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Effects of Heavy Crude Oil on the Physiological Responses of *Zea mays* L. Species

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ABSTRACT

The remediation of oil contaminated soils has been a major problem in oil producing countries. Germination of seeds in soil polluted with crude oil may be significantly reduced the seeds germination. Apparently, the hydrocarbon film created on the seed surface prevents the imbibition of water and oxygen to the developing embryo, inhibited seed germination in oil contaminated soil also can be directly or indirectly related to the presence of oil in soil. The effected of type of crude oil (heavy) was used on different concentrations (0.0 V/V, 0.5 V/V, 1.0 V/V, 2.0 V/V, 4.0 V/V, 6.0 V/V, 8.0 V/V, 10.0 V/V) examined for seed germination and seedling performance the Zea mays L. (Corn), showed promoted heavy crude oil of Zea mays performance was not affected by heavy oil applications. This might be due to that heavy oil is more viscous and less soluble in water.

Keywords: Contaminated; Zea mays. L (Corn); Heavy crude oil

Introduction

The word petroleum means "rock oil" or "oil from the earth". Although exactly how crude oils originated is not established, it is generally agreed that crude oils is derived from the remains of animals and plants that lived in a marine water millions of years ago. Each petroleum type has a unique mixture of molecules, which reflects its own physical characteristic such as color, viscosity and specific gravity. Crude oil varies greatly in appearance depending on its composition. It is usually black flammable liquid or dark brown [1]. Viscosity varies from easily flowing to a substance that pours with difficulty [2]. Specific gravity (density) is used to classify crude oil as light, medium, or heavy [3]. Density is defined as the mass of unit volume of a material at a specific temperature. Petroleum crude oil is a complex mixture of thousands of hydrocarbon and non-hydrocarbon organ metallic compounds and metallic compounds. The ratios of naphthenic and aromatic hydrocarbons are relatively higher than in paraffinic crudes. Water and oil are usually considered to be immiscible and they are insoluble. However, crude oil contains a very small soluble portion referred to as the water soluble fraction [4]. The soluble components are dissolved hydrocarbons. Based on the density crude oil is divided in to the following groups: Light and heavy crude oil.

Physiological Effects of Crude Oil on Plant

Effects on seeds germination

Germination of seeds in soil polluted with crude oil may be significantly reduced the seeds germination [5]. Apparently, the hydrocarbon film created on the seed surface prevents the imbibition of water and oxygen to the developing embryo, inhibited seed germination in oil contaminated soil also can be directly or indirectly related to the presence of oil in soil [6]. Attributed poor seed germination may be due to the penetrating power of the volatile fractions of oil. In contact with a seed, oil would enter the seed coat and readily kill the embryo [7]. The seed germination also can be indirectly hindered by unfavorable soil conditions such as surface crusts and droughty soil conditions related to soil being contaminated with oil [8]. And have reported that the crude oil soaked cotyledons or embryo lead to poor germination of seeds [9]. Most studies of the effects of crude oil in maize (corn) have examined the effect of crude on physiological parameters such as percentages of seed germination [10]. Seed germination of Okra, soybeans and *Amaranths hybridus* oil plants were delayed in the pollution of the soil by crude oil [11-13].

Effects on seedling

Petroleum hydrocarbon contamination may affect plants by retarding seedling growth [14]. The percentage seedling emergence of the maize seeds under the effect of water soluble fraction was decreased as the level of contamination increased. Seedling growing on water insoluble fraction contaminated soil exhibited the lowest seedling emergence rate [4]. Bioassays such as measurements of early seedling growth have been used to monitor effects of oil contaminated sites [13]. The effects of crude oil contaminated soil at various sub lethal chlorophyll contents leaves [15] of cowpea were decreased under oil contaminated soil. With respect to grass species, the work [16] suggests that grasses such as rye grass are fairly tolerant [17].

Material and Methods

Plant seed

A Zea may L. (Maize, corn)*,* family *Poaceae, was* purchased at supermarket seven sea. The seeds was collected from Hei Alsalam area were stored at room temperature ranges from 25°C to 30°C.

Chemicals

Formaldehyde, Distilled Water (DW), the crude oil used was (from Alberigh port, field Alamal) heavy, with the following concentrations of type of oil (0.0 V/V, 0.5 V/V, 1.0 V/V, 2.0 V/V, 4.0 V/V, 6.0 V/V, 8.0 V/V, 10.0 V/V).

Germination test

Sterilized glass petri dishes (9.0 cm) lined with double layers of Whatman No.1. filter paper was used. Glass petri dishes were cleaned and sterilized in an oven at 180°C for 2 hours. The seeds were sterilized with 10% formaldehyde for 3 minutes. Seeds were placed in the petri dishes each contains five seeds. Six replicates were used for each treatment of heavy crude oil. The filter paper was watered by adding 3 ml of distilled water or solution to be tested. All petri dishes were incubated in an incubator of (Gallenkamp) at temperature of 20°C for one week. Distilled water or tested solution was added to the petri dishes whenever it was needed to all replicates at the same time. Germinated seeds were counted daily and germination percentage was calculated at the end of the germination period for each treatment as following:

$$Germination\ percentage = \frac{Number\ of\ seeds\ that\ germinated}{Number\ of\ seeds\ sown} \times 100$$

$$Coefficient\ of\ germination\ velocity\ (CGV) = \frac{A1 + A2 + A3 ... + An}{A1T1 + A2T2 + ...}$$

Where A is the numbers of seeds germinating and T is the number of days taken to germinate, was calculated.

$$GR = \frac{n}{d}$$

'n' number of emerged seeds in day d, d is day after planting.

$$Germination\ index\ (GI) = \frac{Gs}{Gc} \times \frac{Ls}{Lc} \times 100\%$$

Where Gs and Gc are number of seeds germinated in the sample and control, respectively, whereas Ls and Lc are the radicle length in the sample and control, respectively.

Number of non-germinated seeds was calculated daily to determine daily inhibition of germination percentages by using the following formula:

$$Mean\ inhibition\ of\ final\ germination\ percentage\ (\%) = \frac{Final\ number\ of\ non-germinated\ seeds}{Total\ number\ of\ seeds} \times 100$$

$$Mean\ germination\ time\ (MGT) = \frac{n1 \times d1 + n2 \times d3 + n3 \times d3 + ...}{Total\ number\ of\ days}$$

Where, n=number of germinated seed, d=number of days

Daily and final germination percentages (%) were calculated for the determination of some of the following parameters.

$$Mean\ daily\ germination\ (MDG) = \frac{FGP}{D}$$

FGP is final germination percent, D is day of maximum germination (experiment period).

Early seedling development

Different parameters were measured for the determination of seedling growth: These measurements include:

Root and shoot length (cm) for corn, Fresh weight of root and shoot (g) of corn,

Root/shoot ratio (R/S)=Dry weight of root (g)/Dry weight of shoot (g).

Different parameters were measured for the determination of seedling growth, these measurements include: Root and shoot length (cm) for corn, fresh weight of root and shoot (g) of corn.

$$Relative\ water\ contents\% = \frac{Fresh\ weight - Dry\ weight}{Fresh\ weight} \times 100$$

$$Percentage\ seedling\ emergence = \frac{Number\ of\ seedling\ that\ emerged}{Number\ of\ seeds\ sown} \times 100$$

Seedling Vigor Index (SVI) is calculated using the following modified formula:

SVI=Seedling length (cm) × germination percentage

Tolerance Index (TI) is calculated using the following modified formula:

$$TI = \frac{Length\ of\ seedling\ in\ treatment}{Length\ of\ seedling\ in\ control}$$

Results

Seed germination

Mean of daily seed germination percentages of *Zea mays* were calculated under different dilutions of heavy crude oil **Table 1** in appendix. This parameter was not grown under first day it was significantly in second day of germination seeds (F=4.64, $P<0.001$) within treatments. Tukey's pairwise comparisons test reveals significant differences in germination percentages of same plant between control treatment and other treatments, and was not significant differences from third days to last days in treatments. **Figure 1** in showed fourth and seventh days. **Table 2** effect of different dilutions of heavy crude oil on Germination Rate (GR), Inhibition of Final Germination percentages (IFG%), Mean Daily Germination (MDG), Mean Germination Time (MGT) and Germination Index (GI) were shown not affected and not significant differences in treatments. Coefficient of Germination Velocity (CGV) of *Zea mays* was found significantly (F=2.27, $P<0.05$) within treatments. Tukey's pairwise comparisons test reveals significant differences between control and dilutions 6.0 (%v/v) of heavy oil **Figures 2** and **Figures 3** for inhibition of final germination and coefficient of germination velocity.

Table 1: Effect of different dilutions of heavy crude oil on daily germination percentages (%) of *Zea mays* L. (Corn) seeds.

Treatment (%)	Germination percentages (%)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
0.0	+0.00 ± 0.00	***60.0^{a} ± 8.9	+76.7 ± 3.3	+86.7 ± 4.2	+90.0 ± 4.5	+93.3 ± 4.2	+93.3 ± 4.2
0.5	0.00 ± 0.00	13.3^{b} ± 6.7	73.3 ± 8.4	83.3 ± 6.2	86.7 ± 4.2	90.0 ± 4.5	90.0 ± 4.5
1.0	0.00 ± 0.00	33.3^{ab} ± 8.4	66.7 ± 9.9	90.0 ± 6.8	90.0 ± 6.8	93.3 ± 4.2	93.3 ± 4.2
2.0	0.00 ± 0.00	40.0^{ab} ± 10.3	90.0 ± 6.8	93.3 ± 6.7	96.7 ± 3.3	96.7 ± 3.3	96.7 ± 3.3
4.0	0.00 ± 0.00	23.3^{b} ± 8.03	70.0 ± 8.6	86.7 ± 8.4	90.0 ± 6.8	90.0 ± 6.8	90.0 ± 6.8
6.0	0.00 ± 0.00	3.30^{b} ± 3.30	70.0 ± 14.4	80.0 ± 8.9	86.7 ± 4.2	86.7 ± 4.2	86.7 ± 4.2
8.0	0.00 ± 0.00	23.3^{b} ± 9.60	76.7 ± 3.3	96.7 ± 3.3	96.7 ± 3.3	96.7 ± 3.3	96.7 ± 3.3
10.0	0.00 ± 0.00	20.0^{b} ± 7.30	80.0 ± 8.9	86.7 ± 9.9	86.7 ± 9.9	86.7 ± 9.9	86.7 ± 9.9

Table 2: Effect different dilutions of heavy crude oil on the means of Germination Rate (GR), Mean Daily Germination (MDG), Mean Germination Time (MGT) and Germination Index (GI) of *Zea mays* L. (Corn) seeds.

Treatment (%)	GR	MDG	MGT	GI
0	+0.70 ± .03	+ 13.3 ± 0.6	+ 16.9 ± 0.7	+ 83.3 ± 6.9
0.5	0.60 ± 0.03	12.9 ± 0.6	15.6 ± 0.8	44.6 ± 10.0
1	0.70 ± 0.03	13.3 ± 0.6	16.4 ± 1.03	88.2 ± 11.6
2	0.70 ± 0.02	13.8 ± 0.5	17.6 ± 0.8	72.8 ± 13.9

4	0.60 ± 0.05	12.9 ± 0.98	15.9 ± 1.3	65.9 ± 13.4
6	0.60 ± 0.03	12.4 ± 0.6	14.98 ± 0.97	73.4 ± 12.6
8	0.70 ± 0.02	13.8 ± 0.5	17.2 ± 0.6	68.7 ± 10.0
10	0.60 ± 0.07	12.4 ± 1.4	15.6 ± 1.8	59.9 ± 12.0

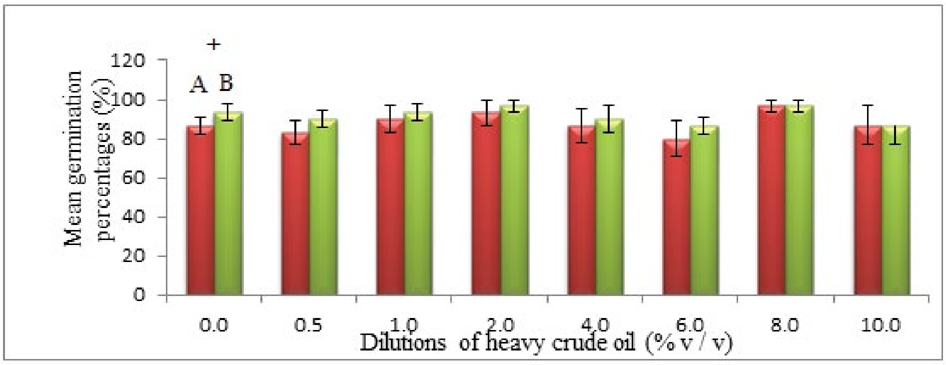

Figure 1: Effect of different dilutions of heavy crude oil on daily germination percentage (%) during the fourth day (A) and the seventh day (B) of *Zea mays* L. (Corn) seeds.

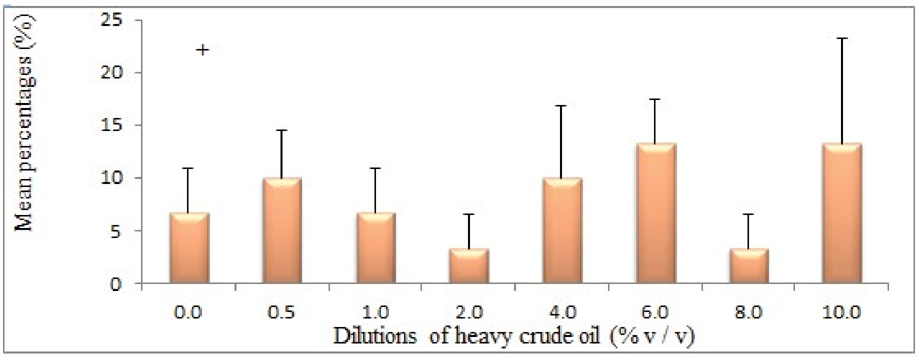

Figure 2: Effect of different dilutions of heavy crude oil on inhibition of final germination percentages (%) of *Zea mays* L. (Corn) seeds.

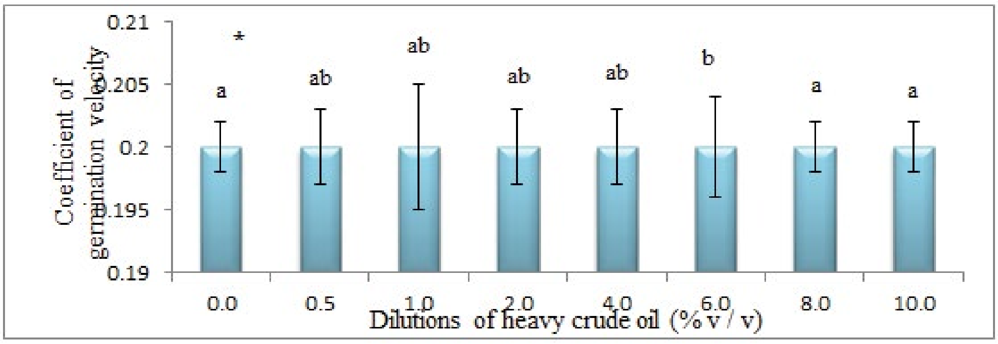

Figure 3: Effect of different dilutions of heavy crude oil on Coefficient of Germination Velocity (CGV) of *Zea mays* L. (Corn) seeds.

Seedling growth

Parameters of length shoots of *Zea mays* measured under different dilutions of heavy crude oil showed in **Table 3** were not significant differences in treatments but were significant (F=2.20, $P<0.05$, F=2.86, $P<0.01$) respectively in length roots and fresh weight of same plant the increased in concentrations of 8.0% V/V and reduced in other treatments. Tukey's pairwise comparisons test reveals significant differences between dilution of 0.5% V/V and 8.0% V/V and between comparison control and 0.5% V/V in fresh weight whereas parameters of fresh weight root was not affected by dilutions **Table 3**. **Table 4** Appendix effect of different dilutions of heavy crude oil on mean of dry weight shoots of corn was significant (F=3.19, $P<0.01$) within treatments. Tukey's pairwise comparisons test reveals significant differences between untreated (control) and concentration of 0.5% V/V. While showing the results as not significant differences in parameters of dry weight **Figure 4**, root/shoot ratio **Figure 5** and relative water content percentages **Figure 6**. **Table 3** appendix inhibition of seedling length of same species plant were had not significant differences in treatments and fresh, dry weight and Grade of Growth Inhibition Index (GGI) was significant differences (F=2.77, $P<0.01$, F=2.78, $P<0.01$, F=2.78, $P<0.01$) respectively within treatments **Table 5** appendix. Inhibition of fresh weight reduce in other treatments from 4.0% V/V up to 8.0% V/V and increased in lower dilution of 0.5 V/V, 1.0 V/V. Tukey's pairwise comparisons test reveals significant differences between dilution of 0.5 V/V and 2.0 V/V. **Table 6** appendix parameters of seedling emergence percentages (%) **Figure 7** of corn was not significant differences in treatments. Were significantly in seedling vigor index on.

Table 3: Effect of different dilutions of heavy crude oil on length shoots, roots (cm) and fresh weight (g) shoots, roots of *Zea mays* L. (Corn) seedlings.

Treatment (%)	Mean values			
	Shoot length (cm)	Root length (cm)	Shoot fresh weight (g)	Root fresh weight (g)
0.0	+15.1 ± 1.5	*22.6^a ± 2.7	**0.40^a ± 0.04	+0.20 ± 0.03
0.5	9.4 ± 1.6	12.1^{ab} ± 2.3	0.20^{bc} ± 0.03	0.12 ± 0.03
1.0	15.07 ± 1.5	22.2^a ± 2.8	0.30^{ab} ± 0.04	0.20 ± 0.03
2.0	13.4 ± 1.9	20.9^a ± 2.8	0.40^a ± 0.05	0.20 ± 0.03
4.0	15.5 ± 1.9	19.6^a ± 2.3	0.40^a ± 0.04	0.20 ± 0.02
6.0	12.8 ± 1.7	19.7^a ± 2.7	0.30^{ac} ± 0.04	0.20 ± 0.03
8.0	12.98 ± 1.2	24.4^{ac} ± 2.5	0.34^a ± 0.03	0.20 ± 0.02
10.0	11.4 ± 1.5	17.7^a ± 2.2	0.30^{ac} ± 0.04	0.20 ± 0.03

Table 4: Effect of different dilutions of heavy crude oil on the means of dry weight (g) of shoots and roots, root/shoot ratio and Relative Water Content percentages (RWC%) of *Zea mays* L. (Corn) seedlings.

Treatment (%)	Mean values			
	Shoot dry weight (g)	Root dry weight (g)	Root/shoot	Relative water content (%)
0.0	**0.02^a ± 0.002	+0.01 ± 0.002	+0.6 ± 0.09	+78.6 ± 6.5
0.5	0.009^b ± 0.002	0.02 ± 0.010	0.7 ± 0.20	58.0 ± 8.3
1.0	0.02^a ± 0.002	0.01 ± 0.002	0.7 ± 0.20	79.3 ± 5.8
2.0	0.02^a ± 0.003	0.015 ± 0.002	0.6 ± 0.09	65.6 ± 7.98
4.0	0.02^a ± 0.003	0.015 ± 0.002	0.8 ± 0.20	77.6 ± 6.4
6.0	0.02^{ab} ± 0.002	0.02 ± 0.002	0.8 ± 0.140	71.4 ± 7.3
8.0	0.02^a ± 0.002	0.02 ± 0.003	1.1 ± 0.200	82.6 ± 5.1
10.0	0.02^{ab} ± 0.002	0.02 ± 0.003	1.0 ± 0.20	73.7 ± 6.9

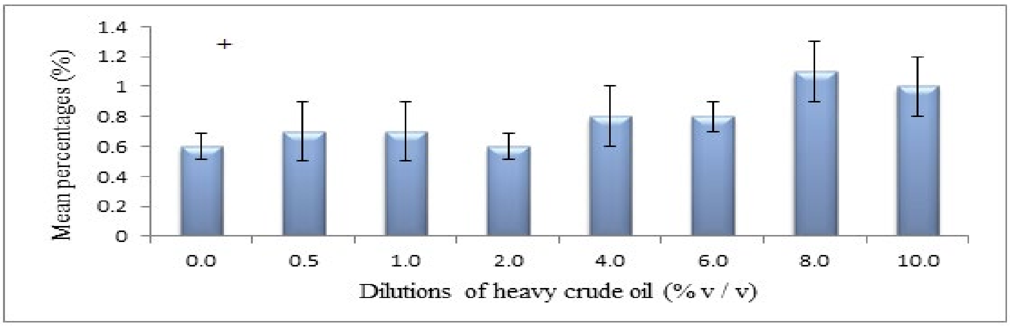

Figure 4: Effect of different dilutions of heavy crude oil on means of dry weight (g) shoots (A) roots (B) of *Zea mays* L. (Corn) seedlings.

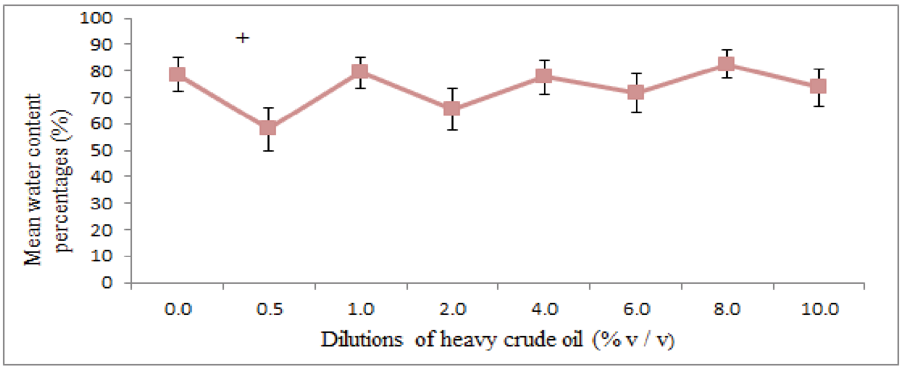

Figure 5: Effect of different dilutions of heavy crude oil on means of root/shoot ratio of *Zea mays* L. (Corn) seedling.

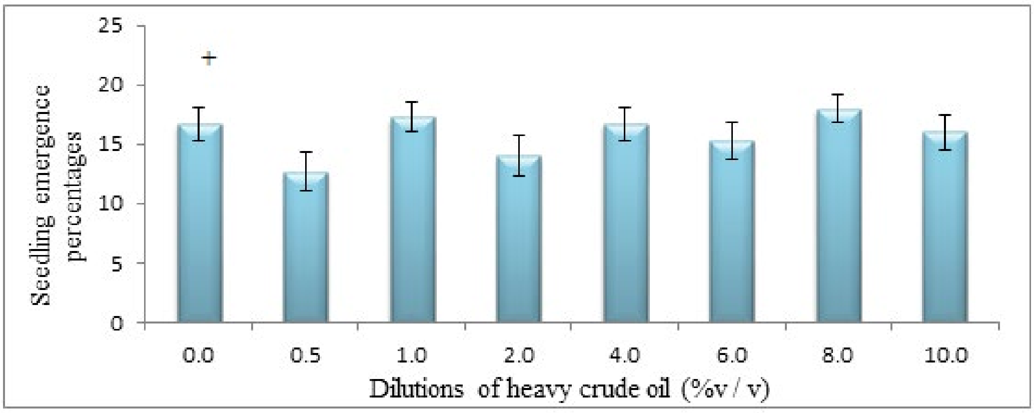

Figure 6: Effect of different dilutions of heavy crude oil on relative water content percentages of *Zea mays* L. (Corn) seedlings.

Table 5: Effect of different dilutions of heavy crude oil on the mean values of seedling growth inhibition percentages (%) and grade of Growth Inhibition Index (GGI) of *Zea mays* L. (Corn) seedlings.

Treatment (%)	Mean values			
	Length (cm)	Fresh weight (g)	Dry weight (g)	Grade of growth inhibition index
0.0	+0.00 ± 0.00	**0.00[a] ± 0.00	**0.00[a] ± 0.00	**0.00[a] ± 0.00
0.5	-35.0 ± 13.7	-44.2[ab] ± 15.2	-32.6[ab] ± 12.4	32.6[ab] ± 12.4
1.0	-13.4 ± 13.3	-34.4[a] ± 16.6	0.94[a] ± 9.97	-0.94[a] ± 9.97
2.0	11.6 ± 6.9	12.9[ac] ± 7.96	17.8[ac] ± 8.70	-17.8[ac] ± 8.70
4.0	-5.2 ± 10.0	0.40[a] ± 9.20	10.9[ac] ± 10.0	-10.9[ac] ± 10.0
6.0	-9.3 ± 10.6	-0.20[a] ± 9.50	4.6[a] ± 12.7	-4.6[a] ± 12.7
8.0	-6.1 ± 10.7	-5.0[a] ± 11.8	19.4[ac] ± 10.7	-19.4[ac] ± 10.7
10.0	-35.9 ± 20.6	-15.4[a] ± 14.5	11.9[ac] ± 8.60	-11.9[ac] ± 8.60

Table 6: Effect of different dilutions of heavy crude oil on seedling emergence percentages (SE%), seedling vigor (SVI) and Tolerance Indices (TI) of *Zea mays* L (Corn) seedlings.

Treatment (%)	Mean values		
	SE%	SVI	TI
0.0	+16.7 ± 1.4	*755[a] ± 74.9	+0.80 ± 0.07
0.5	12.7 ± 1.7	430.3[b] ± 73.9	0.60 ± 0.08
1.0	17.3 ± 1.3	745.3[ab] ± 80.8	0.80 ± 0.09
2.0	14.0 ± 1.7	685[ab] ± 87.4	0.70 ± 0.12
4.0	16.7 ± 1.4	701.7[ab] ± 74.0	0.70 ± 0.095
6.0	15.3 ± 1.6	648.8[ab] ± 80.9	0.70 ± 0.10
8.0	18.0 ± 1.1	717.7[ab] ± 68.9	0.70 ± 0.09
10.0	16.0 ± 1.5	513.7[ab] ± 71.0	0.60 ± 0.09

Same plant within treatments increased in other treatments. Tukey's pairwise comparisons test reveals significant differences between control and dilution 0.5% V/V **Figure 7**. Tolerance Index (TI) was not affect by different dilutions in treatments **Figure 8**.

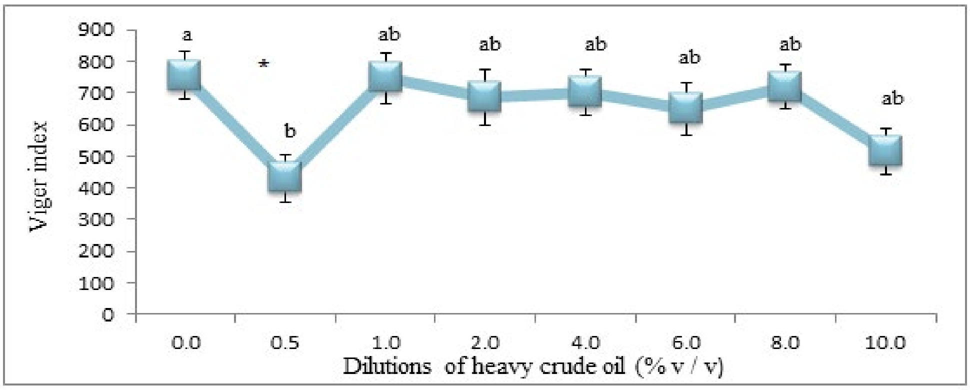

Figure 7: Effect of different dilutions of heavy crude oil on Seedling Vigor Index (SVI) of *Zea mays* L. (Corn) seedlings.

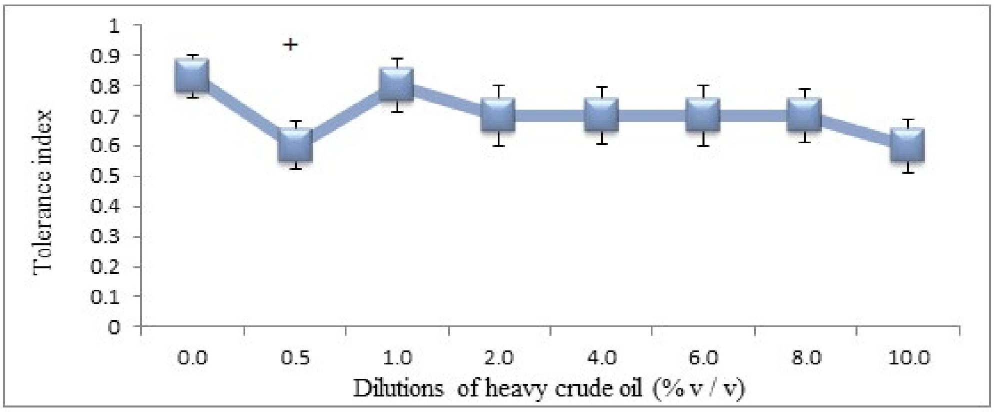

Figure 8: Effect of different dilutions of heavy crude oil on tolerance index of *Zea mays* L. (Corn) seedlings.

Discussion and Conclusions

Effect of crude oil residue on seed germination

Oil pollution in whatever form is toxic to some plant species and their environment has been observed by many researcher workers [11,18] that crude oil affects soil properties and this in turn affects the physiological, anatomical and sensitive phase in plant growth and development, being indicative to any type of environmental contaminants. The effect of heavy crude oil residues were investigated for some seed parameters of some weeds which include *Solanum nigrum, Amaranthus hybridus* and some cultivated plants such as *Triticum aestivum* and *Zea mays* seeds. These results are agreed with development of plants grown on such soils. The germination process is a very extremely the findings reported [19] who found that germination index of Indian mustard was not affect with diesel oil contaminated soil. And have also recorded that four species of grasses germinated successfully in different levels of petroleum hydrocarbon contamination [20]. The effect of phenol and naphthol compounds, as water soluble fractions of crude oil, on the germination and seedling development was investigated for seeds of some crops cultivated in Libya. Coating the seeds with oily substances prevent water and air movement in to the seed and directly causes toxic actions. One of the most possible reasons for seed germination inhibitory effects in crude oil contaminated sites is due to insufficient aeration of hypoxic or anoxic (having little or no oxygen, respectively), conditions. The embryo of seeds could have been injured or killed if it comes in contact with the oil. This effect could also be as a result of formation of polar compounds dissolved in water that could penetrate the seed coat and prevent the germination process [21]. The cessation of seed germination by crude oil is in line with previous research reports [2,3,22-24] reported that growth parameters in *Amaranthus hybridus* decreased as the concentration of crude oil contamination increased. But seed *Zea mays* plant species were promoted by the application of different dilutions of heavy residue of petroleum oil. Whereas, coefficient of germination velocity of both plant species showed similar patterns of response under light and heavy levels of oil residues. In general, seed germination of all target species used in this work was enhanced under the stimulation of heavy crude oil. This is might be due to the hydrophobicity of heavy oil which possesses less solubility in water and therefore causes phytotoxicity. There is however, lack of information on the effects of crude oil on some biochemical processes such as oxidative stress parameters in plant species used in study. It had been found that exposure of plants into petroleum oil caused an increase in the production of stress related phytohormones such as ethylene and abscises acid [4]. Most studies of the effects of crude oil have examined the effect of petroleum residues on physiological parameters such as percentages of seed germination of corn [11,12,25] soybeans and *Amaranths hybridus* where their germination was delayed in the soil polluted by crude oil. Generally, contamination by petroleum hydrocarbon causes retardation of seed germination [24] that led to adverse biological effects of some plant species [6]. Some researchers have considered naphthalene as a more important source of crude oil toxicity than low molecular weight aromatics [26,27]. Shoot growth retardation in plants due to petroleum pollution as observed in this work had been reported by different workers on related studies [2,3,28,29] during their study with three vascular plants (fluted pumpkin, maize and okra) reported retardation in their shoot growth as a result of crude oil contamination. This is in agreement with the result obtained [11] that oil in soil above 2.0% V/V concentrations affects the growth of okra adversely and severely *Zea* mays under the influence of this kind of crude oil.

Effects of crude oil residues on seedling growth

Seedling performance of plants used in this study was measured under different dilutions of different types of oil compounds. Seedling growths of plants that are able to germinate successfully and tolerate the contaminant and show root elongation are tolerant plants [30,31]. But different seedling parameters in terms of fresh and dry measures were increased under different dilutions of the used oils. The high survival rate of these seedlings due to their tolerance to the high levels of oil compounds [32]. Impact of stressful conditions of crude oil pollution has been shown to have adverse effects on plant growth and these may range from morphological aberrations, reduction in biomass to stomatal abnormalities [33]. Accumulation of toxic substances resulted in a decrease in size and biomass production of maize plant species [11,34,35] of the reduction in the growth of seedlings which growing in the media polluted by petroleum oil residues probably due to the poisoning effects of the crude oil on the plant development. Growth reduction could also be explained as being due to harmful effects of oil. Growth reductions following oil pollution of soil have been reported by same authors such as [36,37] who also observed significant effect of engine oil on leaf vegetable (*Amaranthus hydrides* L.). Noticed a significant reduction in height of seedlings, of treatment relative to the control .Different plants can tolerate different levels of petroleum hydrocarbons. Hydrocarbon contamination of soil reduced plant growth but increased microbial activity [38]. Whether the effect of the contaminant is beneficial or adverse depends, to a certain degree, on the concentration of the contaminant and type of plant species. Crude oil and petroleum products vary considerably in their toxicity, and the sensitivity to petroleum varies according to plant species. The toxicity of crude oil can be interpreted as the toxicity of a complex mixture of inorganic and organic, chemicals. The observed negative in the germination percentages, rate of germination as well as, the growth parameters (seedling length, fresh weight and biomass production) measured could be attributed to the numerous hydrocarbons and related compounds which are toxic to living organisms including plants. It seems to the present study that the adverse effect noticed on the treated corn plants may be due to unfavorable germination conditions created by toxic substances contained in the crude oil. Growth reduction in crude oil polluted media as observed in this study for some plant species may also be attributed to a disruption in aeration. This observation is in line with the findings of [39,40] reported delayed germination and reduction in grain yield of maize in crude oil polluted soil. The effected of heavy crude oil examined for seed germination *Zea mays.* L (Corn), they were promoted heavy crude oil. Seedling performance was not affected by heavy oil applications. The influence of heavy crude oil upon different target plant species used in this research was not clearly pronounced (different) that is all plant species were not affected by the applications of heavy crude oil residues. This might be due to that heavy oil is more viscous and less soluble in water.

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