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Growth sensitivity and vulnerability in seedlings of *Sorghum bicolor* L. grown in crude oil polluted soil

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Abstract

The impact of crude oil on seedling growth and survival of *Sorghum bicolor* was evaluated view of profiling the concentration at which this plant can survive crude oil contamination being a staple food in the study area. *Ex-Situ* analysis experimental analysis using four treatments (50ml, 100ml, 150ml and 200ml) concentrations of crude oil and water as control on 7kg of loamy soil weighed on plastic bowl. Seed viability was tested using the floating method and six (6) seeds were sown in each bowl at 3cm depth. Treatment were applied 14 days after planting to the established seedlings and observation of growth parameters such mean plant height, mean stem girth, mean leaf mortality and mean leaf areas of seedlings were studied for four (4) weeks. The result showed significant difference ($P<0.05$) in seedling height in the control compared to the treatments and also in seedling height in 50ml, 100ml, 150ml and 200ml respectively. The highest height of seedlings was obtained in control whereas the least mean height of seedlings was obtained in 100ml. The maximum plant girth of seedlings was obtained in control whereas the least girth was obtained in 150ml. The maximum leaf area of the plant was obtained in control while the least was recorded in 200ml treatment. The highest value of leaf mortality was recorded in 150ml while the lowest number of leaf mortality was obtained in 50ml. The study has demonstrated that seedlings of *Sorghum* grown in crude oil contaminated soil were sensitive and vulnerable.

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Introduction

The oil producing regions of Nigeria is constantly undergoing threat from crude oil activities, mineral resources exploration and exploitation resulting to challenge in crop growth (Erhenhi and Ikhajiagbe, 2012), development and yield. There has been severe impact of on soil in different regions of Nigeria caused by crude pollution including the contamination of soil and plants in Idheze, Delta State, Eleme, Rivers State in addition to other oil producing areas (Abii and Nwosu, 2009; Ikhajiagbe *et al.,* 2012). This has led to destruction of plant communities, animal diversity similarly altering food production and ecosystem benefits.

Most countries of the world are finding new and innovative ways to attain food sufficiency for their growing population (Mingsheng *et al.,* 2012). Successive government in Nigeria has embarked on various agricultural programs to improve the lot of its people to tackle hunger and mortality (Matemilola and Elegbede, 2017). It is imperative to sift some teething problems affecting food production with a view to proffering solutions through researches. Cereals like rice, maize, millets and sorghum major staple diets in Nigeria, Africa and some other countries in the world.

Mutegi *et al.* (2010) reported that sorghum is the fifth cereal grown and regarded to be very important in Asia, Africa and Central America. In most households the northern part of Nigeria, *Sorghum* constitute major diets. There are environmental components mimical to the survival and growth of *Sorghum*.

The exposure of *Sorghum* to crude treatments, revealed its adverse impacts on the plant species. *Sorghum* cultivation has increased globally by 66%.

Sorghum is used to produce flat breads and other diary forms which vary in regions of Africa and Asia (Peterson *et al.,* 2009). Cropland, forest, farmlands and the natural vegetation in Nigeria are constantly under threat due to oil spillage especially the oil producing areas (Ogri, 2001).

Some earlier workers revealed crops like wheat, ground nuts, okra, and some others were affected by crude; sprouting and healthy growth were hindered. The oil not processed underneath the surface of the earth regarded as crude (Ryder *et al.,* 2004) can vary in different colours; clear to black and can exist either as a liquid or solid. The general properties of crude depend on their structure and chemical composition (Ryder *et al.,* 2004). Subsequent pollution by crude can result to reduce fertility, affect crop growth, contaminate soil for long duration and affect plants' metabolism (Gong *et al.,* 1996; Erhenhi, 2017; Ikhajiagbe *et al.,* 2009). The study therefore evaluated the growth sensitivity and vulnerability of seedling of *Sorghum bicolor* L. in crude polluted soil.

Materials and methods

Planting method

Ex-situ experimental analysis at the experimental site of the Department of Botany, campus II of the Delta State University, Abraka, Delta State, Nigeria was done using 7kg of loamy soil weighed in planting bowl. Twenty (20) planting bowls were used in this experiment. Each planting bowl was perforated to allow for aeration and drainage. Six (6) viable seeds were sown into each of the bowls at a depth of 3cm. Daneshvar *et al.* (2017) method was used for the test of seed viability of which the viable seeds were selected and used for planting.

Sprouting began after 5 days and when the plants grew up to a certain stage of uniform height, the numbers of seedlings were thinned down to three seedlings per bowl 14 days after germination. This experiment was laid down in four (4) replicates; control and treatments (50ml, 100ml, 150ml and 200ml). Note. Treatments were only applied to the established seedlings thinned into three seedlings per bowl in the twenty (20) planting bowls.

Determination of growth parameters

Growth parameters assessed during the study were height of plant (cm), leaf area (cm^2), stem girth (cm) and leaf mortality. Three plants were selected to allow calculation of mean and standard deviation. The height of the plant was obtained by measuring the basal to the plant tip. Leaf area was by multiplying the values of the length and breadth with correction factor of 0.75 (Agbogidi *et al.,* 2007). The stem girth (circumference) was measured using a thin thread wrapped around the plant and the length measured using calibrated measuring tape. Leaf mortality was obtained by subtracting the healthy leaves from the initial values recorded.

Data analysis

Microsoft Excel statistical software was used to do the analysis of variance on the data collected from the field studies and was built into graphs for easy understanding.

Results

Field data from investigation of crude impact on survival and growth of the seedlings was obtained following affected growth indices like plant height, girth, area of leaf and leaf mortality. Significant difference ($P<0.05$) was obtained in seedling height in the control compared to the treatments. Significant difference ($P>0.05$) was not obtained in seedling height in 50ml, 100ml, 150ml and 200ml respectively (Fig. 1). The plant height showed sensitivity to crudetreated soil. The plant height decreased from control to the 50ml with steady decrease from 50ml to 200ml. The maximum plant height was obtained in control while the least was obtained in 100ml (Fig.1). Information from the study revealed that *Sorghum bicolor* is very sensitive to crude contamination. It was observed that crude polluted soil lower its retention capacity hence making it difficult for the *Sorghum bicolor* seedlings sown on the contaminated planting bowls to perform poorly. The maximum girth was obtained in control while the least was obtained in 150ml. The mean plant girth in control had significantly difference ($P<0.05$) from values of girth in 100ml. No significant difference ($P>0.05$) between girth in 150ml and 200ml (Fig. 2).There was decrease girth from control to 50ml. There was an increase in mean plant girth of *Sorghum bicolor* from 50ml to 100ml (Fig. 2). Mean plant girth decreased from 100ml to 150ml and 200ml respectively.

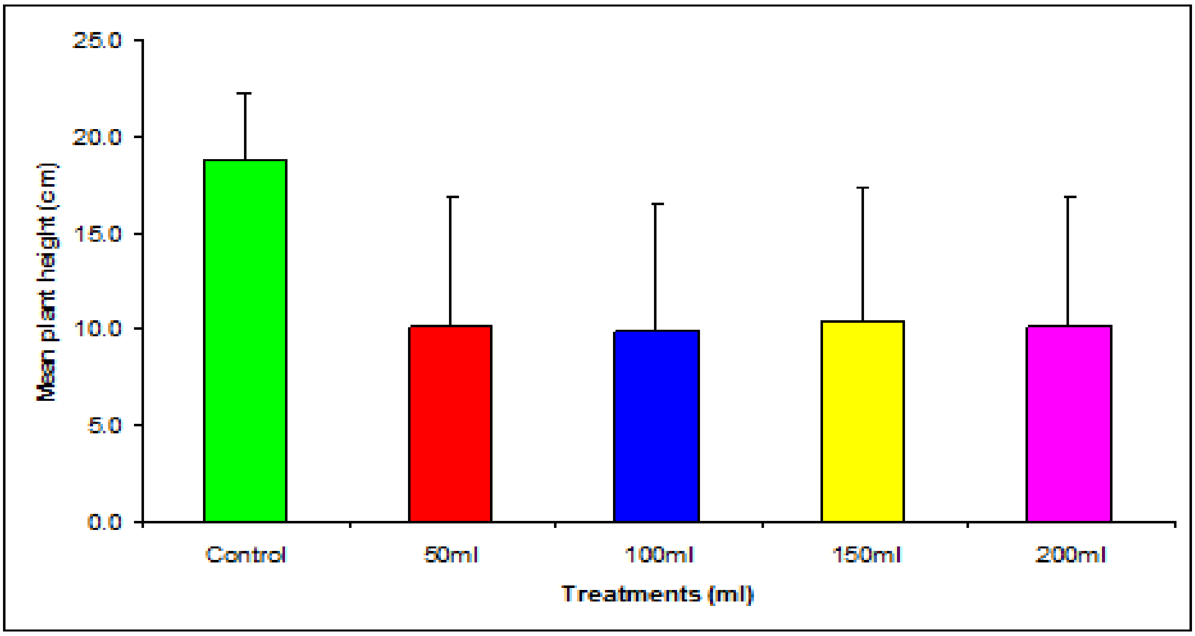

Fig. 1. Impact of crude on plant height (Bar = Mean + Std) after four weeks of planting.

The mean leaf area in control differs significantly ($P<0.05$) from the mean leaf area in 200ml. No observed significant difference ($P>0.05$) between the mean leaf area in 50ml, 100ml, 100ml and 200ml respectively (Fig. 3). The mean leaf area decreased from control to the 50ml, a steady decrease from 50ml to 200ml was observed. The maximum leaf area was obtained in control while the least was obtained in 200ml (Fig. 3).The highest value of leaf mortality was recorded in 150ml whereas the lowest number of leaf mortality was obtained in 50ml. No significant difference ($P>0.05$) between the leaf mortality in 100ml and 150ml was observed (Fig. 4). No leaf mortality was recorded in control; this may be due to having sufficient water for proper growth (Fig. 4). Steady increase from 50ml to 150ml impact was observed, whereas a decrease was obtained in 200ml (Fig. 4).

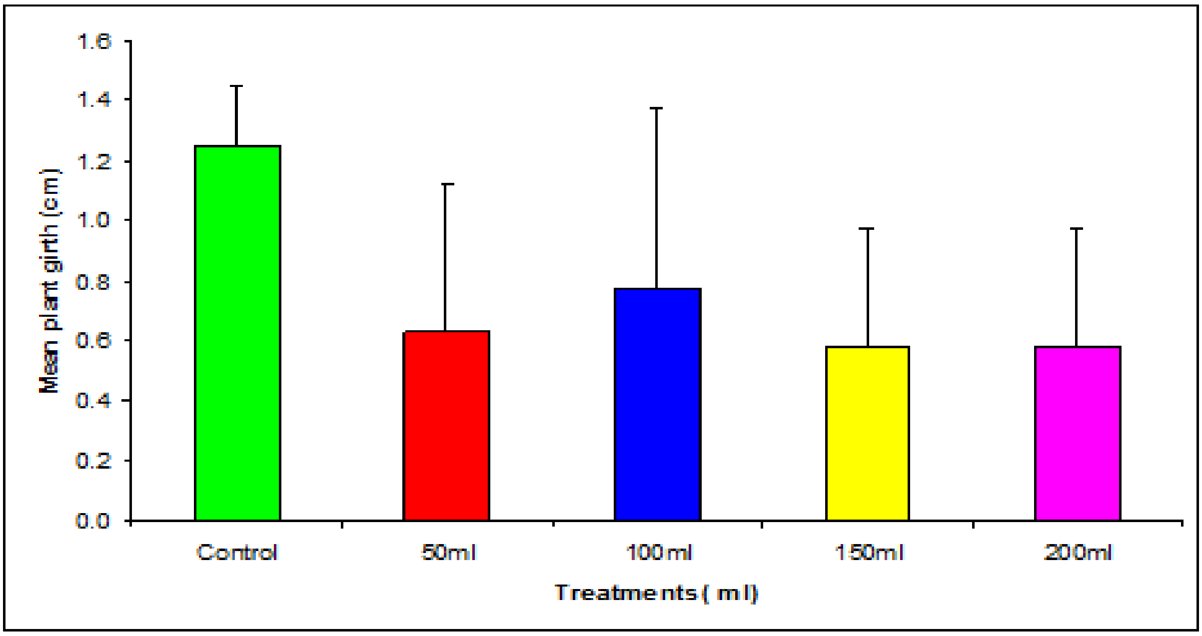

Fig. 2. Impact of crude girth of seedlings (Bar = Mean+ Std) after four weeks of planting.

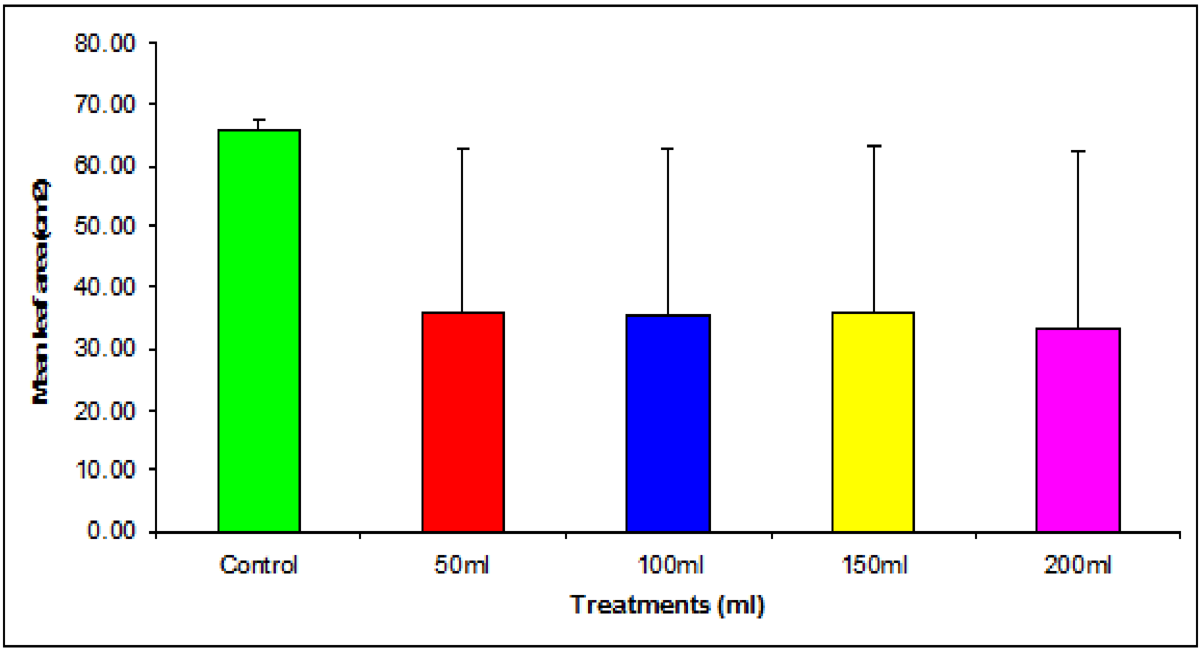

Fig. 3. Impact of crude on leaf area of seedling (Bar = Mean+Std) after four weeks of planting.

Discussion

The tested growth parameters reflected susceptibility of the species to crude oil pollution even at varying concentration. Although the plant responded slightly differently at the different concentrations, the differences expressed using the indices of growth were not significant across the various concentrations as compared to the control; it was observed that the plants responded similarly to crude polluted soil at different concentrations. Crude oil effects on the growth of the seedlings may be due to disruption of nutrient and H_2O uptake (Njoku *et al.*, 2008; Agbogidi and Erhenhi, 2017), reduction of soil phosphorus and nitrogen content (Baran, *et al.*, 2002). Merkl *et al.* (2005) reported similarly that soil moisture can be changed or altered as a result of hydrophobic natured of crude in the polluted or contaminated soil. Similarly, Agbogidi, *et al.* 2007, reported on the immobilization of soil nutrients by microbes due to crude contamination.

The information obtained in the research revealed that crude contamination in the soil had considerable effect on physiological activities of *Sorghum bicolor* seedlings. The reduction in growth properties observed is similar to that recorded by Merkl *et al.* (2004) with test seedlings sown in soil mixed with crude oil.

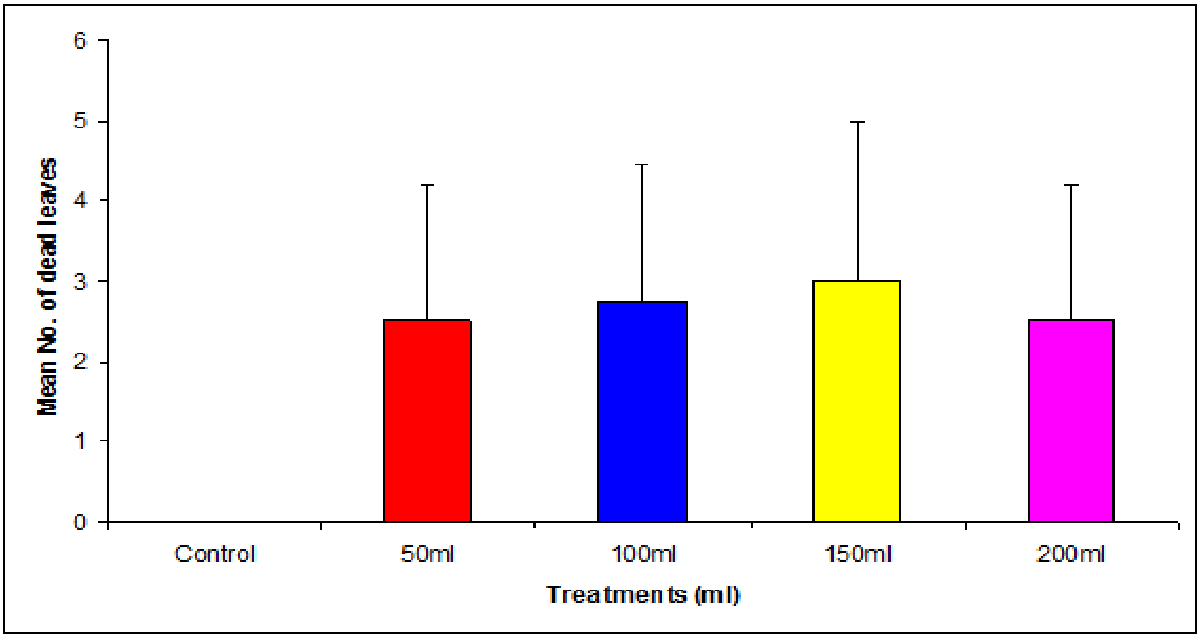

Fig. 4. Impact of crude on leaf fall of seedling (Bar = Mean+Std) after four weeks of planting.

The negative impact of crude on sorghum seedlings may also have resulted from increase in temperature as a result of the dark nature of contaminated soils as crude oil may have led to increase in temperature due to its toxic components. Abii and Nwosu (2009) revealed that crude makes the soil toxic and the soil fertility is reduced thus creating unfavourable conditions for the plant growth. Some heavy metals such as Cu and Zn though essential for plant growth, excessive increment may inhibit plant growth (Hall, 2002).

Conclusion

The study has demonstrated that seedlings of *Sorghum* sown or grown in crude soil are sensitive and vulnerable. The high sensitivity and vulnerability of this plant species makes it a non-candidate for bioremediation or soil reclamation of polluted sites.Hence, there is need to encourage the protection of farmlands and their surroundings against indiscriminate disposal of crude or its derivatives into the environment and stricter measures should be taken to prevent crude oil spillage to the environment.

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