Effect of drainage water on soil contamination with heavy metals (Pb, Cd, and Ni)

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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, and four sites were selected in Babil Governorate. In order to determine the extent of the effect of contaminated drainage water on agricultural soil, the concentrations of heavy metals (lead, cadmium, and nickel) in the soil were estimated. The results of the study showed that the concentrations of heavy metals in stations 3 and 4 in the soil of S1 are higher than their concentrations in stations 1, 2, 3, and 4 in the soil of S2 and S3. It showed higher concentrations of heavy metals in the summer season compared to their concentrations in the winter season, where the highest concentrations of heavy metals were cadmium, lead, and nickel, respectively, in both seasons, and the cadmium element exceeded the permissible limits according to FAW/WHO (2003(

Add keywords: Heavy metals, lead,cadmium, nickel, soil pollution.

introduction

Environmental pollution is one of the most important challenges facing the inhabitants of the Earth at the present time. Environmental pollution is defined as the change in the basic elements of the environment (soil) 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[1]. This increase in concentrations comes as a result of 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[2]. Using sewage water or wastewater that contains heavy metals formed in the soil poses a serious threat to the

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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 selected station sites at 0-30 cm depth for the year 2022 for winter and summer. The soil samples were transported to the laboratory to be air-dried and ground, then passed through a sieve with 2 mm holes and collected in plastic bags for the purpose of preparing them for the procedure. Chemical and physical analyzes required. The ready concentration of heavy elements (pb, Cd, Ni) was estimated according to the proposed method [3.[

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

Samples	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		

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Results and discussion

Heavy metals in soil

Available lead in soil (soluble and exchangeable

The results of Figures (1 and 2) show the concentrations of available lead in agricultural soils irrigated with drainage water. The lowest concentration was recorded at 44.98 mg kg-1 in Station 1 (S3), and the highest concentration was 80.37 mg kg-1 in Station 3 (S1) in the winter season, and the lowest concentration was 47.31. mg kg-1 at station 1 (S3) and the highest concentration was 84.81 mg kg-1 at station 3 (S1). The results of the statistical analysis showed that there were no significant differences between the two seasons, while there were significant differences between the study stations, with a positive correlation between pH and Cation exchange capacity, calcium carbonate, and organic matter (r=0.73, r=0.762, r=875, r=857), respectively.

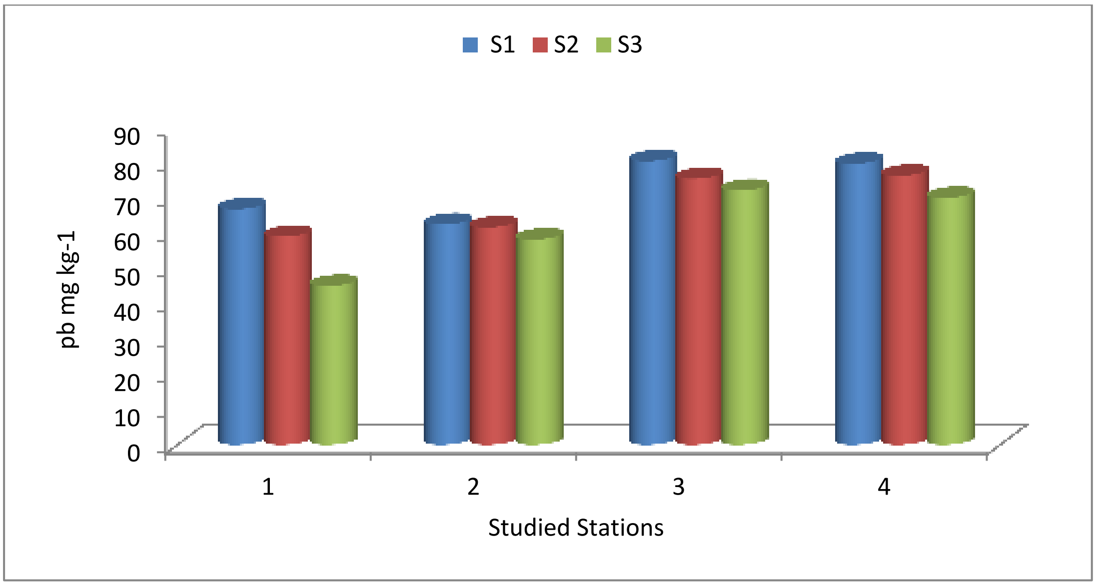

Figure (1) Available lead concentration (mg Kg-1) in the soil in the winter season

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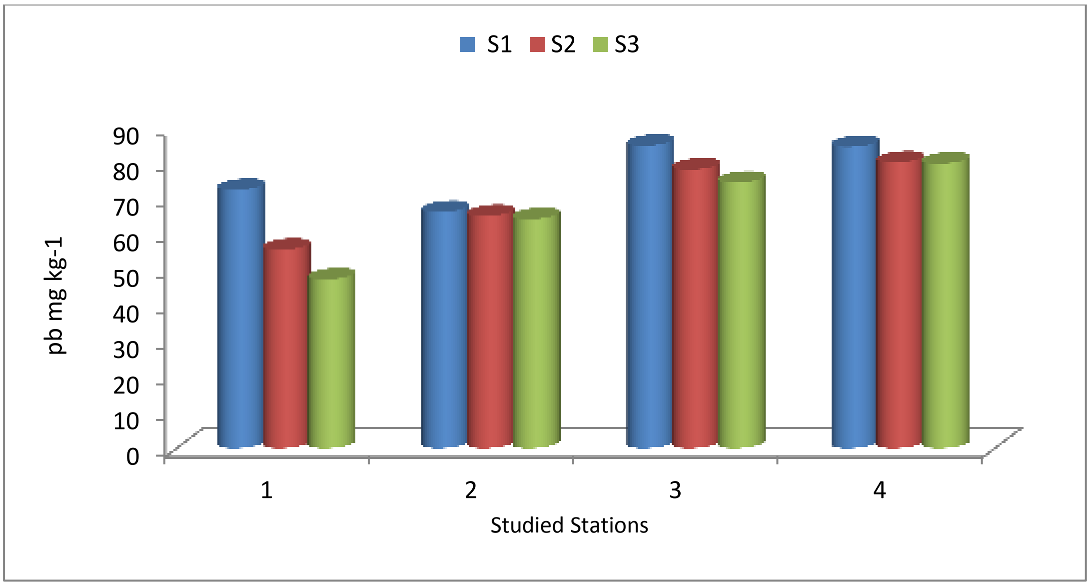

Figure (2) Available lead concentration (mg Kg^{-1}) in the soil in the summer season

Cadmium available

The results of Figures (3 and 4) indicated that the concentrations of available cadmium in the soil recorded the lowest concentration of 10.94 mg kg-1 in Station 1 (S3) and the highest concentration of 16.31 mg kg-1 in Station 3 (S1) in the winter season, and the lowest concentration was 10.71 mg kg-1. in station 1 (S3), and the highest concentration was 18.31 mg kg-1 in station 3 (S1), the summer season.

The results of the statistical analysis showed that there were no significant differences between the two seasons, while there were significant differences between the study stations, with a positive correlation with pH and exchange capacity. cation, calcium carbonate, and organic matter (r=0.774, r=0.820, 0.846, 0.817), respectively

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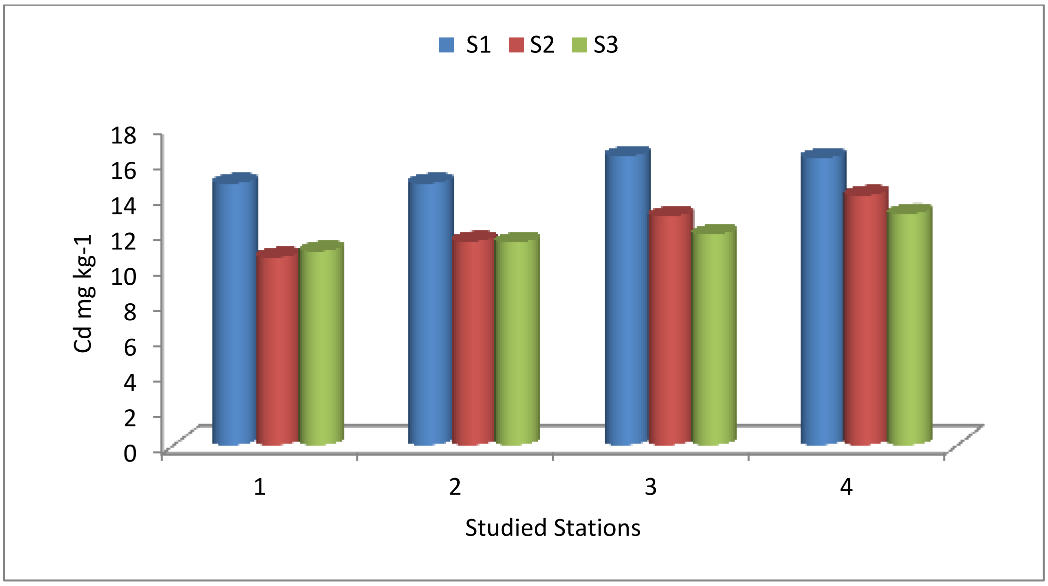

Figure (3) Available cadmium concentration (mg Kg-1) in the soil in the winter season

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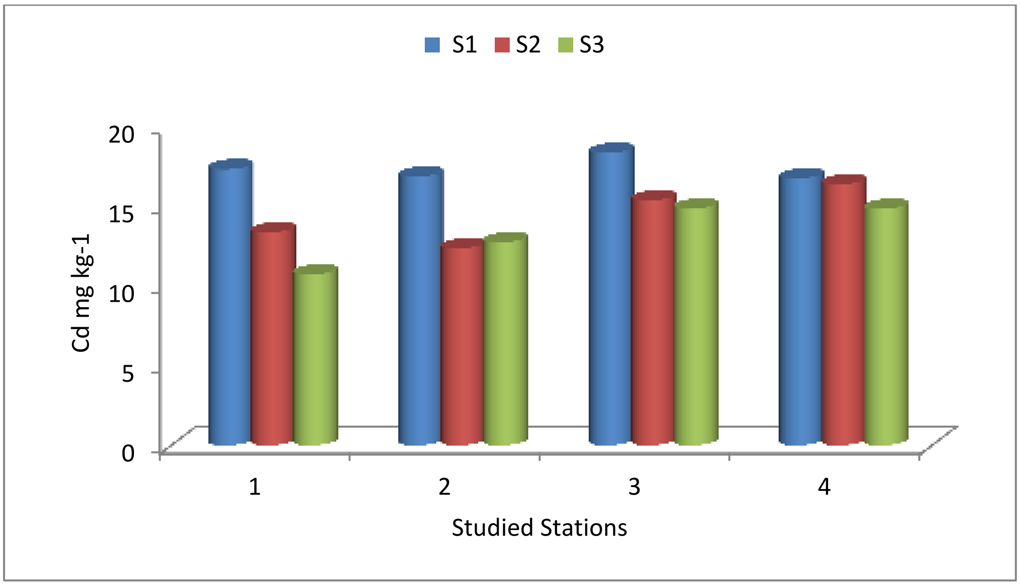

Figure (4) Available cadmium concentration (mg Kg-1) in the soil in the summer season

Ni Available

The results of Figures (5 and 6) showed that the concentrations of available lead in soils irrigated with polluted sewer water were recorded. The lowest concentration was 34.92 mg kg-1 in Station 1 (S3) and the highest concentration was 119.15 mg kg-1 in Station 3 (S1) in the winter season. The concentration was 35.26 mg kg-1 in station 1 (S3) and the highest concentration was 121.18 mg kg-1 in station 3 (S1). The results of the statistical analysis showed that there were no significant differences between the two seasons, while there were significant differences between the study stations, with a positive correlation with the exponent. pH, cation exchange capacity, calcium carbonate, and organic matter (r=0.818, r=0.865, r=0.864, r=0.855), respectively

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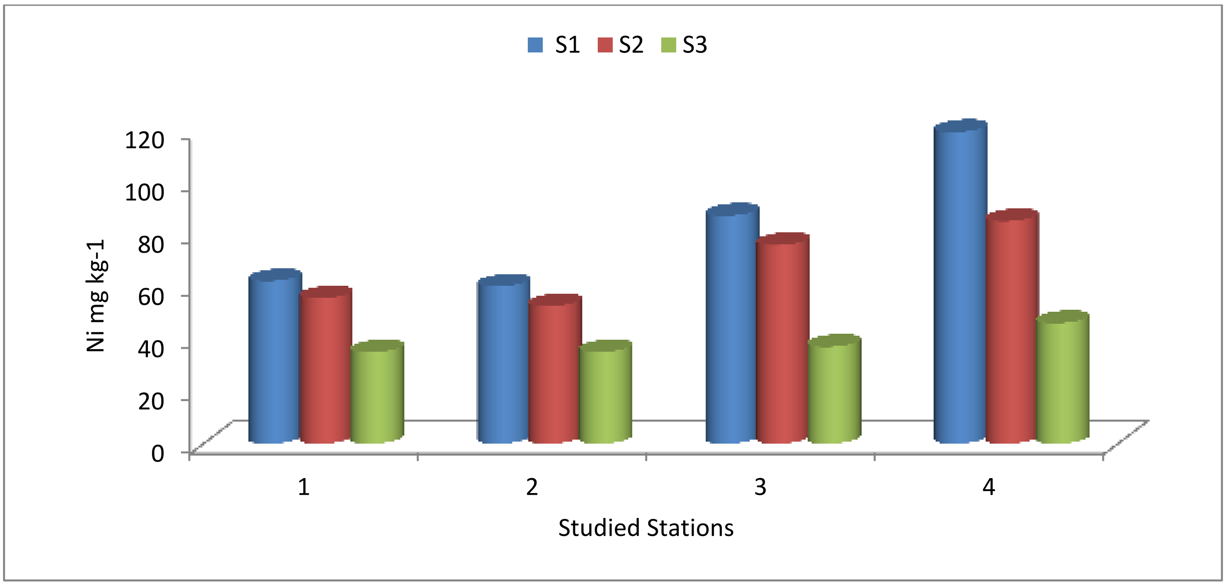

Figure (5) Concentration of available nickel (mg Kg-1) in the soil in the winter season

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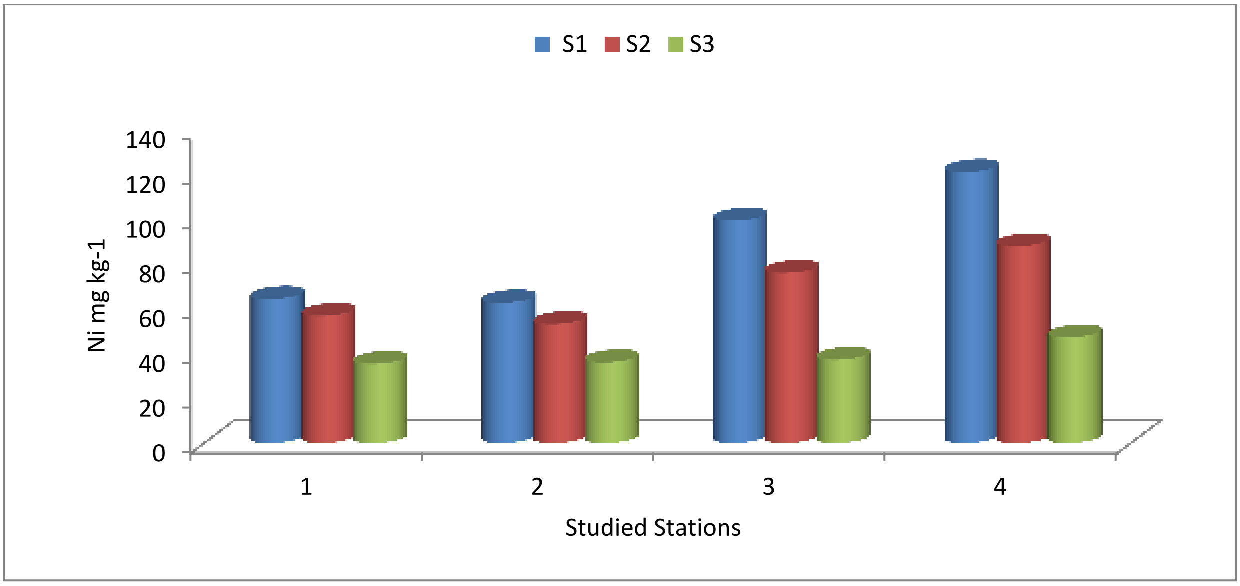

Figure (6) Concentration of available nickel (mg Kg-1) in the soil in the summer season

It was observed from the results that lead, cadmium, and nickel exceeded the permissible limits according to [4]. A clear increase in the concentrations of heavy metals was also observed at Station 4 (S1), which may be due to agricultural activities and what is thrown out by tanker cars that carry heavy water, as well as the use of fertilizers, pesticides, and irrigation. Planted crops with septic tank water contaminated with these elements. This is consistent with what was indicated by [5] that the high concentrations of heavy elements in the soil may be due to the solid waste that enters it and the agricultural activities in the region, and when it decomposes, its concentrations increase in general. Studies have confirmed that nickel is produced from industrial activities. Especially since it is used in the manufacture of car engines, then the sewage that is thrown out without treatment reaches the water [6]. Heavy metal pollutants reach the soil by irrigating the lands with sewage water, and the element is able to be caught between clay grains and organic matter [7]. While mentioned [8]. The increase in concentrations of heavy metals in the agricultural soil adjacent to the peat is a result of farmers irrigating their crops, and this is consistent with the results of the current study, as the concentration of lead, cadmium, and nickel decreases in Station 2 (S1) because ground irrigation is alternated with river water coming from the Shatt al-Hilla, and in the event of water scarcity and interruption, water is used. Farmers resort to irrigation with drainage water, as well as the distance of the study stations from human, agricultural and other activities, causing its low concentrations in the soil. While [9] explained that the causes of soil pollution with heavy elements also result from the elements carried by the wind, as well as atmospheric accumulations of dust that contain these elements. [10] also pointed out that the concentrations of heavy elements in the soil are essentially inherited from the parent materialthe rocks from which it was formed. [3] stated that the presence of heavy elements in the soil of study stations depends on the nature of the study stations. It depends on the nature of the station, the extent to which it is affected by the physicochemical properties, and the extent of the stability of the heavy elements in it, knowing that most of the elements are stable and ineffective, and their source is mineral or organic, as well as the extent of the influence of the soil texture and what enters it. Of extras. The high concentration of heavy elements in the finished form at Station 4 (S1) may be due to the elements increasing their mobility and readiness in the soil and forming complexes with mineral and organic compounds as well as the additives that enter the trocar along its course, especially in Stations 3 and 4, which have significant activity from Agricultural and human pollutants, or pollutants that are added to the riparian soil through which the trowels pass, as shown by the results, an increase in the ions of the prepared part, as the ions of the free elements are considered the most available for contamination, so the dissolved chemical form of the heavy elements is the most toxic [6]. The difference in the exposure of the study stations to variation in human activity, including agricultural, industrial, and domestic waste, which are the main sources of heavy elements that have the ability to form chelating compounds with calcium carbonate, organic matter, and clay, to which the heavy elements are bound, and the results of the current study are consistent with the findings [11.[

The high concentration of heavy elements may be due to several reasons, the most important of which are the proportions of clay joints in the soil, the amount of organic matter, the distribution of oxides, and their specific surface area. It is also affected by acidity factors and the state of oxidation that control every redox reaction in the soil. Organic matter has a positive role in retaining the element, but the nature and composition of the organic matter The environmental conditions surrounding the action of microorganisms and its accumulation and absorption by plants are not important to the microorganisms, and thus may cause the release and release of lead into the soil, and this is what he demonstrated[12]. The presence of heavy elements in high concentrations is due to the fact that the soil is the largest recipient of heavy elements deposited from the air, from the parent material, or from added solid waste, in addition to agricultural, industrial, and domestic waste. The availability of heavy elements and their abundance in the soil depends on several factors, including the interaction of the soil. Humidity, microbial activity, and the density of negative charges on the surfaces of soil colloids and clay, as explained by [13] . pH has a role in the readiness of heavy elements, as the readiness of heavy elements increases with a decrease in pH, decreases with an increase in pH, and increases in sand joints, as cobalt is linked with weak bonds in sand joints and organic materials, forming chelating compounds.This is what was indicated by [14]. The agricultural soils adjacent and close to the drills, in addition to the agricultural pollutants that are added to the bank soil through which the drills pass, show that the results show a high concentration of ready-made cadmium, as the free element ions are considered the most available, so the chemical form of the ready-made element is the most toxic, and this is what was shown [15 . [

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