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PHYTOREMEDIATION OF CADMIUM CONTAMINATED – SOIL BY MAIZE (*ZEA MAYS*) PLANT

Eiman. E. Diab; Elsadig. A. Makeen; Hajo E. Elhassan

Environment, Natural Resources and Desertification Research Institute,
National Center for Research, Khartoum, Sudan

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ABSTRACT

The aim of this study was to detect the ability of two maize verities seeds (Hudeiba one and Hudeiba two) to germinate, grow and remove cadmium element from contaminated soil. In pot experiment two maize varieties (Hudeiba one and Hudeiba two) seeds were grown in soil spiked with different levels of cadmium concentration, which were 0, 10, 25, 50, 75 and 100 mg/L.). Growth parameters and concentration of cadmium in plant tissues was measured. The results showed that for the two varieties of maize Hudeiba one and Hudeiba two seeds have ability to germinate and grow under different concentration of cadmium. Also it was found that cadmium affected the most growth parameters such as leaves area, fresh shoot weight, fresh root weight, dry root weight and dry shoot weight in all treatments. The results also indicated that the two varieties of maize (Hudeiba one, Hudeiba two) seedlings and plant, can uptake cadmium element from contaminated soil with different concentration levels up to 100 mg/kg-1. The results indicated that low concretion levels of cadmium up to 100mg/L can enhance the germination of seeds. Statistical analysis of the results showed that the accumulation of cadmium in roots was greater than in shoots for both seedlings, for the different level of concentrated. In conclusion maize variety, Hudeiba 1 and Hudeiba 2 seedlings can be used for phytoremediation of cadmium contaminated soil.

Keywords: *Phytoremediation, Cadmium, Maize*

1. INTRODUCTION

Global industrialization over the past two centuries has resulted, in widespread contamination of the environment with persistent organic and inorganic wastes. Contaminated land has generally resulted from past industrial activities where awareness of the environmental health effects

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connected with the production, use, and disposal of hazardous substances were less recognized than today. The problem is worldwide, and the estimated number of contaminated sites is significant and increasing (Kirk et al 2005). There have been increasing international efforts to remediate contaminated sites using "green" technologies, either as a response to the risk of adverse health or environmental effects or to enable site redevelopment (Mclalighlin *et al.*, 1999). Heavy metals have been the subject of particular attention because of their long-standing toxicity, mobility in the ecosystems and transfer into the food chains when specific thresholds have been exceeded (Hart *et aI., 2002 and* Adriano 2003). Cadmium (cd) is the most abundant element in the earth curst it is ranked at about the 64th place of elements (Sarkar 2002) in an average concern of about 0.1 mg/kg, and in soils remote from man, the concentrations of cadmium typically range between 0.1 and 0.4 mg/kg). Cadmium is a trace element which has no biological function but many investigations concluded that plants can accumulate cadmium and plant tissue concentrations are significantly related to the cadmium levels in the environment (Alloway 1990).

Maize *(Zea mays)* is one of the most important cereal crops, there are about 50 different species of maize having their own characteristic features and kernel sizes, all belonging to a small number of types Maize usually grow in summer season and its growth depends more on high temperatures. Moreover, large amount of water is needed during its growth (Ciura *et al*, 2005)

The main objective of this study to investigate the potential of Corn (Zea mays) for phytoremediation of soil contaminated with Cadmium. The specific objective of experiments are evaluation the ability of Zea mays to geminate and grow under different soil contaminated with cadmium (10, 25, 50, 75, 100) concentration.

2. MATERIALS AND METHODS

2.1 Seeds collection:

About 500 grams of maize *(Zea mays)* seeds of Hudeiba one and Hudeiba Two, were obtained from the department of seed technology, Federal Ministry of Agriculture, Sudan. The seeds were cleaned and kept in polyethylene bags.

2.2 Soil collection:

Soil was collected from the top layer of agricultural field in the blue Nile bank of pH 8.25 and Ec (94.45) ucm.

2.3 Pots Experiment:

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A pots experiment was carried out, following simple randomize design, where, the disinfected of two Varieties are growth period of ten weeks. The levels of cadmium salts in both treatments were 0, 10, 25, 50, 75 and 100 mg/kg (each concentration has 3 replicates). four maize seeds were placed in each plastic pot.

2.4 Measurement of growth parameters:

Geminated plant percentage was measured for all treatment in the laboratory experiment. Plant height. leaves area, fresh weight, and dry weight for shoots and roots of different pot experiment plants were determined at the nursery.

2.5 Analysis of cadmium concentration:

Analysis of cadmium in both plant tissues and soil samples of the two experiments was determined according to the method described by (AOAC, 2000).

2.5.1 Sample preparation:

The plant tissues of all treatments were prepared for analysis as follow: the plant tissues were firstly subjected to air drying process, after that, every tissue was removed from the paper bags and ground using a mortar and pestle. For larger tissue quantities, an electric blender was used. Ground tissue was placed into clean crucibles, covered with lids and gently placed into a muffle furnace at a temperature of 500C◌̊ for a period of 4 hours to ensure complete ashing. At the end of the period, the crucibles and lids were carefully removed from the muffle furnace and allowed to cool. After cooling, the crucibles with the ashed tissue were placed on a heating plate and 10 ml of a *5N* hydrochloric acid was added. The crucibles were heated to a temperature of approximately 80C◌̊ and allowed to remain on the plate for approximately 20 minutes to dissolve the plant tissue and dry; an additional 10 ml of 20% hydrochloric acid was added to each crucible to dissolve any remaining residue. The solution was poured through an acid washed, filter paper in a glass flannel. The filtered and rinsed solution was collected in a sterile, 50 ml graduated containers.

2.5.2 Soil pH and soil EC determination:

Prepare a *1:5* (soil: water) suspension. Weigh l0g air-dry soil into a bottle and add 50mL deionized water. The mixture was shacked with a mechanic shaker for one hour The solution was stirred with a mechanical stirrer during measurements. EC-meter was used in the same experiments to determine the value of soil electrical conductivity in the soil solution prepared.

3. RESULT AND DISSCUSION

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3.1 Effects of cadmium on maize growth

3.1.1 Effects of cadmium on plant height

Table (1) show indicate the results of maize height for the two varieties for mostly 10 weeks of growth period; the control group average a height of (11.47, 15.68, 23, 90 and 32.22 days cm) at measurable time of (30, 45, 60 and 75 days) respectively while the treatment of cadmium concentration of (10, 25, 50,7 5 and 100mg/kg-1 were (12, 6, 11, 87, 11, 87, 13, 83 and 13.47 mg/kg-1 soil) after 30 days, (17.74, 17, 99, 16, 61, 17, 28 and 17, 04 mg/kg-1 soil) after 45 days, (24.77, 27.23, 25.77, 25.57 and 23.47 mg/kg -1 soil) after 60 days, (36.0, 33.67, 37, 08, 31.13 and 29.17 mg/kg-1 soil) respectively. Statistical analysis indicated that there were no significant differences ($P < 0.05$) in height among the different cadmium treatment for the variety Hudieba one. Statistical analysis indicated that there was no significant cadmium treatment for the variety Hudieba two.

Table 1: Effect of different cadmium concentration on soil to the maize height (Hudeiba 1 and Hudeiba 2) after 30, 45, 60, 75 days

Varieties	*Treatment dosed (ppm)*	*After 30 day*	*After 45 days*	*After 60 days*	*After 75 days*
v_1	0	11.47a	15.68a	23.90b	32.22c
v_1	10	12.60a	17.74a	24.77b	36.00b
v_1	25	11.87a	17.99a	27.23a	33.67c
v_1	50	11.87a	16.61a	25.77a	37.08b
v_1	75	13.83a	17.28a	25.57a	31.13c
v_1	100	13.47a	17.04a	23.47b	29.17d
v_2	0	11.20a	18.44a	25.43a	38.63a
v_2	10	10.13a	17.24a	26.43a	40.84a
v_2	25	8.77b	17.58a	26.13a	36.17b
v_2	50	10.41a	17.05a	26.10a	34.54bc
v_2	75	10.60a	18.34a	23.77b	35.46b
v_2	100	10.67a	18.07a	20.00c	29.39a

Means in the two same column followed by different letters are significantly different ($P < 0.05$) using Fisher Protected L.S.D

3.1.2 Effect on number of leaves:

Table (2) shows the results of two different variety of maize growth response as influenced by different levels of cadmium concentrations, after ten weeks of growth period, the results indicate that the control group averaged of number of leaves of (4.33, 5.67, 5.67 and 7). (30.45, 60 and 75 mg/kg-1) days of growth respectively while the treatment of cadmium concentration of (10.25, 50, 75 and 100mg/kg-1), were (4.33, 5, 4.33 and 5) (5.33, 5.67, 6.6 and 6 leaves), (4.67, 4.67,

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5.67, 5.67 and 4.33 leaves) and (9,8,7.67, 8.33 and 7 leaves) after four periods of measurement Statistical analysis indicated that there was no significant differences ($P < 0.05$) in the numbers of leaves among the different cadmium treatment, only slight different in the number of leaves was shown after 60 days of experiment: compared with previous periods 30 a day 45 days. Were the number of leaves was (5,6,4.33) after (30, 45, 60 days) for the highest concentration level of 100 mg/kg-1 soil. Table 2 shows the growth after 75 days, of maize variety Hudeiba two the control group averaged number of leaves of (4.67, 6.67, 6067 and 8 leaves). While the treatment of cadmium concentrations of 10, 25, 50, 75 and 100 mg/kg-1 were (5,4.67, 5 and 5 leaves) , (6,6,6,6 and 6 leaves), (6.67, 6.67, 7.6 and 5.33 leaves) and (7.33, 8.33, 9, 8.33 and 8 leaves) respectively for the four interval of measurements (30, 45, 60 and 75 days).Statistical analysis indicated that these was no significant differences ($P < 0.05$) in number of leaves among the different cadmium treatment except for the consternation 100gm/kg-1 after 60 days.

Table 2: Effect of different cadmium concentration on soil to the leave number of maize (Hudeiba1 and Hudeiba2) after 30 , 45 , 60 , 75 days

Varieties	*Treatment dose (ppm)*	*After today*	*After 45 days*	*After 60 days*	*After 75 days*
v_1	0	4.33a	5.67a	5.67b	7.00b
v_1	10	4.33a	5.33a	4.67b	9.00a
v_1	25	5.00a	5.67a	4.67b	8.00a
v_1	50	4.33a	6.00a	5.67b	7.67b
v_1	75	4.33a	6.00a	5.67b	8.33a
v_1	100	5.00a	6.00a	4.33b	7.00a
v_2	0	4.67a	6.67a	6.67a	8.00a
v_2	10	5.00a	6.00a	6.67a	7.33a
v_2	25	4.67a	6.00a	6.67a	8.33a
v_2	50	4.67a	6.00a	7.000a	9.00a
v_2	75	5.00a	6.00a	6.00ba	8.33a
v_2	100	5.00a	6.00a	5.33b	8.00a

Means in the two same column followed by different letters are significantly different ($P < 0.05$) using Fisher Protected L.S.D

3.1.3 Effect on leave area:

Table (3) shows that leaves area of two varieties of maize (Hudeiba 1 and Hudieba 2) under different cadmium treatment, they indicate that there were significantly affected by cadmium treatment. In general cadmium application caused a decrease in the leaves area of the two varieties of maize specially after 60 days of growth , but for different periods (30, 45, 75 days) there was sign of significant different or influence of cadmium on leaves area compared to control. The results revealed that after ten weeks of growth period, the control group average a leaves area after four duration of measurements (30,45,60 and 75 days) was (74.83, 132.54,

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160.73 and 178.58 cm2) respectively. While the treatment of cadmium concentrations of 10, 25, 50, 75 and 100 gm/kg-1 after (30, 45, 60,75 d.) were (76.13, 76.8, 83.7, 58.73 and 71.67 cm2) , (148.19, 154.52, 140,39, 128, 74 and 109.26 cm2), and (229.63, 228.07, 182.5, 231.5 and 169.26 cm^2) respectively. Statistical analysis indicated that there was significant differences (P > 0.05) in leaves area among the different cadmium concentration for the variety Hudeiba one. While for the Hudeiba two variety the control group averaged leaves area for the same treatment of cadmium concentrations for the four periods (50, 45, 60 and 75 days). Where (50.57,146.53, 209.63 and 217.92 cm^2) for the control group averaged cadmium treatment concentrations for the four periods with the same cadmium concentration was as flows (49.33,48.97,52.83,49.87, and 44.77 cm^2), (130.49, 133.73, 129.83, 116.74 and 101 .84cm^2) and (200.8, 163.22, 205.11, 212.38 and 117.52 cm^2) respectively. Statistical analysis indicated that these was significant differences (P> 0.05) in leaves area of Hudieba two variety among the different cadmium concentrations especially at the concentrations of 100gm/kg-1 after 60 days of growth, which show that the two varieties of maize have the same behavior according to the cadmium concentrations in soils. i.e the different of varieties have no effect.

Table 3: The leave area of maize (Hudeiba1 and Hudeiba 2) grown in different soil contaminated with cadmium after 30 , 45 , 60 , 75 days

Varieties	*Treatment dose (ppm)*	*After 30 days (cm^2)*	*After 45 days (m^2)*	*After 60 days (cm^2)*	*After 75 days (cm^2)*
v_1	0	74.83b	132.54c	160.73 bcde	178.58c
v_1	10	76.13b	148.19b	144.33de	229.63a
v_1	25	76.80b	154.52a	192.10 abc	228.07a
v_1	50	83.70a	140.39b	193.50abc	182.51c
v_1	75	58.73a	128.74c	206.63 ab	231.50a
v_1	100	71.67b	109.26d	150.43 cde	169.21d
v_2	0	50.57c	146.53b	209.63 a	217.92a
v_2	10	49.33c	130.49c	207.90 ab	200.80b
v_2	25	48.97c	133.73c	191.37 abcd	163.22d
v_2	50	52.83c	129.83c	200.17 ab	205.11b
v_2	75	49.87c	116.74d	163.47 abcde	212.38b
v_2	100	44.77c	101.84d	135.20 e	117.52f

Means in the two same column followed by different letters are significantly different (P < 0.05) using Fisher Protected L.S.D

3.1.4 Effect of soil contaminated with different cadmium concentration on maize shoot, root fresh weight, and maize shoot, root dry weight:-

Table (4) shows the results of two varieties of maize (Hudeiba1 and Hudeiba2) growth which as influenced by different levels of cadmium concentration. These results include maize shoot fresh

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weight, and dry weight. Roots fresh weight and dry weight after ten weeks of growth period. The results indicated that fresh weight of shoot and root of the two maize varieties (Hudeiba1 and Hudeiba2) where significantly affected by cadmium application, while the shoot fresh weight slightly affected, where root and shoot fresh weight were not decreased compared to control one in the highest cadmium concentration of 100 mg/kg. where for Hudeiba one fresh weight is about 96% and 99% for root fresh weight for Hudeiba two. Which means that the application solution in so: (stimulate the growth of maize when the concentration is not high. This result agree with (Rahimi and Nejatkham 2010) stated that maize plants grown in the presence of 10 M/Lcd2+ showed significant growth reduction on both roots and shoot. (Siroka et al 2004). Reported that the growth inhibition is positively related to cadmium concentration by reduction in the viability of root cells. After ten weeks of experiment, the control group averaged shoots fresh weight 37.27g. Cadmium concentration of 10,25,50 ,75 and 100gm/kg-1 average shoot fresh weight for Hudeiba one variety were 48.63,48.4,42.17,47.67 and 35.93 g respectively. Statistical analysis indicated that there was significant difference (P>0.05) in shoot fresh weight among the varying levels of cadmium in soil for Hudeiba one variety. For Hudeiba two the control group averaged shoots fresh weight 43.47 g. cadmium concentrations of 10,25,50,75 and 100 mg/kg-1 average shoot fresh weights were 39.87, 45.63, 47.63, 52.53 and 43.4 respectively. Statistical analysis indicated there was significant differences (P>0.05) among shoot fresh weight of Hudeiba two according to the different cadmium concentration. Results in table 4 show that the control group averaged root fresh weight was 5.51 g. cadmium concentrations of 10, 25, 50, 75 and 100 mg/kg-1 average root fresh weights were 5.74, 5.81, 5.71, 6.2 and 5.24 mg/kg-1 respectively for Hudeiba one variety. Statistical analysis indicated that no significant differences (P <0.05) in roots fresh weight among the different concentration levels of cadmium.

For Hudeiba two variety the control group averaged root fresh weight was 6.83 g . cadmium concentration of 10,25,50,75 and 100 g/kg-1 average root fresh weights were 6.32, 6.00, 6.34 , 6.32 and 5.69 gm-1 respectively. Statistical analysis indicated there was no significant differences (P<0.05) in root fresh weight among the different levels of cadmium concentrations. Table 7 show that dry weight of shoot and root of zea mays. Where significantly affected by cadmium concentration especially for the variety of Hudeiba two of maize, where the root dry weight was decreased in the increase of cadmium concentration and by the companion of the two varieties with control and the highest concentration which 107% for shoot and 100% root dry weight where Cd consult 100mg/kg-1 for Hudeiba one , 43% shoot by weigh of Hudeiba two 75% root dry of the some variety the different can clearly it the comparison is between the two varieties . where the different of highest dose of cadmium (100 mg/kg-1) were 43% for Hudeiba one and 75% for Hudeiba two. Which indicated that the Hudeiba one variety is more tolerance to the lower levels of cadmium. Concentrations (Mangkoedihargio and Surhudimidia,2009.) reported that an increasing of cadmium concentration in nutrients solution caused an increase of

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sodium ad cadmium content in maize plant ad decrease of nitrogen iron manganese, Znic and total dry weight. After ten weeks of growth the control group average dry weight of shoot was 3.1 g. Cadmium concentrations of 10, 25, 50, 75 and 100 mg/kg-1 soil , average shoot weight were 4.2, 4.68, 3.79, and 3.33g respectively. Statistical analysis indicated that there was no significant differences (P<0.05) in shoot dry weight among different cadmium convention levels, for Hudeiba one variety. Where the control averaged group dry weight of shoot of Hudieba2 was 4.12g. cadmium concentrations of 10,25,50 75 and 100 mg /kg-1 soil average shoot weight were 3.67, 3.95,4.16, 4.07 and 3.09 g respectively. Statistical analysis indicated that no significant difference (P<0.05) in shoot) weight of Hudieba two variety among different cadmium concentration levels. After ten weeks of growth results indicate that the control group averaged root dry weight was 0.35 g. cadmium concentrations of 10, 25, 50, 75 and 100 mg/kg-1 soil average root dry weight are 0.25, 0.30, 0.31, 0.25 and 0.35 g respectively for Hudeiba one variety. Statistic analysis indicated that there was no significant differences (P< 0.05) in the root dry weight among different levels of cadmium concretions' for the Hudeiba one varieties. Whereas the control group average of Hudeiba two variety root dry weight was 0.37 g. cadmium concretion of 10, 25, 50, 75 and 100 mg/kg-1, soil average dry weight was 0.30, 0.24, 0.28, 0.26 and 0.16 g respectively. Statistical analysis indicated slight significant difference (P>0.05) in the root dry weight of Hudieba two variety among the different levels of cadmium concentrations where the lowest root dry weight comparing with control one at the highest close of cadmium (100mg/kg-1) 43% which indicated that the root weight decreased according to the increase of cadmium concentration. (Saxena et al 1999) grew maize (zea mays) in hydroponic solutions containing cadmium chloride at a concentration raining from 1 to 40 mg/litre. Uptake of cadmium into the plants increases with time, and cadmium was present at higher concentrations in roots than in shoots, leaf chlorophyll concentration and yield (as dry weight) of both root and shoots decreased with increasing cadmium concentration of Zinc decreased and concentration of iron increased. This gave a liner correlation between cadmium in the leaf and iron/zinc ratio.

Table 4: Effect of cadmium concentration on maize varieties (Hudeiba 1 and Hudeiba2) shoot fresh and dry weight and root fresh and dry weight

Varieties	*Treatment dose (ppm)*	*Root fresh weight (g)*	*Shoot fresh weight (g)*	*Root dry weight (g)*	*Shoot dry weight (g)*
v_1	0	5.51a	37.27d	0.35a	3.10c
v_1	10	5.74a	48.63 ab	0.25a	4.20a
v_1	25	5.81a	48.40 ab	0.30a	4.68a
v_1	50	5.71a	42.17 bcd	0.31a	3.81b
v_1	75	6.20a	47.67 ab	0.25b	3.79b
v_1	100	5.24a	35.93 d	0.35a	3.33c

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v_2	0	6.83a	43.47 bcd	0.37a	4.12a
v_2	10	6.32a	39.87 cd	0.30a	3.67b
v_2	25	6.06a	45.63 abc	0.24b	3.95b
v_2	50	6.34a	47.63 ab	0.28b	4.16a
v_2	75	6.32a	52.53 a	0.26b	4.07a
v_2	100	5.69a	43.40 b	0.16c	3.09c

Means in the two same column followed by different letters are significantly different ($P < 0.05$) using Fisher Protected L.S.D

Cadmium accumulation in maize plant and seedlings tissues:-

Table(5) shows that the accumulation of cadmium in maize seedlings after growth in different soil concentration of cadmium for ten weeks. As the result of experiments showed that cadmium accumulation was higher in roots as compared to shoots. For the laboratory experiment the accumulation of cadmium according to the cadmium concentration was very clear, for the two maize varieties used in the experiment, the result of cadmium uptake was increased as the concentration level was increased, total average accumulation of cadmium in highest and lowest cadmium level concentration of (10,100 mg/kg-1) for the two varieties was (129.34 , 25, 8.78) and (596.47, 2559.49mg/kg-1) respectively. Significant different ($P >0.05$) among the different concentrations of cadmium levels (10,25,50,75 and 100 mg/kg-1) for the two varieties of maize seedlings (Hudeiba one , Hudeiba two). Table 5 indicated that after ten weeks of growth period the cadmium acculturation was higher in roots as compared with shoots, for the two different varieties of maize plants (Hudeiba 1 Hudeiba2) for accumulation of cadmium for roots the statistical analysis indicated that there were significant differences among the different cadmium concentration levels (10,25,50,75,100mg/kg-1) ($P >0.05$) where the average accumulation for the root of the two verities was (85,84, 42.19, 390.86,202.10, and 1413.16 mg/kg-1) and (53.63, 76.4, 366.15, and 940.09 mf/kg-1) respectively. In compression of the two varieties for degree of the uptake of cadmium from soil in higher concentration Hudeiba one accumulate more cadmium than Hudeiba two for the same doses of cadmium applied, (1413.16 and 940.09 mg/kg-1). For shoot significant differences ($P <0.05$) among the different cadmium concentration levels (10,25,50,75 and 100 mg/kg-1) was observed and the accumulation averaged of shoot was (2.43, 26.55, 119.88 and 158.07 mg/kg-1) for Hudeiba one variety and (15.14, 20.22, 141.88, 139.04 and 143.53 mg/kg-1) for Hudeiba two varieties. Statistical analysis showed that the two varieties of maize accumulate cadmium from soil less than root. It was clear that the concentration of cadmium in maize plant showed that the accumulation of cadmium in roots is higher than in shoot, this showed that root of Zea mays is more active than shoot to phytoremediation of cadmium this findings was in line with (Zang et al 2009 and Xiao et al 2008). Normally,

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cadmium irons are mainly retained in the roots, and only small amounts are transported to shoot, as stated by (Cunnigham,1995).

In general the content of cadmium in plants decreases in the order: roots > stems > leaves >fruits >seeds as stated by (Blaylock, 1997) while (Marchiol al 1996) reported that cadmium was easily transported to the aerial parts of tomato plants but was not defected in fruits. Maize accumulated the least cadmium in the stem, shank and grain (0.18 – 0.19 mg/kg-1 d.wt) reported (Baker 1994). Since there are many naturally occurring hyperaccumulators throughout different environment cadmium must be absorbed into maize plant tissue in a quantity of 1000 mg/kg or more or 0.01% by dry weight. (Bakr et al, 2000) reported that foliar concentration above 100 mg-g-1 dry weight (0.01%) is considered exceptional and is used as a threshold value for cadmium hyperaccumulation. It has been demonstrated that maize species were a promising crop for phyforemediation of contaminated soil with cadmium (Yany 1998) reported that maize species can grow and effectively extract materials in multi-metal (cu, Cd, pb and zn) contaminated soils and vascular compartmentalization appeared to go an important source of tolerance of metal accumulation plants. Maize also produces a very large amount of bio mass during growth season and has an extensive root systems. These habits which maize belonged , high biomass production root system and the ability to accumulate cadmium in the roots and prevent the translation to the shoots make zea mays an excellent candidate for translocation. (wagner,1993)

Plants grown in a green house or a container take up more cadmium than the same plants grown in soil with the same cadmium levels in the fields. This is due to greater root development in a confined volume in containers and to the fact that the roots are in contact with Cd contaminated soil In the field, roots may grow down the cadmium – contaminated levels as stated (Schnoor et al, 2002)

The uptake and transport of some minerals nutrients in plant such as ,Fe, Mg and zn were reduced by the present of cadmium (Das et al. 1997), this may due to that an increasing of cadmium concentration in nutrients solution caused increased of sodium and cadmium content in maize plant and decrease of nitrogen, iron, mangoes and zinc and total dry weight. This is may be the fact that defiancey of nutrients would be the one of the explanations for the decrease of the plant growth during cadmium treatments which resulting in decreasing biomass (Brown et al, 1994).

In table 8 results indicated that the control group averaged soil cadmium accumulation for the two varieties of zea mays 0.05 mg/kg-1 and 0.14 mg/kg-1 for Hudeiba one and Hudeiba two respectively. Cadmium concentrations of 10,25,50,75 and 100mg/kg-1 where soil accumulation from cadmium solution added was (1.86, 2.94, 16.36, 38.99 and 39.2 mg/kg-1) and (1.98, 5.62,

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29.36, 34.14 and 75.7 mg/kg-1) for the two variety respectively. Statistical analysis indicated that these significant differences (P >0.05) among the different level of cadmium concentration. The control soil showed slightly amount of cadmium in the soil 0.05 mg/kg-1 and 0.14 for the same soil which mean that the soil which bought from agricultural field may contain little of cadmium due to fertilizer application which contain cadmium (chaney etal, 1997).

Table 5: Cadmium Concentration in maize (Hudeiba1 and Hudeiba2), shoot Root, and soil after 10 weeks

Varieties	*Cadmium Con.*	*Seedlings metal uptake (ppm)*	*Root metal uptake (ppm)*	*Shoot metal uptake (ppm)*	*Soil metal Uptake (ppm)*
v_1	0	0	0	0	0.05f
v_1	10	129.34e	85.84e	2.43f	1.86d
v_1	25	676.37d	42.19d	18.99c	2.94c
v_1	50	1442.65e	390.86c	26.55b	16.36b
v_1	75	1906.24b	202.10b	119.88a	38.99a
v_1	100	2518.78a	1413.16a	158.07a	34.20a
v_2	0	0	0	0	0.14f
v_2	10	596.47e	53.63e	15.14d	1.98d
v_2	25	712.29d	76.4d	20.22d	5.62d
v_2	50	1152.61c	366.15c	141.88b	29.36c
v_2	75	2137.74b	573.9b	139.04b	34.14b
v_2	100	2559.49a	940.09a	143.53a	75.70a

Means in the two same column followed by different letters are significantly different (P < 0.05) using Fisher Protected L.S.D

4. CONCLUSIONS

The followings are the most important conclusions which can be derived from the above work:

1. Maize varieties (Hudeiba one and Hudeiba two) seeds have ability to germinate and grow under different soil contaminate of cadmium up to 300 mg/L.
2. Accumulation of cadmium in roots was greater than in shoots.
3. Cadmium affected most of the growth parameters such as shoot fresh weight, root fresh weight , root dry weight , root dry weight and leave.
4. The variety Hudeiba2 is more tolerance to cadmium uptake than the Hudeiba1 variety.

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