Effects of Crude Oil on Fresh and Dry Weights of *solanum melongena*, *Phaseolus vulgaris* and *Cucumis sativus* Amended with Leaf Litter and Hydrogen Peroxide

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Abstract: ***Studies on the effect of crude oil on Fresh and Dry weights of Solanum melongena, Phaseolus vulgaris and Cucumis sativus using leaf litter and hydrogen peroxide as bioremediators were carried out in the Rivers State University Agricultural Farm. The experiment had 14 treatments and 5 replicates: T1:100ml crude oil (C/O) + 100ml H_2O_2, T2:100ml C/O + 100g l/l, T3:200ml C/O + 200ml H_2O_2, T4:200ml C/O + 200g l/l, T5:300ml C/O + 300ml H_2O_2, T6:300ml C/O + 300g l/l, T7:400ml C/O +400ml H_2O_2, T8:400ml C/O + 400g l/l, T9:500ml C/O + 500ml H_2O_2, T10:500ml C/O + 500g l/l, T11:no pollution + 500ml H_2O_2, T12:no pollution + 500g l/l, T13:500ml C/O + no amendment and T14:control. 420 experimental bags of 10kg capacity were filled with 10kg soil and polluted with C/O at different levels. 140 bags for each plant. Organic and Inorganic manure were applied at 1 month interval after pollution for 4 months, and planting was done afterwards. Fresh and dry weights of the three test crops were determined. Result of fresh weight of phaseolus vulgaris in organic soils had very high values (515-550g) while inorganic amended soils had lower values (49-62g), T11,T12 had the highest values of 655 and 823g while T14 had 137g. However, dry weight values for phaseolus vulgaris in organic amended soils recorded (100-114g) and Inorganic amended soils recorded (7.2-11.7), T11,T12 had higher values (162 and 180g), T14 had 118.4g. Result of fresh and dry weights of cucumis sativus was low values compared to that of phaseolus vulgaris. Cucumus sativus had fresh weight values for organic amended soils (72g-110g) while the inorganic amended soils had lower fresh weight values (37g-42g). The soils without pollution that were amended had the highest fresh weight values in both organic and inorganic amendments with values of (T11=100g and T12=138g). Result for dry weight of cucumber was generally low in all the treatments (0.7-5.3g) with T11 and T12 having the highest values (10.3 and 23.5g). Solanum melongena also had higher values in leaf litter amended soils than the H_2O_2 amended soils. Solanum melongena grown in unpolluted soils with both leaf litter and H_2O_2 had the best results at harvest (T1-100 and T12-104). Treatment 14 (T14) which is the control (no pollution + no amendment) had the lowest total fresh weight of garden egg (5.0). Results for dry weight of garden egg was low as observed in T14 (0.2), followed by T9 (0.6) and T10 (0.7) which had the highest concentration of crude oil. T13 (0.0) had no growth at harvest. The highest total dry weight of garden egg was observed in T12 (10.6) which had organic manure amendment (leaf litter) without pollution, while the inorganic amended soil (H_2O_2) without pollution (T13) had very high dry weight (7.5) as compared to the other treatments. Phaseolus vulgaris had higher fresh and dry weight than solanum melongena and cucumis sativus in the entire experiment hence it is a legume and a hyperaccumulator as well, and leaf litter served as a better amendment as the soils had higher fresh and dry weights.***

1. Introduction

Soil pollution is the introduction of hazardous of elements into the soil which affect plant growth and reduces soil quality. The soil can be contaminated by hazardous materials such as heavy metals, and landfills. Mandri and Lin, (2007) further explained that soil pollution by spent oil is rising due to the frequent use of petroleum products. Plants depend on the nitrogenous compounds present in the soil for their nutrition. Use of insecticides, pesticides and other artificial chemicals absorbs the nitrogen from the soil making it unfit for the growth for plants. Plants are responsible for holding the soil together firmly so, when the plants can not grow the soil splits, leasing to soil erosion. The myriad of oil exploration and exploitation activities in economics that produce and consume oil products bring about crude oil pollution as a natural consequence. This pollution according to Agbogidi and Ejemete, (2005) is due mainly to accidental discharge, human error, sabotage, transportation and other natural causes. Pollution of agricultural soil has in turn significantly affected the growth performance of plants. Agbogidi (2010) reported that contamination of soil with crude oil significantly reduced biomass accumulation in *Jatropha curcas* when compared to seedlings grown in uncontaminated subplots. He also observed a negative interaction between soil crude oil level and weight gain in the plants. It has been reported that crude oil kin soil makes it unsatisfactory for plant growth (Black, *et al.* 2005). This is due to insufficient aeration of the soil due to displacement of air from spaces between the soil particles by crude oil.

Udo and Fayemi (1975) discovered that plants growing in an oil-polluted environment are generally retarded with chlorosis of leaves, coupled with dehydration of the plant. Generally, crude oil contamination causes reduction of plant growth as it interfaces in the uptake of nutrients by plants. It also causes competition for the little nutrient available in the polluted soils between plats and soil microbes and ultimately suppresses the growth of plants in such soil.

2. Materials and Method

Experimental site

Rivers State University Teaching and Research farm, Port Harcourt with latitude of 4.7923 and a longitude of 6.9825. The study site is characterized by tropical monsoon climate with mean annual temperature of 32.15^{0}C, 66% humidity and 0.9948 atmospheric pressure, while, the soil is usually sandy or sandy loam underlain by a layer of impervious pan.

The study site was situated at the Rivers State University Research Farm which functions under the Faculty of Agriculture, Rivers State University, Port Harcourt, Nigeria. An area of 20m x 10m was marked out with a measuring tape and then cleared to ground level. No covering was made so as to ensure sunlight had a direct focus on it, and rain to get to the plant. It represented a natural environment for proper and adequate growth.

Planting Materials

Treated seeds of garden egg (*Solanum melongena*), beans (*Phasseolus vulgaris*) and cucumber (*Cucumis sativus*) were the planting materials used for the experiment. They were obtained from ADP (Agricultural Development Programme) Rumuokoro, Port Harcourt, and Rivers State, Nigeria.

Experimental bags

A total of 420 experimental bags filled with soil were used for the whole experiment. 70 experimental bags were used for each plant which was replicated 2 times for the three (3) plants. The experimental bags were purchased from mile 3 market, Port Harcourt, and were equivalent to 10kg weight which was punctured on all sides and beneath so as to prevent water logging of the experimental bags.

Pollutant (Crude oil)

100 litres of crude oil was purchased from the Port Harcourt Refinery, Eleme, Rivers State, which was then conveyed to the Rivers State University Research Farm and applied as a pollutant on the agricultural soil.

Organic and Inorganic Fertilizer

Organic and inorganic fertilizers were used to carry out this experiment. The organic fertilizer used here was *Terminalia catappa* (leaf litter) while the inorganic fertilizer was Hydrogen peroxide (H_2O_2). The *Terminalia catappa* was obtained from a site in the Rivers State University while the hydrogen peroxide was obtained from a scientific supply shop in Alakahia, Port Harcourt. The leaf litters were gathered in very large quantities, dried in the University of Port Harcourt green house and analysed before use.

Amendment Materials and Treatment

The following materials were used as remediation agents: leaf litter and hydrogen peroxide. The experiment was in 3 blocks for each plant. Block 1; 10kg of soil was used with 100, 200, 300, 400 and 500ml of crude oil amended with leaf litter (100,200,300,400,500g) and hydrogen peroxide (100,200,300,400 and 500ml) with some unpolluted soils that served as the control. The same experiment was replicated for blocks 2 and 3 respectively.

Levels of Crude Oil Pollution and Amendments with Organic and Inorganic Fertilizers on *Phaseolus vulgaris, Cucumis sativus* and *Solanum melongena*

T1	100ml crude oil + 100ml H_20_2
T2	100ml crude oil + 100g leaf litter
T3	200ml crude oil + 200ml H_20_2
T4	200ml crude oil + 200g leaf litter
T5	300ml crude oil + 300ml H_20_2
T6	300ml crude oil + 300g leaf litter
T7	400ml crude oil + 400ml H_20_2
T8	400ml crude oil + 400g leaf litter
T9	500ml crude oil + 500ml H_20_2
T10	500ml crude oil + 500g leaf litter
T11	NO POLLUTION + 500ml H_20_2
T12	NO POLLUTION + 500ml leaf litter
T13	500ml crude oil + NO AMENDMENT
T14	CONTROL

Determination of Fresh Weight

The fresh weights of the harvested plants were weighed with a weighing scale (electric scale). The whole plant part was weighed immediately after harvest.

Determination of Dry Weight

Determination of dry weight was done by oven drying for about three days which was weighed using the weighing scale (LP 620 model) and the results recorded.

3. Results

Plant Morphological Parameters

Total Fresh and Dry Weight of *Solanum melongena* (g)

Results for both fresh and dry weight of garden egg grown in different concentrations of crude oil, and later remediated and weighed after harvest are as shown in Fig. 1. Garden egg had a higher fresh weight (7-15) when grown in leaf litter amended soils (organic manure) in most of the treatments than those grown in Hydrogen Peroxide (H_2O_2) amended soils (7-12). While those grown in polluted soils with no amendment died before harvest. Garden egg grown in unpolluted soils with both leaf litter and H_2O_2 had the best results at harvest (T1-100 and T12-104) and also produced a few fruits on the organic amended soil without pollution (T12), while the inorganic amended soil without pollution (T11) produced no fruit at harvest but performed better than those grown on polluted and amended soils. Treatment 14 (T14) which is the control (no pollution + no amendment) had the lowest total fresh weight of garden egg (5.0)

Results for dry weight of garden egg was low as observed in T14 (0.2), followed by T9 (0.6) and T10 (0.7) which had the highest concentration of crude oil. T13 (0.0) had no growth at harvest. The highest total dry weight of garden egg was observed in T12 (10.6) which had organic manure amendment (leaf litter) without pollution, while the inorganic amended soil (H_2O_2) without pollution (T13) had very high dry weight (7.5) as compared to the other treatments.

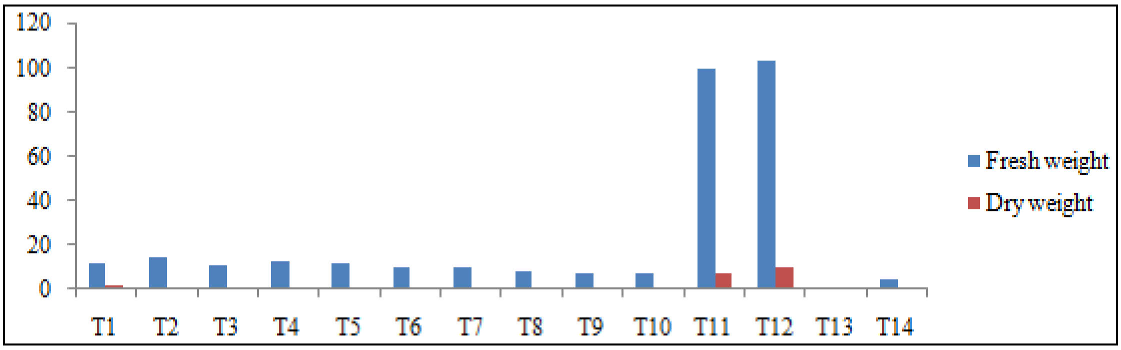

Figure 1: Effects of Organic and Inorganic Manure on the Fresh and Dry Weight of Garden Egg Planted on Soil Polluted with Crude Oil**.** T1 = (100ml crude oil + 100ml H_20_2), T2 = (100ml crude oil + 100g leaf litter), T3 = (200ml crude oil + 200ml H_20_2), T4 = (200ml crude oil + 200g leaf litter), T5 = (300ml crude oil + 300ml H_20_2), T6 = (300ml crude oil + 300g leaf litter), T7 = (400ml crude oil + 400ml H_20_2), T8 = (400ml crude oil + 400g leaf litter), T9 = (500ml crude oil + 500ml H_20_2), T10 = (500ml crude oil + 500g leaf litter), T11 = (no pollution + 500ml H_20_2), T12 = (no pollution + 500g leaf litter), T13 = (500ml crude oil + no amendment), T14 = (control).

Total Fresh and Dry Weight of *Phaseolus vulgaris* (g)

Results for fresh weight of *phaseolus vulgaris* grown in different concentrations of crude oil polluted soil which was later remediated with leaf litter and Hydrogen Peroxide (H_2O_2) and weighed after harvest shown in Fig. 2.

Beans had a higher fresh weight when grown on leaf litter amended soils than that which was grown on H_2O_2 amended soils. The highest fresh weight of beans was observed in T12 (823g) followed by that of T11 (655). T8 (550) and T10 (550) also observed high fresh weight as compared to the other treatments. The lowest fresh weight of beans was observed in T13 (33) which significantly differed from the other treatments. T14 (137) had a higher fresh weight as compared to T1 (49), T3 (62), T5 (53), T7 (59) and T9 (57) all of which were polluted and amended with H_2O_2.

Beans had the highest dry weight in T11 (162.6) and T12 (180.1)), followed by T2 (114.7), T4 (113.42), T6 (103.1), T8 (102.5) and T10 (100.8). T13 (5) had the lowest dry weight of beans followed by T3 (6.05), T14 (18.4) had a higher dry weight as compared to T1 (11.7), T3 (6.05), T5 (7.2), T7 (8.1), T9(7.4) and T13 (5).The lowest dry weight for both H_2O_2 and leaf litter amended soils was observed in T3 (6.05), while T13 (5) gave the lowest among the 14 treatments.

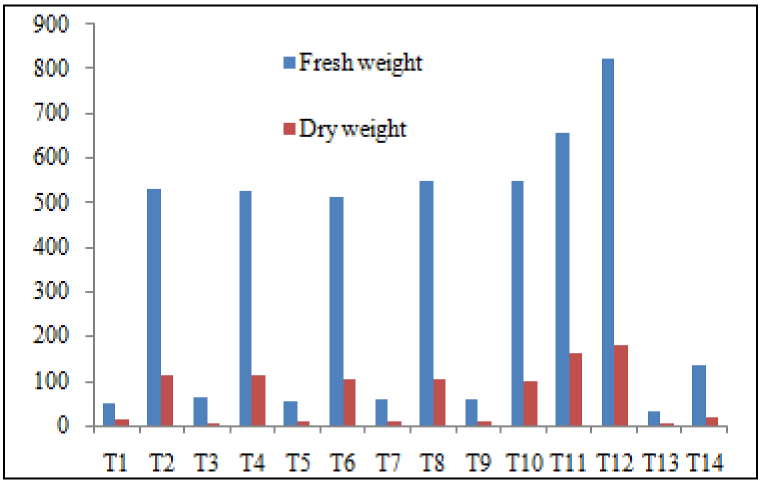

Figure 2: Effects of Organic and Inorganic Manure on the Fresh and Dry Weight of Beans Planted on Soil Polluted with Crude Oil**.** T1 = (100ml crude oil + 100ml H_20_2), T2 = (100ml crude oil + 100g leaf litter), T3 = (200ml crude oil + 200ml H_20_2), T4 = (200ml crude oil + 200g leaf litter), T5 = (300ml crude oil + 300ml H_20_2), T6 = (300ml crude oil + 300g leaf litter), T7 = (400ml crude oil + 400ml H_20_2), T8 = (400ml crude oil + 400g leaf litter), T9 = (500ml crude oil + 500ml H_20_2), T10 = (500ml crude oil + 500g leaf litter), T11 = (no pollution + 500ml H_20_2), T12 = (no pollution + 500g leaf litter), T13 = (500ml crude oil + no amendment), T14 = (control)

Fresh and Dry Weight of Cucumber (g)

Results for both fresh and dry weights of cucumber grown in different concentrations of crude oil and later remediated and weighed after harvest is as shown in Fig. 3.

Cucumber had the highest fresh weight when grown on leaf litter amended soils than those grown on the H_2O_2 amended soils. T12 (138g) had the highest fresh weight and was significantly different from the other treatments, followed by T6 (110g). T11 (100g) also recorded a high fresh weight which was lower than that of T6 (110g).

Treatments 1 (37g), T3 (44g), T5 (42g), T7 (41g) and T9 (37g) had lower fresh weights and no significant difference as compared to treatments 2 (84g), T4 (84g), T6 (110g), T8 (72g), T10 (78g), T11 (100g) and T12 (138g) while T14 (9g) had the lowest fresh weight of cucumber. T13 (0.0g) had no growth, hence there was no result for both fresh and dry weights.

Cucumber had the highest dry weight on T12 (23.5g) which was significantly higher than the other treatments followed by T11 (10.3g). The lowest dry weight was observed in T1 (1.1), T3 (0.91g), T5 (1.05g), T7 (1.1) and T9 (0.7g), while T13 (0.0g) observed no growth. T14 (0.13g) also had a very low dry weight as observed in beans.

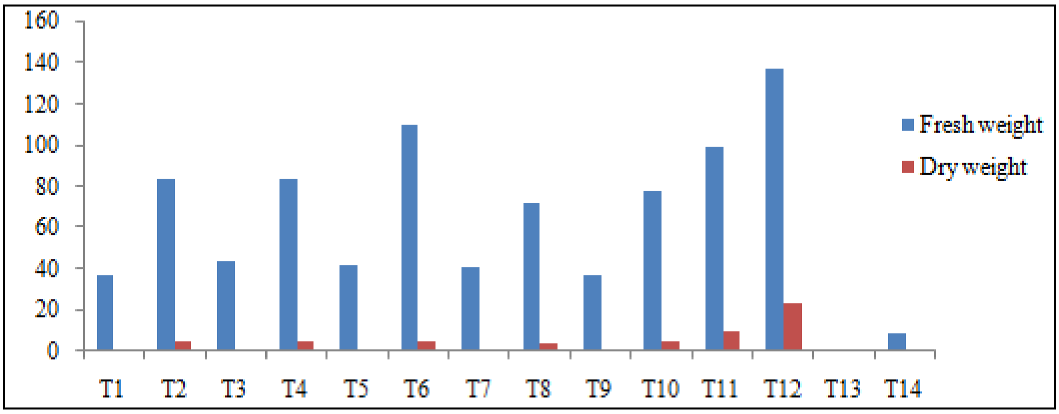

Figure 3: Effects of Organic and Inorganic Manure on the Fresh and Dry Weight of Cucumber Planted on Soil Polluted with Crude Oil**.** T1 = (100ml crude oil + 100ml H_20_2), T2 = (100ml crude oil + 100g leaf litter), T3 = (200ml crude oil + 200ml H_20_2), T4 = (200ml crude oil + 200g leaf litter), T5 = (300ml crude oil + 300ml H_20_2), T6 = (300ml crude oil + 300g leaf litter), T7 = (400ml crude oil + 400ml H_20_2), T8 = (400ml crude oil + 400g leaf litter), T9 = (500ml crude oil + 500ml H_20_2), T10 = (500ml crude oil + 500g leaf litter), T11 = (no pollution + 500ml H_20_2), T12 = (no pollution + 500g leaf litter), T13 = (500ml crude oil + no amendment), T14 = (control)

4. Discussion

A constant reduction in the growth of the plants with increase in crude oil pollution could have been as a result of the soil parameters that changed thereby imposing conditions that were stressful on both the plants and the soil. The condition may have resulted to a disruption of water uptake and exchange of gases which eventually caused physiological drought. According to Adams and Ellis, (1960), a long establishment of soils contaminated with petroleum hydrocarbons doesn't allow the free flow of water from top to bottom, and it becomes swampy or water-logged when the water is in excess.

Determination of Fresh and Dry weights

The presence of crude oil and its derivatives in soil caused an alteration in the fresh and dry weights of garden egg, beans and cucumber in all the treatments except for those without crude oil pollution. Bean plant had the highest fresh and dry weight when compared to the two other test crops hence a phytoremediator and a hyperaccumulator. Cucumber and garden egg had high fresh and dry weights only on the unpolluted and amended soils whereas the control soils (T14) had very low values. But most of the samples died before harvest due to the presence of this petroleum hydrocarbon that had altered the growth of these plants. There was inhibition and numbers of seeds germinated were reduced and did not look healthy. This is in agreement with the reports of Amadi *et al*., (1993) and Onuh *et al.,* (2008). Generally, organic manure and H_2O_2 treated bags produced higher fresh and dry weight percentage than the contaminated soil especially on the leaf litter amended soils.

Litter plays a fundermental role in the nutrient turnover and in the transfer of energy between plants and soil, the source of nutrients being accumulated in the uppermost layers of the soil (Singh, 1971).

The improvement in fresh and dry weights in the nutrient supplemented soils could be attributed to the fact that the leaf litter and hydrogen peroxide acted as a means of nutrient supply to the soil which had obvious results in the soils with beans as sample crops.

The improved fresh weight observed in the amended soils may be that the nutrients in these amended soils enhanced the improvement in the plant height of beans, cucumber and garden egg with time. Madukwe *et al*., 2008, and Onuh *et al*., 2008 also reported the annexation of organic manure on the growth and morphology of crops and also to the reports of Rose *et al.* (1996) who observed that the continuous application of higher amounts of manure would lead to an increased plant nutrient and organic matter in the soil, which generally improves the physio-chemical characteristics of the soil.

5. Conclusion

The study has given appreciable details of how crude oil and its derivatives affect the soil physiochemistry and all other parameters adversely, on productivity of crops which comprises inhibition of germination, growth, fresh and dry weights. Crude oil pollution interfered with the entire plant nutrients present thereby increasing petroleum hydrocarbon amounts in soils, which adversely affected the general plant health.

From the revealed results, beans had a better performance when compared to cucumber and garden egg in the whole experiment because of its hyperaccumulative and nitrogen fixing potentials. Cucumber and garden egg had very poor fresh and dry weights and poor yield as well on all the treatments. From the results, both the polluted, unpolluted and polluted and amended soils performed extremely well in the beans experiment whereas unpolluted and leaf litter amended soils were the only soils that had high fresh and dry weight values in the cucumber and garden egg soils, while the other treatments had very low fresh and dry weights. From the results, the polluted and leaf litter amended soils performed extremely better than the control soils in the bean experiment which implies that regardless of the condition of the soil, beans requires organic amendments for maximum yield. Whereas; cucumber and garden egg gave high fresh and dry weight values only in the unpolluted and leaf litter amended soils, which implies that the aforementioned amendments were not capable of remediating the soil for the growth of cucumber and garden egg.

Based on this study, therefore, it can be suggested that further research be conducted, so as to establish optimal levels of both inorganic manure supplements that are likely to impact maximum economic gains and make agricultural sustainability guaranteed in the areas that produce oil of the humid tropics that are vulnerable to pollution with crude oil.

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