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Effect of crude oil polluted soil on germination and growth of soybean (*Glycine max*)

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ABSTRACT

The effect of crude oil on germination and growth of *Glycine max* was investigated in Calabar, Nigeria. Planting was done in polythene bags measuring (60 x 25x 15cm) and each bag was filled with 5kg of top soil (0-15cm depth) collected from the biological science experimental farm. Five polythene bags per crude oil concentration were used, which made a total of 25 bags. Treatment of the soil was carried out by adding varying concentrations of crude oil ranging from 20ml, 40ml, 60ml and 80ml into soil samples contained in polythene bags. Each concentration of crude oil was added to each soil sample contained in 5 polythene bags and was thoroughly mixed using hand trowel. Three seeds of soybean (*Glycine max*) were planted into each of the soil sample treated with varying concentrations of crude oil. The result indicated that crude oil pollution significantly reduces ($p < 0.05$) the growth of the soybean plant at higher pollution rate than at lower pollution rate. This thus implies that the higher the quantity or concentration of the crude oil in the soil the more effect it would have on the growth and germination of soybean plant.

Key words: Soybean, Crude oil, Germination and growth.

INTRODUCTION

Crude oil and petroleum product is a major source of energy in Nigeria and the world at large. Oil plays a vital role in shaping the economic and political future of the world. Petroleum industry has created economic boom for Nigeria and at the same time environmental and socio - economic problems [1]. Crude oil is extracted in locations that are remote and transported in large quantity, for it to be refined and for the derivation of its useful by-products. The transportation method employed includes the use of oceanic tankers and pipelines overland. These transportation methods sometimes pollute the environment by accidental oil spills and operational discharge resulting to the loss of very large quantities of crude oil into land and sea bodies. This discharge of crude oil on land affects the physicochemical properties of the soil thus causing deleterious effect on plant germination and growth [2]. Consequently, the presence of these hydrocarbons from crude oil in soils results to the further deposition of heavy metals and other various components of hydrocarbon, and decrease in soil fertility and toxicity of plant thereby reducing crop yield [3]. As a result of the increasing economic crisis and highly dependence on importance cash crops such as soybean (*Glycine max*) to both the generation of income and meetings of human and animals need at large, this research is aimed at ascertaining the germination and growth rate of soybean (*Glycine max*) plant on crude oil polluted soil.

MATERIALS AND METHODS

The soybean seeds (TGX 728-ID) were collected from National Cereal Research Institute (N.C.R.I) Amakama Olokoru Umuahia in Abia State, while the crude oil was obtained from Nigerian Agip Petroleum Company, Port Harcourt in River State. The field trial experiment was conducted at the University of Calabar, behind Biological Science Department. A pre-treatment was carried out on the seeds to absorb a uniform amount of moisture for proper growth and to eliminate variation in growing condition. This was carried out just before planting by soaking the seeds to be planted in water for five minute to obtain usually non-infested viable seed for planting. Planting was done in polythene bags measuring (60 x 25x 15cm) and each bag was filled with 5kg of top soil (0-15cm depth) collected from the biological science experimental farm. Five polythene bags per crude oil concentration were used, which made a total of 25 bags. Treatment of the soil was carried out by adding varying concentrations of crude oil ranging from 20ml, 40ml, 60ml and 80ml into soil samples contained in polythene bags. Each concentration of crude oil was added to each soil sample contained in 5 polythene bags and was thoroughly mixed using hand trowel. Three seeds of soybean (*Glycine max*) were planted into each of the soil sample treated with varying concentrations of crude oil. The contrast treatment of number of seeds that germinated from each plastic bag was summed up after seven days. The percentage germination of each treatment was calculated thus;

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

Data collection

Observations on growth and morphology were made on the following:

Days to seedling emergence, Percentage of seedling emergence, Plant height, Leaf area, leaf Length and Number of leaves.

Experimental design/ Statistical analysis

The experiment was arranged in a Randomised Completely Block Design (RCRD), and data collected were subjected to analysis of variance (ANOVA) test while the means were separated using least significant difference (LSD) test.

RESULTS

The effect of crude oil on germination and growth of soybean plant have been investigated on the following parameters. Plant height, leaf length, leaf area and number of leaves. The result obtained shows that significant differences ($p < 0.05$) exist between the various concentration of crude oil used for the experiment during the four weeks data study period. The result for week one and two showed no significant difference ($p > 0.05$) in the plant height but week 3 and week 4 showed significant differences ($P < 0.05$) with 80ml of crude oil having effect on the growth of soybeans plant (Table 1). It was also observed that they were significant reduction ($P < 0.05$) in the leaf length of soybeans plant, indicating that crude oil reduced the leaf length of the plant at higher concentration than at lower concentration as compared with the control (Table 2). The result also showed that they were no significant differences ($P > 0.05$) in the leaf area of the soybean plant at week one and week two but significant differences ($P < 0.05$) were observed at week three and week four with the higher concentration having more effect on the leaf area of soybean plant as compared with the control value (Table 3). The result also showed that they were significant difference ($P < 0.05$) in the number of leaf in week one, week three and week four with no significant difference ($P > 0.05$) in week 2. The significant differences ($P < 0.05$) observed in week one, three and four indicated, that the crude oil affected the number of leaves of the soybean plant (Table 4). The result on the days to seedling emergence showed that they were significant difference ($P < 0.05$) in the germination rate of the soybean plant as compared with the control, implying that crude oil affected the germination rate of soybean at the concentrations used for the study.

Table 1 Plant height

Duration	Control	20ml	40ml	60ml	80ml
Week1	12.96 ^a ±0.52	10.08 ^a ±2.05	9.72 ^a ±1.73	11.02 ^a ±0.52	9.18 ^a ±0.73
Week2	21.45 ^a ±0.80	18.8 ^a ±3.43	19.34 ^a ±0.81	21.76 ^a ±1.10	15.98 ^a ±1.12
Week3	18.92 ^a ±0.45	13.9 ^b ±2.62	13.34 ^b ±0.93	14.00 ^b ±0.23	12.42 ^a ±0.28
Week4	26.68 ^a ±1.02	17.60 ^b ±3.45	19.22 ^b ±0.96	18.12 ^b ±0.50	16.00 ^a ±0.48

Means with same superscript along horizontal array indicated no significant difference ($p > 0.05$)

Table 2 Leaf length

Duration	Control	20ml	40ml	60ml	80ml
Week1	2.90 ^a ±0.14	2.03 ^b ±0.23	1.36 ^c ±0.22	2.20 ^b ±0.32	1.90 ^b ±0.39
Week2	6.06 ^a ±0.26	4.53 ^a ±0.39	3.26 ^c ±0.27	4.36 ^b ±0.62	4.44 ^b ±0.05
Week3	6.94 ^a ±0.28	4.83 ^b ±0.38	3.84 ^c ±0.24	4.88 ^b ±0.49	5.28 ^b ±0.05
Week4	7.34 ^a ±0.20	5.4 ^b ±0.55	4.64 ^c ±0.20	5.66 ^b ±0.40	6.00 ^c ±0.55

Means with same superscript along horizontal array indicated no significant difference ($p > 0.05$)

Table 3 Leaf area

Duration	Control	20ml	40ml	60ml	80ml
Week1	1.88 ^a ±0.04	1.40 ^a ±0.38	0.90 ^a ±0.18	1.46 ^a ±0.26	1.40 ^a ±0.26
Week2	3.24 ^a ±0.26	2.30 ^a ±0.50	2.72 ^a ±0.19	3.00 ^a ±0.16	2.46 ^a ±0.25
Week3	5.34 ^a ±0.29	3.85 ^d ±0.61	3.94 ^c ±0.13	4.40 ^b ±0.22	3.60 ^a ±0.27
Week4	6.58 ^a ±0.30	4.80 ^c ±0.43	4.70 ^c ±0.08	4.96 ^b ±0.24	4.42 ^d ±0.20

Means with same superscript along horizontal array indicated no significant difference ($p > 0.05$).

Table 4 Number of leaves

Duration	Control	20ml	40ml	60ml	80ml
Week1	5.2 ^a ±0.37	4.00 ^c ±0.82	3.4 ^d ±0.24	5.00 ^a ±0.32	4.00 ^c ±0.32
Week2	6.2 ^a ±0.49	4.75 ^a ±0.95	5.2 ^a ±0.86	5.00 ^a ±0.45	4.00 ^a ±0.89
Week3	8.4 ^a ±0.51	6.25 ^d ±0.85	7.4 ^c ±0.68	7.6 ^a ±0.51	5.6 ^a ±0.75
Week4	11.6 ^a ±0.75	8.00 ^d ±1.08	8.8 ^c ±0.73	9.8 ^a ±0.66	7.6 ^d ±0.75

Means with same superscript along horizontal array indicated no significant difference ($p > 0.05$)

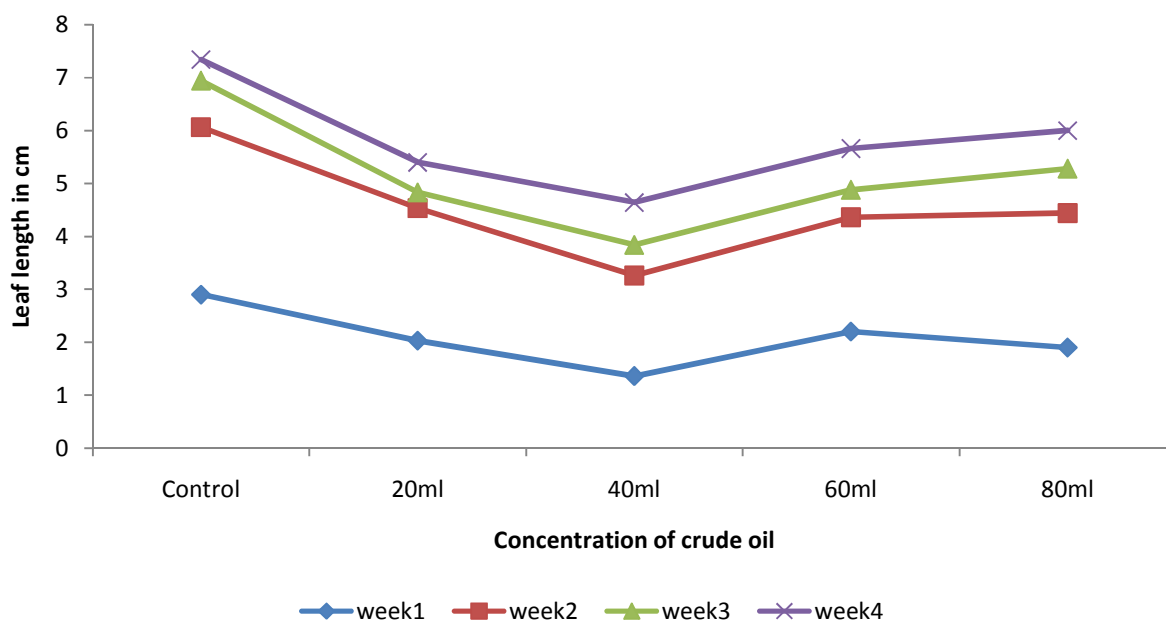


Fig. 1: Effect of crude oil on leaf length of soybean plant

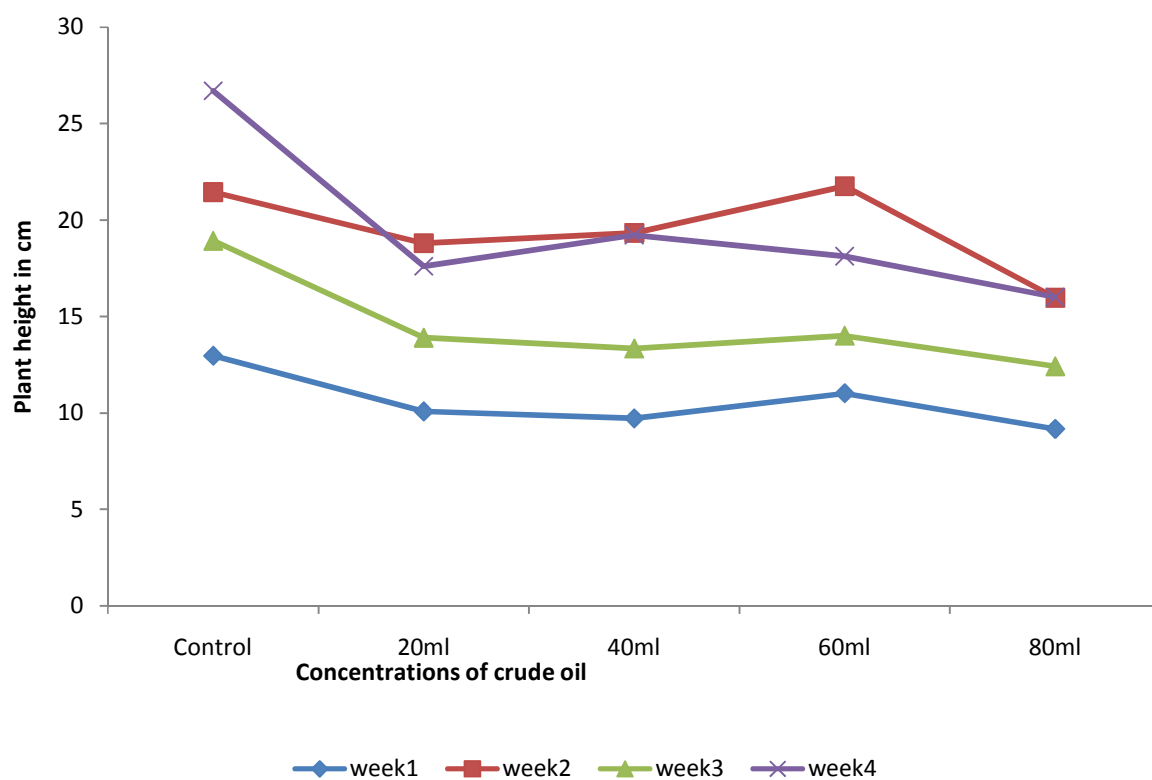


Fig. 2: Effect of crude oil on the plant height

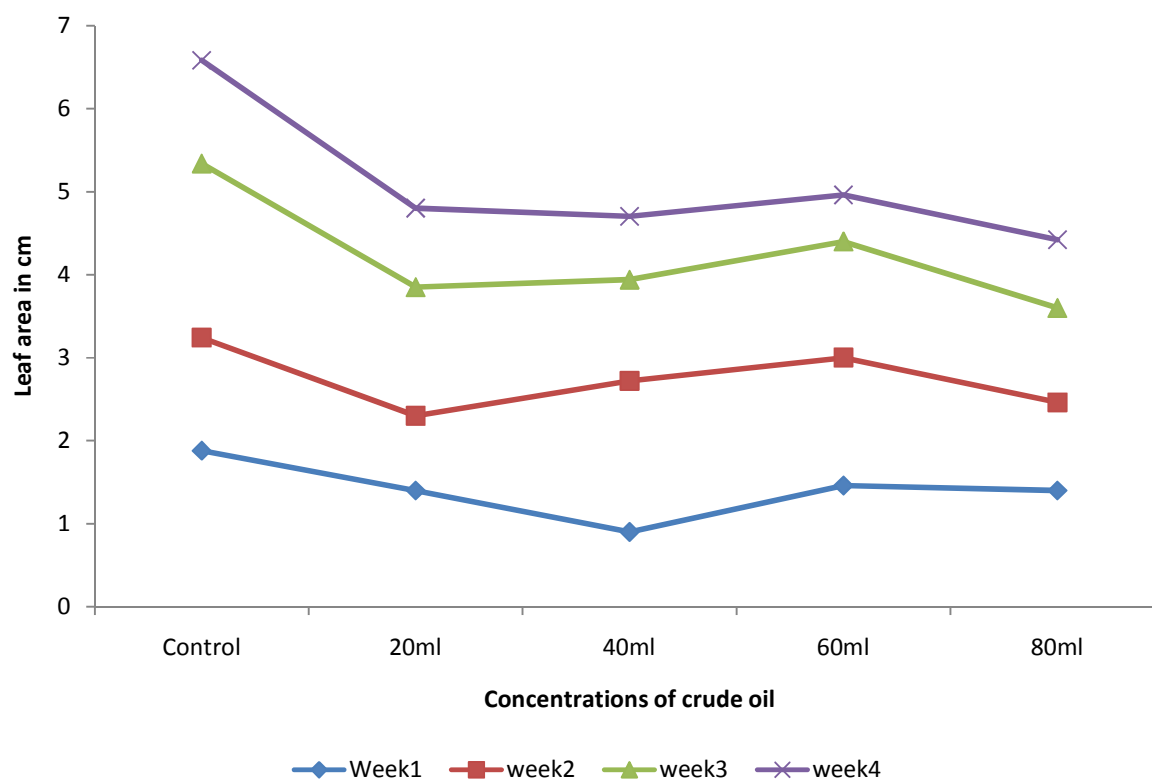


Fig. 3: Effect of crude oil on Leaf area of soybean plant.

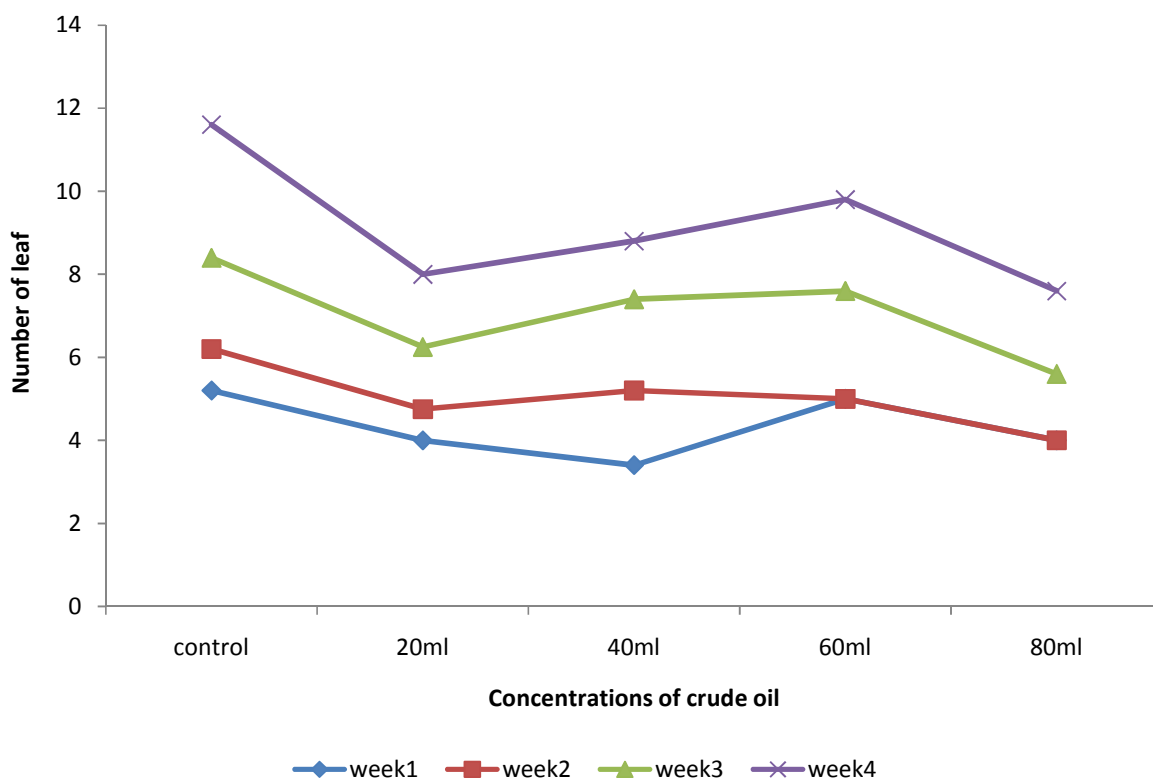


Fig.4: Effect of crude oil on number of leaves of soybean plant.

DISCUSSION

The effects of crude oil on the germination and growth of soybean plant was investigated. The result revealed that the crude oil significantly affected ($P>0.05$) the germination rate of the soybeans plant at the various pollution level. However, the percentage emergence at one week revealed that 80%, 73.33%, 66.67%, 53.33% and 66.67% of seeds germinated in control, 20ml, 40ml, 60ml and 80ml of crude oil polluted soil. From these result it indicates that crude oil have effect on the seedling germination. One of the most possible reasons for inhibition of germination in crude oil contaminated soil is due to unsatisfactory soil conditions because of insufficient aeration due to decrease in air filled space and increased demand of oxygen by oil decomposing microorganisms [4].

The result on plant height which recorded no significant effect of the crude oil on the plant at week one and two, showed that as the plant continued to grow on the polluted soil the toxicity of the oil suffix thus affecting the plant height. In week three and four, they were significant differences ($p<0.05$) showing the reduction of the plant height at different concentration of the oil pollution as compared with the control plant (Fig. 2). The reduction of plant growth observed in this study could be due to reduction of mineral element with increasing oil concentration in the soil. This finding is similar to that of [5] who also observed significant effect of engine oil on leaf vegetable (*Amaranthus hydrides L.*). This effect could also be as a result of reduced availability of mineral elements because according to [6], plant nutrition is based not only on the presence of mineral elements in the soil but their availability.

The result on leaf area also revealed that no significant difference ($P>0.05$) exist at the different pollution level in week one and two of the study but significance effect were observed in week three and four between the different pollution level (Fig. 3). The reduction of leaf area of the plants due to the addition of crude oil can aggravate the photosynthetic level in the plant with resultant poor performance of the plant. The lower performance of the plant treated with crude oil at the first week of growth indicates that the plants has reduced resistant to pollution by crude oil at week one and two than week three and four. This observation is similar to that of [7] who observed more adverse effects on maize exposed to crude oil pollution at tender age than later stages.

The effect of crude oil on the leaf length and number of leaves of soybeans plant was also significantly affected from week (1-4) of the study. [8] noticed a significant reduction in heights of seedlings, leaf length and number of leaves for all levels of treatment relative to the control (Fig. 1). Crude oil pollution had a significant effect on the germination and growth of soybeans plant. The effect on germination was not profound on soybeans plant but profound on the growth of the plant at various concentration of treatment. However, this study has revealed that crude oil pollution has economic implication on growth of soybeans plant.

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