

GROWTH PERFORMANCE OF CUCUMBER (*CUCUMIS SATIVUS* L.) IN SPENT ENGINE OIL CONTAMINATED SOIL AMENDED WITH COMPOST OF *URENA LOBATA* L.

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ABSTRACT

Studies to investigate the growth performance of *Cucumis sativus* L. (variety Nandini 731 F1) in spent engine oil contaminated soil amended with compost of *Urena lobata* was investigated at the University of Port Harcourt Ecological Centre. The soil samples were polluted at four different concentrations, namely, 2%, 3%, 4% and 5% with spent engine oil and amended with decomposed *Urena lobata* at the rate of 0.25kg per 3kg of soil alongside a control (0%). The growth parameters examined were: plant height, number of leaves, leaf area, stem girth and sprouting percentage. The study showed that the control treated with compost gave the highest values for plant height 23.73cm, number of leaves 16.33, leaf area 84.73cm² and stem girth 2.2cm while the 5% contamination recorded the lowest values for plant height 1.83cm, number of leaves 1.33, leaf area 2.19cm² and stem girth 0.1cm. The number of leaves significantly ($P < 0.05$) decreased with increase in the concentrations of spent engine oil from 2% to 5%. The 0% + compost treatment recorded the highest number of leaves while the number of leaves for 0% alone was comparable to 2%, 3% treatments but higher than 5% treatments. The growth parameters decreased with increase in the levels of contamination, however the application of *Urena lobata* significantly increased the plant height, number of leaves, leaf area and stem girth at $P < 0.05$. This study suggests that compost of *Urena lobata* is an effective organic supplement for remediation of spent engine oil contaminated soil where *Cucumis sativus* is cultivated.

KEYWORDS: Growth, *Cucumis sativus*, *Urena lobata*, spent engine oil, contamination, Port Harcourt, Ecological centre

INTRODUCTION

Spent engine oil which is also known as used motor oil is produced when new engine oil (or motor oil) is subjected to high temperature and high mechanical strain. It is a brown-to-brown liquid mixture of heavy metal contaminants such as zinc, lead, and chromium that come from engine parts as they wear down, including low to high molecular weight (C₁₅ to C₁₈) aliphatic and aromatic hydrocarbons, polychlorinated biphenyls, chlorodibenzofurans, lubricating additives and decomposition products (Wang *et al.*, 2000). There are improper disposals of spent engine oil during manual oil changing operation which is not recycled but spilled and dumped by automobile and generator mechanics into runoff, gutters and open vacant plots, thereby polluting both soil and water (Anoliefo *et al.*, 2000). In addition, the oil is also released into the environment from exhaust system during engine use and due to engine leaks (Osubor *et al.*, 2003). In Nigeria and some other developing countries about 20 million gallons of spent engine oil are generated annually from mechanic workshops and discharged carelessly in the environment (Faboya, 1997). It is a common and toxic environmental

contaminant not naturally found in the environment (Dominguez-Rosado and Pitchel, 2004).

Soil is a key component of natural ecosystems because environment sustainability depends largely on a sustainable soil ecosystem (Adriano *et al.*, 1998). When soil is polluted, the ecosystem is altered, and agricultural activities are affected. Contamination of soil by used lubricating oil is rapidly increasing due to global increase in the usage of petroleum products (Mandri and Lin 2007).

Environmental pollution with petroleum and petrochemical products has attracted much attention in recent decades. The presence of different types of automobiles and machinery has resulted in increase in the use of lubricating oil. Spillage of used motor oils such as diesel or jet fuel contaminates our natural environment with hydrocarbon (Hussain *et al.*, 2008).

Contamination of the soil by spent engine oil creates an unsatisfactory condition for life in the soil, which is due to the poor aeration it causes in the soil, immobilization of soil nutrients, loss of water-holding capacity, lowering of soil pH, and reduction in soil catalase enzyme activity (Sathiya-Moorth *et al.*, 2008), as well as inhibitory effects on the nitrate reductase activities of plants (Odjegba and Atebe 2007).

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According to Udo and Fayemi (1975) growth of plants in oil polluted soil was generally retarded and chlorosis of leaves results, coupled with dehydration of the plants indicating water deficiency. High oil concentrations in soil not only reduce the amount of water and oxygen available for plant growth (McGill, 1980) but also can interfere with soil-plant-water relations through direct physical contact, (coating of root tissues) thereby adversely affecting plant growth (Baker, 1971).

Urena lobata is an annual in sub tropic and perennial in the tropics. It is a dicotyledonous weed which belongs to the family Malvaceae. Cucumber (*Cucumis sativus* L.) belongs to the Cucurbitaceae family. It is a creeping vine that roots in the ground. The plant has large leaves that form a canopy over the fruit. The fruit of the cucumber is roughly cylindrical, elongated with tapered ends, and may be as large as 60 centimeters (24in) long and 10 centimeter (3.9in) in diameter. Cucumbers are commonly harvested while still green. They can be eaten raw or cooked, or pickled. The seeds are edible and the thin skin does not require peeling (Herbst 2001).

This study was conducted to evaluate the growth performance of *Cucumis sativus* in spent engine oil contaminated soil amended with compost of *Urena lobata*.

MATERIALS AND METHODS

Source of Materials:

The experiment was carried out at the University of Port Harcourt Ecological Centre. Soil samples sourced from a site at the University of Port Harcourt were used for the study. The seeds of Cucumber (*Cucumis sativus* Nandini 731 F1 variety) were obtained from Songhai Rivers Development Initiative (SRDI) Bunu/Tai Local Government Area in Rivers State. Perforated nursery bags were bought from Choba, while the spent engine oil was sourced from a mechanic workshop in Rukpokwu Town, Obio/Akpor Local Government Area of Rivers State.

Contamination of Soil:

A 3x5 factorial arrangement fitted into completely randomized design were used, each treatment were replicated three times. Top loamy soil weighing 3kg for each bag was used. The soil was mixed thoroughly with different levels of spent engine oil namely, 0%, 2.0%, 3.0%, 4.0% and 5.0% v/w and placed in perforated nursery bags labelled based on each treatment. The bags were perforated at the bases and sides to allow for aeration and drainage. The bags were kept for one week for the oil to acclimatize to the soil before the commencement of the remediation study.

Treatment with amendment:

The compost of *Urena lobata* was used to ameliorate the spent engine oil contaminated soil. The remediation treatment was carried out by adding 0.5kg of each ameliorating materials to different levels of pollution (2%, 3%, 4%, and 5%) in 3kg of soil and were thoroughly mixed before being transferred into the nursery bags.

Germination Procedures:

After the decomposition of *Urena lobata* compost, 4 seeds of *Cucumis sativus* were sown. 2-3 days after planting the seeds sprouted and at one week after planting, the seedlings of *Cucumis sativus* were thinned down to two seedlings and the percentage sprouting for each remediation treatment was calculated as:

$$\text{Percentage germination} = \frac{\text{No. of germinated seeds}}{\text{No. of seeds sown}} \times 100$$

Growth and biochemical parameters:

The following growth and biochemical parameters were analyzed: plant height (cm), leaf number, stem girth, leaf area, pH and heavy metals.

The plant height was measured with a metre tape in centimetres from the soil surface to the plant apex. The leaves of the plant of the various treatments were counted visually. The number obtained was then recorded appropriately against each sample. The stem girth was determined using thread to encircle the circumference of the stem at 2cm above soil level. The thread was then measured on 10cm ruler and length covered recorded as stem girth.

Leaf area was determined by measuring the length and breadth of the leaf and correction factor of 0.75 was used to multiply the length and breadth measurement following the procedure of Agbogidi and Eshgebeyi (2006). The leaves of the test crop were rinsed with distilled water and dried. The dried plant materials of each sample were macerated into powdered form using pestle and mortar. The powder form was sieved through a 0.2mm wire mesh to obtain fine powdered form. Each sample of the powdered materials was kept in small bottles for analysis.

Statistical Data Evaluation:

Data collected for each parameter were subjected to analysis of variance (ANOVA) using Microsoft Excel 2010 version. Means were compared using the least significant Difference (LSD) (Steel and Torrie, 1960).

RESULTS

The pH of the spent engine oil and elemental components are presented in Table 1.

Table 1: Physicochemical Properties of experimental Spent engine oil (mg/kg)

Parameters	Values
Ph	6.10
Pb(mg/kg)	6.0
Ni (mg/kg)	2.6
Cu (mg/kg)	10.30
Zn (mg/kg)	178.15
Fe (mg/kg)	851.6

The plant height of *Cucumis sativus* significantly ($P < 0.05$) decreased with increase in contamination levels of spent engine oil. The soil amended with *Urena lobata* without contamination recorded the highest value (Fig.1).

The number of leaves significantly ($P < 0.05$) decreased with increase in the concentrations of spent engine oil from 2% to 5%. The 0% + compost treatment recorded the highest number of leaves while the number of leaves for 0% alone was comparable to 2%, 3% treatments but higher than 5% treatments. (Fig.1).

The highest value of stem girth was recorded in 2% and 3% spent engine oil amended soils. The stem girth decreased with increase in spent engine oil contamination levels (Fig.1). The control amended with *Urena lobata* recorded the highest value than the control without amendment.

The leaf area significantly ($P < 0.05$) decreased with increase in the contamination levels of spent engine oil. The soil amended with *Urena lobata* without contamination recorded the highest value (Fig.1).

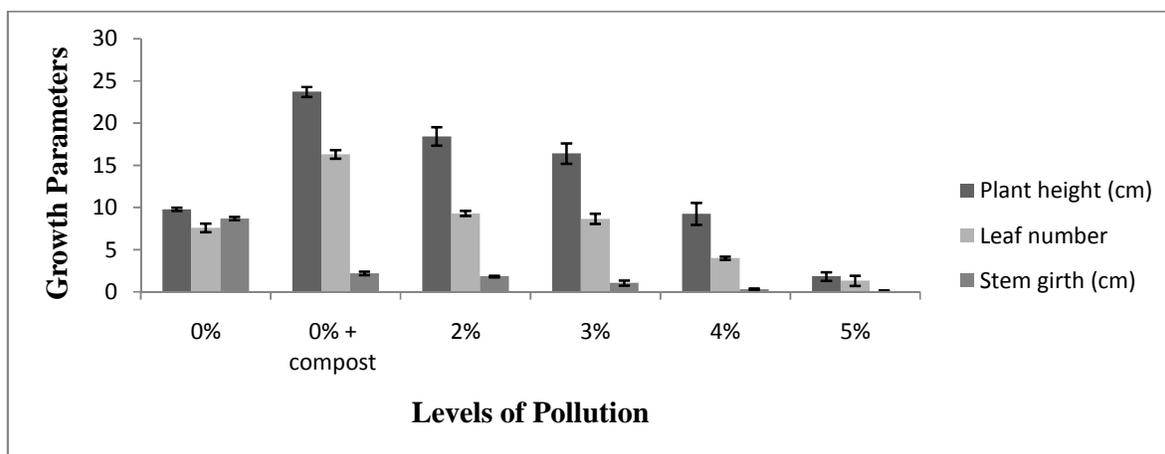


Fig.1: Mean Plant height (cm), Leaf number and Stem girth (cm) of *Cucumis sativus* at 4 weeks after planting.

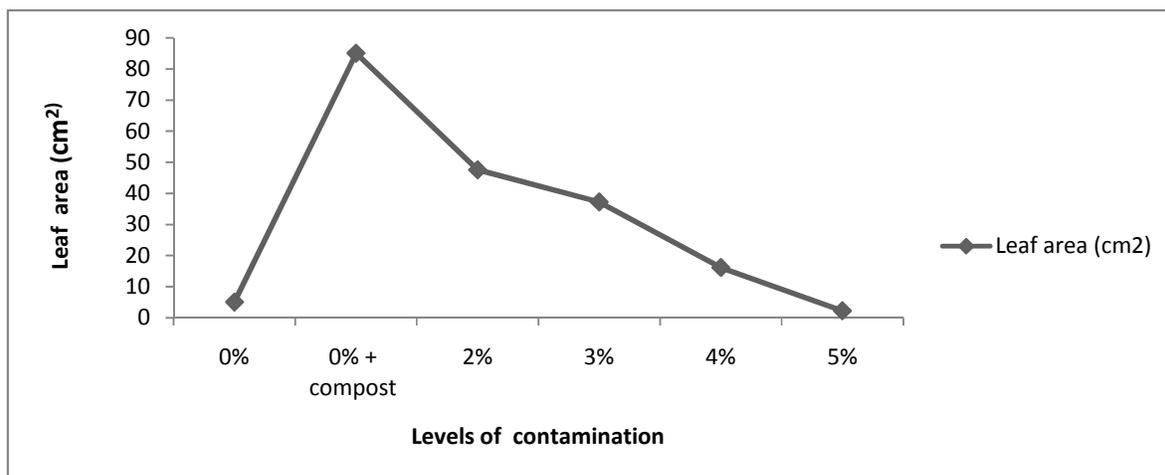


Fig. 2: Mean Leaf area of *Cucumus sativus* at 4 weeks after planting

DISCUSSION

The incorporation of *Urena lobata* to spent engine oil contaminated soil at lower concentration significantly improved the growth of *Cucumis sativus*. This study shows that *Urena lobata* is helpful in improving soil fertility and reducing the toxicity of the spent engine oil on plants. The potentials of similar vegetative components of plant have previously been reported by (Chen and Lee, 1997, Akonye and Onwudiwe, 2004). As a means of remediating soils polluted with petroleum derivatives or crude oil, soil amendments such as sawdust, peat, waste cotton and organic manures are added to soil (Tanee and Akonye, 2009). A soil amendment increases the ability of the soil matrix to supply biologically available water and nutrients to microorganisms that are capable of degrading the target compounds (Davis and Wilson, 2005). The reduced plant height of *Cucumis sativus* in spent engine oil contaminations may be attributed to the stress imposed by artificially created drought conditions as well as the spent engine oil exposition suffered by plant roots due to the root inability to get sufficient water and nutrient from the soil (Unegbu *et al.* 2012). Post oil spill rehabilitation measures are designed to enhance soil recovery and crop improvement. The use of remediation practices that will stimulate and enhance the proliferation of microbial population for enhanced degradation of spent engine oil pollutants is desirable (Lei *et al.* 2005). Therefore the use of *Urena lobata* as indicated in this study was a contributing factor in the growth of *Cucumis sativus* in amended soils.

CONCLUSION

This study showed that the compost *Urena lobata* remediated the soil contaminated with spent engine oil by improving the growth performance of the crop and reducing the toxicity of the metals. Therefore the use of compost will enhance and improve spent engine oil contaminated soil especially where *Cucumis sativus* is cultivated.

REFERENCES

- Adriano, D. C., Chlopecka, A and Kaplan, K. I., 1998. Role of soil chemistry in soil remediation and ecosystem conservation. *Soil Sci. Soc. Am. Spec. Public.* pp. 361-386.
- Agbogidi, O. M and Eshegbeyi, O. F., 2006. Performance of *Dacryodes edulis* (Don. G. Lam H.J.) seeds and seedlings in a crude oil contaminated soil. *Journal of Sustainable Forestry*, 22(3/4): 1-14.
- Akonye, L. A and Onwudiwe, I. O., 2004. Potential for use of sawdust and leaves of *Chromolaena odorata* in the mitigation of Crude Oil toxicity. *Niger Delta Biologia* 4(2): 50 – 60.
- Anoliefo, G. O and Edegbai, B. O., 2000. Effect of Spent Lubricating Oil as a Soil Contaminant on the Growth of Two Egg Plant Species *Solanum melongena* L. and *Solanum incanum* L. *J. Agric. For. Fish.* 1: 21-25.
- Baker, J. M., 1971. Seasonal effects of oil pollution on salt marsh vegetation. *Oikos* 22:106-110.
- Brandt, R., Merkl, N., Schultze-kranft, R., Infante, C and Broll, G., 2006. Potential of vetiver (*Vetiveria zizanioides* L. Nash) for phytoremediation of petroleum hydrocarbon- contaminated soils in Venezuela. *International Journal of phytoremediation*.8:273-284.
- Chen, Z. S and Lee, D. Y., 1997. Evaluation of Remediation Techniques on two Cadmium polluted soil contaminated with metals. *North Word U.K.*1:209-223.
- Bong, P. S., Reudert, G and Hahn, H. H., 1996. Ecological due to Spent Engine Oil (SEO) application. This Effects of combined organic and inorganic pollution on soil microbial activities. *Water, Air, Soil Pollution*.(2007). 96:133-143.
- Daniel-Kalio, L. A and Pepple, S. F., 2006. Effect of bonny light crude oil pollution of soil on the growth of day flower (*Commelina bengalensis*) in the Niger Delta, Nigeria *Journal. Of Applied Science and Environmental Management*.10:111-114.
- Davis, J. G and Wilson, C. R., 2005. Choosing a soil Amendment. *Colorado State University Cooperative extension. Horticulture* 7:23.
- Dominguez-Rosado, R. E and Pichtel, D., 2004. Phytoremediation of contaminated with used motor oil. 1. Enhanced microbial activities from laboratory and growth chamber studies. *Environ. Eng. Sci.*, 2, 157-168
- Ekundayo, E. O and Obuekwe, C. A., 1997. Effects of oil spill on soil physico- chemical properties of a spill site in a typical paled of Mid western Nigeria. *Environmental Monitoring and Assessment* 45:209-221.
- Faboya, O., 1997. "Industrial pollution and waste management", In Osuntokun, A. (ed.), *Dimensions of Environmental Problems in Nigeria*, Ibadan Davidson Press, Nigeria, pp. 26 -35
- Fernandes, J. C and Henriques, F. S., 1991. Biochemical, physiological and structural effects of excess copper in plants. *The Botanical Review*, 57: 246 -273.
- Giddens, J., 1980. Spent motor oil effects on soil and crops. *Journal of Environmental Quality*. 5:179-181.
- Herbst, S. T., 2001. *The New Food Lover's Companion: Comprehensive Definitions of Nearly 6,000*

- Food, Drink, and Culinary Terms. Barron's Cooking Guide. Hauppauge, NY: Barron's Educational Series.
- Hussain, A. I., Anwar, F., Sherazi, S. T. H and Przybylski, R., 2008. Chemical composition. Antioxidant and antimicrobial activities of basil (*Ocimum basilicum*) essential oils depends on seasonal variations. *Food Chemistry*, 108: 986-995.
- Lei, L., Amadi, P., Khodadoust, Makam, T. S and Tabak, H. H., 2005. Biodegradation of sediment-bound PAHs in field contaminated sediments. *Water Research*, 39:349-361.
- Malallah, G., Afzal, M., Kurian, M., Gulshan, S and Dhami, M. S. I., 1998. Impact of oil pollution on some desert plants. *Environ. Int.* 24: 919-924
- Mandril, T and Lin, J., 2007. Isolation and characterization of engine oil Degrading indigenous compounds, pp. 23-27
- McGill, W. B., 1980. Factors affecting oil degradation rates in soils in: Disposal of industrial and oily sludges by land cultivation, In D. M. Shilesky (ed), Resource Systems and Management Association, Northfield, New Jersey, pp. 103-122.
- Odjegba, V. J and Sadiq., 2002. Effect of Spent Oil on the growth parameters, chlorophyll and proteins levels of *Amaranthus hybridus*, L. *The Environmentalist*. 22: 23-28.
- Odjegba, V. J and Atebe, J. O., 2007. The effects of used engine oil on carbohydrate, mineral content and nitrate reductase activity of leafy vegetable (*Amaranthus hybridus* L) *Journal of Applied science and Environmental Management*. 11(2), 191-196.
- Osubor, C. C and Anoliefo, G. O., 2003. Inhibitory effects of spent lubricating oil on the growth and respiratory functions of *Arachis hypogea* L. *Benin Science Digital*, 1:7379.
- Sharifi, M., Sadeghi, Y and Akbarpour, M., 2007. Germination and growth of six plant species on contaminated soil with spent oil. *International Journal of Environmental Science Technology*, 4(4): 463-470.
- Sathiya-Moorthi, P., Deecaraman, M and Kalaichelvan, P. T., 2008. Bioremediation of automobile oil effluent by *Pseudomonas* Sp. *Advanced Biotechnology*. 31:34-37.
- Steel, R. G. D and Torrie, J. H., 1960. Principle and Procedures of Statistics. McGraw-Hill Book Company Inc. New York. PP 480
- Tanee, F. B. G and Akonye, L. A., 2009. Effectiveness of *Vigna unguiculata* as a phytoremediation plant in the remediation of crude oil polluted soil for cassava (*Manihot esculenta*; Crantz) cultivation. *Global Journal of Pure and applied sciences*. PP 43-47.
- Udo, E. J and Fayemi, A. A. A., 1975. The effect of oil pollution on soil germination, growth and nutrient uptake of corn. *Journal of Environmental Quality* 4: 537- 540.
- Unegbu, F. O., Akubugwo, E. I., Iweala, E. J and Uhegbu, O. C., 2012. Impact of spent engine oil on soil and the growth of Zea mays L. seeds. *Scient. J. Environ. Sci.*1(1):1-8.
- Vanlooche, R., DeBorger, R., Voets, J. P and Verstraete, W., 1975. Soil and groundwater Contamination by oil spills; problems and remedies. *International Journal of Environmental Studies*. 8:99-111
- Vwioko, D. E., Anoliefo, G. O and Fashemi, S. D., 2006. Metals concentration in plant tissues of *Ricinus communis* L. (Castor oil) grown in soil contaminated with spent lubricant oil. *Journal of Applied Science and Environmental Management*. 10:127-134.
- Wang, J., Jia, C. R. Wong, C. K and Wong., 2000. Characterization of polycyclic aromatic hydrocarbon created in lubricating oils. *Water Air Soil Pollution*.pp120, 381-396.
- Watts, J. R., Corey, J. C and Mcleod, K. W., 1982. Land application studies of industrial waste soils. *Environmental Pollution*. 28:165-175.
- Wyszkowski, M., Wyszkowska, S and Ziochowska, A., 2004. Concentration of heavy metal in the polluted soil. Effect of soil contamination with diesel oil on recommended that due to adverse effect of spent engine oil yellow lupine, field and macro elements content. *Plant Soil Environment* 50(5): 218-226.