

Evaluation of the Effects of Pollution with Spent Lubricating Oil on the Physical and Chemical Properties of Soil.

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ABSTRACT

This study investigated the impact of spent lubricating oil on the physical and chemical properties of soil. Five medium sized plastic planting pots were filled with the topsoil collected from 4-year old fallowed plot and 500ml spent lubricating oil was added to each pot and allowed to drain through the soil. The planting pots were labeled as Treatment GA, GB, GC, GD, and GE. A control experiment (i.e. top sandy-loamy soil without spent lubricating oil) was equally set up and replicated five times. A constant weight of 3000g was maintained for each planting pot with its soil contents in all the treatments and the control. The treated and control pots were arranged in a greenhouse and were watered for two consecutive days, at 7:00 GMT. Treatment GA, GB, GC, GD, and GE were watered for 7-, 14-, 21-, 28- and 35-days after which the physical and chemical properties of the respective treated soil were determined.

The spent lubricating oil altered the physical and chemical properties of the soil. It resulted in increased bulk density, water porosity, organic matter, and organic carbon contents, and reduced soil capillarity, soil aeration, water holding capacity, nitrogen, phosphorous, sodium, potassium, magnesium and calcium contents in the soil. However the reduction in the spent lubricating oil concentration due to daily watering resulted in the improvements in the physical and chemical properties of the soil sample.

(Keywords: soil quality, soil characteristics, POL, SOL, contamination, chemical properties)

INTRODUCTION

Lubricating oil, produced by vacuum distillation of crude oil (Kalichevsky and Peter, 1960), is an essential product of petroleum that aids the

reduction of frictional forces between contacting metal surfaces of an engine. The spent lubricating oil (SLO) is usually obtained after servicing and subsequent drainage from engines and generators (Anoliefo and Vwioko, 2001; Ogbo *et al.*, 2006).

Service stations in most parts of Nigeria find it difficult to properly dispose of the SLO hence large volume is indiscriminately disposed on plots, land, sewage, and drainage ditches (Odjegba and Sadiqi, 2002) thus increased pollution incidents in the environment are more wide spread than pollution with crude oil (Atuanya, 1980).

Previous studies on crude oil pollution in soil had revealed that the oil makes the soil conditions unsatisfactory for plants (DeJong 1980), and affects soil physical and chemical compositions. There has been a gross dearth of studies on the effects of SLO pollution on the physical and chemical compositions of soil in Nigeria where the pollutant is now assuming unprecedented proportions. This study was therefore conducted to provide baseline information on the effects of SLO pollution on the physical and chemical properties of soil in the study area.

MATERIALS AND METHODS

Sandy-loamy top soil was collected within 5cm depth from a 4-year old fallowed plot in the University Farm, University of Ado-Ekiti, Ado-Ekiti, Nigeria while SLO was collected from a road side mechanic workshop, located along Ado-Iworoko road, Ado-Ekiti. Five medium sized (2000cm³ each) plastic planting pots were filled with the top soil and each was polluted with 500ml SLO. The planting pots, with a uniform weight of 3000g each, were labeled as Treatment GA, GB, GC, GD and GE. A control experiment (i.e. top sandy-loamy soil without spent lubricating

oil) was also set up and replicated five times while the constant weight of 3000g was also maintained for each planting pot and its soil content. The control experiment pots were labeled as CGA, CGB, CGC, CGD and CGE to serve as control experiment for Treatments GA, GB, GC, GD, and GE, respectively.

All the treatments and control pots were arranged in the greenhouse of the Department of Plant Science, University of Ado-Ekiti, Ado-Ekiti, Nigeria. They were watered for two consecutive days, at 7:00GMT. The daily watering was continued in Treatment GA for 7 days, GB for 14 days, GC for 21 days, GD for 28 days, and GE for 35 days. The soil in each treatment was subjected to physical and chemical analyses at the end of its watering regime.

The bulk density was determined according to Ibitoye (2006), soil porosity, soil capacity, water holding capacity and soil air were determined according to Akinsanmi (1975), soil pH was determined on the Electronic Bechman Zeromatic pH meter using a 1:2 (soil:water) suspension. Total nitrogen was determined by the Kjeldal method and the nitrogen content in the digest was determined by distillation, calcium, magnesium, and potassium were extracted by direct cation ammonium saturation method (Anderson and Ingram, 1996). Calcium and magnesium were subsequently determined by EDTA titration. Potassium was determined by flame photometry. Available phosphorus was

extracted by the Bray and Kutz method (1945) and analyzed colometrically.

RESULTS AND DISCUSSION

The presence of spent lubricating oil had considerable adverse effects on the physical and chemical properties of agricultural soil. While rate of capillarity in the control experiment was 8.30cm/hr, treatments GA, GB, GC, GD, and GE had decreased soil capillarity rates of 0.02cm/hr, 0.02cm/hr, 0.04cm/hr, 0.08cm/hr, and 0.10cm/hr, respectively (Table 1).

Soil aeration increased with increased in daily watering. Thus, soil from the control experiment had better aeration than those from spent lubricating oil polluted soil in Treatments GA, GB, GC, GD, and GE.

The presence of spent lubricating oil in the soil increased the bulk density and decreased water holding capacity of the treated soils. The bulk density in the control experiment was 1.38g/cm³ while increased bulk density values were observed in the soil polluted with spent lubricating oil (Table 1).

While the water holding capacity in the control experiment was 59.0ml, the water holding capacity values decreased in the spent lubricating oil polluted soils. Similarly the soil porosity decreased with the increase in the concentration of SLO in the soil (Table 1).

Table 1: Effects of Pollution with Spent Lubricating Oil on Soil Physical Properties.

Treatment	Soil physical properties				
	Capillarity	Air	Bulk Density	WHC, ml.	Porosity, ml.
GA	0.02	80.00	3.80	8.0	71
GB	0.04	80.50	3.70	13.0	74
GC	0.08	83.50	3.15	18.0	88
GD	0.09	88.00	2.78	42.0	112
GE	0.10	88.00	2.70	52.0	117
Control	8.30	48.20	1.38	59.0	122

The pollution of the soil with spent lubricating oil also altered the chemical properties of the soil (Table 2). It was observed that spent lubricating oil made the soil acidic and increased organic matter and carbon contents were observed. These were probably due to the addition of carbon already present in the spent lubricating oil to carbon already present in the soil.

Nitrogen content of the soil dropped from 0.24% in the control experiment to 0.02%, 0.02%, 0.04%, 0.05% and 0.10% in the Treatments GA, GB, GC, GC, GD, and GE, respectively (Table 2). The phosphorus content reduced from 23.70Mg/kg in the control experiment to 7.26Mg/Kg, 8.44Mg/Kg, 10.62Mg/Kg, 11.13Mg/Kg, and 13.92Mg/Kg in Treatments GA, GB, GC, GD and, GE, respectively.

There was a decrease in the available magnesium content with the increase in the spent lubricating oil concentration. Calcium, sodium, and potassium contents in the soil of Treatments GA, GB, GC, GD, and GE reduced considerably with the presence of spent lubricating oil in the polluted soils.

The results obtained in this study revealed that spent lubricating oil at high concentration altered the physical and chemical properties of the soil. It destroys the soil structural classes and as well as leads to increased bulk density of the soil, which can reduce root penetrations of crops and subsequently impedes nutrient uptake from the soil. An increase in the bulk density of soil especially above 1.4g/cm³ may lead to reduction in crop yield (Janssen and Vander-Weert 1977).

The presence of SLO decreases soil water-capillarity. However, increase in the duration of watering reduced the concentration of the spent lubrication oil and an improved soil water capillarity and conductance were achieved.

SLO affects the soil aeration in the polluted soil. Previous assertion by Bossert and Bartha (1984) had revealed that crude oil readily penetrates the pore spaces of terrestrial vegetation on land following any spill with heavier friction, which may block the pores of the soil particles. SLO is likely to have similar effects on land.

Table 2: Effects of Pollution with Spent Lubricating Oil on Soil Chemical Properties.

Treatments	Chemical properties								
	pH	Organic matter	Organic carbon	N	P	K+	Na+	Ca2+	Mg2+
LA	3.82	6.38	3.70	0.02	7.26	0.31	0.18	1.81	0.50
LB	4.20	4.90	2.84	0.02	8.44	0.31	0.18	1.85	0.50
LC	6.10	4.55	2.64	0.04	10.62	0.33	0.20	2.10	0.85
LD	6.24	4.33	2.51	0.05	11.43	0.34	0.20	2.50	0.90
LE	6.54	4.26	2.47	0.10	13.92	0.35	0.25	2.78	1.00
Control	7.40	3.70	2.18	0.24	23.70	0.55	0.50	6.00	1.60

Spent lubricating oil in soil reduced phosphorus, nitrogen, calcium, and magnesium contents of the soil. The low phosphorus and nitrogen and high carbon obtained in this study agreed with the results of Ogirri *et al.* (2001), Gbaruko *et al.* (2005), and Benka-Coker and Ekundayo (1995). A study by Amadi *et al.* (1993), reported that the difference in the amount of phosphorus in the tissues of *Zea mays* grown in unpolluted and crude oil polluted soils was high.

CONCLUSION

The results of this study had revealed that pollution of vegetative soil with spent lubricating oil altered the physical and chemical properties of the soil. Thus, public awareness should be intensified, in the study area, on the detrimental effects of SLO pollution and its indiscriminate disposal should be discouraged. Strict laws must be made to guide against its indiscriminate disposal in the study area while the existing laws on pollution should be reviewed with the aim of being made more effective and complementary with the present trend. Also, there should be effective implementation of the laws on pollution in the study area.

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