FULL LENGTH RESEARCH ARTICLE

EFFECTS OF POULTRY MANURE AND COW DUNG ON THE PHYSICAL AND CHEMICAL PROPERTIES OF CRUDE OIL POLLUTED SOIL

ONUH, M. O.; *MADUKWE, D. K. & OHIA, G. U.
Department of Crop Science & Biotechnology,
Imo State University, P.M.B. 2000, Owerri, Nigeria.
*(Corresponding author)
donkele2002@yahoo.com

ABSTRACT

An experiment was conducted in the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, Imo State University, Owerri, Nigeria to investigate the potentials of using poultry manure and cow dung as bioremediants for crude oil polluted soils. The experiment was arranged in a Randomized Complete Block Design of a split plot fashion with four main plots represented by the levels of crude oil pollution (0 ml, 100 ml, 200 ml and 300 ml), while the organic manure (poultry manure and cow dung) and a control (no-treatment) plots constituted the subplots. The entire setup was replicated 3 times. Maize seeds (Oba super) were used as a test crop. Soil collected from the university's farm site was used to fill the buckets for planting. Thirty-six pieces of 30 cm^3 capacity buckets were filled to 2/3 capacities with soil collected from the farm site, and polluted with the crude oil according to the levels. Organic manure was applied at 14days after pollution while the maize seeds were planted at 28days after pollution. Soil samples were collected at three intervals first, before pollution, secondly 14 days after pollution and then 14 days after manure application for physical and chemical analysis of the soil. At two weeks after germination, the germination percentage and plant height were determined while cob length, number of seeds per cob were determined at maturity (90 days after planting). Results revealed that crude oil pollution significantly affected the soil physical and chemical properties and also impaired maize plant growth. At increased level of pollution (300 ml), the soil chemical and physical properties were severely degraded, however, the application of poultry and cow dung manures significantly repaired the degraded soil. The results also revealed that poultry manure showed superiority over cow dung in amending crude oil degraded soil. Soil pollution also impaired the maize seed germination and growth. At 300 ml, crude oil pollution the lowest (58.50 %) germination percentage was recorded, but with application of poultry manure germination percentage was 100 %. It was recommended that poultry manure be employed in the amendment of crude oil polluted soils.

Key words: Effect, physical, chemical, properties, cow dung, poultry manure, and maize.

INTRODUCTION

Soil is the key component of natural ecosystem because environmental sustainability depends largely on a sustainable soil ecosystem (Adedokun & Ataga 2007; Adenipekun 2008).

Crude oil and petroleum products such as gasoline, fuel oils and diesel fuels are complex mixtures of organic compounds and have been shown to be toxic to plants, in addition to their adverse affects on the soil ecosystem through adsorption to soil particles (Anonymous 2003).

In Nigeria, most of the terrestrial ecosystem and shore lines in oil producing communities are important agricultural land under continuous cultivation. Any contact with crude oil usually results in damage to the soil, microorganism and plants (Adedokun & Ataga 2007). Oil pollution prevents normal oxygen exchange between soil and the atmosphere, due to hydrophobic properties of oil (Onuoha *et al.* 2003). The most serious result of pollution is its harmful biological effects on human health and on the food chain, birds and marine life. Pollution can destroy vegetation that provides food and shelter. it can seriously disrupt the balance of nature and in extreme cases can cause the death of humans (Amakiri & Onefeghara 1983).

Some studies have been carried out on the effects of crude oil pollution on seed germination, plants and soil. For example, Ogboghodo *et al*. (2001) reported that crude oil inhibited the germination and growth of maize at high pollution levels while the growth of Okra and *Telfairia* seedlings were highly reduced with an increase in crude oil concentrations (Asuquo *et al.* 2001).

iThe effects of crude oil pollution on the properties of soil have been the subjects of many studies. Okolo *et al.* (2005) reported that oil pollution increases soil organic carbon and reduced soil nitrates and phosphorous, thus imposing a condition that impaired oil degradation in the soil. Organic manure has over time been used to improve soil fertility. Its efficacy in promoting plant growth in crude oil polluted soils has been studied (Okolo *et al.* 2005). This study therefore, was aimed at investigating the potentials of using poultry manure and cow dung as bioremediants in crude oil polluted soils.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, Imo State University, Owerri, Nigeria using a Randomized Complete Block Design arranged in a split plot fashion with four replications. The levels of crude oil pollution (0 ml, 10 ml, 200 ml and 300 ml) made up the main plots, while organic manures (poultry manure and cow dung) constituted the subplots. Maize seeds (Oba super) collected from Imo State Agricultural Development Programme (IMOADP) were used as the test crop. The organic manures (poultry manure and cow dung) were collected from the University's livestock farm, while spent engine oil collected from Orji mechanic village was used and also spent engine oil was collected from Orji mechanic village in Owerri.

29 kg soil collected from the University's farm site was filled into 36, 30cm^3 buckets to 2/3 volumes. The spent engine oil was used to pollute the soils in the buckets at various levels (0 ml, 100 ml, 200 ml

and 300 ml). The polluted soils were allowed to stand under natural environment for 14 days after which the organic manures were applied by incorporating into the soil in the buckets at the rate of 1Kg of manure per 20 Kg soil at 28 days after pollution. Maize seed was sown in the soil at the rate of one seed per bucket at the dept of 4 cm. Soil samples were collected from the buckets at three intervals, first was before crude oil application, second was at 14 days after crude oil application and third was at 28 days after pollution and used to determine the soil physical and chemical properties. Weeding of the plots was carried out as the need arose. Data were collected on the number of days to germination, germination percentage, plant height (cm), cob length (cm) and number of seeds per cob and subjected to Analysis of Variance (ANOVA). Separation of means was carried out by Duncan Multiple Range Test (Onuh & Igwema 2001).

RESULTS

Effect of crude levels on the physical and chemical properties of the soil: Results of the soil analysis showed the soil to be a sandy loamy type, with sand value of 88 %, silt 8 % and Clay 4 % (Table 1). The analysis also showed a slight change in the pH value as crude oil level increased (Table 2). The pH increased from 6.15 at 0 ml of crude oil to 6.21, 6.22 and 6.24 at 100 ml, 200 ml, and 300 ml, respectively (Table 2). There was also increase in Organic Carbon (OC) but decreased Organic Matter (OM), as the level of crude oil pollution increased. The OC increase from 1.43 % (Table 1) to 3.05 %, 3.31 % and 3.83 % at 100 ml, 200 ml and 300 ml respectively (Table 2) while OM decreased from 6.62 % at 0 ml of crude oil (Table 1) to 5.72 %, 5.27 %, and 2.48 % at 100 ml, 200 ml, and 300 ml, respectively (Table 2).

The Total Nitrogen (TN) decreased correspondingly as pollution level increased. TN decreased from 0.33 % as seen in Table 1 to 0.29 %, 0.28 % and 0.12 % at 100 ml, 200 ml and 300 ml, respectively (Table 2) similarly, the cation Exchange Capacity (CEC) reduced as pollution level increased. From the Table 1, CEC value was 5.04 cmol/kgsoil at 0 ml of crude oil and after pollution, it reduced to 3.90 cmol/kgsoil, 3.86 cmol/kgsoil and 3.85 cmol/kgsoil at 100 ml, 200 ml and 300 ml, respectively (Table 2). The sand content of the soil increased from 88 % at 0 ml of crude oil (Table 1) to 94.40 %, 90 % and 94.60 % at 100 ml, 200 ml and 300 ml, respectively (Table 2).

Effect of organic manure on the physical and chemical properties of crude oil polluted soil: Organic manure significantly influenced the properties of the polluted soils as seen in the Table 3. Plots that received poultry manure amendment showed significant reduction in pH value. From the Table 2, plots polluted with 100 ml of crude oil had a pH value of 6.21, which was reduced to 5.52 and 6.14 with the application of poultry and manures, respectively (Table 3). which was significantly different from the germination percentage (58 %) recorded from plots treated with 300ml of crude oil pollution (Table 4).

The unpolluted (control) plots gave the highest mean plant heights of 43.70 cm and 90.70 cm at two weeks after planting (WAP) and four WAP, respectively, which were significantly different from the mean plant heights of 27.80 cm and 52.70 cm observed at two WAP and four WAP respectively from plots that received 300ml of crude oil pollution (Fig 1). Plant heights in the plots that received poultry manure were significantly higher (77.7 cm) than the plots that did not receive poultry manure, with mean value of 30 cm (Fig 2).

Cob length of maize: Crude oil pollution significantly affected the length of maize cob produced, although, there was no significant difference in the length of cob from the control plots (11.80) and the plots that received 100 ml of crude oil (11.38) (Table 5). However there was significant difference between the unpolluted plots and the polluted. Plots polluted with 300 ml crude oil gave the shortest cob length (8.80 cm) which was significantly different from mean cob length of 11.80 cm observed in the control plots (Table 5). Plots amended with poultry manure gave the highest cob length (13.65 cm), which was significantly different from the cob length of 7.13 cm observed in the control plots that did not receive poultry manure (Table 5).

Number of seeds per Cob: The highest number of seeds per cob (236.25) was observed from the unpolluted plots, which was significantly different from the lowest number of seeds per cob (144.75) observed from the 300ml of crude oil (Table 5). Mean number of seeds per cob was also found to be higher in the plots that received organic manure than the plots that did not receive the manures. From the Table 5, poultry manure and cow dung treatments recorded mean number of seeds per cob of 255.50 and 189.50 respectively, which were significantly different from the mean value of 83.75 seeds per cob recorded in the plots untreated with manures (Table 5).

TABLE 1: PHYSICAL AND CHEMICAL PROPERTIES OF THE SOIL BEFORE POLLUTION

Soil parameters	Values
pH	6.15
Organic carbon (%) (O.C)	1.43
Organic matter (OM) (%)	6.62
TEA (cmol/kgsoil)	0.70
Al^{3+} (cmol/kgsoil)	0.40
H^{+}	0.30
Total Nitrogen (TN) (%)	0.12
Ca^{++} (cmol/kgsoil)	2.40
Mg++ (cmol/kgsoil)	1.60
Na+ (cmol/kgsoil)	0.14
CEC (cmol/kgsoil)	5.04
Base Saturation (BS) (%)	86.11
Available P. (ppm)	3.20
K+ (cmol/kgsoil)	0.20
% Sand	88.00
% Silt	8.00
% Clay	4.00

DISUCSSION

The results showed an increase in the pH as the level of crude oil pollution increased, agreeing with the reports of Amadi *et al.* (1994), who observed that increased crude oil level results in increase in the soil pH. The increase in Organic Carbon and decrease in Organic Matter observed in this study had been observed earlier (Asuquo *et al.* 2001). Results also showed that the Total Nitrogen (TN) of the soil decreased with increase in the level of pollution while the Cation Exchange Capacity (CEC) reduced as the pollution level increased. However, with the application of manure (poultry manure), the TN level increased to almost its original levels. Mulongoy & Merckx (1993) had earlier observed that organic manure balances the Nitrogen level of the

TABLE 2: SENSITIVITY OF ANTIBODIES TO *O. volvulus* EXTRACT DEPENDING ON PARASITOLOGICAL STATUS.

Soil parameters	Pollution levels (ml)			
	0	100	200	300
pH	6.15	6.21	6.22	6.24
Sand (%)	88.0	94.4	90.0	94.6
Silt (%)	80.0	2.00	6.00	1.40
Clay (%)	4.00	4.00	4.00	4.00
OC (%)	1.43	3.05	3.31	3.83
OM (%)	2.48	5.27	5.72	6.62
TEA (cmol/kgsoil)	0.70	0.40	0.60	0.30
Al^{3+} (cmol/kgsoil)	0.40	0.20	0.60	0.20
H^{+} (cmol/kgsoil)	0.30	0.20	0.60	0.10
TN (%)	0.33	0.29	0.28	0.12
Ca^{++} (cmol/kgsoil)	2.40	1.25	2.00	2.20
Mg^{++} (cmol/kgsoil)	1.60	0.80	0.80	0.6
K^{+} (cmol/kgsoil)	0.20	0.25	0.21	0.15
Na^{+} (cmol/kgsoil)	0.14	0.20	0.25	0.20
CEC (cmol/kgsoil)	5.04	3.90	3.86	3.85
B.S (%)	86.11	82.2	84.4	92.2
P (ppm)	3.20	3.10	2.95	2.90

TABLE 3: PHYSICAL AND CHEMICAL PROPERTIES OF THE SOIL AFTER MANURE APPLICATION (AMENDMENT)

Treatment	Unamended			Amended with Poultry manure			Amended with Cow dung		
Level of pollution (m)	100	200	300	100	200	300	100	200	300
pH	6.21	6.22	6.24	5.52	5.81	6.01	6.14	6.51	6.47
Sand (%)	94.40	90.00	94.60	88.00	88.10	88.40	90.00	90.00	90.00
Silt (%)	2.00	6.00	1.40	6.40	6.20	6.00	6.00	6.00	6.00
Clay (%)	4.00	4.00	4.00	6.00	6.10	5.60	4.00	4.00	4.00
O.C (%)	3.05	3.31	3.83	1.65	2.41	2.65	2.37	3.00	3.39
O.M (%)	5.72	5.27	2.48	3.21	3.43	4.21	4.10	5.01	5.86
TEC (cmol/kgsoil)	0.40	0.60	0.30	0.80	0.80	0.50	0.30	0.65	0.50
Al^{3+} (cmol/kgsoil)	0.20	0.60	0.20	0.50	0.14	0.20	0.15	0.01	0.30
H^{+} (cmol/kgsoil)	0.20	0.60	0.10	0.30	0.67	0.30	0.5	0.64	0.20
TN (%)	0.29	0.28	0.33	0.19	0.30	0.32	0.20	0.25	0.29
Ca^{++} (cmol/kgsoil)	1.25	2.00	2.20	1.20	1.40	1.20	0.80	1.90	1.80
Mg^{++} (cmol/kgsoil)	0.80	0.80	0.6	1.00	1.00	0.80	0.60	0.85	1.00
K^{+} (cmol/kgsoil)	0.25	0.21	0.15	0.15	0.20	0.11	0.19	0.25	0.22
Na^{+} (cmol/kgsoil)	0.20	0.25	0.20	0.20	0.25	0.25	0.20	0.27	0.40
CEC (cmol/kgsoil)	3.90	3.86	3.85	3.96	3.86	3.86	3.09	3.90	3.92
B.S (%)	82.2	84.4	92.2	76.1	82.5	82.5	85.6	85.5	87.2
P (ppm)	3.10	2.95	2.90	3.20	2.80	2.80	2.90	3.05	2.19

TABLE 4: EFFECT OF CRUDE OIL POLLUTION LEVEL AND MANURE TREATMENTS ON GERMINATION OF MAIZE

Treatments	Mean number of days to germination	Mean percentage germination (%)
A. Crude oil levels (ml)		
0 (control)	3.00[b]	100.00[a]
100	3.50[b]	85.90[b]
200	3.20[b]	80.20[b]
300	4.70[a]	58.50[c]
B. Manures		
Zero (Control)	5.30[a]	70.00[c]
Poultry	3.10[b]	100.00[a]
Cow dung	3.60[b]	85.60[b]

Means having the same letter(s) in the same column are not significantly different at $p \leq 0.05$ according to Duncan New Multiple Range Test (DNMRT).

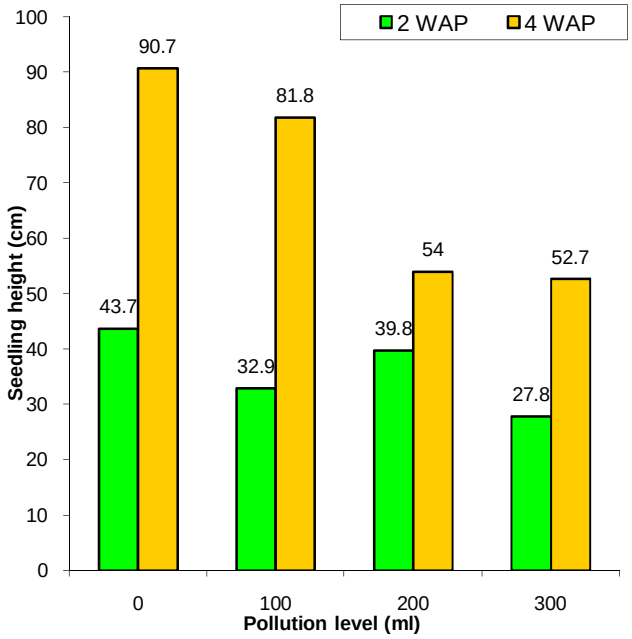

FIG 1: EFFECT OF CRUDE OIL ON MAIZE PLANT GROWTH

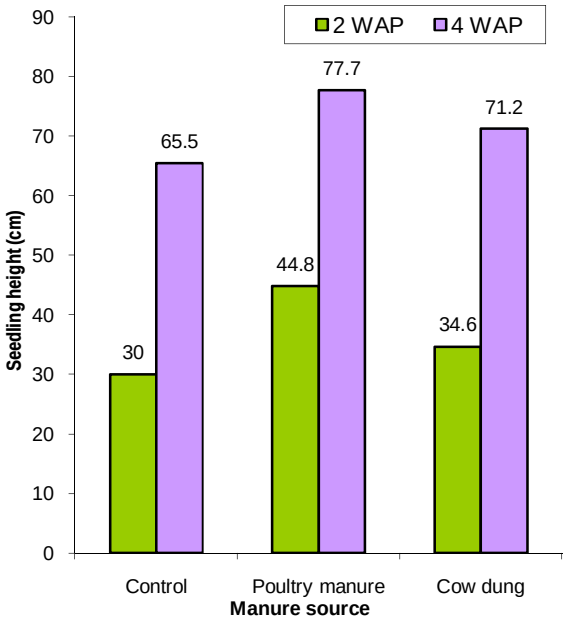

FIG 2: EFFECT OF MANURE APPLICATION ON MAIZE PLANT GROWTH

TABLE 5: EFFECT HAS CRUDE OIL AND MANURE TREATMENTS ON MAIZE COB QUALITY

Treatments	Mean length of cob (cm)	Mean number of seeds per cob
A. Crude oil levels (ml)		
0 (control)	11.80[a]	236.25[a]
100	11.38[a]	220.25[b]
200	10.58[b]	220.56[b]
300	8.80[c]	144.75
B. Manures		
Zero (Control)	7.13[bc]	83.75[c]
Poultry	13.65[a]	255.50[a]
Cow dung	9.48[b]	189.50[b]

soil even under degraded conditions. Despite the application of organic manure, the available phosphorous (P) in the soil decreased as the level of crude oil pollution increased. This was due to the fact that organic manure applications do not affect soil available phosphorus in crude oil soils (Ogboghodo *et al.* 2005).

Even though there was a slight decrease in percentage sand and increase in percentage silt, the effect of crude oil on the soil texture was somewhat minimal even after the application of manures. This may be attributed to the aggregation of the soil particles by organic manures as observed by Okolo *et al.* (2005).

The germination of maize seed was impaired by crude oil pollution and the effect increased with increase in the level of pollution, thus giving credence to the reports of Murphy (1965), that germination of seeds was adversely affected by crude oil pollution and that the effect was proportional to the level and concentration of the pollution. However, with application of organic manure, the germination of maize seeds was improved, attaining optimal level with the poultry manure. This could be due to the microbial mineralization of the crude oil by some microorganism inhibiting the organic materials which reduces some of the phytotoxic effect of the crude oil on the seeds (Okolo *et al.* 2005) The performance of poultry manure was in line with some reports (Hussein 1997; Christo *et al.* 2008), that poultry manure is superior to other organic manures.

The crude oil adversely affected the growth of maize plant, especially at the earlier stage (2WAP) and the effect increased at the increased level of crude oil pollution. This observation was similar to findings of Ogboghodo *et al.* (2001), who reported that the presence of crude oil in the soil retarded the growth of maize seedlings.

However, at 4 WAP the growth of maize seedlings seemed to improve especially in the plots with lower (100 ml) level of crude oil pollution. This could however, be due to the fact that the soil microbes may have acclimatized to the polluted environment, thus encouraging microbial mineralization of the crude carbon compounds as once reported by Okolo *et al.* (2005), Amakiri & Onefeghara (1983). Maize seedling growth improved further with the application of manures, especially poultry manure.

Increasing level of crude oil pollution impaired the quality of cob produced by the maize plant. The maize plant that grew under 300 ml of crude oil pollution produced dwarfed cobs. However, application of poultry manure significantly improved the cob length of maize plants grown under crude oil pollution. This could be due to the ability of the poultry manure to release in good time, Nitrogen and other minerals needed for cob formation (Amadi *et al.* 1994).

CONCLUSION

Organic manures enhanced bioremediation of crude oil polluted sandy-loamy soil. However, the extent of this depends on the source of the organic manure. It was observed that poultry manure effectively remediated the crude-oil polluted soil used in this study. This was evidenced by the improvement in the soil physical and chemical properties and improved growth characteristics of the maize after application of poultry manure.

REFERENCES

Adedokun, O. M. & Ataga, A. E. 2007. Effects of amendments and bioaugumentation of soil polluted with crude oil, automotive gasoline oil, and spent engine oil on the growth of cowpea (*Vigna unguiculata* L. Walp). *Scientific Research and Essay* Vol. 2(5):197-149.

Adenipekun, C. O. 2008. Bioremediation of engine oil polluted soil by *Pleurotus tuber-regium* Singer, a Nigerian whole-rot fungus. *African Journal of Biotechnology* Vol. 7(1):055-058.

Amadi, A.; Samuel, D. A. & Anthony, M. 1994. The effect of crude oil spillage on the soil microbial properties of a tropical rainforest. *Journal of Water, Air and Soil Pollution* 67 (1-3): 28-30.

Amakiri, J. O. & Onfeghara, F. A. 1983. Effect of crude oil pollution on the growth of *Zea mays*, *Abelmoschs esculentus and caspicum frustenscens. Oil and petrochemical Pollution Journal* 2(4):199-205.

Anonymous, 2003. Remediation of Petroleum. Contaminated Media (Online). Bioremediation: An Alternative Tool, Available at http.//www.xlenvironmental.com/ library/winter.htm (Assessed 15 June 2006).

Asuquo, F. E.; Ibanga, I. J. & Hungafa, N. 2001. Effects of Qua Iboe crude oil contamination on germination and growth of Okra (*Abeloschus esculintus* L.) and fluted pumpkin *(Telflaric occidentalis* L.) P*roc of the 27th Annual Conf. Of the Soil Sci. Soc. of Nig.* Nov. 5 – 9, 2001. University of Calabar, Nigeria.

Christo, I. E. C.; Madukwe, D. K. & Onuh, M. O. 2008. Growth and Yield of Cowpea (*Vigna unguiculata* (L.) Walp) As Influenced by cultivar and organic manure source in the Humid Tropical Environment. *International Science Research Journal* 1(1): 47-52.

Hussein, T. O. 1997. Effect of poultry manure on the growth of tomato. *Proceedings of the 15th annual Conference* HORTSON April 8-11, 1997 NIHORT Ibadan Nigeria

Mulongoy, K. & Merckx, R. 1993. Soil Organic matter Dynamic and Sustainability of Tropical Agriculture, Wiley-wayce 10 publication Belgium.

Murphy, J. F. 1965. Some effects of crude petroleum on nitrate production, seed germination and growth. *Soil Science Journal* 27:117-120.

Ogboghodo, I. A.; Azenabor, U. F. & Osemwota, I. O. 2005. Amelioration of crude oil polluted soil with poultry manure and the effect on growth of maize and some soil properties. *Journal of Plant Nutrition* 28(1): 21-32.

Ogbohodo, I. A.; Iruafa, E. K.; Osenwota, I. O. & Chokor J. U. 2001. An assessment of the effect of crude oil pollution on soil properties; germination and growth of maize. *Proceedings of the 27th annual conf. of the Soil Science Society of Nigeria*. Nov. 5-9, 2001. University of Calabar Nigeria.

Okolo, J. C.; Amadi, E. N. & Odu, C. T. I. 2005. Effects of soil treatments containing poultry manure on crude oil degradation in a sandy loamy soil. *Applied Ecology and Environmental Research* **3**(1): 47-53.

Onuhoha, C. I.; Arinze, A. E. & Alaga A. E. 2003. Evaluation of growth of some fungi in crude oil polluted environment. *Global Journal of Agricultural Science,* 2:1596-2903.