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Evaluation of growth indices of *Telfairia occidentalis* Hook and physiological properties of soil containing crude oil and *Mucuna pruriens* manure treatment.

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Abstract

The soil physico-chemical properties and responses of *Telfairia occidentalis* Hook to crude oil polluted soil amended with compost of *Mucuna pruriens were investigated using the following treatment:* 0-control (soil only), pollution treatment- soil + 120ml crude oil, and remediation treatment- 0.5kg *M. pruriens* + 120ml crude oil + soil, 1.0kg *M. pruriens* + 120ml crude oil + soil, 1.5kg *M. pruriens* + 120ml crude oil + soil, and 2.0kg *M. pruriens* + 100ml crude oil + soil. Experiment was conducted using perforated polythene bags, and. three (3) seeds of *T. occidentalis* were maintained in each polythene bag based on treatment. Chemical properties of experimental soils were examined before and after harvest. There were significant ($P< 0.05$) reductions in phosphorus and nitrogen contents of contaminated soils relative to the control (unpolluted soil).The plant height, root length, leaf number and moisture contents of the test crop showed significant ($P < 0.05$) reductions in contaminated soils relative to unpolluted treatment. The addition of organic manure from *M. pruriens* ameliorated the adverse effects of crude oil pollution, although, the crop growth parameters were comparatively lower than those of the control (unpolluted soil). This study suggests that compost generated from *M. pruriens* can remediate the adverse effects of crude oil pollution by improving the soil physico- chemical properties as well as create favourable conditions and supply the needed nutrients for growth and development of the test cropthe palm oil mill effluent been relatively more effective than rubber sludge

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Introduction

The Niger Delta region is an agricultural zone where intensive farming activities are carried out for subsistence and commercial purposes (Okonwu *et al.*, 2010; Etukudo *et al.*, 2011). However, this region has been subjected to adverse effects of petroleum oil. The economic benefits derivable from crude oil are enormous, but have no doubt left negative impacts on the Nigerian environment (Adedokun and Ataga, 2007; Nwachukwu *et al*., 2007). The adverse effects of crude oil pollution include among others, adsorption of oil to soil particles, generation of an excess carbon that may be unavailable for microbial use and induction of a limitation in soil nitrogen and phosphorus (George-Okafor *et al*., 2009; Okolo *et al*., 2005). Natural rehabilitation of crude oil polluted soil usually takes a longer period compared to artificial methods involving the use of bioremediation strategies to hasten the process. Although, several remediation approaches have been adopted, the effectiveness of each method might be influenced by heterogeneity of soils and crude oil samples as well as possible interactions between the soil amendment and natural soil constituents (Okolo *et al*., 2005).

The test crop, *Telfairia occidentalis* Hook, commonly called fluted pumpkin belongs to the family, Curcubitaceae (Grubben and Denton, 2004). Its leaves are consumed as vegetable while the rind and pulp of the fruits are used as fodder for livestock due to the rich nutritive values (Oderinde *et al*., 1990; Schippers, 2002; Grubben and Denton, 2004). The source of bioremediation material, *Mucuna pruriens*, belong to the Family, Fabaceae and is commonly called velvet beans. It is an annual climbing legume (Duke, 1981). It is often regarded as one of the under-utilized wild legumes, and is widespread in tropical and sub-tropical regions of the world. It is usually utilized as a source of proteins in food and feed (Janardhanan *et al*., 2003; Pugalenthi *et al*., 2005), and contains a high protein contents of 23-35%. The digestibility of the seeds compares favourably to that of lima bean, rice bean and soybean addition its digestibility, which is comparable to that of other pulses such as soybean, rice bean, and lima bean (Gurumoorthi *et al*., 2003). Various remediation approaches have been reported, however, some rehabilitation techniques are sometimes difficult for the local farmers to interpret and adopt.

Therefore, the research work explores the effectiveness of locally available organic manure such as compost from *M. pruriens* towards enhancing microbial biodegradation of hydrocarbon polluted arable soil as well as improving the test crop (*T. occidentalis* Hook) growth performance in crude oil contaminated soil.

Materials and Methods

Pollution Experiment: Sandy- loam soil was obtained from Cross River University of Technology, Calabar, Nigeria. The physico-chemical properties of the soil were determined using standard procedures (A.O.A.C, 2003). Two kilograms (2kg) of sandy-loam soil were mixed thoroughly with 120ml of crude oil. Pollution treatment was obtained by mixing thoroughly two kilograms (2kg) of sandy-loam soil. A control treatment (0ml) containing no crude oil was used, and the set up with and without crude oil were left to condition for five (5) weeks.

Remediation Treatment: Leaves of *M. pruriens* collected from local farmers in Cross River State, Nigeria were used to prepare organic manure for remediation experiment. The leaves were sectioned into small pieces and mixed with 2kg of sandy-loam soil and 120ml of crude oil at the rate of 0.5, 1.0, 1.5 and 2.0kg. The set up was allowed to condition for 6 weeks.

Germination Studies: Viable seeds of *T. occidentalis* were sterilized with 0.01% mercuric chloride solution for 30 seconds, washed several times with distilled water and air dried. Five (5) seeds of *T. occidentalis* were sown in perforated polythene bag containing the following treatments: 0-control (soil only), pollution treatment- soil + 120ml crude oil, and remediation treatment- 0.5kg *M. pruriens* + 120ml crude oil + soil, 1.0kg *M. pruriens* + 120ml crude oil + soil, 1.5kg *M. pruriens* + 120ml crude oil + soil, and 2.0kg *M. pruriens* + 100ml crude oil + soil. Three (3) seedlings per bag were maintained in each treatment after few days of seedling growth. Each treatment was replicated five times using randomized complete block design, and maintained under natural light condition for eight (8) weeks.

Analysis of Soil Samples: Soil samples (0-15cm depth) collected from the study site, Cross River University of Technology, Calabar, Nigeria were analysed using standard methods of A.O.A.C 2003) for physico-chemical properties.

Growth Studies: The test crop growth parameters such as plant height, root length, leaf number were measured at the end of the experiment.

Statistical Analysis: Standard errors of the mean values were calculated and data were subjected to analysis of variance (ANOVA) ($P < 0.05$) to compare the means (Obi, 2002).

Results

The physico-chemical parameters of crude oil polluted soil before harvest are presented in Table 1. The pH value (5.10) of the pollution treatment was lower than those of the control (5.30) and the amended soil (5.35, 5.40, 5.60, and 5.65 at 0.5, 1.0, 1.5 and 2.0kg of *M. pruriens*, respectively) (Table 1). The contents of nitrogen and available phosphorus in pollution treatment were lower than those of the control and remediation treatments (Table 1). The contents of organic carbon, calcium, magnesium, sodium and potassium increased with increase in the levels of organic supplements (Table 1).

The plant height of the test crop increased with increase in the levels of organic supplement. These values were significantly ($P <0.05$) higher than those of the pollution treatment (Table 2). The values of leaf number recorded in all levels of remediation treatment were higher than those of the pollution treatment (Table 2). The root length of the crop increased above those of the pollution treatment from 11.33cm at 0.5kg level of organic supplement to 13.76cm at 2.0kg level of organic supplement (Table 2). The lowest moisture content (32.07%) of the crop was recorded at the pollution treatment while the highest (52.33%) was recorded at 2.0kg level of organic supplement relative to the control with 60.72% moisture content (Table 2). The pH values of the control and amended soils decreased from 5.30 and 5.10 to 5.20 and 5.10, respectively after harvest (Table 3). The contents of phosphorus, nitrogen, calcium, magnesium, sodium and potassium in pollution and amended soils after harvest decreased relative to the contents of these elements recorded before harvest (Table 3). However, the content of organic carbon increased in the pollution and amended soils at harvest comparable to those recorded before harvest (Table 3).

Table 1: Chemical properties of experimental soil before harvest

Properties	Garden Soil (0-Control)	Pollution Treatment	Remediation Treatment- Levels of *Mucuna pruriens* (kg)			
			0.5	1.0	1.5	2.0
pH	5.30 ± 0.41	5.10 ± 0.27	5.35 ± 0.39	5.40 ± 0.42	5.60 ±0.36	5.65 ±0.40
Available-P (mg/100g)	7.32 ± 0.26	0.17 ± 0.04	0.53 ±0.05	0.72 ± 0.06	2.07 ±0.72	2.14 ±0.34
Ca (mg/100g)	2.41 ± 0.24	2.93 ± 0.46	3.02± 0.34	3.13 ± 0.29	3.32 ±0.53	3.46 ±0.55
Organic-C (%)	2.07 ± 0.24	3.20±0.24	3.30 ± 0.42	3.42 ±0.33	3.50 ±0.21	3.76±0.29
Total N- (%)	2.14 ± 0.34	0.26 ±0.03	0.31 ± 0.26	0.40 ± 0.06	1.17 ±0.23	1.21 ±0.33
Na (mg/100g)	3.31 ± 0.24	4.26 ±0.63	2.07 ±0.21	2.41 ±0.45	2.72 ±0.10	2.86 ±0.29
Mg (mg/100g)	1.80 ± 0.54	2.06 ± 0.72	2.09 ±0.50	2.17 ±0.19	2.31 ±0.62	2.86 ±0.77
K (mg/100g)	1.47 ± 0.21	2.21 ±0.23	1.52 ± 0.55	1.61 ±0.34	1.70 ±0.72	1.80± 0.30

Mean value ± Standard error of 5 replicates

Table 2: Growth parameters of *T. occidentalis* Hook grown in crude oil polluted soil amended with varying levels of compost from *M. pruriens* (MP)

Treatment	Plant Height (cm)	Leaf Number	Root Length (cm)	Moisture content (%)
0 (Control)	47.21±0.84	15.25 ±0.42	17.30±0.25	60.72±0.54
Pollution Treatment	14.60 ±1.22	7.06 ±0.15	8.45 ±0.56	32.07±0.32
0.5kg MP	30.61 ±1.23	12.40 ±0.58	11.33 ±0.50	40.71±0.43
1.0kg MP	31.26 ±1.40	13.07 ±0.23	13.07 ±0.59	43.72±0.21
1.5kg MP	40.76 ±1.70	13.32 ±0.37	13.43 ±0.94	50.07±0.32
2.0kg MP	42.33 ±1.90	13.97 ±0.28	13.75 ±0.55	52.33±0.31

Mean value ± Standard error of 5 replicates

Table 3: Chemical properties of experimental soil after harvest

Properties	Garden Soil (0-Control)	Pollution Treatment	Remediation Treatment- Levels of *Mucuna pruriens* (kg)			
			0.5	1.0	1.5	2.0
pH	5.20 ± 0.52	4.10 ± 0.23	5.40 ± 0.93	5.50 ± 0.23	5.70 ±0.38	5.70 ±0.20
Available-P (mg/100g)	4.72 ± 0.69	0.10 ± 0.02	0.21 ±0.02	0.30 ± 0.03	0.86 ±0.24	1.02 ±0.29
Ca (mg/100g)	2.07 ± 0.66	1.94 ± 0.72	2.01± 0.30	2.13 ± 0.77	2.23 ±0.53	2.36 ±0.32
Organic-C (%)	1.20 ± 0.53	7.21±0.24	2.40 ± 0.33	2.52 ±0.71	2.60 ±0.54	2.95±0.35
Total N- (%)	0.12 ± 0.04	0.14 ±0.02	0.10 ± 0.06	0.14 ± 0.02	0.16 ±0.03	0.19 ±0.03
Na (mg/100g)	1.61 ± 0.44	2.96 ±0.33	0.92 ±0.11	1.07 ±0.55	1.14 ±0.16	1.21 ±0.74
Mg (mg/100g)	0.72 ± 0.43	1.52 ± 0.22	0.32 ±0.03	0.59 ±0.05	0.72 ±0.42	0.97 ±0.04
K (mg/100g)	0.21 ± 0.01	1.32 ±0.26	0.32 ± 0.05	0.40 ±0.04	0.56 ±0.02	0.62± 0.08

Mean value ± Standard error of 5 replicates

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Discussion

Poor physico-chemical properties of soils were recorded in crude oil polluted soil relative to the control and remediation treatments. Low pH value and nitrogen and phosphorus contents were recorded in pollution treatment comparable to other treatments. pH reduction has been reported in crude oil polluted soil (Gighi *et al*., 2012). This deteriorating soil condition might have resulted in the poor growth performance of *T. occidentalis* as indicated in this study. Petroleum oil contaminated soil is characterized by limited nitrogen and phosphorus as well as anaerobic soil conditions that make essential nutrients like nitrogen and oxygen unavailable (Okonwu *et al.,* 2010; Etukudo *et al*., 2011, Chen *et al*., 1995).

This study revealed that the plant height, root length, leaf number and moisture content of the test crop were enhanced in remediation treatment comparable with the crude oil polluted soil. This reversal of the adverse effects of crude oil pollution on the growth of the test crop may be attributed to effectiveness of the compost from *M. pruriens* as a bioremediation material. Organic manure are known to improve the physic-chemical conditions of the soil as well as create a favourable condition for microbial degradation (Ikpe and Powel, 2002). Organic manure also contributes substantially to improvement of limiting resources such as oxygen, nutrient and moisture required by petroleum oil degraders (Belay *et al*., 2001; Okolo *et al*., 2005).

The pH values increased in remediation treatment relative to the pollution treatment. Similarly, the nutrients contents of the soil increased due to the application of compost from *M. pruriens.* The pH increase recorded in bioremediation treatment with organic manure could be due to the buffering effects of the organic amendments (Ijah and Antai, 2003, Ijah *et al*., 2008). pH ranges between 6 and 9 have been reported to enhance degradation of hydrocarbons by microorganisms due to the favourable soil conditions created by higher pH values (Atlas and Bartha, 1992, Tanee and Kinako, 2008, Etukudo *et al*., 2010)

Conclusion

This study suggests that compost generated from *M. pruriens* can remediate the adverse effects of crude oil pollution by improving the soil physico- chemical properties as well as create favourable conditions and supply the needed nutrients for growth and development of the test crop.

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