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Modeling growth response of *Cucumis sativus* L. growing under spent engine oil contamination stress in an Ultisol

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Abstract
A pot experiment was set up to investigate the effects of spent engine oil (SEO) soil on plant growth parameters of *Cucumis sativus*. This was laid out in a randomized complete block design with three replications. Soils were contaminated with different levels of spent engine oil (0ml = control, 20ml, 50ml and 100ml) while growth parameters (leaves number, shoot length and internode) were determined at 14 days after planting (DAP) at an interval of 7 days for four consecutive rounds. The results confirmed that the contaminant significantly reduced the growth of studied plant. Correlation analysis indicated that spent engine oil contamination was responsible for 88.2% reduction in the shoot length, 96.5% reduction in leaf number and 91.6% reduction in internodes. Also, polynomial regression analysis enhanced the derivation of time-dependent models predicting the variation in growth parameters as a function of contaminant concentrations. These models retained high accuracy of predictions (with R^2 values ranging from 0.551 – 0.999). From this study, evidences abound that the growth reducing effects of spent engine oil may be predicted using biometric techniques. Knowledge from such predictions may be useful for better understanding of the effects of different levels of contamination / pollution on crops and may be incorporated for the betterment of remediation of the effects of petroleum-based contaminants on this and other crops.

Keywords: Spent engine oil, biometry, model, growth, *Cucumis,* DAP

1. Introduction

Engine oil is a non-volatile liquid and lubricant important in the maintenance of automobile, motorcycles, heavy duty earth moving equipment and other internal combustion engines. This oil is drained periodically (maybe two weeks or more) from the engine or machines during routine maintenance. The oil drained in this process is known as spent engine oil (Anoliefo and Vwioko, 1995) [4].

Poor disposal of spent engine oil is a serious problem which affects different biotic components (plants, animals and microbes) as well as abiotic members or processes in the environment. The problem of poor disposal of spent engine oil is far more common and wide spread than crude oil spillage since there are several automobile technicians and machine repairers who dumped this oil waste into neigbouring farmlands, roads, runoffs, drainage constructions and sometimes directly into water bodies without caution (Osubor and Anoliefo, 2003; Odjegba and Sadiq, 2002) [18, 13].

Most often than not, spent engine oil is discarded directly on farmlands or it is being carried through rain water where it spreads and then seeps into the soil. Soil remains the outermost layer of the earth crust which supports plant growth. Hence contamination of soil by spent engine oil or other petroleum products/waste creates a derogatory impact on soil quality thus affecting growth and metabolic activities of plants and other soil depending organisms (Odiegba and Atebe, 2017) [12].

Cucumis sativus (cucumber) is a member of the cucurbitaceae family. It is a creeping vine which possesses large leaves that forms canopy over its fruits. Cucumber fruits may either be cylindrical, curvy or elongated in shape with roughly flat ends with a diameter of about 8 to 10 cm and is widely cultivated in different parts of Nigeria (Herbst, 2001) [7].

Several authors have reported the effects of petroleum products / waste on growth and other parameters of common food crops including fluted pumpkin (Onwusiri, *et al.*., 2017) [17] groundnut (Osubor and Anoliefo, 2003) [18], Maize (Okonokhua, *et al*.., 2007) [16], tomatoe and pepper (Anoliefo and Vwioko, 1995) [4], okra (Okon and Mbong, 2013) [14] and Spinnach (Odjegba, and Sadiq, 2002) [13]. Specifically, Eremrena and Mensah (2017) [6] have reported the growth performance of cucumber in spent engine oil contaminated soil amended with compost of *Urena lobata*.

The application of relevant statistical techniques to biological data with a view to solving specific problem is biometry. However, till present no research has been carried to predict the dynamics of *Cucumis sativa* growing in spent engine oil contaminated soils in Nigeria. Hence this study aims at bridging such empirical gaps by deriving quantitative models capable of predicting the effects of varied levels of spent engine oil contamination of soil on plants growth using *C. sativus* as a test crop. Such knowledge may be needed for the identification of cost effective and practical techniques of predicting the adverse effects of spent engine oil or other contaminants on our crops. Furthermore, this research finding may serve to educate our farmers, automobile mechanics and the public in general on the harm associated with poor disposal of spent engine oil or other petroleum derivatives.

2. Materials and Methods

2.1 Study Area

This study was carried out in Heritage Polytechnic Botanical Garden (Latitude 04:39:26.028; Longitude 07:58:30.871), Ikot Udota village, Eket Local Government Area, Akwa Ibom State, Nigeria. Eket situates at the south-central portion of the State and is bounded on the North by Nsit Ubium Local Government Area, on the West by Onna Local Government Area and on the South by Ibeno Local Government Area. The major occupation of the people comprises of farmers, artisan and fishermen (AKSG, 2008) [3].

2.2 Source of Materials / Contamination of Soil

Matured dry seeds of *Cucumis sativus* were obtained from Fiong etuk Market in Eket L. G. A. 10 liters of spent engine oil was obtained from an automobile technician workshop in Ikot Udota village, Eket L.G.A. The soil was obtained from Heritage Polytechnic Botanical Garden, Ikot Udota village, Eket, Akwa Ibom State through repeated coring at a depth of 0-15cm by means of soil auger.

Four kilogram's (4kg) of loamy soil was weighed using Mettler (P.165) weighed balance into five (5) perforated plastic pots measuring 38cm in width and 40cm in height, the perforation enhanced drainage. Each soil samples were thoroughly mixed with 0ml (control), 20ml, 50ml and 100ml of used engine oil and allowed for three days according to the methods of Okon and Mbong (2013) [14].

2.3 Planting and Determination of growth parameters

Three viable dry seeds of *Cucumis sativus* were sown directly into perforated pot half-filled with loamy soil at the depth of about 3cm. The experimental set up was exposed to normal field conditions. Growth parameters (shoot length, leaf number and internodes) were measured using measuring tape or visual counting after 14 days of planting at an interval of 7 days for 4 rounds.

2.4 Statistical analysis

The results were expressed as mean + Standard Error (S.E) of the three replicates of each treatment. Significant difference between the treatments was determined by two-way Analysis of variance (ANOVA). $P<0.05$ was considered statistically significant. Karl Pearson Product Moment Correlation analysis was applied to assess the level of association existing between concentration of contaminants and the growth indices using statistical package for Social Science (SPSS) while polynomial regression modeling was employed to predict the effect of spent engine oil contamination on different growth indices of the plant using Microsoft Excel Spreadsheet.

3. Result

3.1 Effects of Spent engine oil contamination of soil on Shoot length (cm) in *C. sativa*

The result of this study shows that at 14, 21, 28 and 36 DAP (Days After Planting), the control (0ml of spent engine oil) has the highest mean value of 13.3 ± 1.13, 23.25 ± 0.35, 25.68 ± 0.49 and 28.40 ± 0.14 for shoot length respectively, followed by the soil contaminated with 20ml of spent engine (9.70 ± 0.28, 20.40 ± 0.84, 22.30 ± 0.94 and 23.75 ± 2.33) and the least mean value was recorded for the soil contaminated with 100 ml of spent engine oil (5.20 ± 0.42, 3.75 ± 0.35, 6.65 ± 0.35 and 7.05 ± 0.21) as shown in Table 1.

Table 1: Effects of Spent engine oil contamination of soil on Shoot length (cm) in *C. sativa*

Treatment	14 DAP	21 DAP	28 DAP	35 DAP
SEO (100ml)	5.20 ± 0.42	5.75 ± 0.35	6.65 ± 0.35	7.05 ± 0.21
SEO (50ml)	5.55 ± 0.35	6.10 ± 0.28	6.70 ± 0.14	7.05 ± 0.35
SEO (20ml)	9.70 ± 0.28	20.40 ± 0.48	22.30 ± 0.94	23.75 ± 2.33
SEO (0ml)	13.3 ± 1.13	23.25 ± 0.35	25.65 ± 0.49	28.40 ± 0.14

3.2 Effects of Spent engine oil contamination of soil on Leaves number in *C. sativa.*

At 14, 21, 28 and 35 DAP, the control (0ml of spent engine oil) has the highest mean value (4.5 ± 0.70, 5.75 ± 1.06, 7.0 ± 0.70 and 7.5 ± 0.70) for number of leaves followed by the soil that was contaminated with 20ml of spent engine oil (5.25 ± 0.35, 6.0 ± 0.70, 6.0 ± 0.70 and 6.5 ± 0.70). The least mean value was recorded for soil that was contaminated with 100ml of spend engine oil which (3.5 ± 0.70, 3.5 ± 0.70, 3.3 ± 0.70 and 3.5 ± 0.70) as shown in table 2.

Table 2: Effects of Spent engine oil contamination of soil on Leaves number in *C. sativa.*

Treatment	14 DAP	21 DAP	28 DAP	35 DAP
SEO (100ml)	3.50 ± 0.70	3.50 ± 0.70	3.50 ± 0.70	3.50 ± 0.20
SEO (50ml)	3.50 ± 0.70	4.00 ± 0.00	4.25 ± 0.35	4.50 ± 0.70
SEO (20ml)	5.25 ± 0.35	6.00 ± 0.70	6.00 ± 0.70	6.50 ± 0.60
SEO (0ml)	4.50 ± 0.70	5.75 ± 1.06	7.00 ± 0.00	7.50 ± 0.50

3.3 Effects of Spent engine oil contamination of soil on internode length (cm) in *C. sativa*

At 14, 21, 28 and 35 DAP, the control (0ml of spent engine oil) has the highest mean value (2.6± 0.70, 3.55±0.70, 3.6±0.14 and 3.80±0.14) for internodes followed by the soil contaminated with 20ml of spent engine oil (2.65±0.21, 2.80±0.14, 3.0±0.14 and 3.20±0.14). The least mean value (1.40 ± 0.14, 1.40 ± 0.14, 1.50 ± 0.07 and 1.60 ± 0.14) was recorded for the soil contaminated with 100ml of spent engine as shown in table 3.

Table 3: Effects of Spent engine oil contamination of soil on internode length (cm) in *C. sativa*

Treatment	14 DAP	21 DAP	28 DAP	35 DAP
SEO (100ml)	1.40 ± 0.14	1.40 ± 0.14	1.50 ± 0.07	1.60 ± 0.05
SEO (50ml)	1.45 ± 0.70	1.45 ± 0.70	1.75 ± 0.70	1.80 ± 0.14
SEO (20ml)	2.65 ± 0.21	2.80 ± 0.14	3.00 ± 0.14	3.20 ± 0.01
SEO (0ml)	2.60 ± 0.70	3.55 ± 0.70	3.00 ± 0.14	3.80 ± 0.14

3.4 Correlation Matrix Showing the Relationship between Plant Growth Parameters at 35 DAP with Spent Engine Oil (SEO) Contamination: The relationship between the plant's growth indices and the contaminant level is shown in the correlation matrix below (Table 4). It reveals that the concentration of the contaminant revealed negative correlation coefficients with shoot length (-0.882), leaf number (-0.965) and internode (-0.916).

Table 4: Correlation Matrix Showing the Relationship between Plant Growth Parameters at 35 DAP with Spent Engine Oil (SEO) Contamination

	Shoot length	Leaf number	Internode	SEO Concentration
Shoot length	1			
Leaf number	0.973*	1		
Internode	0.995**	0.989*	1	
SEO Concentration	-0.882	-0.965*	-0.916	1

3.5 Polynomial Regression models evaluating the effects of contaminant on different growth parameters of *C sativus.*

Table 5 bears evidence of evaluation models which have been derived from plant growth indices per time which predict the growth parameters (y or predicted variable) of test plant as affected by contaminants concentration (x or predictor variable). The accuracy of the prediction models is adjudged as being quite reliable since the R^2 coefficients mostly exceed 0.7. Table 6 bears the comparison of the actual and predicted numerical values recorded for changes in growth characteristic of test plant in relation to contamination gradient using the derived models presented in Table 5.

Table 5: Polynomial Regression models evaluating the effects of contaminant on different growth parameters of *C sativus.*

	Parameter	Models	R^2
14 DAP	Shoot length	$y= 0.0014x^2-0.2261x+13.413$	0.9979
	Leaf Number	$y= 0.00005x^2-0.0205x+4.8685$	0.5511
	Internodes	$y= 0.0001x^2-0.0292x+2.7863$	0.8273
21 DAP	Shoot length	$y= 0.0027x^2-0.4658x+24.998$	0.9146
	Leaf Number	$y= 0.0001x^2-0.0393x+6.0691$	0.9909
	Internodes	$y= 0.0004x^2-0.06x+3.6472$	0.8791
28 DAP	Shoot length	$y= 0.0031x^2-0.5193x+27.535$	0.9163
	Leaf Number	$y= 0.0004x^2-0.0725x+7.0986$	0.9909
	Internodes	$y= 0.0001x^2-0.0304x+3.1799$	0.8791
35 DAP	Shoot length	$y= 0.0035x^2-0.5921x+30.272$	0.9325
	Leaf Number	$y= 0.0003x^2-0.0549x+3.9207$	0.9696
	Internodes	$y= 0.0004x^2-0.0767x+7.6277$	0.9883

Table 6: Application of Polynomial Regression models in predicting the effects of spent engine oil contamination on different growth indices of *C. sativus* at 21, 28 and 35 DAP.

21 DAP	Shoot length		Leaf Number		Internodes	
Concentration	**Observed**	**Predicted**	**Observed**	**Predicted**	**Observed**	**Predicted**
0	23.25	24.99	5.75	6.07	3.55	3.64
20	20.40	16.76	6.00	5.32	2.80	2.61
50	6.10	8.45	4.00	4.35	1.45	1.65
100	5.75	5.42	3.50	3.13	1.40	1.64
28 DAP	Shoot length		Leaf Number		Internodes	
Concentration	**Observed**	**Predicted**	**Observed**	**Predicted**	**Observed**	**Predicted**
0	25.65	27.54	7.00	7.09	3.00	3.18
20	22.30	18.40	6.00	5.81	3.00	2.61
50	6.70	9.32	4.25	4.48	1.75	1.91
100	6.65	6.61	3.50	3.96	1.50	1.14
35 DAP	Shoot length		Leaf Number		Internodes	
Concentration	**Observed**	**Predicted**	**Observed**	**Predicted**	**Observed**	**Predicted**

0	28.40	30.27	7.50	3.92	3.80	7.62
20	23.75	19.83	6.50	3.00	3.20	6.30
50	7.05	9.42	4.50	1.93	1.80	4.80
100	7.05	6.06	3.50	1.43	1.60	3.96

4. Discussion

From the present result, there is ample evidence that spent engine oil has significant ($P< 0.05$) growth reducing effects considering the studied parameters. This corroborates the views of Neelima and Jaganmohan (2006) [10] who showed that soil hydrocarbon contamination is associated with delaying germination and retarding plant growth, photosynthetic rate and biomass production. Also, the reduction in growth parameters of test plant was dose dependent. The effect of spent engine oil on the plant growth parameters as observed in the current research concur with those reported by Osubor and Anoliefo (2003) [18], Okonokhua *et al*., (2007) [16] and Okon and Mbong (2013) [13] while studying the effect of petroleum-based contaminants on other crops.

This dose-dependent growth reduction correlates with the views of Dimitrow and Markow (2000) [5] who opined that the presence of spent engine oil in the soil significantly decreased the soil available forms of phosphorus and potassium to plants. This nutrient imbalance may be due to gross acidification and the anoxic anaerobic condition created within the soil matrix due to the presence of petroleum waste leading to the dead of important soil aerobic bacteria responsible for nutrient mineralization.

Accordingly, Verma and Verma (2007) [21] emphasized that these nutrients (phosphorus and potassium) are essentially needed and in reasonable amounts for optimum plant growth and development hence reduction in their bioavailability is believed to contribute to the reduced plant growth noted in this result. In confirming this, Adedokun and Ataga (2007), Nkoju *et al.* (2008) and Okon *et al.* (2012) [1] also confirmed that treatment of soil with hydrocarbons significantly reduced the time of germination and growth of important crops.

The application of biometric techniques is well suited in this study. In this result, the multivariate correlation employed assist in the identification of the strength and nature of relationships existing between pairs of variables with regards to contaminants concentration and plant growth indices. This tally with the views of Ubom, (2003) [20], Mbong, *et al.* (2014) [9] and Mbong *et al.* (2020) [8]. From the matrix, the negative correlation coefficients obtained between contaminant (SEO) with all growth parameters interprets that increased soil contamination tallies with reduced growth in the test plant. A similar trend was noted by previous researchers (Adu, *et al*., 2015) [2].

Knowledge on the use of diverse regression techniques in generating prediction models abound in literature. Notably, regression analysis as seen in this result served a great deal in generating numerical models for valid predictions of the effects of contaminants on plant growth (Sokal and Rolf 1995, Ubom, 2003) [19, 20]. Its applicability was not solely to assess the effects of contaminant concentration on plant growth parameters but also to describe and predict using quantitative models, the extent to which spent engine oil contamination affect plant growth using the test parameters.

5. Conclusion and Recommendation

From this study, it can be concluded that spent engine oil contamination of soil adversely affect growth of *Cucumis sativa*. Also, the effect of the contaminant on plant is concentration dependent. Correlation and regression analyses can be employed in predicting dependable estimates on the effects of varied concentrations of contaminants on plant growth. In line with this, the following is recommended:

1. Prohibition of indiscriminate dumping of spent engine oil into potential farm lands and drainage systems.
2. Relocation of automobile workshops away from farming settlements need be enforced.
3. There is need to create massive awareness programs by relevant government agencies on the effect of poor disposal of petroleum waste on the ecosystem.

6. References

1 Adedokun OM, Ataga AE. Effects of amendment and bioaugumentation of soil polluted with crude oil, automobile gasoline oil, and spent engine oil on the growth of *Vigna ungiculata.* Scientific Research and Essay. 2007;2(5):147-149.
2 Adu AA, Aderinolo OJ, Kasemiju V. Comparative effects of spent engine oil on the growth and yield of *Vigna unjuiculata.* International Journal of Science and Technology. 2015;4(3):234-261.
3 AKSG, 2008. www.aksgonline.com/articlepage_qrid_1236.html
4 Anoliefo GO, Vwioko DE. Effect of spent lubricating oil on the growth of Capsicum annum and Lycopersicon esculentum. Environmental Pollution, 1995;88:361-364.
5 Dimitrow DN, Markow E. Behavior of available forms of NPK in soils polluted by oil products. Poczwoznanie Agrochimija Ekologia. 2000;35(5):3-8.
6 Eremrena LPO, Mensah SI. Growth performance of Cucumber (*Cucumis sativus* l.) in spent engine oil contaminated soil amended with compost of Urena lobata. Global Journal of Pure and Applied Sciences, 2017;23:53-57.
7 Herbst ST. Comparative definitions of 6, 000 food, drink and culinary. Baron’s Educational Serials. 2001;3:706-818.
8 Mbong EO, Osu SR, Uboh DG, Ekpo I. Abundance and Distribution of Species in relation to Soil Properties in Sedge-dominated habitats in Uyo Metropolis, southern Nigeria. Global Journal of Ecology. 2020;5(1):24-29.
9 Mbong EO, Ogbemudia FO, Essang Q. Biometric Edaphological Assessment: The role of soil properties on the synthesis of essential molecules in Nigerian Gnetum species. International Journal of Research, 1 2014;(10):1968-1975.
10 Neelima P, Jaganmohan RK. Bioabsorption of Some Heavy Metals in Different Plant Species. Nature Envir. Pollut. Tech. 2006;5:53-56.
11 Njoku KL, Akinola MO, Oboh BO. Germination survival and growth of accession of *Glycine max* and *Lycopersicon esculentum* in crude oil polluted soil. Research Journal of Environmental Toxicology. 2008;2(2):77-84.
12 Odjegba VJ, Atebe JO. The effect of used engine oil on carbohydrate, mineral content and nitrate reductase

activity of leafy vegetable (*Amaranthus hybridus* L.) J. Appl. Sci. Environ. Management. 2017;11(2):191-196.
13 Odjegba VJ, Sadiq. Effects of spent engine oil on growth parameter, chlorophyll and protein level of Amaranthus hybrids. The Environmentalist. 2002;22:23 -28.
14 Okon JE, Mbong EO. Effects of nutrients amendments and spent engine oil polluted soil on some growth parameters of *Abetmosehus esculentus.* Bullentia of Environmental Pharmacology and Life Science. 2013;2(5):75-78.
15 Okon JE, Esenowo GJ, Umoh NS. Effects of crude oil pollution of soil and amelioration treatment on the growth of eight varieties of *Manihot esculenta.* International Journal of Chemical, Environmental and Pharmaceutical Research. 2012;3(2):163-169.
16 Okonokhua BO, Ikhajiagbe B, Anieliefo GO, Emede T O. The effects of spent engine oil on soil properties and growth of Maize (*Zea mays* L.). Journal of Applied Sciences and Environmental Management. 2007;11(3):147-152.
17 Onwusiri KC, Aguoru CU, Akomolafe GF. Effect of spent engine oil on Germination and growth parameters of fluted pumpkin (*Telfairia occidentalis* Hook F.) in Makurdi, Benue State, Nigeria. 2017.
18 Osubor CC, Anoliefo GO. Inhibitory effects of spent lubricating oil on the growth and respiratory functions of Arachis hypogea L. Benin Sci. Dig. 2003;1:73-79.
19 Sokal RR, Rohlf FJ. Biometry, New York: Colt Freeman Company. 1995, 887p.
20 Ubom RM. Biometry. 3 Eds. Abams Publishers. Uyo, 2003, 23p.
21 Verma SK, Verma M. A Textbook of Plant Physiology, Biochemistry and Biotechnology. Sixth Edition. New Delhi: S. Chand and Company Ltd. 2007, 93-95p.