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EFFECT OF RUMEN-BASED WASTE ON CASSAVA (*MANIHOT ESCULENTA CRANTZ)* GROWN ON CRUDE OIL POLLUTED SOILS.

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Abstract: In a field study conducted at the Teaching and Research Farm of the Federal College of Education (Technical) Omoku, in Rivers State, Nigeria to determine the bioremediation potentials of rumen- based wastes (RBW) on crude oil polluted soils, Cassava (Manihotesculenta Crantz.) was used as test crop. In this study, the soil was contaminated with Bonny Light crude oil obtained from OB/OB Nigeria Agip Oil Plc. Fresh RBW were obtained from an abattoir in Omoku, Rivers State. Cassava stems were obtained from the Green River Project at Obiafu-Obrikom in Omoku. The soil was pulverized, made into raised seed beds, then contaminated with crude oil at the rates of 0litre m^{-2}(control), 1.5litre m^{-2}(mild), 3litre m^{-2} (moderate) and 4.5litre m^{-2} (severe). Two weeks after contamination, RBW were applied as mulches at the rates of 0,2,4 and 6kg/m^{-2}. It was a 4×4×3 split plot experiment fitted into a completely randomized design with three replications. Results obtained shows that RBW treatment had no significant effect on stem sprouting but significantly (P=0.05) enhanced stem survival at Mild and Moderate crude oil contamination levels. Shoot length increased significantly (P=0.05) at 4 and 5 months after planting (MAP) with RBW treatment. Mean leaf area increased significantly (P= 0.05) at 1MAP with increasing application of RBW.
Keywords: Studies, Rumen-based waste, cassava, crude oil, pollution, bioremediation, Omoku.

Introduction

Crude oil exploration and exploitation is a major economic activity in Nigeria. Incidents of crude oil spill are common among crude oil bearing communities in Nigeria. Spillages of petroleum hydrocarbon substance have continued irrespective of improved technological advancement in the exploration and exploitation of crude oil. At the event of crude oil spill, oil components such as polycyclic aromatic hydrocarbon which is difficult to clean up due to its low volatility, resistance to microbial degradation and with high degree affinity. Other hydrocarbon fractions and heavy metals contaminate the environment. Oil (petroleum hydrocarbon) spill is known to cause serious alterations in both aquatic and terrestrial

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environment (Powell, 1985). Habitat fragmentation, destruction and disruption of ecosystem, interference in natural biological and chemical cycles and loss of plant life have been identified as some of the effects of crude oil spills on our environment. In different studies Dejong (1980), Rowell (1977) and Smith *et al*. (1989) reported that chlorosis, root stress, reduction in leaf growth and unsatisfactory plant growth are among some of the adverse effects of petro-chemical pollution on plants. Soils contaminated with crude oil have resulted to negative effects on germination of seeds and consequently plant growth (Agbogidi and Eshegbeyi, 2006; Qianxin and Mendelssohn, 1998). Soils polluted by oil can also lead to the removal of vegetative cover, expose soil to enhanced erosion and as a result reduce the value of soils (Amadi, Abbey and Nma, 1996; Ekeke, Oyebade and Nwiisuafor, 2008).Impact of petroleum hydrocarbon on benthic macro invertebrates such as crab, *Ucapugnax* include behavioural changes, mortality, reduced juvenile settlement, reduced locomotory ability and increased antennular flickering rate (Kreb and Burns, 1977; Pearson *et al*; 1981).

Awareness on the impact of oil spill in the social and economic life of people in oil bearing communities is high. Over the years crude oil spills have been tackled with the use of chemical dispersants or by physical removal but effective decontamination of the environment through these methods have not been achieved.

Studies on the usefulness of bioremediation as a means of decontaminating crude oil environment have produced interesting result. Plant based bioremediation technology have received increased attention over other methods of crude oil decontamination (Sadowsky, 1999). Soils can be detoxified using different soil amendment materials such as cowdungs, poultry droppings, sawdust and other organic materials, aquatic macrophytes and microbes (Ayotamuno, Kogbara, and Egwuenu, 2006, Agbodigi and Bamidele, 2007). Work by Agbodigi (2009) showed that contaminated soils treated before 3 months of planting teak seedling performed better than those planted immediately after treatments in terms of plant height, number of leaves, leaf area and the collar diameter. Success in biological remediation of crude oil polluted environment have engineered studies into other strategies such as phyto-remediation, bio-stimulation, bio-augmentation, rhizo-secretion or extraction, etc. Apart from being the most cost effective method in the decontamination of polluted environment, the target compounds in bioremediation is the heavy metals, chlorinated solvents, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, pesticides, etc.

In the Niger Delta area of Nigeria cassava production is a serious economic activity and a major source of income to the farmers. It is an important food crop whose tuber is peeled and eaten raw or boiled or fermented into paste that is steamed to produce fufu. The tuber is often peeled and processed into garri, tapioca, farihna, etc (Iyagba, 2011). In recent times cassava starch has become an important export product in Nigeria. Incidentally yield per unit land area of this important food crop has dropped among farmers in the Niger Delta area of Nigeria. This is due mainly to the problem of crude oil contamination arising from the activities of oil companies. Various methods of decontamination of crude oil polluted cropland have been adopted but each of the methods employed have not produced the desired result on complete crude oil clean up and soil fertility recovery. Plant based bioremediation technology have received increased attention in the recovery of polluted environment but studies on the use of plant/animal based organic substance in bioremediation is scanty.

Rumen-based waste has high pH and is a large store house of microbial organism, enzymes and elements some of which are necessary for plant growth and development. Each time ruminant animals are slaughtered in the abattoir the products of the rumen are heaped carelessly and abandoned with little or no regard to its possible use in bio-augmentation of polluted crop land. The aim of this study therefore was to determine the effectiveness of rumen-based waste in the decontamination of polluted crop land and promote vegetative growth in cassava.

Materials and methods

This work was carried out at the Teaching and Research Farm of the Federal College of Education (Technical), Omoku in Rivers State, Nigeria. The land for the experiment was fallowed for four years after cassava grown on it was harvested. The soil type was loam, land was ploughed and plant thrash removed. The soil was leveled and a land area of 30mx15m was marked out with the aid of a measuring tape. It was 4x4×3 split plot factorial experiment fitted into a completely randomized design with 3 replications. Each replicate had 12 sub-plots measuring 2 x 2m each. The sub plot was then made into raised beds of 30cm high. Crude oil (Bonny light) obtained from OB/OB Agip oil Nigeria Plc. was applied at the rates of 0,1.5, 3.0 and 4.5liters per m^{-2} with the aid of a watering can. Watering can was considered to ensure uniform distribution of the crude oil. Care was taken to avoid splash effect. Rumen-based waste freshly obtained from an abattoir in Omoku was applied at the rates of 0,2,4 and 6kg per m^{-2} two weeks after crude oil treatment but before planting. Cassava stem was then planted on the soil earlier polluted with the crude oil and later treated with rumen-based waste. The cassava was planted at a spacing of 1m x 1m after two weeks of crude oil and rumen-based waste treatment.

Emergence rate was determined by direct count of planted, sprouted and emerged shoots against total stem planted per plot.

Shoot length was determined 2-6 months after planting (MAP) with the use of meter rule and measuring tape.

Leaf area was determined by measuring the length x breadth of the central lobe of the leaf and multiplying with the factor as shown in the equation: $Y= 6.11 \times L$, where: Y = Area of leaf, L = Length and breadth of the mid-rib of the central lobe (Ramanujam and Indira, 1978). Data was subjected to statistical analysis of variance and response trends were described graphically. Means were separated using the Duncan's Multiple Range Test (DMRT)

Results

Emergence: In the study, the use of rumen-based waste to augment crude oil contamination did not produce any significant effect (P=0.05) on cassava stem sprouting (Figures 1 and 2). Crude oil + rumen-based waste augmentation treatment in the study accounted for 31.0% and 19.6% of the total variability 14 and 16DAP across mild, moderate and severe crude oil treatment.

Stem survival rate: Stem survival was significantly enhanced (P=0.05) across mild and moderate crude oil treatment levels with the use of rumen-based waste to augment the effect of the crude oil contamination but at severe crude oil treatment level, survival rate declined considerably irrespective of the level of rumen-based waste applied (Figs 3 and 4). However, at the control experiment, overall positive effect of rumen-based waste on stem survival was significantly higher (P=0.05) than the total positive effect recorded at the moderate and severe crude oil application levels.

Shoot length: Result of the effects of rumen-based waste on shoot length across the control, mild, moderate and severe crude oil contamination is as shown in Figures 5-8. In the control experiment (Figure 5) shoot length increased linearly with addition of rumen-based waste and higher shoot length was obtained at the highest (6kg) rumen-based waste treatment 4 and 5 months after planting but variation among the means was not significant. Though addition of rumen-based waste did not produce any significant difference across mild, moderate and severe crude oil treatment 2-5WAP, overall effect of the mean shoot length obtained with the addition of rumen-based waste across moderate (Figure 7) and severe (Figure 8) crude oil treatment was significantly (P=0.05) higher than mean shoot length obtained at the corresponding levels of rumen-based waste in the control treatments (Figure 5) at 4 and 5WAP.

Leaf Area: Rumen-based waste augmentation treatment significantly suppressed mean leaf area across control, mild, moderate and severe crude oil treatment at 1MAP (Figure 9). Increasing addition of rumen-based waste increased mean leaf area (2MAP) across control, mild, moderate and severe crude oil treatment (Figure.10). For instance, at the control experiment, the highest rumen-based waste treatment level (6kg) recorded a mean leaf area of 280cm^2, whereas at the same level of rumen-based waste treatment a mean leaf area of 400cm^2, 250cm^2 and 300cm^{2}were recorded across mild, moderate and severe crude oil treatment respectively. A similar response pattern was observed at 3 and 4MAP (figures 11 and 12).

Mean number of leaves increased linearly with addition of increasing levels of rumen-based waste (Figures 13 – 16) but variation among the means did not differ significantly. Overall effect of the rumen-based waste treatment across the mild, moderate and severe crude oil treatments did not vary significantly from the mean number of leaves obtained at the control.

Discussion

Ordinarily, cassava stem has very low dormancy duration especially where the relative humidity is adequate and under ambient temperature. Whether planted in the soil or not it has the capacity to sprout except where it is exposed to unfavorable environmental conditions (dryness, heat, moisture stress, etc).

In this study, the use of rumen-based waste to augment the effect of pre-planting crude oil spill did not show any significant effect on cassava stem sprouting. The ability of any organic material to enhance seed germination, stem sprouting/ emergence and support growth of any plant depends to a great extent on its earliness to humify, mineralize and release nutrients. The process of complete humification and mineralization of most organic material would hardly be achieved within 14-16DAP during which data on stem sprouting was collected in this study. The inability of the rumen-based waste to enhance stem sprouting/emergence in cassava in the crude oil contaminated soil is therefore expected.

Significant increase in stem survival rate with the addition of rumen-based waste across plots treated with mild and moderate crude oil shows the potency of the organic material to ameliorate the effect of mild and moderate crude oil contamination on cassava stem survival rate. In a separate study Isirima, Okejim and Ezekiel (2007) reported a linear increase in survival rate of Sweet potatoes vine grown on crude oil contaminated soil and amended with levels of rumen-based waste. In that study, lowest and highest mean Sweet potatoes vine survival values of 2.1 and 6.3 were obtained at 0kg and 4kg rumen-based waste application rate respectively. Similarly, the capacity of 2kg rumen-based waste to support okra seed survival in a crude oil contaminated soil has been documented (Isirima, Okejim and Imegi; 2007). In the present study, however, the observed significant increase in stem survival with addition of rumen-based waste did not ameliorate effect of severe crude oil pollution level.

The observed no significant difference in shoot length in this study agrees with earlier results of Njoku *et al*.(2008) on growth of *Glycine max* grown on crude oil polluted soil and augmented with cow dung but does not agree with the earlier reports of Onu *et al*.(2008) and Madukwe *et. al*.(2008) on the effects of poultry droppings on maize and cowpea grown on oil polluted soils.

The observed significant increase in shoot length with rumen-based waste augmentation across moderate and severe crude oil treatment against result obtained from the corresponding levels of rumen-based waste at the control experiment 4-5MAP suggest that a prolonged humification and mineralization of rumen-based waste in a crude oil polluted soil has the potency to enhance shoot growth significantly across high crude oil contamination level. Morphological aberrations, reduction in biomass and stomatal abnormalities are among adverse effects of environmental pollution on crops (Sharma, *et al*; 1980). Results obtained in this study shows that the negative effect of crude oil on cassava leaf area cannot last beyond 2 MAP, especially where rumen-based waste is used as soil amendment. Rumen-based waste humification in the face of crude oil degradation (two months after treatment) is able to raise soil nutrient concentration to cushion the initial suppressive effect usually associated with crude oil spills. Though Daniel-Kalio and Pepple (2006) observed a significantly higher leaf area in day flower at control than oil treated plots, the result of this study shows that after two months of crude oil application, leaf area improved with rumen-based waste augmentation.

The beneficial effect recorded on leaf area with addition of rumen-based waste implies that the organic manure has the capacity to decompose, mineralize and release nutrients to support plant growth or that the rumen–based waste stimulated rapid multiplication in the population of hydrocarbon degrading microbes hereby facilitating crude oil degradation and subsequent humification of the applied rumen-based waste leading to the release of nutrients required to enhance growth and production of leaf. Amadi and Uebari (1992) in an earlier documentation reported that addition of poultry manure enhanced maize height and leaf area. In the same study, a significant depression in leaf area and plant height arising from crude oil treatment was reported, thereby corroborating the result of this study. However, the observed depression in cassava leaf area with crude oil treatment was only prominent at 2 MAP. The plant seems to recover from this initial depression effect after 2 months. This implies that decomposition of applied rumen-based waste and degradation of the crude oil arising from activities of bacteria and other factors must have led to the release of plant nutrients at levels required to enhance foliage production and cassava growth.

Summary and conclusion

The results obtained from this study shows that addition of rumen-based waste has the capacity to significantly enhance stem survival at mild and moderate crude oil contamination levels only and that significant increase in shoot length can be achieved 4 and 5MAP.Adequate humification and degradation of the rumen-based waste organic substance is probably achieved at this point, thereby translating into increase nutrient mineralization and enhanced crop performance.

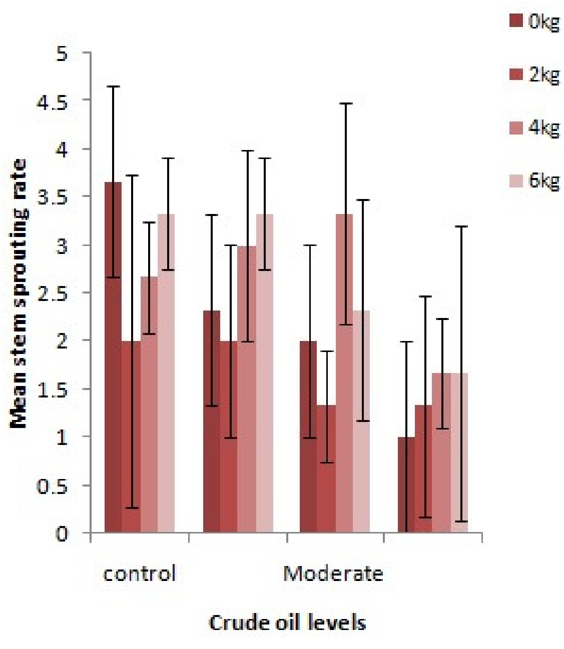

Figure 1 a. Crude Oil Amended with Rumen-based waste treatment on stem sprouting14 DAP

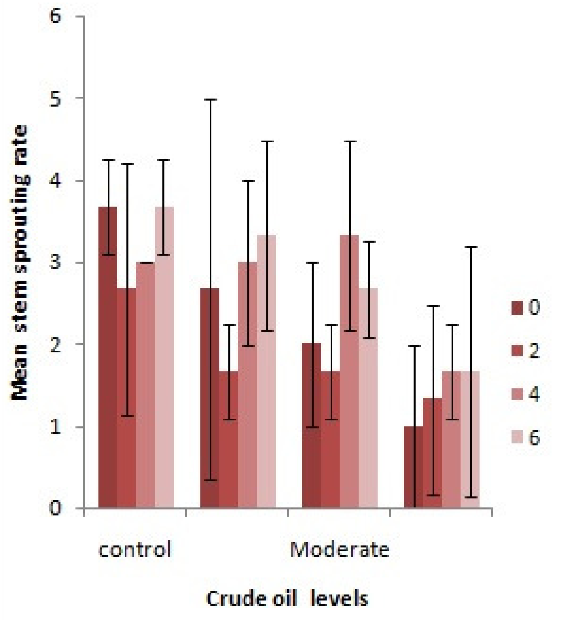

Figure 2 a. Crude Oil Amended with Rumen-based waste treatment on stem sprouting rate 16 DAP

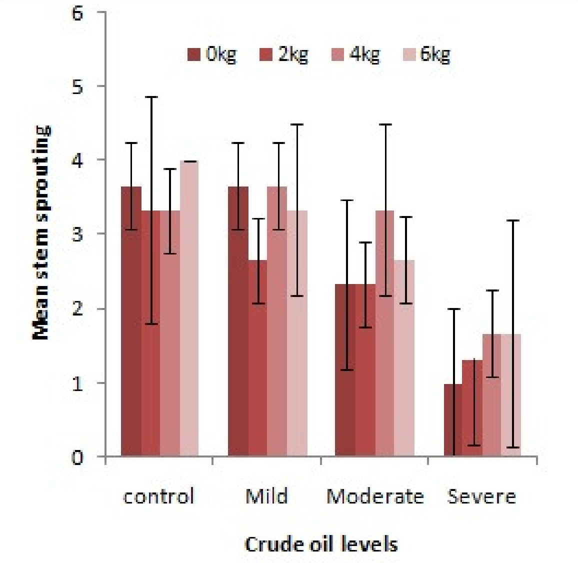

Figure 3. *Crude Oil Amended with Rumen-based waste treatment on stem sprouting rate 18DAP*

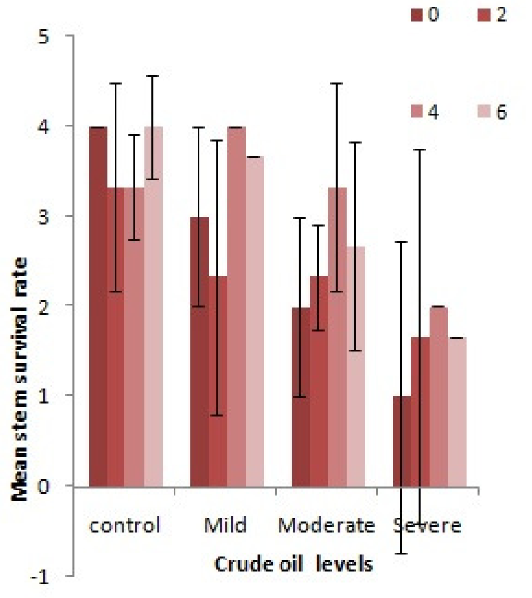

Figure 4. *Crude Oil Amended with Rumen-based waste treatment on stem survial rate 30 DAP*

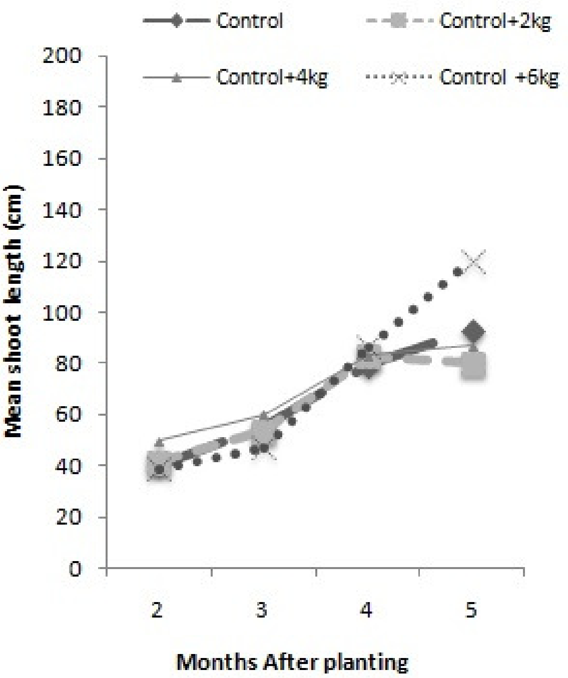

Figure 5.*Crude Oil Amended with Rumen-based waste treatment* on shoot length MAP

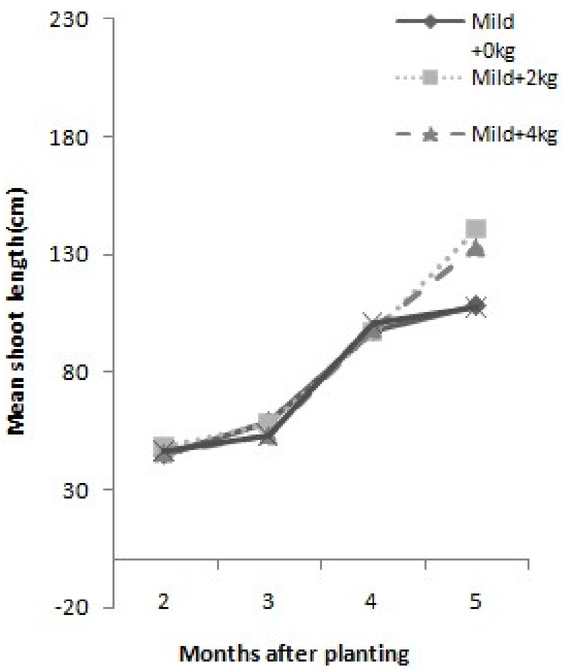

Figure 6. Crude Oil Amended with Rumen-based waste treatment on shoot length MAP

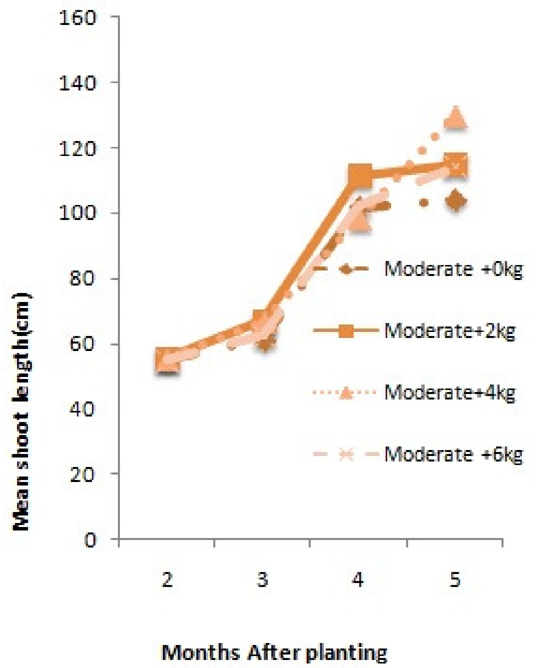

Figure 7. Crude Oil Amended with Rumen-based waste treatment on shoot length MAP

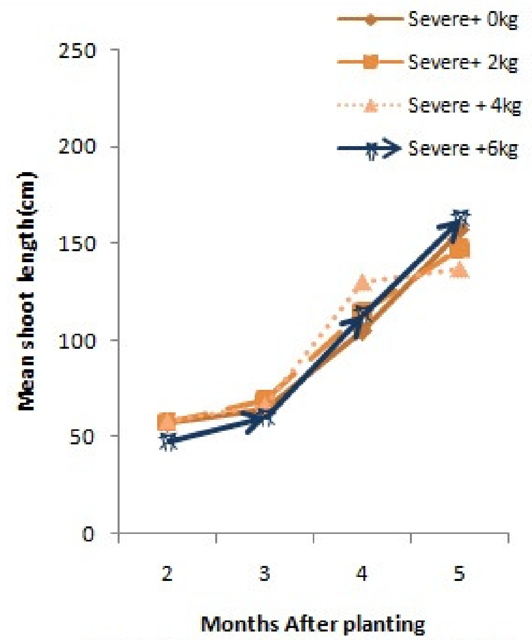

Figure 8. Crude Oil Amended with Rumen-based waste treatment on shoot length MAP

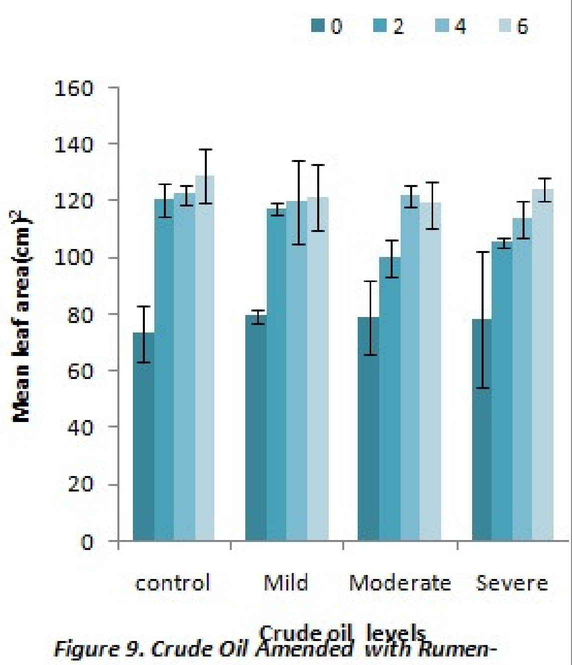

Figure 9. Crude Oil Amended with Rumen-based waste treatment on leaf area 1MAP

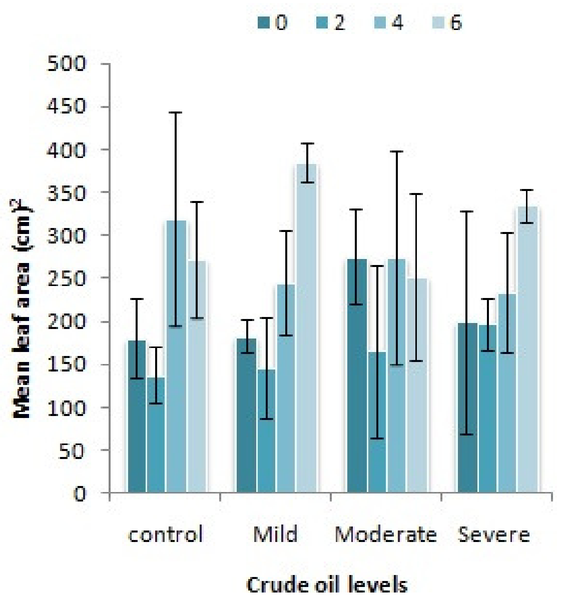

Figure 10. *Crude Oil Amended with Rumen-based waste treatment on leaf area 2MAP*

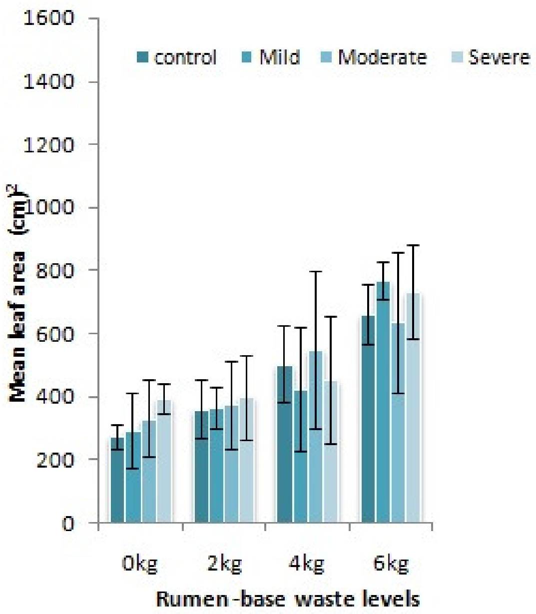

Figure 11. Crude Oil Amended with Rumen-based waste treatment on leaf area 3MAP.

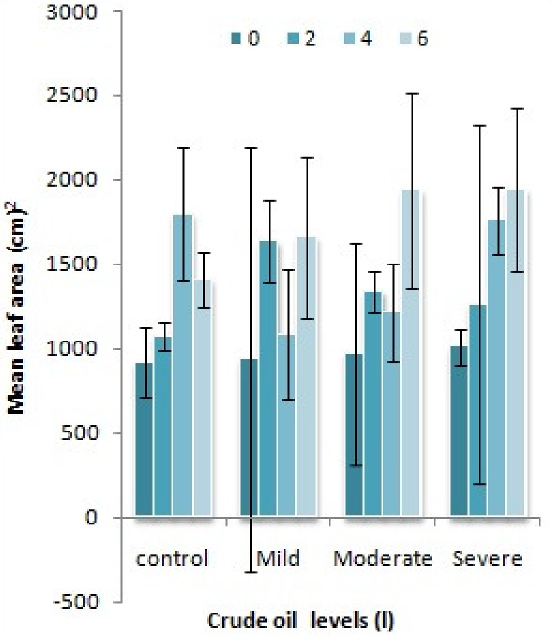

Figure 12. Crude Oil Amended with Rumen-based waste treatment on leaf area 4MAP.

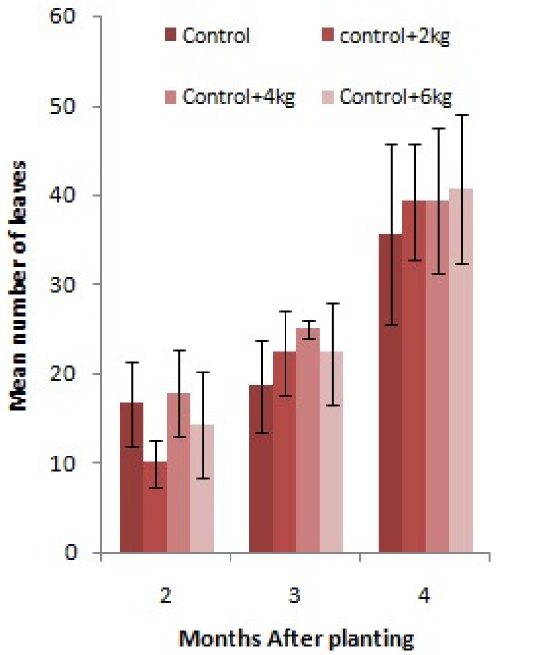

Figure 13. Crude Oil Amended with Rumen-based waste treatment on number of leaves MAP.

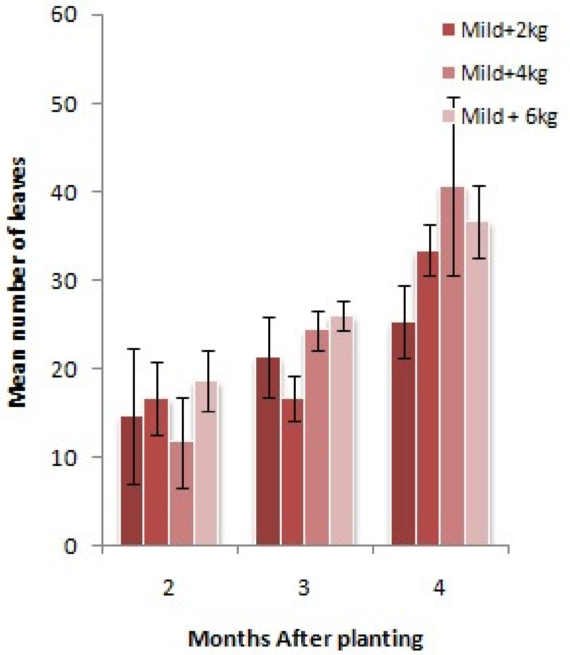

Figure 14. Crude Oil Amended with Rumen-based waste treatment on number of leaves MAP.

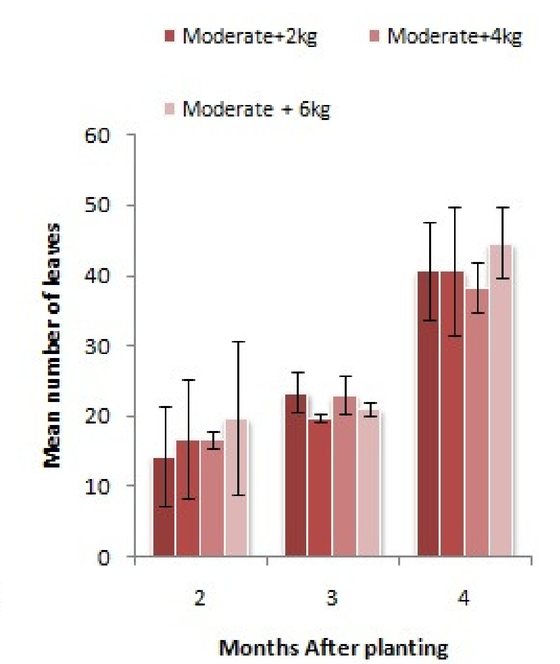

Figure 15. Crude Oil Amended with Rumen-based waste treatment on number of leaves MAP .

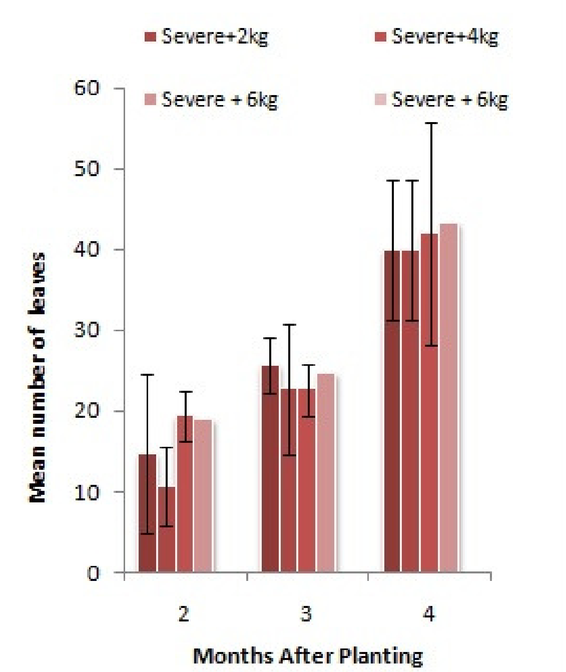

Figure 16. Crude Oil Amended with Rumen-based waste treatment on number of leaves MAP .

References

[1] Agbodigi, O.M. (2009). Detoxification of soils contaminated with crude oil: studies on Teak (*Tectona grandis* Linn). *African J. Environ. Pollut Health*. (1): 1-6.

[2] Agbodigi, O.M. and Eshegbeyi, O.F. (2016). Performance of *Dacryodes edulis* (Dor. G. Lam. H.J.) seeds and seedlings in a crude oil contaminated soil. *J. Sustainable Forestry.22* (3/4): 1-14.

[3] Amadi, A.; Abbey, S.O. and Nma, A. (1996). Chronic effects of oil spill on some properties and microflora in rain forest Ecosystem in Nigeria. *Water Air and Soil Pollution.* 86:1-11.

[4] Amadi, A. and Uebari, Y. (1992). Use of Poultry Manure for Amendment of Oil Polluted Soils in relation to growth of maize (*Zea mays* L.) *Environment International U.S.A pergamon press* Ltd Vol. 18:521-52

[5] Ayotamuno, J.M., Kogbara, R.B and Egwuenu, P.N (2006). Comparison of corn and elephant grass in the phytoremediation of a petroleum hydrocarbon contaminated agricultural soil in Port Harcourt, *Nigeria. J. Food Agric Environ*. 4 (3 and 4): 218-222.

[6] Daniel-Kalio L.A and Pepple, S.F. (2006) Effect of Bonny Light Crude Oil Pollution on soil on the growth of day flower (*Commelina benghalensis L*) in the Niger Delta Nigeria.*J. Appli. Science Environ. Mgt.*Vol. 10 (2) pp11-114.

[7] Dejong, E. (1980). The Effect of Crude Oil Spills on cereals. *Environmental Pollution Journa*l. 22:187-196.

[8] Ekere, B.A; Oyebade, B.A. and Nwiisuator D., (2008). Environmental and socio-economic imports of petroleum exploration and production activities in the rain forest zone of Nigeria. In: Oyekwelu, J.C; Adekunle, V.A.J. and Oke, D.O (eds). *Proc. 1st National Conf. of the Forests and Forest Products Soc. of Nigeria* (FFPN) held at the Federal University of Technology, Akure, Ondo state, Nigeria, 16th-18th April, 2008 pp 129-135.

[9] Isirima, C.B., Okejim, J. and Imegi, O. (2007). Bio-stimulative Effects of Rumen Content on Okra (*Abelmoschus esculentus*) grown on crude oil Polluted soils. *Journal of Research in Agriculture. Vol.* 4 (3). pp 1597-7994.

[10] Isirima, C.B.;Okejim, J. and Ezekiel, P.O. (2007).Bioremediation: Effects of Rumen Content on Sweet Potatoes (*lpomoea batatas*) Grown on Crude Oil Polluted Soils. *Journal of* Research *in Agriculture* Vol. 4, (4):1597-7994.

[11] Iyagba A.G (2011). *Arable and tree crop production: principles and practices.* Proofnet communications Ltd. Port Harcourt, Nigeria.

[12] Krebs, C. T. and Burns, K.A. (1977). Long-Term Effects of an Oil Spill on Population of the Salt Marsh Crab (*Ucapugnax). Science Journal* 197:484-487

[13] Pearson, P.; Sugarman, C.; Woodruff, D.L. and Olla B.L. (1981). Impairment of the chemosensory Antennular Flickering Response in the Dungeness Crab (*Metacarcinus magister*) by Petroleum Hydrocarbon. *Fish Bull*; 79:641-647.

[14] Powel, C.B.; Whyte, S.A.; Ibebe, D.D., Baranews Ka-Duticiewicz, B.; Isoun, M. and Ofoegbu, U. (1985). Oshika Oil Spill Environmental impact effect on Aquatic Biology. Paper presented at the NNPC/EMHE. *International Seminar on the Petroleum Industry and the Nigerian Environmen*t. 11th-13 November, 1985.

[15] Qiaxin, L. and Medelssohn, A.I (1998). The combined effects of phyto-remediation and biostimulation in enhancing habitat restriction and oil degradation of petroleum contaminantes. *Wetlands Ecol. Eng* 10: 363-374.

[16] Ramanujam, T. and Indira, P. (1978). Linear measurement and weight methods of estimation of leaf area of cassava and Sweet Potato. Centro International de Tropical (CIAT). *Journal of Root Crops* 4(2): 47-50.

[17] Rowell, M.J. (1997). Effect of crude oil spill on soils. *A Review of Literature* in: Toogood, J.A. (Ed.). The Reclamation of Agricultural soils after oil spills. Part 1. Edmonton, Canada pp.1-33.

[18] Sadowsky, M.J. (1999). Phytoremediation Past, Promise and Future Practices, Proceedings *of the 8th international Symposiums on Microbial Ecology*. Atlantic Canada Society for Microbial.

[19] Sharma, G.K., Chandler, C., and Salem, L. (1980). Environmental Pollution and leaf cultivar variation in Kadzu (Pueriar *lobeta wild*). *Annals of Botany* 45; 77-80