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Impact of Irrigation of Saline Water on Availability of Cadmium In Some Marsh Soils.

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ABSTRACT

An experiment was conducted in the Department of Soil Science and Water Resources - Faculty of Agriculture - University of Baghdad for the season 2016 - 2017 in the plastic house according to the complete random design CRD by growing oats in the 2 kg of dried marsh land soil, treated with five levels of cadmium 0, 25 , 50 , 100 and 250 mg kg-1 are Cd0, Cd1, Cd2, Cd3 and Cd4 using cadmium sulfate (3CdSO4.8H2O), wateried tap water and marsh water I0, I1in three replicates to determine the effect of water quality on the growth of oats in soil contaminated with several Levels of cadmium component.A soil sample was taken from a cultivated field in the Karmashiya area (DhiQar governorate, north of Hawr al-Hammar) from the surface layer 0-30 cm with a 4 mm sieve. The results of the study showed a decrease in the growth indices of plant height and biological weight (straw and grain weight), while the concentration of cadmium in the biological (straw and grain weight) was increased due to the addition of cadmium levels compared to the comparison treatment. The increased salinity of the marsh water increased cadmium readiness, which increased its absorption in oats compared to the comparison treatment. Cadmium absorption and accumulation in straw was greater than in grains.

Keywords: irrigation, saline, cadmium, Marsh soil

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INTRODUCTION

Oats are annual herbaceous plants belonging to the Poaceae, such as wheat and barley, a food for both humans and animals. Oats are rich in important nutrients such as proteins, carbohydrates, calories, fiber, minerals and vitamins(Wikipedia,https) .

Cadmium is a toxic element of humans, animals and plants because experiments have proved its negative impact in all living organisms. The soil may be contaminated with cadmium due to either direct addition during mineral and organic fertilization and irrigation water.Or indirectly by depositing it on the surface layers of the soil by atmospheric air on cadmium particles, or by burning fuel, plastics, random brick factories, fat, cigarettes, etc. (Gunilla, 2002; Kherbani*et al*., 2015; Shi *et al*., 2016; Cadmium Cd is a major environmental concern because it is highly toxic to plants and animals and is highly mobile in the terrestrial environment. The total content of cadmium is affected by the physical and chemical properties of the soil as well as the organic matter content of O.M, and pH of the soil is one of the main factors affecting the absorption of cadmium in the soil. The pH of the soil mainly affects the accumulation of cadmium in barley grains and has the highest accumulation of cadmium in leaves, roots and protein parts of plants (Fritioff*et al*., 2006).Kherbani*et al*. (2015) found that increasing the concentration of the Cd cadmium caused a decrease in germination and inhibited the growth and height of barley plant. The small quantities of cadmium accumulate due to the continuous contamination of cadmium resulting from the use of wastewater and the disposal of factory waste, as the roots are the primary place of accumulation. The length of the root does not change with the presence of cadmium or may reduce its length slightly, and the toxic effect results in a decrease in cell divisions and encourages the abnormal division and the formation of abnormal chromosomes (Toppi *et al*., 1999) Cadmium moves in the plant, initially introducing cadmium ions to the elongated stem cells of the barley roots, which causes its accumulation in the region, and then extends to the mature zone (Dixit *et al*., 2001). Many scientific institutions have sought to establish the limits of the maximum and minimum limits for heavy elements in the agricultural soils approved by WHO (1975). WHO (1975) stated that the permissible limits for total cadmium concentration in soils are between 0.01 - 0.7 mg kg^{-1} soil , But these limits were changed by the same organization in 2000 to be between 0.1 - 0.4 $mgkg^{-1}$ soil for the importance of the effects of this element on human and animal health. Yassin and Amani (2009) found that the increase in cadmium concentrations in agricultural soils affected by industrial and agricultural activity due to the use of sewage in Basrah governorate in the summer season amounted to 3.652 mg kg^{-1} soil and decreased in the winter season to reach 3.242 $mgkg^{-1}$ soil. Al-Sabah (2009) found that the concentration of cadmium within mineral and organic separators is 2.3 mg kg^{-1} soil, 85% of the total concentration of most of the images of this element is related and the highest correlation is calcium carbonate, manganese oxides, crystallized and non- crystallized iron as well as organic matter, Of which is already found in the soil of mineral and organic colloids.Khuwaydem*et al*. (2009) found increase in the level of cadmium in the soil of the city of Basra because of its proximity to the oil facilities Basrah refinery in the Shuaiba area, containing the output of industrial processes and burning gases day and night, which may seep into the waters of Shatt al-Arab, leading to an increase in concentration. Al-Yaseri (2011) found that the pond areas is one of the most contaminated areas with cadmium, while al-Nakhara area is the least affected by cadmium. In a study comparing the levels of cadmium in the water of southern Iraq rivers between 1996 and 2010, Mohamed noted in his study on the chemical analysis of subsurface water samples covering 12 sites of the Tigris, Euphrates, Al-Azz, Shatt al-Arab, the main drainage river and Khor al-Zubayr. This component was much higher than the previous period, between the dissolved and suspended phases, which is higher than the allowedlevels by WHO(1975) . Organization and the Iraqi river protection system without specifying the specific phase, and the fluctuation in concentration in the region because of what is added as a result of pollutants used in these areas P Hydrological and geochemical properties of water.The salinity of river water and stagnant water and its deposition can lead to the movement of heavy metals as hydrolysis complexes (Hahne and Kroontje, 1973) due to the high solubility and persistence of the $CdCl_2$ complexes, while their adsorption on the surfaces and hard part of the soil is reduced due to their low efficiency and release in solution (Comans and Van Dij, 1988; Doner, 1978). Paalman*et al*. (1994) noted the ease of cadmium release from the hard soil segment due to weak bonding between them and the ease of formation of chloro-complexation complexes due to the presence of bivalent ion ions when increasing soil salinity such as Mg^{2+} and Ca^{2+} and monoclonal such as K^{+} and Na^{+}. Balls *et al*. (1994) increased the release of cadmium from the solid phase in the soil by increasing the salinity of four soil models in Scotland.Geringa*et al*. (2001), rapid release of cadmium from the CdS complex on the solid phase by increasing salinity through the oxidation process of the reduced precipitation of this heavy element and the release of cadmium involves the exchange of ions and the formation of chloride complexes. Between Du Laing *et al*. (2008) The effect of salinity

in the movement, readiness and behavior of cadmium in oxidation conditions only. Gambrell *et al*. (1991) observed an effect of salinity by oxidation of reduced pollutant elements in saline marshes and found an increase in dissolved cadmium when salinity increased. Gregeret *al*. (1995) showed an effect of salinity in the absorption of cadmium for some of the submerged plants Potamogetonpectinatus in water and sediments due to increased release from sediments and increased concentration in water caused by the uptake of plants. Low surface salinity has reduced cadmium accumulation in fibrous tissue, and salinity and heavy element pollution have widespread and rapidly increasing effects, but their interactions and environmental consequences are still unknown, Zanders and Rojas, 1996). Wegglaer*et al.* (2004), the use of five irrigation water salinity levels of sodium chloride (0, 400, 800, 1200 and 1600 mg L^{-1}) and four levels of solid organic waste (0, 20, 40 and 80 g kg^{-1} soil) of plant grown in South Australia , The increase in salinity of irrigation water caused an increase in the concentration of cadmium in the soil solution (920, 8920, 12096, and 16240 mgL^{-1}) sequentially, compared to the comparison treatment.Gabrijel*et al*. (2009) In a study to assess the effect of four salinity levels (0, 20, 40 and 60 mMNaCl) and three levels of cadmium 0.3, 5.5 and 10.4 mg kg^{-1}, there is an accumulation of cadmium in the melon in organic soils, causing salt stress to reduce the biomass of the fraction And the exposure to salinity for 25 and 50 days increased the accumulation of cadmium in the leaves by 46% and 87%, respectively, while the concentration of cadmium in the fruit 43 times compared to the concentration in the leaves, and increased cadmium accumulation in the tissues of melon in the treatment of soil contaminated with cadmium Compared to non-contaminated soils.Conesa *et al.* (2011) found that factors controlling the vital availability of heavy elements in different environments (sand dunes, saline, dry river and bush) found in Mediterranean marshes contaminated with toxic wastes were almost as low as pH) And electrical conductivity (EC) between 2.2-17.1 dSm^{-1} and showed an increase in cadmium concentration of 51 mg kg^{-1} soil, in subsurface saline soils and total concentrations of EDTA elements were as follows: Dry <saline soil.Shafi*et al*. (2010) showed a decrease in the total vegetation of three wheat varieties (Bakhtawar-92, Pirsabak-85 and Khyber-87) (0.87, 0.29 and 0.25), (0.44, 0.29, 0.18),(0.64, 0.25 and 0. 21) g $plant^{-1}$, respectively, for the three cultivars at increasing cadmium levels (0, 0.22 and 0.45) mg L^{-1}.

MATERIALS AND METHODS

An experiment was conducted in the Department of Soil Science and Water Resources. faculty of Agriculture . University of Baghdad for the season 2016 - 2017 in the plastic canopy according to the CompleteRandomizedDesign (CRD) by growing oats in 2 kg of dried marsh land soil treated with five levels of cadmium 0, 25, 50, 100 and 250 mg kg^{-1} are Cd_0, Cd_1, Cd_2, Cd_3 and Cd_4 using cadmium sulfate ($3CdSO_4.8H_2O$), wateried with tap water and marsh water I_0, I_1 and three replicates and table 1 showing the characteristics of the irrigation water used to study the effect of cadmium and irrigation by marsh water on oats crop.Soil sample was collcted from a field planted in the Karmashiya area (DhiQar governorate north of Hawr al-Hammar) from the surface layer 0-30 cm, dried with antennae, fine, crushed and passed through a 4 mm diameter sieve. Some physical and chemical properties of the study were estimated, Table 2. The soil was spread on plastic and sprayed with cadmium levels according to the treatment. The soil was then dried for each treatment to be prepared for use in the experiment. 2 kg of soil was deposited in each pot according to treatment. The soil was classified according to the fertilizer recommendation of nitrogen, phosphorus and potassium (50K, 30P and N 100 kg ha^{-1}) in the form of potassium sulphate, calcium phosphate and urea.Fertilizers of each treatment were mixed well with the surface soil of the pods (0-10 cm). Phosphorus and potassium were added at once in agriculture. Nitrogen was added in the first two stages when mixed with phosphorus and potassium, and 45 days after germination. Seeds of oats were planted on December 15, 2016, with 10 seeds of the pot diluted to 5 plants a week after germination. Irrigation with tap water and marsh water was reduced to the field capacity after planting and continued to irrigate when 60% of the field capacity was lost. The soil characteristics of the marshlands were calculated according to the Black (1965) method and the tissue was determined. The electrophoresis of the soil extract 1: 1, the degree of soil reaction (pH), organic carbon (OC), calcium carbonate equivalent (CCE) and ions are determined according to the methods described in Page *et al.* (1982). The exchange capacity of positive CEC for soil was estimated according to the method suggested by Papanicolaou (1976) and described in Jackson (1958). Carbonate minerals ($CaCO_3$) by Richards (1954) , Gypsum was estimated according to the method given in Page *et al.* (1982). organic matter was measured in wet digestion according to the Walkly and Black method (1965).

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Table 1 characteristics of used irrigation water (tap water and marshes)

Type		Water Tap	Water Marshlands	Unit
Ph		7.13	7.13	---
EC		0.72	3.2	dSm^{-1}
Dissolved ions	Ca^{2+}	3.45	8.15	meq L^{-1}
	Mg^{2+}	2.12	13.22	
	Na^{+}	1.58	9.34	
	SO_4^{2-}	3.02	1.4	
	HCO_3^{-}	2.00	3.30	
	Cl^{-1}	2.12	27.11	

Table 2: Chemical and physical characteristics of the study soil of the marsh area (Al-Hamar Marsh)

Type	Soil		Unit
pH 1:1	7.30		_____
EC 1:1	9.83		dSm^{-1}
CEC	28.2		$Cmol_+kg^{-1}$
O.M	21.5		g Kg^{-1}
Gypsum	9.5		
Lime	265		
Dissolved ions	Ca^{2+}	3.02	$Cmol_+kg^{-1}$
	Mg^{2+}	2.71	
	K^{+}	0.07	
	Na^{+}	3.63	
	HCO^{-}	3.17	
	SO_4^{2-}	4.18	

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	Cl^-	2.15	
Field capacity	30		**%**
Soil separators	sand	220.0	g kg^{-1}
	silt	410.7	
	clay	369.3	
Texture	Clayloam		

RESULTS AND DISCSION

Effect of cadmium levels and irrigation water quality on plant height:

The results in Table 3 show a significant decrease in the salinity of irrigation water (I_0, I_1) in the average height of the plant. The values of the two types of irrigation water were 59.36 and 43.24 cm, respectively, with a decrease of 27.17%. The results showed a significant decrease in the average height of the plant when increasing the level of cadmium application, where the values of 61.50, 54.90, 50.70, 46.10 and 43.30 cm respectively and the highest decrease in the level of the fifth cadmium decreased by 38.93% compared to the comparisontretment. The decrease in plant height to the toxic effect of cadmium for its association with the Thiol (SH) group in both proteins and enzymes, which impede its work within the plantA significant decrease was also found in the effect of the applied two water qualitied (I_0, I_1) and cadmium levels in the plant height. The highest reduction in I_1Cd_4 was 36.60 cm compared to the comparison treatment of 70.90 cm with a decrease of 48.38%. Table 4 and Figs. 1 and 2 show the effect of cadmium levels and the quality of irrigation water on average plant height (cm) per week. We observe a significant decrease in plant height per week, salinity levels and cadmium levels at plant height with growth stages. These findings are consistent with those found by(Francois *et al*.,1994 ; Dori ,2005 ;Shafi*et al*.,2010).

Table 3 shows the effect of cadmium levels and irrigation water quality in plant height medium (cm)

Water quality / Cd levels	Cd_0	Cd_1	Cd_2	Cd_3	Cd_4	Average
I_0	70.9	64.6	58.2	53.1	50	**59.36**
I_1	52.1	45.2	43.2	39.1	36.6	**43.24**
Average	**61.5**	**54.9**	**50.7**	**46.1**	**43.3**	

LSD 0.05		
I	Cd	I× Cd
0.301	0.475	0.672

Table 4: shows the effect of cadmium levels and irrigation water quality on average plant height (cm) per week

Tre. / week	3	4	5	6	7	8	9	10	11	12
I_0Cd_0	10.20	16.20	21.20	27.20	32.20	40.00	55.10	60.10	66.50	70.90

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I_0Cd_1	8.80	14.80	18.80	25.80	32.10	38.10	48.10	55.40	60.10	64.60
I_0Cd_2	7.20	13.20	17.20	24.20	29.20	36.90	44.50	50.40	55.20	58.20
I_0Cd_3	5.50	11.50	16.10	22.50	27.50	33.00	41.30	46.10	49.10	53.10
I_0Cd_4	4.60	10.20	14.80	21.60	24.60	29.70	37.20	41.50	46.00	50.00
I_1Cd_0	9.10	14.20	18.40	25.40	29.80	34.20	37.20	41.20	45.20	52.10
I_1Cd_1	7.10	12.40	17.30	22.30	28.10	32.10	34.10	38.40	40.70	45.20
I_1Cd_2	6.30	11.70	15.80	19.70	24.20	28.30	33.30	38.10	42.50	43.20
I_1Cd_3	4.80	9.80	14.10	17.80	23.80	27.80	31.80	34.00	36.20	39.10
I_1Cd_4	3.40	8.40	12.80	16.10	20.20	24.40	26.80	29.00	33.80	36.60

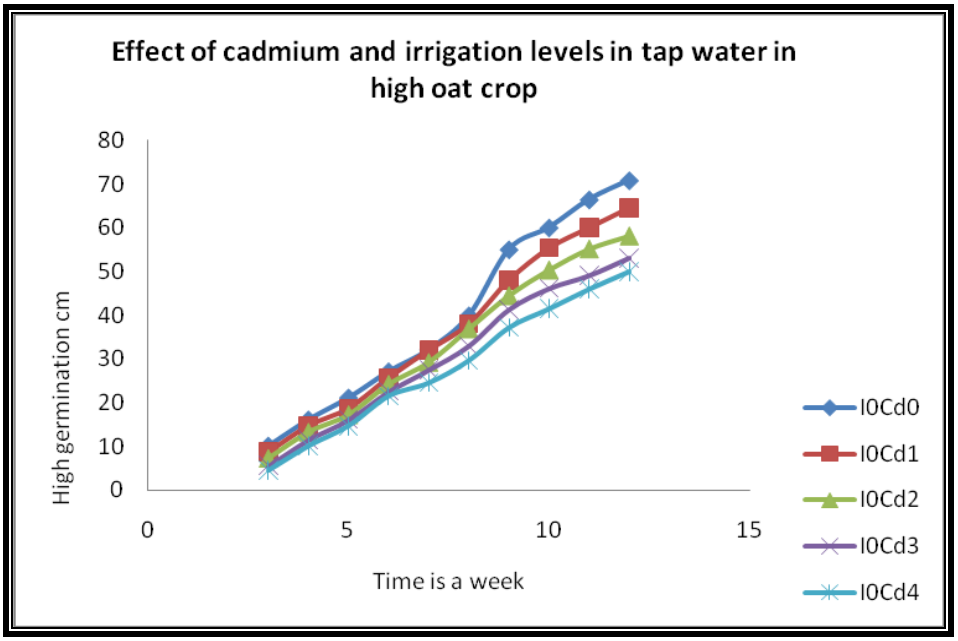

Figure 1: represents the effect of irrigation with tap water and cadmium levels in average plant height (cm) per week

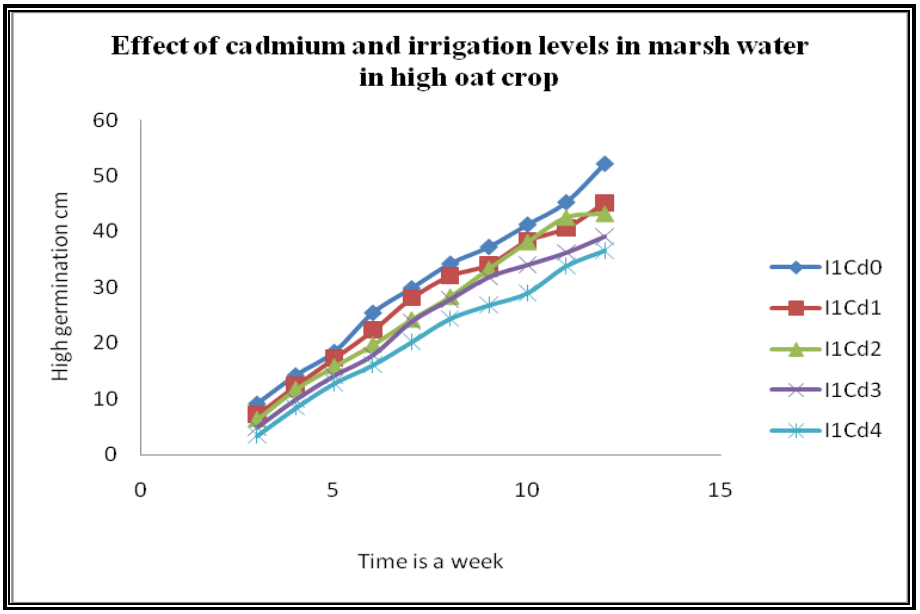

Figure 2: represents the effect of irrigated water irrigation and cadmium levels in average plant height (cm) per week

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Effect of cadmium levels and irrigation water quality in the weight of dry matter (straw) in the plant:

The results in Table 5 show a significant decrease in salinity of irrigation water (I_0, I_1) in average dry weight (straw). The values of irrigation water types were 3.70 and 2.35 g pot^{-1}, respectively, with a decrease of 36.49%. The results showed a significant decrease in average dry weight (straw) by increasing the level of cadmium application, with values of 3.54, 3.26, 3.06, 2.78 and 2.50 g pot^{-1}, respectively. The highest significant decrease was in the fifth level of cadmium (Cd_4) with a decrease of 29.39 % Compared to the comparison treatment.There was also a significant decrease in the effect of the those two water qualitiedinteraction (I_0, I_1) and the cadmium levels in the average dry weight (straw). The highest decrease was in the treatment of I_1Cd_4 of 1.90 g pot^{-1}

Table 5: shows the effect of cadmium levels and the quality of irrigation water in the dry weight of straw (g pot^{-1})

Water quality / Cd levels	Cd_0	Cd_1	Cd_2	Cd_3	Cd_4	Average
I_0	4.24	3.9	3.76	3.5	3.1	**3.7**
I_1	2.83	2.62	2.35	2.05	1.9	**2.35**
Average	**3.54**	**3.26**	**3.06**	**2.78**	**2.5**	

LSD 0.05		
I	Cd	I× Cd
.01333	.02107	.02980

Effect of cadmium levels and irrigation water quality in grain weight of plant:

The results in Table 6 show a significant decrease in the salinity of irrigation water (I_0, I_1) in the average dry weight of the grains. The values of the irrigation water types were 2.56 and 0.40 g pot^{-1}, respectively, with a decrease of 84.38%. The results showed a significant decrease in the average dry weight of grains by increasing the level of addition of cadmium, with values of 2.56, 1.50, 1.20, 1.03 and 0.74 g pot^{-1}., respectively. The highest decrease was in the fifth level of cadmium (Cd_4) Compared to the comparison treatment.

Table 6: effect of cadmium levels and the quality of irrigation water in the dry weight of grains (g pot^{-1})

Water quality / Cd levels	Cd_0	Cd_1	Cd_2	Cd_3	Cd_4	Average
I_0	4.95	2.56	2.13	2.1	1.04	**2.56**
I_1	0.76	0.44	0.27	0.1	0.43	**0.4**
Average	**2.85**	**1.5**	**1.2**	**1.03**	**0.54**	**1.38**

LSD 0.05		
I	Cd	I× Cd
0.2336	0.3694	0.5224

There was also a significant decrease in the effect of the used water qualitiedinteraction (I_0, I_1) and the cadmium levels in the average dry weight of the grains. The highest decrease was in the treatment of I_1Cd_4 of 0.43 g pot^{-1}. Indicating the difference in the behavior of cadmium levels in the direction of water quality in

terms of electrical conductivity. The decrease in the dry weight of the vegetative parts may be due to the increase in salinity levels to the negative salinity effect in photosynthesis process and the low utilization of materials produced by photosynthesis in the construction of cells (Sayad, 2003;Kao *et al*., 2003; Ashraf and Shahbaz, 2003; Munns, 2002; Hasegawa *et al*., 2000 ;Gupta *et al*., 2002), such as protein synthesis and inhibition of enzymes (Hernandez and Almansa, 2002). This in turn reduces the dry weight of plants, and results agree findings ofWeggler*et al.* (2004), when cultivating wheat yield in Australia at different salinity levels and researchers (Shafi*et al.,* 2010; Sayyad *et al*., 2009; Ozturk*et al*., 2003). The effect of cadmium levels, however, On the self-stress of the plant, which includes the exchange of energy to resist high levels of salinity, which may affect the amount of carbohydrates produced through the process of photosynthesis within the plant.

Effect of cadmium levels and irrigation water quality in cadmium concentration in hay:

The results in Table 7 show a significant increase in the salinity of irrigation water (I_0, I_1) in the average cadmium concentration in dry weight (straw). The values of the irrigation water types were 12.63 and 18.62 µg gm^{-1} respectively. The results showed a significant increase in the average cadmium concentration in dry weight (straw) by increasing the level of cadmium additive, with values of 3.54, 3.26, 3.06, 2.78 and 2.50 µg gm^{-1} respectively and the highest increase at level 5 of cadmium (Cd_4) It was 24.598 µg gm $^{-1}$ plant with a rise of 639.79% compared to the comparison treatment 3.325 µg g^{-1} plant. (I_0, I_1) and cadmium levels were found in the average cadmium concentration in dry weight (straw). The highest increase in I_1Cd_4 was 29.121 µgg - plant 1 compared with the comparison treatment of 2.925 µg g^{-1} plant with an increase of 895.59%.

Table 7: effect of cadmium levels and the quality of irrigation water in cadmium concentration in straw (µg gm^{-1}).

Water quality / Cd levels	Cd_0	Cd_1	Cd_2	Cd_3	Cd_4	Average
I_0	2.925	8.752	13.775	17.625	20.075	**12.63**
I_1	3.725	13.825	20.052	26.375	29.121	**18.62**
Average	**3.325**	**11.29**	**16.91**	**22**	**24.6**	

LSD 0.05		
I	Cd	I× Cd
0.1731	0.2737	0.3870

Effect of cadmium levels and irrigation water quality in cadmium concentration in grains:

The results in Table 8 show a significant increase in the salinity of irrigation water (I_0, I_1) in the average cadmium concentration in the dry weight of the grains. The values of the two types of irrigation water were 5.436 and 8.168 µg gm^{-1} plant, respectively, up by 50.26%. The results showed a significant increase in the average cadmium concentration in the dry grain weight by increasing the level of addition of cadmium, with values of 1.753, 4.683, 7.788, 9.014, and 10.775 µg gm^{-1} plant respectively, and the highest increase in the level of cadmium (Cd_4) was 10.775 Micrograms of 1 gm increased by 514.661% compared to the comparison treatment of 1.753 µg gm^{-1} plant.

(I_0, I_1) and cadmium levels were found in the average cadmium concentration in the dry weight of grains. The highest increase in the treatment of I_1Cd_4 was 12.90 µg gm^{-1} plant compared to the comparison treatment 1.075 µg gm^{-1} plant by height 1100.00%.

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Table 8: effect of cadmium levels and the quality of irrigation water in cadmium concentration in grains (µg gm^{-1} plant)

Water quality / Cd levels	Cd_0	Cd_1	Cd_2	Cd_3	Cd_4	Average
I_0	1.075	3.454	6.851	7.152	8.65	**5.436**
I_1	2.431	5.911	**8.724**	**10.88**	12.9	**8.168**
Average	**1.753**	**4.683**	**7.788**	**9.014**	**10.78**	

LSD 0.05		
I	Cd	I× Cd
0.1088	0.1721	0.2734

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Images represent the experiments of the experiment during the growth stages and the formation of the ears and pictures of the post-harvest

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