Enhanced Growth Performance Of Okra (*Abelmoschus esculentus*) In Crude Oil Polluted Soil Using Rice (*Oryza sativa*) Husks And Cassava (*Manihot esculata*) Peels

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Abstract: The study was on the enhanced growth performance of okra in crude oil polluted soils amended with rice husks and cassava peels. Three kilogrammes each of composite soil samples were weighed into 48 perforated polyethylene bags and artificially polluted with 200ml of crude oil and allowed for two weeks before the amendments were applied at 0g, 50g, 100g, 150g and 200g of both wastes. After four weeks treatment, okra seeds were sown in the various treated groups. Soil samples were collected from the various treated groups for physicochemical analysis. The result showed that the amendment of hydrocarbon polluted soil with rice husks and cassava peels significantly improve the moisture content, pH of the soil as compared to the crude oil control. The amelioration with rice husk significantly reduce ($P<0.05$) the organic carbon content of the soil compared to the cassava peels amended soil. The result implies that the enhancement of the polluted soils with rice husk and cassava peels improves the soil quality and thereby increase the growth performance of okra grown in the soil.

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Introduction

Crude oil production and exploitation is a major source of income for the Nigerian economy. Petroleum provides about 90% of the export earnings and serves as a primary raw materials for the chemical industries. The high demand for petroleum product such as cooking gas, aviation fuel, gas oil, engine lubricating oil and coal tar has increase the rate of oil spill due to the bye-product. Adverse contamination of the soil through oil well blow out, tanker accident, accidental rupture of pipelines and routines clean up operations has also been reported (Anoliefo and Vwioko, 1994; Atlas, 1991). The spill of petroleum and its products has led to deterioration of terrestrial and aquatic environment degradation (Ekpo *et al,* 2012). The impact on terrestrial environment ranges from aesthetic quality modification to death of sensitive biotic species. One of the environmental challenges posed by oil pollution is the alteration in the physical and chemical properties of the soil which subsequently affects the growth of plants (Chikere *et al,* 2011). Petroleum hydrocarbon contamination may affect plant by retarding seed germination and reducing height, stem density, photosynthetic rate and biomass or resulting in complete mortality (Akpoveta *et al*. 2011).

The environmental consequences of oil pollution on most agricultural lands have turned hither of productive areas into wastelands, with increasing soil infertility due to the alteration of physiochemical properties of the soil, and dwindling agricultural productivity thus has lead to redundancy of farming and fishing activities resulting in Urban and Rural migration, in oil producing area due to the attendant economic downturn (Atlas, 1991). It has been shown that the existing mode of indiscriminate disposal of spent oil does not only increase pollution incident in the environment but it is equally more prevalent than crude oil pollution (Odjegba and Sadiq, 2002). The soil is the most valuable component of the farming ecosystem and environmental sustainability largely depends on proper soil management; thus hydrocarbon products affects the soil by reducing the nutrient content of the soil, increase the toxicity of heavy metals and increases water infiltration into the soil as a result of hydrophobic characteristics (Wood and Roper, 2000). Thus sustainable use of agricultural soil on which plants depend is absolutely necessary for agricultural productivity. The degree of oil impact also depends on various factors such as the type and amount of oil, the extent of oil coverage, the plant species, and the season of the spill, the soil composition and the flushing rate. Oiled shoot of crops like pepper, okra, cocoyam, yams and tomatoes may wilt and die off due to blockage of stomata thereby inhibiting photosynthesis, transpiration and respiration. Infact, germination, growth performance and yield of these crop stifled by oil spillage (Aro *et al.* 2010).

Materials And Methods

The study was conducted in Biological Science Experimental Farm, University of Calabar, Calabar. Seeds of okra (*Abelmoschus esculentus*) were obtained from Watt Market in Calabar. Viable seeds were selected and soaked in water for 24 hours to break the dormancy. Rice (*Oryza sativa*) husks was obtained from a rice mill in Ugep, Yakurr L.G.A while cassava (*Manihot esculata*) peels were obtained from New airport field; Calabar South L.G.A. Top soil (0-20cm depth) was collected from three points around Biological Science Experimental Farm, bulked to form composite soil samples (Agbor *et al*., 2012). Three kilogrammes (3kg) each of the composite soil samples were weighed into 48 perforated polyethylene bags leaving a space of 2.5cm from the top to make allowance for addition of amendment and water. Crude oil *(Bonny Light*) was obtained from Nigerian Agip Oil Company, Port – Harcourt, Rivers State.

The forty eight (48) polyethylene bags containing the soil samples were artificially polluted with 200ml and allowed for 14 days for soil. *Oryza sativa* husks and *Manihot esculata* peels were applied to the polluted soil based on the following treatment levels 0g, 50g, 100g, 150g and 200g. After the application of the amendments the experimental set-up was for 30 days to monitor the rate of biodegradation of the crude oil.

Planting of Seeds and Water Application

Okra (*Abelmoschus esculentus*) seeds were sown into the various polyethylene bags containing the remediated soils, and application of water was done when necessary to keep the soil moist and to avoid drought. It should be noted that watering was undertaken at 2 days interval to maintain crop growth.

Determination of physicochemical parameters of soil

Ten (10) grams sieved (2mm sieve) soil samples were dried to constant weight at 105^0C for 2 hours. The moisture/water content was reported as the loss in weight on drying after 2 hours. Soil pH was determined using the Jenway model 370 pH meter, by dipping the electrode into a 1:25 soil/water suspension. The electrical conductivity was determined using the conductivity meter (Jenway model 350 conductivity meter), by dipping the electrode into the same 1:25 soil/water suspension mentioned above. Soil texture otherwise known as particle size was carried out by the hydrometer procedure as described by Eno *et al*. (2009) using mechanical shaking and sodium hexametaphosphate as physical and chemical dispersants, respectively. The textural triangle was used to determine the soil textural name after the percentage of sand, silt and clay fraction in the soil, were determined in the laboratory. Organic carbon in the soil was determined by the wet oxidation method of (Eno *et al*. 2009). One gram of the soil sample was dispersed with 10ml of 1N potassium dichromate ($K_2Cr_2O_7$). The organic matter in the solution was oxidized using 20ml of concentrated sulphuric acid. The resulting solution was allowed to stand for 30 minutes, and diluted with 200ml of distilled water. Then 1ml of diphenylamine indicator was added before titrating with 1N ferrous sulphate ($FeSO_4$). Available phosphorus was determined by Bray P-1 method (Eno *et al*. 2009). Six grams of air-dried soil sample was extracted with 30ml of P-1 solution, centrifuged at 2000rpm for 15 minutes and filtered. Then 2ml of the resulting solution that was diluted to 40ml distilled water reacted with 8ml of ascorbic acid for colour development and absorbance determined using a spectrophotometer at 882nm. The determination of total nitrogen was done using the Kjeldah method (Eno *et al.* 2009) in which the nitrogen in 10g of the air-dried soil sample was converted into ammonium product by digestion with concentrated H_2SO_4. The reaction was facilitated by adding 2 g of $CuSO_4$ and 5g of Na_2SO_4). These last two products acted as catalyst to promote the oxidation of organic matter. The nitrogen content of the sample was obtained by titration with 0.1N HCl. Exchangeable cations in 4g of air-dried soil sample were determined after extraction of soil with 1N ammonium acetate (1N NH_4OAC) for 1 hour. The resulting leachate was used both for the determination of Ca and Mg by 0.02N ethylenediamine tetra-acetic acid. Exchangeable acidity (H^+ + Al) in 5g of air-dried soil sample was determined after extraction of soil with 1M HCl by repeated centrifugation at 2000rpm for 30 minutes, followed by titration with NaOH (Eno *et al.* 2009).

Data Collection

Data were collected based on the following parameters: days to seed germination, number of leaves, leaf length, plant height, internodes length, petiole length, number of pods, leaf area, days to flowering, number of flowers per plant.

Statistical analysis

Collected data were subjected to analysis of variance (ANOVA) test using 2 factorial in a Completely Randomization Design (CRD). Significant means separated using Least Significant Difference (LSD) test at 5% probability level.

Results

Physicochemical Properties of hydrocarbon remediated soil.

The result obtained shows that the amendment of the hydrocarbon polluted soil with rice husks and cassava peels significantly improve the moisture content of the soil as compared with the crude oil control soil (COC). The pH of the soil was also significantly increased (P<0.05) in the amended soil as compared with the pristine soil and crude oil control soil. The significant increase in the pH was observed in all the treatment groups except the pristine soil and crude oil control soil. Significant reduction in the organic carbon content of the soil was also observed in all the amended soil and the reduction is treatment dependent (the higher the concentration of the amendment the more the reduction). Among the two amendments, rice husks was observed to significantly reduce (P<0.05) the organic carbon than the cassava peels.

The nitrogen content of the soil was observed to show no significant difference (P>0.05) with the control group. The phosphorus content of the amended soil also significantly increase (P<0.05) as compared with the pristine control and crude oil control soil. The increase in the phosphorus content of the soil was treated dependent and rice husks at high concentration was observed to have the highest phosphorus content than soil treated with cassava peels. The calcium, magnesium, potassium and ECEC of the soil was also observed to significantly increase (P<0.05) in all the amended soil as compared with the pristine control and crude oil control soil.

Table 2: Physicochemical Properties Of Hydrocarbon Remediated Soil Using Rice Husks And Cassava Peels

Rice husks	Cassava peels											
Parameters	PC1	COC1	50RH	100RH	150RH	200RH	PC2	COC2	50CP	100CP	150CP	200CP	LSD
Moisture	8.4±0.06	6.73±0.18	10.4±0.12	11.57±0.12	15.67±0.18	16.37±0.23	8.4±0.06	6.73±0.18	12.7±0.15	14.7±0.16	20±0.25	20.7±0.15	0.34
pH	5.5±0.06	5.63±0.22	7.2±0.06	7.83±0.09	8.1±0.15	8.23±0.19	5.5±0.06	5.63±0.22	6.77±0.09	7.3±0.06	7.73±0.09	7.8±0.06	0.64
Org.c	0.96±0.01	3.96±0.01	2.05±0.01	1.54±0.01	1.18±0.01	1.05±0.01	0.96±0.01	3.96±0.01	2.5±0.06	2.08±0.01	1.99±0.01	1.86±0.01	0.04
Nitrogen (%)	0.17±0.01	0.06±0.01	0.17±0.01	0.21±0.02	0.28±0.01	0.36±0.02	0.17±0.01	0.06±0.01	0.19±0.02	0.18±0.01	0.22±0.01	0.25±0.01	NS
Phosphorus	20.77±0.11	7.7±0.06	38.2±0.13	76.67±0.21	80.77±0.16	88.67±0.19	20.77±0.11	7.7±0.06	27.87±0.12	36.83±0.16	40.67±0.20	47.97±0.18	0.68
Calcium	0.84±0.03	0.46±0.01	1.08±0.04	1.27±0.02	1.80±0.05	1.96±0.03	0.84±0.03	0.46±0.01	0.8±0.01	1.13±0.02	1.37±0.01	1.47±0.02	0.07
Magnesium	1.00±0.01	0.61±0.02	1.09±0.01	1.20±0.01	1.25±0.04	1.26±0.02	1.00±0.01	0.61±0.02	0.87±0.01	1.17±0.02	1.19±0.01	1.2±0.01	0.04
Potassium	0.16±0.01	0.10±0.01	0.17±0.02	0.19±0.01	0.27±0.02	0.28±0.01	0.16±0.01	0.10±0.01	0.12±0.02	0.19±0.01	0.19±0.01	0.21±0.01	0.02
Sodium	0.04±0.01	0.03±0.01	0.07±0.01	0.08±0.01	0.06±0.01	0.04±0.01	0.04±0.01	0.03±0.01	0.05±0.01	0.07±0.01	0.07±0.01	0.1±0.01	NS
ECEC	2.07±0.03	1.19±0.02	2.3±0.02	2.81±0.01	3.34±0.06	3.6±0.09	2.07±0.03	1.19±0.02	1.83±0.04	2.55±0.02	2.76±0.02	2.98±0.03	0.05
H^+	0.04±0.01	0.03±0.01	ND	ND	ND	ND	0.04±0.01	0.03±0.01	0.01±0.01	ND	ND	ND	NS
Al^{3+}	0.06±0.01	0.08±0.02	0.01±0.06	ND	ND	ND	0.06±0.01	0.08±0.02	0.02±0.01	ND	ND	ND	NS
BS	95.12	90.68	99.56	100	100	100	95.12	90.68	100	100	100	100	NS

Means with the same case letter along the horizontal array indicate no significant difference (P>0.05)

Growth performance of okra on hydrocarbon remediated soil using rice husks and cassava peels.

The amelioration of the soil with rice husks and cassava peels produces no resultant differences in the days to germination compared to the positive and negative control. Plant height of okra grown on crude oil remediated soil shows that there were significant difference (P<0.05) in plant height at different amendment levels, which implies that the responses of the plant to the remediated soil was dose dependent. The highest plant height was obtained in 200RH, followed by soil treated with 50RH, 100RH, 150RH, PC_2, 50CP, 100CP, 150CP and 200CP which had no variation while the +ve and -ve produces okra with stunted height (Table 1). Soil amended with 200RH, 150RH, 100RH, 50RH had significantly high leaf area followed by 200CP, 150CP, 100CP, and 50CP, then +ve control soil while the -ve control had the smallest leaf area. Both amendments at higher concentrations produces longer leaf length, followed by the low concentrations and pristine soil while the crude oil control had the smallest leaf length. The leaf width of okra plant showed significant improvement due to the amendments applied. The increase in leaf width was greater in soil amended with 200gRH than the pristine soil while the crude oil control soil produces the smallest leaf width (Table 1). Increased number of leaves of the okra plant was obtained from soil amended with 200RH, while other concentration of the amendments and pristine control had no significant difference (P>0.05) in the number of leaves except the crude oil control soil that had no amendment (Table 1). It was observed that the crude oil control soil did not flowered while the pristine soil had prolonged days of flowering than the amended soil. Soil amended with 200RH and 150RH flowered much earlier than soil amended with 200CP, 150CP, 100RH and 50RH. The result on the number of flowers of okra plant indicates that the crude oil control plant did not produce flowers while the soil amended with 200RH and 150RH had significantly high (P<0.05) numbers of flowers followed by the pristine soil and soil amended with 100RH, 50RH, 200CP, 150CP, 100CP and 50CP with no significant difference (P>0.05). The number of pods of okra grown on hydrocarbon remediated soil shows that 200RH had significantly high (P<0.05) number of pods followed by 150RH and 200RH, also followed by 100RH and150CP, the soil amended 100RH and 150CP also produces significantly high (P<0.05) number of pods while 50RH, 50CP and 100CP had fewer number of pods but higher than number of pods obtained in the pristine soil. Okra plant in 200RH amended soil had significantly high (P<0.05) pods weight followed by 150RH, 100RH, 50RH and 200CP which had no significant difference (P>0.05), followed by okra plant grown in pristine soil, also followed by soil amended with 150CP while soil amended with 50CP and 100CP had the lowest pods weight (Table 1).

Table 1: Growth performance trait of hydrocarbon remediated soil using rice husks (RH) and cassava peels (CP)

Rice Husks							Cassava Peels						
Parameters	PC1	COC1	50g	100g	150g	200g	PC2	COC2	50g	100g	150g	200g	LSD
Days to germination	3.25±0.08	4.75±0.04	3.35±0.03	3.00±0.02	3.00±0.03	3.00±0.04	3.50±0.01	5.00±0.02	4.5±0.02	4.00±0.02	4.25±0.01	3.50±0.02	0.60
Plant height	13.98±0.1	7.45±0.2	16.89±0.09	19.71±0.11	22.48±0.1	27.74±0.08	15.89±0.1	7.86±0.09	20.39±0.8	19.41±0.08	22.09±0.2	24.25±0.2	2.60
Leaf area	102.63±3.0	31.75±1.5	158.25±2.3	323.63±1.2	356.13±2.4	439.13±3.1	104.9±2.7	51.2±1.1	129.9±3.0	186.1±2.2	216.8±2.0	236.3±1.5	19.4
Leaf length	4.89±0.07	1.76±0.1	5.01±0.09	5.79±0.04	6.48±0.1	6.98±0.05	4.93±0.02	1.53±0.01	4.41±0.5	5.85±0.04	6.25±0.02	7.43±0.05	0.70
Leaf width	4.09±0.09	1.63±0.01	5.70±0.03	6.81±0.03	7.75±0.02	8.64±0.07	4.34±0.01	1.66±0.02	5.95±0.01	6.4±0.06	6.85±0.05	7.5±0.02	0.61
Number of leaves	4.63±0.02	2.25±0.02	5.63±0.05	6.63±0.05	7.75±0.04	9.13±0.1	4.63±0.02	2.5±0.01	4.63±0.08	5.63±0.08	6.5±0.09	7.5±0.05	1.08
Days to flowering	60.5±0.12	0.00±0.00	52.25±0.12	49.75±0.3	46.5±0.2	45.00±0.4	60.25±0.2	0.00±0.00	56.25±1.3	56.00±0.6	50.75±0.8	49.25±0.4	1.54
Number of flowers	1.75±0.01	0.00±0.00	2.25±0.01	2.75±0.02	3.5±0.03	3.5±0.02	1.75±0.02	0.00±0.00	1.25±0.01	1.75±0.01	2.5±0.2	2.75±0.01	0.57
Number of pods	2.5±0.02	0.00±0.00	3.25±0.01	4.00±0.03	4.5±0.04	5.00±0.02	2.5±0.01	0.00±0.00	3.0±0.01	3.5±0.02	4.0±0.03	4.50±0.02	0.48
Weight of pods	4.43±0.01	0.00±0.00	4.7±0.03	4.78±0.02	5.05±0.03	5.43±0.01	4.43±0.02	0.00±0.00	3.7±0.02	3.85±0.01	4.13±0.02	4.85±0.04	0.22

Means with the same case letter along the horizontal array indicate no significant difference ($P>0.05$)

Table 3: Chemical characteristics of the amendments

Parameters	Rice husk dust (RHD)	Cassava peels (CP)
Organic matter	27	52.2
Total N	0.86	0.38
Avail. P	3.44	0.80
Ca	2.43	1.20
Mg	1.30	0.73
K	1.16	0.76
Na	0.14	0.30

Discussion

Crude oil production and exploitation is a major source of income for the Nigerian economy because petroleum provides about 90% of the export earnings and serves as primary raw materials for the chemical industries. Accidental spillage due to oil well blow-out has led to the alteration of soil physiochemical status, with the consequent abandonment of such lands leading to the reduction of productive land resource base available to rural farmers (Ekpo *et al.,* 2012). As a tool in the improvement of agricultural produce in hydrocarbon polluted environment several mechanisms ranging from chemical, mechanical and physical has been used. Though most of the methods prove to be effective but at the time injurious to the soil micro-organisms and other physical and chemical properties of the soil. Undoubtedly, the use of agricultural waste in reclaiming polluted soil is beginning to gain grounds due to it nutritive roles in the soil and thus environmentally friendly (Agbor *et al,* 2013). Degradation of hydrocarbon product in the soil is mostly achieved at a pH range 6.8 to 9.0. The pH value obtained in the amended soil, signified that the wastes possesses a strong buffering effect. A high significant reduction in the organic carbon content of the soil amended with rice husk dust at high concentration was observed. The reduction in the organic carbon content could be attributed to the high nitrogen and phosphorus level in the waste. The reduction in the organic carbon content was more than that achieved in the cassava peels amended soil. Mbah *et al*., (2009) reported that organic wastes such as riche husk dust and poultry droppings significantly reduces spent oil contaminated soils. Agbim (1985) has also used cassava peels and poultry dropping as amendments for the degradation of hydrocarbon soil in southeastern Nigeria. However, the phosphorus and nitrogen level of the rice husk dust amended soil were significantly higher than the cassava peels amended soil. the reduction in the organic carbon content and the improvement of the nitrogen and phosphorus could be a key factor in the high growth performance of okra. The high performance of okra was ascertained in comparing the amended soil plant and the crude oil control plant. It was observed that rice husk dust (RHD) amended produces plants with significantly high growth rate than the cassava peels (CP) amended soil plants.

Conclusion

The results obtained showed that rice husk and cassava peels enhances the growth performance of okra in crude oil polluted soil ($P<0.05$). It can be concluded from this study that rice husk and cassava peels are good bio-remediation agent for crude oil polluted soil.

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