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Article

Evaluation of pollution with some heavy metals for soils and plants of agricultural Locations in Basrah province

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Abstract
To Evaluate the state of pollution with heavy metals (Zn, Cr, Cu, Ni, Pb), ten Locations with different chemical and physical properties were selected from the agricultural Locations of Basrah province: 1/Al-Qurna, 2/Al-Madina, 3/Al-Dair, 4/Al-Haritha, and 5/Karmat Ali (University).), 6/ Al-Tanuma, 7/ Abu Al-Khasib, 8/ Al-Siba, 9/ Al-Faw and 10/ Al-Zubayr (Al-Burjisiya station) and a site was chosen for comparison, where soil samples were collected from agricultural Locations close to the source of pollution, while plant samples were collected from near and far from the source Pollution and the necessary analyzes were Carried out for the study. The results showed an increase in the concentration of total heavy metals in the soils of most of the study Locations, and they were polluted compared to the comparison treatment. The soils of most agricultural Locations exceeded the internationally permissible limits. The results indicated that the total average concentration of lead, Nickel, copper, chromium and zinc in the Hartha area (the fourth site) was 615.88, 165.55, 390.40, 48.45, 465.83 mg kg^{-1} soil sequentially, which is higher compared to the average concentration in other agricultural sites, as well as the concentrations of heavy metals increased (Pb, Ni, Cu, Cr, Zn) in plants grown in locations close from the source of pollution. The concentrations of these elements decreased in plants far from the source of pollution. It is noted that the pollution factor (CF) values of Pb and Zn in all study Locations ranged from moderate contamination to very high contamination.

Keywords: PLI, pollution Factor (CF), oil installations, soil pollution, plant pollution.

Introduction

The problem of pollution is one of the most critical environmental problems that have taken severe environmental, economic and social dimensions, especially after the industrial revolution in Europe and the massive industrial expansion supported by modern technology, in addition to the emergence of some industries in the recent times, which led to the pollution of the ecosystem. The problem of environmental pollution is not a new or urgent problem Rather, what is new in it is the increase in the intensity of pollution in both quantity and quality in our present time , and The human being is the main factor in the environmental imbalance as a result of the increase in industrial activity due to the tremendous development witnessed by the world, as this has led to damage to the components of the environment as a result of its pollution by many Pollutants, including heavy metals ([1] Heavy metals such as lead, cadmium and Nickel are among the most dangerous pollutants for soil, water and plants and The most important sources of pollution with these elements are factory waste, fuel combustion and automobile exhaust and Soil pollution with these elements leads to poor fertility and deterioration The quality of the crops grown in it [2,3] and studies have proven that the danger of heavy elements lies in their cumulative qualities in the bodies of living organisms and cause harm to humans when eating food contaminated with these elements[4]. The problem of industrial diversity in Iraq, including Basrah province, which is characterized by specific environmental characteristics, has caused a deterioration in the quality of the local environment in terms of the non-conformity of most of the locations of industrial complexes, electric power plants, and oil refineries to the conditions Environmentally correct location, the age of these facilities, and their lack of means of treating pollution led to a rise in the pollution resulting from them and its impact on the surrounding environment and view of the potential pollution caused by these industrial facilities to the surrounding environment with heavy metals, and to evaluation the seriousness of this pollution in the agricultural location of Basrah province, this study was conducted.

Materials and Methods

Field and laboratory procedures

Ten agricultural locations with different chemical and physical characteristics were selected in Basrah province, nine of which are close to the source of pollution locations: the first (Al-Qurna), the second (Al-Madina), the third (near the paper mill in Al-Dair), the fourth (Al-Haritha), the fifth (Karmat Ali, the University) and the sixth (Al-Tanuma), the seventh (Abi Al-Khasib), the eighth (Al-Siba), the ninth (Al-Faw), and the tenth site (Al-Zubair, Al-Burjisiya station) and A comparison location was chosen for its distance from the source of pollution. Soil samples were collected from agricultural locations from the surface layer at a depth of (0-30) cm, with three replications for each location. The samples were air-dried and passed through a (2) mm sieve. Some of the chemical and physical properties of soils were estimated according to the standard methods of analysis mentioned in [18], [10] and [14], as shown in Tables 1 and 2.

No.	Locations	pH 1:1	$CaCO_3$ %	O.M %	CEC	EC	cations				anions			
					C.mole+ kg^{-1}	dsm^{-1}	$mmole^{-1}$							
							Ca^{+2}	Mg^{+2}	K+	Na+	Cl^-	HCO^-_3	$CO^=_3$	$SO^=_4$
1	Al-Quran	7.66	39.60	0.31	15.89	14.50	25.37	20.12	2.33	54.66	121.12	4.37	Nil	23.08
2	Al-Madina	7.91	43.50	0.45	17.27	5.80	10.87	11.00	1.98	13.71	31.34	1.20	Nil	24.76
3	Al-Dair	7.78	38.10	0.48	18.17	12.40	23.12	21.25	2.07	33.20	97.78	3.87	Nil	22.18
4	Al-Haritha	7.69	40.00	0.38	17.13	12.49	18.25	22.25	2.16	40.97	92.45	3.37	Nil	26.91
5	Karmat Ali	7.57	41.00	0.21	16.18	5.10	8.00	9.62	2.07	14.57	28.75	4.25	Nil	16.89
6	Al-Tanuma	7.58	32.10	0.17	17.03	14.50	21.75	23.25	2.41	55.46	102.5	5.50	Nil	36.12
7	Abi Al-Khasib	7.35	39.55	0.41	15.30	7.60	12.00	14.62	2.14	21.45	46.25	4.62	Nil	24.47
8	Al-Siba	7.92	44.00	0.18	14.13	13.50	23.12	15.25	2.30	57.60	98.45	4.12	Nil	32.51
9	Al-Faw	7.68	34.50	0.18	16.30	18.64	32.00	32.37	2.64	56.80	142.56	3.25	Nil	39.55
10	Al-Burjisiya (comparison)	8.10	17.25	0.09	5.11	4.40	9.34	7.50	1.25	9.65	27.34	2.75	Nil	12.71

Table 1. Some chemical and physical properties of the study soils.

No.	Locations	Clay	Silt	Sand	Soil Texture	No.	Locations	Clay	Silt	Sand	Soil Texture
		%						%			
1	Al-Qurna	5.42	49.52	45.06	Silty clay	1	Al-Tanuma	4.78	56.36	38.86	Silty clay loam
2	Al-Madina	6.79	46.54	46.67	Silty clay	2	Abi Al-Khasib	5.34	52.30	42.36	Silty clay
3	Al-Dair	7.49	45.29	47.24	Silty clay	3	Al-Siba	4.63	53.89	41.48	Silty clay
4	Al-Haritha	6.00	52.00	42.02	Silty clay	4	Al-Faw	6.88	49.10	44.02	Silty clay
5	Karmat Ali	4.84	56.60	38.56	Silty clay loam	5	Al-Burjisiya (Comparison)	89.81	3.93	6.26	Loamy sand

Table 2. Percentages of soil Texture for the study locations.

Also, samples were taken from the cultivated plants (the vegetative part) for each agricultural location and at two distances near and far from the source of pollution for each location. Plant samples were washed with distilled water, then dried at a temperature of 65 °C, and until the weight was stable, they were crushed and sieved and then kept in plastic containers for analysis. To estimate the concentration of heavy metals in the soil and plants of the studied locations, the soil samples were digested with an acidic mixture ($HClO_4$: $H2SO_4$). Then, the heavy metals were estimated in the digestion solution using an Atomic Absorption Spectrophotometer (AAS) according to the method used (Davies, 1992). As for the estimation of the plant's heavy metals content, the wet digestion method was followed in digesting the plant samples using the acid mixture (HNO_3: $HClO_4$) in a ratio (4: 1) according to the method described in [5], then the plant's heavy metals content was estimated using a device. Atomic absorption. (AAS)

pollution standards

Contamination factor (CF)

Contamination factor (CF) was calculated based on the equation [6]

CF = C Sample / C background

C Sample: Total element concentration (mg kg^{-1})

C background: The concentration of the total element in the comparison sample.

Value	Classification
≤ 1	**Low Contamination**
1 ≤ CF < 3	**Moderate Contamination**
3 ≤ CF < 6	**Considerable Contamination**
CF ≥ 6	**Very high contamination**

Table 3. Range of Contamination factor index values.

Pollution Load Index (PLI)

The pollution load index was calculated based on Equation [6]

$PLI = (CF1 \times CF2 \times CF3 \times \ldots\ldots \times CFn)^{1/n}$

CF: Contamination factor

n: The number of studied elements

PLI	Classification
PLI < 1	**denote perfection**
PLI = 1	**indicates that only baseline levels of pollution are present**
PLI > 1	**deterioration of location quality**

Table 4: Range of Pollution Load Index (PLI).

Results and Discussion

The total concentration of heavy metals in the soil:

Figure 1 and Table 5 show the results of the total concentration of Lead element (mg kg^{-1}) in agricultural soil samples for the studied locations and the comparison treatment Whereas, the highest value of total Lead concentration in the soils of the studied locations was in Al-Hartha area 615.88 mg kg^{-1} soil and the lowest value was 65.57 mg kg^{-1} in Al-Barjisiya area (comparison treatment). The results indicate that the total concentration of Lead element in the soils of agricultural locations was 212.59 mg kg^{-1} soil, which is higher than the average concentration of Pb in calcareous soils of 26 mg kg^{-1} soil [1] This may be attributed to the impact of electric power stations such as Al-Hartha and Najibiyah stations and oil installations, and the gaseous, liquid or solid that contain high concentrations of heavy elements, Lead element, which have led to soil pollution and our results are consistent with what [7] found of the high concentration of heavy metals in the soil, Lead element, in the nearby locations of the Al-Furat Chemical Factories and Kufa Cement.

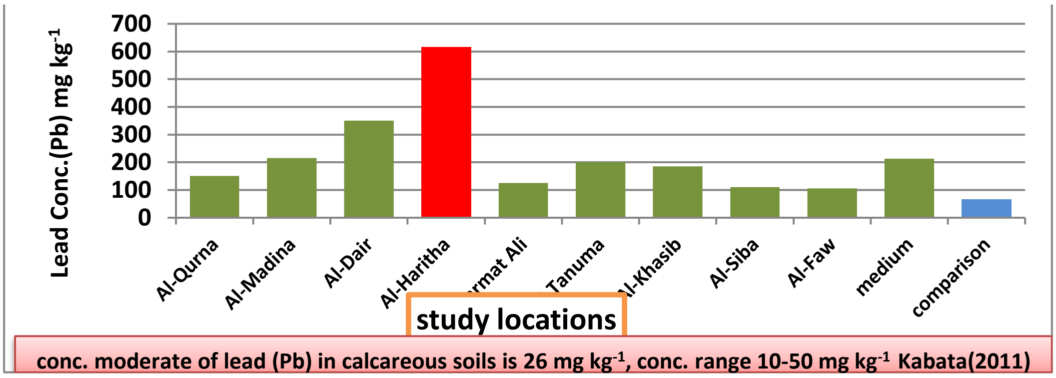

Figure 1. Total lead concentration in the soils of agricultural locations.

The results of Table 5 and Figure 2 showed the total concentration of Nickel (mg kg^{-1}) in the agricultural soil samples of the studied locations, where the highest value of the total Nickel concentration in the soil of agricultural locations was in Al-Haritha area 165.55 mg kg^{-1} soil. The lowest value was 50.25 mg kg^{-1} of soil in the Al-Barjisiya area (comparison treatment), and the average total concentration of Nickel in agricultural locations was 92.55 mg kg^{-1} of soil, which is higher than the average concentration of Nickel in calcareous soils [1]. Soil contamination with heavy metals is affected by the distance and proximity to the source of pollution. It is noted from the study results that the total concentration of Nickel in the soil increases in the areas close to the source of pollution (Al-Hartha area). In addition to the other industrial areas and decreases in distance from them, the results of our study were consistent with what [9] of the high concentrations of Nickel in the areas close to the Thermal power plant in Wasit, which gave a concentration higher than the average concentration of Nickel in calcareous soils: 26 mg kg^{-1} soil.

Study Locations	**heavy metals (mg kg^{-1} soil)**				
	Pb	Ni	Cu	Cr	Zn
Al-Qurna	150.25	78.87	195.30	34.70	195.24
Al-Madina	215.85	85.29	245.95	28.45	215.94
Al-Dair	350.55	140.35	389.10	42.10	288.25
Al-Haritha	615.88	165.55	390.40	48.45	465.83
Karmat Ali	125.35	120.30	200.50	22.80	176.45
Al-Tanuma	200.87	76.50	253.24	38.37	203.55
Abi Al-Khasib	185.78	72.86	135.20	24.25	225.63
Al-Siba	110.25	66.35	120.55	20.56	120.67
Al-Faw	105.50	69.22	255.56	18.65	145.56
Al-Burjisiya (comparison)	65.57	50.25	65.95	10.15	70.98
General Average	212.59	92.55	225.18	28.85	210.81
moderate concentration of heavy metals in calcareous soils (mg kg^{-1})	26	34	23	83	100
Concentration range mg kg^{-1} Kabata (2011)	-5010	2 - 450	6.8 - 70	5- 500	10-570

Table 5. The total concentration of heavy metals in agricultural soils.

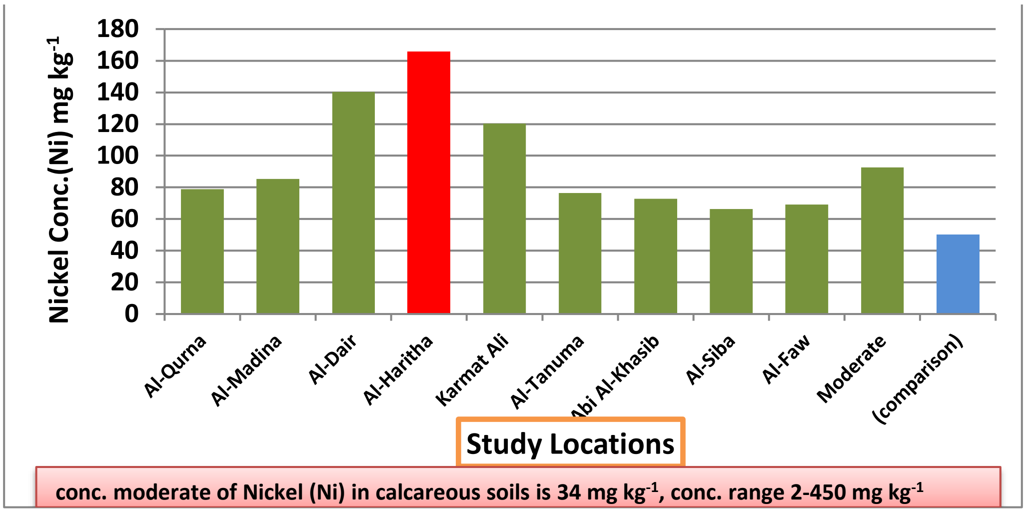

Figure 2. Total Nickel concentration in the soils of agricultural locations.

The results of Table 5 and Figure 3 indicate the total concentration of chromium (mg kg^{-1}) in the agricultural soil samples of the studied locations, where the highest value of the total chromium concentration in the soil of agricultural locations in Al-Haritha area, 48.45 mg kg^{-1} soil and the lowest value 10.15 mg kg^{-1} soil in Al-Barjisiya area (comparison treatment) while the average chromium concentration in the soil of agricultural sites was 28.85 mg kg^{-1} soil. It is noted from the results of the study that the total chromium concentration in all studied locations was less than the average concentration of chromium in calcareous soil 83 mg kg^{-1} soils and within the internationally permissible limits for this element (5-500) mg kg^{-1} [1].

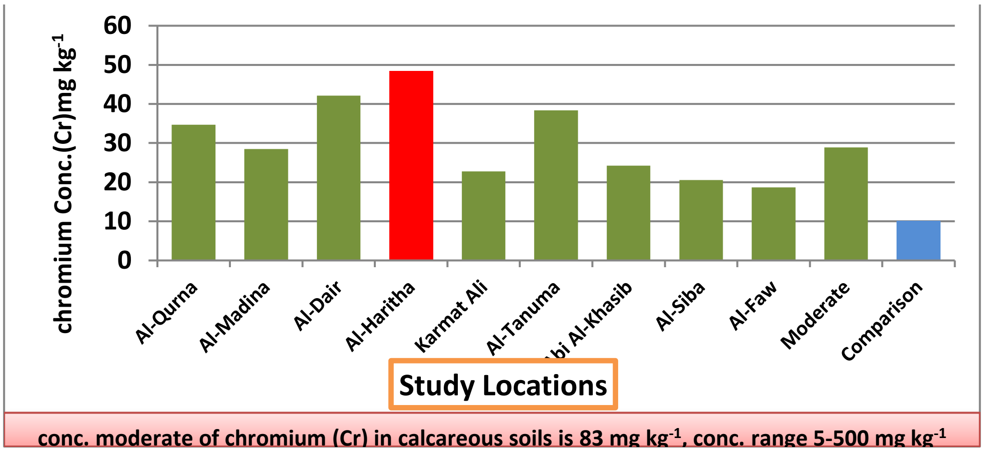

Figure 3. Total Chromium concentration in the soils of agricultural locations.

The results of table 5 and figure 4 showed the total concentration of Zinc element (mg kg^{-1}) in the agricultural soil samples of the studied locations, where the highest value of the total Zinc concentration in the soil of agricultural locations in Al-Haritha area 465.83 mg kg^{-1} soil and the lowest value 70.98 mg kg^{-1} soil in Al-Barjisiya area (comparison treatment) ,and the average total concentration of zinc in the soil of agricultural sites amounted to 210.81 mg kg^{-1} soil, and it is noted from the results of the study that the total concentration of Zinc in the soil of all studied locations except for the Barjisiya area (comparison treatment) It was more significant than the average concentration of the element Zinc in the calcareous soil 100 mg kg^{-1} soil and within the internationally permissible limits for this element (10-750) mg kg^{-1} soil [1] and the results show a high total concentration of Zinc in agricultural locations close to the source of pollution compared to areas far from the source of pollution, and this may be attributed to incomplete combustion of fuel in electrical stations and oil sites, where gaseous emissions contain heavy metals that move by air to areas near the source of pollution.

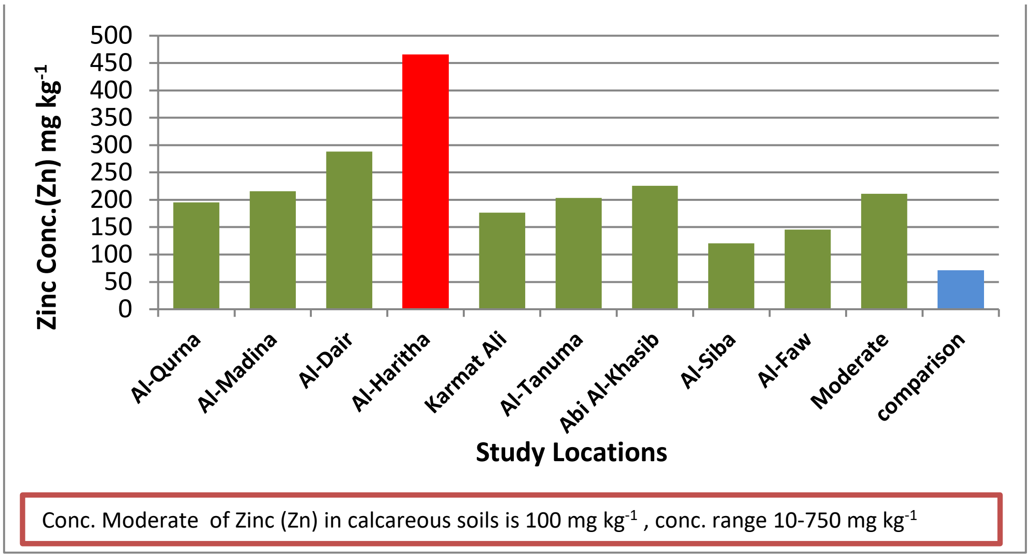

Figure 4. Total Zinc concentration in the soils of agricultural locations.

The results of Table 5 and Figure 5 showed the total concentration of copper in the agricultural soil samples of the studied locations. The results of the study indicated that the Al-Haritha and Al-Deir areas gave the highest value of the total Copper concentration in the soils of the agricultural locations, amounting to (390.40 and 389.10) mg kg^{-1} soil, sequentially and less the value of copper element recorded in Al-Barjisiya are (comparison treatment) 65.95 mg kg^{-1} soil. The results in Figure 5 indicate that the total copper concentration in soil models and for all locations was more significant than the average Copper concentration in calcareous soil 23 mg kg^{-1} soil and higher than the permissible limit of 6.8-70 mg kg^{-1} soil [1]) This may be attributed to the gaseous emissions raised by oil fields and industrial facilities, such as power stations and paper mills, to the agricultural lands adjacent to these industrial facilities, in addition to the uncalculated additions of chemical fertilizers to agricultural lands all this led to the pollution of land with heavy metals, Copper element.

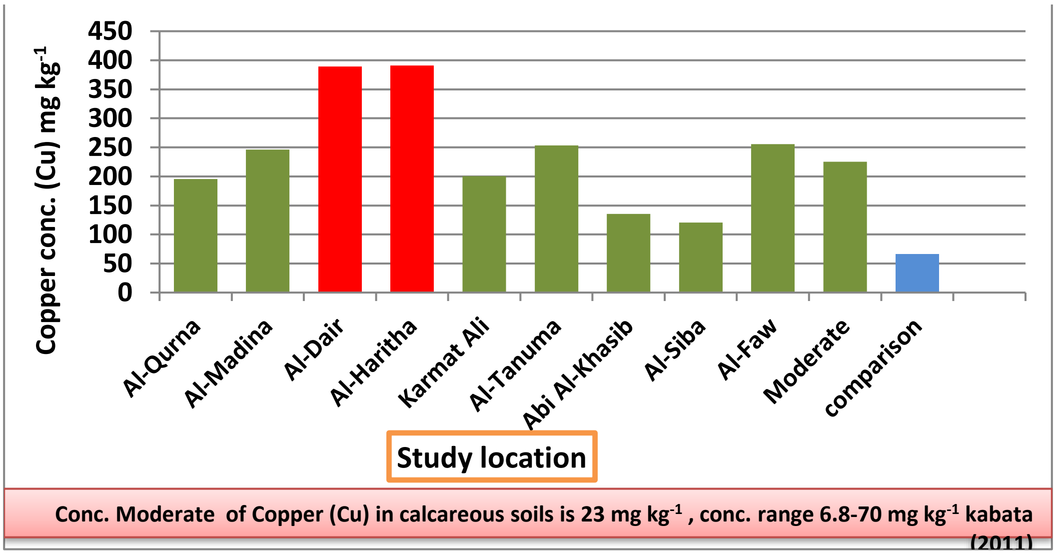

Figure 5. Total Copper concentration in the soils of agricultural locations.

The total concentration of heavy metals in the plant:

The results of Table 6 showed the total concentration of heavy metals in the vegetative total of plants grown in agricultural sites near and far from the source of pollution. The results of the study indicated a high concentration of heavy metals. (Pb, Ni, Cu, Cr, and Zn) In plants growing in locations close to the source of pollution, the concentrations of these elements are lower in plants far from the source of pollution, as the results of table (6) showed that the highest value of the elements Pb, Ni, Cu, Cr, and Zn was (15.89, 13.60, 30.77, 11.76 and 56.54) mg kg^{-1} dry matter sequentially in the vegetative part of the plants cultivated (*Allium cepa* , *Solanum melongena* , *Cucumis Sativus* , *Solanum melongena and Abelmoschus esculentus*) Sequentially in the study location close to the source of pollution (Al-Haritha, Al-Deir, Al-Madina, Al-Deir and Karma Ali) sequentially, while the location far from the source of pollution for the same plants and study location recorded a lower value for the plant content of the mentioned heavy elements The results of the study indicated that the lowest value recorded for the elements Pb, Ni, Cu, Cr, and Zn was (1.95, 2.73, 10.41, 2.25 and 12.87) mg kg^{-1} dry matter sequentially for plants (*Solanum Iycopersicum*, *Raphanus Sativus* , *Zea mays* , *Lawsonia inermis and Hordeum vulgare*) in the study locations close to the source of pollution (Al-Barjisiya station, Abi Al-Khasib, Al-Tanamah, Al-Faw and Al-Siba) sequentially and When comparing the results of the study with the permissible limits for Copper (4-15 mg kg^{-1} dry matter), Chromium (0.2-1.0 mg kg^{-1} dry matter), and Nickel (0-1.0 mg kg^{-1} dry matter) The plant content of Cu, Cr and Ni elements and for all study locations close to the source of pollution was higher than the permissible limits, while the content of plants from Zn element in the locations near and far from the pollution source and for all study locations was within the permissible limit (15-200 mg kg^{-1} dry matter), as for the concentration of Pb in plants for the two study locations (Al-Hartha and Al-Dair) and in the areas close to the source of pollution, it was higher than the permissible limits (0.1-10 mg kg^{-1} dry matter) in general the concentration of heavy metals in the vegetative part of the plant increased in the study locations close to the source of pollution, and the concentration of these elements in the plant decreased for areas far from the source of pollution. This may be attributed to the contamination of the soil of the study locations with heavy elements and then their absorption by the growing plants or their absorption directly by the growing plants as a result of the gases emitted from the industrial areas and the heavy elements.

***Locations**	**Plant**		**Heavy element (mg kg^{-1} dry matter)**				
			Pb	**Ni**	**Cu**	**Cr**	**Zn**
1	*Vicia faba*	Close	3.81	7.80	22.85	7.45	30.89
		Far	1.25	1.09	2.16	0.98	3.75
2	*Cucumis sativus*	Close	10.97	8.65	30.77	5.90	32.98
		Far	1.19	1.34	2.70	0.89	4.23
3	*Solanum melongena*	Close	12.77	13.60	25.12	11.76	45.87
		Far	1.65	1.56	2.89	1.67	5.34
4	*Allium cepa*	Close	15.89	11.77	18.75	10.86	24.15
		Far	1.90	1.75	3.10	1.33	2.97
5	*Abelmoschus esculentus*	Close	3.57	9.44	17.55	4.45	56.54
		Far	0.63	1.15	1.95	0.41	6.32
6	*Zea mays*	Close	8.10	5.78	10.41	9.43	28.48
		Far	0.95	0.95	1.68	1.09	3.98
7	*Raphanus sativus*	Close	6.40	2.73	15.45	5.15	32.50
		Far	0.86	0.81	2.09	0.79	4.89

8	*Hordeum vulgare*	Close	2.54	4.10	23.13	3.57	12.87
		Far	0.35	0.56	2.55	0.45	2.34
9	*Lawsonia inermis*	Close	2.30	4.30	22.38	2.25	22.90
		Far	0.25	0.65	2.89	0.19	2.98
10	*Solanum Iycopersicum*	Close	1.95	4.84	14.19	2.98	18.76
		Far	0.17	0.44	1.08	0.25	1.75
Moderate		Close	6.83	7.30	20.06	6.38	30.59
		Far	0.92	1.03	2.31	0.80	3.85
Range conc. Of Heavy metals in crops (Allaway,1968)			0.1-10	0- 1.0	4-15	0.2-1.0	15-200

Table 6. Concentration of heavy metals in the vegetative part of plants grown in the study locations (mg kg^{-1} dry matter)
***Locations: 1. Al- Qurna 2.AL- Madina 3. Al- Dair 4. Al-Haritha 5. Karmat Ali 6. Al- Tanuma 7.Abi Al-Khasib 8. Al- Siba 9. Al- Faw 10. Al-Burjisiya (comparison)**

Pollution standards for heavy metals in study soils:

Contamination Factor (CF)

The results of table 7 indicate a discrepancy in the Contamination factor (CF) values for heavy metals (Pb, Ni, Cu, Cr and Zn) in the study sites, where Pb and Zn were recorded in the fourth site (Al-Hartha) the highest value of the Contamination factor was 9.39 and 6.56 it is noted that the values of the Contamination factor for the two element in all study locations ranged from moderate contamination to very high contamination as for the element Ni, Cu and Cr the highest value of the Contamination coefficient was (3.29, 5.92 and 4.77) sequentially in the fourth location (Al-Haritha), and the values of the Contamination factor (CF) for these elements in all study locations ranged from moderate Contamination to high contamination this may be attributed to the proximity of the study locations to the industrial facilities represented by electric power stations, oil fields and industrial laboratories, and the waste of heavy elements that they secrete to the neighboring environment without treatment, all of which led to soil pollution with these elements compared to the tenth location (comparison treatment).

*Locations	Pb	Pollution situation	Ni	Pollution situation	Cu	Pollution situation	Cr	Pollution situation	Zn	Pollution situation
1	2.29	Moderate	1.57	Moderate	2.96	Moderate	3.42	High	2.75	Moderate
2	3.29	High	1.70	Moderate	3.73	High	2.80	Moderate	3.04	High
3	5.35	High	2.79	Moderate	5.90	High	4.15	High	4.06	High
4	9.39	V.high	3.29	High	5.92	High	4.77	High	6.56	V.high
5	1.91	Moderate	2.39	Moderate	3.04	High	2.25	Moderate	2.49	Moderate
6	3.06	High	1.52	Moderate	3.84	High	3.78	High	2.87	Moderate
7	2.83	Moderate	1.45	Moderate	2.05	Moderate	2.39	Moderate	3.18	High
8	1.68	Moderate	1.32	Moderate	1.83	Moderate	2.03	Moderate	1.70	Moderate
9	1.61	Moderate	1.38	Moderate	3.88	High	1.84	Moderate	2.05	Moderate
Moderate	3.49	High	1.93	Moderate	3.68	High	3.05	High	3.19	High

Table 7. Contamination factor index (CF) for heavy metals in the soils of the studied locations
***Locations: 1. Al- Qurna 2.AL- Madina 3. Al- Dair 4. Al-Haritha 5. Karmat Ali 6. Al- Tanuma 7. Abi Al-Khasib 8. Al- Siba 9. Al- Faw.**

Pollution Load Index (PLI)

The results of Table 8 indicated the different pollution load values for the soil of study sites for heavy metals (Pb, Ni, Cu, Cr and Zn); the third and fourth locations (Al-Deir and Al-Haritha) recorded the highest value of the pollution load index, which amounted to (4.31 and 5.64) respectively. The general average of the pollution load index for the soil of the study locations and for all the studied elements has exceeded the permissible limit (PLI >1), and this indicates the presence of a state of deterioration in the soil of the studied location compared to the comparison treatment (the tenth location) this may be attributed to the gases and fumes of industrial facilities and oil fields and the heavy elements they carry to the neighboring agricultural lands, which leads to soil and plant pollution with these elements.

*Locations	Pb	Ni	Cu	Cr	Zn	PLI	Pollution situation
1	2.29	1.57	2.96	3.42	2.75	2.51	Deterioration of site quality
2	3.29	1.70	3.73	2.80	3.04	2.82	Deterioration of site quality
3	5.35	2.79	5.90	4.15	4.06	4.31	Deterioration of site quality
4	9.39	3.29	5.92	4.77	6.56	5.64	Deterioration of site quality
5	1.91	2.39	3.04	2.25	2.49	2.39	Deterioration of site quality
6	3.06	1.52	3.84	3.78	2.87	2.87	Deterioration of site quality
7	2.83	1.45	2.05	2.39	3.18	2.30	Deterioration of site quality
8	1.68	1.32	1.83	2.03	1.70	1.70	Deterioration of site quality
9	1.61	1.38	3.88	1.84	2.05	2.01	Deterioration of site quality
Moderate	3.49	1.93	3.68	3.05	3.19	2.95	Deterioration of site quality

Table 8. Pollution load index (PLI) for heavy metals in the soils of the studied locations.
***Locations: 1. Al- Qurna 2.AL- Madina 3. Al- Dair 4. Al-Haritha 5. Karmat Ali 6. Al- Tanuma 7. Abi Al-Khasib 8. Al- Siba 9. Al- Faw.**

Discussion

The study results indicate a high concentration of Nickel in areas experiencing industrial activity compared to the comparison treatment, which may be attributed to pollution resulting from various activities in oil refineries and electric power plants. The results of our study agreed with what we found [8] from the high concentration of total Nickel in the soil in the industrial areas (Al-Dora area). He attributed the reason to the region's various activities, including a refinery and the Dora power station. Moreover, the results indicate a high total concentration of chromium in agricultural locations close to the source of pollution, and this may be attributed to the increase in human activities in the industrial areas and the waste they put into the environment without treatment, and thus the increase in the concentration of heavy metals in them the results of our study agree with what was indicated [11,12]. The data of the study are consistent with the findings of [13] from the increase of Zinc element in different environments of Kirkuk governorate, and that the average values of zinc for the soils of the studied locations ranged between 275.70 - 355.21 mg kg^{-1} soil and it was within the permissible limits in France And higher than the maximum limits in Spain and Denmark, and the results of our study also agreed with what [14] found of an increase in the total concentration of Zinc in agricultural soil models close to the source of pollution compared to areas far from it. He attributed the reason to the impact of power stations and oil installations such as the Dora refinery and the waste they produce that contains high concentrations of heavy elements such as zinc.

The results were consistent with the findings of [15] from the high of copper in the neighboring areas of the Petrochemical Company. They attributed the reason to the throwing and leakage of pollutants from laboratory petrochemicals to the soils near and surrounding the factory. [16] studies on the elevation of heavy metal pollution in agricultural soils near industrial areas in China showed an increase in the concentration of Copper and Zinc in the soil that exceeded the permissible limits, and they attributed the reason to mining activities in the region. The results of our study also agreed with the findings of 13 of an increase in the total concentration of copper in the nearby agricultural sites of the industrial establishments in the region. They attributed the reason to the region's agricultural and industrial activity, such as the presence of electrical stations, oil refineries, and mining operations.

Furthermore, it coincided with the findings of [14,15] from the high content of the plant of heavy metals in locations close to pollution sources. Besides, the results of our study agreed with his finding [13,17] of an increase in the contamination factor values of heavy metals for agricultural sites near industrial facilities, and they attributed the reason to the gases and fumes emitted from these industrial facilities and their impact on the surrounding environment. Finally, the results of our study agreed with what was found by [19,20] from the height value of the pollution load index in agricultural lands close to industrial facilities represented by cement, chemical and brick factories, as well as electrical stations, and the pollutants that they present to the surrounding environment, containing heavy metals, which leads to the pollution of agricultural soils with these elements.

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