

Remediation of Crankcase Oil Contaminated Soil with Different Sources of Manure in Abakaliki, Southeast, Nigeria

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¹Department of Soil Science and Environmental Management, Faculty of Agriculture and Natural Resources Management, Ebonyi State University, PMB 053, Abakaliki, Nigeria

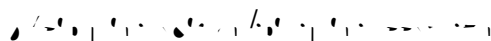
²Mekelle University, Mekelle, Ethiopia




Remediation of crankcase oil contaminated soil with different sources of manure was studied using randomized







The experiment was carried out at the Teaching and Research farm of the Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki. The site is located by latitude 06°4' N and longitude 08°65' E in derived savannah of the South east 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. The total annual rainfall ranges from 1700 mm to 2000 mm. The minimum and maximum temperatures are 27°C and 31°C, respectively. Relative humidity is 80% during the rainy season but declines to 60% in the dry season [8]. The soil is derived from sedimentary rock as the Abakaliki agroecological zone lies within "Asu River" from tertiary and cretaceous period. The soil is underlain by shale deposit and consists of olive brown sandy shale, fine grained sand stones and mudstone. The soil belongs to the order ultisol classified as Typic Haplustult [9].




The land area which measured 12 m × 15 m and approximately 0.02 ha was used for the experiment. The site was cleared with cutlass and debris removed. The experimental site was spread with 50,000 mgkg⁻¹ of crankcase oil sourced from mechanic site in Abakaliki

 Nwite JN, Department of Soil Science and Environmental Management, Faculty of Agriculture and Natural Resources Management, Ebonyi State University, PMB 053, Abakaliki, Nigeria, E-mail: ayason4real@yahoo.co.uk

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before cultivation. is was done using hand knapsack sprayer. e

recommended levels that could be injurious to plants, livestock and even mankind [21].

Table 2 shows effect of different sources of manure on soil physical properties contaminated with crankcase oil. There were no significant ($P < 0.05$) differences in bulk density among the treatments. Control plot had highest bulk density of 1.50 mgm^{-3} and this was higher by 5 and 6% than the values obtained in plots amended with of poultry droppings and a combined of poultry droppings and NPK fertilizer. The total porosity followed the trend obtained in bulk density. The plot amended with a combination of NPK fertilizer and poultry droppings was 19% each higher in total porosity when compared to the control and the plot amended with NPK fertilizer alone.

The combined fertilizer and NPK fertilizer treated plots had an improved aggregate stability of 12% and 11% respectively when compared to the control. These plots were also 12% and 18% higher in GMC when compared to single fertilizer treatments.

The significant positive effect of different sources of manure amendment on aggregate stability and GMC of crankcase oil contaminated soil has been reported before [5,22-24]. Similarly, positive improvements recorded in plots contaminated with crankcase oil and amended with different sources of manure when compared to control are in tandem with the findings of Ref. [25-28] reported that low soil porosity was one of the fertility problems of oil contaminated soil which often occurs as a result of compaction resulting in high bulk density.

The superior improvements in soil properties in plots amended with a combined poultry droppings and NPK fertilizer compared to other manure treatments could be attributed to its effectiveness and efficiency in attenuating and remedying soil contaminated with crankcase oil.

This could be linked to higher mineralization of nutrients from the treatments into the soil that stimulated more microbial action to degrade the hydrocarbon oil which was corroborated by Mbah [22].

The non-significant treatment effect on bulk density and total porosity implies that manure sources could not be used to remedy compaction and porosity of crankcase oil contaminated soil to levels they would not impose limitation to productivity.

Treatment	Bulk Density (mgm^{-3})	Aggregate Stability (%)	GMC (%)	Total Porosity (%)
C	1.50	43	37.95	9.0
D	1.42	47	37.85	15.0
N	1.50	43	37.60	14.0
DN	1.41	47	42.67	17.0
P (0.05)	NS	NS	0.77	0.27

Where, C - Control; PD - poultry droppings; NPK - NPK fertilizer; GMC - gravimetric

Table 2: Effect of different sources of manure on soil physical properties contaminated with crankcase oil.

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Table 3: Effect of different sources of manure on soil chemical properties contaminated with crankcase oil.

Table 3 shows effect of different sources of manure on soil chemical properties contaminated with crankcase oil. Results indicated that treatments had significant ($P < 0.05$) effect on available phosphorus, calcium and cation exchangeable capacity (CEC), but no significant increase in nitrogen or organic carbon was evident. The plot amended with NPK fertilizer was 6% each higher in soil pH when compared to values of those amended with poultry droppings and a combination of poultry droppings and NPK fertilizer. Furthermore, significant ($P > 0.05$) differences were observed in available phosphorus in plots amended with different sources of manure. The plot amended with poultry droppings was 22% higher in available phosphorus when compared to control and plots receiving NPK fertilizer and combination of poultry droppings and NPK fertilizer, respectively.

The organic carbon content of plot amended with a combination of poultry droppings and NPK fertilizer was higher by 20, 19 and 25% when compared with control, plots amended with poultry droppings and NPK fertilizer.

There were significant differences in calcium among the treatments. Similarly, the plot amended with combination of poultry droppings and NPK fertilizer was 75, 30 and 50% higher in calcium when compared to control, plots amended with poultry droppings and NPK fertilizer, respectively. Plot amended with NPK fertilizer was respectively higher in Mg, K and Na by 57, 19 and 31% relative to control and also varied from other treatments. Cation exchange capacity of plots receiving amendments was significantly ($P < 0.05$) higher than control.

The plot amended with a combination of poultry droppings and NPK fertilizer was respectively higher by 18, 34 and 66% in CEC when compared with the plots amended with poultry droppings, NPK fertilizer and control. Base saturation was 5 and 4% higher in base saturation in plot amended with combination of poultry droppings and NPK fertilizer compared to control and plots amended with poultry droppings.

The no significant treatment effect obtained in soil pH, Nitrogen, organic carbon and exchangeable Mg, K, Na and BS could be attributed to low fertility trend of soil used for study and effect of crankcase oil contamination. It further implies that the amendments were not effective and efficient enough to attenuate the problem of crankcase oil contamination on these soil properties Vuoto et al. [25]. had earlier reported that fertility problem in soil contaminated with spent lubricant oil due to the fact that it contained toxic materials which affected Nitrogen, organic carbon exchangeable, Mg, K, Na and BS as well as some other nutrients in the soil which affect inherent productivity of soil.

The low nitrogen in soil is in line with the report of Atuanya [29] who pointed out that nitrogen was not significantly affected by amendments in oil contaminated soil. Low nitrogen obtained in plot amended with a combination of poultry droppings and NPK fertilizer

relative to values obtained for those receiving poultry droppings and NPK fertilizer could be attributed to higher microbial activities which led to immobilization of nitrogen into microbial tissues for degradation of hydrocarbon oil. Several authors [30-32] had reported low total nitrogen, organic carbon and soil pH in soil contaminated with spent lubricant oil. Low values of Na, K and Mg were noted by Nwite [33] in his study of soil contaminated with automobile oil. Exchangeable Na, K and Mg can enter into complexes with other elements and this could be one of the reasons for their low values in the soil. Tiger et al. pointed out that Na was particularly low in soil contaminated with hydrocarbon oil due to its immobilization. The significant treatment effect on available P, exchangeable Ca, cation exchangeable capacity (CEC) suggests that the amendments have the potentials to restore crankcase oil degraded soil by increasing these nutrients in the soil. The significant effect of treatments on available phosphorus could further be attributed to improvements on soil pH and organic carbon of amended plots (Table 3). This is because high pH and organic carbon in soil has positive influence on soil available phosphorus. Significant exchangeable Calcium could be attributed to characteristic of strongly weathered soils of the tropics and already high calcium content at pre-planting period. This finding is in line with the observation of Ref. [30]. Abii and Nwosu that calcium was high and significant due to strongly weathered characteristics of tropical soils. The significant CEC could be attributed to positive effects of amendments on one hand and improved values of soil pH, available phosphorus, organic carbon and exchangeable Ca, Mg and Na on the other (Table 3). Superior performance of combination of poultry droppings and NPK fertilizer treatment on improving nutrients of soil compared to other treatments could be linked to higher mineralization which spurred higher microbial degradation of hydrocarbon oil. This finding is in line with the report of Adesodun [1] that higher microbial action on hydrocarbon oil increased soil productivity.

Table 4 shows effect of different sources of manure on heavy metals concentration of soil contaminated with crankcase oil. Results indicate that there was no significant ($P < 0.05$) treatment effect on heavy metals concentration of soil. Heavy metals of control were higher than the values obtained in amended plots, respectively. The values of Pb are 25, 33 and 55% higher in control compared to plots amended with poultry droppings, NPK fertilizer and combination of droppings and NPK fertilizer. Cadmium was 10 and 20% higher in control relative to plots amended with NPK fertilizer and combined poultry droppings and NPK fertilizer.

Higher concentration of Pb and Cd in control relative to amended plots indicates that crankcase oil contamination could be remedied through different sources of manure amendments. This finding is in line with Anikwe [34] who reported that organic wastes could be used to ameliorate heavy metals concentration in soil contaminated with spent lubricant oil and increase its productivity. Low values of

Pb and Cd in amended plots compared to control could be attributed to adsorption by materials provided by the amendments into the soil. Jones et al. [35] pointed out that heavy metals were adsorbed at particle surface or to carbonates as well as occluded in iron or manganese oxides, organic matter or sulphide. This was corroborated by Anikwe [36]. In his findings where he noted that heavy metals were chelated by organic matter and thus reduced its presence in the soil. The Pb and Cd in soil are higher than low levels of 0.0-0.1 and 0.0-0.003 recommended by LASEPA to be safe to life. Lead and Cadmium are lower than recommended high values by WHO for ecotoxicity.

Table 5 shows effect of different sources of manure on plant heights of soil contaminated with crankcase oil at 2, 4, 6, 8 and 10 weeks after planting (WAP). The result showed significant ($P < 0.05$) treatment effect on plant height relative to control at different sampling periods. Similarly, there were significant ($P < 0.05$) differences among treatments in plant height at different sampling periods. The plot amended with a combined poultry droppings and NPK fertilizer had tallest maize plant at 2, 4, 6 and 10 WAP compared to control and plots amended with poultry droppings and NPK fertilizer, respectively. These were 34, 27, 16%; 35, 13, 20%; 2, 31, 12% and 14, 22, 16% respectively taller maize plants in plot amended with combined poultry droppings and NPK fertilizer compared to control, plots amended with poultry droppings and NPK fertilizer. $C_e w67 (r)13 ts << \text{Lang (S)MCID } 5m ts << (in)4 (e)-5$

of poultry droppings and NPK fertilizer had superior performance in increasing and sustaining soil productivity when compared to other treatments. It could be recommended that different sources of manure be used to ameliorate and sustain productivity of soil contaminated with crankcase oil.



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1. lubricant oil and its quality assessment using micro-morphological analysis.

grain yield of maize of soil contaminated with crankcase oil. Results indicated that grain yield of maize in amended plots was significantly ($P < 0.05$) higher than control. Significantly ($P < 0.05$) higher grain yield of maize was obtained in plot amended with a combination poultry droppings and NPK fertilizer when compared with control, plots treated with poultry droppings and NPK fertilizer, respectively. It was 44, 36 and 40% respectively higher than the control, plots amended with poultry droppings and NPK fertilizer. The increase in grain yield of maize is as follows $PD+NPK > PD > NPK > C$ in the treatments.

The low grain yield in control could be due to poor physical and chemical properties of the soil (Tables 2 and 3). This implies low nutrient utilization in the soil [37]. Similarly, Brady and Weil [3] noted that productive capacity of soil contaminated with spent lubricant oil was degraded. Mbah et al. [4] reported low maize grain yield in spent oil contaminated soil. The significant increase in grain yield of maize in plots treated with different sources of manure and particularly one receiving combined poultry and fertilizer treatment could be linked to improvements in physical and chemical properties of soil (Tables 2 and 3). Similar observations were made [23,27,38] of significant increase in grain yields of maize in soil amended with organic wastes. The grain yields of maize were below global maize yield of 2.5 t ha^{-1} [39] and high value according to the recommendation of NPAFS [40,41] under different sources of manure treatment and control.

CONCLUSION

The result of this study had shown that amendment of soil contaminated with crankcase oil with different sources of manure improved soil properties and agronomic yield of maize and generally its productivity. Significantly higher effect of treatments was obtained on aggregate stability, gravimetric moisture content, available phosphorus, exchangeable calcium, cation exchange capacity, maize plant height and grain yield of maize in amended plots relative to control. Comparatively, the plot amended with combined sources of manure

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