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The Effect of Crude Oil on the Germination and Growth Performance of *Moringa oleifera* Lam.

[1]Emerhi, E. A. and David-Sarogoro, N.

[1]Department of Forestry and Wildlife, Delta State University
Abraka, Delta State, Nigeria

[2] Department of Forestry and Environment Rivers State University of Science and Technology, Port Harcourt, Rivers State, Nigeria

[1]Corresponding author: eaemerhi@yahoo.com

Abstract

In order to determine the effects of contaminating soil with varying levels of crude oil on adaptability, germination and growth of Moringa oleifera, 0, 4, 8, 12 and 16ml of crude oil were thoroughly mixed with 1 kg each of top-soil soil in poly-pots in an experiment that was replicated thrice. Three seeds of Moringa oleifera were sown per pot, and monitored for 12 weeks. The results showed that crude oil in soil significantly affected the performance of M. oleifera seedlings, the effect being oil concentration-dependent. Germination commenced on the 4th day after sowing (DAS) and was concluded between 14th and 15th days, with germination percentages varying from 20.00% to 73.33%. The control group (0 ml/kg of soil) had the highest germination percentage of 73.33% in week 1. Plant heights at the 8th week after planting (WAP), were 2.12cm for the control group, and 1.25cm and 0.79cm for the 4 and 16ml/kg of soil groups respectively. Death of some seedlings was recorded at higher oil concentration levels of 12ml and 16ml/kg of soil, while the control group had the highest mean leaf number (6.57), and plants in soil contaminated at 16ml/kg had the lowest (3.47). The mean height (cm) of the seedlings in soils contaminated with 8 and 16ml of oil per kg of soil were highly affected by the concentration of crude oil. The study established that crude oil in soil significantly reduced performance of M. oleifera seedlings in terms of plant height, number of leaves and leaf girth. It was concluded that although Moringa oleifera seedlings tolerated low concentrations of crude oil, their performance was severely affected by higher levels of oil contamination in this study.

Keywords: *Moringa oleifera*, Crude oil, contamination, Pollution, Germination, Growth Performance.

Introduction

Background information

Nigeria Environment Study Action Team (NEST) (1991), describes crude oil as the world's treasure. It is regarded as the live wire of the Nigerian economy (Adegeye *et al*., 1993). Nigeria is a major producer and exporter of crude petroleum oil as well as being an important agricultural nation in the West Africa sub-region (Agbogidi and Nweke, 2005a 2005b). Nigeria has abundant deposits of oil and natural gas, and their exploitation has improved the economy substantially, but with serious environmental costs (Ogri, 2001).

Severe ecological damage has occurred in the Niger Delta where most of the oil industries are based (Adegeye *et al*., 1993).

The oil industry contributes significantly to the foreign exchange earnings, employment, and inter-industrial linkages but has continued to have a negative impact on the socio-economic life of the oil producing communities (Ihejiamazu, 1999). During its exploitation, refining and distribution, oil is inevitably discharged into water bodies, agricultural lands and other ecosystems through spills, tanker accidents, natural disasters, mechanical failure, and vandalization of pipe lines and flow lines (Dudley, 1970; Benka and Coker, 1991). Such spillages usually have negative impacts on farmlands and water (Ekundayo and Obuekwe, 1997).

Oil pollution effects vary with the type and amount of oil involved, time of the year, the plant species affected and their ages, physical and chemical properties of the oil, presence of other pollutants in the environment, the type of soil, its water status as well as other environmental conditions (Baker,1987; Anoliefo and Vwioko, 1995).

The continuous exploration, production and processing of crude oil, and its transportation exposes the environment to constant threat of oil pollution (Agbogidi and Nweke 2005a). Crude oil pollution is an inevitable phenomenon in oil-producing and consuming areas worldwide (Agbogidi and Eshegbeyi, 2006). It starts from human error, accidental discharges and other sources (Agbogidi and Ayelo, 2010). Oil pollution has deleterious effects on agricultural lands and hence, significant effects on plant growth (Agbogidi *et al.,* 2007). It has been reported to create some condition in the soil which make some essential minerals and non-essential nutrients unavailable to plants, or cause them to rise to toxic levels (Adams and Ellis, 2000).

Impact of Oil Pollution

The production, refining, transportation, storage and consumption of petroleum and its by-products, if not properly handled, create some environmental risk (Oyibo and Ogboola 1983as cited in Agbogidi (2009). The most toxic compounds found in crude oil and in many refined products are aromatic hydrocarbons, also known as volatile organic compounds (VOCs). These hydrocarbons mix with lower levels of the atmosphere and, when heated by the sun, create ground-level Ozone, a major component of smog and a greenhouse gas

Oil spills can have significant short- and long-term impact on the ecosystems due to oil's physical effects and chemical toxicity leading to decreased primary production, plant die-back, wildlife mortality and marsh erosion (Njoku, et al, 2009). The mechanisms of these impacts are through disruption of plants-water relationships, direct impacts on plant metabolism, toxicity to living celsl and reduced oxygen exchange between the atmosphere and the soil (Njoku *et. al.,* 2009).

If leaves are coated with spilled oil, leaf stomata are blocked, oxygen diffusion to the roots decreases and root oxygen stress increases, leading to reduction in plant growth. An oil-covered soil surface decrease oxygen movement, resulting in more anaerobic soil conditions and increasing low-oxygen stress on plant roots. The severity of these impacts is controlled by the amount of oil spilled, types of dispersed oil and sensitivity of plants.

Since commercial exploration of petroleum started in Nigeria in 1958 (Okoh, 2003), petroleum has continuously grown to be the mainstay of the Nigerian economy. However, the exploration of petroleum has led to the pollution of land and waterways. Agricultural lands have become less productive (Dibble et al 1979) and creeks and the fishing waters have become dead (Okpokwasili and Odokuma; 1990). Several civil unrests due to environmental degradation due to oil exploration have also been witnessed in the Niger Delta region of Nigeria (

Ogbo (2009) demonstrated the effects of diesel fuel contamination on seed germination of four crop plants –*Arachis hypogaea*, *Vigna unguiculata*, *Sorghum biocolor* and *Zea mays*. Diesel fuel contamination caused a reduction in the length of the radicle for the four crop plants, and this varied with level of contamination. The phytotoxicity of the different levels of diesel fuel contamination on seed germination indices varied with the type of crop plant.

Moringa oleifera has many common names according to various languages or dialects. In English language, it is called "drum stick" or "horseradish", while in India, it is called "munga" or "saragwa". It is an exceptionally nutritious vegetable tree with a variety of potential uses. *Moringa* tree is grown mainly on semi-arid, tropical and subtropical areas. It grows best in dry sandy soils, and tolerates poor soils, including coastal soils. It is considered one of the world's most useful trees, as almost every part of the tree can be used for food, or for some other beneficial purpose. In the tropics, it is used as forage for livestock, as *moringa* micronutrient liquid in many countries. As a natural anti-helmintic (kills parasites) and adjuvant (to aid or enhance another drug) it is used as a metabolic conditioner to aid against endemic diseases in developing countries.

A traditional food plant in Africa, this little-known vegetable has potential to improve nutrition, boost food security, foster rural development and support sustainable land care. The immature green pods called "drum sticks" are probably the most valued and widely used part of the tree. They are commonly consumed in India, and are generally prepared in a similar fashion to green beans, and have a slight asparagus taste. The flowers are edible when cooked, and are said to taste like mushroom. The roots are shredded and used as a condiment (food seasoning used at table such as salt etc).

However, it contains the alkaloid Spirochin, a potentially fatal nerve-paralyzing agent. The presence of this compound is not a threat or menace because large amounts are required to elicit deleterious (harmful) effects, and spirochin even displays anti-bacteria properties when consumed in small amounts. The leaves are highly nutritious being a significant source of beta-carotene vitamin C, protein, iron and potassium. The leaves can be cooked and used like spinach or eaten raw in salad. In addition to being used fresh as a substitute for spinach, its leaves are commonly dried and crushed into a powder and used in soup sauces (stewed fruit served with a meal).

Imagine a tree in your backyard that will meet all your nutritional needs, take care of you medicinally, and purify your water for you. This tree exists, for centuries, is native of northern India, and many parts of Africa have known of the many benefits of *Moringa oleifera*. Its uses are as unique as the name, such as clarifier tree, horseradish tree and drum stick tree (referring to the large drumstick-shaped pods) and in east Africa, it is called "mother's best friend". Virtually every part of the tree can be used. It is now widely cultivated in Africa, central and south America, Sri-Lanka, India, Malaysia and the Philippines. This tree, though little known in the western world, is a nutritional dynamo.

There are literally hundreds of uses for this tree. The mature pods are the most valued and widely used of the tree parts.

The pods are extremely nutritious, containing all the essential amino acids along with many vitamins and other nutrients. The immature pod can be eaten raw or prepared like green peas or green beans, while the mature pods are usually fried, and possess a peanut-like flavour. The tree is a good source of calcium and phosphorus. In siddha medicine, these drumstick seeds are used as sexual virility (potency) drugs for treating erectile dysfunction (failure to function normally) in men and in women for prolonging sexual activity. *Moringa* leaves and pods are helpful in increasing breast milk in the breastfeeding months. One table spoon of leaf powder provides 14% of the protein, 40% of the calcium, 23% of the iron and most of the vitamin A needs of a child age one (1) to three (3). Six table spoons of leaf powder will provide nearly all of a woman's daily iron and calcium needs during pregnancy and breastfeeding. *Moringa* seeds yield 38-40% edible oil (called ben oil). The refined oil is clear and odourless and resists rancidity at least as well as any other botanical oil. The seed cake remaining after oil extraction may be used as a fertilizer or flocculent to purify water. The Moringa tree has great medicinal uses, both for prevention and treatment of human ailments. India's ancient tradition of Ayurveda says the leaves of *Moringa* tree prevent 300 diseases. Scientific research has shown that the tree is capable in treating cancer. More rigorous studies are required in order to achieve a level of proof required for full medicinal endorsement of *Moringa* as, in this case, a cancer preventive plant. This tree is truly a "miracle" tree offering hope, nutritional, medicinal and economic relief to devastatingly poor 3rd world countries. It has recently begun being used as a supplement in a juice form and as powdered-leaf tablets.

Moringa oleifera is a small shrub or tree that can reach 12m (36ft) in length at maturity and can live for up to 20 years, a short but intense life. A life in the fast lane, *Moringa* is perhaps the fastest growing of all trees as it can reach 3m (9ft) in just 10 months after the seed is planted. It has deep roots and therefore can survive in dry regions, and a wide-open crown with a single stem. Moringa is a healer, food magician, beauty and a beautician, a plant with surprising water purification capabilities, a best friend and humanitarian who works for so little. It is one of the most useful trees on earth.

Currently, information on the germination and early growth of *Moringa oleifera* on oil-contaminated soil is scanty since virtually no study has been carried out in this aspect. Thus, a study on the effects of crude oil on germination and seedling growth of *Moringa oleifera* has become necessary. This will lay a foundation for the establishment of large scale plantation of the species for large scale bioenergy (biodiesel) production.

Many plants which are important for food and income in Nigeria, as it is the case in many other Africa countries are sourced from the forest; hence the forests are under pressure. These pressures have led to large scale destruction of natural forests and it is estimated that 5% of closed forests are cleared annually for other uses with negative repercussion. In Nigeria, oil is produced in the southern states that are in the humid tropical forest zones. Frequent spills have been reported and claims of damages made by local inhabitants, very few systematic studies have been conducted to evaluate the effects of oil on *Moringa oleifera* under prevailing and ecological conditions. Consequently, findings of this study will aid farmers to know at what stage crude oil contamination of the soil is most injurious to *Moringa oleifera*.

The importance of *Moringa oleifera* cannot be over emphasized. There have been little or no effort made to domesticate this important tree, no conscious effort has been made by local farmers to domesticate it. The incessant exploitation of trees and environmental problems associated with oil exploitation has led to the disappearance of most trees species. Therefore, it is important to study the germination and growth performance of the plant on crude oil contaminated soil to determine the effect of the crude oil on this important species.

The general objective of this study was to evaluate the germination and growth performance of *Moringa oleifera* grown in crude oil contaminated soil in so doing determine the effects of crude oil on the germination and growth performance of *Moringa oleifera* seedlings grown in soil contaminated with various levels of crude oil, and to access the tolerance of *Moringa oleifera* to different levels of crude oil contamination.

Materials and Methods

Study Area

The experiments were conducted in Delta State University, Asaba campus, Asaba, Nigeria (Latitude $6^0$14'N; Longitude $6^0$49'E; Mean annual temperature of 28 $\pm$ 6^0C; Mean annual rainfall of 1505mm; relative humidity of 69-80% and sunshine of 4-8 bars). Asaba is located in the rainfall agro-ecological zone of Nigeria (Asaba metrological station, 2011).

Experimental Procedures

Moringa oleifera dry pods were collected randomly from *Moringa oleifera* trees the Delta State University premises in Asaba, Delta State, Nigeria. Fifty (50) seeds were removed from the fruit pods by hand, and sun-dried for about a day.

Top-soil samples were collected from the *Gmelina arborea* plantation behind the Department of Forestry and Wildlife, Faculty of Agriculture, Delta State University, Asaba campus, Asaba, Delta State Nigeria. The samples were air-dried and sieved using a 2mm sieve to remove stones, roots and other materials that may obstruct the emergence of plumules upon seed germination.

To determine the effects of varying levels of crude oil contamination on adaptability and germination of *M. oleifera*, crude oil was obtained from Pan Ocean Company, Ovade, Oghara, Delta State, Nigeria. Two kilogram (2kg) of the air-dried soils were put into each of 15 similar-sized poly-pots, divided into five treatments (T1, T2, T3, T4 and T5) of 3 pots each. Soils in the five treatment pots were contaminated with 0, 8, 16, 24 and 32ml of crude oil per poly-pot, corresponding to 0, 4, 8, 12 and 16ml/kg (v/w) of soil respectively for T1, T2, T3, T4 and T5. T1 with no crude oil served as the control treatment. The soils were thoroughly mixed with the different quantities of crude oil.
The experiment was therefore a completely randomized design replicated three times.

Three *Moringa oleifera* seeds were planted in each poly-pot and allowed to germinate. The poly-pots were watered twice daily (morning and evening) throughout the duration of the experiment. Germination counts were taken daily beginning from the first day of germination, and monitored for 20days.

Data Collection

Growth Parameters measured on replicate basis included the following;

i. **Germination percentage**, which was taken as the percentage of seeds planted that germinated within two weeks.
ii. **Number of leaves per seedling per treatment** was determined by counting the number of leaves on a plant per replication and recorded every two weeks from the 14th day after planting.
iii. **Leaf area (cm^3)** was obtained by multiplying the product of the length and breadth of an average-sized leaf of a seedling by the total number of leaves of the seedling; following the method of Bamidele and Agbogidi (2006).
iv. **Shoot height (cm)** was measured with a metre rule from the soil level to the terminal bud. The measurements were taken every two (2) weeks from the second week after planting (WAP).
v. **Stem girth (cm)** was taken at the base of the seedlings (2cm from the soil level), and was taken for a total of twelve weeks.
vi. **Cumulative germination percentage** was calculated by dividing the cumulative number of seeds that germinated by total seeds planted, and then multiplied by 100.

Data Analysis

The collected data were subjected to analysis of variance (ANOVA) at 5% level of probability. Means which were significantly different were separated using Fisher least significant difference (LSD).

Results

There were no significant differences between treatments (P>0.05) in overall germination percentage for the first two weeks (Table 1). Germination commenced on the 4th day after sowing (DAS) and was concluded between the 14th and 15th day, with germination percentage varying from 20.00% to 73.33 %.

Table 1: Germination (%) of *Moringa oleifera* as influenced by different crude oil levels in the soil

Treatment	WK 1	WK 2	Mean
T1	73.33	20.00	46.67
T2	53.33	20.00	35.17
T3	33.33	26.67	30.00
T4	26.67	53.33	40.00
T5	26.67	53.33	40.00

Differences between means were non-significant (P>0.05) using (LSD)

The result in Table 1 also shows that the control treatment (0.00ml crude oil/kg of soil) had the highest germination percentage of 73.33 % in week 1. Both the control treatment and T2 (4.00ml crude oil/kg of soil) had the lowest germination percentage (20.00 %) in week 2.

The results of growth performance in terms of plant height (cm), number of leaves, leaf area (cm^2) and stem girth (cm) of *Moringa oleifera* seedlings as influenced by various levels of crude oil in soil are presented in Tables 2, 3, 4, and 5 respectively.

Table 2: Shoot height (cm) of *Moringa oleifera* as influenced by different crude oil levels in soil

	Weeks						
Treatment	**2**	**4**	**6**	**8**	**10**	**12**	**Mean**
T1	9.47	18.07	24.43	27.30	29.80	31.85	23.48a
T2	5.60	10.07	14.60	15.27	16.20	17.63	13.23b
T3	3.00	5.20	7.80	8.43	8.60	9.40	7.12d
T4	4.33	7.40	10.13	10.17	9.53	10.00	8.59c
T5	3.13	5.07	7.90	8.20	7.07	7.50	6.48e

LSD = 1.34
Means with the same alphabet are not significantly different at $P \leq 0.05$ level of significance using (LSD)

The results show that crude oil in soil had a significant ($P<0.05$) depressing effect on germination and growth of *M. oleifera* seedlings, and the effect was dependent on oil concentration. For example, at 0.00 level of oil contamination (T1) at the 8th week after planting (WAP), the plant height was 27.30cm, 15.27cm at 4.00ml/kg (v/w) (T2) and 8.20cm at 16ml/kg (T5) (Table 2).

Death of some of the seedlings was recorded at oil concentration levels of 12ml/kg (T4) and 16ml/kg (T5), while the control treatment had the highest mean leaf number(6.57), and plants in T5 (16ml of oil/kg of soil) had the lowest mean leaf number (3.47) as can be seen in Table 3.

Table 3: Leaf Number of *Moringa oleifera* as influenced by different crude oil level in soil

	Weeks						
Treatment	**2**	**4**	**6**	**8**	**10**	**12**	**Mean**
T1	5.20	6.07	7.20	6.73	6.67	7.57	6.57a
T2	4.00	4.60	5.80	4.93	4.47	4.47	4.71b
T3	2.80	3.13	4.07	3.73	3.73	3.73	3.49d
T4	3.67	4.67	5.60	4.67	4.47	3.80	4.48c
T5	3.87	4.20	4.80	3.13	2.67	2.13	3.47e

LSD = 1.34
Means with the same alphabet are not significantly different at $P \leq 0.05$ level of significance using (LSD)

While mean leaf area (cm^2) was generally unaffected ($P>0.05$) by soil contamination with as much as 12ml/kg when compared with the control treatment (T1), pollution with 16ml/kg (T5) led to a slight but significant reduction in leaf area (Table 4).

Oil contamination significantly ($P<0.01$) reduced plant girth, with the reduction generally increasing in severity as the level of oil in the soil increased (Table 5).

The cumulative germination percentage indicated that germination did not occur in the first 3 days after planting as presented in Table 6.

Table 4: Leaf Area (cm^2) of *Moringa oleifera* as influenced by different crude oil levels in soil

Treatment	Weeks 2	4	6	8	10	12	Mean
T1	2.84	3.57	4.47	2.67	3.02	3.27	2.77a
T2	1.81	2.61	3.45	2.65	2.11	1.87	2.42a
T3	1.21	1.37	1.71	1.78	1.87	1.65	1.58a
T4	1.22	1.91	2.28	1.90	1.63	1.22	1.69a
T5	0.81	1.47	1.79	1.31	0.97	.072	1.18b

LSD = 1.34
Means with the same alphabet are not significantly different at $P \leq 0.05$ level of significance using (LSD)

Table 5: Stem Girth (cm) of *Moringa oleifera* as influenced by different crude oil level in soil

Treatment	Weeks 2	4	6	8	10	12	Mean
T1	0.41	0.89	1.94	2.12	2.38	2.37	1.69a
T2	0.26	0.64	1.35	1.25	0.75	0.78	0.84b
T3	0.25	0.5	1.13	0.79	0.49	0.52	0.61c
T4	0.27	0.64	1.23	0.93	0.71	0.73	0.75d
T5	0.24	1.03	0.97	0.79	0.49	0.49	0.67e

LSD = 1.34
Means with the same alphabet are not significantly different at $P \leq 0.05$ level of significance using (LSD)

Table 6. Cumulative Germination %

Days	Percentage (%)
1	0.00
2	0.00
3	0.00
4	1.33
5	9.33
6	14.67
7	22.67
8	25.33
9	28.67
10	30.00
11	33.33
12	36.00
13	39.33
14	39.33
15	40.00
16	40.00
17	40.00
18	40.00
19	40.00
20	40.00

Discussion

The significant reduction observed in the performance of the *Moringa oleifera* seedlings in terms of plant height, number of leaves, and stem girth with increasing oil level agrees with the earlier reports of Cook and Westlake (1974) on microbial degeneration of northern crude oils. The adverse effects of crude oil-contaminated soils have also been reported by Amakari and Onofeghara (1983) on *Abelmuschus esculentus*, Baker (1987) on plants, Anoliefo and Vwioko (1995) on *Capsicum annum*, Malallah *et al., (*1996) on *Vicia faba*, Li *et al., (*1997) in their work on the importance of soil water relations in assessing the endpoint of bioremediated soils, Odjegba and Sadiqi (2002) on *Celosia argentea*, Agbogidi *et al.* (2007) on *Dacryodes edulis*, and Odejimi and Ogbalu (2006) on *Telferia accidentalis*. Retardation observed in *M. oleifera* seedling development in soil contaminated with 12 and 16ml/kg soil particularly on number of leaves and yellowing of leaves (chlorosis) as against the control is in support of earlier report on the deleterious effect of crude oil on plant development (Baker, 1981a ,b). The negative effects of crude oil on plant height, leaf area and number of leaves observed in the experiment was corroborated by Agbogidi and Ofuoku (2005), who reported similar effects of oil spill contamination on *Anona muricata* and attributed them to direct herbicidal and phytotoxic effects. The increased performance in plant height, number of leaves and leaf area recorded in 4ml of crude oil per kg of soil between weeks 2 and 6 was supported by Vwioko and Fashemi (2005) who recorded growth enhancement in the seedlings of *Ricinuuus commuris* (castor oil). Bamidele and Agbogidi (2006) also recorded growth of three aquatic macrophytes on oil contamination. Sharif *et al.*, (2007) observed similar result with six different species at low doses of oil. The observed increase in stem girth of seedlings especially at 0.00ml (T1) may be attributed to free translocation of nutrients and water to xylem vessels but the decrease with level of oil contamination with time could be attributed to water stress imposed by the oil contamination of soil. This observation supports the report of Freedman (1989) that the ecosystem is gradually being taken over by myriads of hazardous materials from contamination.

The inability of many people in developing countries to afford fossil fuels and the failure of energy infrastructure have increased their dependency on bioenergy (Onyekwelu and Akindele, 2006). In Africa, between 75-95 % of energy needs of most rural household have biomass as the primary energy source. A significant number of small scale rural and urban industries in Africa such as tea, tobacco, cassava production, brick and tiles industries, alcoholic beverage production, wood processing, bakeries, etc, rely on bioenergy. The potentials of bioenergy are hinged on the renewability, availability, versatility and sustainability of its resources and its environmental benefits, coupled with land availability for energy plantations. *Moringa oleifera* is easily established through seed or cuttings. The seeds are sown either directly or in containers, without any pre-treatment, and germinates in 4 to 15 days after sowing. Moringa seeds have high germination capacity, with the seeds germinating regularly within a short time. The result shows that germination of the seeds ranged from 20 to73 %. The germination percentage recorded in this study is within the range recorded for some forest species (e.g. Agbogidi *et al.,* 2007 (*Dacryodes edulis*); Ojeifo *et al.,* 2007 (*Dacryodes edulis)*) but generally higher than what was reported for other forest seeds species (e.g. Aduradola *et al.,* 2005 (*Chrysophyllum albidum*)). There was indication that *Moringa* seeds germinated easily, as was indicated by the high early germination. There was also indication that most of the seeds germinated uniformly within a short period (from 5th to 10th day after sowing). The significant effect of crude oil contamination on *Moringa* seed germination in this study agrees with the report of Agbogidi *et al., (2007*) who observed the significant effect of crude oil on the germination of *Dacryodes edulis* seeds. *Moringa oleifera* is a tree species with a fast growth rate as observed in the current study. Within the three-month growth period, average total height of the plants ranged from 6.48 and 23.48cm while average mean stem girth varied from 0.67 and 1.69cm. These values are higher than what has been reported for seedlings of some other tropical tree species. Agbogidi *et al.,* (2007) reported total height and collar diameter range of 1.5-19.6cm and 0.8- 1.5cm respectively for *Dacryodes edulis* seedlings after three months of growth. Ojeifo *et al., (*2007*)* and Ekeke *et al.,* (2006) reported mean *Dacryodes edulis* seedling height of 16.4 and 20.4cm after 6 and 12 weeks, respectively, which are much lower than that of *Moringa oleifera* in this study. The seedlings of this species grow faster than those of fast growing tropical *Gmelina arborea*, which has been reported to attain an average annual height of between 1.5 and 2.5m during the first year of growth. *Moringa oleifera* seedlings have considerably higher number of leaves compared to the seedlings of other tree species, which could positively explain the much higher growth performance of *Moringa* seedlings. Agbogidi *et al.* (2007) reported a much lower number of leaves (between 5 and 10) for *Dacryodes edulis* seedlings. Similarly, Ojeifo *et al.* (2007) reported between 6 and 8 leaves after 6 weeks of growth for *Dacryodes edulis* seedlings. Abdulhadi and Kawo (2006) also examined the effects of used engine oil pollution of soil on the growth and yield of *Arachis hypogaea* L. and *Zea mays* L. and reported significant differences between the control plants and those grown in the oil treated soils. In their experiment, the mean height of the control plants was significantly greater than those for plants growth in soil treated with 40-200 ml used engine oil. The various oil concentrations did not have any significant effect on the seed germination and early growth rate of *Moringa* seedlings. Chlorosis (yellowing of leaves) and death were recorded at the oil concentration of 12 and 16ml/kg between weeks 8 and 10 after planting. This result may have confirmed that *Moringa* can be adversely affected by high concentrations of crude oil. The non-significant effect of crude oil on germination rate of *Moringa* seeds could be attributed to the ability of the species to sprout even in soils with low contamination of crude oil.

Conclusion

In this study, *Moringa oleifera* seeds had a high germination capacity, with the seeds germinating regularly within a short time and concluding within two weeks of sowing, and germinated easily without a need for pre-treatment prior to germination. *Moringa* seedlings also exhibited fast growth rates, and tolerated low contamination of soil with crude oil such as 4 and 8ml of crude per kg of soil. Death of seedlings was recorded at the highest levels of contamination such as 12 and 16ml/kg of soil in weeks 8 and 10 after planting.

Germination of *Moringa* seedlings were unaffected at all level of contaminations. Germination was regular within a short time and concluding within two weeks of sowing.

The performance of seedlings in terms of plant height decreased with increasing levels of contamination with time.

The study shows that crude oil addition to soil has a negative effect of reducing the growth of *M. oleifera* seedlings.

From the results obtained from this study, the following recommendations are hereby made:

1. *Moringa oleifera* should not be planted in soil with high concentration of crude oil.
2. Manure should be applied whenever *Moringa oleifera* is planted in soil with high concentrations of crude oil.
3. *Moringa oleifera* can be planted in soil with low levels of crude oil contamination.

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