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Effects of Kerosene Contaminated Soil on the Growth of Maize (*Zea mays* L.)

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ABSTRACT

This study was carried out in 2013 at the Research farm of the Department of Botany, Faculty of Science, Delta State University, Abraka, Nigeria to evaluate the germination and growth of maize plant as influenced by kerosene in the soil. 0.0, 0.45, 0.90, 1.35 and 1.80% (w/w) of the kerosene constituted treatments. Two seeds of maize were sown in the kerosene contaminated soil. The experiment was laid in a randomized complete block design with four replications. Growth variables measured on two-weeks basis were plant height, number of leaves and leaf area. The results showed a significant ($P \leq 0.05$) decrease in the performance of maize seedlings in terms of germination percentage, days to germination, plant height, and number of leaves, leaf area and fresh and dry weight biomass with increasing levels of kerosene contamination. For example, while 19.70cm was recorded for plant height sown in the control plot, 8.30cm was the value obtained for plants grown in the kerosene contaminated soil at 6 weeks after planting. The control plants showed a significant increase ($P \leq 0.05$) in plant height, number of leaves and leaf area when compared with seedlings grown in contaminated soil. This present study suggests that kerosene contaminated soil has a significant effect of reducing the germination, growth and development of maize.

KEYWORDS: Seedling emergence, growth, maize, kerosene contaminated soil

INTRODUCTION

Nigeria is a major crude oil and natural gas exporter as well as an important agricultural nation in the West Africa Sub-region. In the same vein, economic benefits accruable from oil and natural gas have in no doubt left negative impact on the biotic and abiotic components of the Nigerian environment (Agbogidi *et al.*, 2005a). Natural gas found with petroleum varies in composition, ranging from almost pure mixture of hydrocarbon to gases that are free of organic constituents (Abudulin, 2001). Pollution results when a change in the environment negatively impacts the quality of human life and has adverse effects on plants, agricultural lands and animals. Kerosene spillage, one of the exploration and production activities of crude oil usually impacts negatively on the aquatic and terrestrial ecosystems of the host communities thereby affecting their socio-economic activities (Ogri, 2001; Agbogidi *et al.*, 2005b).

Kerosene is a complex mixture of hydrocarbons consisting of paraffins, cyclo-paraffins, aromatic and olefinic hydrocarbons with carbon numbers predominantly in the C9 to C16 range. It boiling point ranges from 320^0F–465^0F (Atlas and Barhta, 2002). It has been reviewed that hydrocarbons in particular the aromatic and olefinic hydrocarbons are toxic to the germination and growth of plants due to their chemical nature. According to Ekpo and Nwankpa (2005), Kerosene polluted soil generally retards plant growth and soil productivity, reduces aeration by blocking air spaces between soil particles, hence create a condition of an aerobiosis (Al-Qahtani, 2011), and causes root stress in plant which also reduces leaf growth when compared to non-polluted soil. Kerosene is a product of crude oil which is highly carbonaceous and contains some proportions of nitrogen, thus accounting for the increased levels of carbon and nitrogen in the kerosene simulated soil. Many researchers have reported on the adverse effects of oil activities on the crop plants (Asuquo *et al.,* 2002; Agbogidi *et al.,* 2007). The discharge of crude oil on land affects the physicochemical properties of the soil thus causing deleterious effects on plant germination and growth (Agbogidi *et al.,* 2007). Consequently, the presence of hydrocarbons from crude oil and 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 (Odjegba and Atebe, 2007). Since petroleum oil contamination can improve soil content with some nutrient elements including Mg, K, P, Na and exhibits a highly significant effects on the chemical composition of a maize yield (Agbogidi *et al.,* 2007). The present study specifically evaluates the effects of kerosene contaminated soil on the growth of maize, staple food in Africa and Nigeria in particular.

MATERIALS AND METHODS

Study area

The experiment was carried out in Delta State University, Botany garden, Abraka. Abraka is in Ethiope East Local Government Area of Delta State. It is located at the latitude 5^0 46′ 54″N and longitude 6^0 05′ 59″E of the equator. It has annual temperature of 30^0C, relative humidity of 69%, annual rainfall of 2500mm, soil pH of 4.0 – 5.0, soil type: sandy 90%, climate: humid subequatorial, natural vegetation: rain forest/swamp forest, pressure: 1015Hg (or 1015mb), land elevation: 50 meters above sea level (abraka-delsunigeria/meteorological instrumentation, 2012).

Source of maize and experimentation: The maize seeds composite (Suwan 1) were purchased from the Agricultural Development Programme (ADP) at Agbor, Delta State, while the Domestic Petroleum Kerosene (Kerosene) samples was obtained from Oando filling station in Abraka, Delta State. The soil samples collected was air dried and passed through a 2mm sieve. The kerosene was applied at 0.0, 0.45, 0.90, 1.35 and 1.80% w/w (based on their concentration). The soil/kerosene samples were thoroughly mixed together by hand. The mixtures were poured into bottom perforated polypots (60x25x15cm in dimension). A pre-treatment was carried out on the seeds to ensure 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 minutes to obtain usually non-infected viable seed for planting. Two seeds of maize were planted into the soil sample treated with varying concentrations of kerosene including the control (without kerosene treatment). The number of seeds that germinated from each polythene bags was summed up after eight days. The percentage germination of each treatment was calculated thus; following earlier procedure of Agbogidi and Eshegbeyi (2006)

$$\text{Percentage germination} = \frac{\text{No.of seeds that germinated}}{\text{No.of seeds planted}} \text{ x} \frac{100}{1}$$

Data collection

Observations on growth and morphology were made in every two weeks Growth indices measured were; plant height, number of leaves, leaf area, and stem girth. Plant height was determined with a meter rule at 2cm from soil level to the tip of the terminal bud while the number of leaves was determined by visual counting of the leaves. Leaf area was by tracing the margins of the leaf on a graph paper and the total leaf area/plant was obtained by counting the number of 1-cm square. The stem diameter was measured by the use of venire calipers. Biomass accumulation was thereafter taken after 12^{th} weeks of planting of which measurement of fresh weight on root, stem, leaf and grain/cob was done with the aid of triple beam balance and dry weight was also determined by subjecting in electronic heater and subsequently measured with the aid of electronic compact scale.

Experimental design

The experiment was arranged in a randomized complete block design (RCBD) with four replicates. The polypots were watered to field capacity immediately after planting and thereafter, every other day until the end of the trial. The set-up was monitored for 12 weeks after transplanting (WAT).

Statistical analysis

Data collected were subjected to analysis of variance while the significant means were separated with the Duncan's multiple range tests (DMRT) using SAS (2005).

RESULTS AND DISCUSSION

The effect of kerosene on the germination and growth of maize plant have been investigated on the following parameters; days to germination of seeds, percentage germination, rate of germination, plant height, leaf area, number of leaves, biomass accumulation on root, stem and leaves, grain and cob produced. The results show that seedlings emergence and growth characteristics of maize were significantly ($P \geq 0.05$) affected when compared with the control (Table 1).

Table 1: Effects of kerosene contaminated soil on germination characteristics of maize

Oil in soil (% w/w)	Days of Germination	% Germination	Rate of Germination
0.00	5.0	100.0^a	0.4^a
0.45	6.1	100.0^a	0.33^a
0.90	7.0	100.0^a	0.29^a
1.35	8.0	50.0^b	0.13^b
1.80	8.0	50.0^b	0.13^b
2.25	0.0	0.0^c	0.0^c

Means with different superscripts are significantly differed at ($P \leq 0.05$) using the Duncan's multiple range tests

Table 2: Plant height (cm) of maize seedlings as influenced by kerosene contaminated soil

Oil in soil (% w/w)	Plant height/WAP						
	2	4	6	8	10	12	Mean
0.00	7.33	12.83	19.70	29.33	70.0	85.0	37.30^a
0.45	5.16	7.92	12.20	18.00	29.30	52.0	20.76^b
0.90	5.00	6.50	11.48	15.00	26.50	49.80	19.05^c
1.35	4.50	5.00	8.50	9.50	16.00	30.0	12.25^d
1.80	2.80	3.80	8.30	8.00	14.00	15.0	8.65^e

Means with different superscripts are significantly differed at ($P \leq 0.05$) using the Duncan's multiple range tests

The results also showed that significant differences existed between the various concentrations of kerosene used and the parameters measured. In all the ages of growth, significant reductions ($P \leq 0.05$) were observed in the performance when compared with maize plants grown without treatment (Tables 2, 3, 4, 5 and 6).

The higher the level of kerosene contamination, the lower the performance of the seedling. The observed significant reduction in the germination characters and other growth variables could also be attributed to one or a combination of the following factors; an interruption in the soil-water interrelation of the kerosene contaminant, reduction in the gaseous exchange resulting in a high oxygen demand by soil organisms and damaging effect/phtotoxicity of the petroleum product contaminant.

Table 3: Number of leaves of maize seedlings as influenced by kerosene contaminated soil

Oil in soil (% w/w)	Number of leaves/WAP						
	2	4	6	8	10	12	Mean
0.00	4.0	5.5	6.2	7.7	9.33	9.00	6.96[a]
0.45	3.2	4.33	5.0	6.0	5.33	6.7	5.09[b]
0.90	3.0	4.0	4.3	5.5	5.0	6.5	4.72[c]
1.35	3.0	2.5	3.0	5.0	5.0	5.0	3.92[d]
1.80	3.0	2.0	3.0	5.0	5.0	5.0	3.83[e]

Means with different superscripts are significantly differed at ($P \leq 0.05$) using the Duncan's multiple range tests

Table 4: Leaf area (cm^2) of maize seedlings as influenced by kerosene contaminated soil

Oil in soil (% w/w)	Number of leaves/WAP						
	2	4	6	8	10	12	Mean
0.00	61.7	385.7	685.70	1827.5	2773.8	2584.6	1386.5[a]
0.45	29.1	126.3	222.3	444.8	851.7	1042.5	452.8[b]
0.90	25.4	68.3	207.6	385.9	493.8	990.0	361.8[c]
1.35	20.3	22.5	81.61	95.81	216.0	337.5	128.9[d]
1.80	20.0	20.4	70.7	89.0	196.35	129.4	87.64[e]

Means with different superscripts are significantly differed at ($P \leq 0.05$) using the Duncan's multiple range tests

Other mechanisms surrounding the reduced or absence of germination in oil treated substrates may include some volatile oil compounds which have been shown to have severe inhibitory impacts on germination of several plant species as well as the polycyclic aromatic compounds which have been found to have indirect secondary effects including disruption of plant-water-air relationships (Vwioko *et al*., 2006; Agbogidi and Dolor, 2007; Sharifi *et al*., 2007). Herbicidal properties of crude oil and its refined products have been reported by various researchers including Agbogidi and Ejemete (2005), Agbogidi and Eshegbeyi (2006), Odjegba and Atebe, (2007). Biomass reduction following different contaminants have been reported by Asuquo *et al.* (2002) and Odjegba and Atebe (2007).

Table 5: Biomass accumulation of maize plants (fresh weight (g)) as affected by kerosene contaminated soil

Oil in soil (% w/w)	Leaf	Root	Stem	Cob	Grain	Means
0.00	31.50	9.90	48.25	46.30	0.900	27.37[a]
0.45	13.5	5.25	24.10	23.00	0.53	13.28[b]
0.90	9.55	3.25	16.50	15.70	0.09	9.02[c]
1.35	4.10	2.00	4.25	0.00	0.00	2.07[d]
1.80	1.90	1.43	2.65	0.00	0.00	1.20[e]

Means with different superscripts are significantly differed at ($P \leq 0.05$) using the Duncan's multiple range tests

Table 6: Dry weight (g) of maize plants as influenced by kerosene contaminated soil

Oil in soil (% w/w)	Leaf	Root	Stem	Cob	Grain	Means
0.00	7.35	2.92	10.66	21.0	0.20	8.43[a]
0.45	3.15	1.62	4.35	11.10	0.09	4.06[b]
0.90	1.87	1.59	2.53	5.50	0.04	2.31[c]
1.35	0.68	0.21	0.63	0.00	0.00	0.51[d]
1.80	0.49	0.11	0.18	0.00	0.00	0.51[e]

Means with different superscripts are significantly differed at ($P \leq 0.05$) using the Duncan's multiple range tests

CONCLUSION

The current study has demonstrated that kerosene contaminated soil has a significant effect of reducing the germination and growth responses of maize.

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