EFFECT OF SPENT ENGINE OIL ON THE GERMINATION AND DEVELOPMENT OF GINGER (*Zingiber Officinale* ROSCOE)

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Prelude

The present study was carried out to evaluate the effect of spent engine oil on germination and growth attributes of ginger (Zingiber Officinale Roscoe) rhizome with a view to investigate the level of the pollutant that the tested plant can tolerate. The soil samples used in this study were collected from three experimental farms and mixed up to get a composite soil, spent engine oil was obtained from different mechanic workshops within Calabar while the Rhizomes were sourced from Watt market in Calabar. Soil samples (4kg per bag) were mixed homogenously with 25, 50, 75 and 100ppm of spent engine oil, with Oppm as the positive control. Rhizomes were then sown into planting bags. Soil analysis and Heavy metal analyses were carried out before and after contamination. Data were collected four times at interval of 21 days, for growth parameter which include numbers of days to cotyledon emergence, percentage germination, number of leaves, plant height, leaf width and leaf length. The chlorophyll content of the tested plant was also determined. Data collected were subjected to one-way Analysis of variance (ANOVA) and means were separated using LSD at 5% probability. Results obtained showed that spent engine oil contain higher concentrations of heavy metals above the regulatory limits. There were significant differences ($p<0.05$) in soil nutro-physical properties of soil challenged with different concentration of spent oil. After 9 weeks of planting, all plant parameters evaluated were significantly ($p<0.05$) reduced as the concentration of spent oil increases. The chlorophyll content of plants on treatments also varied. The results suggest that spent engine oil as low as 25ppm could be considered inhibitory to the growth and yield of ginger. Hence, the present study showed that spent engine oil adversely affects the germination and growth of ginger.

INTRODUCTION

Ginger (Zingiber officinale) belongs to the family of Zingiberaceae . It is a slender perennial plant with thick and branched underground stem (rhizome), it is a spice grown across many parts of the world. Ginger is likely cultivated originated from India, where it is being cultivated in commercial level (Hass, 1998). Ginger was introduced in Africa and the Caribbean by the colonial masters and it is now cultivated throughout the humid tropics. It got to Nigeria in 1927 and its cultivation started around Kwoi , Kubacha , Kafanchan and Kagarlco areas of Southern Kaduna state and around the neighboring part of plateau state (KADP , 2000) .

Zingiber officinale is usually consumed in most Nigerians homes as a spice which can be used to spice up many dishes such as stew, pepper - soup and even different kinds of soups and a range of other value added products including flavouring in candies and beverages. Medically, studies indicate that ginger is effective in reducing inflammation in arthritic conditions (Srivastava et al. , 1992) . Another case study presented ginger as a preventive agent for migraine headache without any side effect (Muhammed et al. , 2007) . In view of the fact that ginger root has been used in several parts of the world in the management of motion sickness , researchers attempted to clucidate the mechanism of action . In one of the studies , it was proposed that ginger constituent may increase gastric motility and prevent the accumulation of toxic substances , thereby blocking the gastrointestinal reactions which trigger the nausea

Environmental pollution due to spent - engine oil is a common hazard in developing countries were environmental laws are in effective or at best rudimentary . The basic challenges faced by mankind is how to produce enough food crops with increased yield to meet the ever increasing demand due to rapid increase in population .. Research has shown that millions of people in developing countries lack enough food to meet their daily demand . This food shortage is partly attributed to soil pollution due to spent - engine oil which is caused by man's residence and his activities on earth. This is because of the manifold surge in the number of automobiles coupled . Most of the automobile companies and workshops dispose their petroleum derived waste either into open soil or into water bodies and irrigation canals which ultimately reach to agricultural plants (Iwuoha et al . , 2015) .

The physical and chemical properties of soil polluted with petroleum hydrocarbons, undergo marked changes, the changes in soil due to contamination with petroleum derived substances can lead to water and oxygen deficit as well as shortage of available forms of nitrogen and phosphorus which are essential element that affect the growth and yield of plants . Contamination of soil with spent - engine oil leads to significant reduction of soil moisture content which subsequently induces the retardation in plant growth (Iwuoha et al., 2015).

Plants are known to respond differently to their environment right from germination and at their different stages of growth. Hence there is need to evaluate the effect of polluted soil on the growth performance of ginger.

Indiscriminate disposal of spent engine oil by mechanics is of great threat to the environment as it contributes immensely to the degradation of the environment due to the excess hydrocarbon , which may adversely affect the germination , growth and yield of various plants . Since much work has not been done and published and this plant is of great importance to the society ; hence this study is necessary to determine the performance of the test plant (Ginger) grown on soil polluted by spent engine oil .

MATERIALS AND METHODS

Experimcntal site

This research work was carried out in the Department of Genetics and Biotechnology, University of Calabar, Calabar, while the field work was carried out at the experimental farm of the Faculty of Biological Sciences, University of Calabar.

Laboratory Analysis

Heavy metal contents of the spent engine oil analysis were carried out in the Department of Chemistry, University of Calabar, Calabar.

Sample collection

Rhizome of Ginger was obtained from Watt Market Calabar, Cross River State. Spent engine oil was obtained from diferent mechanic workshops located at Calabar Municipality, Cross River State. Top soil (0-25cm) was collected from different points in the experimental farm and mixed together to get a composite soil. Black polythene bags Were obtained from Ministry of Agriculture, Calabar, Cross River State.

Four kilograms (4kg) of dry soil each was weighed into 25 bags perforated at the base and side to ensure proper drainage and aeration.

Soil preparation/ treatment

Twenty-five (25) bags each containing loamy soil were contaminated using Oml, 25ml, S0ml 75ml and 100ml of spent engine oil. Each treatment was replicated five (5) times

Planting of Rhizomes

Five rhizome of Ginger were sown in each polythene bag (a total of 25 bags) at a depth of 3cm.

Evaluation of Growth Parameters

The plants were monitored for a period of 9 weeks to ensure good conditions of sown rhizomes

Data Collection

Data were collected based on the following parameters; number of days to sprouting, plant height, number of leaves, leave width and leave length.

Experimental Design

This experiment was arranged using a randomized complete design (RCD) with (5) five replicates.

Analysis of Spent Engine Oil and Soil Used

Determination of moisture content in soil

Weigh the aluminum dish to be used. Aliquot approximately 50g of moist soil into aluminum dish and reweigh, hence, the moist weight of the soil sample is now known .

Dry the soil overweight at 105°C in the oven then remove the dish from the oven and allow them to cool. Reweigh the dish plus the even dry soil. Now, the weight of the dry soil is known, Calculate the soil moisture content each sample using the following equation:

Percentage moisture content (ML) = [wet weight-dry weight].

3.8.2 Digestion process for heavy metals analysis in soil samples

Homogenized the samples, the 0.5g of the sample into digestion bottle and add 100ml of distilled water to dissolve the sample. 0.5ml of conc. HNO; of conc. HCL to break the bond and release the metals, Heat in oven at temperature of 105°C for 2 hours and filter the sample using Whattman's filter paper into 120 ml beaker then add distilled water to make up the volume. Finally proceed for AAS analysis.

RESULTS

Table 1 reveals results of heavy metal analysis of soil after treatment which shows significant differences ($P<0.05$) in mean concentration of the treatment groups compared to the control. There was a gradual increase in the concentration of the metals as the concentration of the spent oil in the soil increased. The mean concentration of Cr was 0.00mg/kg for the control sample and 0.02, 0.04 and 0.06mg/kg for 25ppm. SOppm, 75m and 100ppm of spent oil in soil. Mean concentrations of Pb were 3.4, 9.5, L1.1, 11.8 and 12.4mg/kg for control, 25, 50, 75 and 100ppm of spent oil respectively. Average concentrations of Fe in soil samples were 17.9, 33.2, 40.1, 45.0 and 48.3 for control, 25, 50, 75 and 100ppm while those of As were 0.01 at all treatment levels.

Nutrient analysis of soil polluted with spent engine oil (revealed in table 2) showed that the concentration of Nitrate and phosphate of the control samples were significantly higher ($P<0.05$)

compared to the treatment groups. The mean concentration of Nitrate reduced as the Concentrate of the spent oil increased; hence the mean values were 24.0, 15.1, 14.5, 15.3 and 10.0mg/kg for control, 25, 50, 75 and 100ppm of spent oil in the soil. Similar the phosphate concentration increased with increased level of spent oil with precisely mean values of 21.6, 17.30, 15.90, 15.40 and |1.3mg/kg for 0, 25, 50, 75 and 100ppm of spent oil respectively. For potassium, the mean concentration increased as the concentration of the spent oil increased. Mean concentration of P was 20.0mg/kg for the control sample and 23.0, 31.0, 30.0 and 29.0mg/kg for treatment with spent engine oil at 25, 50, 75 and 100ppm respectively. Total organic carbon content of soil of the treatment groups were significantly higher with mean values of 21.40, 29.10, 30.20, 31.20 and 34.70 mg/kg for control sample, 0, 25, 50, 75 and !00ppm of spent engine oil respectively. The moisture content of soil treated with !00ppm of spent engine oil was higher (4.44%) compared to the Control group (2.29%) and soil samples treated with 25, 50, and 7Sppm of spent engine oil with MC of 2.16, 2.34 and 2.13% respectively. The temperature of soil samples treated with spent engine oil was statistically Similar (P>0.05). The specific mean values of the soil samples were 27.50, 27.40, 27.47, 27.63 and 27.40°C for 0, 25, 50, 75 and 100ppm level of the spent oil. In terms of pH of the soil, the treatment groups were statistically similar (P>0.05) compared to the control. All soil samples were acidic regardless of the concentration of the spent oil, the specific pH values of the soil samples were 6.82, 6.84, 6.46, 6.26 and 6.49 for 0, 25, 50, 75 and 100pm treatment levels.

Table 3 shows result of chlorophyll content of Ginger grown on soil polluted with spent engine oil. Spectrophotometry analysis of Ginger grown on polluted soil indicated that chlorophyll contents were higher in the control groups compared to the treatments. The control had a relatively chlorophyll a and b content of 13.01 and 3.96mglg while those of the treatment groups were 11.75 and 3.81, 12.13 and 3.43, 12.81 and 2.97 and 13.04 and 3.72mg/g for 0, 25, 50, 75 and 100ppm treatment levels respectively.

Growth attributes of ginger grown on spent engine oil polluted soil is shown in figure 1. The result shows that, germination rate was significantly affected (p<0.05) by the presence of spent oil in the soil. Significant decrease was noted in percentage germination of seeds sown on contaminated soil compared to the control. 5.92%, 75%, 57%, 42% and 18% germination were recorded in soil polluted with 0, 25, 50, 70 and 100ppm of spent engine oil respectively. Average number of days to cotyledon emergence was delayed as it took the control group 7 days to germinate while those of 25, 50, 75 and 100ppm treatments took average 11, 16, 25 and 31 days respectively to sprout as presented in figure 2.

Results of the growth attributes of ginger on spent engine oil polluted soil are presented in Table 4. Result obtained from the plant height showed that spent oil significantly affect (p<0.05) plant height at 3, 6 and 9 week after planting. Higher mean plant height of 25.80, 32.60 and 37.60cm was observed in plants on the control group at 3, 6 and 9 weeks after planting while the means plant height of 5.02, 9.38 and 21.00cm were recorded on soil polluted with 100ppm of spent oil at 3, 6 and 9 week alter planting as indicated in table 4. There was significant difference (p<0.05) in average number of leaves across the treatment groups When compared to the control at weeks 3 and 9 after planting, however, no significant difference (p>0.05) was observed between the control and treatment groups at weeks three after planting. Significantly higher mean number of leaves (10.40. 9.80 and 15.20cm) were observed on plants grown on the control while those of plants on 100ppm of spent engine oil were 2.00. 6.00. and 7.40 at 3. 6 and 9 weeks after planting as presented in table 4. In terms of leaf length, spent oil significantly (p<0.05) influenced lengths of leaves as plants on the control had mean leaf length of 15.02, 17.86 and 21.28em at 3, 6 and 9 weeks after planting. These values were significantly higher compared to those recorded on plants grown on spent oil polluted with 100ppm at weeks 3, 6 and 9 after planting (4.96, 8.16 and 9.34cm). Similarly, there was significant reduction in leaf width of plant sown on spent oi Polluted soil, Mean leaf width of 2.26, 4.42 and 1.96em were recorded on the control at 3.6 and 9 weeks after planting. Lower mean leaf width of 0.92, 0.98 and 1.72cm were however noted for plants on 100ppm spent engine oil at the same weeks after planting.

Table 1: Heavy Metals Result Soil Challenged by Various Levels of Treatments

Parameters	Control	25ppm	50ppm	75ppm	100ppm
Pb(mg/kg)	3.4±0.1	9.5±2.1	11.1±1.9	11.8±2.4	12.4±2.2
Cr(mg/kg)	ND	0.02±0.00	0.04±0.01	0.04±5.2	0.06±0.01
Fe(mg/kg)	17.9±2.1	33.2±3.6	40.1±4.8	45.0±5.2	48.3±4.9
As(mg/kg)	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00

Pb=Lead; Cr=; Fe= Iron; As= Arsenic

Table 2: Nutro-physical Parameters of Soil Treated with Spent Engine Oil

Parameters	Control	25ppm	50ppm	75ppm	100ppm
Nitrate (mg/kg)	24.0±0.9	15.1±1.5	14.5±2.1	15.3±1.2	10.0±0.4
Phosphorus (mg/kg)	21.6±0.4	17.3±0.8	15.9±1.1	15.4±0.5	11.3±0.7
Potassium (mg/kg)	20.0±0.1	23.0±0.0	31.0±0.0	30.0±0.0	29.0±0.0
TOC (mg/kg)	21.4±0.02	34.7±1.2	31.2±1.6	29.1±1.8	30.2±2.3
MC%	2.29±0.0	2.16±0.0	2.34±0.0	2.13±0.0	4.44±0.0
Temperature ^{0}C	27.5±0.0	27.4±0.0	27.5±0.0	27.6±0.0	27.4±0.0
pH	62.82±0.0	6.84±0.0	6.46±0.0	6.26±0.0	6.49±0.0

TOC=Total organic carbon; MC=Moisture content

Table 3: Chlorophyll Content of Ginger Grown on Soil Polluted with Spent Engine Oil

Chlorophyll type	Control	25ppm	50ppm	75ppm	100ppm
Chlorophyll a (mg/g) at 645nm	13.01±0.0	11.75±0.0	12.13±0.0	12.81±0.0	13.04±0.0
Chlorophyll b (mg/g) at 633nm	3.96±0.0	3.81±0.0	3.43±0.0	2.97±0.0	3.72±0.0

Table 4: Mean ± S.E of Growth Attributes of Ginger on Spent Engine Oil Polluted Soil

	3 Weeks after planting					6 weeks after planting					9 weeks after planting				
Parameters	0ppm	25ppm	50ppm	75ppm	100ppm	0ppm	25ppm	50ppm	75ppm	100ppm	0ppm	25ppm	50ppm	75ppm	100ppm
Plant height (cm)	25.80±2.60^{a}	21.56±1.73^{a}	19.62±1.68^{a}	12.48±0.78^{b}	5.02±1.67^{c}	32.60±2.95^{a}	23.60±1.46^{a}	24.10±0.39^{a}	15.46±1.27^{b}	9.38±0.59^{d}	37.60±2.92^{a}	29.58±1.70^{b}	28.58±0.54^{b}	21.78±0.59^{c}	21.00±0.89^{a}
Number of leaves	10.40±1.7^{a}	7.00±0.84^{b}	4.00±0.32^{c}	2.80±0.84^{c}	2.00±0.95^{c}	12.80±1.36^{a}	9.40±0.40^{a}	9.00±0.63^{a}	7.60±1.14^{a}	6.00±0.90^{a}	15.20±0.73^{a}	12.00±0.71^{b}	10.00±0.71^{b}	10.20±0.49^{b}	7.40±0.75^{c}
Leaf length (cm)	15.02±0.79^{a}	11.20±0.70^{b}	10.44±1.05^{b}	0.86±0.65^{b}	4.96±2.07^{b}	17.86±1.10^{a}	13.00±0.76^{b}	12.96±1.18^{b}	9.72±0.75^{c}	8.16±0.94^{c}	21.28±0.37^{a}	16.12±0.25^{b}	14.56±0.96^{b}	12.48±0.69^{c}	9.36±0.79^{d}
Leaf width (cm)	2.26±0.10^{a}	2.22±0.20^{a}	1.98±0.49^{a}	1.60±0.90^{a}	0.92±0.39^{b}	4.44±0.24^{a}	3.24±0.33^{b}	3.32±0.23^{b}	1.94±0.10^{c}	0.98±0.67^{d}	4.96v0.75^{a}	3.82±0.18^{b}	3.60±0.20^{b}	2.18±0.73^{c}	1.72±0.18^{d}

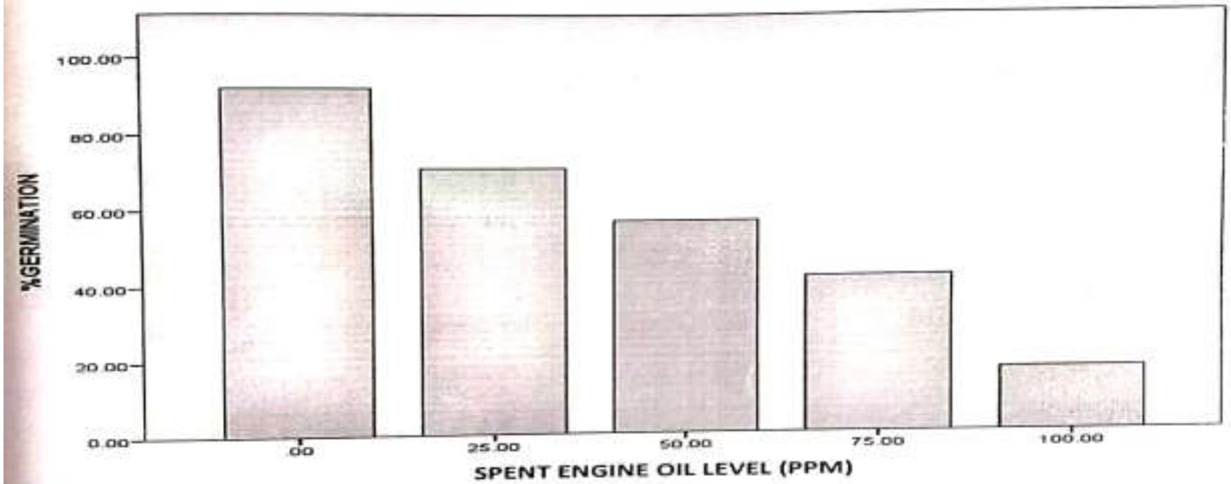

Fig 1: Percentage germination of ginger grown on spent engine oil polluted soil.

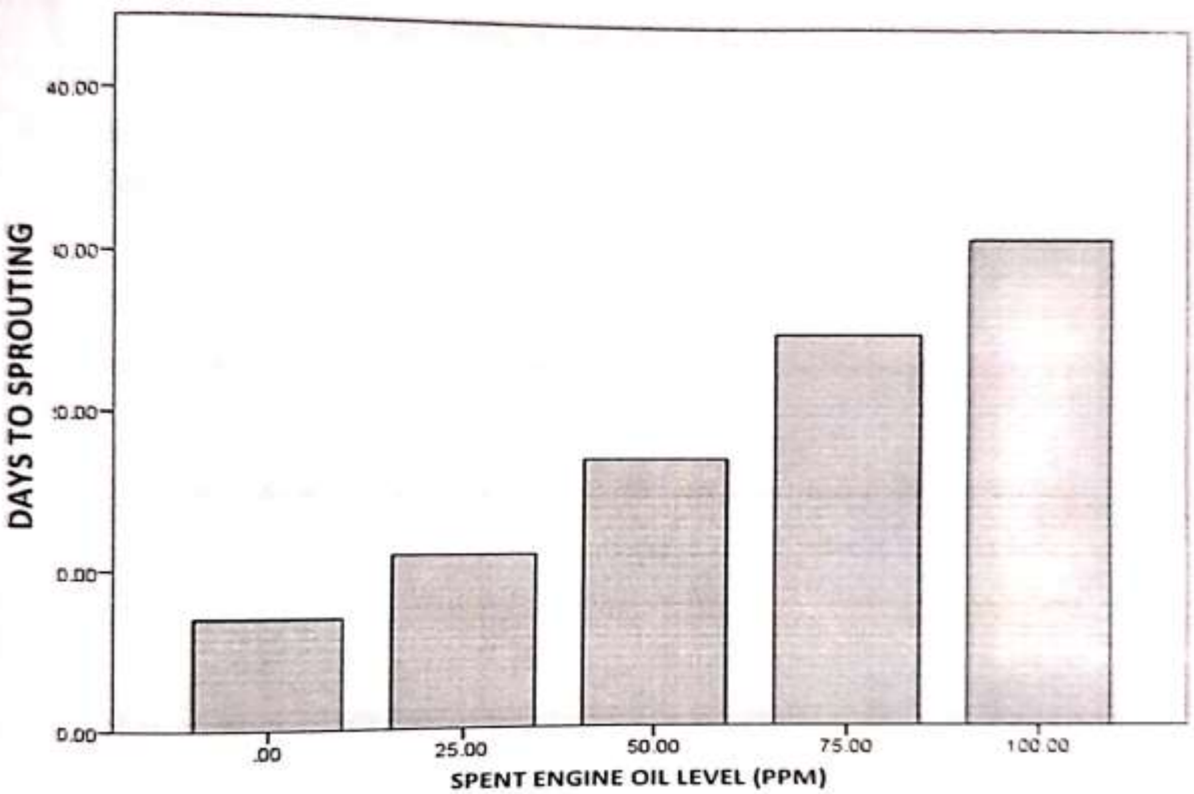

Fig 2: Days to sprouting of ginger grown on spent engine oil polluted soil

DISCUSSION

Some heavy metals such as Pb, Cr, Fe and As are usually associated with al] petroleum products that affect plant growth. The result of the analysis of spent engine oil content revealed that the concentration of Pb was significantly higher above the regulating limit of 0.05me/I permitted in any unused crude oil products. This is an indication of severer contamination of the spent oil by Pb producing activitics. On the other hand, the mean concentrations of Cr and Fe were within the regulatory and acceptable limits for lubricants. This implied the absence or near absence of Cr and Fe activities in the spent oil. However, the concentration of Arsenic in the spent oil was significantly low beyond the detection limit (0.00Ikg/l) of the equipment used. These result tallics with the report of so many researchers who reported that spent engines oil contained heavy metals in a significantly higher concentration that is detrimental to both plant and animals (Okonokhua eg al., 2007; Uchendu, ef al., 2014; Nwite ef al., 2015; Onwusin ef a/., 2017).

SPD content of the soil used in this study was analyzed before spent engine oil was introduced. Results showed that the sandy nature of the soil was relatively higher (46%) compared to clay and silt which constitute 30 and 24% of the soil. Similar results was obtained by Nwite et al,(2015) who observed 690, 200 and 110gkg" for sand, clay and silt respectively of soil sample obtained.

Heavy metal analyses of soil afier treatment were carried out. The same heavy metal species analyzed for spent oil was conducted for various soil samples afier been Challenged by various concentrations of spent engine oil. Result showed elevated Concentrations of Pb on the control sample, indicating prior pollution of the soil by the spent oil. The presence of Fe'* concentration, though within regulating limit in the control sample could be attributed to natural processes. The trace concentration of arsenic is Within the 30mg/I spent engine oil as permissible and regulatory limits.

However, the effects of the spent engine oil on the soil severely revealed a linear selationship between treatment concentration and the four heavy metal concentrations ic ys level of treatment increases from 25-100ppm so also docs the heavy metals concentration increased in the soil. The results obtained in the present study is slightly different from that of Uchendu ef al, (2014) who noted that the concentration of heavy metals in polluted soil were irregular but however agree with the report of Okonokhua ef al., (2007) who concluded that heavy metals (Fe, Cu, Zn and Pb) concentrations of soil increased with increasing concentration of spent engine oil. The order of magnitude of feavy metal concentration observed in the spent engine oil analyses was similar to that observed in soil samples after the introduction of spent engine oil with the swapping of fe and Cr. A possible explanation of this could be that, the test plant take up more Cr than Fe.

The concentration of Nitrate, phosphate and potassium ions was determined as nutrient component of the soil after contamination. Results indicated that there was ' significant reduction

N and P concentration with increasing concentration of the spent oil except among the 75ppm treatment level. The concentration of nitrate was highest in the control group, followed by phosphate before potassium. Surprisingly, the concentration of K severely increased with increasing concentration of the spent engine oi! with the exclusion of the 75 ppm treatment level suggesting that the soil at this level could be Slightly different from others or the spent engine oil exhibits a mechanism that is entirely different from other. This result agrees with the findings of Nwite et al., (2015) who Stated that available P. exchangeable K, Mg, Na and Ca were 143, 123, 34 and 48% significantly (P<0.05) lower at 1.01/poly bag of spent engine oil treatment compared with the control. They pointed out that spent engine oil at 1.0k severely affected physiochemical properties of soil more than any other levels except with regards to O, C and N concentrations.

The SPD result revealed a higher proportion sandy and silly proportion to clay in the control samples. However, the sandy proportion becomes reduced as treatment concentration increased. The spent engine oil seems to close the sand spaces, rendering it harder by blocking the wide ‘pore spaces. This gives rise to clay soil condition as evidenced in increasing clay concentration and soil nutrient percentage decreases. This explains wholly why the nitrogen and potassium concentration decreased as the spent engine oil treatment level increases. There were significant increase (p<0.05) in TOC. MC and Temperature of soil treated with 100ppm of spent oil though the pH levels of soil sample were all acidic. The pH values recorded in the present study is significantly higher compared to the pH range of 5.43-6.79 recording by Uchendu ef al., (2014) in soil polluted with different concentration of spent engine oil.

The chlorophyll content of the control samples was significantly higher than those of the experimental samples. Samples challenged by 25ppm spent oil caused a reduction in chlorophyll @ content though invariably causcd a higher chlorophyll / contents. Similar results was obtained by Clementine er al., (2008) on their study on the cflect of spent engine oil on growth and chlorophyll content of Corchorus olitorius, they noted higher chlorophyll content of 11.5mg/c on plant grown on the control samples compared to those planted on polluted soil.

The results from the present study indicate that spent engine oil contaminated soil Severcly affected the germination and growth of the ginger plant. According to the result Presented, there was a significant reduction in growth performance of plants grown on soil samples polluted with 50-100ppm of spent engine oil. The number of days to sprouting and growth rate was delayed and poor respectively, in contaminated soil compared to the control. This is in agreement with the findings of Clementina et al, (2008) and Uchendu et al., (2014). Okonokhua, (2007) who reported that the number of gays to emergence of seeds and growth performances after germination were adversely affected with increasing concentration of spent engine oil.

The mean leaf length and width of ginger were greatly affected by the spent engine oil. The significant reduction in leaf length and width in this report could be due to reduction in nutrient content of the soil challenged by different concentration of spent engine oil. It could also, due in part to the increasing concentration of the heavy metal content of the polluted soil samples as revealed by Agbogidi et al., (2013). Similarly, Onwusiri et al., (2017) also observed a gradual reduction in leaf length and width of fluted pumpkin grown on soil contaminated with 20, to 60, 80 and 100ml of spent engine oil.

Plant height was generally poor on contaminated soil. This is an indication that spent oil inhibited the growth performance of ginger. This could be as a result of imbalance in plants growth hormones triggered by the change in chemical composition of soil challenged with spent engine oil. Mean number of leaves per plant were significantly different on soil challenge with spent engine oil at various weeks after planting. The significant reduction in number of leaves per plants may be due to lower chlorophyll content noted in plants challenged with spent engine oil. Apart from reduction in number of leaves, the colour of the leaves was yellowish which is a symptom of nutrient deficiency in plants. This is in agreement with the report of Clementina er al., (2008) and Uchendu et al, (2014),

CONCLUSION

The present study was carried out to check the effect of spent engine oil on the germination and development of ginger. The experiment was arranged in a 4x5 factional experiment using completely randomized design (CRD) with five replicates. Soil samples (4kg/bag) were treated with 25, 50, 75 and 100ppm level of spent engine oil. One group with Oppm of spent oil served as the control. Soil analysis and heavy metal analyses were carried out before and after contamination. Data were collected four times at interval of 21 days, for growth parameter which include numbers of days to sprouting, percentage germination, number of leaves, plant height, leaf width and leaf length. The chlorophyll content of the ginger plants was also determined. At 9 weeks after planting, plants showed significant reduction in growth performance and chlorophyll content with increasing concentration of spent engine oil

Results obtained from the present study revealed that contamination of soil with spent engine oil causes increased in heavy metals content of soil, reduction in nutrients and chlorophyll content of both soil and plants. A linear relationship was observed between the treatment concentrations and the heavy metal contents of the soil. Consequently, the pollutant adversely affects the germination, growth performance and yield potential of the tested plant (ginger).

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