Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.14, 2015

Comparative Study of Trace amount of Hydrocarbon in Polluted soil on Bean (*Vigna unguiculaga*) and Waterleaf (*Talimum triangulase*)

Florence Anem Aisueni Tari Hudson Ekiyor Barisi Samuel Felix
School of Applied Sciences, Rivers State Polytechnic, P.M.B. 20, Bori, Rivers State, Nigeria.

ABSTRACT

The effect and comparison of plants grown in polluted soil containing trace amount of hydrocarbon was investigated and the stem length, leaf length, leaf width, and germination were observed and measured in water leaf and bean plants. Loamy soils (3kg) were measured into a container and polluted with a 1:1 dilution of hydrocarbon (diesel) giving a 1M concentration. The same loamy soils were measured into another container which was not polluted. These crops planted on polluted soil were compared with the same crops planted on unpolluted soil in a container. Observation on growth and morphology were noted and recorded. Percentage germination in the bean crop in polluted and unpolluted soil was 67% and 100% respectively. Plant height, leaf width and leaf length of bean crop were measured in centimeters in polluted and unpolluted soil as 2.9, 1.0, 1.8 and 3.2, 1.5, 2.0 respectively. The same measurement and unit was done in water leaf plant in polluted and unpolluted soil which resulted in 2.1, 0.7, 1.0 and 2.5, 0.9 1.25 respectively. The percentage germination in water leaf plant was 67% in polluted soil as against 83% in unpolluted soil. From the data obtained, it was concluded that trace amount of hydrocarbon can affect plant germination and growth.

1.0 INTRODUCTION

The petroleum industry, (which includes the global processes of exploration, extraction, refining, transporting and marketing petroleum products), produces over 95% of the Nigeria's Gross Domestic Products (Onakoya, 2013), and as such, petroleum is used in almost every sector of Nigeria's economy. Crude oil and petroleum products are a major source of energy in Nigeria, and the world at large (Palmroth, 2006). Hydrocarbons are the major components of crude oil. This is because decomposed organic matter, the parent material of crude oil contains an abundance of carbon and hydrogen. Hydrocarbons can be solids/waxes (e.g. naphthalene), liquid (e.g. benzene), gases (e.g. methane), or polymers (e.g. polyethene) (Cerniglia& Sutherland, 2001). Hydrocarbon belongs to the family of organic compounds, composed entirely of carbon and hydrogen.

The petroleum industry has created economic boom for Nigeria and at the same time environmental and socio economic problems. Crude oil is extracted in locations that are remote and transported in large quantity, for it to be refined and for the derivation of its useful by-products. The transportation method employed includes the use of oceanic tankers and pipelines overland. These transportation methods sometimes pollute the environment by accidental oil spills and operational discharge resulting to the loss of very large quantities of crude oil into land and sea bodies. (Cerniglia& Sutherland, 2001).

Trace hydrocarbons-polluted soils are soils with low amount or content of hydrocarbons caused by spilled engine oil, oil leakages from farm planting machines or equipment, or treated crude oil spillage sites used in agriculture, automobile exhaust gas discharge, etc. This discharge of crude oil on land affects the physicochemical properties of the soil, thus causing deleterious effects on plant germination and growth (Rahbar *et al.,*2012). As a result of the increasing economic crisis and high dependence on important cash and leguminous crops such as beans for both the generation of income and meeting of human and animals need at large in Nigeria, there has to be a need to ascertain the effect of trace amount of hydrocarbon on crop germination and growth especially cash crops.

This research is based on the Khana Local government Communities, located in Rivers State, in the Niger Delta region of Nigeria. The main occupation known to the communities in this local government and its environs is farming. Based on their strategic location in an oil producing state, and also with civilization and development of the oil and gas sector, there is bound to be oil spillage, automobile exhaust gas, gas flaring etc. at one point or the other. All these petroleum products finding a way to settle in the soil in large or trace amounts can hinder the growth of crops (bean, water leaf, yam, corn, cassava, plantain etc.) which is the main source of feeding in these communities.

Two crops typically cultivated extensively in Khana local government and Nigeria at large will be examined and they include, Bean (*Vignaunguiculata*) and Water leaf *(Talinumtriangulare).* Bean (*Vignaunguiculata*) is thecommon name widely applied to many plants of the legume family (Chazan, 2000). The seeds and pods of these plants are used for food and forage. The seeds themselves are also called beans and are valuable as food because of their high protein content. The term 'bean' is also applied to plants of other families, such as the Indian bean, which is a North American specie, and the sacred bean or Indian lotus.

Water leaf *(Talinumtriangulare)* is an erect, glabrous perennial vegetable herb up to 80–100 cm tall, usually strongly branched; roots swollen and fleshy; stem succulent. Leaves alternate, simple, almost sessile, succulent; stipules absent; blade obovate to spatulate, 3–15 cm × 1–6 cm, base long-tapering, apex rounded to notched, mucronate, entire, venation pinnate, indistinct. Inflorescence a terminal cyme on a triangular stalk up to 12 cm long. Flowers bisexual, regular; pedicel 1 cm long, recurving in fruit; sepals 2, free, with 3 prominent veins; petals 5, free, obovate, up to 1 cm long, pink; stamens numerous; ovary superior, 1-celled, style slender, with 3-branched stigma exceeding stamens. Fruit a globose to ellipsoid capsule 4–7 mm long, 3-valved, elastically dehiscent, many-seeded (Opabode&Adebooye, 2005)

Soil polluted with petroleum hydrocarbons such as polycyclic aromatic reduces the microbiological life and organic matter of the soil. This reduction can lead to inhibited growth and even metabolic disorders for beans, water leaf and other plants of all species being grown in the soil (Adam & Duncan, 2002).

The broad bean (*Vignaunguiculata*) and water leaf (*Talinumtriangulare*) have both been cultivated since prehistoric times and are still the most common bean and vegetable in many parts of African and Nigeria. The cowpea, asparagus bean, and hyacinth bean are also cultivated, particularly for forage and water leaf (*Talinumtriangulare*) for vegetable nutrients.

The hydrocarbons usually cling to the surface and affect the texture of top soil. Additives and other chemicals attached to petroleum hydrocarbons from leaking farm machines and equipmentcan erode nutrients and minerals in the soil, affect porosity, displace oxygen levels and impact fertility of soil especially leguminous and vegetable plants like beans (*Vignaunguiculata*) and water leaf (*Talinumtriangulare*) that have their root just at the soil top level (Cairney & Meharg, 2002). Processes such as photosynthesis essential to plant growth are often incapacitated by hydrocarbon. Poor soil conditions as a result of the exhaustion of minerals and oxygen inhibit plant growth and cause malignant growth (Abu & Nwosu, 2009). When hydrocarbon products are dropped into the soil, it not only kills off microbial life but can also make the soil impassible for worms and other small organisms. This inactivity leads to a lack of aeration in the soil that can literally suffocate the soil until the affected area is little more than dust. Soil polluted in this way is unsuitable for any growth, and contaminated areas have taken years and specialized treatment to recover fertility. Because hydrocarbons reduce oxygen and mineral levels in the soil it makes it difficult for a seed to germinate. Likewise, car oil can suffocate the emerging seedling or radicle before it is able to take root.

This research is aimed at examining the effect of trace hydrocarbon polluted soil on the germination growth of beans (*Vignaunguiculata*) and water leaf (*Talinum triangulare*) comparing them to the growth rate of beans (*Vignaunguiculata*) and water leaf (*Talinumtriangulare*) on unpolluted soil.

2.0 MATERIAL AND METHOD

2.1 MATERIALS USED:

The materials and apparatus used in this research work are: Four (4) planting containers (custard bucket), seeds of bean (*Vignaunguiculata*), stem of water leaf *(Talinumtriangulare)*, trace amount of hydrocarbon (methanol + diesel), two (2) 250ml beakers, two measuring cylinders, soil (loamy soil), and weighing pan.

2.2 SAMPLE COLLECTION:

The seed beans (*Vignaunguiculata*) and stems of water leaf *(Talinumtriangulare)* were bought from Bori Market in Khana Local Government Area of River State. Unmeasured qualities of loamy soils were collected from arable farm area in Bori, Nigeria.

2.3 FIELD SELECTED AREA OF STUDY:

Field trail experiment was conducted at the Botanical garden of the Department of Science Laboratory Technology, River State Polytechnic Bori, Nigeria.

2.4 PREPARATION OF HYDROCARBON:

5ml of diesel was measured with a measuring cylinder and was transferred into 2 beakers each. Also 5ml of methanol was measured and transferred into the same 2ml beakers containing already measured 5ml of diesel to make it up to 10ml of trace amount of hydrocarbon. This was a 1:1 dilution of hydrocarbon (diesel).

2.5 TREATMENT OF SOIL SAMPLES:

The planting was done in 4 plastic containers (custard containers) each container was filled with 3kg of the collected loamy soil obtained from arable farm land area inBori.
The treatment of the soil was carried out by mixing already prepared 10ml of diesel and methanol trace hydrocarbon into two soil samples only in each of the plastic containers and was thoroughly mixed using hand gloves.

2.6 PROCEDURE FOR PLANTING:

Four (4) seeds of beans (*Vignaunguiculata*) were planted in one polluted soil sample and four (4) seeds of beans (*Vignaunguiculata*) were also planted in the other unpolluted soil sample. Four (4) stems of water leaf *(Talinumtriangulare)* were planted in the remaining polluted soil sample and four (4) stems of water leaf *(Talinumtriangulare)* in one of the unpolluted soil samples. All the four containers containing the planted seed and stems were then watered and allowed to grow. Contrast treating of number of seeds and stems that germinated from each planting containers were summed up after 7days, the percentage of germination of each polluted soil.

$$percentage = \frac{No\ of\ germinated\ seeds}{No\ of\ seed\ planted} \times 100 \qquad \text{Eq. 1}$$

2.7 DATA COLLECTION

Observation on growth and morphology were noted and recorded.
Percentage seed germination (germination), Plant height, Leaf area, Leaf length were obtained by measurement using a meter rule and the number of leaves, colour of leave were all observed visually and recorded accordingly.
The comparison of each plant was done based on the measured height, leaf, length leaf area, leaf width usingHoyt & Bradfield, (1962),Correlation For Co-efficient (R) with the formula:

$$LA = L \times W \times R \qquad \text{Eq. 2}$$

Where LA = Leaf of area
L = Leaf of length (height)
W = Leaf width
R = Correlation co-efficient (0.5)

The measurements and observations were done at an interval of one week for a period of three (3) weeks.

3.0 RESULTS AND DISCUSSION

3.1 RESULTS:

The results of the study on the effect of trace hydrocarbon on the germination and growth of beans (*Vignaunguiculata*) and water leaf *(Talinumtriangulare)* observed by percentage germination, plant height, nature of leaves, leaf length, leaf width and correlation leaf area for three (3) weeks are shown in the tables 1 below.

Table 1: shows the result of both beans and water leaf plants on unpolluted and polluted soil samples and their characteristics for week one.

S/NO	PARAMETERS	BEANS	BEANS	WATER LEAF	WATER LEAF
		UNPOLLUTEDSOIL	POLLUTED SOIL	UNPOLLUTEDSOIL	POLLUTED SOIL
1	% GERMINATION	100	67	83	67
2	PLANT HEIGHT (Cm)	3.2	2.9	2.5	2.1
3	NATURE OF LEAF	GREEN	GREEN	GREEN	GREEN
4	LEAF LENGTH (Cm)	2.02	1.80	1.25	1.0
5	LEAF WIDTH (Cm)	1.5	1.0	0.9	0.7
6	CORRELATION AREA (LXWXR) (Cm^2)	1.5	0.9	0.56	0.35

Table 2: shows the result of both beans and water leaf plants on unpolluted and polluted soil samples and their characteristics for week two.

S/NO	PARAMETERS	BEANS	BEANS	WATER LEAF	WATER LEAF
		UNPOLLUTEDSOIL	POLLUTED SOIL	UNPOLLUTEDSOIL	POLLUTED SOIL
1	PLANT HEIGHT (Cm)	14.3	10.2	3.4	2.9
2	NATURE OF LEAF	GREEN	GREEN	GREEN	GREEN
3	LEAF LENGTH (Cm)	2.6	2	1.5	1.1
4	LEAF WIDTH (Cm)	1.7	1.3	1.2	0.9
5	CORRELATION AREA (LXWXR) (Cm^2)	2.21	1.3	0.9	0.5

Table 3: shows the result of both beans and water leaf plants on unpolluted and polluted soil samples and their characteristics for week three.

S/NO	PARAMETERS	BEANS	BEANS	WATER LEAF	WATER LEAF
		UNPOLLUTEDSOIL	POLLUTED SOIL	UNPOLLUTEDSOIL	POLLUTED SOIL
1	PLANT HEIGHT (Cm)	32.3	27.8	5.2	5
2	NATURE OF LEAF	GREEN AND BROAD	YELLOW PATCHES AND SLENDER LEAVES	GREEN AND BROAD	DECOLOURATION OF LEAVES
3	LEAF LENGTH (Cm)	3.4	2.7	2.1	1.6
4	LEAF WIDTH (Cm)	2.3	1.8	1.2	0.9
5	CORRELATION AREA (LXWXR) (Cm^2)	3.91	2.43	1.26	0.72

3.1.1 BAR CHARTS SHOWING RESULTS OF MEASURED PARAMETERS IN POLLUTED AND UNPOLLUTED SOIL FOR BEANS PLANTS (*Vignaunguiculata*) FROM WEEK 1 TO WEEK 3.

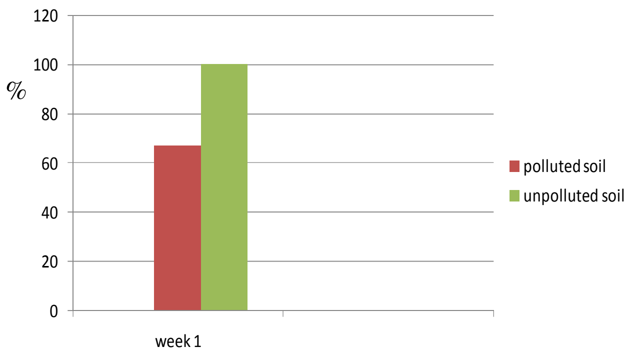

Fig 6: the percentage (%) germination rate of beans seeds in trace amount of hydrocarbon polluted soil and unpolluted soil for week one only.

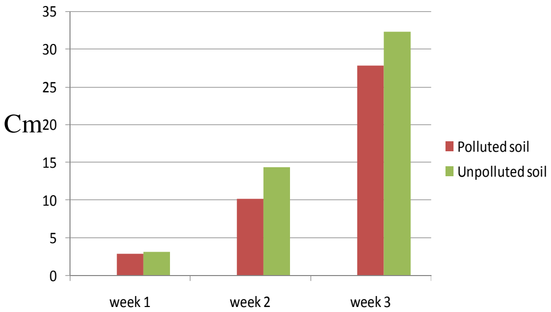

Fig 7: plant height of beans grown in polluted andunpolluted soil from week 1 to 3

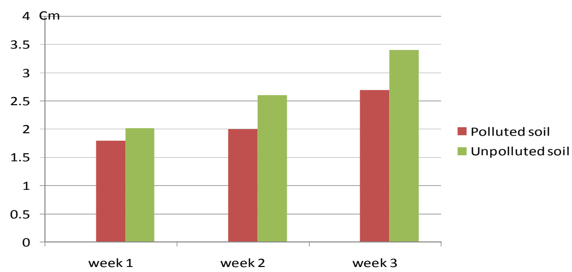

Fig 8: the leaf length of beans plants grown in polluted and unpolluted soil from week 1 to 3

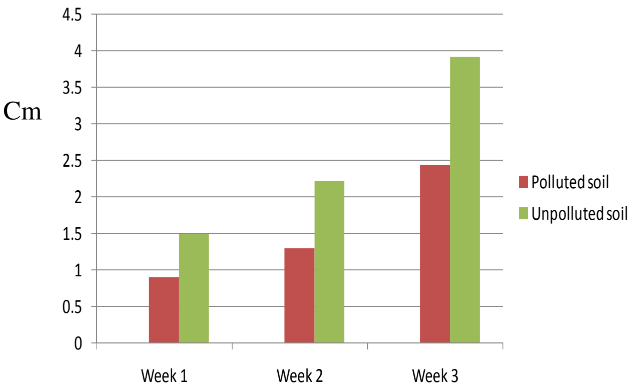

Fig 9: the leaf width of beans plants grown in polluted and unpolluted soil from week 1 to 3

Fig 10: The leaf correlation area (L x W x R) of beans plants grown in polluted and unpolluted soil from week 1 to 3

3.1.2 BAR CHARTS SHOWING RESULTS OF MEASURED PARAMETERS IN POLLUTED AND UNPOLLUTED SOIL FOR WATER LEAVE PLANTS (*Talinumtriangulare*) FROM WEEK ONE TO WEEK 3.

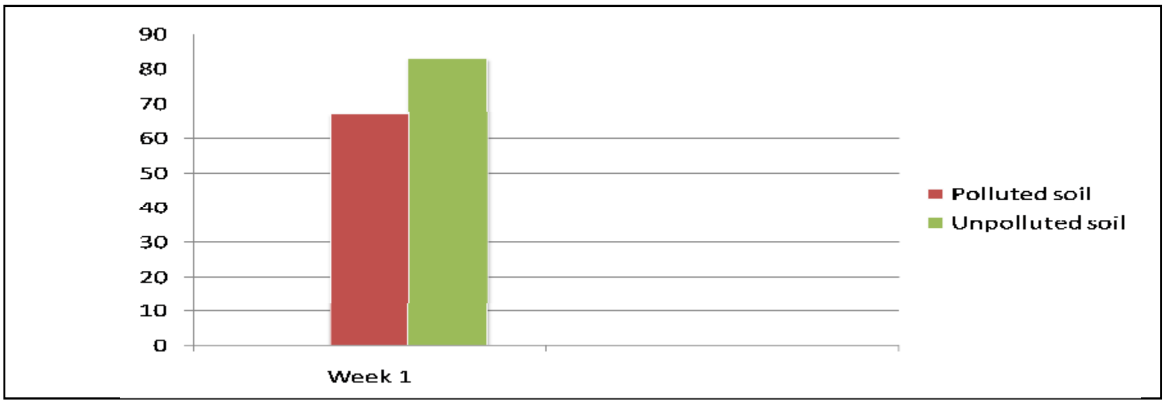

Fig 11: Percentage (%) germination rate of water leaf plants in trace amount of hydrocarbon polluted soil and unpolluted soil for week one only.

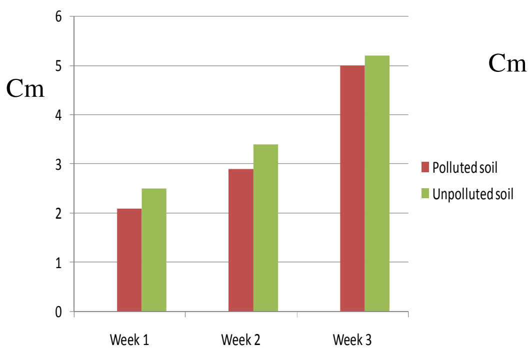

Fig 12: Plant height of water leave grown in polluted and unpolluted soil from week 1 to 3

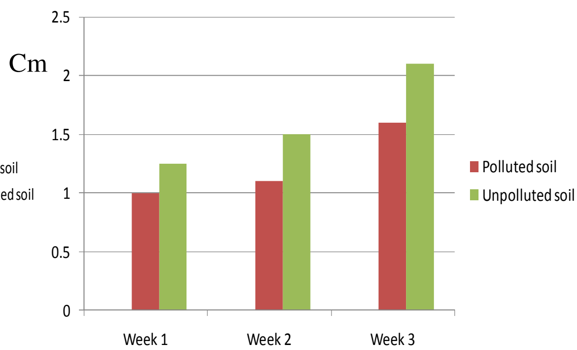

Fig 13: Leaf length of water leave plants grown in polluted and unpolluted soil from week 1 to 3

Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.14, 2015

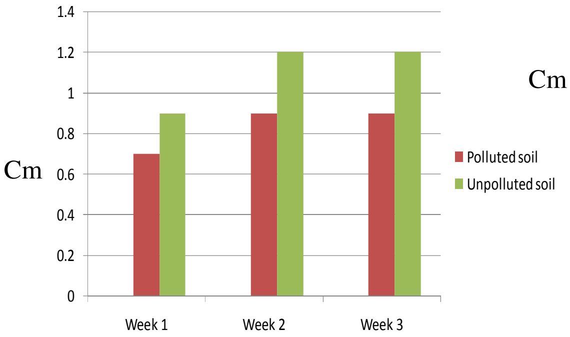

Fig 14: Leaf width of water leaf plants grown in polluted and unpolluted soil from week 1 to 3

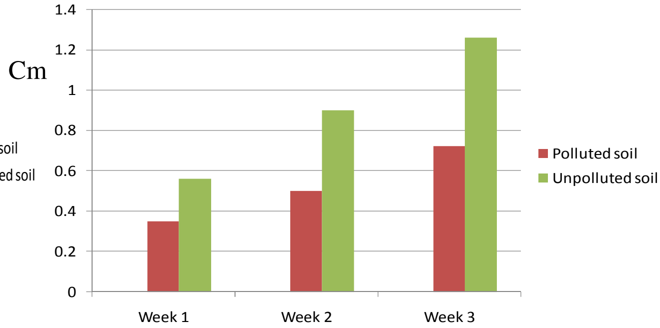

Fig 15: Leaf correlation area (L x W x R) of water leaf plants grown in polluted and unpolluted soil from week 1 to 3

3.2 DISCUSSION AND COMPARISON.

From the results in tables 1, 2 and 3, the growth different is shown in all aspects of comparison, both in plant height, nature of leaves, length of leaves, width of leaves and leaf area. The plants grown on unpolluted soil germinated with a higher percentage and grew faster, having broad leaves and ever green, week after week; but that of the polluted soil had low and delayed germination percentage.

Germination is the most important vegetative stage of plants, the germination rate standard for bean seed is two (2) days and that of water leaf is five (5) days (Chaineau *et al.,* 1997). Germination rate was observed in all the soils, but the germination rate decreased in the soil with trace amount of hydrocarbon which was in agreement with the findings of Njoku *et al.,* (2009). Decreasing germination might be due to reduced oxygen and moisture, poor accessibility to nutrient for plants, and increasing toxicity materials of petroleum compositions in soil. Delay in germination at concentration was in agreement with the findings of Kirk*et al.,* (2005) which reported that petroleum compositions provided a soft layer around the seed and prevented the plant from accessing oxygen and water. This led to delayed germination in the polluted soil caused by hydrocarbon. During seed germination, plants are particularly sensitive to environmental stress (Gulzar *et al.,* 2001). Chaineau *et al.,* (1997) suggested "a link between poor germination and subsequent poor growth of plants in hydrocarbon-contaminated soils". On the other hand, Li *et al*., (1997) remarked that "germination of seeds could be unaffected whereas growth is diminished significantly in hydrocarbon contaminated soils".

Tables 1, 2 and 3 presents the characteristics of plants growth in three weeks after the first week of germination. The growth of beans plant and water leave plants on the unpolluted soil had a high growth in leave area plant height, plant length, plant width and leaf area) whereasthe same plants grown in hydrocarbon polluted soil with 5ml of diesel and 5ml of methanol (1:1) had a poor growth which did not measure up to the parameters used in comparison (plant height, plant length, plant width and leaf area). Shirdam *et al.,* (2008) reported that "a little quantity of hydrocarbon or any petroleum product is enough to alter soil ecology leading to a drastic reduction of growth in any plant". Crude oil in soil makes that soil to become hydrophobic and this condition leads to dehydration in plants growing in the soil. This study showed that crude oil has resulted in contamination of soil and brought about waste of land, which diminished agricultural practices due to their toxic effects in the soil. Hence from the results obtained, farmers are advised to avoid any farm suspected to be polluted with hydrocarbon.

Based on the results obtained from all four tables, it was observed that the leaves were green and broad for all unpolluted soil for four weeks. The plants in polluted soil were green in the first two weeks but results from tables 2 and 3 indicate that these plants had yellow patches on them and began to fold gradually. This implies that the soil is not fertile enough for its growth, as the concentration of hydrocarbon found in such soil inhibited the nutrient and fertility of soil.

www.iiste.org

4.0 SUMMARY, CONCLUSION AND RECOMMENDATION

4.1 CONCLUSIONS:

In this study the effect and comparison of plants grown in trace amount of hydrocarbon was investigated on stem length, leaf length, leaf width, germination and leaf morphology of water leaf and bean plant. The results showed that the traced amount of hydrocarbon had a negative effect on germination and growth of the water leaf and bean plant. Germination and stem lengths decreased significantly in the soil polluted with hydrocarbon. The results of this study showed that the plants on unpolluted soil grew better than plants on polluted soil. Therefore trace amount of hydrocarbon can affect or hinder the proper growth of crops and therefore, a reduction in agricultural yield.

4.2 RECOMMENDATION.

Based on the findings, it is recommended that further studies on the effects of trace amount of hydrocarbon in the soil on the growth of beans (*Vignaunguiculata*) and water leaf *(Talinumtriangulare)* should be carried out on other plants of different varieties. Furthermore, the concentration of hydrocarbon should be put into consideration to know whether or not an increase or decrease in the quantity of hydrocarbon has the same or different effect on the growth of these plants. In addition, ways of reducing effects of trace amount of hydrocarbon in the soil on plants should also be carried out in other to improve agriculture in the affected farmland area.

References

Abu, T. A., & Nwosu, P. C. (2009). The effect of oil-spillage on the soil of Eleme in Rivers State of the Niger-Delta area of Nigeria. *Research Journal of environmental sciences*, *3*(3), 316-320.

Adam, G., & Duncan, H. J. (1999). Effect of diesel fuel on growth of selected plant species. *Environmental Geochemistry and Health*, *21*(4), 353-357.

Adam, G., & Duncan, H. (2002). Influence of diesel fuel on seed germination. *Environmental pollution*, *120*(2), 363-370.

Cairney, J. W., & Meharg, A. A. (2002). Interactions between ectomycorrhizal fungi and soil saprotrophs: implications for decomposition of organic matter in soils and degradation of organic pollutants in the rhizosphere. *Canadian Journal of Botany*, *80*(8), 803-809.

Cerniglia, C. E., & Sutherland, J. B. (2001, November). Bioremediation of polycyclic aromatic hydrocarbons by ligninolytic and non-ligninolytic fungi. In *BRITISH MYCOLOGICAL SOCIETY SYMPOSIUM SERIES* (Vol. 23, pp. 136-187).

Chaineau, C. H., Morel, J. L., & Oudot, J. (1997). Phytotoxicity and plant uptake of fuel oil hydrocarbons. *Journal of Environmental Quality*, *26*(6), 1478-1483.

Chazan, M., (2000). World Prehistory and Archaeology of cowpea: Pathways through Time. Pearson Education, Inc.

Gulzar, S., Khan, M. A., & Ungar, I. A. (2001). Effect of salinity and temperature on the germination of Urochondrasetulosa (Trin.) CE Hubbard. *Seed Science and Technology*, *29*(1), 21-30.

Hoyt, P., & Bradfield, R. (1962). Effect of varying leaf area by partial defoliation and plant density on dry matter production in corn. *Agronomy journal*, *54*(6), 523-525.

Kirk, J. L., Moutoglis, P., Klironomos, J., Lee, H., & Trevors, J. T. (2005). Toxicity of diesel fuel to germination, growth and colonization of Glomus intraradices in soil and in vitro transformed carrot root cultures. *Plant and soil*, *270*(1), 23-30.

Li, X., Feng, Y., & Sawatsky, N. (1997). Importance of soil-water relations in assessing the endpoint of bioremediated soils. *Plant and Soil*, *192*(2), 219-226.

Njoku, K. L., Akinola, M. O., & Taiwo, B. G. (2009). Effect of gasoline diesel fuel mixture on the germination and the growth of Vignaunguiculata (Cowpea). *African Journal of Environmental Science and Technology*, *3*(12).

Onakoya, A. B. (2013). Agriculture and intersectoral linkages and their contribution to Nigerian economic growth. *Economics*, *2*(5), 38-54.

Opabode, J. T., & Adebooye, O. C. (2005). Application of biotechnology for the improvement of Nigerian indigenous leaf vegetables. *Afr. J. Biotechnol*, *4*(3), 138-142.

Palmroth, M. (2006). Enhancement of in situ remediation of hydrocarbon contaminated soil. *Tampereenteknillinenyliopisto. Julkaisu-Tampere University of Technology. Publication; 595*.

Rahbar, F. G., Kiarostami, K., & Shirdam, R. (2012). Effects of petroleum hydrocarbons on growth, photosynthetic pigments and carbohydrate levels of sunflower. *J Food Agric Environ*, *10*(1), 773-776.

Shirdam, R., Zand, A. D., Bidhendi, G. N., & Mehrdadi, N. (2008). Phytoremediation of hydrocarbon-contaminated soils with emphasis on the effect of petroleum hydrocarbons on the growth of plant species. *Phytoprotection*, *89*(1), 21-29.