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Full Length Research Paper

Remediation of Diesel Oil Polluted Soil with Poultry Manure: Impact on Germination and Growth of Forest Tree Species

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The effect of organic manure amendment on diesel oil polluted soil on germination percentage, plant height (cm), root length (cm), leaf length (cm), leaf width (cm), leaf area (cm^2), moisture content and leaf numbers of some forest tree species (*Delonix regia, Bauhinia sp and Cassia siamea)* were investigated. Soil samples were polluted with diesel oil (1000ml) and amended separately with different quantity of poultry manure (0g, 100g, 200g, 300g, and 400g). Germination percentage was analyzed after three weeks of planting and growth parameters were recorded at the end of 6 months. Results revealed that diesel oil pollution significantly affected the soil physical and chemical properties and also impaired germination and growth performance of forest tree species. Poultry manure amendments were able to remedy the effect of the diesel oil pollution and enhance the germination and growth performance of the tree species. The remediation effect depend on the quantity of poultry manure applied and the highest growth parameters were recorded in 400g of poultry waste amended with diesel oil polluted soil. This study has shown that soil contaminated by diesel oil may have adverse effect on germination and growth performance of forest tree species, but this can be remedied by addition of organic nutrients especially poultry waste which act as a bioremediation and also organic manure that enhance soil fertility. It was recommended that poultry manure be employed in the amendment of diesel oil polluted soils.

Keywords: Diesel oil, Forest tree species, Poultry manure amendments, Bioremediation.

INTRODUCTION

In a never-ending search for improvement in quality of life, man has made great strides. The scientific and technological vehicle which has carried man in his odyssey towards ultimate enjoyment of natures has been fueled by various petroleum derivatives. Pollution of the soil with petroleum derivatives is often observed in municipal soils around industrial plants, through pipe line vandarization, along major high ways tankers, and in areas where petroleum and natural gas are obtained (Adam et al., 2002; Venossa, et al., 1996). Processing and distribution of petroleum hydrocarbons as well as the use of petroleum products leads to contamination of soil. Changes in soil properties due to contamination with petroleum-derived substances can lead to water and oxygen deficits as well as to shortage of available forms of nitrogen and phosphorus (Wyszkowska and Kucharski, 2000). Contamination of the soil environment can also limit its protective function, upset metabolic activity, unfavourably affect its chemical characteristics, reduce fertility and negatively influence plant production (Onyeri, 1998). The introduction by man directly or indirectly of petroleum derivatives into the environment result in deleterious effects as human health and that of the organisms that are dependent on the soil (Aboribe, 2001). The increasing use of diesel oil in diesel engines of cars, industrial trucks and generators has led to an increased demand for diesel oil (Ogbo, 2009) result in

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Accidental spillage of diesel along Nigerian high ways. Thus, pollute agricultural lands. Diesel oil is one of the major products of crude oil and it constitutes a major source of pollution to the environment (Nwaogu *et al*., 2008). Diesel oil can enter into the environment through leakage from storage containers, refueling of vehicles, wrecks of oil tankers and warships carrying diesel oil and through improper disposal by mechanics when cleaning diesel tankers. Diesel spills on agricultural land generally reduce plant growth, reduces soil fertility and soil microflora population (Torstenssen *et al*., 1998). Wyszkowski and Ziolkowska (2008) also reported that the addition of diesel oil to the soil led to a significant reduction of organic carbon content of the soil. Diesel oil is phytotoxic to plants at relatively low concentrations. Ogbo (2009) reported that diesel oil contamination of the soil caused a reduction in the length of the radicles of

Arachis adical , *Vigna unguiculata*, *Sorghum bicolor* and *Zea mays.* Treatment of soils with crude oil, Automotive Gasoline Oil (AGO) and spent engine oil significantly delayed the period of germination, reduced percentage germination, plant height, leaf production and biomass of *V. unguiculata* (Adedokun and Ataga, 2007). Although the effects of the individual petroleum products on plants have been evaluated by many studies (Siddiqui and Adams, 2002; Anon, 2003; Andrade *et al*., 2004; Adedokun and Ataga 2007; Shahid, 2007), there is the need to find out a remediation method to counter the effects of some of the petroleum products on plants. However, oil contaminated soils are amendable to bioremediation because micro-organisms capable of degrading petroleum hydrocarbons are present (Jone and Edington 2005) and the fraction of total microbial population in soil able to degrade varies from bacteria and fungi. This study therefore evaluates the effects of diesel oil polluted soil on the germination and growth performance of forest tree species and remediation effect of organic nutrient to the polluted soil.

Botany of the Plants species used in the Study

Delonix regia

Commonly known as flame of the forest is a dicotyledonous tree belonging to the family leguminosae. It is a deciduous tree that flourishes in tropical and sub-tropical regions. In the presence of sunlight and good drain soil, the tree grows to an average height of about 18 metres (Etukudo, 2000). Under suitable conditions, the seedlings grow very rapidly and reach a height of about 8 metres in four years (Hutchinson and Dalzial, 1998). The tree can be propagated by seed and by marcotting (Robert, 1979). The plant is used as ornamental plant, for making charcoal, used for fuel wood, for wood pulp and other furniture products.

Bauhinia species

Belong to the family leguminosae. It is a native to tropical and sub-tropical countries (Kipps, 1981). The species can be propagated through seed and by marcotting (Robert, 1979). Under favourable condition, the seedlings grow very rapidly and reach the height of about 8 meters on five to six years (Hutchinson and Dalzial, 1998). The plant is used as ornamental, for production of charcoal, as fuel wood and other furniture products (Igugu et al., 1986)

Cassia siamea

Belong to the family leguminosae. The species originated from Asia, and common distributed throughout tropic and sub-tropic. Under favourable conditions, the seedlings can grow to an average height of 25 meters. The plant can be propagated by seeds and by marcotting (Raven et al., 2001). The plant is used as ornamental, use in controlling erosion, for making charcoal, fuel wood and other furniture works (Igugu, et al 1986).

MATERIALS AND METHODS

The study was carried out between March to September in research and experimental farms, Department of Botany and Ecological Studies, Akwa Ibom University, Ikot Akpaden, Mkpat Enin, Akwa Ibom State. Nigeria.

Akwa Ibom State is one of the Niger Delta States of Nigeria. The area is a low lying coastal region that is vulnerable to hydrocarbon pollution. Since the discovery of oil in Nigeria in the 1950s, the country has been suffering the negative environmental consequences of oil exploration and exploitation. The growth of the country's oil industry, combined with a population explosion and a lack of enforcement of environmental regulations has led to substantial damage to biogeophysical resources in the Niger Delta region. When there is an oil spill on water, spreading immediately takes place. The gaseous and liquid components evaporate. Some get dissolved in water and even oxidize, and yet some undergo bacterial changes and eventually sink to the bottom by gravitational action. The soil is then contaminated with a gross effect upon the terrestrial life. As the evaporation of the volatile lower molecular weight components affect aerial life, so the dissolution of the less volatile components with the resulting emulsified water, affects aquatic life (Akpofure et al, 2000).

The harmful effects of oil spill on the environment are many. Oil kills plants and animals in the estuarine zone. Oil settles on beaches and kills organisms that live there, It also settles on ocean floor and kills benthic (bottom-dwelling) organisms such as crabs. Oil poisons algae, disrupts major food chains and decreases the yield of

edible crustaceans. It also coats birds, impairing their flight or reducing the insulative property of their feathers, thus making the birds more vulnerable to cold. Oil endangers fish hatcheries in coastal waters and as well contaminates the flesh of commercially valuable fish.

In the coastal environment of Akwa Ibom State, large areas of the mangrove ecosystem have been destroyed. The mangrove was once a source of both fuel wood for the indigenous people and a habitat for the area's biodiversity, but is now unable to survive the oil toxicity of its habitat. Oil spills in the Niger Delta have been a regular occurrence, and the resultant degradation of the surrounding environment has caused significant tension between the people living in the region and the multinational oil companies operating there. It is only in the past decade that environmental groups, the Federal Government, and the foreign oil companies operating in the Niger Delta began to take steps to mitigate the impacts. Large areas of the mangrove ecosystem have also been destroyed. The mangrove forest was in the past a major source of wood for the indigenous people. In some places it is no longer in a healthy state to sustain this use (Nwilo and Badejo 2005).

Sample collection and preparation

The soil samples used for this study were collected from a site in the Reserve Forest in Akwa Ibom State, Nigeria. The soil samples were collected from 0-30cm of the topsoil and transported to the preparation site in clean plastic buckets. The diesel oil was bought from Nigerian National Petroleum Corporation (NNPC) mega station, Uyo, Akwa Ibom State. The poultry wastes were obtained from Akwa Ibom State University farms. The matured seeds of (*Delonix regia, Bauhinia sp and Cassia siamea*) were collected from Reserve Forest in Akwa Ibom State, Nigeria and identified by a plant taxonomist with the Department of Botany and Ecological Studies, Akwa Ibom State University. To prepare the soil samples for diesel oil pollution, about 50kg of soil was properly mixed with 1000ml of diesel oil. These were dispensed into plastic buckets in 10kg weights each and mixed with various quantities of poultry manure (0g, 100g, 200g, 300g and 400g). The samples were exposed to rain and sunlight throughout the period of the study. For germination study, healthy seeds were sorted out and then sterilized the seeds with 0.01% mercuric chloride solution for 30 seconds; the seeds were thoroughly washed several times with distilled water and air dried. During this treatment floating seeds or those that had bubbles were discarded. Three seeds were sown in each plastic bucket containing the polluted soil amended with various quantities of poultry manure. Samples were taken for growth parameters analysis at the end of 6 months.

The criterion for germination was taken as emergence of 2mm (0.2cm) adical at the time of observation (Singh and Singh, 1981).

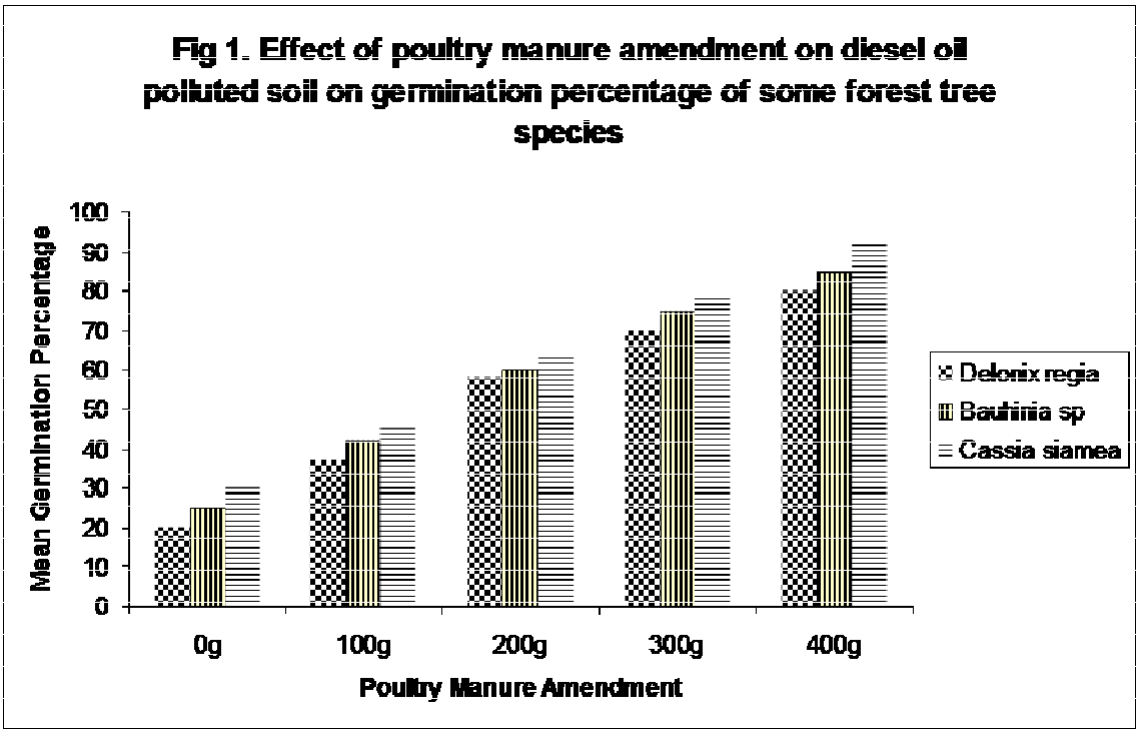
Growth parameters measurement

These include the plant height, root length, leaf length, leaf width, leaf area, moisture content and total number of leaf. The plants from each treatment were carefully uprooted washed in running tap water to flush out the soil particles. The plant height, root length, leaf length and leaf width were measured in (cm) using a meter rule at the end of 6 months. The leaf area was obtained in duplicates by placing the leaf on a graph paper of one square centimeter ($1cm^2$). The squares enclosed by the margin were counted after the trace. The squares which were divided by the leaves area were counted if they are greater than or equal to 0.5 cm^2. Those that were less than $0.5cm^2$ were ignored (Hoyt and Bradfied, 1962). The mean of the duplicate figures was taken as the leaf area. The leaf numbers were obtained by visual counting of the leaves. The percentage moisture content of the sampled species was determined as follows. The difference between the fresh and dry weight of the plant species, this was done by measuring fresh weights of the plant species using Mettler P. 165 weighing balance. The weighed plants were dries in a Gallenkamp oven at 80^0C until the weights were constant. All the parameters were obtained at the end of 6 months.

RESULTS

The effects of diesel oil polluted soils amended with various quantities of poultry manure on the germination percentage of forest tree species (*Delonix regia, Bauhinia sp and Cassia siamea)* is presented in Figure 1. The result shows an increase in germination percentage of the tree species (*Delonix regia, Bauhinia sp and Cassia siamea)* with increase in the quantities of poultry manure added to the diesel polluted soils. Treatment of diesel polluted soil amended with 400g of poultry showed a significant increase in the ($p<0.05$) the germination percentage. Also there were variations in germination percentage among the different tree species with the highest observed in *Cassia siamea*. The 0g treatment of poultry manure on diesel oil polluted soil had the least germination percentage, this may be attributed to the effect of diesel oil polluted soil which affect the physical and chemical properties of the soil and impaired germination percentage of forest tree species .It was observed that the higher the quantity of the poultry dung, the higher the germination percentage of the forest tree species.

There was significant $p< 0.05$ increase in growth parameters of all the tree species used in the study with increase in the number of months in all the treatments amended with poultry manure (Table 1). While there was



a significant decrease in growth parameters of the forest tree species in the 0g treatment of poultry manure. Also there was variation in plant heights among the different tree species with the highest observed in *Cassia siamea*. It was shown that the higher the quantity of the poultry manure, the higher the growth performance of plant species used in the study. Plant heights in the 400g poultry manure amendments were significantly higher than other treatments ($p<0.05$). The leaf areas, moisture content and the number of leaf of the tree species (*Delonix regia, Bauhinia sp and Cassia siamea)* in the diesel polluted soils amended with poultry manure differed from each other according to the quantities of organic manure applied (Table.1). There was a direct proportionate increase in leaf area with increase in the quantity of poultry wastes but inverse proportionate decrease with decrease in the quantities of organic manure (Table 1). It was observed that the quantities of poultry dung had significant effect on the leaf area with the highest effect observed in 400g in the 6 months (16 cm_2). There was an increase in the number of leaves as the quantity of the poultry manure increased and also as the number of months increased though there was a reduction in the number of leaves on the 0g treatment of poultry manure. Generally, there was an increase in the number of leaves with increase in the quantity of poultry wastes with the highest number of leaves observed in the 400g treatment (47 leaves). The dry matter accumulation of the plant species treated with 400g of poultry manure out yielded all others treatment and was significantly ($P<0.05$) higher than that of 300g, 200g, and 100g of poultry manure.

DISCUSSION

Diesel oil like the other petroleum products adversely affects the germination and growth performance of forest plants as indicated in the results. The effect of the diesel oil on the plant height observed in the study were similar to those reported on the effect of crude oil on *Vigna sinensis* (Ekpo, 1998). Njoku *et al*. (2008) found similar findings on the effect of crude oil on the growth of accessions of *Glycine max* and *Lycopersicon esculentum*. Etukudo (2004) also showed that treatment of soils with crude oil, automotive gasoline oil and spent engine oil significantly affected the time of germination, plant height, leaf production and biomass of *Abelmoschus esculentus*.. The decrease in germination of forest tree species in diesel oil polluted soil used in the study indicates that diesel oil affect the availability of water, oxygen and temperature in the soil which are important factors responsible for seeds germination. The effect of diesel oil polluted soil on leaf area indicates that the diesel oil interrupts with the growth of the plant. According to Kathirvelan and Kalaiselvan (2007) the leaf surface area determines in large part the amount of carbon gained through photosynthesis and the amount of water lost through transpiration and ultimately the crop yield. Therefore the reduction of the leaf area as

Table 1. Effect of poultry manure amendment on diesel oil polluted soil on plant height, root length, leaf length, leaf width, moisture content and leaf area of some forest tree species.

parameters	Poultry Manure Amendments				
	0g	100g	200g	300g	400g
Plant height (cm)					
Delon ix ra gia	20.34 ± 0.32	68.05 ± 0.50	92.12 ± 0.62	124.04 ± 0.10	139.07 ± 0.40
Bauhinia sp	23.15 ± 0.12	76.15 ± 0.61	101.02 ± 0.12	136.05 ± 0.30	156.14 ± 0.70
Cassia siamea	19.20 ± 0.25	72.20 ± 0.15	98.25 ± 0.14	134.27 ± 0.10	148.15 ± 0.20
Root length (cm)					
Delon ix ra gia	9.45 ± 0.51	14.07 ± 0.20	20.04 ± 0.10	20.94 ± 0.50	22.45 ± 0.13
Bauhinia sp	9.57 ± 0.10	15.16 ± 0.25	18.41 ± 0.30	19.05 ± 0.10	21.60 ± 0.25
Cassia siamea	10.39 ± 0.15	17.09 ± 0.36	22.10 ± 0.40	22.75 ± 0.20	24.70 ± 0.10
Leaf length (cm)					
Delon ix ra gia	2.14 ± 0.10	3.15± 0.78	4.05 ± 0.14	4.98 ± 0.25	5.10 ± 0.22
Bauhinia sp	2.56 ± 0.20	2.95.±0.68	3.67 ± 0.25	4.10 ± 0.11	4.35 ± 0.15
Cassia siamea	2.78 ± 0.50	4.09± 0.70	4.56 ± 0.46	5.10 ± 0.12	5.25 ± 0.13
Leaf width (cm)					
Delon ix ra gia	0.97 ± 0.17	1.60± 0.04	1.80 ± 0.01	2.15 ± 0.19	2.25 ± 0.25
Bauhinia sp	1.43 ± 0.31	2.15± 0.15	2.45 ± 0.25	2.53 ± 0.10	2.75 ± 0.12
Cassia siamea	1.78 ± 0.02	2.75± 0.06	2.86 ± 0.01	3.05 ± 0.28	3.10 ± 0.07
Leaf area (cm^2)					
Delon ix ra gia	4.54 ± 0.31	8.74± 0.21	12. 21 ± 0.71	12.34 ± 0.21	15.21 ± 0.74
Bauhinia sp	3. 24 ± 0.51	6. 13± 0. 15	10. 11 ± 0.13	12. 05 ± 0.22	14.10 ± 0.55
Cassia siamea	4.61 ± 0.24	7. 12 ± 0.22	12. 05 ± 0.54	13. 20 ± 0.91	16.12 ± 0.02
Number of leaf					
Delon ix ra gia	7	13	15	22	31
Bauhinia sp	9	15	18	31	35
Cassia siamea	11	17	22	36	47
Moisture content %					
Delon ix ra gia	6.32 ± 0.12	8.31±0.34	15.21± 0.07	24.05 ± 0.10	34.09 ± 0.11
Bauhinia sp	5.16 ± 0.01	11.01±0.14	17.11 ± 0.13	23.14 ± 0.23	33 18 ± 0.23
Cassia siamea	8.02± 0.11	14.09 ± 0.32	21.16 ± 0.05	27.05 ± 0.11	38.21 ± 0.15

observed in this study implies that there would be low photosynthetic efficiency of the plant as much of the solar energy emitted by sun would not be absorbed by plant for photosynthesis. This can lead to low yield of the plant with subsequent poor timber formation and stunted growth. According to Walker *et al*. (2001), availability of nitrogen in the soil directly affects the relative growth rate of plants. (Agbogidi *et al*., 2007) reported that petroleum-products are known to reduce nitrogen availability in the soil. This could be the cause of adverse effect on the plant growth parameters in diesel oil polluted soil. The effect of poultry manure amendment on diesel polluted soil was found to ameliorate the soil condition and enhanced the germination and growth performance of (*Delonix regia, Bauhinia sp and Cassia siamea)*. According to Wyszkowski and Zoilkowska (2008), proper growth of cultivated plants is dependent on the content of nutrients in the soil. The inhibition of the growth of the forest tree species observed in the treatment 0g treatment of poultry manure may be due to the effect diesel oil had on soil. The adverse effects could be due to disruption of the absorption and uptake of nutrients by petroleum products, increase the soil pH and increasing acidity content of the polluted soil (Njoku *et al*., 2008). These nutrients (nitrogen, phosphorus, potassium and calcium are essential to plant growth and development hence reduction in their bioavailability will lead to reduction in plant growth. From the results, it can be concluded that poultry manure is effective bioremediation materials for diesel oil polluted soil and at the same time restored the fertility of the soil, thus enhancing plant growth and timber productivity.

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