contamination and poultry manure amendment.

Treatment	Bulk density (mgm^{-3})	Total porosity (%)	Aggregate stability (%)	GMC (%)
Control	1.41	13.96	46.65	10.29
10	1.40	13.87	46.89	12.29
20	1.36	14.40	48.78	17.90
30	1.27	32.10	52.00	24.61
FLSD-0.05	NS	3.06	3.77	2.40

FLSD = Fisher's Least Significant Difference, GMC = Gravimetric moisture content, 10, 20, and 30 tha^{-1} treatment levels of poultry manure.

The results indicated that pH value was 8.9. The respective values for organic carbon, organic matter, nitrogen and phosphorus were 29.9, 51.6, 0.50% and 1.60 $mgkg^{-1}$. Exchangeable cations were 5.50, 3.50, 2.50 and 0.50 $cmolkg^{-1}$ for calcium, magnesium, potassium and sodium, respectively. The carbon – nitrogen ratio was 60.

The pH is slightly alkaline (Schoenebeger et al., 2002) while organic carbon and organic matter are very high (FMARD, 2002). Nitrogen according to Landon (1991) is very low. Phosphorus is low (FMARD, 2002). Exchangeable cations except for sodium are moderate (Asadu and Nweke, 1999). Besides, organic carbon and organic matter in the nutrient composition of poultry manure and that of soil before the study are comparable but far higher than nutrient composition of kerosene oil.

Soil physical properties

Table 4 shows physical properties of soil following kerosene oil contamination and poultry manure amendment. Poultry manure amendment had no significant ($P<0.05$) treatment effect on bulk density of kerosene oil contaminated soil. Control was 10% higher in bulk density when compared with kerosene oil

Table 5. Soil chemical properties following kerosene oil contamination and poultry manure amendment.

Treatment	pH(KCl)	OC(%)	N(%)	P(mgkg^{-1})	K	Mg	Na	Ca	CEC	%BS
					cmolkg^{-1}					
Control	5.0	1.91	0.15	8.66	0.28	3.0	0.12	7.9	14.8	63.53
10	5.2	2.41	0.16	10.85	0.37	3.0	0.13	7.8	16.0	65.31
20	5.2	2.42	0.18	13.66	0.35	3.8	0.15	8.4	17.2	70.34
30	5.3	2.84	0.18	13.85	0.37	3.8	0.17	8.4	18.8	83.74
FLSD	NS	NS	NS	NS	NS	NS	0.02	NS	NS	

FLSD – Fisher's Least Significant Design, NS – Not Significant, OC- Organic carbon, N- Nitrogen, K- Potassium, Mg- magnesium, Ca- Calcium, CEC- Cation exchange capacity, BS- Base saturation, 10, 20 and 30tha^{-1} treatment levels of poultry manure.

contaminated soil receiving 30 tha^{-1} of poultry manure. Furthermore, kerosene oil contaminated soil amended with 30 tha^{-1} of poultry manure had lowest bulk density compared to those amended with 10 and 20 tha^{-1} of poultry manure. The plot treated with 30tha^{-1} of poultry manure had significantly ($P<0.05$) higher total porosity, aggregate stability and gravimetric moisture content (GMC) relative to control and those receiving 10 and 20 tha^{-1} of poultry manure, respectively. This accounts for 57, 10 and 56% increments in total porosity, aggregate stability and gravimetric moisture content (GMC) in plot amended with 30 tha^{-1} of poultry manure when compared with control. Similarly, plot treated with 30 tha^{-1} of poultry manure was respectively higher by 57 – 55%, 10-6% and 50-27% in total porosity, aggregate stability and gravimetric moisture content (GMC) when compared to values obtained in plots treated with 10 and 20 tha^{-1} of poultry manure.

Higher bulk density and significantly lower total porosity, aggregate stability and GMC recorded in control could be attributed to negative effect of kerosene oil contamination of soil. This suggests that kerosene oil contamination of soil could cause degradation of soil fertility through reduction of available moisture and soil disaggregation all of which could lead to compaction. Previous studies on hydrocarbon oil contamination of soil by Mbah et al. (2009), Nwite (2013) and Ogbohodo et al. (2001) reported similar findings. Lower bulk density as well as significant effect of poultry manure on total porosity, aggregate stability and gravimetric moisture content (GMC) on plots receiving amendment implies that negative effect of kerosene oil contamination of soil could be attenuated with poultry manure. On the other hand, poultry manure loosened soil compaction and increased its total porosity, improved aggregate stability as well as moisture content of soil. These observations are supported by the report of Adesodun (2004) and Nweke and Okpokwaili (2003) that animal manure used to ameliorate spent lubricant oil contaminated soil loosened soil compaction and increased porosity, stability and water content. This by implication means that there could be proper aeration in the soil due to increased volume and high porosity as well as higher stabilization. High stabilization could increase soil's ability to retain more nutrients and water as well as increase its resilience to degradation. Significant soil properties obtained in plots amended with 30 tha^{-1} of poultry manure compared to those treated with 10 and 20 tha^{-1} of poultry manure could be attributed to robust effect of the treatment on kerosene oil contaminated soil translated in improvement of total porosity, aggregate stability, GMC and bulk density. It therefore, implies that 30 tha^{-1} of poultry manure could be the appropriate rate for attenuation of kerosene oil contamination of soil for sustainable productivity.

Soil chemical properties

Chemical properties of soil following kerosene oil contamination and poultry manure amendment are presented in Table 5. Results showed no significant ($P<0.05$) treatment effect on the studied chemical properties of soil except for sodium. Significant differences were obtained in Sodium among plots treated with poultry manure. Generally, control recorded lower soil chemical properties when compared to values recorded in plots amended with poultry manure. The values of soil chemical properties varied among the plots amended with poultry manure with plot receiving 30 tha^{-1} recording highest values of chemical properties. This translated to 33, 37, 27, and 24% increments in organic carbon, nitrogen, phosphorus, CEC and base saturation in plot amended with 30tha^{-1} of poultry manure compared to control.

The generally low values of chemical properties of soil in control indicate that kerosene oil contamination could cause soil degradation through poor availability of nutrients. This implies low fertility, poor nutrients utilizations by plants (Aulakh et al., 2007) and consequently low soil productivity. This observation corroborates the earlier findings by Kayode et al. (2009) and Uheghu et al. (2012) that spent oil contamination depressed availability of nutrients in soil. The improvements obtained in chemical properties of soil amended with poultry manure could be due to positive

Table 6. Maize plant height.

Treatment	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
10	18.80	46.04	82.40	120.80	135.60
20	25.60	54.00	108.80	135.40	138.40
30	38.00	69.06	128.20	157.80	168.20
FLSD(0.05)	5.97	12.30	14.80	20.80	19.50

FLSD – Fisher's Least Significant Difference, WAP- at 2, 4, 6, 8 and 10 weeks after planting, 10, 20 and 30tha^{-1} treatment levels of poultry manure.

effect of the added material. This in effect means that poultry manure has the capacity to ameliorate negative effect of kerosene oil contamination on soil by increasing its nutrients status. This is in line with the reports of Adesodun (2004) and Mbah et al. (2009) that animal manures increased nutrients status of hydrocarbon oil contaminated soil. The non-significant treatment effect on the chemical properties of soil kerosene oil contaminated soil is supported by studies carried out by Okonokhua et al*.* (2007) and Ogbohodo et al*.* (2001) that there were no significant treatment effects on soil chemical properties treated with spent lubricant oil and amended with poultry manure. The higher chemical properties obtained in plot amended with 30 tha^{-1} of poultry manure when compared to those receiving 10 and 20 tha^{-1} suggests that the rate could be appropriate for remediation of kerosene oil contaminated soil. Adesodun (2004) noted that higher rates of organic wastes supplementation on spent lubricant oil contaminated soil had higher treatment effect and raised nutrients status more than those receiving lower rates.

The significant treatment effect on sodium could be attributed to on one hand that it is not important in plant nutrition and on other hand, that there was poor utilization of the nutrient by maize crops and less effect of kerosene oil contamination.

Maize plant height

Table 6 shows maize plant height following kerosene oil contamination and poultry manure amendment. There were significant poultry manure treatment effects on maize plant height at 2, 4, 6, 8 and 10 weeks after planting (WAP) except plot amended with 10tha^{-1} at 4, 8 and 10WAP respectively compared to control.

Tallest maize plants were obtained in plot amended with 30tha^{-1} of poultry manure relative to those treated with 10 and 20 tha^{-1} at different sampling periods. Maize plants grown in plot amended with 30 tha^{-1} of poultry manure were 51, 33, 36, 23 and 19% taller than those planted in control plots at 2, 4, 6, 8 and 10 WAP respectively. The height of maize plants followed trends obtained in improvements of physicochemical properties l; of soil owing to attenuation effect of poultry manure amendment. The short maize plants obtained in control plot could be attributed to effect of kerosene oil contamination of soil. Odjegba and Sadiq (2002) noted that maize seedlings grown in hydrocarbon oil contaminated soil showed significant reduction in height compared to normal plants. Significant maize plant height in plots receiving poultry manure amendment could be due to amelioration of effect of kerosene oil contamination on the soil. Similar finding was reported by Odokuma (2003) and Adesodun (2004) that organic wastes amendment of spent oil contaminated soil reduced its effect and significantly increased plant height compared to control. The tallest plants in plot amended with 30 tha^{-1} of poultry manure could be adduced to its superior effect on physicochemical properties of soil.

Grain yield of maize

Table 7 and Figure 1 show grain yields of maize following kerosene oil contamination and amendment of poultry manure. The plots amended with poultry manure had significantly ($P<0.05$) higher grain yields of maize when respectively compared to control. There were no significant ($P<0.05$) differences in grain yield of maize among the plots receiving poultry manure amendment. Nevertheless, the plots amended with 20 and 30 tha^{-1} of poultry manure had significantly ($P<0.05$) higher grain yield of maize relative to the one amended with 10 tha^{-1}. Generally, the plot treated with 30 tha^{-1} of poultry manure had higher grain yield of maize when compared to plots amended with 10 and 20 tha^{-1} respectively. This accounted for 29 and 11% increments in grain yield of maize in plot amended with 30 tha^{-1} of poultry manure compared to those treated with 10 and 20 tha^{-1}. Whereas grain yield of maize was 45% higher in plot amended with 30 tha^{-1} of poultry manure relative to control.

The low grain yield of maize in control compared to those obtained in plots receiving poultry manure amendment could be linked to poor availability and utilization of nutrients by the crop. Aulakh et al. (2007) reported that poor nutrient utilization by crops in hydrocarbon contaminated soil led to their low yields. Several researchers (Adeoye et al., 2005 and Wang et al., 2002 and Mbah et al., 2009) corroborated that there

Table 7. Grain yield of maize following kerosene oil contamination and poultry droppings amendment.

Treatment	Yield(tha^{-1})
Control	2.1
10	2.7
20	3.4
30	3.8
F-LSD 0.05	0.6

FLSD- Fisher's Least Significant Design, tha^{-1} – tons per hectare, 10, 20 and 30 tha^{-1} - treatment levels of poultry manure.

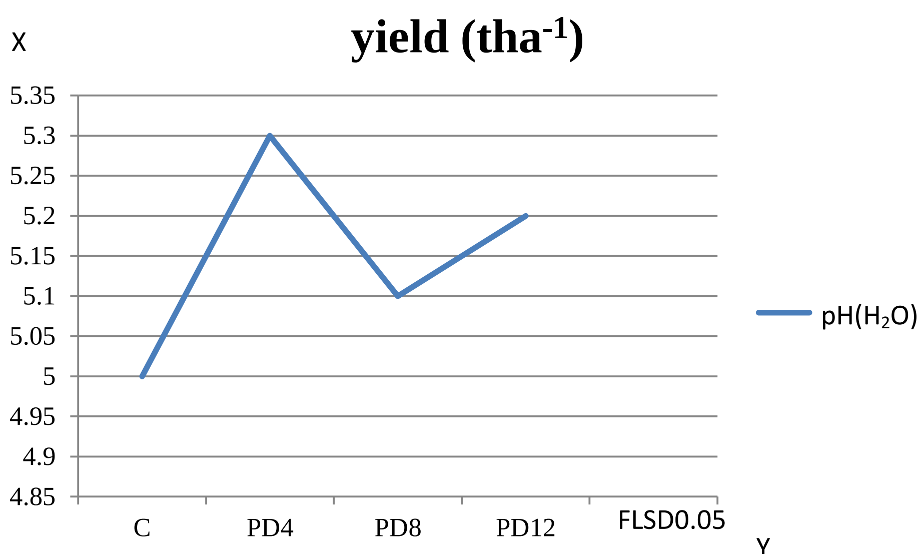

Figure 1. Grain yield of maize following kerosene oil contamination and poultry droppings amendment.

were poor and low yields of maize crops grown in hydrocarbon oil contaminated soil not receiving treatments. Significant higher grain yield of maize in plots amended with poultry manure in contrast to control could be attributed to mineralized nutrients from poultry manure which dissipated negative effect of kerosene oil contamination on soil. This increased the productivity of the soil. According to Odjegba and Sadiq (2002) plants grown on hydrocarbon oil contaminated soil but received amendment had higher yield than those grown on contaminated unamended soil. The significantly higher grain yield of maize obtained in plot amended with 30tha^{-1} of poultry manure when compared to those receiving 10 and 20tha^{-1} is attributed to its higher positive effect on the physicochemical properties of soil. It could probably be linked to its superior and robust attenuation of negative effect of kerosene oil contamination on soil. This finding is supported by report of Nwite et al. (2016) that there was significant grain yield of maize grown on spent lubricant oil contaminated soil that had the highest rate of amendment compared to others with lower rates of treatments.

Conclusion

This study has shown that effect of kerosene oil contamination of soil could be attenuated using poultry manure. Poultry manure amendment was able to attenuate negative effect of kerosene oil contamination and improve physicochemical properties of soil compared to control. The amendment of poultry manure at 30 tha^{-1} had significant robust effect on physicochemical properties of kerosene oil contaminated soil more than other treatments. Plant heights and grain yields of maize followed the trends of amendments giving tallest maize plant and highest grain yield of maize in plot amended with 30 tha^{-1} of poultry manure. In conclusion, poultry manure is recommended for remediation of kerosene oil contaminated soil but rate of application should be of paramount concern for achieving sustainable soil productivity.

Conflict of Interests

The authors have not declared any conflict of interests.

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REFERENCES

Anon (2016). A Survey of National Population Census and Agriculture as viable alternative to increased Gross Domestic Product (GDP) in Nigeria. A Study on Imperatives of Economic Diversification. pp 1-20.

Adeoye MB, Sridher MKC, Adeoluwa OO, and Akinsoji NA (2005). Evaluation of Naturally Decomposed Solid Waste from Municipal Sites for their Manurial Value in Southeast. J. Sust. Agric. 26(4):142-152.

Adesodun JK (2004). Bioremediation of Alfisol Contaminated with spent lubricant oil and its quality assessment using micro-morphological analysis Ph.D. thesis, university of Nigeria Nsukka. pp. 1-280.

Asadu GLM, Nweke FI (1999). Soils of Arable Crop Fields in Sub-Sahara Africa:Focus on Cassava Growing Areas. Collaborative Study of cassava on Africa. Working Paper No18. Resources and Crop Management Division, IITA, Ibadan, Nigeria. pp. 1-182.

Aulakh MS, Garg AK, Kabba BS (2007). Phosphorus accumulation, Leaching and Residual effects on crop yields from long-term Applications in the subtropics. Soil Use and Manage. 23:417-427

Bremner JM (1996). Nitrogen – Total, In: Sparks D. L. (ed). Method of Soil Analysis, chemical method. Am. Soc. Agron. 5(3):1085-1121.

Biswas TS, Mukherjee SK (2008). Textbook of Soil Science 2nd (ed). Tata McGraw Hill Publishing Company Ltd, New Delhi. pp. 120-422.

Blake GR, Hartage KH (1986). Bulk density in Klute, A. (ed.) Methods of Soil Analysis. Physical and Mineralogical Methods. American Society of Agronomy, Madison, Wisconsin, USA

Brady NC, Weil RR (2002). The Nature and Properties of Soils. New Jersey, Person Education, Inc. pp. 1-837.

FDALR (1985). Federal Department of Agriculture and Land Resource. Reconnaissance Soil Survey of Anambra State, Nigeria soil. Soil Report Kaduna. P 3.

FMARD (2002). Federal Ministry of Agriculture and Rural Development. Fertilizer Use and Management Practice for Crops in Nigeria. *In:* Aduayi, E.A, Chude, V.O., Adebusyi, B.A. and Oloyiwola, S.O. (eds). Federal Fertilizer Department, Abuyi. P 188.

Gee GW, Or D (2002). Particle Size Analysis. *In:* Dane, J.H. and Topp, G.C. (eds). Methods of Soil Analysis: Physical Methods. Am. Soc. Soil Sci. 5(4):255-293.

Jackson MI (1958). The Soil Chemical Analysis London: constable.

Kayode J, Oyedeji AA, Olowoyo O (2009). Evaluation of the effect of pollution with spent lubricant oil on the physical and chemical properties of soil. Pacific J. Sci. Technol. 10(1):387-391.

Kemper DL, Rosenau RR (1986). Aggregated Stability and Size Distribution. *In:* Klute A., (ed.) Methods of Soil Analysis. Am. Soc. Agron. 9(1):425-440.

LASEPA (2002). Lagos State Environmental Protection Agency. Lagos State Environmental Report 3:28-33.

Landon JR (1991). Booker, Tropical Soil Manual. A Handbook for Soil Survey and Agricultural and Evaluation in Tropics and Subtropics. New York, USA. John Wiley and Sons Inc. Third Avenue.

Mba CC (2004). Selected methods for Soil Plant and Environment Analysis: Department of Soil Science Handbook, Department of Soil Science, University of Nigeria, Nsukka. p 47.

Mbah CN, Nwite JN, Nweke IA (2009). Amelioration of spent oil contaminated Ultisol with Organic Wastes and its effects on Soil Properties and maize (*Zea mays* L.) yield. World J. Agric. Sci. 5(2):163-168.

NPAFS (2010). National Programme for Agriculture and Food Security Federal Ministry of Agriculture and Rural Development. Report of the Agricultural Production Survey. pp. 1-76.

Nweke CO, Okpokwaili GC (2003). "Drilling fluid base oil biodegradation Potential of a Soil staphylococcus species. Afr. J. Biotechnol. 2:293-295.

Nwite JN (2013). Evaluation of Automobile Oil Contaminated Soil Amended with Organic Wastes in Abakaliki Southeast, Nigeria. Ph.D Thesis, University of Nigeria, Nsukka pp. 1-142.

Nwite JN, Aya FC, Okolo CC (2016). Remediation of Crankcase Oil Contaminated Soil with Different Sources of Manure in Abakaliki, Southeast, Nigeria. J. Bioremediat. Biodegrad. 7:(3)1-6.

Nwite JN, Alu MO (2015). Effect of different levels of spent engine oil on Soil Properties Grain Yield of Maize and its Heavy Metal uptake in Abakaliki, Southeastern, Nigeria. J. Soil Sci. Environ. Manage. 5(4):44 -51.

Obi ME (2000). Soil physics: A compendium of lectures. Atlanto Publishers Ltd, Nsukka. pp. 1-240.

ODNRI (1989). Overseas Development of Natural Resources Institute. Nigeria profile of Agricultural Potential, ODA, United Kingdom.

Odokuma LO, Dickson AA (2003). Bioremdiation of Crude Oil Polluted Tropical Rainforest. Glob. J. Environ. Sci. 2:29-40.

Odjegba VJ, Sadiq AO (2002). The Environment. Effect of spent Engine oil on the growth Parameters, Chlorophyll and Protein levels of *Amaranthus hybridus* L. The Environmentalist 22(1): 23-28.

Ogbohodo AE, Osemwota IO, Choke JU (2001). An Assessment of the effect of Crude Oil Pollution on Soil Properties, germination and growth of Maize (*Zea mays* L.) Two crude types of focade light (UQCC) and Escravos light (Chevron). Proceeding of Annual Conference, Soil Science Society of Nigeria, Unical Calabar Nigeria. pp. 299- 3000.

Ohiri AC, Ano AO (1985). Soil Physical and Chemical Characterization of Southeastern State of Nigeria. Monograph of National Root Crops Research Institute, Umudike, Nigeria. pp 1-85.

Okonokhua BO, Ikhajiagbe B, Anoliefo GO, Emede TO (2007): The Effect of spent engine oil on soil properties and growth of maize (*Zea mays* L.). Appl. Sci. Environ. Manage. 11(3):147-152.

Page AL, Miller RH, Keeney DR (eds) (1982). Methods of Soil Analysis. Am. Soc. Agron. 5(2):579-585.

Steel GD, Torrie JH (1980). Proceedures of Statistics. A biometrical approach. 2nd Ed. McGraw Hill, Book Company, New York, p 63.

Stewart FS, Beswick TS (1977). Bacteriology, Virology and Immunology for Students in Medicine. 10th (ed). The English Language Book Society, London. 620 p.

Susan WC, Kelvin JC (1993). Bioremediation of Soil Contaminated with Polynuclear aromatic hydrocarbons(PAHs): A review. J. Environ. Pollut. 81:229-249.

Schoenebager PJ, Wysocki DA, Benham EC, Broderson WD. (2002). Field Book for describing and Sampling Soils. (version1:1). Natural Resources Conservation Service, USD, National Survey Centre, Lincoln.

Uheghu FO, Akubugwo EI, Iweala EJ, Uhegbu OC (2012). Impact of Spent Engine Oil on Soil and Growth of *Zea mays* L Seeds. Sci. J. Environ. Sci. 1(1):1-8.

Wang QR, Liu XM, Cui YS, Dong YT, Christie P (2002). Response of legume and non-legume crop species to heavy metals in soil with multiple metal contamination. Journal of Environmental science and Health. Part A, Toxic/Hazardous substance and environmental engineering 37:611-621.

Wikipedia (2016). Properties of Kerosene Oil. Accessed online on 12/07/2016. http://en.m.wikipedia.org.