EFFECT OF OIL PALM EMPTY FRUIT BUNCHES (OPEFB) AMENDMENTS IN CRUDE OIL POLLUTED SOIL ON GERMINATION AND GROWTH PERFORMANCE OF WHITE MANGROVE SPECIES (LAGUNCULARIAA RACEMOSA)

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Abstract

The study investigated the effect of oil palm empty fruit bunches (OPEFB) amendments of crude oil polluted soil on germination percentage and growth parameter of white mangrove (*Laguncularia racemosa*). Soil samples were polluted with 1000ml of crude oil and amended with various quantities of (OPEFB) 0g, 100g, 200g, 300g and 400g and the control (unpolluted soil + seed). Germination percentage was analyzed after 21 days after planting and growth parameters were recorded at the end of nine (9) months. Results revealed that
crude oil pollution significantly affected the soil physical, chemical properties and nutrient contents which directly affect the germination and growth performance of *Laguncularia racemosa*. Oil palm empty fruit bunches amendments were able to
ameliorate the effect of the crude oil pollution and enhance the germination and growth performance of the white mangrove (*Laguncularia racemosa*) species. The remediation effect depend on the quantity of oil palm empty fruit bunches applied and the highest growth parameters were recorded in 400g of oil palm empty fruit bunches amended with crude oil polluted soil. This study revealed that crude oil polluted soil may have adverse effect on germination and growth performance of white mangrove species

((*Laguncularia racemosa*), but this can be remedied by addition of organic nutrients especially oil palm empty fruit bunches which act as a bioremediation and also organic manure that enhance soil fertility. It was recommended that oil palm empty fruit bunches which are byproducts from palm oil processing in the mill and may cause environmental pollution problems and spread diseases in the environment can be used in the amendment of crude oil polluted soils in the coastal community of Niger Delta region of Nigeria.

Keyword: Oil Palm Empty Fruit Bunches, amendments, Crude Oil, *Laguncularia racemosa*.

Introduction

Crude oil pollution has been, and will continue to be a significant source of environmental degradation in the Niger Delta region of Nigeria. The exploration and exploitation of crude oil pose a serious environmental problem due to contaminations of the products in air, water and soil in the oil producing communities (Trindade *et al.,* 2005). Crude oil varies in appearances and composition from one kind to another (Akaniwor *et al.,* 2007). Since discovery of oil in Niger Delta region of Nigeria, the ecosystem in the region has suffered untold hardship due to oil spillage, pipeline vandalization and transportation of crude oil derivatives. Crude oil pollution has been reported to have deleterious effects on both flora and fauna, and mostly affect the germination and growth performance of plant in the region (Kyung-Hwu *et al* 2004). Oil spills affect plants growth by creating conditions which make essential nutrients like nitrogen, phosphorous and oxygen needed for plant unavailable to them (Ogbo *et al* 2009). Pollution by crude oil has been found to decrease the dry matter content, moisture content, crude protein and crude fibre of *Telfairia occientalis*. (Ogbuehi *et al* 2010). Oil pollution have been found to reduced plant germination percentage, growth parameters and yield of crops such as *Arachias hypogea L.* and *Zea mays L.* (Abdulhadi and Kawo, 2006). Environmental pollution from activities of oil exploration and exploitation in Niger Delta region of Nigeria due to indiscriminate disposal crude oil is inevitable. Pollution of soils with crude oil, significantly delayed the period of germination velocity, reduced percentage germination, plant height, leaf production and biomass of *V. unguiculata* (Adedokun and Ataga, 2007). Although the effects of crude oil pollution on plants have been evaluated by many studies (Siddiqui and Adams, 2002; Anon, 2003; Andrade *et al.*, 2004; Adedokun and Ataga 2007; Shahid, 2007), there is the need to find out a remediation method to counter the effects of crude oil pollution on germination and growth performance of mangrove species grown in the coastal area of Niger Delta of Nigeria.

Mangrove species is used as fuel wood, construction and building materials, drugs, chemicals, feed and food for the coastal dwellers. However, oil contaminated soils are amendable to bioremediation because micro-organisms capable of degrading petroleum hydrocarbons are present in organic matter (Jone and Edington 2005). Oil palm empty fruit bunch (OPEFB) is one of the organic matter gotten as byproducts left during palm oil processing in the mill. This palm is grown mostly in the Niger Delta region of Nigeria. The residues from oil palm especially Empty Fruit Bunch (EFB) may cause environmental pollution problems and spread diseases in the environment. They also serve as breeding ground for pests and disease causing organisms on the environment. Studies have shown that oil palm empty fruit bunch (OPEFB) can be used as fertilizer to improve soil fertility (Udoetok, 2012). This study therefore evaluates the effect of oil palm empty fruit bunches OPEFB) in enhancing crude oil degradation in soil on the germination and growth performance of white mangrove species (*Laguncularia racemosa*) in the Niger Delta region of Nigeria.

Botany of White Mangrove *(Laguncularia racemosa)*

The White mangrove *(Laguncularia racemosa*) is from the family Combretaceae, a native to the coasts of western Africa from Senegal to Cameroon. White mangrove species exist as a tree or shrub with maximum heights of l5 m. The leaf shape is a broad, flat oval rounded at both ends. Leaf lengths approach 7cm. Two glands are found at the base of each leaf at the apex of the petiole. When growing in oxygen deprived sediment the White mangrove often develop peg roots which are similar to pneumatophores except they are shorter and stouter in appearance.

Importance of Mangrove in Coastal Ecosystem

It is obvious that mangroves play an important role in maintaining a healthy coastal ecosystem by exporting large quantities of detritus and supplying abundant food and feed to aquatic organisms, maintaining nutrient cycling, biogeochemical functions and energy flow along complex food chains and food webs. It also provides a habitat for a variety of animals especially waterfowl and birds, and acts as a nursery for juvenile species through provision of food and shelter from predation. The prop roots and pneumatophores of mangrove plants, and the shading effect under the leaf canopy allow the small animals escape or hide from their predators. In addition to ecological functions, mangrove ecosystems are important to the subsistence livelihoods of tropical coastal communities (Kaplowitz, 2001 and Rivera-Monroy, *et al.*, 1999). At present, millions of coastal dwellers throughout the region are dependent on mangroves for their livelihoods. Mangrove ecosystems can be directly exploited by extracting fish, agricultural products, and wildlife, as well as a variety of other goods including wood for fuel, construction and building materials, drugs, chemicals, feed and food (Kovacs, 1999). Mangrove ecosystems and their ecological functions also provide an array of important indirect services for people such as prevention of storm damage, flood and water control, support of fisheries, pollution mitigation, recreation and transport.

Material and Methods

Nigerian light crude oil was collected from Exxon Mobile Unlimited in Eket Local Government Area of Akwa Ibom State, Nigeria. The oil palm empty fruit bunches (OPEFB) was collected from palm oil mill industry in Utu Abak, Abak Local Government Area, Akwa Ibom State, Nigeria. The oil palm empty fruit bunches was grinded into fine powder with Nulux mills machine (Model RPM SR 400-061, Bombay, India) to pass through a sieve of 2mm mesh size. The soil sample used for the study was collected from the Botanical garden, Akwa Ibom State University, Ikot Akpaden, Mkpat Enin Local Government Area, Akwa Ibom State, Nigeria. The soil was sieved with 2mm mesh size before use. A total of eighteen (18) plastic buckets perforated at the base for easy drainage were used. Each treatment consists of 5kg of soil thoroughly mixed with 1000ml of crude oil and amended with various quantities of oil palm empty fruit bunches (OPEFB) (0g, 100g, 200g, 300g, 400g) respectively. The mixture was allowed to stay for two weeks (14 days). This was to allow free mixture of crude oil polluted soil and oil palm empty fruit bunches to maintain a uniform component mixture before the seeds of *Laguncularia racemosa* were planted. The control experiment was (loamy soil (unpolluted) + seeds of *Laguncularia racemosa*). The experiments were left for nine months and were exposed to rain and sunlight throughout the period of the study.

For germination study, healthy seeds of *Laguncularia racemosa* were obtained from Eastern Obolo Local Government Area which is a coastal area in Akwa Ibom State. The seeds were sorted out and then sterilized with 0.01% mercuric chloride solution for 30 seconds; the seeds were thoroughly washed several times with distilled water and air dried. During this treatment floating seeds or those that had bubbles were discarded. A seed of *Laguncularia racemosa* was sown in each plastic bucket containing the polluted soil amended with various quantities of oil palm empty fruit bunches. The criterion for germination was taken as emergence of 2mm (0.2cm) at the time of observation (Singh and Singh, 1981). Germination percentage was observed from seven to 21 (7 – 21) days after planting (DAP) and the percentage was calculated using the formula according to the International Seed Testing Association (ISTA, 2009):

Germination Percentage (%) = Number of seeds germinated X 100

Number of seeds tested

Growth Parameters Measurement

The growth parameters of *Laguncularia racemosa* include the plant height, root length, leaf length, leaf width, leaf area, total number of leaf moisture content and dry matter content. The plants from each treatment were carefully uprooted washed in running tap water to flush out the soil particles. The plant height, root length, leaf length and leaf width were measured in (cm) using a meter rule at the end of 6 months. The leaf area was obtained in duplicates by placing the leaf on a graph paper of one square centimeter ($1cm^2$). The squares enclosed by the margin were counted after the trace. The squares which were divided by the leaves area were counted if they are greater than or equal to $0.5\ cm^2$. Those that were less than $0.5cm^2$ were ignored (Hoyt and Bradfied, 1962).

The mean of the duplicate figures was taken as the leaf area. The leaf numbers were obtained by visual counting of the leaves. The percentage moisture content of the sampled species was determined as follows. The difference between the fresh and dry weight of the plant species, this was done by measuring fresh weights of the plant species using Mettler P. 165 weighing balance. The weighed plants were dries in a Gallenkamp oven at 800C until the weights were constant. All the parameters were obtained at the end of nine (9) months.

Results

The effects of oil palm empty bunches (OPEFB) amended with crude oil polluted soils on the germination percentage of white mangrove species (*Laguncularia racemosa)* is presented in Figure 1. The result shows an increase in germination percentage of *Laguncularia racemosa* with increase in the quantities of oil palm empty bunches (OPEFB) in crude oil polluted soils. Treatment of crude oil polluted soil amended with 400g of oil palm empty bunches (OPEFB) showed a significant increase in the ($p<0.05$) germination percentage. The 0g treatment (zero treatment) of oil palm empty bunches (OPEFB) in crude oil polluted soil had the least germination percentage. The lower value of percentage germination observed in 0g (zero treatment) of oil palm empty fruit bunches may be attributed to the effect of crude oil pollution in soil which affect the physical and chemical properties of the soil and inhibit the germination of *Laguncularia racemosa* seeds. It was observed that the control treatment (unpolluted soil + seed) gave the highest germination percentage (100%) of *Laguncularia racemosa* seeds. The percentage germination of *Laguncularia racemosa* seeds sown in crude oil polluted soil amended with various quantities of oil palm empty fruit bunches were found in the following increasing order Control treatment

100%> 400g 98% > 300g 72% > 200g 65% > 100g 48 > and 0g 20%. Figure 2 showed the percentage moisture content and percentage dry matter content of white mangrove species (*Laguncularia racemosa)* after nine months. The percentage moisture content and dry matter accumulation of the white mangrove species treated with 400g of poultry manure out yielded all others treatment and was significantly ($P<0.05$) higher than the 300g, 200g, and 100g treatment of oil palm empty bunches (OPEFB). However, there was no significant difference ($p >0.05$) between the control treatment and 400g treatment of oil palm empty fruit bunches.

Plant heights, root length, leaf length, leaf width, leaf areas and the number of leaves in the control and 400g treatment with oil palm empty bunches (OPEFB) record the highest values (Table.1). There was a direct proportionate increase in plant height , root length, moisture contents and leaf area with increase in the quantity oil palm empty bunches (OPEFB) but reverse proportionate decrease in the growth parameters of *Laguncularia racemosa* plant with decrease in the quantities of oil palm empty bunches (Table 1). It was observed that the quantities of oil palm empty bunches (OPEFB) had significant effect on the leaf area with the highest effect observed in the control and 400g treatment (25 cm^2 and 22cm^2) respectively. There was an increase in the number of leaves as the quantity of oil palm empty bunches (OPEFB) increased and a reduction in the number of leaves on the 0g and 100g treatment of oil palm empty bunches (12 and 34) respectively. However, the number of leaves observed in crude polluted amended with various quantities of oil palm empty fruit bunches were found in the following increasing order Control treatment 85 >400g 73 >300g 58 > 200g 30 > 100g 22 >0g 8. The results showed that oil palm empty fruit bunches which is a waste product and constitutes environmental nuisance can degrade crude oil pollution in soil and also add manure to the soil.

Discussion

Crude oil pollution on coastal region of Niger Delta of Nigeria affects the germination and growth performance of *Laguncularia racesmosa* in the area as indicated in the results. The effect of the crude oil spillage on the plant height, root length, leaf area, moisture content and dry matter observed in the study were similar to those reported on the effect of crude oil on *Manihot esculentus* (Ogbuehi *et al* 2010). Njoku *et al*. (2008) found similar findings on the effect of crude oil on the growth of accessions of *Glycine max* and *Lycopersicon esculentum*. Etukudo (2004) also showed that treatment of soils with crude oil, automotive gasoline oil and spent engine oil significantly affected the time of germination, plant height, leaf production and biomass of *Abelmoschus esculentus*.. The decrease in germination of *Laguncularia racesmosa* seeds in 0g treatment of soil with crude oil indicates that crude oil affect the availability of water, oxygen and temperature in the soil which are important factors responsible for seeds germination. The effect of crude oil polluted soil on leaf indicates that its interrupts with the photosynthesis process, thereby reduce the leaf area. According to Kathirvelan and Kalaiselvan (2007) the leaf surface area determines in large part the amount of carbon gained through photosynthesis and the amount of water lost through transpiration and ultimately the crop yield. Therefore the reduction of the leaf area as observed in 0g treatment of (OPEFB) in crude oil polluted soil implies that there would be low photosynthetic efficiency of the plant as much of the solar energy emitted by sun would not be absorbed by plant for photosynthesis. This can lead to poor growth of the plant with subsequent poor timber formation and low yield. According to Walker *et al*. (2001), availability of nitrogen in the soil directly affects the relative growth rate of plants. (Agbogidi *et al*., 2007) reported that petroleum products are known to reduce nitrogen availability in the soil. This could be the cause of adverse effect on growth parameters of Laguncularia racemosa observed in 0g treatment of (OPEFB) in crude oil polluted soil. According to Wyszkowski and Zoilkowska (2008), proper growth of crops is dependent on the content of nutrients availability in the soil. The inhibition of the growth of the white mangrove species (*Laguncularia racesmosa)* observed in the 0g treatment of oil palm empty fruit bunches may be due to the fact that crude oil affects the physical and chemical properties of the soil and also affect its nutrient contents. The adverse effects could be due to disruption of the absorption and uptake of nutrients by crude oil in the polluted soil, increase the soil pH and increasing acidity content of the polluted soil (Njoku *et al*., 2008). From the results, it can be concluded that oil palm empty fruit bunches can degrade crude oil polluted soil and it is effective bioremediation materials for crude oil pollution and at the same time restored the fertility of the soil, since it contain nitrogen, phosphorus, potassium and calcium which are essential to plant growth and development. Hence increase in the quantity of (OPEFB) in oil polluted soil will lead to increase in germination percentage of *Laguncularia racemosa*, increase in growth parameters and dry matter contents, thus, enhance timber productivity and yield of white mangrove species (*Laguncularia racemosa*).

Figure 1. Effect of Oil palm Empty Fruit bunches amended with crude oil polluted soil on Germination Percentage of *Laguncularia racemosa*

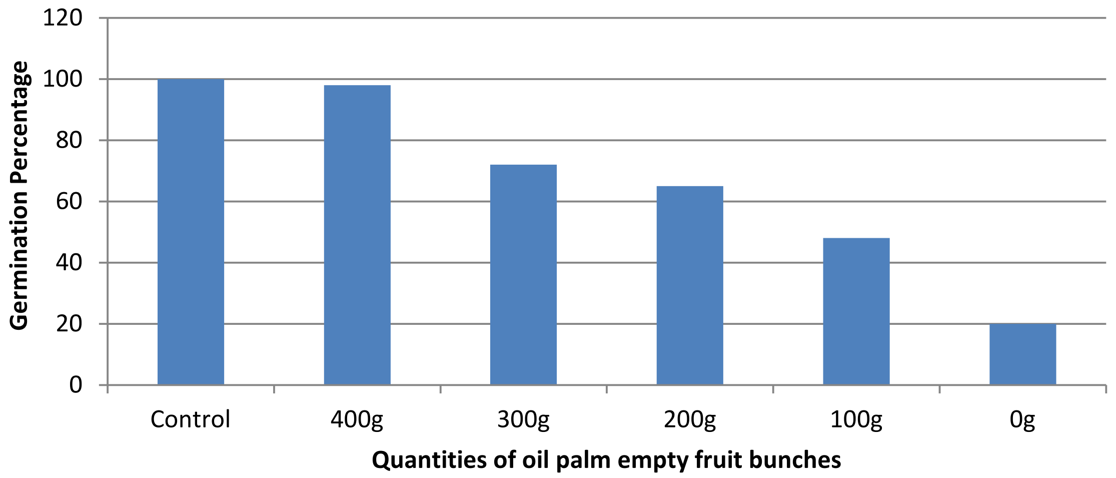

Figure 2. Percentage Moisture and Dry matter contents of *Laguncularia racemosa* after 9 months

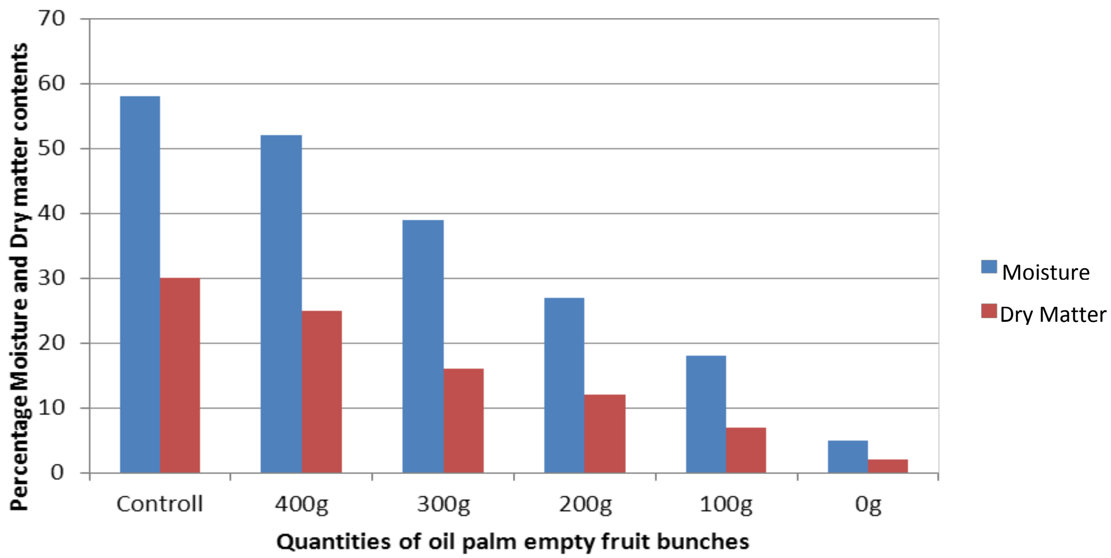

Table 1. Effect of oil palm empty fruit bunches amended with crude oil polluted soil on growth parameters of White mangrove (*Laguncularia racemosa)*

Growth Parameters	**0g**	**100g**	**200g**	**300g**	**400g**	**Control**
Plant height (cm)	15.14±0.04	98.15±1.34	153.02±0.29	178.14±0.10	278.25±0.19	295.15±0.05
Root length (cm)	6.94±1.25	51.10±3.05	75.19±0.72	84.19±3.25	128.39±0.01	136.01±0.40
Leaf length (cm)	2.10±0.05	6.13±0.55	8.14±1.25	9.42±1.00	13.05±0.10	14.02±1.05
Leaf width (cm)	073±0.15	2.78±1.22	3.15±1.05	4.19±1.15	7.12±1.00	8.03±1.20
Leaf area (cm^2)	1.18	12.78	19.23	29.60	69.42	84.05
Number of leaves	8	22	30	58	73	85

Data were processes and expressed as mean ± SD of three replicates

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