Bioaccumulation for some heavy metals on the impact of irrigating soil and plant with wastes of Al-Muamirah station

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ABSTRACT

In order to evaluate the state of soil and plant contamination, studying some physical and chemical properties affecting the behavior of heavy metals as a result of irrigation with wastewater of Al-Muamirah station. The present study selected five locations located between two longitudes "111 ´24 32°-"282 ´25 32° N and two latitudes "232 ´28 44°- "279 ´28 44° E for agricultural soils in Babylon province. The positive ions exchange capacity was between (12.05-40.47 cmol q.kg^{-1}). The content of calcium carbonate for the study of soil was between (221.70-437.70 g.kg^{-1}). The total concentration of heavy metals (lead, zinc, copper) was within the limits of the World Health Organization (WHO, 2003). Cadmium exceeded the allowed limits for the soil of the station only. The heavy metal content of zinc and copper in all parts of the Alfalfa and Barley plant was within the limits of the organization while the elements of lead and cadmium exceeded the permissible limits. The values of Bioconcentration factor (BCF) from soil to root were for lead (0.34), cadmium (0.47), zinc (0.35) and copper (0.43) for the growing Alfalfa plant in the station. It amounted to (0.31, 0.38, 0.34, 0.47; 0.34, 0.32, 0.37, 0.33) in Al-Rasheed and Al-Rifaaiya soils. It amounted to (0.51, 0.31, 0.47, 0.56; 0.41, 0.38, 0.41, 0.38) in the two control soils (Prophet Ayyub (peace be upon him) and Al-Sayyah), respectively. As for the bioconcentration factor from soil to stem was lower than that in the dry matter for the root for each of the study soils. The bioconcentration factor from the soil to the root for the growing barley plant was higher from the soil to the stem for most heavy metals in the study soils, The translocation factor (TF) of Alfalfa plant from root to the grew leaves in the study soils amounted to (0.40, 0.39, 0.70, 0.59; 0.46, 0.58, 0.83, 0.51; 0.68,0.51, 0.59, 0.80), respectively. It amounted to (0.30, 0.64, 0.47 and 0.34; 0.67, 0.28, 0.48, 0.60) at the two control soils of Prophet Ayyub (peace be upon him) and Al-Sayyah for the mentioned elements under study, respectively. As for the results of the translocation factor from the root to the stem are lower than the translocation factor from root to leaves in both affected and control soils. Likewise, the translocation factor for barley from root to leaves was higher than root to stem.

Keywords: bioaccumulation, heavy metals, translocation factor, wastewater.
Research paper from thesis for the second author.

التراكم الحيوي لبعض العناصر الثقيلة على اثر ري التربة والنبات بمخلفات محطة المعيميرة

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الملخص

لأجل تقييم حالة تلوث التربة والنبات، ودراسة بعض الخصائص الفيزيائية والكيميائية المؤثرة في سلوك العناصر الثقيلة نتيجة الري بمياه مخلفات محطة المعيميرة، اختيرت الدراسة الحالية خمسة مواقع تقع بين خطيّ طول"111 ´24 32°-"282 ´25 32° شمالاً، ودائرتي عرض "232 ´28 44°- "279 ´28 44°شرقاً لترب زراعية في محافظة بابل. إذ كان التوزيع الحجمي لمفصولات التربة يسود فيه الطين, ويأتي بعده الغرين والرمل في الغالب. ومحتوى التربة من المادة العضوية تراوح بين0.23-3.62غم كغم$^{-1}$. والسعة التبادلية للايونات الموجبة بين 12.05-40.47 سنتيمول شحنة كغم$^{-1}$. والمحتوى من كربونات الكالسيوم لترب الدراسة بين221.70-437.70غم كغم$^{-1}$. وكان التركيز الكلي للعناصر الثقيلة الرصاص والزنك والنحاس ضمن حدود منظمة الصحة العالمية

(WHO,2003)أما الكادميوم فقد تجاوز الحدود المسموح بها لتربة المحطة فقط. وكان محتوى العناصر الثقيلة من الزنك والنحاس في جميع الأجزاء لنباتي للجت والشعير ضمن حدود المنظمة في حين عنصري الرصاص والكادميوم تجاوزت الحدود المسموح بها. في حين عنصري الرصاص والكادميوم تجاوزت الحدود المسموح بها. وكانت قيم معامل التركيز الحيوي(BCF) من التربة إلى الجذر الذي كان للرصاص 0.34 والكادميوم 0.47 وللزنك 0.35 وللنحاس 0.43 لنبات الجت النامي في داخل المحطة. وكان 0.31, 0.38, 0.34 ,0.47؛ 0.34, 0.32, 0.37, 0.33 في تربتي الرشيد والرفيعات. وبلغ 0.51, 0.31, 0.47, 0.56؛ 0.41, 0.38, 0.41, 0.38 في تربتي المقارنة النبي أيوب (ع) والصياحية على التتابع. أما معامل التركيز الحيوي من التربة إلى الساق فقد كان أقل مما هو عليه في المادة الجافة للجذر لكل من ترب الدراسة. وكان معامل التركيز الحيوي من التربة إلى الجذر لنبات الشعير النامي أعلى من التربة إلى الساق لأغلب العناصر الثقيلة في ترب الدراسة, ومعامل الانتقال الموقعي(TF) لنبات الجت من الجذر إلى الأوراق النامي في ترب الدراسة 0.40، 0.39، 0.70، 0.59؛ 0.46، 0.58، 0.83 ،0.51؛ 0.51،0.68، 0.59 و0.80 على التتابع. وكان 0.30، 0.64، 0.47 و0.34؛ 0.67، 0.28، 0.48 و0.60 عند تربتي المقارنة للنبي أيوب(ع) والصياحية للعناصر المذكورة قيد الدراسة على التتابع. أما نتائج معامل الانتقال الموقعي من الجذر إلى الساق أقل من معامل الانتقال الموقعي من الجذر إلى الأوراق في كل من الترب المتأثرة والمقارنة. وكذلك كان معامل الانتقال الموقعي لنبات الشعير من الجذر إلى الأوراق أعلى من الجذر إلى الساق.

الكلمات المفتاحية: التراكم الحيوي, العناصر الثقيلة , معامل الانتقال الموقعي, مخلفات المياه .

البحث مستل من رسالة الباحث الثاني.

1. INTRODUCTION

The issue of water scarcity and its poor quality has emerged in many countries, as a result of increasing population growth and climate changes, as well as a human activity. It is considered one of the growing resources with population growth and human progress, unlike fresh resources that have become limited, where irrigation with wastewater causes in many cases the emergence of cases of plant toxicity associated with the use of this water, which has caused confusion in the environmental balance due to the increasing concentrations of heavy metals which their accumulation is considered a serious problem around the world through potential threats to the safety of ecosystems, including food contamination and its harmful effects on human and animal health (Hu, 2017). The problem of contamination with heavy metals has taken great care in all over the world where it has the ability to contaminate the soil and plants that can collect in the plant and the matter is getting more serious where most of these heavy metals are accumulated in the rhizosphere region from the soil (Rezaei and Sayadi, 2015). Human sources are considered among the most important sources of contamination with heavy metals. These sources include the use of wastewater, fertilizers, and pesticides. These wastes and fertilizers are deposited by physical, chemical, and biological processes (Wang and Zhang, 2012). The plant world is characterized by various characteristics and methods that reflect the ability of plants to respond with what surrounds it with all its details and its components. This harmony between plants and the media remains the title of the natural state until any expression in the particles of the media shows an increase or decrease. Plants bear the risk and toxicity of heavy metals because of their growth in soils rich in these elements. Adaptation to the type of these heavy metals and their degree is through the occurring a known phenomenon to many plants, which is the accumulation phenomenon, that is, heavy metals accumulate in plant tissues. The general concept of accumulation is that the concentration of the element in the plant is higher than the media in which it grows, it is a natural tendency for some of the plants accumulating heavy metals without the appearance of toxic symptoms on that plant, these elements include copper, nickel, and zinc, among which there is no physiological role such as cadmium and lead, and aluminum (Alkorta et al., 2004). Therefore, the study of the Bioconcentration Factor (BCF) was to indicate the ability of the plant to accumulate heavy metals from the soil and It compares the concentration of the element in the plant tissues with its concentration in the soil, and this parameter is used to determine whether the plant is an accumulation of the heavy element or not. If its value is greater than one, the plant is considered accumulated for the element, and it is not considered accumulated if it is less than one (Liu et al., 2007). The Transfer Factor (TF) indicates the plant's ability to transfer heavy metals from the root system to the total vegetative, as well as between the plant parts from the root to the stem, and from the stem to the leaves, if its value <1 means that the element moved from the root to the rest of the plant, but if it has a value > 1, this means that the plant collected the heavy element in its root, and the transition to the rest of the plant part was weak (Singh and Agrawal, 2007).

2. MATERIALS AND METHODS

Six samples were taken at a depth of (0-50 cm), with four pedons for agricultural soils from Babylon province (Appendix 1) located between the longitudes of "111 ´24 32 ° -" 282 ´25 32 ° N, and between the latitudes "232 ´28 44 ° -" 279 ´28 44 ° E. Three of them are irrigated with wastewater treated by Al-Muamirah station in Al-Hillah city: the first location represented by the sample Ss1 and the pedon 1 (p1) for soil inside the station, The second location in the Al-Rasheed region, about 2 km from the station, which represented by the Ss2 sample and the Ss21 sample. The third location in the Al-Rifaaiya region, at the end of irrigation with wastewater, 4 km from the center of the station, which represented by the sample Ss3 and pedons 2 (p2). Two soils were chosen to compare one of them in the opposite direction for the wind, 1.5 km behind the water station irrigated by the Shatt Al-Hillah water in the Prophet Ayyub which represented by the sample Sco1 and pedon 3 (p3), and other in Al-Sayyah village, Nile district is irrigated with water from the Jadwal Babil which is represented by the sample Sco2 and pedon 4 (p4). Alfalfa plant growing in the study soils for five locations was selected which represented by its parts in the first location LL1 for leaves and LS1 for stem and LR1 for root, and the second location (LL2, LS2, LR2), and the plant parts for growing Alfalfa in the third location were represented by samples (LL2, LS2, LR2) for leaves, stem, and root, respectively. Thus, for the samples of the plant parts that took the 4th sequence for the growing Alfalfa plant in the soil of the Prophet Ayoub, and the 5th sequence in Al-Sayyah soil. Barley was chosen for only two growing regions in the plant. The first location is represented by its parts BG1 for grains BL1 for leaves, BS1 for stem and BR1 for root, the fifth location (Al-Sayyah) is represented by samples (BG5, BL5, BS5, BR5) for grains, leaves, stem, and root, respectively.

The relative distribution for soil separates:

The calibration method (Protocol Micropipette) was used to estimate the size distribution for soil separates and their textures according to the method mentioned in (Pansu and Gautheyrou, 2006).

Soil reaction (pH):

The soil reaction was measured using a pH meter (type 710 WTW) after its calibration according to the method described in (Jones و 2001) through the extract of soil: water (1: 1).

Organic Mater (O.M):

The organic matter was estimated using a wet oxidation method according to the (Walkley-Black) method described in (Black et al., 1965).

Total carbonates:

Total carbonate minerals were estimated by the weighted method contained in the (U.S. Salinity Laboratory Staff, 1954) by treating the soil with hydrochloric acid (3 standards).

Cation-exchange capacity (CEC):

The Cation-exchange capacity is estimated according to the method proposed by (Papanicolaou, 1976) and mentioned in (Page et al., 1982).

Heavy metals availability in the soil:

The studied heavy metals were extracted according to the method of (Lindsay and Norvell, 1978). It was estimated by the Atomic absorption spectroscopy (AA 400).

The total content of heavy metals in plant parts:

The heavy metals under study were extracted according to (Jones, 2001) by the Atomic absorption spectroscopy device at the Ministry of Science and Technology - Baghdad.

Bioconcentration factor (BCF):

The bioconcentration factor for each of the heavy metals understudy in the dry matter for roots and stems (BCF1 and BCF2) was estimated to be in the soil, respectively in equations (1, 2):

$$\mathrm{BCF}_1 = {[\mathrm{Metal}]_{\mathrm{Root}}}/{[\mathrm{Metal}]_{\mathrm{soil}}} \quad \text{..........(1)}$$

$$\mathrm{BCF}_2 = {[Metal]_{Shoot}}/{[Metal]_{soil}} \quad \text{........(2)}$$

According to (Liu et al., 2007; Cui et al., 2007).

The translocation factor (TF)

It was estimated through concentration of the heavy metals in both the dry matter for stem and roots (TF1 and TF2), respectively in equation (3, 4) (Liu et al., 2007; Cui et al., 2007):

$$TF_1 = {[Metals]_{Shoot}}/{[Metals]_{Root}} \quad \text{.........(3)}$$

$$TF_2 = {[Metals]_{Leaves}}/{[Metals]_{Root}} \quad \text{........(4)}$$

3. RESULTS AND DISCUSSION

Table (1) shows the size distribution for soil separates and their textures, where the amount of clay ranged between (345.11-490.72), silt (313.82-485), sand (127-199.56 g.kg^{-1}) in the surface samples for the soil irrigated with the wastewater of the station, thus became a texture mostly of its clay and silt nature, This was confirmed by soil horizons for pedon (1, 2), which reflected the same textile class with a quantity of clay ranged between (306-531.40), then followed by silt between (226.80-530), and sand with a quantity between (60.10-323.60 g.kg^{-1}). Through observing the results, it appears that the study soils from them were not far from the source of river sedimentation, which is characterized by the transfer of clay for long distances, and Among them, it was in a medium state in the distance from the source, its ability to carry the silt particles with less distance than clay and greater than sand, according to the granular size of these separates which classified by the USDA (Hassan, 1999; Unemployed, 2006). The content of study soil from the organic material ranged between (1.40-2.95 g.kg^{-1}) for surface samples affected by the wastes of the station, and between (0.40-1.84 g.kg^{-1}) for surface samples at the control soil. Their contents in the horizons of soil pedons (1, 2) ranged between (1.27-3.62 and 0.50-1.56 g.kg^{-1}), respectively. In the soil of Pedon (3, 4) were (0.23-1.47 and 0.53-1.17 g.kg^{-1}), respectively. The results indicate that the soil irrigated with the waste of the station was more organic than the control soil. These results agree with (Usman et al., 2004) that the increase in the organic matter for soils irrigated with wastewaters leads to an increase in the soil content of organic carThe soil reaction values for the contaminated surface samples ranged between (7.1-7.5, between (7.4-7.8) in the control soil, and in the Pedon 1 soil, it was between (7.0-7.5), between (7.4-7.7) at the soil pedon 2, and between (7.7-7.8 and 7.3-7.9) at the soil pedons (3, 4), respectively. The results indicate that the interaction for the soil was within the extent of Iraqi soil interaction tilted to bases (Rahi et al., 1991). Perhaps the reason for this decrease is due to the improvement of plant growth and the spread of its roots, which leads to the release of carbon dioxide, which results in carbonic acid that degrades the residues of plant organic matter inside the soil texture. thus, the decomposition of organic matter and the waste from the station accumulated in the soil pedon 1 lead to high levels of amino and organic acids and all products of bioactivity for both the root system

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and the micro-organisms for what contains the wastewaters from ammonium, which oxidizes biologically and generates hydrogen ions that reduce soil reaction levels (Ali et al., 2007). Table (1) shows the content of calcium carbonate at surface samples for soils irrigated with the station wastes ranged between (278.61-437.70 g.kg^{-1}). As for the surface samples of the control soil, it ranged between (324.01-369.50 g.kg^{-1}). In the horizons of soil pedons (1, 2) irrigated with the waste of the station, the carbonate content ranged between (221.70-245.11 and 290.88-315.44 g.kg^{-1}). The calcium carbonate content was (316.70-354.80 and 289.91-409.30 g.kg^{-1}) in the horizons of the soil pedons (3, 4), respectively. The results indicate the high carbonate content in the study soils, this may be due to the original material of calcareous soils (Al-Muhaimid, 1984). Perhaps this increase in the content of calcium carbonate affected the availability of some heavy metals such as lead, and this was confirmed by (Chen et al., 1997) that the presence of calcium carbonate affected the availability of some heavy metals in general. The values of the Cation-exchange capacity in Table (1) at the soils of surface samples irrigated with the wastewater of Al-Muamirah station ranged between (16.98-24.26 cmol q.kg^{-1}). The surface samples for the control soil were between (17.30-34.36 cmol q.kg^{-1}). at the horizons of the soil pedons (1, 2), it ranged between (12.60-15.60 and 12.35-15 cmol q.kg^{-1}), and at the horizons of the soil pedons (3, 4), it ranged between (14.66- 16.45 and 38.22-40.47 cmol q.kg^{-1}), respectively.

Table 1: Some physical and chemical traits for the study soil.

Samples	Relative distribution of soil separates (g.kg^{-1})			Texture	Organic matter (g.kg^{-1})	pH	Calcium carbonate (g.kg^{-1})	Cation-exchange capacity (CEC) (cmol q.kg^{-1})
	Clay	Silt	Sand					
Ss_1	388	485	127	SIC	1.40	7.1	278.61	17.09
Ss_2	486.62	313.82	199.56	C	1.44	7.3	369.50	16.98
Ss_{21}	490.72	329.88	179.40	C	2.95	7.5	386.33	17.17
Ss_3	345	468	187	SiCL	1.67	7.00	437.70	24.26
Sc_{01}	394	426	180	SiCL	0.40	7.4	369.50	17.23
Sc_{02}	540.1	227.90	232	C	1.84	7.8	324.01	34.36
P_1Ap	306	530	164	SiCL	3.62	7.00	227.40	15.66
C_2	396	468	136	SiC	1.6	7.5	221.70	14.51
C_3	480	459.9	60.10	SiC	1.2	7.5	245.11	12.05
P_2Ap	448	468	84	SiC	1.56	7.7	315.44	15.11
C_2	449.60	226.80	323.60	C	0.50	7.4	290.88	12.35
C_3	531.40	356.20	112.40	C	0.75	7.6	306.50	15.39
P_3Ap	411.80	496.9	91.30	SiC	1.47	7.8	316.70	15.79
C_2	201	448	351	L	0.23	7.7	354.80	16.45
C_3	431	429	140	SiC	0.33	7.8	298.83	14.66
P_4AP	460.65	334.63	204.72	C	1.17	7.9	349.00	40.47
C_2	366	340	294	CL	0.75	7.5	289.91	38.78
C_3	554	328	118	C	0.53	7.3	409.30	38.22

Soil content of heavy metals

Table (2) shows the soil content of the irrigated with the wastewater of the station where the available lead ranged between (1.83 - 4.14), cadmium (1.42-2.41), zinc (11.86-25.17), and copper between (10.33-19.91 mg.kg^{-1}) at surface samples, and the available content ranged between (2.66-4.15, 1.39-3.20, 18.02-31.89, 16.00-24.38 $mg.kg^{-1}$), at the surface horizons of the soils for the study pedions, At its lower horizons, the lead was between (0.58-1.05), cadmium between (0.33-0.92), zinc (10.30-11.06), and zinc (5.88-11.55 $mg.kg^{-1}$). The results indicate that the content of soil samples and surface horizons was higher than soil of the lower horizons due to multiple their sources of industrial waste, fertilizers, agricultural chemical pesticides, and other sources that spread to the upper layers of the soil through air and irrigating crops (Kabata-Pendias and Adriano, 2000; Al-Halfi, 2010). its decrease in soils of the lower horizons confirms that its movement is slow because it has a high specific density, as well as some of them, are linked to organic matter, forming ionic-organic complexes that are concentrated in the surface horizons of the soil (Nisafi et al., 2015). Zinc and copper amounted to the highest values in the soil of the study despite the available quantity of them in the different soil systems. This result agrees with (Usman et al., 2004) who found when adding three levels of Sewage sludge to calcareous soils that there was a significant increase in the movement of zinc and copper availability, compared to lead and cadmium whose movement is restricted by the formation of organic complexes. The content of available heavy metals in the soils of the samples and the surface horizons of the control pedons was lower than in the soils irrigated with the wastewater, where the lead ranged between (0.53-0.83), cadmium (0.53-0.66), zinc (5.36-9.14), copper (5.68-7.08), and between (0.0.13- 0.27, 0.16-0.19, 4.78-6.06, 3.06-4.71 $mg.kg^{-1}$), respectively at the soils of the lower horizons. This enhances the contribution of the effect of wastes resulting from wastewater treatment by the filter station on soil contamination with heavy metals under study.

Table 2: Soil content of heavy metals.

Heavy metals availability ($mg.kg^{-1}$)									
Samples	**Soil irrigated with the wastewater of the station**				**Samples**	**The control soils irrigated with fresh water**			
	Pb^{++}	**Cd^{++}**	**Zn^{++}**	**Cu^{++}**		**Pb^{++}**	**Cd^{++}**	**Zn^{++}**	**Cu^{++}**
Ss_1	4.14	2.13	25.17	19.91	**Sco_1**	0.71	0.35	5.36	4.73
Ss_2	1.87	1.75	18.01	15.00					
Ss_{21}	2.91	2.41	22.21	17.02	**Sco_2**	0.53	0.48	8.03	5.68
Ss_3	1.83	1.42	11.86	10.33					
P_1Ap	4.15	3.20	31.89	24.38	**P_3Ap**	0.83	0.66	8.50	6.95
P_1C_2	2.07	1.87	25.17	18.30	**P_3C_2**	0.40	0.35	6.19	5.83
P_1C_3	1.05	0.92	11.06	11.55	**P_3C_3**	0.13	0.16	6.06	4.71
P_2Ap	2.66	1.39	18.02	16.00	**P_4Ap**	0.58	0.41	9.14	7.08
P_2C_2	1.25	0.98	11.78	10.25	**P_4C_2**	0.41	0.28	7.18	5.61
P_2C_3	0.58	0.33	10.30	5.88	**P_4C_3**	0.27	0.19	4.78	3.06

The dry matter content of the total vegetative for the heavy metals

Table (3) shows the total content for heavy metals in the parts of the growing Alfalfa plant in the study soils, where Lead in the leaves ranged between (0.41-0.57), cadmium (0.23-0.57), zinc (2.55-6.23), and copper (2.69-5.00). It ranged between (0.22-0.40, 0.09-0.33, 1.49-4.82, 1.34-3.70 $mg.kg^{-1}$), respectively in the dry matter for the stem while the root content was higher than lead between (0.63-1.41, cadmium 0.45-1.01, zinc 4.32 -8.75, copper 3.36-8.50 $mg.kg^{-1}$) compared to the leaves and stem. The barley leaves content of lead was between (0.13-0.28 $mg.kg^{-1}$), cadmium between (0.15-0.25 $mg.kg^{-1}$), zinc ranged between (0.60-1.25 $mg.kg^{-1}$) and copper (0.40-0.80 $mg.kg^{-1}$). In the

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stem between (0.09 -0.46, 0.05-0.11, 1.10, 0.30-0.83 $mg.kg^{-1}$) for the studied elements, respectively. Chang et al., (1995) confirmed that most heavy metals accumulate in the rhizosphere and the root spread of (0-40 cm) of soil in dry environments conditions. Table (3) shows that the growing plant parts at the control soil had less heavy metals under study than the plant parts when the soil irrigated with the wastewater of the station.

Table 3: the total content of the heavy metals in the plant parts.

Heavy metals availability ($mg.kg^{-1}$)										
Region	**Plant parts**	**Heavy metals ($mg.kg^{-1}$) in Alfalfa plant**				**Plant parts**	**Heavy metals ($mg.kg^{-1}$) in Barley plant**			
		Pb^{++}	**Cd^{++}**	**Zn^{++}**	**Cu^{++}**		**Pb^{++}**	**Cd^{++}**	**Zn^{++}**	**Cu^{++}**
The station	**LL_1**	0.57	0.39	6.13	5.00	BG_1	0.20	0.12	1.22	0.75
	LS_1	0.39	0.27	4.82	3.02	BL_1	0.28	0.25	1.25	0.80
	LR_1	1.41	1.01	8.75	8.50	BS_1	0.46	0.11	1.10	0.83
Al-Rasheed	**LL_2**	0.41	0.57	6.23	4.11	BR_1	0.43	0.40	1.56	0.90
	LS_2	0.40	0.33	3.40	3.70	----	--	----	---	---
	LR_2	0.89	0.91	7.55	8.00	---	--	---	---	---
Al-Rifaaiya	**LL_3**	0.43	0.23	2.55	2.69	---	--	----	---	---
	LS_3	0.22	0.09	1.94	1.34	---	---	---	---	---
	LR_3	0.63	0.45	4.32	3.36	---	---	----	---	---
Prophet Ayyub	**LL_4**	0.11	0.07	1.19	0.91	----	---	---	---	---
	LS_4	0.07	0.09	1.07	0.66	---	---	---	---	---
	LR_4	0.36	0.11	2.51	2.65	BG_5	0.07	0.12	0.70	0.12
Al-Sayyah	**LL_5**	0.14	0.05	1.61	1.29	BL_5	0.13	0.15	0.06	0.40
	LS_5	0.06	0.08	1.42	1.50	BS_5	0.09	0.05	1.10	0.30
	LR_5	0.21	0.18	3.33	2.16	BR_5	0.19	0.05	0.80	0.45

Bioconcentration factor

Table (4) indicates the values of the bioconcentration factor from the soil to the root which was (0.34, 0.47, 0.35, 0.43) for lead, cadmium, zinc, copper, respectively for the growing Alfalfa plant in the station and in Al-Rasheed soil (0.31, 0.38, 0.34, 0.47), and Al-Rifaaiya (0.34, 0.32, 0.37, 0.33) for lead, cadmium, zinc, and copper, respectively. Whereas in the control soil of Prophet Ayoub and Al-Sayyah amounted to (0.51, 0.31, 0.47, 0.56 and 0.41, 0.38, 0.41, 0.38) for the elements under study, respectively. As for bioconcentration from soil to stem was (0.09 for lead, 0.13 cadmium, 0.19 zinc, and 0.15 copper) for the plant growing at the station. In Al-Rasheed (0.14, 0.14, 0.15, 0.22) and Al-Rifaaiya (0.12, 0.06, 0.17, 0.13) for lead, cadmium, zinc and copper, respectively. While in the control soil, it was (0.09, 0.26,0, 0.20, 0.14; 0.11, 0.17, 0.18, 0.26), respectively for the elements under study. Through observing the results, the bioconcentration factor for the root gave the highest values for all elements in the irrigated areas with the wastes, as well as for the control soil of the bioaccumulation in the stem due to the high root content of the heavy metals compared to the stem. This is due to the root length of Alfalfa plant because it is a perennial crop, where some studies have indicated that the root length of Alfalfa can amount to 2.5 m when groundwater is available (Fox and Lipps, 1955).

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Table 4: Bioconcentration factor in plant parts for growing Alfalfa crop growing in the studied soils.

Region	Root/Soil BCF=				BCF=Shoot/Soil			
	Bioconcentration factor for heavy metals in Alfalfa plant irrigated with wastewater							
	Pb^{++}	Cd^{++}	Zn^{++}	Cu^{++}	Pb^{++}	Cd^{++}	Zn^{++}	Cu^{++}
The station	0.34	0.47	0.35	0.43	0.09	0.13	0.19	0.15
Al-Rasheed	0.31	0.38	0.34	0.47	0.14	0.14	0.15	0.22
Al-Rifaaiya	0.34	0.32	0.37	0.33	0.12	0.06	0.17	0.13
Bioconcentration factor for heavy metals in Alfalfa plant irrigated with freshwater								
Prophet Ayyub	0.51	0.31	0.47	0.56	0.09	0.26	0.20	0.14
Al-Sayyah	0.41	0.38	0.41	0.38	0.11	0.17	0.18	0.26

Translocation factor (TF)

Table (5) shows the results of the translocation factor that was (0.40, 0.39, 0.70, 0.59) for lead, cadmium, zinc, and copper, respectively for the growing Alfalfa plant in the soil of station, and amounted to (0.46, 0.58, 0.83, 0.51) in the soils of Al-Rasheed, and in Al-Rifaaiya soil amounted to (0.68, 0.51, 0.59, 0.80) for lead, cadmium, zinc, and copper, respectively, while at the control soils for Prophet Ayyub and Al-Rifaaiya amounted to (0.30, 0.64, 0.47, 0.34 and 0.67, 0.28, 0.48, 0.60), respectively for the mentioned elements under study. Through observing the results, we find that the transfer of heavy metals from the root to the stem is weak. This result agrees with (Singh and Agrawal, 2007). The results were based on the content of heavy metals in the roots and leaves that were low in the roots and high in the leaves. The translocation factor became higher than when the content was reversed. As for the results of the translocation factor from the soil to the stem in the station for (0.28, 0.27, 0.55, 0.36), respectively for lead, cadmium, zinc, 0.36 and amounted to (0.45, 0.36, 0.45, 0.46) in Al-Rasheed soil. In Al-Rifaaiya soil, it was (0.33, 0.20, 0.45, 0.40) for lead, cadmium, zinc, and copper, respectively, while the control soils of Prophet Ayoub and Al-Sayyah amounted to (0.19, 0.82, 0.43, 0.25 and 0.29, 0.44, 0.43, 0.69), respectively for the mentioned elements under the study. The values of the translocation from the root to the stem also coincided with the translocation from the stem to the leaves, and it was weak for all elements. In varying proportions, it depended on the varying concentrations of elements in the leaves according to the areas of the study irrigated with the waste and control. Table (6) shows that the bioconcentration factor for the heavy metals from the soil to the root for the barley growing in the station where amounted to (0.10, 0.19, 0.06, 0.05), respectively for lead, cadmium, zinc, and copper and in Al-Sayyah of (0.36, 0.10, 0.10, 0.08), respectively for lead, cadmium, zinc, and copper. The bioconcentration factor from soil to stem at the station was (0.11, 0.05, 0.04, 0.04), respectively for lead, cadmium, zinc, and copper and in Al-Sayyah of (0.17, 0.10, 0.14, 0.05), respectively for lead, cadmium, zinc, and copper. The results show that the bioconcentration factor that expresses whether the plant is accumulating for the heavy element or not, where it was not observed in the present study any plants with a high accumulating for (Pb, Cd), this result agrees with (Zaho et al., 2002) by the scarcity of higher accumulating for these two elements is due to the toxicity of these two elements for the plant. Therefore, the low bioaccumulation for lead and cadmium has been explained by the high affinity for these two elements of organic matter (MC Bride, 2001) or perhaps because plants have the electoral advantage in absorbing the elements. Alloway, (1995) mentioned that the organic matter and clay minerals restrict the movement of heavy metals in the soil, and allowing them to be absorbed by the plant, which indicates that the barley plant is not accumulating for the heavy metals.

Table 5: Translocation factor for all of the heavy metals in the Alfalfa plant

Region	TF = Leaves/Root				TF = shoot/Root			
	Pb	Cd	Zn	Cu	Pb	Cd	Zn	Cu
The station	0.40	0.39	0.70	0.59	0.28	0.27	0.55	0.36
Al-Rasheed	0.46	0.58	0.83	0.51	0.45	0.36	0.45	0.46
Al-Rifaaiya	0.68	0.51	0.59	0.80	0.33	0.20	0.45	0.40
Prophet Ayyub	0.30	0.64	0.47	0.34	0.19	0.82	0.43	0.25
Al-Sayyah	0.67	0.28	0.48	0.60	0.29	0.44	0.43	0.69

Table 6: Bioconcentration Factor and Translocation Factor for Barley plant.

Region	TF = Leavs/Root				TF = shoot/Root			
	Pb	Cd	Zn	Cu	Pb	Cd	Zn	Cu
The station	0.10	0.19	0.06	0.05	0.11	0.05	0.04	0.04
Al-Sayyah	0.36	0.10	0.10	0.08	0.17	0.10	0.14	0.05
Region	TF = Leavs/Root				TF = Shoot/Root			
	Pb	Cd	Pb	Cd	Pb	Cd	Pb	Cd
The station	0.65	0.63	0.80	0.89	1.07	0.28	0.71	0.92
Al-Sayyah	0.68	3.00	0.75	0.88	0.47	1.00	1.38	0.67

Table 7: The wastewater and freshwater content of dissolved heavy metals (mg.L^{-1}).

Samples	Pb	Cd	Zn	Cu	pH
	wastewaters				
The station	2.44	0.62	5.12	4.08	7.2
Al-Rasheed	1.11	0.40	4.03	3.02	7.3
Al-Rifaaiya	0.75	0.22	3.10	2.12	7.4
Freshwater					
Prophet Ayyub	-----	-----	0.043	0.020	8.2
Al-Sayyah	----	-----	0.041	0.012	8.1

CONCLUSIONS

1- The values of the bioconcentration factor in the dry matter for root were higher than the stem for barley and Alfalfa plants, especially zinc and copper (greater than one).
2- The Translocation factor for the heavy metals under the study was variance in each of the dry matter for all the plant parts.

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