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ORIGINAL ARTICLE

EFFECT OF CRUDE OIL POLLUTION ON GERMINATION, SEEDLING GROWTH AND YIELD OF THREE VARIETIES OF *ABELMOSCHUS ESCULENTUS*

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ABSTRACT: The effect of crude oil pollution on germination, seedling growth and yield of three varieties of okra (*Abelmoschus esculentus*) were investigated. Three varieties of okra were planted in a well-drained humus soil polluted with 0%, 0.5%, 5%, 7.5%, and 10% crude oil per kilogram of soil. Data were collected on the following parameters: days to seedling emergence, percentage germination, plant height, internodes length, leaf area, number of leaves per plant and number of fruits per plant. The results show that there were significant difference ($p < 0.05$) in the days to seedling emergence and percentage germination. No significant differences ($p > 0.05$) were observed on internodes length but plant height differed significantly ($p < 0.05$) due to the concentrations of the crude oil in the soil. It can be concluded that the three varieties of okra used in these study were not tolerant to crude oil effect; in order to achieve a better performance of the plant in crude oil polluted environment, remediation of the polluted soil should be carried out before cultivation.
KEYWORDS: Crude oil, Germination, Seedling growth, Yield, *Abelmoschus esculentus*

INTRODUCTION

The growing demand and supply of fuel and new chemicals by the industrialized society has led to frequent occurrence and accidental discharge of crude oil into the environment, thereby resulting in the pollution of the natural environment. Crude oil pollution has been reported to have deleterious effects on plant germination and seedling growth, which is due to the insufficient aeration of soil because of displacement of air (Rowell, 1977). Baker (1994) associated most physiological defect on plant grown on oil polluted soil on a result of interference with photosynthesis and transpiration probably by blocking the stomata. It has also been reported that petroleum oil cause deterioration and death of trees and ornamentals due to toxicity by sulphides and excess manganese brought about by the anaerobic soil atmosphere created by the leaking natural gas displacing the soil air. Poor growth has also been attributed to adverse changes in soil plant-water relationship, which is an over-riding factor that disrupts nutrient supply to plants in oil polluted soil. In Nigeria, Okra production is concentrated to sustainable farmer. *Abelmoschus esculentus* is among the most heat-and drought- tolerant vegetable species in the world. It will tolerate poor soil with heavy clay and intermittent moisture but severe frost can damage the pods. Okra tolerates pH ranges of 6.0-7.5. The plant performs poorly in waterlogged soil (Nonneke, 1989). Okra is a tender crop, unable to tolerate low temperature for long and is susceptible to frost. Commercial production of okra requires sustained warmth, with optimum temperature of 21-30^{0}C. However several studies have been carried out on seedling growth of okra but no studies have extensively been carried out on the effect of crude oil on growth performance of okra. This present study is to assess the effect of crude oil on the germination and seedling growth of okra (*Abelmoschus esculentus*).

MATERIALS AND METHODS

The study was carried out behind the Biological Science Experimental Farm, university of Calabar. The three varieties of okra were obtained from Micheal Okpara University of Agriculture, Umudike and the crude oil (Bonny light) was supplied by Shell Petroleum Company, Port Harcourt, Rivers State. The concentrations of the crude oil used were 0ml/kg, 5ml/kg, 50ml/kg, 75ml/kg, and 100ml/kg. The low level of crude oil was to assess the minimum level of contamination that would cause damage to the seedlings and inhibit germination of the seeds of *Abelmoschus esculentus*.

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2.1. Planting of Seeds

20kg of top soil (0-20cm depth) was weighed into 75kg polyethylene bags. The polyethylene bags containing the soil were then polluted with bonny light crude oil using measuring cylinder, the application of the crude oil was made three days before planting. During planting the seeds were soaked in water for 12 hours prior to planting to test for the viability of the seeds. 10 seeds of *Abelmoschus esculentus* were sown directly into the prepared polyethylene bags. The depth of the sowing was 1-2cm. on germination, the seedlings was thinned to four plants per bags. The polyethylene bags were watered immediately after planting and twice a week subsequently. Seeds sprouting began four to eight days after planting. Emergence counts were calculated by the methods of Amadi *et al.*, (1993). Seeds that failed to sprout after this time were regarded as having not emerged.

Emergence (%) was calculated using the formula below

$$\text{Emergence\%} = \frac{\text{Number of seedling that germinated}}{\text{Number of seeds planted}} \times \frac{100}{1}$$

2.2. Morphological and Yield Studies

Data were collected on the following parameters, days to seedling emergence, plant height, number of leaf per plant, leaf area, internodes length and days to flowering. Germination was observed as the emergence of the cotyledons above the soil surface. The plant height was measured from the soil levels to the terminal bud using a metre ruler. Leaf area was determined by cutting some leaves from each of the concentration and placing it on a graph book and tracing through the leaf margin. Each unit of one cube was counted as $1cm^2$.

2.3. Statistical Analysis

Data collected were subjected to a one way analysis of variance and means separated using least significant difference (LSD) test.

RESULTS

3.1. Percentage Germination

The result obtained shows that there were significant difference (P<0.05) in the percentage germination of the okra plant at different concentration of crude oil pollution. It was observed that Clemson spinless okra at 0% pollution had the highest percentage germination, followed by lady finger at 0.5% pollution level, this was also followed by lady's finger at 0% pollution and then Clemson spinless at 5% pollution level. It was also observed that no significant difference (P>0.05) exist between Clemson spinless at 7.5% pollution and oboro dwarf at 0.5% pollution level. Clemson spinless at 0.5%, 10% pollution level and lady finger at 7.5% and 10% pollution level did not produced any significant difference (p>0.05) in the percentage germination of the plant. Observation made also shows that the oboro dwarf at 5%, 7.5% and 10% pollution shows no significant difference (p>0.05) in the percentage germination of the plant (Figure 1).

3.2. Leaf Area

It was observed from the result obtained that oboro dwarf at 0% pollution produces significantly larger (p<0.05) leaf area, followed by lady finger at 0% pollution and oboro dwarf at 0.5% pollution level that had no significant difference (p>0.05) in the leaf area. This was then followed by the leaf area of oboro dwarf at 5% pollution level and lady finger at 5% pollution level. The result also shows that no significant difference (P>0.05) were found in the leaf area of Clemson spinless at 0%, 0.5% and lady's finger at 10% pollution level. However, the leaf area of Clemson spinless at 5%, 7.5%, 10%, lady's finger at 7.5% and oboro dwarf at 10% pollution level were not significantly different (p>0.05), while the smallest leaf area was observed in oboro dwarf at 7.5% pollution level (Table 1, Figure 2).

3.3. Number of Leaves

The result of this study indicates that oboro dwarf produces significantly higher (P<0.05) number of leaves than other cultivars used in the study. It was observed that the cultivation of oboro dwarf at 0% pollution level produces more number of leaves, followed by 0% pollution on Clemson spinless and 0% pollution on lady finger. No significant difference (p>0.05) were found in the number of leaves of 0.5% pollution on lady finger, and 0.5% pollution on oboro dwarf but their number of leaves were significantly higher (P<0.05) than 0.5%, 5%, 7.5% pollution of crude oil on Clemson spinless, 5%, 7.5% crude oil pollution on lady finger and 5%, 7.5% pollution level. It was also observed that the number of leaves of Clemson spinless in 10% pollution level, lady's finger in 10% pollution level and oboro dwarf in 10% pollution produces no significant differences (P<0.05) between the cultivars. However, from this result on number of leaves it thus implies that the higher the pollution levels the more the effect of the crude oil concentrations on the growth performance of the okra (Figure 3).

3.4. Plant Height

The result for the plant height of the three varieties of okra shows the significant difference ($p<0.05$) exist in the height of the okra plant. It was observed that Clemson spinless had the highest plant height, followed by lady's finger and the oboro dwarf that had the shortest length. The result shows that the higher the concentrations of the crude oil the more the resultant effect on the plant height of the okra (Figure 4).

3.5. Internodes Length

The result of the study shows that significant difference ($p<0.05$) were found between the different crude oil concentrations and control. It was however, observed that all the control plants shows no significant difference ($P>0.05$) in the internode length. Observation made signified that the different crude oil control shows no significant difference ($P>0.05$) in the internode length (Table 1)

3.6. Days to Flowering

It was observed that significant difference ($p<0.05$) were found in the days to flowering of the cultivars of okra. The results shows that Clemson spinless at 0% pollution level flowered before Clemson spinless at 5% pollution, oboro dwarf at 7.5% pollution level, which shows no significant difference ($p>0.05$) in the days to flowering. This was followed by Clemson spinless at 0.5%, 7.5%, lady's finger at 0%, 0.5%, 5%, 7.5%, 10% pollution level; oboro dwarf at 0%, 0.5% and 5% showing no significant difference ($p>0.05$). However, 10% pollution affected the days to flowering of all the 3 cultivars used.

3.7. Number of Pods

The number of pods obtained from each of the cultivars of okra treated with varying concentrations of crude oil differs significantly ($p<0.05$). The 0% pollution produces higher number of pods in clemson spinless, followed by 0.5% of the treatment on Clemson spinless, this was also followed by the number of pods of lady's finger at 0% pollution. The number of pods of lady's finger at 0.5% pollution and oboro dwarf at 0% pollution shows no significant difference ($p>0.05$). Also the number of pods of lady's finger at 7.5%, 10% pollution and oboro dwarf at 0.5% pollution shows no significant difference ($p>0.05$). While the number of pods of Clemson spinless at 7.5% and oboro dwarf at 5% pollution were also not significantly different. 10% pollution in all produces no number of pods.

3.8. Fresh Weight of Fruit

The fresh weight of the fruit of okra produced from Clemson spinless was significantly higher ($P<0.05$) than the fresh weight of fruit obtained in Clemson spinless at 0.5% pollution, while no significant difference ($P>0.05$) were observed between Clemson spinless at 5% pollution and oboro dwarf at 0% pollution. It was also observed from table 1 that no significant difference ($P>0.05$) exist between the fresh weight of fruit obtained from Clemson spinless at 7.5% pollution, lady's finger at 0%, 0.5% pollution and oboro dwarf at 0.5% pollution. The result also shows that the fresh weight of fruit from lady's finger at 5% and 7.5% pollution were not significantly different ($P>0.05$), oboro dwarf at 5% pollution had the smallest fresh weight of fruit of okra.

Table 1: Means and standard error of morphological and yield attributes of three varieties of okra seedling treated with varying concentration of crude oil

Varieties	Crude oil application	Percentage germination	Days to seedling emergence	Leaf area	Number of leaf per plant	Plant height	Internodes length	Days to flowering	No. of pods	Fresh weight of fruits (g)
Clemson Spinless	0%	$9.7^{a}\pm0.33$	$9.3^{a}\pm0.00$	$67^{f}\pm4.0$	$7.3^{b}\pm0.33$	$38.8^{a}\pm3.2$	$3.9^{a}\pm0.2$	$53.3^{c}\pm10.1$	$13.2^{a}\pm0.32$	$14.04^{a}\pm0.45$
	0.5%	$3.7^{g}\pm2.2$	$4.67^{d}\pm0.33$	$67^{f}\pm12.6$	$5.7^{e}\pm0.33$	$35.6^{c}\pm3.2$	$3.3^{b}\pm0.4$	$65^{a}\pm3.5$	$10.1^{b}\pm0.29$	$12.05^{b}\pm0.30$
	5%	$6.7^{d}\pm1.8$	$4.67^{d}\pm0.33$	$54.3^{g}\pm8.9$	$5.7^{e}\pm0.33$	$31.2^{d}\pm3.6$	$3.2^{b}\pm0.4$	$60^{b}\pm3.5$	$6.30^{d}\pm0.23$	$10.21^{c}\pm0.31$
	7.5%	$5.3^{f}\pm0.9$	$5.0^{c}\pm0.00$	$57.7^{g}\pm2.6$	$5.0^{e}\pm0.00$	$29.1^{e}\pm1.6$	$2.7^{b}\pm0.4$	$71.3^{a}\pm2.3$	$0.20^{g}\pm0.01$	$8.94^{d}\pm0.29$
	10%	$4.0^{g}\pm0.98$	$6.0^{b}\pm0.00$	$52.3^{g}\pm6.9$	$4.0^{f}\pm0.00$	$26.5^{f}\pm0.5$	$2.8^{b}\pm0.2$	-	-	-
Lady's finger	0%	$8.3^{c}\pm1.7$	$4.0^{e}\pm0.00$	$155.3^{b}\pm21.2$	$6.7^{c}\pm0.30$	$37.5^{b}\pm3.5$	$4.0^{a}\pm0.2$	$63.67^{a}\pm3.5$	$8.52^{c}\pm0.19$	$9.09^{d}\pm0.18$
	0.5%	$9.0^{b}\pm0.98$	$4.3^{d}\pm0.33$	$79.7^{d}\pm11.5$	$6.0^{d}\pm0.00$	$31.1^{d}\pm1.5$	$3.4^{b}\pm0.1$	$67^{a}\pm6.1$	$5.01^{e}\pm0.12$	$9.00^{d}\pm0.17$
	5%	$5.7^{e}\pm0.33$	$5.33^{c}\pm0.33$	$76.7^{e}\pm1.8$	$4.7^{e}\pm0.30$	$27.5^{f}\pm1.5$	$3.1^{b}\pm0.1$	$64.7^{a}\pm5.5$	$4.81^{f}\pm0.08$	$7.82^{e}\pm0.10$
	7.5%	$4.3^{g}\pm1.2$	$5.33^{c}\pm0.33$	$53.7^{g}\pm4.9$	$4.7^{e}\pm0.70$	$26.7^{f}\pm0.5$	$3.1^{b}\pm0.2$	$64.3^{a}\pm1.7$	$4.26^{f}\pm0.09$	$7.07^{e}\pm0.14$
	10%	$4.0^{g}\pm1.2$	$6.67^{b}\pm0.33$	$56.3^{f}\pm15.3$	$3.7^{f}\pm0.70$	$20.6^{h}\pm0.5$	$2.6^{b}\pm0.2$	-	-	-
Oboro dwarf	0%	$5.7^{e}\pm1.2$	$4.67^{d}\pm0.33$	$237^{a}\pm48.2$	8.0a$\pm$0.00	$37.6^{b}\pm3.6$	$3.7^{a}\pm0.5$	$72.7^{a}\pm4.9$	$5.21^{e}\pm0.11$	$10.90^{c}\pm0.29$
	0.5%	$5.0^{f}\pm1.5$	$5.33^{c}\pm0.33$	$153.7^{b}\pm27.9$	$6.3^{d}\pm0.30$	$29.9^{e}\pm1.0$	$3.3^{b}\pm0.2$	$69^{a}\pm1.7$	$2.62^{f}\pm0.03$	$8.63^{d}\pm0.20$
	5%	$2.3^{h}\pm1.3$	$5.00^{c}\pm0.00$	$88.7^{c}\pm14.1$	$5.0^{e}\pm0.00$	$32.4^{d}\pm3.0$	$3.3^{b}\pm0.2$	$61.7^{b}\pm2.6$	$0.11^{g}\pm0.01$	$4.09^{f}\pm0.07$
	7.5%	$2.3^{h}\pm1.3$	$6.3^{b}\pm0.33$	$46.7^{h}\pm4.2$	$5.0^{e}\pm00$	$24.0^{g}\pm4.9$	$3.0^{b}\pm0.2$	$66.3^{a}\pm4.0$	0.00	0.00
	10%	$2.3^{h}\pm1.3$	$6.3^{b}\pm0.33$	$46.7^{g}\pm4.2$	$3.0^{f}\pm0.58$	$20.3^{b}\pm6.8$	$2.6^{b}\pm0.2$	-	-	-

Means with the same superscript along the vertical array represent no significant difference ($P>0.05$)

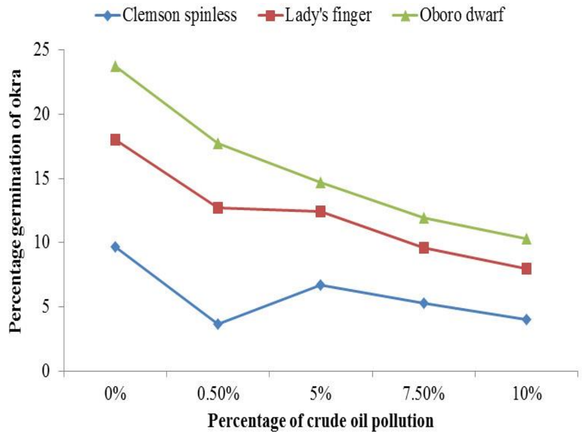

Figure 1: Effect of crude oil polluted soil on percentage of germination of okra (*Abelmoschus esculentus*)

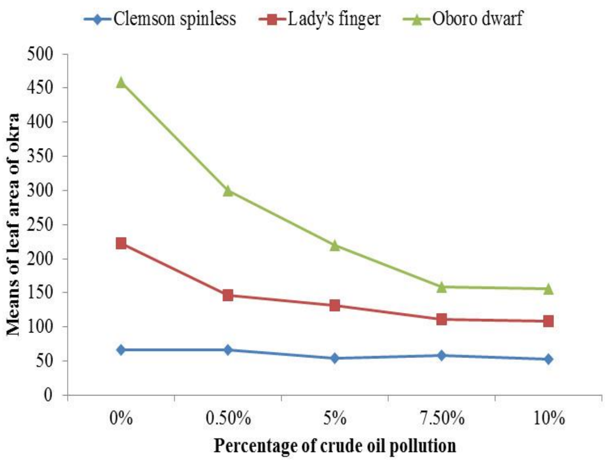

Figure 2: The effect of crude oil polluted soil on Leaf area of okra *(Abelmoschus esculentus)*.

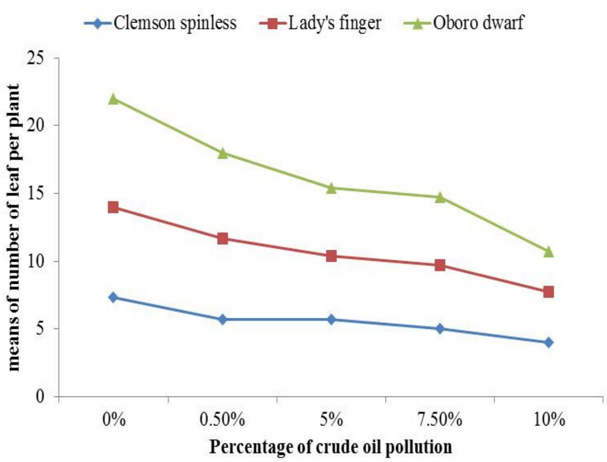

Figure 3: Effect of crude oil polluted soil on number of leaf per plant of okra (*Abelmoschus esculentus*).

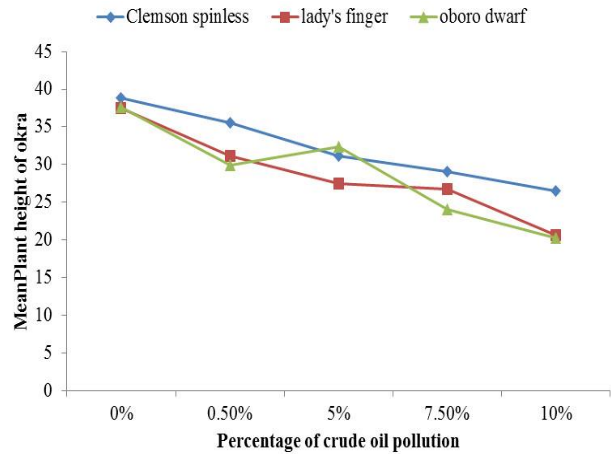

Figure 4: The effect of crude oil polluted soil on the plant height of three varieties of okra (*Abelmoschus esculentus).*

DISCUSSION

Crude oil polluted soil have been observed through several studies to produce toxic effect on growth of some plants that are not tolerant to crude oil effect. Okra a widely consumed vegetable crop by Nigerians has been assessed for it tolerance to crude oil effect and the result review that crude oil at higher concentrations affects the growth and yields of plant. Plant height was significantly reduced ($p< 0.05$) at the different pollution levels. None of the cultivars was tolerant to the pollution. However, 10% pollution level significantly reduced the height followed by 7.5%, 5%, 0.5% as compared with the control values. Adedokun and Ataga (2007) reported that treatment of soils with crude oil, automotive gasoline oil and spent engine oil significantly affected the time of germination, percentage germination, plant height, leaf production and biomass of *V. unguiculata.* In that study, growth rate was reduced, as it is in this case with *A. esculentus*. The result also showed significant reduction in the leaf area of the three cultivars. This is an indication that the various level of pollution significantly affected the leaf area of the plants. The leaf surface area determines in large proportion the amount of carbon gained through photosynthesis and the amount of water lost through transpiration and ultimately the crop yield Kathirvelan and Kalaiselvan (2007). Significant reduction ($p<0.05$) in the number of leaves was also observed. Pollution of the soil with 10% of crude oil shows a reduction in the number of level followed by 7.5%, 5%, and 0.5% respectively as compared with the control values. Dimitrow and Markow (2000) reported that pollution of soil with crude oil significantly decreased the availability of phosphorus and potassium to plants. However, plants need these essential nutrients for their growth and development, the lack of these elements in the soil could eventually lead to reduction in growth and poor performance of the plant. The morphological and yield attributes studied revealed that the three varieties responded differently to the various concentration of crude oil. Significant increase in the days to germination was observed in all the varieties, this is an indication that the concentration delayed the germination of the plant; If germination of a plant is adversely delayed this is an indication that the physiological composition of such plants may have been altered due to the presence of crude oil in the soil. It was observed that during the watering process, the control soil tend to retained the water in the soil why the treated soil tend to lost its water content. The loss of this water may also be a factor that affects the normal photosynthetic activities of the plant. It can be concluded that the three varieties of okra used in these study were not tolerant to crude oil effect; in order to achieve a better performance of the plant in crude oil polluted environment, remediation of the polluted soil should be carried out before cultivation.

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