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Effects of Soil Amendment on the Toxicity of a Two- Month Old Waste Engine Oil-Polluted Soil on *Solanum esculentum* Linn

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Abstract
This study investigated the effect of sawdust on the toxicity of waste engine oil- polluted soil on *Solanum esculentum* grown at various concentrations of waste engine oil and changes in the physicochemical properties of soil. This was with a view to assessing the soil remediation potentials of sawdust in waste engine oil polluted-soil. This study was carried out in the screen house of the Faculty of Agriculture, Obafemi Awolowo University, Ile-Ife. Waste engine oil sample was pooled from a heavy duty vehicles auto mechanic workshop in Sabo, Ile-Ife. Six concentrations of waste engine oil 0%, 1%, 2%, 3%, 4% and 5% were used to contaminate 3 kg of air-dried soil in perforated buckets. Another set of pots containing 3 kg of air-dried soil were also contaminated with six concentrations of waste engine oil but amended with 20 t/ha of sawdust. Each treatment was replicated thrice in a Completely Randomized Design. Nursery bed was prepared for the tomato variety (Roma VF) obtained from the National Horticulture Research Institute, Ibadan. With five seeds planted per hole at the depth of 3 cm. Two weeks after germination of the seeds in the nursery bed, the seedlings were transplanted into the perforated buckets at rate of 2 seedlings per pot. The growth parameters such as plant height, number of leaves and number of branches were measured weekly for 5 weeks. At the end of the five weeks, total harvesting of plants and sorting into roots and shoots was carried out. Pre and post cropping analyses of soils were done to determine the heavy metal content and physicochemical properties of the soils using standard methods. Plant parts nutrient content and plant heavy metal content were also analysed using standard method. The data obtained were subjected to appropriate descriptive and inferential statistical analyses.
After five weeks growth in the soils treated with 5% waste engine oil, growth performance of tomato was significantly ($p< 0.05$) higher in sawdust treated waste engine oil- contaminated soil. Results showed that addition of sawdust increased the soil nutrient status as well as plant nutrient uptake of *Solanum esculentum* in waste engine oil- contaminated soil. At 5% waste engine oil contamination level, plant nutrient uptake was significantly ($p< 0.05$) higher in waste engine oil- contaminated soil treated with sawdust (nitrogen: 2.16%; potassium: 0.43%; magnesium: 0.22% and calcium: 0.71%) than in soils treated with only waste engine oil (nitrogen: 0.58%; potassium: 0.11%; magnesium: 0.06% and calcium: 0.20%).
This study concluded that sawdust has the potential of amending waste engine oil- contaminated soil for improved nutrient uptake by tomato. Though, in the non-contaminated soil samples, sawdust did not significantly improve nutrient availability to tomato.
Keywords: Engine-oil, Farmland, Contaminated, Pollution, Amendment, Sawdust.

1.0 INTRODUCTION

The disposal of waste engine oil into gutters, water drains, open vacant plots and farmland is a common practice in Nigeria, especially by motor mechanics that change oil from motor vehicles, power generating sets and other machines. In Nigeria, the existing mode of indiscriminate disposal of waste engine oil increases pollution incidents in the environment and it has been shown to be more widespread than crude oil pollution (Atuanya, 1987; Victor and Sadiq, 2002). Most of the indiscriminate disposals of waste engine oil happen near homes and because tomato is a popular vegetable crop that is mostly planted in gardens near homes, it is prone to pollution from waste engine oil.

Various methods of protecting plants against oil contamination include use of absorbent materials, chemical dispersants and burning. But most of these methods have undesirable ecological effects on the crops and the environment. Therefore, protecting the plants with vegetative components that form parts of the environment becomes necessary (Gelter *et al.*, 1984; Lin and Mendelsson, 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 the soil (Tanee and Akonye, 2009). A soil amendment is any material added to the soil to improve its physical properties, such as water retention, permeability, water infiltration, drainage, aeration and structure (Davis and Wilson, 2005), it also increases the ability of the soil matrix to supply biologically available water and nutrients to microorganisms that are capable of degrading the target compounds. In addition, the amendments bind pollutants to reduce acute toxicity of the soil's aqueous phase, thereby allowing microorganisms to survive in soils containing very high concentration of toxicants

Tomato is one of the most popular and widely grown vegetables in the world. Its popularity is attributed in large part to its versatility, and the variety it lends to the human diet (FAO, 2005). Tomato is considered to be one of the most sensitive vegetable species to excessive soil moisture. However, the effect of indiscriminate disposal of waste engine oil into the environment which a common practice in Nigeria and Since most of the methods used for protecting plants against oil contamination, such as use of sorbent materials, chemical dispersants and burning, have undesirable effects on the crop and the environment, this study will therefore provide information on the effect of waste engine oil on plant and the effect of sawdust as an amendment on the toxicity of *Solanum esculentum* planted in waste engine oil-polluted soil.

2.0 Materials and Methods

Topsoil was collected randomly to a depth of about 15 cm from the teaching and research farm, Obafemi Awolowo University, Ile-Ife and thoroughly mixed to obtain homogeneity. The soil sample was air dried and later sieved to remove the particles other than soil. Fresh waste engine oil was pooled from an auto mechanic workshop that specializes in the repair of heavy duty trucks in Sabo, Ile-Ife and was stored in a 25 litre jerry can and for the amendment, fresh sawdust sample was collected from a sawmill. It was air dried and passed through a 2 mm sieve and the less than 2 mm was similarly retained for use.

The entire experiment was divided into three regimes; the control (0%), the polluted soil (waste engine oil contaminated soil) and the amended polluted- soil (polluted soil treated with sawdust). For the control regime three kilograms of soil was measured into perforated plastic buckets and further divided into two treatments (1- only air dried soil sample and 2- air dried soil sample with sawdust) and was replicated five times in a completely randomized design consisting of 10 pots. For the polluted soil, three kilograms of soil sample was carefully measured onto a flat platform covered with cellophane. Five levels of waste engine oil contaminations (1%, 2%, 3%, 4%, and 5%) were poured into the measured soil and were thoroughly mixed before taken into the buckets. Each treatment was replicated five times in a completely randomized design consisting of 30 pots. For the amended polluted- soil, soil samples were mixed with five different levels of waste engine oil pollution (1%, 2%, 3%, 4%, and 5%), but this time, 20 tonnes/hectare of sawdust was mixed with the soil in each perforated bucket and the treatments were also replicated five times in a completely randomized design consisting of 30 pots. The set up was left in the screenhouse for two months. A nursery bed was prepared for the hybrid tomato variety (Roma V F) obtained from National Horticultural Research Institute (NIHORT), Ibadan. Two weeks later the seedlings were transplanted into the perforated buckets established for each treatment at the rate of 2 seedlings per bucket. The entire set up was left in the screen house for five weeks. Within this period, soil was carefully watered everyday with 200 ml of water.

After five weeks of transplanting, each of the tomato plants was harvested and then oven dried at 70^oC for 48 hours (Nottidge *et al*., 2005). The oven dried plant samples were ground using Willey micro hammer stainless steel mill and then digested using Juo, (1979) procedure. The digested samples were analyzed for phosphorus using the Vanadomolybdate yellow method, sodium and potassium were analyzed using a Gallenkamp flame photometer and calcium, magnesium, chromium, lead and cadmium were analyzed using a spectronic 20 atomic absorption spectrophotometer.

Soil sample collected were analyzed for particle size, exchangeable cations, nitrogen, phosphorus, organic carbon and pH. The soil pH was measured in 1:1 soil–water suspension, 1:2 0.01M $CaCl_{2,}$ using the glass electrode pH meter while the Total Nitrogen was determined by Kjedahl method. Total Phosphorus was determined by using Bray – 1 solution. (Bray and Kurtz, 1945). Exchangeable cations were also determined by leaching soil samples with 1M ammonium acetate solution and exchangeable Na and K were determined in the leacheate by flame photometer and Ca by Atomic Absorption spectrophotometer. Soil particle size distributions were determined by the hydrometer method using hexametaphosphate as the dispersing agent (Bouyoucos, 1962).The presence of heavy metal such as Cd, Pb, and Cr were also analyze using AAS.

Sample of the sawdust used to amend the waste engine oil polluted soil was digested using concentrated H2SO4 and H2O2, and the digest was analysed for organic carbon, total nitrogen and phosphorus using the same procedure applied in soil sample analysis. The exchangeable cations contents of the tissue in the digest were also determined using spectronic 20 Atomic Absorption Spectrophotometer and Gallenkamp flame photometer.

3.0 Result

Physiochemical Properties of the Soil used in the Experiment

The physical and chemical characteristics of the soil used in the greenhouse study before waste engine oil was added are presented in the Table1. The texture of the soil was loamy sand with 89.2% sand. The pH in 1:1 soil to water is 5.9 for the topsoil indicating a slightly acidic soil condition.

Table.1: Physiochemical Properties of Soil used for the Study.

Parameters	Values
Clay	6.8%
Silt	4.0%
Sand	89.2%
pH in water (H_2O)	5.9
Organic carbon (g/kg)	50.10
Nitrogen (g/kg)	3.30
Available phosphorus (mg/kg)	10.4
Ca^{2+} (mg/kg)	31.0
Mg^{2+} (mg/kg)	2432.5
K^+ (mg/kg)	260.5
Na^+ (mg/kg)	272.5
Lead (mg/kg)	0.00
Cadmium (mg/kg)	0.00
Chromium (mg/kg)	10.75

3.1 Chemical Composition of the Sawdust used for the Study

The chemical composition of the sawdust used for the study is presented in Table 2. The organic carbon content was 53.9% with a total nitrogen content of 0.07%. Available phosphorus content of the sawdust sample was 0.013% while the potassium content was 0.058%. The exchangeable cations content of the sawdust sample were as follows: calcium (Ca) was 0.02%, sodium (Na) was 0.026%, and magnesium (Mg) was 0.031%. Selected heavy metals contents of the sawdust sample were as follows: lead (Pb) was 2.31 mg/kg, cadmium (Cd) 0.48 mg/kg and chromium 37.2 mg/kg.

Table.2: **Chemical Properties of Sawdust used for the Study.**

Parameters	**Value**
Organic carbon (%)	53.9
Total N (%)	0.07
Available phosphorus (%)	0.013
K^+ (%)	0.058
Na^+ (%)	0.026
Ca^{2+} (%)	0.02
Mg^{2+} (%)	0.031
Lead (mg/kg)	2.31
Cadmium (mg/kg)	0.48
Chromium (mg/kg)	37.2

3.2 Effects of Waste Engine Oil on the Chemical Properties of the Soil after harvest

Waste engine oil pollution significantly decreased the pH of the soil, with the control experiment having the highest pH value. The pH of the contaminated soil decreased significantly with increasing concentrations of waste engine oil (Table 3). Waste engine oil did not significantly affect the organic carbon content of the soil at 1 % and 2 % contamination levels, but the effect became significant at 3 %, 4 %, and 5 % levels of contamination, with increase in the organic carbon content. Nitrogen content of the polluted soil increased with increasing concentrations of waste engine oil. Waste engine oil did not significantly affect the sodium content of the soil until at 5 % contamination level (Table 3).

3.3 Effects of Sawdust on the Chemical Properties of the Non- Contaminated Soil after harvest

The pH and the nitrogen content of the soil decreased significantly after the application of sawdust. Sawdust significantly increased the phosphorus, calcium and magnesium contents of the soil at $p < 0.05$. The addition of sawdust did not significantly affect the potassium content of the soil (table 3).

3.4 Effects of Sawdust on the Chemical Properties of the Contaminated Soil after harvest

The impact of sawdust on the pH of the contaminated soil did not become significant until the 5 % contamination level, where the addition of sawdust increased the pH of the soil significantly. The non- amended polluted soils have higher nitrogen values than the amended soils at all levels of pollution. At 5 % contamination level, Phosphorus, sodium and potassium contents of the soil increased with the application of sawdust. However, sawdust significantly increased the calcium content of the contaminated soils at all levels of contamination (Table 3).

3.5 Effect of Waste Engine Oil on the Shoot Nutrients of *Solanum esculentum* in the Contaminated Soil

The uncontaminated samples had the highest nitrogen, phosphorus, magnesium, potassium and calcium contents which subsequently decreased with increasing concentrations of waste engine oil (Table 4).

3.6 Effects of Sawdust on the Shoot Nutrients of *Solanum esculentum* in both Contaminated and Non-Contaminated Soil

Table 4 showed that while application of sawdust increased the nitrogen content of *Solanum esculentum* control 2 (T2), it has no significant effect on the phosphorus content. The shoots of *Solanum esculentum* in the non-amended samples (i.e. T1) had higher phosphorus value than in the amended samples (Table 4). Sawdust significantly improved the nitrogen, potassium and phosphorus content of *Solanum esculentum* when the soil is polluted with waste engine oil. However, this is not the case at the highest contamination level (5 %) (Table 4).

Table 3: Effect of Waste Engine Oil on the Chemical Properties of Soil after Harvesting of *Solanum esculentum*

Parameter Treatment		pH	OC (g/kg)	N (g/kg)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Na (mg/kg)
CONTROL(T1)	0.00	6.60e	47.88a	2.62a	33.35c	3.19b	29.67c	2403.7c	280.5a
WEO	1.00	6.17d	66.88b	3.02ab	34.88c	2.85a	30.97d	2245.0a	333.5a
	2.00	5.63c	66.89b	3.07ab	33.57c	2.94ab	31.53d	2302.3b	331.5a
	3.00	5.33b	67.23c	3.12b	30.65b	2.88a	24.67a	2414.8c	332.3a
	4.00	5.10a	71.06d	2.89ab	24.70a	3.18b	25.23ab	2501.2d	327.7a
	5.00	5.13a	73.67e	3.59c	25.03a	2.96ab	25.63b	2710.3e	218.1b
CONTROL(T2)	0.00	6.03b	27.02a	2.36a	34.64d	3.20c	34.53d	2730.8b	356.0d
AWEO	1.00	6.17c	47.37b	2.58b	28.93a	3.14c	33.20c	2692.5a	350.3c
	2.00	6.20c	51.34c	2.69c	29.06a	2.92a	34.53d	2684.5a	350.3c
	3.00	6.03b	51.66c	2.82d	29.88b	3.04b	31.73b	2826.2c	328.5b
	4.00	5.97b	53.74d	2.82d	33.52c	3.18c	33.23c	2820.8c	329.0b
	5.00	5.80a	55.96e	2.98e	35.90e	3.19c	30.11a	2862.0d	327.5a

Means with the same letter(s) in each column and group are not significantly different at $p < 0.05$

Legend: T1= Control Treatment 1
T2 = Control Treatment 2
WEO = Waste engine oil Pollution
AWEO = Amended Waste Engine Oil Pollution

Table 4: Effect of Waste Engine Oil Amended or Non- Amended on the Nutrient Content of *Solanum esculentum*

Property treatment	WEO	%N	%P	%K	%Ca	%Mg	%Na
CONTROL(T1)	0.00	2.47d	0.53e	0.92d	0.54b	0.36e	0.14b
WEO	1.00	2.22c	0.41d	0.43c	0.51a	0.29d	0.12a
	2.00	2.22c	0.39c	0.43c	0.57c	0.28c	0.12a
	3.00	2.15b	0.36b	0.39b	0.57c	0.28c	0.14b
	4.00	2.13b	0.22a	0.38a	0.67d	0.25b	0.15c
	5.00	2.06a	0.22a	0.38a	0.73e	0.22a	0.17d
CONTROL(T2)	0.00	2.60e	0.50f	0.86e	0.46b	0.37e	0.12a
AWEO	1.00	2.51d	0.49e	0.50d	0.41a	0.36d	0.13b
	2.00	2.32c	0.48d	0.48c	0.49b	0.35c	0.13b
	3.00	2.26b	0.39c	0.48c	0.55c	0.26b	0.16d
	4.00	2.27b	0.28b	0.46b	0.62d	0.26b	0.15c
	5.00	2.12a	0.27a	0.42a	0.70e	0.21a	0.13b

Means with the same letter(s) in each column and group are not significantly different at $p < 0.05$

Legend: WEO = Waste Engine Oil Pollution
AWEO = Amended Waste Engine Oil Pollution
Control T1 = Control Treatment 1
Control T2 = Control Treatment 2

4.0 DISCUSSION

The chemical properties of waste engine oil polluted soil showed that the pH of the soil increased with increasing concentrations of waste engine oil. This, according to Alexander (1999) and Eweis *et al.* (1999), could be due to the degradation of the hydrocarbons, which may have resulted in the release of acidic intermediates. Ekundayo and Obuekwe (1997) and Odu (1972) respectively reported significant increase in the organic carbon and nitrogen contents of hydrocarbon polluted soils. There is an increase in the Cations of soils treated with waste engine (Amadi *et al.,* 1993). When treated with Sawdust, the pH of the polluted soil increased, this agrees with the work of Ikhajiagbe and Anoliefo (2010). Ayuba *et al.* (2005), reported that organic wastes incorporation into the soils increase the pH because they contain cations. Olayinka and Adebayo (1985) and Tanee and Albert (2011) reported increase in organic carbon and nitrogen contents of oil polluted soils treated with organic wastes. This, according to them, is attributed to high nutrients level in the amended soils which stimulates microbial population and activity.

Waste engine oil significantly reduced the nutrients concentration (N, P, K, Ca, Mg and Na) in the shoot of *S. esculentum*, this agrees with the work of Victor and Sadiq (2002) who reported that treatment of soil with 4 and 5 percent waste engine oil significantly reduced the amount of water and dissolved mineral nutrients entering the plant. However, application of Sawdust significantly increased the concentration of nutrients (P, N, K, Ca and Mg) in the shoot of S. *esculentum.*

5.0 Conclusion

This study concluded that sawdust has the potential of amending waste engine oil- contaminated soil for increase tomato performance as it is capable of improving the uptake of nutrients by tomato from waste engine oil-contaminated soil.

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