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The dynamics of Vetiver (*Vetiveria zizanioides*) and Guinea grass (*Panicum maximum*) Amended with Organic Manures in Remediation of Crude Oil Contaminated Soil in Port Harcourt

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ABSTRACT

In a field study, conducted at the Teaching and Research farm of Rivers State University, soil polluted with Bonny Light crude oil at 0% and 2% v/w was subjected to remediation processes using vetiver (*Vetiveria zizanioides*) and guinea grasses (*Panicum maximum*) amended with organic manures for a period of twelve months. Two weeks after pollution, poultry and Rabbit manures were applied at 0, 10, 20 and 30 tons/ha respectively. Vetiver and Guinea grasses were planted two weeks later. It was fitted in factorial split plot. Results showed 80% of vetiver survived in contaminated unamended plots against 85% in control, percentage survival in guinea grass was 60% in contaminated unamended against 85% in control. There was initial delay in germination on contaminated plots for the two grasses. Amendment of the soil with organic manure improves the growth and performance of the grasses. Vetiver height was significantly ($p<0.05$) different from guinea grass in contaminated unamended plots implying that vetiver has better adaptation to pollution than guinea grass. Remediation of soil with vetiver and guinea grasses degraded the THC in the soil to 23 and 21% respectively; amendment of soil with different levels of organic manure increased the level of degradation to 70.6 and 67.9% for vetiver and guinea grasses respectively. Vetiver uptake of THC in plant tissues was significantly ($p<0.05$) different from that of guinea grass. Amendment of the soil with organic manure reduced the uptake. Generally, both grasses were tolerant to THC with vetiver being more tolerant with higher survival rate. Poultry manure as amendment material planted with vetiver grass was more effective than rabbit manure in remediation of crude oil contaminated soil.

INTRODUCTION

Soil is one of the valuable resources for the production of food and fibre. The wealth of any nation and indeed Nigeria depends on how well it is managed and maintained.

The wealth of Nigeria in the nineteen sixties (1960's) and early seventies (1970's) depend mostly on revenue generated from agriculture. As a result of rapid increase in the exploration and exploitation of crude oil, there was sharp decline in the output of agricultural production due to negative impact of crude oil contamination on the environment.

Presently, about 90% of Nigeria's economy depends largely on revenue generated from crude oil, most of this oil comes from numerous small producing oil fields located in both on, and offshore zones of Niger Delta (Zakka, 2013). The exploration and exploitation of this oil have brought about hardship and negative effects due to oil pollution which has adversely affected the soil, plants, micro-organisms and human beings dwelling within the ecosystems (Emola et al.,1992).

The Niger Delta of Nigeria has one of the world wetlands covering over 20,000km^2 in the South Eastern Nigeria (World Bank, 1995). Of the resources available, oil and gas are presently the most valuable in the national economy (Horsfall and Spiff, 2001). Despite these numerous natural resources, the region is threatened by diverse environmental problems of which oil pollution is most paramount.

Oil spillage is one of the major causes of crude oil pollution of soil and water. There is no oil exploration operation that is 100% efficient, equipment failure may lead to spillage Anyaegbu, 1987), when oil spillage occurs, the environment is adversely affected, the ecosystem is damaged, the food chain disrupted and it brings about emotional, socio-economic, stress and youth restiveness to the inhabitants of the environment.

It is important to note that oil contamination on soil is not itself toxic to plants rather has an indirect effect as it creates a condition that makes essential nutrients for plant growth unavailable and at the same time makes some nutrients that are toxic to plants available (Isirimah *et al.,* 2006).

A number of biological, physical and physicochemical remediation techniques have been used to decontaminate soils and water. These techniques range from setting ablaze (fire) to the crude oil polluted site, excavation of contaminated area, use of bioremediation (micro-organism), organic manures, inorganic fertilizer and plants. The aim of all these practices is to ensure protection of human health and the environment.

Phytoremediation is an alternative method of remediation that utilizes plants to decontaminate soil, water and air environment (Prasad, 2003).

It is relatively environmentally friendly, because it uses naturally occurring organisms and presents the environment in a more natural state as opposed to mechanical clean up. It is simple, cost effective , non environmentally disruptive and its by-products can find a range of other use (Truong, 2000).

Weeds are generally referred as plants growing in place where they are not wanted. Several plant species which are regarded as weeds are useful for other purposes such as phytoremediation. An ideal plant species for phytoremediation should have one of the following characteristics: high biomass with enhanced metal uptake potential, low biomass with very high metal accumulation capacity.

Phytoremediation of soil with the use of vetiver and guinea grasses amended with organic manures in Niger Delta is very limited as revealed in literature..

The use of these remediation materials will restore the physico-chemical and biological condition of the soil and at the same time reduce the effect of heavy metal contamination of the soil and plants. The objective of this study is to remediate soil polluted with crude oil with vetiver and guinea grasses amended with organic manures.

MATERIALS AND METHODS

Study Site

The study was conducted at the teaching and research farm of Rivers State University, Nkpolu, Port Harcourt. The study site is located by latitude 4^o 5^1 N and longitude 7^o 0^1 E with an elevation of 18m above sea level (FAO, 1984).

The mean annual rainfall ranges from 3000 to 4000mm (FAO, 1984) and is bimodal in nature with peaks in June and September with a period of low precipitation in August. Annual temperature varies between 22 to 31^{o}C, (FDRD,1981), the relative humidity (RH) varies between 35 to 90% depending on the particular period of the year.

Soil of the study site

Soil of the study site was from coastal plain sands geomorphic region. It is typically sandy loam (typic paleudult) formed over sedimentary rocks. It belongs to the ultisol order of the United State Soil Taxonomy (Soil Survey Staff, 1975).

SOURCES OF CRUDE OIL

Nigerian Bonny light crude oil (fresh) obtained from shell Petroleum Company Nigerian Limited, Bayelsa State flow station was used and a concentration of 0 and 2% was used in the studied area.

Each of the experimental plots (3 x 4m) with the exception of the control plot was treated with crude oil from a watering can; evenly sprayed and worked into the soil with garden fork.

Amendment Materials

Poultry and rabbit manures were used as amendment materials. These organic manures were applied onto the soils with the exception of control plots two weeks after contaminating the soil with crude oil. The organic manures were broadcast and worked into the soil with garden fork

Poultry and rabbit manures were incorporated into the experimental plots at the rate of 0, 10, 20 and 30 tons per hectare, respectively.

Preparation and Planting of Plant Materials

The study area had been under continuous cultivation with different crops, the last being cassava and maize. The site was ploughed, and harrowed with tractor, marked and pegged. Vetiver grass (*Vetiveria zizanioides*) and guinea grass (*Panicum maximum*) collected from National Root Research Institute, Umudike, Abia State and Rivers State University Teaching and Research Farm, respectively were planted two weeks after amendment materials were added at a spacing of 20 by 30 cm and 30 by 30 cm for vetiver and guinea grasses respectively.

Experimental Design

A total of 32 treatment combinations (Table 1) were laid out in a factorial fitted into a split plot randomized complete block design with contaminated and uncontaminated as the main plots. Other factors served as sub plots. All the treatments were replicated three times making a total of 96 plots.

Table 1: Treatment combinations

Treatment code	Key
COP0	Control, no crude oil no poultry manure (0 t/ha) plus vetiver grass
COP1	No crude oil, poultry manure at 10 t/ha plus vetiver grass
COP2	No crude oil, poultry manure at 20t/ha plus vetiver grass
COP3	No crude oil, poultry manure at 30t/ha plus vetiver grass
COR0	No crude oil, no rabbit manure (0 t/ha) plus Vetiver grass
COR1	No crude oil, rabbit manure at 10 t/ha plus vetiver grass
COR2	No crude oil, rabbit manure at 20 t/ha plus vetiver grass
COR3	No crude oil, rabbit manure at 30 t/ha plus Vetiver grass
C1P0	Contaminated with crude oil, no poultry manure (0 t/ha) plus vetiver grass
C1P1	Contaminated with crude oil, poultry manure at 10 t/ha plus vetiver grass
C1P2	Contaminated with crude oil, poultry manure at 20 t/ha plus vetiver grass
C1P3	Contaminated with crude oil, poultry manure at 30t/ha plus vetiver grass
C1R0	Contaminated with crude oil, no rabbit manure (0 t/ha) plus vetiver grass
C1R1	Contaminated with crude oil, rabbit manure at 10t/ha plus vetiver
C1R2	Contaminated with crude oil, rabbit manure at 20 t/ha plus veitver grass
C1R3	Contaminated with crude oil, rabbit manure 30 t/ha plus vetiver grass
COP0	Control, no crude oil, no poultry manure (0t/ha) plus guinea grass
COP1	No crude oil, poultry manure at 10 t/ha plus guinea grass
COP2	No crude oil, poultry manure at 20 t/ha plus guinea grass
COP3	No crude oil, poultry manure at 30 t/ha plus guinea grass
COR0	No crude oil, no rabbit manure 0t/ha)plus guinea grass
COR1	No crude oil, rabbit manure at 10t/ha plus guinea grass
COR2	No crude oil, rabbit manure at 20t/ha plus guinea grass
COR3	No crude oil, rabbit manure at 30t/ha plus guinea grass
C1P0	Contaminated with crude oil, no poultry manure (0 t/ha) plus guinea grass
CIP1	Contaminated with crude oil, poultry manure at 10 t/ha plus guinea grass
CIP2	Contaminated with crude oil, poultry manure at 20t/ha plus guinea grass
CIP3	Contaminated with crude oil, poultry manure at 30t/ha plus guinea grass
CIR0	Contaminated with crude oil, no rabbit manure (0 t/ha) plus guinea grass
CIR1	Contaminated with crude oil, rabbit manure at 10 t/ha plus guinea grass
CIR2	Contaminated with crude oil, rabbit manure at 20t/ha plus guinea grass
CIR3	Contaminated with crude oil, rabbit manure at 30t/ha plus guinea grass

Collection and Preparation of Soil Sample for Laboratory Analysis

Randomly, soil samples were collected from a depth 0-20cm from each of the plots with a bucket auger. The samples were crushed with hands, spread on a flat surface, composited and left to air-dry at room temperature in the laboratory. The samples were later pulverized with mortar and pistle, sieved in a 2mm mesh screen and stored in a polythene bag for analysis.

Laboratory Analytical Procedures

Total hydrocarbon content was estimated using the method of Odu *et al.,* (1985). 10g portion of the soil sample was shaken with 10ml of carbon–tetrachloride. The hydrocarbon was extracted and determined by the absorbance of the extract at 420nm spectrophotometer. Standard curve of the absorbance of different known concentrations of equal amount of crude oil in the extractant was first drawn after taking reading from the spectrometer.

Plant Sampling and Data Collection

The following data were collected from the weed species (vetiver and guinea grass).

Plant Survivability

Two weeks after planting of vetiver and guinea grasses, the percent survivability count was taken in all the plots.

Plant Height

Five plants from each net plots at the middle were randomly selected, tagged and were used for data collection. The average of the five plants was taken as value per plant for each treatment plot**.**

Plant height for both vetiver and guinea grasses within the experimental periods was measured with a 30 meter measuring tape from the base of the plant to the tip of the leaves; the results were recorded in centimeters (cm) thirty days after planting. Subsequent measurements were done at thirty days interval for a period of three hundred and sixty days.

Preparation of Plant Samples for Chemical Analysis

The plant tissue (root and shoot) parts were washed using tap water to remove dust, mucor and soil particles and dried at 80^0C, in muffle furnance for 12 hours, and thereafter ground for analysis. The samples were digested with concentrated nitric acid ($HNO_{3)}$ and hyperchloric acid ($HCLO_4$,).

Statistical Analysis

Statistical analysis used for the study is Analysis of variance (ANOVA). Duncan-test was used to test the data

RESULTS AND DISCUSSION

Effect of Treatments on Plant Survivability

Effect of the treatments on the mean percentage survivability of the plants is presented in Table 2. The percentage plant survivability count for vetiver grass (*Vetiveria zizanioides*) was 90% as mean. Average of 80% survived in contaminated unamended plot as against 85% that survived in control plot. This is in complete contrast to that of guinea grass (*Panicum maximum)* where the mean percentage survivability recorded was 41% indicating poor adaptability to oil pollution. There was a delay in growth of most of the guinea grass plant. The overall percentage that survived was poor 41% for guinea grass unlike vetiver grass that recorded very high survival rate 90%. Generally, there was initial delay in growth especially on the contaminated plots for all the plants. This agrees with Asuquo *et al.,* (2005) that even small amount of contamination of soil with crude oil can delay plant germination while large amount can cause reduction of growth**.**

From the statistical analysis, it was found that the growth of plant (vetiver grass) in terms of percentage survivability and growth rate was not significantly different between the contaminated unamended plots and the control plot implying that the crude oil contamination did not affect the survival and growth rate of vetiver grass. This finding confirmed the report of Truong, (2000) that vetiver grass is highly tolerant and could grow in crude oil contaminated soil. This is in contrast to guinea grass plots where a significant difference was observed between the contaminated unamended and control plots.

Vetiver grass performed better in terms of survival rate in crude oil contaminated soil over that of guinea grass. The ability of these grasses to survive and grow well in harsh soil condition could be attributed to their ability to establish a symbiotic association with soil microbes; this is in line with the finding of Siripin (2000) who observed from his study that Vetiver establishes a strong symbiotic association with a wide range of soil microbes in the rhizosphere that provide nutrients(Nitrogen fixing bacteria, phosphate solubilizing bacteria and fungi) and phytohormones (plant growth regulator bacteria) for plant development. Amendment of the soil with organic manures only gave slight improvement on vetiver over guinea grass. In guinea grass, there was no germination on plots C1R2 and C1R3 (Contaminated with crude oil and amended with rabbit manure at 20t/ha and 30t/ha respectively.

Table 2 : Effect of treatments on percentage (%) survivability rate of the Vetivar grass and Guinea grasses

	Weed species	
Treatment	**Vetiver**	**Guinea Grass**
COP0	85	80
COP1	85	0
COP2	95	85
COP3	100	10
CIP0	80	60
CIP1	85	45
CIP2	90	80
CIP3	94	80
COR1	95	0
COR2	90	0
COR3	96	78
CIR1	82	50
CIR2	90	0
CIR3	93	5

Means in column followed by the same letter are not significantly different at 5% level of probability by Duncan Multiple Range Test.

Effect of Treatments on Plant Height

Table 3 shows the mean plant height of vetiver grass and guinea grass. The result of the plant height of vetiver and guinea grasses ranged from 30.3 to 158.3cm and 6.2 to 301.6cm, respectively for the 12 months under investigation. The results revealed that plant height decreased from 42.2 in control plots to 30.3cm in contaminated unamended plots and 10.2cm in control to 6.2cm in contaminated unamended plots for vetiver and guinea grass respectively within the first 30 days of measurement.

This trend continued up to the 120th day for vetiver, thereafter, the plant height increased to 150.2cm on contaminated unamended plots as against 124.0cm recorded in control plots for vetiver grass. This is in contrast to guinea grass where the decrease continued throughout the 12th months under investigation as the plant height rose to 298.0cm in control plots against 118.7cm recorded in contaminated unamended plots.

Result of the study revealed a significant reduction in plant height from control plot to contaminated unamended plot within the first 120th day for vetiver grass, thereafter the plant height significantly increased, implying that contamination of the soil with crude oil initially reduced the height of vetiver plant but with time the height was vetiver grass was significantly higher in contaminated unamended plots than control plots. The trend in vetiver was in contrast to that of guinea grass where there was a significant reduction in plant height in contaminated unamended plots over that of control throughout the period of the experiment. The reason for the reduction in plant height could be attributed to anaerobic conditions prevalent in crude oil contaminated soil, insufficient aeration, increase in oxygen demand caused by oil decomposing micro-organisms and interference with uptake of soil water by the root system Rowell, (1977); Gudin and Syrat, (1975) as quoted by De-Jong, (1980). Amendment of the soil with organic manures significantly increased the plant height in both vetiver and guinea grasses remediated plots.

The improvement noticed on plant height in contaminated unamended plots as against the control plots could probably be as a result of increase in organic matter, addition of nutrients from microorganisms killed by crude oil contamination and possibly Nitrogen fixation in the soil as reported by Odu, (1981) in Isirimah, (1989).

Addition of organic manures increased the height of the plants. The result showed that guinea grass plant has the highest height of 301.6 cm as against vetiver grass height of 158.3cm.This finding confirmed the report of Truong, (2000) that vetiver grass is highly tolerant and could grow in crude oil contaminated soil. This is in contrast to guinea grass plots where a significant difference was observed between the contaminated unamended and control plots.

The ability of these grasses to survive and grow well in harsh soil condition could be attributed to their ability to establish a symbiotic association with soil microbes; this is in line with the finding of Siripin, (2000) who observed from his study that Vetiver establishes a strong symbiotic association with a wide range of soil microbes in the rhizosphere that provide nutrients (Nitrogen fixing bacteria, phosphate solubilizing bacteria and fungi) and phytohormones (plant growth regulator bacteria) for plant development. Amendment of the soil with organic manures improves the growth of the grasses (vetiver and guinea).

Table 3: **Effect of treatments on plant height (cm) of vetivar grass and guinea grass**

Treatment	Number of Days											
	30	60	90	120	150	180	210	240	270	300	330	360
Guineagrass												
COPO	10.2h	38.6f	83.6b	118.3b	168.3b	234.0a	265.1b	283.2b	289.1b	293.5b	298.0b	290.2b
COP2	15.8f	45.1d	87.2a	125.0a	171.8a	241.1b	272.1a	289.0a	300.1a	301.0a	301.6a	294.4a
CIPO	6.2j	22.6i	35.1n	65.7h	78.4j	88.8k	100.0d	114.4k	116.0k	118.2n	118.7l	114.2n
CIP1	8.0i	19.5j	38.6l	51.8d	67.1d	95.0 i	109.1j	116.3j	126.2j	123.0l	128.9i	126.0l
CIP2	14.1g	30.3g	40.8m	56.2i	78.1j	88.3 k	95.2e	103.6e	117.8m	125.0k	126.1j	130.1k
CIP3	13.4g	28.6h	48.6l	65.4h	83.6 i	96.5h	118.4g	141.3e	152.6d	152.8d	153.0e	145.3h
COR3	12.5g	41.3e	80.5c	119b	148.0c	196.3c	220.1c	235.6c	240.6c	240.8c	242.0c	234.8c
CIR1	7.2i	20.6k	30.8o	47.3j	66.8k	71.2m	85.4l	92.4f	105.1n	105.8o	106.1m	109.3o
Vetivar grass												
COPO	42.2b	55.4b	74.0d	82.5e	86.0h	88.6l	105.4k	115.1k	118.2m	120.5m	122.4k	124.0m
COP1	40.1c	56.2b	68.5g	85.0d	88.4g	90.0k	101.4l	114.8k	120.0l	123.5l	126.1j	126.5f
COP2	44.0a	60.1a	70.4f	81.2f	88.0g	94.0i	105.0k	116.0j	123.1k	130.2j	135.0h	140.1j
COP3	41.8b	56.0b	74.8d	88.0c	92.5e	98.6g	110.3j	122.7i	127.0j	136.3i	141.1g	143.0i
CIPO	30.3e	42.0e	58.2k	81.5f	87.0g	92.5j	115.1h	126.0h	130.1i	139.2h	145.0d	150.2g
CIP1	32.8e	40.8e	60.4j	83.2e	88.7g	94.0i	113.2i	128.1g	132.4h	140.1h	148.2f	155.1e
CIP2	31.2e	42.8e	63.1i	86.1d	89.8f	97.3h	118.0g	130.1f	132.0h	145.1f	142.8g	151.2f
CIP3	34.5d	41.3e	65.0h	84.3e	90.7f	99.0g	120.2f	131.2f	135.6g	143.7g	146.0d	154.0e
COR1	42.0b	54.2b	70.0f	86.0d	91.8e	114.1f	122.4e	130.3f	135.1g	144.0f	147.2f	152.1f
COR2	40.8c	48.5c	72.1e	88.9c	90.1f	116.2e	125.4d	132.0f	137.1f	147.1e	150.2f	150.8g
COR3	44.8a	45.0d	65.7h	83.4e	94.1e	118.5d	112.0e	143.0d	140.3e	149.1e	152.1e	156.1d
CIR1	31.7e	40.8e	65.7h	68.4g	96.0d	118.0d	120.0c	143.0d	140.0e	148.5e	148.9f	151.0g
CIR2	33.8d	42.0e	60.7e	68.8e	91.2b	120.2a	125.0b	145.1b	143.1b	150.1b	158.0a	156.0b
CIR3	33.6d	44.7d	62.3d	70.5d	88.5c	119.6a	127.2a	148.1a	149.8a	152.0a	153.1b	158.3a

Means in column followed by the same letter are not significantly different at 5% level of probability by Duncan Multiple Range Test

Effect of Treatments on Total Hydrocarbon Content (THC) in Soil and Plants

Table 4 shows the percentage of total hydrocarbon (THC) in soil degraded after remediation with vetiver, guinea grass and organic manures. Result of the study revealed that both vetiver and guinea grasses amended with organic manures have higher capability of degrading crude oil contamination in soil. A range of 23% to 70.6% of THC was degraded in vetiver remediated plots while 21.2% to 67.9% of THC was degraded in guinea grass remediated plots within the period under investigation

This high rate of degradation of THC in soil as observed in the study could be attributed to the presence of the plants (vetiver and guinea) grasses and organic manures which enhanced their ability. This is in line with Biondini *et al.,* (1988) and Banks *et al., (*1999) who in their study recognized the relevance of plants in the degradation of crude oil in soil.

The high rate of degradation of THC in the soil could also be due to the degrading action of micro-organisms that utilize hydrocarbon as energy source in their tissues over a given time. This agrees with Cook *et al.,* (1976) who observed a decrease in crude oil and an increase in soil recovery after a given time with the help of crude oil degrading organisms.

Table 4: Effect of treatments on percentage (%) THC in soil after remediation with vetiver, guinea grasses and organic manures

	Weed species	
Treatment	**Vetiver**	**Guinea Grass**
CIP0	23	21
CIP1	52.6	50
CIP2	61.2	57.9
CIP3	70.6	67.9
CIR1	49.7	47.9
CIR2	59.3	0
CIR3	64.6	0

Means in column followed by the same letter are not significantly different at 5% level of probability by Duncan Multiple Range Test

The quantity of THC (µg/g) degraded in the soil during the period of the study is presented in Table 5. There was significant ($p<0.05$) difference between the treatments and the two grasses (vetiver and guinea) with vetiver having the highest mean of 3882.30 in contaminated and amended with poultry manure (C1P3) in contrast to a mean value of 3173.10 in contaminated and amended with poultry manure (C1P3) recorded in guinea grass; thus indicating that vetiver grass has higher capability of degrading crude oil contaminated soil than guinea grass.

Table 5: Quantity of THC (µg/g) degraded in the soil during the period of the study

Weed species	Treatment	THC (ug/g)
Vetiver grass	CIPO	1252.0^{c}
	CIPI	2879.2^{b}
	CIP2	3348.2^{a}
	CIP3	3882.3^{a}
	CIR1	2721.0^{b}
	CIR2	2978.13^{b}
	CIR3	3533.7^{a}
Guinea grass	CIPO	1157.6^{c}
	CIP1	2755.4^{b}
	CIP2	2717.25^{b}
	CIP3	3173.1^{d}
	CIR1	2620.9^{b}
	CIR2	0.0^{d}
	CIR3	0.0^{d}

Means in column followed by the same letter are not significantly different at 5% level of probability by Duncan Multiple Range Test

Amendment of the soil with organic (poultry and rabbit) manures also enhanced the ability of vetiver and guinea grasses to degrade the contaminants. This is in line with observation of Hutchinson *et al.,* (2001) that adequate fertilization is necessary for enhanced hydrocarbon degradation rates in polluted soil. The reason according to their observation was that adequate fertilization helped to reduce competition between plants and micro-organisms: hence degradation is enhanced.

The result also revealed that hydrocarbon degradation was higher in vetiver planted plots amended with poultry manure than those amended with rabbit manure

Generally, result of the study revealed that application of organic manures especially poultry enhanced the performance of vetiver grass in degradation of crude oil on a contaminated soil and has higher capability of absorbing the contaminants on the plant tissues over that of guinea grass.

The effect of Soil Remediated with Vetiver grass and guinea grass and Organic Manure on THC uptake is presented in Table 6 There was no statistical difference between vetiver and guinea grasses in the control plots in THC uptake in plant tissues. While a significant ($p<0.05$) difference was observed between the treatments and the two grasses (vetiver and guinea) in contaminated plots with vetiver remediated plots having a mean of 878.3 in contaminated unamended plot as against a mean of 846.10 in contaminated unamended plot in guinea grass remediated plots. The result therefore showed that the uptake of THC in vetiver tissues was higher than that of guinea grass.

The increase in the rate of absorption of THC in plant tissues could probably be due to the fact that addition of vegetation to a contaminated system influences the rate of contaminant removal. This corroborates with the findings of Lee and Banks *et al., (*1993) and Banks *et al..,* (1999) who reported that hydrocarbons depending on their chemical properties may be absorbed by plant roots and shoots and accumulate in plant tissues, volatilize or metabolize by the plants. Banks et al., (1999) observed that contaminant dissipation is enhanced by plant roots.

Result of the study revealed that both vetiver and guinea grasses amended with organic manures have higher capability of degrading crude oil contamination in soil

Table 6. Effect of Soil Remediated with Vetiver grass and guinea grass and Organic Manures on THC uptake

Weed species	Treatment	THC(**µg/g)**
Vertivar Grass	COP0	0.04[k]
	CIP0	878.3[a]
	CIP1	832.6[c]
	CIP2	668.4[g]
	CIP3	578[j]
	CIR1	812[d]
	CIR2	698.4[f]
	CIR3	575.9[j]
Guinea Grass	COP0	0.04[k]
	CIP0	846.1[b]
	CIP1	760.2[e]
	CIP2	644.0[g]
	CIP3	525.8[j]
	CIR1	605.4[h]

Means in column followed by the same letter are not significantly different at 5% level of probability by Duncan Multiple Range Test

CONCLUSION

Based on the result of this work, phytoremediation through the use of vetiver and guinea grasses amended with organic manures is effective in the remediation of crude oil polluted soils. The study showed that vetiver grass amended with poultry manure was more effective than guinea grass.

Both grasses were tolerant to total Hydrocarbon content (THC), however, vetiver grass was found to be more tolerant than guinea grass. The study also revealed that vetiver grass has high survival rate of 90% compared with 41% of guinea grass.

Application of organic manures (poultry and rabbit) increased the ability of the grasses to n degrade THC, in the soil and reduce the intake ability of these grasses to absorb THC in their tissues. Therefore, application of amendment materials improved the capability of these grasses to remediate crude oil polluted soil.

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