Effect of drainage water on plant contamination with heavy metals

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Abstract

The effect of drainage water contaminated with heavy metals (lead, cadmium, and nickel) on irrigation of agricultural lands was studied. Four sites were selected in Babylon provainc, and the concentrations of lead, cadmium, and nickel elements were recorded in the root part, with the lowest concentration recorded at 11.74 mg kg-1 and 6.65 mg kg-1. And 13.77 in soil S3, and the highest were 22.35 mg kg-1, 11.89 mg kg-1, and 18.02 mg kg-1, respectively, in the winter season of wheat plants, while the lowest concentrations of the same elements were recorded at 8.69 mg kg-1 and 15.65 mg kg-1 for the element Lead, 5.43 mg kg-1, 6.84 mg kg-1 for cadmium, 9.77 mg kg-1, and 12.68 mg kg-1 in S3 soil, while the highest concentration was 11.54 mg kg-1, 18.03 mg kg-1, and 5.78 mg kg-1. 1, 6.84 mg kg-1, 11.35 mg kg-1, and 16.85 mg kg-1 in S1 soil in the summer season for bean and Alfalfa plants. As for the concentrations of heavy metals in the leaf mass, the lowest concentration was 8.65 mg kg-1, 5.52 mg kg-1, and 8.64 mg kg-1 in soil S3, and the highest concentration was 11.74 mg kg-1, 7.71 mg kg-1, and 12.33 mg kg-1 in S1 soil in the winter season of wheat plants, while the lowest concentration was recorded at 4.88 mg kg-1, 7.43 mg kg-1, 2.87 mg kg-1, 3.46 mg kg-1, 5.97 mg kg-1, and 7.21 in S3 soil, 6.65 mg kg-1. And 8.64 mg kg-1, 3.46 mg kg-1, 4.52 mg kg-1, 6.83 mg kg-1, and 8.48 mg kg-1 in soil S1 in the summer season. The results showed that the concentrations of heavy metals in the roots of plants are higher than their concentrations in the leaves. It was observed through the current study that the concentrations of heavy metals present in the soil exceeded the permissible limits according to the World Health Organization, while the concentrations of heavy metals in plants (root and vegetative growth) did not exceed.

introduction

Environmental pollution is one of the most important challenges facing the inhabitants of the Earth at the present time. Environmental pollution is defined where the change in the basic elements of the environment plants to the extent that leads to the deterioration of its various characteristics as a result of various human activities. Heavy elements are considered the most important pollutants released to the environment at the present time. Its danger increases when it remains in the soil or undergoes chemical changes, which then leads to the contamination of fruits and vegetables that humans eat, which is reflected in their health. High concentrations of these elements in plants beyond the permissible limits puts the consumer's life at risk. This increase in concentrations comes as a result of

ISSN 2072-3857

growth. Plants in polluted soil for many reasons, including irrigation with water contaminated with human industrial and agricultural waste, due to the lack of fresh water in arid and semi-arid areas. Many farmers use septic tank water, domestic wastewater, or industrial wastewater, which has led to an increase in heavy elements in the soil due to repeated use of it. The soil cannot absorb these high concentrations of elements when it is released into the soil, as plants absorb a quantity of it, or it forms complexes with functional groups present in soil particles, or it moves little downward until it reaches groundwater, the effect of agricultural lands in the long term. Using sewage water or wastewater that contains heavy metals formed in the soil poses a serious threat to the cultivated soil and the food chain, causing risks related to human health. Heavy elements in the soil can cause bioaccumulation in plants and in the organs of the human body. By eating foods that contain high concentrations of heavy elements, humans and animals need a proportion of the heavy elements, some of which may be obtained in plants through the food chain. Therefore, high concentrations These elements in plants beyond the permissible limit endanger the life of the consumer. This increase in concentrations comes as a result of the growth of plants in soil contaminated with these elements for reasons related to geological weathering factors in the soil or as a result of excessive use of chemical fertilizers and agricultural pesticides. Most often, it is the result of irrigation with water contaminated with waste from factories, laboratories, and farms. In addition to sewage waste, in a study conducted on barley plants to evaluate pollution with elements (lead, cadmium, and nickel), the results showed an increase in the concentration of lead more than the permissible limit, reaching 1.8 mg kg-1. The researcher pointed out that increasing the consumption of this plant leads to problems. Healthy in society. It was also shown that wheat and barley plants have a high ability to absorb and accumulate heavy elements, especially in plant seeds, and they increase the height of the plant compared to plants irrigated with polluted water, as there are more than 20 million hectares that use untreated polluted water to irrigate agricultural lands due to lack of water. available for this purpose

Materials and methods

Field procedures

Soil samples were collected for the selected station sites to a depth of 0-30 cm, as shown in Table (1) for the year 2022 for the winter and summer seasons. The soil samples were transported to the laboratory to be air dried and ground, then passed through a sieve with 2 mm openings and collected in plastic boxes for the purpose of preparing them for the procedure. Chemical and physical analyzes required. The available concentration of heavy elements (pb, Cd, and Ni) was estimated according to the proposed method [3]. As for the determination of plant heavy elements, the wet digestion method was used according to the method described [2}

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Table (1) Some areas of Babylon Governorate that are irrigated with drainage water and covered by chemical contamination from heavy compressors.

Samples taken	station	No.
Soil at 50 m – S1	Northern drainge	1
Soil at 100 m – S2		
Soil at 100 m – S3		
Soil at 50 m – S1	Sothern drainage	2
Soil at 100 m – S2		
Soil at 100 m – S3		
Soil at 50 m – S1	Haji Ali drainage	3
Soil at 100 m – S2		
Soil at 100 m – S3		
Soil at 50 m – S1	Al-Yahodia drainage	4
Soil at 100 m – S2		
Soil at 100 m – S3		

Heavy elements (pb, Cd, and Ni) in plants

Lead element in root system

.The results of Figures (1 and 2) showed the concentration of lead in the root system of wheat plants. The lowest concentration was 11.47 mg kg-1 dry matter in station 1 in soil S3, and the highest concentration was 22.35 mg kg-1 dry matter in station 4 in soil. S1 in the winter season, while the plants grown in the summer season varied, as the lowest concentration of lead was recorded for the bean plant, 8.69 mg kg-1 dry matter in station 1 in the soil of S3, and the highest concentration was 11.54 mg kg-1 dry matter in station 1 in the soil of S1. The lowest concentration of lead for the Alfalfa plant was recorded at 15.65 mg kg-1 dry matter in station 4 in the soil of S3, and the highest concentration was 18.03 mg kg-1 of dry matter in station 4 in the soil of S1

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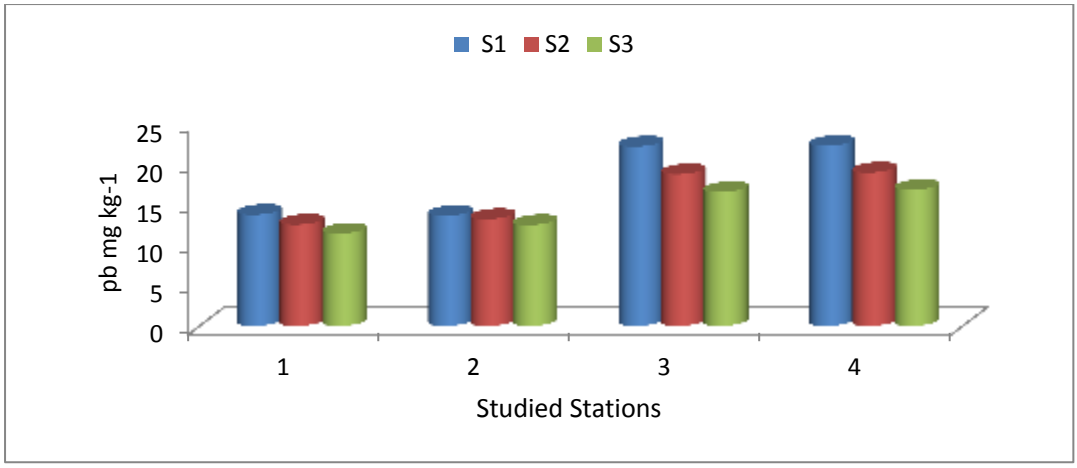

Figure (1) Concentrations of lead (mg kg^{-1} dry matter) in the root system of plants during the roasting season

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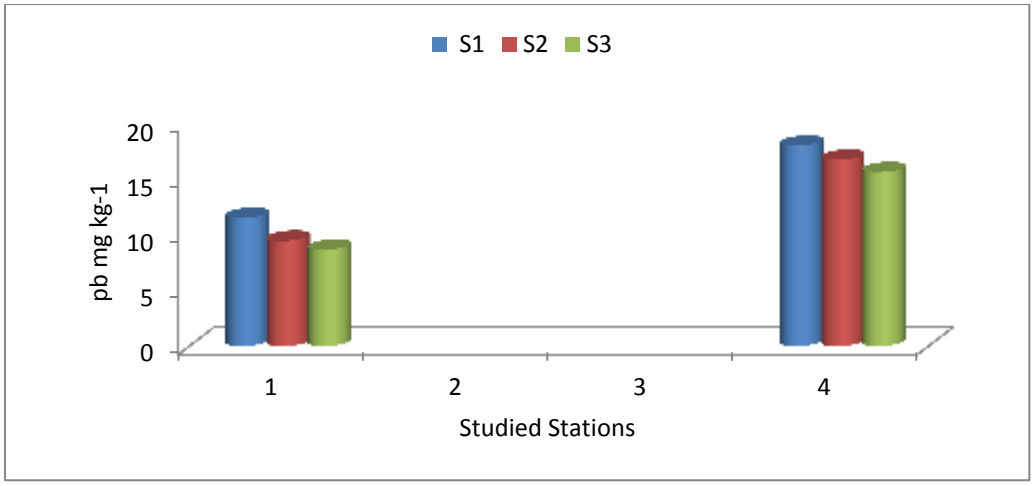

Figure (2) Lead concentrations (mg kg-1 dry matter) in the root system of plants in the summer season

Cadmium (Cd) in root system

The results of Figures (3 and 4) showed that cadmium concentrations in roots of wheat plants recorded the lowest concentration of 6.65 mg kg-1 dry matter in station 1 in the soil of S3, and the highest concentration of 11.89 mg kg-1 of dry matter in station 1 in the soil of S1 in the winter season, while Concentrations of the element in the bean plant recorded the lowest concentration of 5.45 mg kg-1 dry matter in station 1 in soil S3 and the highest concentration of 5.87 mg kg-1 dry matter, while the lowest concentration of cadmium in the Alfalfa plant was 6.84 mg kg-1 dry matter in station 4 in S3 soil and the highest concentration was 7.85 mg kg-1 dry matter in station 4 in S1 soil

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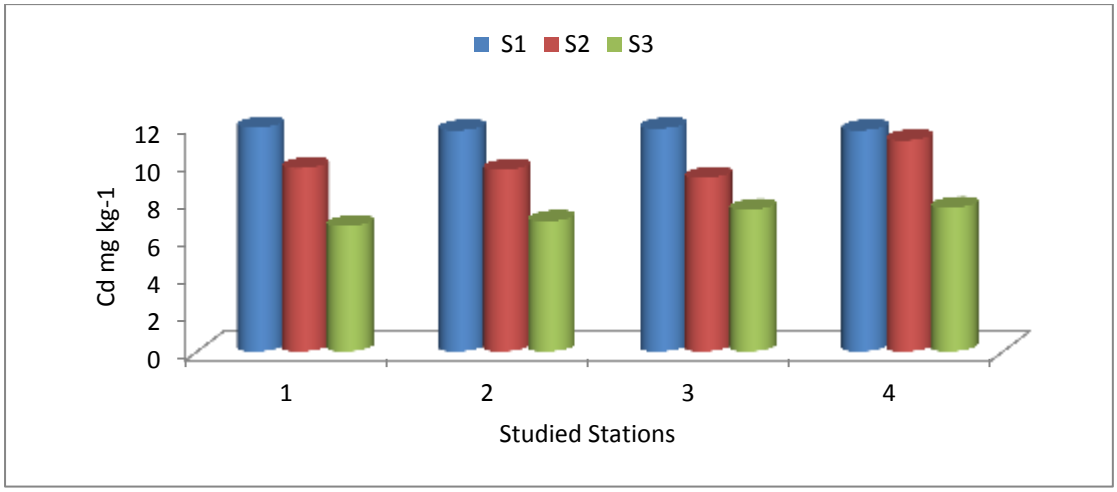

Figure (3) Cadmium concentrations (mg kg-1 dry matter) in the root system of plants in the winter season

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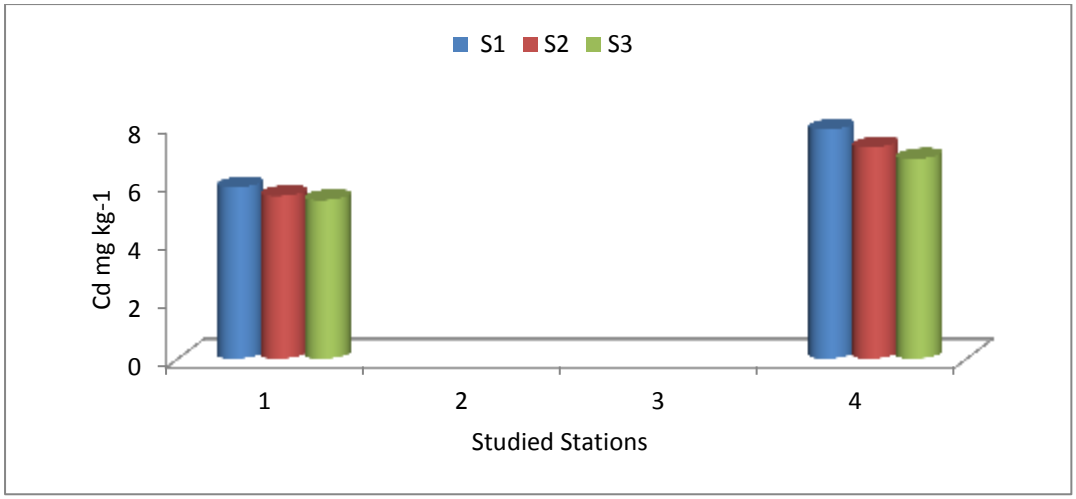

Figure (4) Cadmium concentrations (mg kg-1 dry matter) in the root system of plants in the summer season

Nickel element Ni in root system

The results of Figure (5 and 6) recorded nickel concentrations in the roots of wheat plants, which gave the lowest concentration of 13.77 mg kg-1 dry matter in station 2 in the soil of S3, and the highest concentration of 18.02 mg kg-1 of dry matter in station 3 in the soil of S1 in the winter season. While the lowest concentration of nickel was recorded in the bean plant, 9.77 mg kg-1 dry matter in station 1 in the soil of S3, and the highest concentration was 11.35 mg kg-1 of dry matter in station 1 in the soil of S3, and the lowest concentration of nickel in the Alfalfa plant was 12.68 mg kg-1. Dry matter in station 4 in S3 soil, and the highest concentration was 16.85 mg kg-1 dry matter in station 4 in S1 soil.

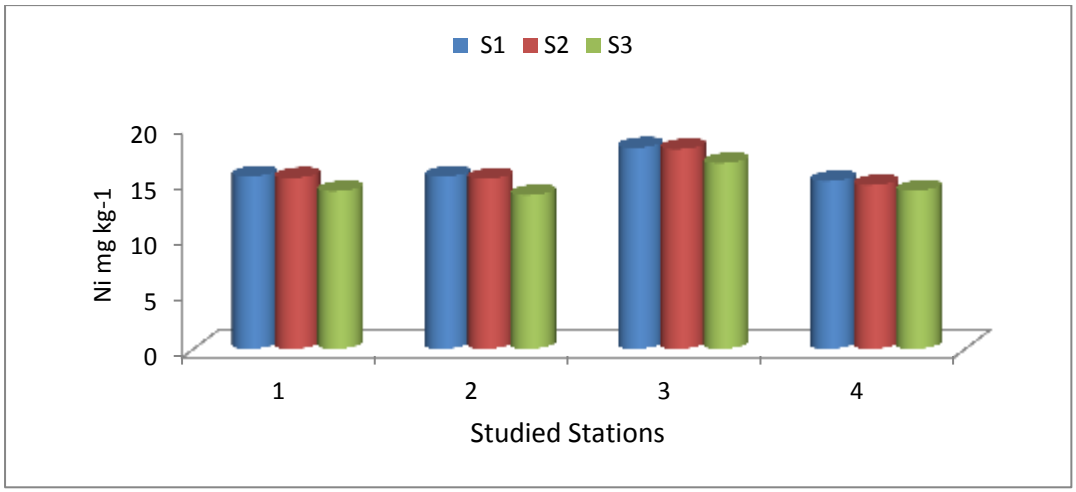

Figure (5) Nickel concentrations (mg kg-1 dry matter) in the root system of plants in the winter season

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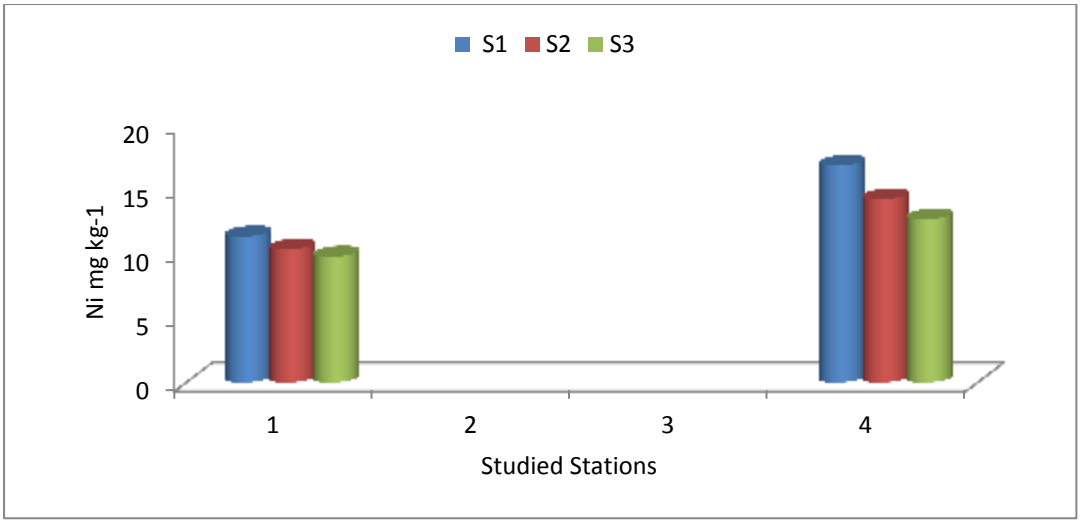

Figure (6) Nickel concentrations (mg kg-1 dry matter) in the root system of plants in the winter season

Due to the lack of technology to get rid of these contaminated elements, which contributed to their transfer with the drainage water to reach the plants grown in the neighboring lands along the drainage process through the irrigation process. Also, the cumulative state of these elements may be caused by repeated watering with polluted drainage water, and this is consistent with what was found. [11]. In a study to estimate the levels of contamination with some heavy metals in a variety of vegetables in the south of Basra. [12] showed that the concentration of heavy metals in plants growing in contaminated soil is higher than their concentrations in clean soil. Heavy elements are affected by the degree of reaction and organic matter, so their available increases when the degree of reaction decreases. The increase in lead, cadmium, and nickel indicates that this plant has high levels of these elements. This may be due to the accumulation and storage of these elements within the plant tissues in non-toxic forms or that they possess a mechanism. Especially to withstand high concentrations of elements, or they absorb the elements in high concentrations and transform them into inactive forms in the sap vacuoles inside the plant cells [13] explained [14] the concentrations of elements vary according to the study stations because pollutants by their nature are often not available for absorption by the plant if they are bound With other components, they form complexes that are difficult to absorb by the wheat roots, which absorb the free element available for absorption. This depends on the physical and chemical conditions of the root environment, which makes this a strong influence on the processes related to the absorption of element ions. There are plants that by nature do not absorb pollutants, while other plants are distinguished by their ability to remove heavy elements. From the environment in which it lives due to the processes of absorption and bioaccumulation within tissues, it has been widely used in phytoremediation processes, as elements can be transferred from the soil and concentrated in plant tissues, which makes water and soil less harmful to living things [9]. In general, and according to what was stated in [10] The concentrations of lead (mg kg-1) in the studied plant did not exceed the specified

ISSN 2072-3857

range for this element (5-10 mg kg-1), cadmium (0.20 mg kg-1) exceeded the permissible limits, and nickel (0.1-5 mg kg-1). It did not excelled the permissible limits according to the Food and Health Organization [15] and [16[

Lead element (Pb) in leaves

The results of Figures (7 and 8) show that the concentrations of lead in the leaves of wheat plants, as the lowest concentration was 8.65 mg kg-1 dry matter in station 2 in the soil of S3, and the highest concentration was 11.74 mg kg-1 of dry matter in station 3 in the soil of S1 in the winter season. As for lead concentrations in the summer season, they differed according to the crops grown, as the lowest concentration was recorded at 4.88 mg kg-1 dry matter for the bean plant at station 1 in the soil of S3, and the highest concentration was 6.56 mg kg-1 of dry matter at station 1 in the soil of S1, and the lowest concentration was 7.43. mg kg-1 dry matter in station 4 in S3 soil, and the highest concentration was 8.64 mg kg-1 dry matter for the Alfalfa plant in station 2 in S1 soil

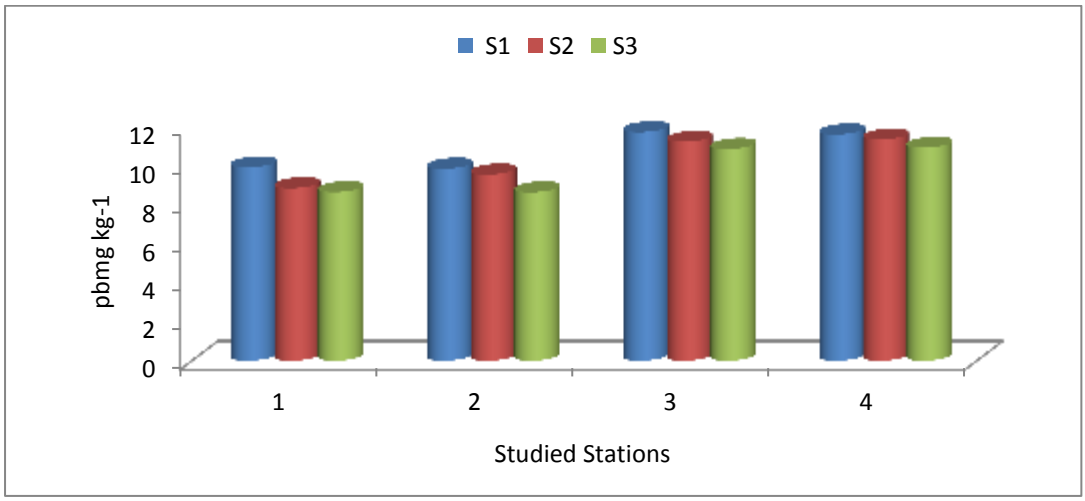

Figure (7) Lead concentrations (mg kg-1 dry matter) in the foliage of plants in the winter season

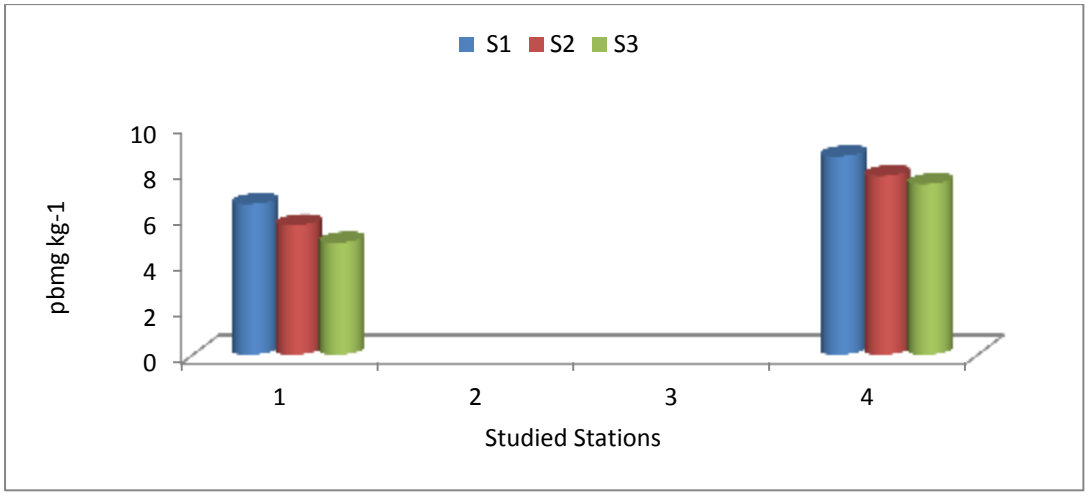

Figure (8) Lead concentrations (mg kg-1 dry matter) in the foliage of plants in the summer season

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Cadmium (Cd) in leaves

The results of Figures (9 and 10) showed the concentrations of cadmium in wheat plants, as the lowest concentration was 5.52 mg kg-1 dry matter in station 2 in S3 soil, and the highest concentration was 7.71 mg kg-1 dry matter in station 4 in S1 soil in the winter season. The concentrations of cadmium in plant leaves varied depending on the cultivated plant. The lowest concentration was 2.87 mg kg-1 dry matter for the bean plant in station 1 in soil S3, and the highest concentration was 3.46 in station 1 in soil S1, and the lowest concentration of cadmium for the Alfalfa plant was 3.46 mg kg-1. Dry matter in station 4 in S3 soil, and the highest concentration was 4.52 mg kg-1 dry matter in station 4 in S1 soil

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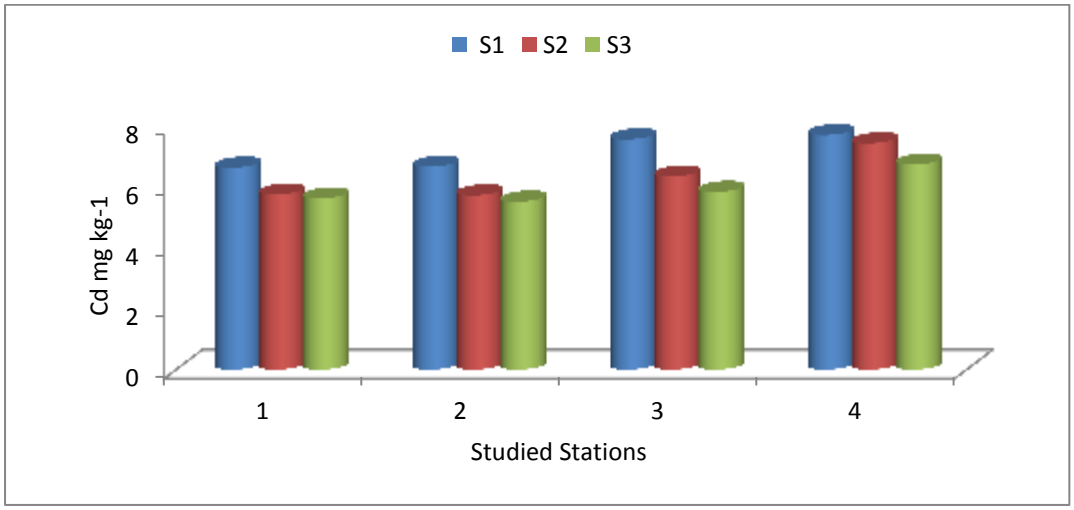

Figure (9) Cadmium concentrations (mg kg-1 dry matter) in the foliage of plants in the winter season

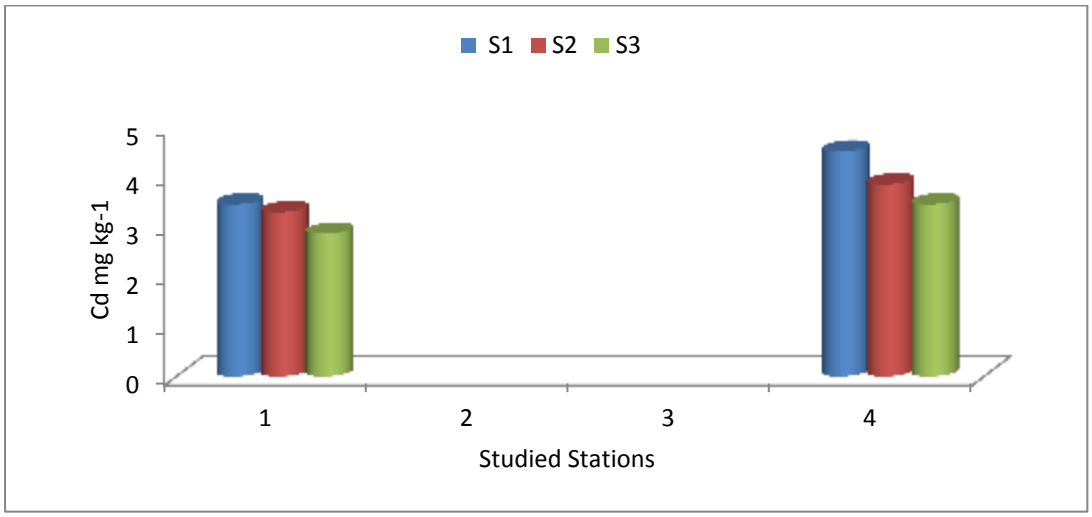

Figure (10) Cadmium concentrations (mg kg-1 dry matter) in the foliage of plants in the summer season

ISSN 2072-3857

The element nickel (Ni) in leaves

The results of Figures (11 and 12) show the concentrations of nickel in the leaves of wheat plants. The lowest concentration was 8.64 mg kg-1 dry matter in station 2 in the soil of S3, and the highest concentration was 12.33 mg kg-1 of dry matter in station 3 in the soil of S1 in the winter season. The lowest concentration was 5.97 mg kg-1 of dry matter in station 1 in the soil of S3, and the highest concentration was 6.83 mg kg-1 of dry matter in station 1 in the soil of S1 for broad bean plant, and the lowest concentration was 7.21 mg kg-1 of dry matter in station 2 in the soil of S3, and the highest concentration was 7.21 mg kg-1 of dry matter in station 2 in the soil of S3. 8.48 mg kg-1 dry matter in station 2 in soil S1 of the Alfalfa plant

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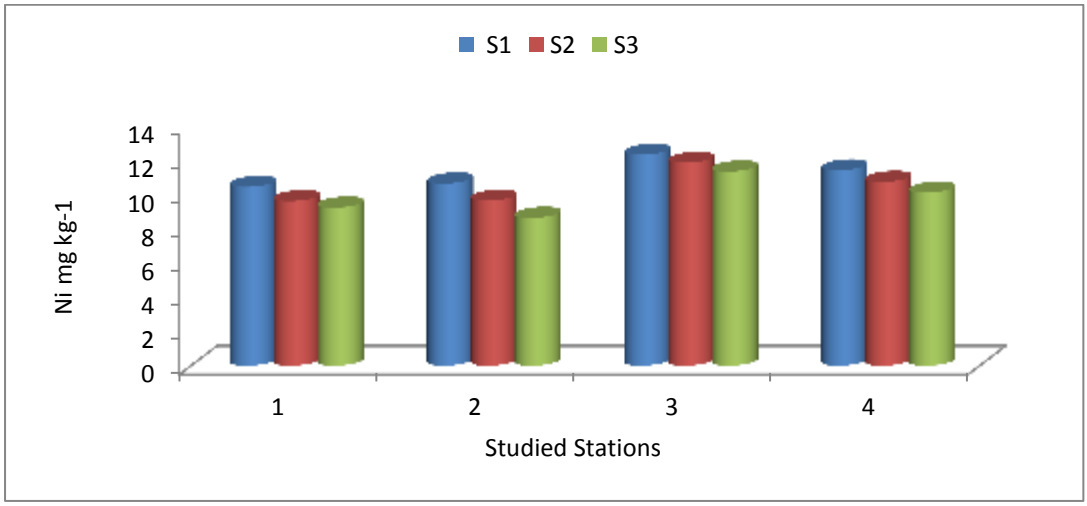

Figure (10) Nickel concentrations (mg kg-1 dry matter) in the foliage of plants in the winter season

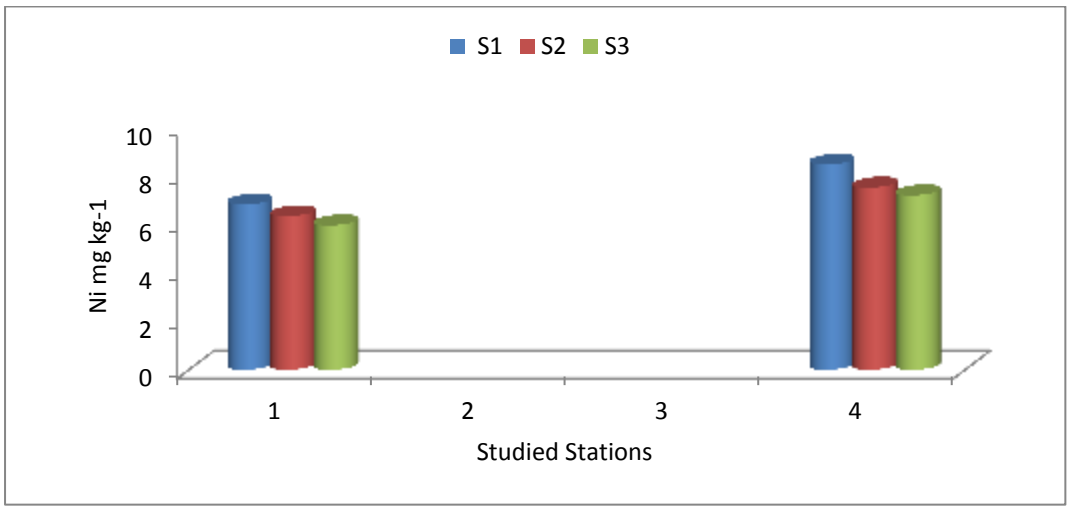

Figure (10) Concentrations of nickel (mg kg-1 dry matter) in the foliage of plants in the summer season

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The results also indicate that lead in plants in the two seasons (winter and summer) and in all study stations took the same trend, as sources of pollution had the greatest impact on the concentration of lead in plants compared to the type of plant and its physiological traits. The highest concentration of lead was in the summer season in the Alfalfa plant. In the root system and vegetative system, respectively, and its concentration in the root system exceeds its concentration in vegetative system. This may be attributed to the fact that the branched roots directly absorb the lead in the soil, since the surface of the soil is in contact with pollutants more than its depths. It may also be due to the fact that lead is absorbed by the plant. Passively by the root hairs and is stored to a large extent in the cell walls of the roots or in gaps inside the cell, and this is consistent with what was indicated by [17.[

The results also generally indicate higher concentrations of heavy metals in plants close to the sources of pollution compared to the concentrations of heavy metals in plants relatively far from these sources, which were selected based on the methods of these pollutants, such as the direction of the wind and the path of the flow of the sewers. The results indicated a variation in the concentrations of the elements. Heavy metals in plants irrigated with polluted sewer water. In wheat plants, the concentrations of heavy metals in the winter season were higher compared to vegetable crops grown during the summer season. This may be due to the long period of rest of the plant in the soil until its harvest period, in addition to the fact that its capillary roots are within the surface layer, so the absorption of elements is possible. Through root hairs in greater concentrations, this may also be attributed to the use of fertilizers and pesticides containing heavy elements that are sprayed on the vegetative part of the plant, in addition to the cultivation of wheat crops on large areas of land that have an effective role in receiving the large amount of pollutants adsorbed on the surfaces of the particles falling on the soil. The plant comes from polluted sources of waste water or through the use of fertilizers and pesticides, and this is consistent with what was found [18.[

The high concentrations of heavy metals in the soil and plants pose a great danger not only to the population who live near polluted dumps in which the remains of sewage and wastewater are thrown, causing diseases and epidemics, but also to the people who depend on crops such as wheat, barley and other major plants. It is consistent with what was mentioned by [19.[

The use of polluted sewer water to irrigate lands planted with important consumer vegetables in Stations 4 and 5 in the summer season leads to disruption of the food security of the region in addition to the health threat to the local population. This may be attributed to the texture of the soil in these two sites, which is a sandy or sandy mixture, that is, relatively lighter soil. From the tissues of other plants, which contributes to increasing the available of heavy elements for the plant through the weakening of the binding energy between the surfaces of soil particles and heavy elements, and this is consistent with what was indicated by [20.[

Conclusions

The current study included an analysis of heavy metals in the plants grown in the mentioned study stations and in the two seasons (winter and summer), which are irrigated from the farms adjacent to the agricultural lands. The results of the study showed that the concentrations of heavy

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metals in the winter season compared to their concentrations in the summer season may be attributed to the longer dormancy period of the wheat plant compared to In summer crops (peas and wheat), which increases the concentration of heavy elements in the wheat plant. In addition, the concentrations of heavy elements in the root part are higher than the concentrations of heavy elements in the leafy part. This may be attributed to the contact of the root hairs with the surface of the soil, which contains concentrations greater than its depth.

Recommendations

Do not grow vegetable crops that are directly eaten by humans and animals on contaminated lands or for which contaminated irrigation water is used. It is possible to use low-pollution water to irrigate agricultural lands after mixing it with river water, or use it for irrigation alternately with river water. It is recommended that wastewater that is thrown into sewers used to irrigate crops such as wheat and vegetable crops should be treated to avoid toxicity with heavy metals.

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