AMELIORATIVE POTENTIAL OF DIFFERENT RATES OF CARBON FROM POULTRY MANURE ON SOILS CONTAMINATED BY CRUDE OIL: EFFECT ON AGRONOMIC PARAMETERS AND DRY MATTER YIELD OF WATER LEAF PLANT

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ABSTRACT
In other to determine the ameliorative potential of poultry manure on soils contaminated with crude oil, a pot experiment was carried out. Soil samples were collected from Michael Okpara University of Agriculture, Umudike SIWES farm .Contamination of the soil was done by application of crude oil at a 3:1 (soil: crude oil mixture).Treatment with poultry manure was done at the rates of 0g, 100g, 300g and 600g in triplicates after a week of contamination with crude oil. A duplicate group without the crude oil contamination was also laid out, an uncontaminated soil not receiving the treatment was selected from this group and used as the control giving a total of 24 observational units.Planting of water leaf stems was carried out. Physicochemical analyses of the soil were done using standard methods. While base saturation and effective cation exchange capacity were calculated. The results obtained were subjected to analysis of variance in CRD and significant means were separated using Fisher's LSD. Poultry manure at higher rates of application improved the physicochemical properties of the soil and the dry matter yield of water leaf both incontaminated and uncontaminated soils.ECEC was significantly ($p<0.05$) increased across the treatments. The increase on ECEC recorded on this study may be attributed to increase in basic cation which serves as a boast to the ECEC. The highest value of BS was recorded on samples contaminated with crude oil with 3% poultry manure (97.65%) followed by 95.09% from crude oil contaminated soil treated with 2% poultry manure.The effect on the number of leaves were higher on the study soils with poultry manure application compared to the control and the crude oil contaminated soil with poultry manure treatment. The rate of effect varied directly with the percent application rate of poultry manure as well as the time of sampling, the effect on the dry matter yield were higher on the study soils with poultry manure application compared to the control and the crude oil contaminated soil with poultry manure treatment.

Keywords: Dry matter yield, number of leaves, crude oil, poultry manure, base saturation, exchangeable cations

1. INTRODUCTION

Crude oil contains thousands of different kinds of hydrocarbon molecules, making them very difficult to characterize. They are distinguished primarily by how the carbon atoms bounds to each other by the presence of elements other than carbon and hydrogen. The hydrocarbon families include: Alkane, Alkene, Alkynes, Aromatic and Alcohol crude oil is typically composing of between 50% to 98% hydrocarbons. Other important components of crude oil can be Sulfur (0-10%), Nitrogen (0-1%) and Oxygen (0-5%). Heavy metals can be found in parts per million levels [NRC. 1985].

Crude oil and its products are known to be toxic to life and have been used in weed control since the year 1940 [Klingman and Ashton 1975] The type of organisms exposed to hydrocarbon and their life cycle stage for instance the egg, larva, juvenile and adult is an important factor in determining the toxicity of the hydrocarbon for particular organisms, the general health of the organisms if already stressed as indicated by water salinity, temperature and abundance of food is also a determinant of toxicity level of hydrocarbon contamination.

Crude oil in the soil makes the soil condition unfavorable for plant growth, Gill et al., (1992) and Omosun et al., (2008), reported that stomata in *chromolaenaodorata* were grossly affected by crude oil which manifested as distortion and reduction in the number of stomata per unit area of the leaf. Leaf depression following stressed condition (presence of crude oil) has been reported for melon [Anoliefo 1991] hot pepper and tomatoes [Anoliefo and Nwoko, 1984], aquatic microphytes [Bamidele and Agbogidi 2002] and *amarathushybridus*[Odejegba and Sadiq, 2002].

If oil is sprayed on vegetation, it penetrates into the plant tissues through the sensitive stomata. These penetrations are made possible by its transfer through the vascular system of plants [Baker, 1970]. This result in the reduction of photosynthesis and respiration rates of the plant involved. The reduction in photosynthesis is due to film of oil covering the leaf surface. Plant contaminated with crude oil generally show a dark discoloration, yellowing, death and abscission of its leaves [Odu, 1981]. Plants maybe killed or growth maybe retarded for already established crops when in contact with crude oil. This is because the activities of organisms have been inhibited such as free water supply and soil aeration [Deuel, 1990]. Reports from the American Petroleum Institute [API, 1980] observed that 1% oil and grease is recommended as a practical threshold where the hydrocarbons become detrimental to plant life. Similar results were also obtained in a stimulated pollution studies by Uquetan, *et al.*, (2017).

The inability of soil to absorb water in an oil spilled area is due to hydrophobic nature of the oil, because the oil itself has displaced the water, air and at the same time occupying the natural pore spaces of the soil. It was also reported by Rowell, (1971), that the volatile components of the oil faction evaporate when they are at their drying states and at the same time make the bigger oil fragment to stick together in aggregate forms and thus result in causing hazards especially in sloppy areas.

2. MATERIALS AND METHODS

Description of Study Site

The experiment was carried out in Michael Okpara University of Agriculture Umudike, Abia State. This is located at about 10km East of Umuahia axis along the road from Umuahia to IkotEkpene between Latitude 05° 29' North, and longitude 7° 33′ East elevated 122m above the sea level located in the tropical rain forest. This area has a mean annual rainfall of 2117mm distributed over 9-10 months in a bimodal rainfall pattern. Monthly average air temperature ranges from 20°C to 24°C and 28°C to 35°C for minimum and maximum temperature respectively, while the soil temperature ranges from 23.0°C to 24.6°C. [NRCRI, 2009].

Table1 : Pre-characterization of the Soil and Organic Manure Used for the Study

Soil properties	Value	Poultry manure	Value
Sand %	71.6	Nitrogen %	2.46
Silt %	10.6	Phosphorus %	2.17
Clay %	17.8	Potassium %	2.59
Texture	Sandy loam	pH	6.8
pH (H_2O)	4.8	Organic carbon %	21
pH (KCl)	4.0	Organic %	36.20
AP (mg/kg)	15.7		
TN (%)	0.108		
OC (%)	1.09		
OM (%)	1.88		
CaCmol/kg	3.80		
Mg Cmol/kg	1.20		
K Cmol/kg	0.250		
Na Cmol/kg	0.177		
EA. Cmol/kg	1.36		
ECEC Cmol/kg	6.79		
Al^{3+}	0.28		
Base Saturation	79.32		

*AP: Available phosphorus, *TN: Total Nitrogen, *OC: Organic Matter, *EA: Exchangeable Acidity, *ECEC: Effective Cation Exchange Capacity

Sample Collection and Preparation

Soil samples for the experiment were collected randomly with a metal soil auger and core sampler at the surface soil at the depth of 0-15cm. The soil sample collected was air dried, gently crushed and passed through a 2mm mesh sieve 3.0 kg was weighed into perforated 8kg capacity buckets and placed in a greenhouse randomly. This perforation allows for proper drainage (avoid water logging) and better aeration of the experimental soil. The soil was contaminated with crude oil at the ratio of 3:1 (soil: crude oil mixture) and allowed to stand at field capacity water content for one week before amendment with organic manure, then planting of two stems of waterleaf plant per pot. The pot experiment was terminated at water leaf maturity (that is six weeks after planting). After one week of crude oil contamination, organic manure from poultry droppings were processed and applied at specific rates in triplicates. The poultry manure was collected from the poultry farm in MOUAU, air dried, crushed and passed through 4mm mesh sieve before application to the contaminated soil. The poultry manure was applied at the rate of 0g, 100g, 300g and 600g respectively in triplicates. Another set (triplicate) was without crude oil or poultry manure application. This gave a total of twenty-four observational units.

Evaluation of agronomic parameters of water leaf plant

After one week of amendment application, two stems of water leaf plants were introduced per pot and the effect of the treatment on growth parameter analyzed at two weeks' interval for six weeks. The growth parameters were assessed.

Number of leaves per plant, was determined at two weeks' interval by counting. Stem girth of the plants was also measured at two weeks' interval from soil level to terminal bud till final harvest using a measuring tape. Dry matter content of the plant was determined by weighing the plants before oven drying and weighing after oven drying at the end of the experiment.

Laboratory Analysis

The soil pH was determined in 1:1 soil water suspension and in KCl 1:2:5 salt solution ratiousing a glass electrode method [Mclean, 1982]. The Walkley and Black dichromate wet oxidation method as modified by Osodeke (1997) was used to determine organic carbon.The organic carbon was calculated thus,

$$\%OC=\frac{(meqK_2Cr_2O_2\times meqFeSO_4)\times 0.03\times 100\times (F)}{volume\ of\ air\ dry\ soil}\times 100$$

……...eqn. (1)

Where;

F = correction factor = 1.33

Meq = normality of solution × ml of solution used.

Organic matter content was computed as

%OM=%OC×1.72 …………………eqn. (2)

Where: 1.724 is Van Bernmelen factor. Available phosphorus was determined by Bray 2 method as described by Bray and Kurtz (1945)

Total nitrogen was determined by Kjaldahl digestion method as outlined by Bremner (1996). The soil particle size analysis of was performed using the Bouyoucous Hydrometer method [Bouyoucous, 1951]. Total exchangeable bases (Ca, Mg, Na and K) were determined using 1N NH_4OAC method. Percentage of the saturated bases was calculated using the equation:

$$\text{Base saturation} = \frac{Total\ Exchangeable\ base}{ECEC}\times 100$$

……………eqn.(3)

For aggregate stability measurement, the method of Le Bissonnais (1996)was used.

Statistical analysis

The results obtained were subjected to analysis of variance (ANOVA) using CRD and the significant means were separated using Fishers Least Significant Difference (FLSD) at 5% probability level.

3. RESULTS AND DISCUSSION

3.1 Physicochemical Properties of Soil

Particle Size Distribution

The results in Table 2, shows the effect of organic manure on selected physical properties of crude oil contaminated soil at six weeks after planting (WAP), the result showed that the sand particles ranged from 71.60% to 75%,with the highest value of 75% observed in the contaminated sample without poultry manure treatment, followed by 73.4% from crude oil contaminated sample treated with 1% poultry manure and 72.3% from crude oil contaminated sample treated with 3% poultry manure, the lowest value of 71.60% was recorded on the control soil (without crude oil or poultry manure). The result showed significant ($p<0.05$) variation on sand particles as a result of applying organic manure on crude oil contaminated soil.

Silt particles increased from 10.6% to 15.0% as a result of crude oil contamination, highest value of silt (15%) was recorded on the sample with crude oil alone, followed by 14%, 13% and12% from crude oil contaminated soil treated with 1% poultry manure, crude oil contaminated soil treated with 2% poultry manure and crude oil contaminated soil treated with 3% poultry manure respectively.

The clay particles ranged from 10% to 17.8% with the highest value (17.8%) recorded on control and samples with poultry manure, followed by crude oil contaminated sample treated with3%poultrymanure 15.7% while the lowest value of clay 10% was obtained from sample contaminated with crude oil alone.

The increase in sand and silt fractions and decrease in clay fraction recorded on this study is in contrast to the findings of Abosede, (2013) who reported that crude oil pollution did not significantly ($p<0.05$) influence particle size distribution, However, Uquetan, *et al*., (2017), also noticed a slight increase in silt content following contamination with crude oil and spent lubricating oil. The result showed that the textural class of the soil is sandy loamy (SL).

Soil Reaction (pH)

Soil reaction value ranged from 6.57 to 4.1, with the highest value 6.57 recorded on sample contaminated with crude oil and 3% poultry manure, followed by 6.2 from sample contaminated with crude oil and 2% poultry manure (Table 3). The result showed that all the samples treated with crude oil and poultry manure had higher pH values when compared with samples with poultry manure alone, though 3% poultry manure gave a higher pH value of 5.7 than soil contaminated with crude oil alone with the pH of 5.03. There is a significant ($p<0.05$) increase in pH as a result of applying poultry manure and crude oil. The result observed in pH was in agreement with the observations of Mullins *et al.,* (2002).

Available Phosphorus (Av.P)

Available phosphorus result varied between 12.8 to 25.37mg/kg, with the highest value of 25.37mg/kg recorded in sample contaminated with crude oil and 3% poultry manure treatment, followed by 23.4mg/kg from sample treated with 3% poultry manure alone. Sample treated with crude oil alone had a value of 15.93mg/kg while the lowest value of 12.8mg/kg was obtained from the control pot. The result showed a significant ($p<0.05$) increase as a result of applying crude oil and poultry manure. The result is in accordance with Ibeawuchi*et al*., [24] where he reported a higher increase of available phosphorus as a result of applying animal manure (poultry).

Total Nitrogen (TN)

The result of total nitrogen varied significantly ($p<0.05$) when compared with the treatments. The total nitrogen values ranged from 0.091 to 0.402% with the highest value recorded on the sample contaminated with crude oil and 3% poultry manure, (0.402%) followed by 0.304% from crude oil contaminated soil with 2% poultry manure treatment, 0.281% from 3% poultry manure treatment and 0.179% from sample contaminated with crude oil alone, while the lowest value was obtained on the control 0.091%. The increase on the total nitrogen recorded on this work may be attributed to the high concentration of Nitrogen in the poultry manure. The result is similar to the observation made by Budhar et *al*., [25].

Organic Carbon/Organic Matter

Organic carbon values ranged from 1.06 to 5.66%, with the highest value 5.66% recorded on the sample contaminated with crude oil and 3% poultry manure treatment followed by 4.56% from sample contaminated with crude oil and 2% poultry manure treatment, 3.55% from sample contaminated with crude oil alone, while the control gave the lowest value of 1.06%. The result showed that application of crude oil alone, poultry manure alone and in combination of crude oil and poultry significantly ($p<0.05$) increased organic carbon content of the soil after the experiment. Organic matter followed the same pattern where crude oil contamination with 3% poultry manure treatment gave the highest value of organic matter 9.75% followed by 7.85% from crude oil contaminated soil with 2% poultry manure treatment, 7.09% from crude oil contaminated soil with 1% poultry manure and 6.13% from sample contaminated with crude oil alone. The lowest value was recorded on the control pot 1.83%. The increase recorded on organic carbon and organic matter may be attributed to the high concentration of hydrocarbon in the crude oil. The observation was similar to the findings of Mullins *et al*., (2002)

Exchangeable Calcium (Ca)

The result in table 3 shows that calcium value ranged from 9.5 to 3.3 Cmol/kg, with highest value of Ca recorded on the sample contaminated with crude oil and 3% poultry manure treatment (9.5 Cmol/kg) followed by 8.10 Cmol/kg from crude oil contaminated soil with 1% poultry manure treatment, 6.4 Cmol/kg from sample treated with poultry manure 3% alone while the sample contaminated with crude oil alone gave a moderate value of calcium (6.0Cmol/kg), though the lowest value of calcium was recorded on control (3.3Cmol/kg). The result showed that application of poultry manure and crude oil significantly ($p<0.05$) increased exchangeable calcium after six weeks of the experiment. The result is in accordance with the findings of Ibeawuchi*et al*., (2006)

Exchangeable Magnesium (Mg)

Magnesium varied between 4.97 to 0.87Cmol/kg with the sample contaminated with crude oil with 3% poultry manure treatment giving the highest value Mg (4.97Cmol/kg) followed by 3.97 Cmol/kg from crude oil contaminated soil with 2% poultry manure treatment, 3.0Cmol/kg from crude oil contaminated soil with 1% poultry manure treatment, 3% poultry manure alone and crude oil respectively, while 0.87Cmol/kg which is the lowest value obtained on the control sample. The application of crude oil and poultry manure significantly ($p<0.05$) increase Magnesium content of the soil used for experiment, the result is in accordance with the report of Ibeawuchi*et al*., (2006).

Exchangeable Potassium (K)

Potassium values ranged from 0.211 to 0.655Cmol/kg with highest value recorded on the sample contaminated with crude oil and 3% poultry manure treatment (0.655Cmol/kg) followed by 0.600Cmol/kg from crude oil contaminated soil with 2% poultry manure treatment, 0.501Cmol/kg from crude oil contaminated soil with 1% poultry manure treatment and 0.413Cmol/kg from the sample treated with 3% poultry manure alone, while the lowest value of potassium was observed on the control sample (0.211Cmol/kg). The result showed that potassium significantly ($p<0.05$) increased as a result of applying poultry manure on a crude oil contaminated soil. The result obtained on exchangeable K is similar to the findings of Mullins *et al*., (2002).

Exchangeable Sodium (Na)

Exchangeable sodium varied between 0.163 to 0.414 Cmol/kg, the highest value was obtained on sample contaminated with crude oil and 3% poultry manure treatment, followed 0.373Cmol/kg from crude oil contaminated soil with 2% poultry manure treatment while the lowest value was obtained from the control sample 0.163Cmol/kg. The result showed a significant ($p<0.05$) increase as a result of applying poultry manure on a crude oil contaminated soil.

Exchangeable Acidity (EA)

Exchangeable acidity ranged from 0.37 to 1.37Cmol/kg; the highest value was recorded on the control sample 1.37Cmol/kg, followed by 1.34 and 1.25Cmol/kg from 1% and 2% poultry manure treatment respectively. The sample treated with crude oil alone had 1.27Cmol/kg while the lowest value was obtained on the sample contaminated with crude oil and 3% poultry manure treatment (0.37Cmol/kg) the decrease in exchangeable acidity observed on the treated sample may be attributed to the ameliorating ability of poultry manure. The result is in agreement with Ibeawuchi *et al*., (2006)

Exchangeable Aluminum (Al^{3+})

Aluminum followed the same pattern as exchangeable acidity. Aluminum varied between 0.32 to 0.04Cmol/kg. The result showed aluminum significantly (p<0.05) decreased as a result of applying poultry manure. The highest value of aluminum was recorded on the control sample followed by 0.25Cmol/kg from 1% poultry manure treatment while the lowest value of aluminum was obtained from crude oil contaminated soil treated with 3% poultry manure (0.04Cmol/kg).

Effective Cation Exchange Capacity (ECEC)

ECEC varied between 5.91 to 15.91Cmol/kg with the highest value recorded on the sample contaminated with crude oil and 3% poultry manure, followed by crude oil contaminated soil with 2% poultry manure treatment (13.71 Cmol/kg), 10.93 Cmol/kg from 3% poultry manure treatment alone and 10.80 Cmol/kg from crude oil contaminated soil alone while the lowest value was obtained from control sample (5.91Cmol/kg). ECEC was significantly (p<0.05) increased across the treatments. The increase on ECEC recorded on this study may be attributed to increase in basic cation which serves as a boast to the ECEC. The result is in accordance with the findings of Ibeawuchi*et al*., (2006)

Table 2: Mean Effect of organic manure on the physical properties of crude oil contaminated soil

Treatment	Sand %	Silt %	Clay %	Texture	MWD (mm)
Control	71.60	10.6	17.8	SL	0.988
Pm 1%	71.60	10.6	17.8	SL	0.995
Pm2%	71.60	10.6	17.8	SL	0.999
Pm3%	71.60	10.6	17.8	SL	0.995
Crude	75.00	15.0	10.0	SL	2.430
Crude+Pm1%	75.00	14.0	11.0	SL	1.633
Crude+Pm2%	73.40	13.0	13.6	SL	1.484
Crude+Pm3%	72.30	12.0	15.7	SL	1.068
SE	0.031	0.024	0.039		0.047
F-LSD $_{(0.05)}$	0.52	0.42	0.46		0.319

Base Saturation (BS)

Base saturation ranged from 76.78 to 97.65%. The result showed that BS value increased significantly (p<0.05) as a result of applying poultry manure on a crude oil contaminated soil. The highest value of BS was recorded on sample contaminated with crude oil with 3% poultry manure (97.65%) followed by 95.09% from crude oil contaminated soil treated with 2% poultry manure while the least value of 76.78% was recorded on control sample. The result is similar to finding of Mullins *et al*.,(2002).

3.2 Growth Parameters of Water Leaf

Number of Leaves

The result in figure 1 shows that application of poultry manure significantly ($p < 0.05$) increased number of leaves of water leaf across two weeks, four weeks and six weeks after planting. The number of leaves ranged from 2 to 13 at two weeks after planting, 4 to 17 at four weeks after planting and 6 to 34 at six weeks after planting. The highest number of leaves was recorded on poultry manure 3% treated soil followed by poultry manure 2% treatment rate while the lowest number of leaves were recorded on samples contaminated with crude oil (2) at two weeks after planting even with poultry manure application. The number of leaves at four weeks and six weeks after planting followed the same trend like as two weeks were the highest value on number of leaves at four weeks was obtained with 3% poultry manure (17 number of leaves) while lowest came from crude oil contaminated sample irrespective of the sampling time compared to the poultry manure treatment soils without crude oil contamination.

Generally, the effect on the number of leaves were higher on the study soils with poultry manure application compared to the control (without crude oil or poultry manure) and the crude oil contaminated soil with poultry manure treatment. The rate of effect varied directly with the percent application rate of poultry manure as well as the time of sampling.

Table 3: Mean Effect of organic manure on the chemical properties of crude oil contaminated soil

TREATMENT	pH H20	AV.P Mg/kg	TN %	OC %	OM %	Ca	Mg	K	Na Cmol/kg	EA	Al^{3+}	ECEC	BS %
Control	4.1	12.8	0.091	1.06	1.83	3.30	0.87	0.211	0.163	1.37	0.32	5.91	76.78
Pm 1%	4.6	16.23	0.161	1.84	3.27	3.73	1.30	0.248	0.173	1.34	0.25	6.79	78.69
Pm2%	5.0	19.73	0.201	2.22	3.83	4.70	1.83	0.308	0.189	1.25	0.18	8.28	84.86
Pm3%	5.7	23.40	0.281	3.49	6.02	6.4	3.00	0.413	0.238	0.83	0.13	10.93	91.92
Crude	5.03	15.93	0.179	3.55	6.13	6.00	3.00	0.319	0.207	1.27	0.21	10.80	88.21
Crude+Pm1%	5.4	20.07	0.266	4.11	7.09	7.2	3.00	0.501	0.317	0.79	0.15	11.81	93.30
Crude+Pm2%	6.2	21.90	0.304	.56	7.85	8.10	3.97	0.600	0.373	0.67	0.08	13.71	95.09
Crude+Pm3%	6.57	25.37	0.402	5.66	9.75	9.5	4.97	0.655	0.414	0.37	0.04	15.91	97.65
SE	**0.062**	**0.051**	**0.001**	**0.015**	**0.024**	**0.028**	**0.051**	**0.006**	**0.002**	**0.003**	**0.005**	**0.067**	**0.144**
F-LSD $_{(0.05)}$	**0.16**	**0.49**	**0.007**	**0.20**	**0.29**	**0.23**	**0.20**	**0.001**	**0.008**	**0.02**	**0.01**	**0.29**	**1.01**

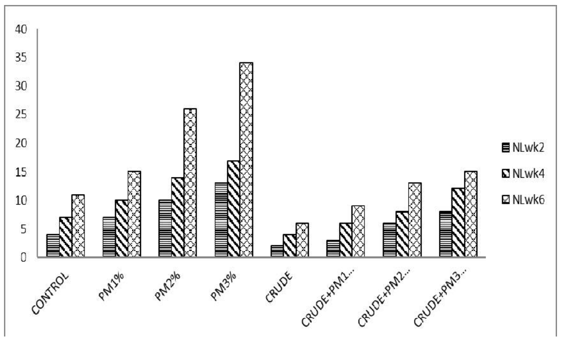

Figure 1 Effect of treatments on number of leaves

Stem Girth

Stem girth values ranged from 0.12cm to 0.90cm at six weeks after planting, 0.21cm to 1.21cm at four weeks after planting and 0.50cm to 1.30cm at six weeks after planting. The highest value of stem girth was recorded on the sample treated with poultry manure 3%, 0.90cm at two weeks, 1.21cm at four weeks and 1.30cm at six weeks after planting while the lowest value was obtained from samples contaminated with crude oil alone 0.12cm at two weeks, 0.21cm at four weeks and 0.35cm at six weeks after planting. The effect on the stem girth were higher on the study soils with poultry manure application compared to the control (without crude oil or poultry manure) and the crude oil contaminated soil with poultry manure treatment. The rate of effect varied directly with the percent application rate of poultry manure as well as the time of sampling.

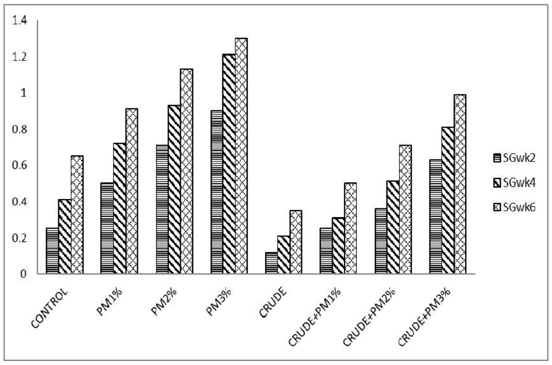

Figure 2 Effect of treatments on stem girth

Dry Matter Yield

The result of dry matter yield displayed in figure 3 indicated that the value of dry matter varied between 0.75g to 7.77g with the highest value recorded at 3% poultry manure application rate (7.77g) followed by (5.20g) 2% poultry manure application rate and (5.10g) from crude oil contaminated sample with poultry manure 3% application rate while the lowest value was recorded with soil receiving crude oil alone (0.75g) without poultry manure application. The effect on the dry matter yield were higher on the study soils with poultry manure application compared to the control (without crude oil or poultry manure) and the crude oil contaminated soil with poultry manure treatment. The rate of effect varied directly with the percent application rate of poultry manure as well as the time of sampling.

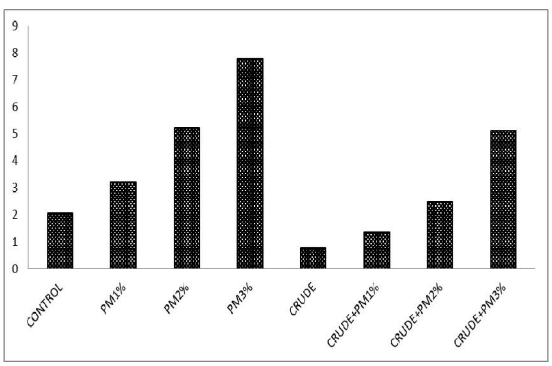

Figure 3 Effect of treatments on dry matter yield

4. CONCLUSION

Application of poultry manure, significantly ($p<0.05$) improved soil physicochemical characteristics, growth parameters and dry matter yield of water leaf plant in crude oil contaminated soils.

From the parameters studied, there seemed to be an interaction between crude oil contamination and poultry manure application that improved soil physicochemical properties. Hence, the detrimental effect of crude oil on dry matter yield and growth parameters of water leaf may not be due to studied physicochemical parameters but due other factors that influence the growth and yield of water leaf.

The study recommends investigations into other culpable parameters of the soil-plant ecosystem that could be altered by crude oil contamination.

REFERENCES

Abosede, E. E. (2013). Effect of Crude Oil Pollution on some Soil Physical Properties.*IOSR Journal of Agriculture and Veterinary Science.*6(3):14-17

American Petroleum Institute (1980) 'Analysis of mussel Mytilus califormarus communities in Areas Chronically exposed towards oil Seepage'. Washington D.C.

Anoliefo, G.O. (1991). Focados blend Crude Oil Effects on Respiratory Mechanism, Mineral Element Composition and Growth of Citrillus vulgaris.

Anoliefo, G.O. and Nwoko, D.F. (1994).Effects of spent Lubricating on the growth of Capsicumannum (L) LycopersiconesculentusEnvironmental Pollution. 88: 361-364.

Bamidele, J.F. and Agbogidi, D.M. (2002).Toxicity of Odidi Petroleum Oil and its water soluble fraction on three aquatic macrophytes, Nigerian Journal of Science. 113- 121.

Baker, J.M. (1970). The Effect of Oil on Plants.Environmental Pollution 1: 27-44

Bray, R. H. and L. T. Kurtz (1945). Determination of total organic and available forms of phosphorus in soils.Soil Science. 59:39-45

Bremner, J. (1996). Determination of nitrogen in soil by the kjeldahl method.The journal of Agricultural Science. 55(1): 11-33

Bouyoucous, G. H. (1951). A recalibration of the Hydrometer method for making mechanical analysis of soil.Agron. Journal. 43:434-438

Budhar, M.N., Palaniappan, S.P. and Rangasamy, A. (1991).Effect of farm wastes and green manures on lowland rice. Indian Journal of Agronomy. 36 (3): 251.

Deuel, I.E. (1990). ''Evaluation of Limiting Constituents suggested for Land Disposal of Exploration and Production of Wastes'', Proceedings of the U.S.

Environmental Protection Agency's First International Symposium on oil and Gas Exploration and Production Waste Management Practices New Orleans, LA. Pp. 411-430.

Gill, L.S.H, Nyawuamen G.K. and Ehikhametalor (1992). Effect of crude oil on growth and Anatomical features of

Chromolaenaodorata C. U., Chromolaenaodorata Newsletter No. 6: 1-6

Ibeawuchi, I.I., Onwerenmadu E.U. and Oti N.N. (2006).Effect of poultry manure on green (Amaranthuscruntus) and water leaf (Talinumtriangulare) on degraded ultisol in Owerri, South Eastern Nigeria.J. Animal and Vet. Adv. 5(1): 53-56.

Le Bissonnais Y. (1996): Aggregate stability and assessment of soil crustability and erodibility: Theory and methodology. Eur. J. Soil Sci., 47: 425–437.

Klingman G.G. and Ashton, F.M (1975).Weed science: Principles and Practices pp. 263-273.

Mclean, E. O. (1982). Soil pH and line requirements. In methods of Soil Analysis, part 2. Chemical and Microbiological properties.Ag.Monogragh No. 9, 2nd edition.

Mullins, G.L. et al. (2002). Virginia Tech Pub.No. 424-034.Virginia state university

National Research Council (1985). Oil in the sea: Inputs Fates and Effects, Washington D.C.: National Academic Press.

National Root Crop Research Institute, Umudike Agro- Meteorology Station (2009).

Odu, C.T.I. (1981). The Petroleum Industry and the Nigerian Environment.Volume 1. 143-152

Odjegba and Sadiq (2002) Effects of spent engine oil on growth parameters, chlorophyll and protein levels of Amaranthushybridus L. The Environmentalist. 22:23-28

Omosun G., Markson A.A. and Mabanasor O., (2008) Growth and Anatomy of Amaranthushybridus as affected by different crude oil contamination.

Osodeke, V. E. (1997): A laboratory manual for soil analysis, MOUA Umudike

Rowell, M.J. (1971). The Effects of Crude Oil Spills on soils. A review of Literature in the Reclamation of Agricultural Soils after Oil spills. Pp. 1-3

Uquetan U. I., Osang, J. E., Egor, A. O., Essoka, P. A., Alozie, S. I. and Bawan, A. M. (2017).A Case Study of the Effects of Oil Pollution on Soil Properties and Growth of Tree Crops in Cross River State, Nigeria. International Research Journal of Pure and Applied Physics.5(2):19-28