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Evaluation of Maize (*Zea mays*) Growth Performance In Crude-Oil Polluted Agricultural Soil Remediated Using Poultry Manure And Palm Kernel Shell Powder.

Voke Emesaha, Matthew O. Wegwu and Kingsley C. Patrick – Iwuanyanwu
Department of Biochemistry, Faculty of ScienceUniversity of Port Harcourt P.M.B 5239 Choba, Rivers State Nigeria.

Abstract
This study investigatedthe efficacy of palm kernel shell powder (PKSP) and poultry manure (PM) as amendment materials for the enhancement of remediation ofcrude-oilpolluted agricultural soil of Obio-kpor Local Government Area, Rivers State in relation to maize (Zea mays) growth. Experimental studies encompassingbio stimulation was carried out on the remediation of the crude-oil polluted soil amended with PM and PKSP. The experiment comprised of eight groups each set up in triplicate totaling twenty-four cells in a completely randomized block design. The cells were artificially contaminated with 500mls of Escravous light crude oil. The Ist set up with no pollution and no amendment was designated as positive control. Set up 2 which was polluted soil and no amendment was designated negative control. Three of the set up were designated treatments (P100gPKSP, P200gPKSP and P400gPKSP) and were treated with 100g of palm kernel shell powder, 200g of palm kernel shell powder and 400g of palm kernel shell powder respectively. Another three set up were designated treatments (P100gPM, P200gPM and P400gPM) were treated with 100g of poultry manure, 200g of poultry manure and 400g of poultry manure respectively. The amended soils were allowed to stay for the remediation period of 3 months before maize seeds (Oba Super 6) variety were planted in them. Maize growth assessment parameters showed that cells amended with PM had better performance in terms of germination percentage (95.67±1.33, 97.33±1.45 and 98.67±1.33 %), maize plant height, (153.00, 159.00 and 150.67 cm) leaf length (151.00, 155.00 and 146.67 cm) and leaf area (822.95, 772.85 and 995.91 cm^2) at 12 weeks afterplanting. This was followed by PKSP and the positive control. Thelowest was noted in thenegative control.Similarly, the resultshowed thatPMexhibiteddominance over palm kernel shell powder in amending crude-oil polluted soils.

Keywords.*Remediation, Maize, Crude-oil, Palm kernel shell powder, poultry manure.*

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I. Introduction

Soil pollution has constantly remained a danger to persons living in Niger-Delta area of Nigeria. Previously, it has been estimated that over four thousand crude-oil spills have taken place in the Niger Delta area of Nigeria since 1960, releasing so many containers of crude-oil (sometimes comprising of heavy metals) into the neighbouring surroundings. [1]. Due toanthropogenic activities, substantialamounts of soil have been polluted with crude-oil [2]. Petroleum polluted soils induces organic pollution of local ground water, endangering the safety of drinkable water causing massive economic loss and ecological calamity as well as damages agronomic products[3,4]. Trace metals existing in crude-oils have been well recognizeduniversally[1,5]. The occurrence of heavy metals in some surroundings has thus beenlinked to mining of crude-oil in addition tocrude-oil leakages[6]. Crude oil pollution of agricultural soil is well-thought-out to be the keyreasonresponsiblefor decreased crops productivity within Nigeria.

The social, economic and agronomicchallenges instigated by crude-oil pollution to the surroundings most notably, in crude-oilwealthy areasfor example Niger Delta area of Nigeria hasresulted to serious unabated food uncertainty in those areas.Crude-oil polluted soils are of persistentecologicalworriessince they are not appropriate for agronomic and leisurepurposes and are probablefoundations of surface and ground water pollution[7]. Pollution of soil with crude-oil leads tobuildup of essential organic carbon, phosphorus, calcium, and non-essential magnesium, lead, zinc, iron and copper elements within soils and the subsequent translocation in tissues of plants [8].Consequently, thiscausesincreasedharm and communitywell-beingproblemssince plant consumers arevulnerable to hazardous heavy metals. Crude-oil pollution occurrence in soils mightmodify the physiochemicalcharacteristics of soils,pore spaces couldturn out to be clogged, leading to a decline in soil aeration and water infiltration, subsequently altering the growth and development of plantsin those soil type [9].

Agricultural related challengesin crude- oil polluted soils have been previously recognizedby some researchers [10, 11, 12, 13]. Crude-oil pollution applies its negative consequences on plants throughforming conditions in soil resulting to buildup of manganese and ferrous ions, that might attain poisonousconcentrationsin plants [14]. Crude-oil pollution as wellfashions soil conditions that causes nitrogen, phosphorus, and oxygen, which are indispensable for plant growth inaccessible to plants.

Increasedlevels of heavy metals within soils couldharmfullydisrupt seedling germination as well as growth and development of crops,becausesuch metals disrupt metabolic processeswithin plants, as well as physical and chemical processes, inhibits photosynthetic in addition to respirative activities, disintegration of key cellular organelles, therebyresulting to plant death[15, 16].In additionto reduction ofplant products, crude-oil possess a secondary effecton soil protection, because the weakeningplants cannot shield the soil from wearing away occurrences. Soil polluted with heavy metals mightas well result to variations in the assembly of soil microbial community, thusharmfullyaltering the soil properties[17].

Crude-oil spillshampersuitable soil ventilationbecause oil coating on the soil surface turns out to be a physical barricadebetween air and soils. In reality,crude-oil pollution alters the physiochemicalcharacteristics soilsfor instance temperature, structure, nutrient status andpH.

Current technologies employed forcleaningcrude-oil polluted soil includessoil washing, solvent extraction, thermal treatment, composting, chemical oxidation and bioremediation (bioaugmentation, bio stimulation and phytoremediation). The physiochemicalmethods are quite exorbitant also, resulting products mightlead to a secondary pollution of soil which might generate a request for additional post-treatment. Hence, theuniversalattention in bioremediationfor total mineralization of crude-oil to CO_2 and H_2O which are environment friendly by products. Additionally, efforts to remediate the undesirableeffect of crude-oil pollution on water and soil has resulted to several methods like Remediation by Enhanced Natural Attenuation which entails numerous technologies involving land farming by bio stimulation or bio augmentation of soil biota using commercially accessible micro flora [18].Bio stimulation is a remediation technology that is extremelyeffective, quite economical and environmentally friendly in nature. Previous researchers[19,20] have reported the effective roles played by various organic amendments such as poultry droppings, cow dung, pig manure and periwinkle shells in degrading hydrocarbon pollutantsoccurring in crude oil polluted soils. Previous studies [21, 22, 23] have also noted that bio stimulants like coconut shell, yam peel, rice husk, banana skin, saw dust have previously been employed for elimination of petroleum hydrocarbons from crude oil polluted soils.

The objective of this studyis to investigate the efficacy of the amendment materials (Palm kernel shell powder and poultry manure) for enhancement of crude-oil polluted agricultural soil reflected on the growth performance of maize (*Zea mays*). The findings of this study would provide vital information on bioremediation technique of crude-oil polluted agricultural soil thus enhancing agricultural productivity in Niger Delta areawhere pollution arising from crude-oil is a foremostsource of anxiety.

II. Materials And Methods

2.1 Description of Experimental site

The study site is a fallowed agricultural farmland located at Obio- Kpor Local Government Area of Port Harcourt in Rivers State, Nigeria. at Latitude 4°51.3278N and Longitude 6°58. 5811E. It lies in the tropical rainforest zone, characterized by abundant rainfall with little dry season. The rainy season occurs between April and October, bringing heavy rainfall ranging from 2000 to 2500mm with temperatures up to 25°C and a relatively constant humidity.

2.2 Experimental Design

A fallowed agricultural farmland located at Obio-Kpor Local Government Area of Rivers State was cleared of bushes and a soil surface area measuring $15.39m^2$ (5.7m × 2.7m) was further sub-divided into eight (8) smaller experimental cells of size measuring 0.3m × 0.3m ($0.9m^2$) each with a spacing of 0.3m between the respective cells. The cells measuring 0.3m × 0.3m were prepared using a hoe.Shallow drains were constructed in order to prevent treatment from one cell into another either by surface runoff or interflow. The experiment comprised of eight treatments with three replicates that gave a total of twenty-four cells in a completely randomized block design. The first cell was left in its natural state and served as a positive control. The second cell was polluted and devoid of amendment serving as negative control, while the remaining six plots were polluted and amended with the amendment material (poultry manure and palm kernel shell powder). Each cell of 0.9m size was artificially polluted with 500 mls of Escravous light crude-oilhaving a specify gravity of 0.866. The crude oil was obtained from Warri Refining and Petrochemical Company (WRPC), Delta State. The crude- oil was cautiously measured into anirrigatingcontainer and with the aid of fine hose it was sprayed uniformly on each cell. The crude-oil was thereafterdriven into the soil using a garden fork and the polluted cells were left undisturbed for a period of two weeks in order to allowappropriate infiltration of the crude-oil, thereafter the amendment material (palm kernel shell powder and poultry manure with varying doses of 100g, 200g and 400g) were applied using the method of [24, 25]. The amended soils were remediated using palm kernel shell powder and poultry manure for a period of three months.

The amended soils were tilled using a plastic shovel to allowfor proper aeration and mixing of the amendment material and microorganisms with the polluted soil and thereafter composite soil samples between 0-30cm were collected using soil auger for laboratory analysis before contamination with crude oil, two weeks after contamination, 1 MAT, 2 MAT and 3 MAT of crude oil polluted soils on a monthly basis. Four seeds of maize were planted at a depth of 4cm but later thinned to 3 after two weeks of planting. The cells were kept free of weed by the use of hoe and handpicking at an interval of three weeks after planting., thereafter plant growth evaluation was done for a period of 12 weeks.

2.3 Application of Amendment materials

Poultry manure and Palm kernel shell powder which are organic fertilizers were used as amendment material for the polluted soil samples during the three months' period of treatment.The poultry manure was obtained from a poultry farm at NTA Road, Mgbuoba in Obio- Kpor Local Government Area. While the palm kernel shells were obtained from a local food vendor at NTA Road, in Obio-Kpor Local Government Area.The poultry manure was sun dried for three weeks and afterwards it was crushed and ground into powdered form and weighed before its application into the polluted soils. The ground poultry manure was passed via a 2 mm standardizednetfilterafterwards, some of the powderedpoultry manure sampleswere taken to the laboratory for analysis of its minerals content for example carbon, nitrogen and phosphorus, etc.

The palm kernel had previously been boiled, the husk removed and the oil extracted. The palm kernel shells were properly dried under direct sunlight for a period of three weeks before cracking in order to separate the shells from the kernel. Thereafter it was ground with local mortar and pestle with the help of several hands. This took a period of 2 months. The ground palm kernel shell was passed via a 2mm standardizednet filter in order to obtain the palm kernel shell powder and afterwards, some samples were also sent to the laboratory for determination of chemical composition, such as nitrogen, phosphorus, potassium, pH etc. as presented in Table 1. This was done in order to ascertain the remediating potential of the palm kernel shell powder. Polluted soils were amended with 100g, 200g and 400g of Palm kernel shell powder and Poultry manure respectively

The amendment material was applied to polluted soils as illustrated below,

Cell 1: Unpolluted control
Cell 2: Polluted control.
Cell 3: Polluted +100g palm kernel shell powder (P100gPKSP)
Cell 4: Polluted +200g palm kernel shell powder (P200gPKSP)
Cell 5: Polluted +400g Palm kernel shell powder (P400gPKSP)
Cell 6: Polluted +100g Poultry manure(P100gPM)
Cell 7: Polluted +200g poultry manure (P200gPM)
Cell 8: Polluted + 400g poultry manure (P400gPM)

The amended soils were tilled with a plastic shovel to enable proper aeration and mixing of the amendment material and microbes with the polluted soil. The amended soils were remediated using palm kernel shell powder and poultry manure for a period of three months before maize seeds were planted.

2.4 Maize planting

Maize (*Zea mays*) seeds (Oba Super 6 Hybrid) weregotten from the Centre for Ecological Studies, University of Port Harcourt and were thereafter planted after three months' amendment treatment incorporation into the soils. Four grains of maize plants were planted at the center of each cell at a depth of 4cm. After two weeks of planting, the seedlings were thinned to three (3) per cell following germination. Thereafter evaluation of the maize plant (*Zea mays L*) growth by means of some carefully chosen growth parameters as a reference of amendment effects was monitored on a weekly basis for a period of 12 weeks. Furthermore, maize yield analysis was carried out after the harvest of maize.

2.5 Evaluation of maize growth performance

Some carefully chosenmaize growth indices which includegermination percentage, plant height, leaf length, leaf area, leaf number, root length and plant density, was carried out at weekly interval during the three months planting period. Maize yield components such as the cob length, number of seeds, number of rows per cobs and weight of grains was also determined after the maize was harvested.

Maize plant height was assessed by adopting the method of [26]. This was achieved by measuring the plant height with the aid of a meter rule at the early growth stage and a flexible measuring tape from the base of the plant to the collar of the last leaf on the plant to determine the plant height in centimeter at the

advanced stage when the plants had outgrown the meter rule 3 weeks after planting (3WAP) and continued for twelve weeks (12 WAP).
Leaf area of maize plant was determined weekly over the 12 weeks planting period.Evaluation of leaf area of the maize plant was done with the aid of a flexible measuring tape, taking the total length and width at both the broadest point and the longest leaf in the same plant. The result was then multiplied by a correction factor 0.89.
The formula: Leaf area (LA) = 0.89 × length of the leaf × width of the leaf (broadest part) and 0.89 is a constant [27].
The number of leaves formed was determined by visually counting intact green leaves as described by [28]. Counting of leaves was done on a weekly interval for the period of 12 weeks planting
Germination percentage test was carried out on maize (*Zea mays L*) grains by the method as described [29]. The germination test was done over a 5-day period. Germination percentage was assessedthrough counting the number of seeds that germinated within 5 days after planting. This was calculated thus

$$\textbf{Germination \%} = \frac{\textbf{No of seeds that germinated per cell}}{\textbf{No of seeds planted per cell}} \times \frac{100}{1}$$

Root length was determined with the aid of a meter rule calibrated in (cm) as described by Tanee and Jude (2017) by measuring the length of roots in each cell and the average values were recorded.

Maize Plant Density was determined by counting the total numbers of plants in each cell and dividing by the soil area as described by the method of [30].

2.6 Maize yield parameters
Cob length, number of seeds, number of rows per cob and weight of grains.
Cob length was measured in cm using a measuring tape and the average was taken.
Number of seeds per cob in each cell was physically counted and the average was recorded.
Number of rows per cob was determined by counting the rows in cobs from each cell and the average was taken.
Grains from each cell were counted after shelling and were divided by the number of cobs. Thereafter they were weighed to determine the grain yield per cell in kg.

Statistical Analysis
Resultsofthestudyareexpressedasmeans±standarddeviationoftriplicatedetermination. Toascertainasignificantdifferencebetweenthegroups,statisticalanalysiswascarriedoutusing one-wayanalysisofvariance(ANOVA). Databetweengroupswereanalyzed bytheTukey's test usingStatisticalPackagefortheSocialScience(SPSS®)Version20 statistics softwareat95% (p<0.05) confidencelevel.

2.7RESULTS AND DISCUSSION
Effect of organic amendment materials on growth performance of maize plant:
The result of maize plant height, leaf length, leaf area and number of leaves are presented in Figures 1-4. Results obtained revealed a simultaneous increase in the plant height, leaf length, and leaf area over the 12 weeks' period. Likewise, a similar increase was recorded in the number of leaves from week 1 through 10, however, a sudden decline was observed from week 10 through 12.The simultaneous increase in plant height of all the amended groups discloses a positive correlation between the organic amendments employed in this study and growth rate. [31], However, the significant increase observed in the poultry manure amended groups signifiesthat there was quick absorption of the nutrients bythe maize plant culminating in their speedy growth. This is in line with reports of [26], who notedthat poultry manure comprisesof abundant microbes, possessing easily dissolvable and absorbable nutrients resulting to swift growth rate.[26, 32]. According to [33], the application of poultry manure to crude-oil polluted soil led to an increase in plant height from 20cm to 149cm.Addition of soil amendments favors plant growth and development.

Likewise, the observed increases in leaf length of maize plant grown in the amended soils could also be related to the organic amendments applied to the polluted soil. The organic amendments meaningfullyenhanced agricultural properties of maize. This aligns with the finding of [34] who reported improved increase in leaf length of maize grown in crude oil polluted soils amended with poultry manure. According to [35], the incorporation of several amendment material to soil has been verified to arouse a positive result on plant growth and development.

The observed increase in leaf area of maize plants grown in amended soils could be associatedwith the favorableoutcome of the organic amendment resulting to an increase in moisture content appropriate for good growth and development of the leaf. This can be supported with reports fromof [36] who stated that water stress can restrict development of leaves mainlyvia a decrease in cell size other than cell number in *Nicotiana tabacum* and *Gossy pium arboreum*.Comparable results of increased leaf area in crude-oil amended soils have previously been noted by several researchers. [26, 33, 34]. The observed significant increase in leaf area of maize plants grown in soils amended with poultry manure suggests that the incorporationof poultry manure to the crude-oil polluted soils boostedlarger leaf area in maize plants due to the increased organic matter resulting to the release of nutrients for leaf development. According to [37], Application of soil amendment and bioaugmentation could lead to a positive characteristic in enhancing plant growth.

The enhanced maize growth parameter evident in the number of leaves from maize plants grown in amended soils could be credited to the improvement of the soil physical and chemical characteristics caused by the organic amendment material (poultry manure and palm kernel shell powder). Likewise reports of enhanced plant growth parameters have been reported by various researchers [26, 38]. The increase in leaf number can also be related to ameliorating role played by the organic amendment which resulted to a decrease in the concentration of hydrocarbon hence favoring the growth and proliferation of leaves all through the planting period. This aligns with the findings of [39] who reported that crude-oil spills on soil results toinfiltration of oil into plant leaves through their pores as well ashindersphotosynthesis. The number of leaves of cells amended with poultry manure were higher than those of PKSP.The polluted control soil also had the least number of leaves as a result of the effect of crude oil on leave development as well as photosynthetic activities.

Table 1: Chemicalcomposition of poultry manure and palm kernel shell powderparameters used as remediation materials.

PARAMETER	POULTRY MANURE	PALM KERNEL SHELL POWDER
pH	7.35	7.08
Nitrogen Mg/L	1.92	0.96
Phosphorus	1.76	0.98
Potassium	0.135	0.180
Organic matter	2.62	5.19
Organic Carbon Mg/Kg	0.91	1.81
C: N Ratio	1:2	1:3
Calcium (Mg/L)	2.310	1.840
Sodium (Mg/L)	4.117	3.298
Magnesium (Mg/L)	0.216	0.201

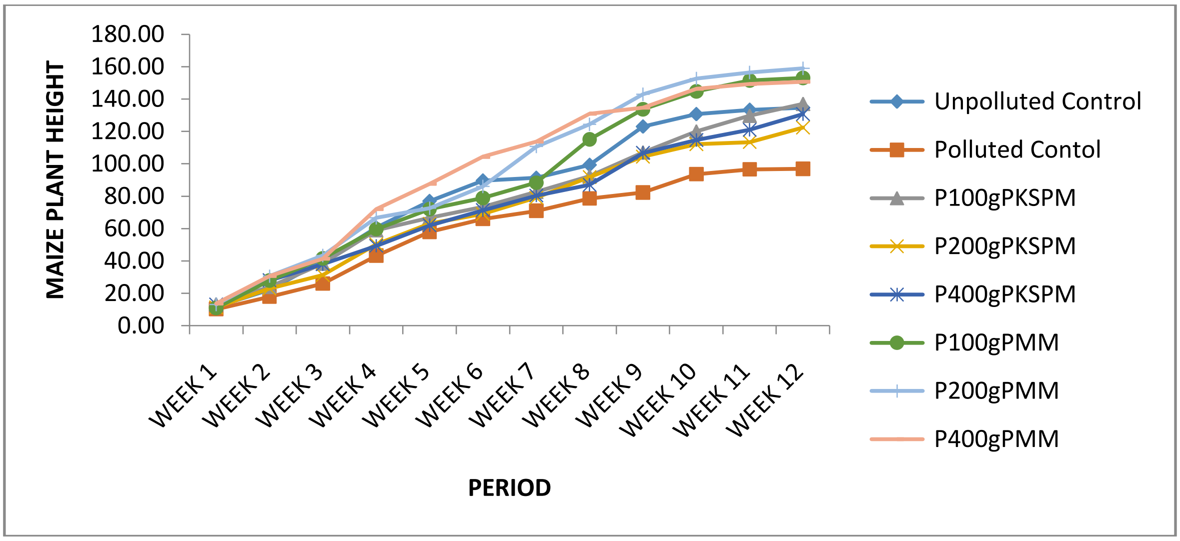

Figure 1: Height measurement (cm) of maize plant grown in remediated soils
Values are mean of triplicate determination.

Note: P100gPKSPM = Polluted + 100g Palm Kernel Shell Powder + Maize; P200gPKSPM = Polluted + 200g Palm Kernel Shell Powder + Maize; P400gPKSPM = Polluted + 400g Palm Kernel Shell Powder + Maize; P100gPMM = Polluted + 100g Poultry Manure + Maize; P200gPMM = Polluted +200g Poultry Manure + Maize; P400gPMM = Polluted + 400g Poultry Manure + Maize

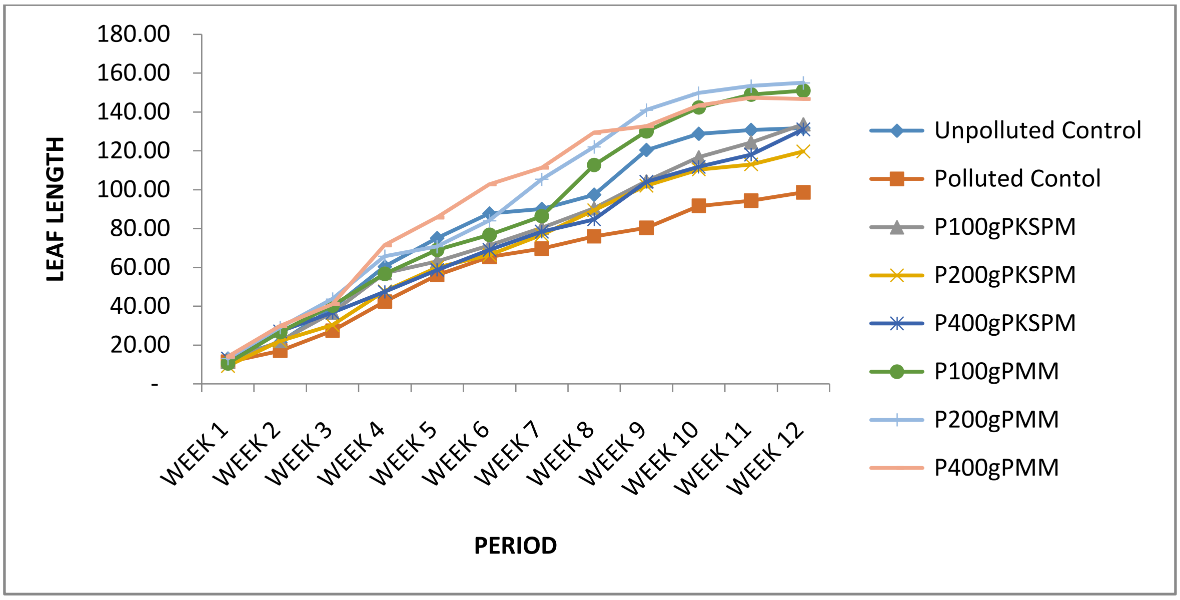

Figure 2: Leaf length (cm) of maize plant grown in remediated soils

Values are mean of triplicate determination.

Note: P100gPKSPM = Polluted + 100g Palm Kernel Shell Powder + Maize; P200gPKSPM = Polluted + 200g Palm Kernel Shell Powder + Maize; P400gPKSPM = Polluted + 400g Palm Kernel Shell Powder + Maize; P100gPMM = Polluted + 100g Poultry Manure + Maize; P200gPMM = Polluted +200g Poultry Manure + Maize; P400gPMM = Polluted + 400g Poultry Manure + Maize.

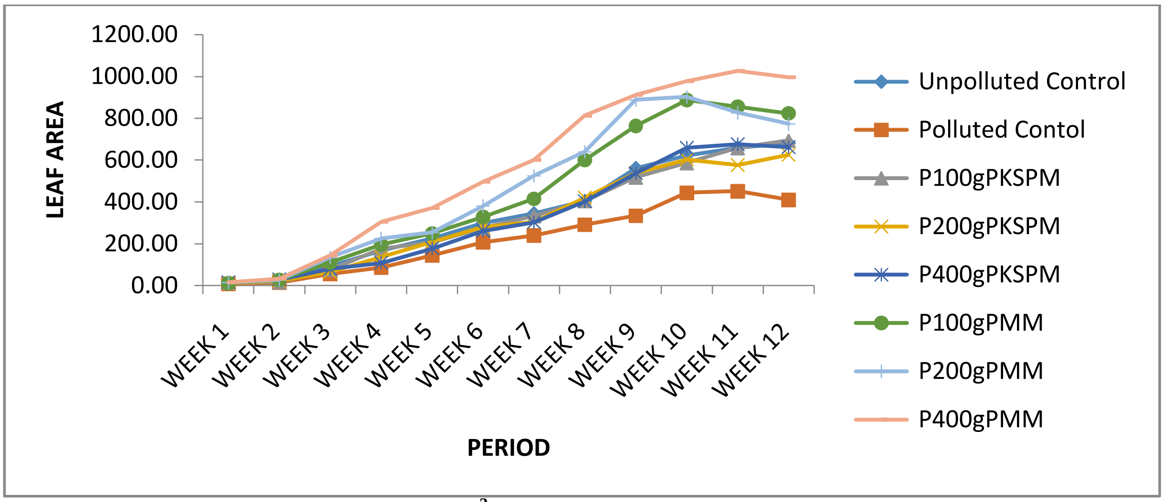

Figure 3: Leaf area (cm^2) of maize plant grown in remediated soil

Values are mean of triplicate determination.

Note: P100gPKSPM = Polluted + 100g Palm Kernel Shell Powder + Maize; P200gPKSPM = Polluted + 200g Palm Kernel Shell Powder + Maize; P400gPKSPM = Polluted + 400g Palm Kernel Shell Powder + Maize; P100gPMM = Polluted +100g Poultry Manure + Maize; P200gPMM = Polluted +200g Poultry Manure + Maize; P400gPMM = Polluted + 400g Poultry Manure + Maize

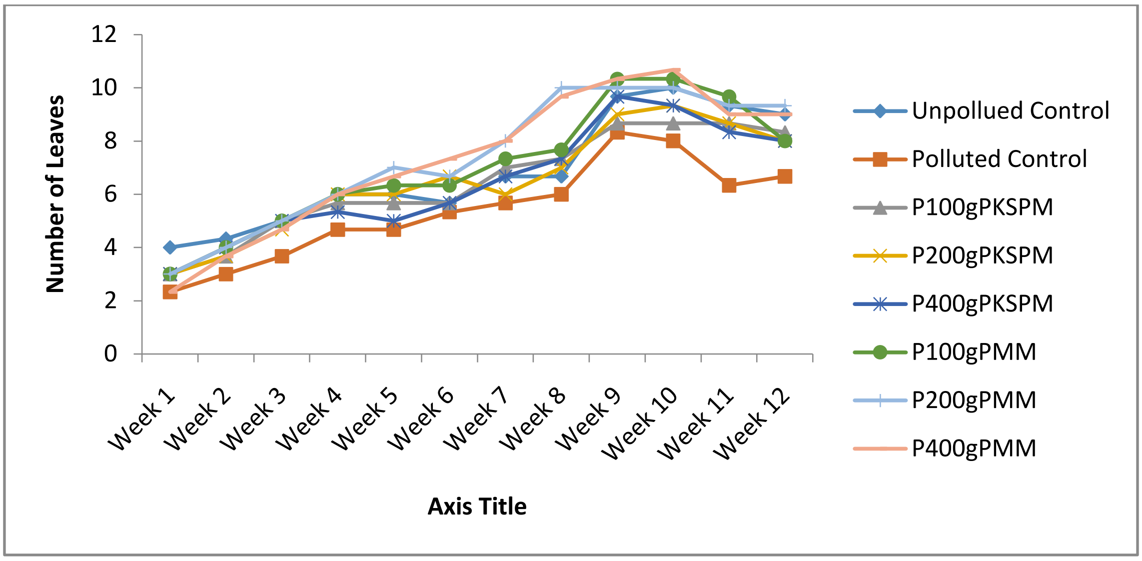

Figure 4: Number of leaves of maize plants grown in remediated soils

Values are mean of triplicate determination.

Note: P100gPKSPM = Polluted + 100g Palm Kernel Shell Powder + Maize; P200gPKSPM = Polluted + 200g Palm Kernel Shell Powder + Maize; P400gPKSPM = Polluted + 400g Palm Kernel Shell Powder + Maize; P100gPMM = Polluted + 100g Poultry Manure + Maize; P200gPMM = Polluted +200g Poultry Manure + Maize; P400gPMM = Polluted + 400g Poultry Manure + Maize

Root length, Plant density and Germination percentageoftheRemediatedSoils:

The result obtained for the root length, plant density and germination percentage are presented in Table 1. The observed significantly (p<0.05) higher values observed in the root length, plant density and germination percentage of the amended soils when compared to polluted control indicates that the organic amendments were able to contain the pollutants thus enhancing a favorable environment for growth even in the presence of the polluted soil.

Thegreatergermination percentage noted in theremediatedsoils in comparison withthepollutedcontrolsoilssuggeststhattreatmentofthesoils usingtheorganic amendmentsenhanced thesoilgermination ability. Furthermore, the organic amendments were easily dissolved and absorbed as well thereby enhancing microbial degradation of the petroleum hydrocarbons. Germination was also seen occurring in the polluted soil lacking organic amendment.This is in conformity with findings of [40]who noted germination of maize seedlings in crude-oil polluted soil. The germination percentage of maize plants grown in the polluted control soil implies that the presence of crude-oiltransformed, negatively affected the maize seeds germination and hindered their growth. Environmental factors such as temperature, pH, nutrients and oxygen were absent in the crude-oil polluted soil whereas that of the amended soils recorded a higher germination percentage as a result of the active role played by the organic amendments in reorganizing the crude-oil impacted soil thereby providing anadvantageous environment for the germination of the maize seedsdue to positive alteration of the physiochemical properties of the soil enhancing the maize germination as against the polluted soil. It can also be said that the amended soils which recorded a higher level of removal of hydrocarbons also had a higher percentage germination when compared to the polluted control soil where degradation of petroleum hydrocarbon was hindered recording a low germination percentage. The amendment material had a limiting impact of the negativeconsequencescreated by the crude oil pollutant. This could be related to the observation that the maize grains were soaked with the crude oil thereby rendering them not viable. Viability is a requirementfor theactive germination of a seed [41]. Research work conducted by [42]asserted that at low concentration of crude-oil spills (for example,1% of crude-oil pollution) germination might be slowed downas a result of inadequate moisture as well as toughening of soil structure. However, at high pollution of soil, germination might probably not occur at all. Consequently, this could result to seed decaying due to leaking of crude-oil into the seeds via the outer integument. Intrusion of oil into soil, air and water is an alternativeroute of obstructing seed germination. According to [43] the noxiousoutcome of crude-oil attached to poor ventilation and changed wettability of the soil as a resultof oil spillscauses poor seed germination.

Cob length, number of seeds, number of rows per cobs and weight of grains:

The results of the cob length, number of seeds, number of rows per cobs and weight of grains are presented in Table 2.Grain yield is a factor that is linked to several other factors such as plant density, number of cobs per plant, number of rows per cob, number of grains per row and grain weight. Consequently, an upsurge or decline in any of the above parameters mightaffectcrop yield.The outcome of the organic amendments in the amended soils was clearly seen after the harvest of the maize grains. Maize yield parameters which include cob length, number of seeds, number of rows per cobs and weight of grains harvested from the remediated soils showed a significant increase when compared to the polluted soils due toa favorable environment backing up plant growth. This portrays the fact that the amended soils were more appropriate for the growth of the maize plant as the quantity of pollutants became reduced by the role played by the organic amendments added to the soil which boosted crop maturation, fruit production and formation of seed., In contrast, the poor maize yield parameters observed in maize that developed from the polluted control soil establishes the fact that the pollutants harmfullyimpacted the yield of maize culminating in poor yield. The least grain yield noted in the polluted control cell could be due to the non-application of amendment materials. Other researchers (24,44, 45],have alsostated that crude-oil pollution triggers increased soil organic carbon which is harmful to the growth and development of plants due to higher C: N ratio. The maize yield result obtained from this study showed that the maize plant responded significantly to the amendment material when compared to the polluted soils. This is in agreement with the findings of [46] thereby culminating in higher grain yields after the remediation period. These results are in harmony with those of [47].

Table 3: Root length, plant density and germination percentage of maize plants grown in palm kernel shell powder and poultry manure treatedsoils

CELLS	ROOT LENGTH	PLANT DENSITY	GERMINATION PERCENTAGE
Unpolluted Control	27.43±0.30	0.03±0.01	97.33±1.45
Polluted Control	14.03±0.58[a]	0.03±0.01	31.33±0.88[a]
P100gPKSPM	23.93±0.52[a, b]	0.07±0.04	98.33±1.67[b]
P200gPKSPM	25.00±0.12[b]	0.21±0.14	96.33±2.03[b]
P400gPKSPM	27.80±0.42[b]	0.07±0.05	67.23±0.39[a, b]
P100gPMM	25.67±0.88[b]	0.06±0.01	97.33±1.45[b]
P200gPMM	29.00±0.58[b]	0.08±0.04	98.33±1.20[a, b]
P400gPMM	35.67±0.88[a, b]	0.38±0.03[a, b]	95.67±1.33[b]

Values are mean ± standard error of triplicate determination. 'a' is significant at *p*<0.05 when compared with the unpolluted control. 'b' is significant at *p*<0.05 when compared with the polluted control. '*' is significant at *p*<0.05 when compared with the corresponding baseline values.
Note: P100gPKSPM = Polluted + 100g Palm Kernel Shell Powder + Maize; P200gPKSPM = Polluted + 200g Palm Kernel Shell Powder + Maize; P400gPKSPM = Polluted + 400g Palm Kernel Shell Powder + Maize; P100gPMM = Polluted + 100g Poultry Manure + Maize; P200gPMM = Polluted +200g Poultry Manure + Maize; P400gPMM = Polluted + 400g Poultry Manure + Maize.

Table 4: Cob length, number of seeds, number of rows per cobs and weight of grains maize plants grown in palm kernel shell powder and poultry manure treatedsoils

CELLS	COB LENGTH (cm)	NO OF SEEDS PER COB	NO OF ROWS PER COBS	WEIGHTOF GRAINS
Unpolluted Control	9.50±0.29	57.33±1.45	10.33±1.53	24.33±1.20
Polluted Control	6.00±0.58[a]	9.00±0.58[a]	5.67±1.53[a]	12.33±1.45[a]
P100gPKSPM	7.50±0.29[a]	58.33±1.20[b]	7.67±0.58	22.00±1.15[b]
P200gPKSPM	8.93±0.12[b]	21.67±3.76[a]	8.67±0.58	23.00±1.15[b]
P400gPKSPM	10.10±0.06[b]	28.33±3.76[a, b]	10.33±0.58[b]	23.67±0.88[b]
P100gPMM	9.03±0.15[b]	40.67±2.33[a, b]	10.00±1.00[b]	25.33±0.88[b]
P200gPMM	10.07±0.18[b]	51.67±2.60[b]	10.33±0.58[b]	32.00±0.58[b]
P400gPMM	13.50±0.29[a, b]	63.67±1.76[b]	14.00±1.00[a, b]	28.67±0.88[a,b]

Values are mean ± standard error of triplicate determination. 'a' is significant at *p*<0.05 when compared with the unpolluted control. 'b' is significant at *p*<0.05 when compared with the polluted control. '*' is significant at *p*<0.05 when compared with the corresponding baseline values.
Note: P100gPKSPM = Polluted + 100g Palm Kernel Shell Powder + Maize; P200gPKSPM = Polluted + 200g Palm Kernel Shell Powder + Maize; P400gPKSPM = Polluted + 400g Palm Kernel Shell Powder +

Maize; P100gPMM = Polluted + 100g Poultry Manure + Maize; P200gPMM = Polluted +200g Poultry Manure + Maize; P400gPMM = Polluted + 400g Poultry Manure + Maize.

III. Conclusion

Agricultural soils polluted with crude-oil negatively affects the soil ecosystem, however, the condition could be betteredthroughaugmentingwith soil nutrients (bio stimulants). Data obtained from this research work hasestablished the efficacyof the remediation materials (palm kernel shell powder and poultry manure) as an ameliorating mediator in crude-oil polluted soilsfor reducing petroleum hydrocarbon andenhancement of plant growth parameters such plant height, leaf length, leaf area, number of leaves as well asimproving maize yield components

It can also be said thatpoultry manure and palm kernel shell powder possess positive influence on crude-oil polluted sandy silty sand soil (*Zea mays* L.) in Rivers State, Nigeria.

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