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To cite this article: B A Al-Qasi *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **904** 012057

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## Effect of Nitrogen Fertilizer Sources, Lead and Cadmium Pollution on Some Properties of Barley (*Hordeum vulgare*)

B A Al-Qasi<sup>\*1</sup>, M M Sharqi<sup>2</sup>, S E Faiath<sup>3</sup>

<sup>1,2</sup> College of Education for Girls– University of Anbar , Iraq

<sup>3</sup>Biotechnology and Environmental Center, University OF Fallujah

\*Corresponding author's e-mail: [baraka95ali@gmail.com](mailto:baraka95ali@gmail.com)

**Abstract.** The study was conducted in the Department of biology - College of Education for Girls - University of Anbar in order to study the effect of cadmium and lead pollution and nitrogen fertilizer sources on the accumulation of heavy metals in the root, the vegetative part, yield and its components of barley (*Hordeum vulgare* L.) during growing season 2020-2021, Where the experiment was carried out in pots containing 20 kg of soil. The experiment was designed according to a randomized complete block design and in the order of factorial experiments with three replications. The experiment included two factors, the first factor is three concentrations of the elements lead and cadmium (0, 40, 80 mg liter<sup>-1</sup>), and the second factor is three types of nitrogen fertilizer sources are (ammonium sulfate (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>, ammonium nitrate NH<sub>4</sub>NO<sub>3</sub> and urea CO(NH<sub>2</sub>)<sub>2</sub>). The experiment was planted and irrigated with the three nitrogen fertilizer sources on 1/11/2020. After 14 days of planting, heavy metals were added to the soil in the above-mentioned concentrations in the form of two batches. The weight of 1000 grains / g and the concentration of heavy elements (Pb, Cd) in the root, vegetative and grains after harvest were calculated. The results of the study showed: The barley plant had the ability to accumulate heavy elements in the different parts of the plant, and their concentration in the root system was the highest, then the vegetative system, then the grain. However, the accumulated amounts of lead were less than cadmium in the roots, as the highest concentrations of lead and cadmium in the roots were (24.78 and 37.22 mg kg<sup>-1</sup>) and (61.13 and 92.3 mg kg<sup>-1</sup>). for the concentrations (40 and 80 mg L<sup>-1</sup>) respectively.

### 1.Introduction

The barley crop is among the most important grain crops in Iraq, and its cultivation ranks second after wheat for winter crops, due to the frequent use in various food, fodder and industrial purposes. It ranks fourth among the most grain crops for the cultivated area in the world and production, and its grains are characterized by their high protein content of 11.8%, carbohydrates 78.8%, 5.3% of raw fibers and 3.0% minerals, 1.8% of fats (1). Any change in the composition of one of the main elements of the environment that occurs either naturally or by the influence of humans and animals is environmental pollution, and environmental pollution is one of the most dangerous problems for humanity and all components of the ecosystem (2). Soil pollution with heavy metals has received great attention because it is one



of the important obstacles to crop productivity and quality. This situation has been exacerbated by the increasing population growth and the increasing demand for food as plants cannot escape the toxicity of heavy metals as exposure to heavy metals causes many physiological, chemical and biological changes (3).

Heavy metals are naturally found in the soil in low concentrations, but human activities have increased their concentration to reach concentrations that are toxic and fatal to humans and animals (4). Cadmium and lead are among the most dangerous heavy metals for humans, animals and plants, and soil is the main source of plant pollution with toxic compounds, and then their transmission through the food chain to humans and animals (5). The natural sources of pollution with these elements the burning of forests and volcanoes(6).the One of the most prominent and complex problems of environmental pollution is the excessive use of chemical fertilizers and chemical pesticides, and these fertilizers are nitrogen fertilizers, which are another source of soil pollution, as this leads to the transfer of many heavy elements to the soil, plants and then animals to eventually reach humans (7).Heavy metals are among the most dangerous pollutants in the soil, and their danger lies in their staying in the soil for a long time without undergoing any change, decomposition or chemical change. As a result of their presence in agricultural soil, they not only affect plant growth, but also lead to contamination of grains and fruits that ingested by humans (8). Lead and cadmium are considered unnecessary elements in the growth of plants that have no known physiological role (9).

Phytoremediation is an alternative and environmentally friendly solution, where plants are used to analyze, extract or accumulate heavy metals in their vegetative parts, as it is an inexpensive technique for treating environmental pollutants, whether in soil or water. Barley is one of the crops that accumulate heavy metals (10) .Soil pH is one of the most important factors that control the movement and concentration of elements in the soil, especially heavy elements, and the response of the plant and its absorption of nitrogen forms is one of the most important factors that cause a change in the pH of the soil The various forms of nitrogen fertilizer vary in their effect on the absorption of other ions and on the movement and accumulation of heavy elements in the soil (11). . Nitrogen is one of the most important elements that plants need in large quantities because it has an effect on increasing production as will as entering into the synthesis of protein [12]

It is grown in most countries of the world because it is more tolerant of harsh environmental conditions such as humidity and salinity. It is also considered a good fodder for animals, It is considered one of the accumulated crops of somewhat heavy elements. This study came to find out the response of barley to the pollution with heavy metals and nitrogen fertilizer sources and their effects on growth and yield

## 2.Materials and Methods

Soil analysis was carried out at the Desert studies Center ,University of Anbar. The Table (1) shows Chemical and physical properties of soil

**Table 1. Chemical and physical properties the soil used in the study**

Results	Studied traits
2.755dsm <sup>-1</sup>	electrical connection
8	PH
Sandy loam	Soil texture
12.43mg kg <sup>-1</sup>	P
1.7mg kg <sup>-1</sup>	K
0.070%	N
0.0049mg kg <sup>-1</sup>	Cd
0.058mg kg <sup>-1</sup>	Pb
3.37Cmol kg <sup>-1</sup>	Ca
0.17 Cmol kg <sup>-1</sup>	K
10 Cmol kg <sup>-1</sup>	Na

The experiment was carried out during the winter season of 2020-2021 on Khalidiya Island - Kartan .The area is located in latitude( 33°.26 , 33°.22) and longitude(43°.49 , 43°.48). The seed were obtained from the General Authority for Agricultural Research (*Hordeum vulgare Tpa 99*) . region in order to find out the effect of three nitrogen fertilizer sources and their interaction with three different concentrations of cadmium and lead in the root, vegetative, and grain of Barley *Hordium vulgare* L. The experiment was designed according to a randomized complete block design and in the order of factorial experiments with three replications. The study included two experiments for each of (Pb and Cd), the first factor was the concentrations of the heavy element (Pb, Cd), which are (0, 40 and 80 mg kg<sup>-1</sup>), and the second factor is the fertilizer sources (ammonium sulfate, ammonium nitrate, and urea). The seeds were planted and irrigant with nitrogen sources on 1/11/2020 in pots containing 20 kg of soil, After 14 days heavy metals were added, and the plants were irrigated with the mentioned solutions, with some changes being made to take into account the requirements of the experiment. The solution containing Fe-chelate was prepared by dissolving (1350 mg) of Na<sub>2</sub>-EDTA in a specific volume of distilled water in a glass beaker (500 ml) after continuous mixing and quiet heating, (900 mg) FeSO<sub>4</sub>.7H<sub>2</sub>O was added from to the beaker, then heated the solution to complete dissolving and complete the volume to 500 ml [13] . The harsh lead solution (2000 mg kg<sup>-1</sup>) was prepared by dissolving (2.68 g) PbCl in a quantity of distilled water from a substance in a volumetric bottle of 1 liter and then completing the volume to the mark. In addition, the standard cadmium solution (2000 mg kg<sup>-1</sup>) was prepared by dissolving (3.58 g) of cadmium chloride CdCl<sub>2</sub>.H<sub>2</sub>O in an amount of distilled water in a volumetric bottle of 1 liter and then completing the volume to the mark [12]Where it was initially irrigated with the three natural nitrogen fertilizer sources in the form of one batch, and after 14 days the heavy elements were added to avoid what the aforementioned heavy elements might cause the death of some seedlings during plant growth. Where the heavy elements were estimated in the shoot and root system, and the samples were digested according to the method used by [14]. The characters that were studied in this study were:

1. Concentration of lead in root, vegetative and grain
2. Cadmium concentration in root, vegetative, and grain
3. Weight of 1000 grains (gm)
4. Plant height

### 3. Results and Discussion

[1] *The content of the roots, shoots and dry grains of lead element (mg kg<sup>-1</sup> dry weight).* Tables 2, 3, and 4 indicate the presence of significant effects of lead concentrations and nitrogen fertilizer sources and their interactions on the concentration of lead in the root, vegetative and dry grains of barley plant, respectively. The same tables show that the lead content of the three plant parts increases with the increase in the concentration of lead in the soil solution. The concentration of lead in the root reached 24.78 and 37.22 mg kg<sup>-1</sup> dry weight at concentration 40 and 80 mg L<sup>-1</sup>, respectively. Where it significantly outperformed the control treatment 0 mg L<sup>-1</sup>, which gave the lowest average for this trait (3.41 mg kg<sup>-1</sup> dry matter). Whereas for the vegetative content of lead, the concentrations of 40 and 80 mg L<sup>-1</sup> were significantly superior to the control treatment 0 mg L<sup>-1</sup> (1.17 mg kg<sup>-1</sup> dry matter), as it gave the highest concentration of lead in the vegetative (23.95 and 27.79 mg kg<sup>-1</sup> dry weight, respectively). While the grain content of lead was (2.537 and 4.207 mg kg<sup>-1</sup> dry weight) at concentration 40 and 80 mg L<sup>-1</sup> with significant differences over the control treatment 0 mg kg<sup>-1</sup>, which reached the value of lead concentration in grains 0.979 mg kg<sup>-1</sup>.

When looking at the results of the above table, we note that the highest concentration of lead is in the root system, then the vegetative group, then the dry grains of barley, and these results are consistent with what was reached [15] .Where it was noticed that the concentration of lead in the outer periphery increased, its concentration in the roots and the vegetative system of maize (*Zea mays*) increased, but its concentration in the root system remained higher than its concentration in the vegetative parts.[16] was also able to prove that lead is slow moving inside the plant. It was mentioned by [17]that the amount of lead transmitted from the root system to the vegetative system is much less than the amount accumulated in

the roots of barley (*Hordium vulgare*) and maize (*Zea mays*). This is due to the fact that lead does not have the ability to penetrate the endodermis, which hinders its movement or transmission. The study conducted by the researchers above on the roots of these two plants under the electron microscope indicated an increase in the concentration of lead in the cell walls and cytoplasm. Where the researcher [18] reported that the large differences between the concentrations of lead in roots and leaves indicate that there are important restrictions that work on the internal transfer of lead from roots to leaves., and [19] reached the same results regarding lead .This is due to the fact that lead is negatively absorbed by plants by root hairs and is stored to a large extent in the root cells and in the intracellular vacuoles, and not a small part of it is transmitted to the leaves. This proves that the amount of lead in the root system is higher than the shoot [12]. The researchers mentioned that lead causes inhibition of some enzymes work and release the reactive oxygen species (ROS) ,which causes oxidation stress in the roots of plants which is the most accumulated part of lead in plant[17]

As for the interaction between lead concentrations and nitrogen fertilizer sources and tables 1, 2, and 3, there are clear differences between the three parts of the barley plant in their content of lead, according to the type of nitrogenous source added to the plant. Whereas, the concentration of lead was the highest in the roots when adding ammonium sulfate fertilizer, which gave the highest rate for this trait, which amounted to 40.85 mg kg<sup>-1</sup> dry weight, which differed significantly from the lowest value of lead concentration when treated with ammonium nitrate plant for both concentrations 40 and 80 mg L<sup>-1</sup>. The root content of lead was 33.9, 18.72 and 21.72 mg/kg-1 dry weight for the fertilizer source: ammonium sulfate, ammonium nitrate and urea, respectively, for a concentration of 40 mg L<sup>-1</sup>.in addition, the root content of lead was 40.84, 34.10 and 36.71 mg kg<sup>-1</sup> dry weight of ammonium and urea ammonium nitrate, respectively, for concentration of 80 mg L<sup>-1</sup>.

For the vegetative parts, it was found that the concentration of lead was the highest for the concentrations 40 and 80 mg L<sup>-1</sup>, respectively, when adding ammonium nitrate fertilizer, as it gave the highest lead content of 37.77 and 28.74 mg kg<sup>-1</sup> dry weight of the two concentrations, it significantly outperformed the concentrations of 40 and 80 mg L<sup>-1</sup> when adding urea fertilizer, which reached a value of 28.47 and 24.72 mg kg<sup>-1</sup> dry weight for concentrations 40 and 80 mg L<sup>-1</sup>, respectively. While the ammonium nitrate fertilizer gave the lowest lead content when lead was added with concentrations of 0,40,80 mg L<sup>-1</sup>, respectively, with a value of 17.14, 18.40 and 1.17 mg kg<sup>-1</sup>. This shows the results of the tables, that the content of lead in the root system is higher than the vegetative. As for the grain content of lead, the results showed that the addition of ammonium nitrate fertilizer reduced the lead content in the grains, and this treatment differed significantly with all sources of nitrogen fertilizers. These results are in agreement with the study carried out by researcher[20] on maize that *Zea mays* fertilized with ammonium sulfate increased the absorption of heavy metals compared to fertilized with ammonium nitrate. The researcher [21] added that the treatment with ammonium nitrate reduced the concentration of lead in the plant tissues.

**Table (2) Effect of lead concentrations, nitrogen fertilizer sources on the root content of lead ( kg mg<sup>-1</sup> dry weight).**

Concentration	Nitrogen fertilizer source			Conc. Mean
	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	NH <sub>4</sub> NO <sub>3</sub>	CO(NH <sub>2</sub> ) <sub>2</sub>	
O	4.25	1.65	4.33	3.41
40	33.90	18.72	21.72	24.78
80	40.85	34.10	36.71	37.22
Mean N fertilizers	26.33	18.16	20.92	
L.S.D <sub>0.05</sub>		N	Conc.	N*Conc
		1.821	1.821	3.155

**Table 3. Effect of lead concentrations, nitrogen fertilizer sources on the shoots content of lead ( kg mg<sup>-1</sup> dry weight).**

Concentration	Nitrogen fertilizer source			Conc. Mean
	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	NH <sub>4</sub> NO <sub>3</sub>	CO(NH <sub>2</sub> ) <sub>2</sub>	
0	1.38	1.73	0.97	1.17
40	28.74	18.40	24.22	23.95
80	37.63	17.14	28.47	27.79
Mean N fertilizers	22.63	12.23	18.05	
L.S.D <sub>0.05</sub>		N 1.319	Conc. 1.319	N*Conc 2.284

**Table 4. Effect of lead concentrations , nitrogen fertilizer sources on the grains content of lead( kg mg<sup>-1</sup> dry weight).**

Concentration	Nitrogen fertilizer source			Conc. Mean
	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	NH <sub>4</sub> NO <sub>3</sub>	CO(NH <sub>2</sub> ) <sub>2</sub>	
0	0.663	0.303	2.000	0.979
40	2.870	1.716	3.025	2.537
80	5.762	3.125	3.733	4.207
Mean N fertilizers	3.089	1.715	2.919	
L.S.D <sub>0.05</sub>		N 0.352	Conc. 0.352	N*Conc 0.611

[2] The content of the roots, shoots and dry grains of Cadmium element (mg kg<sup>-1</sup> dry weight). Statistical analysis tables 4, 5, and 6 showed significant differences for cadmium concentration and nitrogen fertilizer sources and their interactions in each of the root, vegetative, and dry grains of barley respectively. The results showed that the concentration of cadmium in the root system is higher than the vegetative and dry grain, as its accumulation increases with increasing its concentration in the soil solution n, where its concentration in the root reached 61.13 and 92.3 mg kg<sup>-1</sup> for the concentrations 40 and 80 mg L<sup>-1</sup> respectively, and these results are significantly outperformed the control treatment 0 mg kg<sup>-1</sup>, which gave the lowest average value for this trait, which was 3.7 mg kg<sup>-1</sup>. Whereas the vegetative content of cadmium, concentrations of 40 and 80 mg L<sup>-1</sup> were superior to the control treatment, as it gave the highest average for this trait. The highest concentrations were 26.25 and 25.64 mg kg<sup>-1</sup> dry weight respectively, compared to the control treatment, which gave the lowest rate for this trait. While the grain content of cadmium, which reached a value of 4.424 and 4.510 mg kg<sup>-1</sup>, it was obtained from concentrations of 40 and 80 mg L<sup>-1</sup>, with significant differences from the control treatment, which gave the lowest rate of 1.179 mg kg<sup>-1</sup>. The results also indicate that the highest concentration of cadmium in the root, then vegetative, and then grains of the barley plant. These results are consistent with the findings of [22], which confirmed that the increase in the concentration of cadmium in the soil solution increased its concentration in the root of three varieties of maize.

[23] also confirmed that plants absorb cadmium easily from the soil through the roots., and [24] indicated that the uptake of cadmium from the soil is largely linked to genetic and

environmental factors, and that the reason for the increase in the concentration of cadmium in the root is the competition of calcium and cadmium ions for ion exchange sites, which contributes to an increase in the concentration of cadmium in the soil and its uptake by the roots.

The researcher [25] confirmed that soil salinity leads to the formation of some complexes with cadmium Cd-Cl and its ease of dissolution and absorption by plants.

Table 4, 5, and 6 indicates a significant two-way interaction between the nitrogen fertilizer sources and the cadmium concentration, which differed according to the different fertilizer sources used, as the cadmium content in the root, vegetative, and grains was higher when adding ammonium sulfate fertilizer, then urea, while barley had less cadmium accumulation when ammonium nitrate was added. It was found that the highest concentration of cadmium in the root was when the plant was treated with ammonium sulfate ( $101.4 \text{ mg kg}^{-1}$ ) at a concentration of  $80 \text{ mg L}^{-1}$ , which is the highest rate compared with the control treatment, which differed significantly with the lowest value of cadmium obtained when treated with ammonium nitrate for both concentrations 40 and  $80 \text{ mg L}^{-1}$ , respectively. The cadmium content of the roots was (72.9, 35.1 and  $75.4 \text{ mg kg}^{-1}$ ) for ammonium sulfate, ammonium nitrate and urea, respectively at a concentration of  $40 \text{ mg L}^{-1}$ . The cadmium content of the roots was ( $101.4$ ,  $85.8$  and  $89.7 \text{ mg kg}^{-1}$ ) of ammonium sulfate, ammonium nitrate and urea, respectively, at a concentration of  $80 \text{ mg L}^{-1}$  of cadmium.

The cadmium content of the shoot was increased by increasing the concentration of cadmium 40 and  $80 \text{ mg liter}^{-1}$  as the two concentrations gave the highest content of cadmium in the shoot ( $36.0$  and  $36.23 \text{ mg kg}^{-1}$  dry weight) respectively when adding ammonium sulfate fertilizer. Which significantly outperformed at concentrations 40 and  $80 \text{ mg L}^{-1}$  when adding urea fertilizer, as it reached  $24.45$  and  $21.89 \text{ mg kg}^{-1}$ , respectively. While the ammonium nitrate fertilizer gave the lowest cadmium content in the vegetative parts for concentrations of 0, 40 and  $80 \text{ mg L}^{-1}$ , the value was 1.32, 18.00 and  $18.80 \text{ mg kg}^{-1}$ -dry weight respectively. These results indicate that the cadmium content was the highest when adding nitrogenous fertilizers.

The results showed that the addition of nitrogen fertilizer ammonium nitrate reduced the grain content of cadmium, this treatment differed with all sources of nitrogen fertilizers, including ammonium sulfate, which is the most source that helped deposit cadmium in grains in large quantities, where the grain content was 6.783, 3.344, and  $3.145 \text{ mg kg}^{-1}$  dry weight at the sources of nitrogen fertilizer ammonium sulfate, ammonium nitrate and urea, respectively, for a concentration of  $40 \text{ mg L}^{-1}$ . Whereas, the concentration of  $80 \text{ mg L}^{-1}$  led to an increase in the grain content of cadmium, as it gave the highest rate for this trait of 6.25, 3.45 and  $3.83 \text{ mg kg}^{-1}$  dry weight. These results are in agreement with the study of [26] in that the addition of nitrogen fertilizers increases the concentration of cadmium in the soil and its ease of absorption by plants. In addition that [27] confirmed in the study they conducted on carrot plants, that the addition of nitrogen fertilizers increased the concentration of cadmium in the root. [28] indicated that the addition of nitrogen fertilizer increases or decreases the absorption of heavy elements from the soil, as he showed that cadmium increases its absorption by plants when adding ammonium sulfate fertilizer, which works to displace cadmium despite the high PH and this is due to the effect of exchanged ions in calcium nitrate fertilizer, where calcium ions are replaced by cadmium ions in the soil, which causes the absorption of cadmium in large quantities.

**Table 5. Effect of cadmium concentration ,nitrogen fertilizer sources on the root content of cadmium (kg mg<sup>-1</sup> dry weight) .**

Concentration	Nitrogen fertilizer source			Conc. Mean
	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	NH <sub>4</sub> NO <sub>3</sub>	CO(NH <sub>2</sub> ) <sub>2</sub>	
O	4.4	2.8	4.0	3.7
40	72.9	35.1	75.4	61.13
80	101.4	85.8	89.7	92.3
Mean N fertilizers	59.56	41.23	56.36	
L.S.D <sub>0.05</sub>		N 7.03	Conc. 7.03	N*Conc 12.18

**Table 6. Effect of cadmium concentration nitrogen fertilizer sources on the shoots content of cadmium (kg mg<sup>-1</sup> dry weight).**

Concentration	Nitrogen fertilizer source			Conc. Mean
	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	NH <sub>4</sub> NO <sub>3</sub>	CO(NH <sub>2</sub> ) <sub>2</sub>	
O	2.25	1.34	1.00	1.52
40	36.00	18.00	24.45	26.15
80	36.23	18.80	21.89	25.64
Mean N fertilizers	24.83	12.71	15.78	
L.S.D <sub>0.05</sub>		N 1.871	Conc. 1.871	N*Conc 3.240

**Table 7. Effect of cadmium concentration, nitrogen fertilizer sources on the grains content of cadmium (kg mg<sup>-1</sup> dry weight).**

Concentration	Nitrogen fertilizer source			Conc. Mean
	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	NH <sub>4</sub> NO <sub>3</sub>	CO(NH <sub>2</sub> ) <sub>2</sub>	
O	1.573	0.880	1.083	1.179
40	6.783	3.344	3.145	4.424
80	6.250	3.450	3.830	4.510
Mean N fertilizers	4.869	2.558	2.686	
L.S.D <sub>0.05</sub>		N 0.436	Conc. 0.436	N*Conc 0.756

### 3. Weight of 1000 grain (gm)

The results indicate that there are significant differences between the concentrations of heavy metals and nitrogen fertilizer sources and their two-way interaction on the characteristic weight of 1000 grains (Table 7). Results also shows that there is a significant effect of nitrogen fertilizer sources on the average of this trait, and that the highest value obtained from



urea fertilizer was 40.25 gm, which differed significantly from the lowest value for this trait (34.90 gm) when adding ammonium nitrate fertilizer. These results are consistent with the findings of [29], which confirmed that urea fertilizer has a positive effect on grain yield. [30] also showed that the productivity of crops increases with the increase of nitrogen fertilizers. The researcher [31] also confirmed that treating rice with ammonium sulfate fertilizer increased grain yield. The researcher [32] explained in his study on barley that nitrogen fertilization promotes growth through cell elongation, as ammonium sulfate activates the work of enzymes that help in biochemical reactions inside the plant.

The researcher [33] confirmed that the increase in grain yield is due to the plant's use of nitrogen fertilizers, which plays an important role in stimulating dormant buds and stimulating vegetative growth because nitrogen is included in the synthesis of proteins, amino acids, nitrogenous bases, the synthesis of DNA and RNA, and in the formation of biological compounds.

The same table showed that there was a significant effect of heavy metals concentrations on the mean of this trait, as they had a negative effect on the mean of this trait, as the highest mean of the control treatment was 40.97 gm. The lowest value for concentrations was 36.60 gm with a concentration of 80 mg kg<sup>-1</sup>, these results do not agree with [34] stated, as he indicated that the grain yield was not affected by heavy metals present in the soil solution. Whereas, [35] confirmed that lead has the ability to reduce the weight of 1000 grains of wheat plant *Triticum aestivum* treated with lead, and this ability increases by increasing its concentration in the soil solution.

This is due to what was mentioned by [36] also confirmed that heavy metals have the ability to cause many physiological and metabolic changes.

The two-way interaction between the concentrations of the elements and the three nitrogen fertilizer sources had a significant effect on the average of this trait, as the interaction between ammonium sulfate and the concentration 0.0 gave the highest average for this trait (43.97 gm). While the lowest rate for this characteristic was obtained from the two-way interaction of ammonium nitrate and the concentration of 80 mg L<sup>-1</sup> (34.10 gm). Whereas, [37] showed that the use of nitrogen fertilizers increased the concentration of heavy elements, as nitrogen fertilizers reduce the acidity of the soil, which causes an increase in the absorption of heavy elements. The study by [38] confirms that nitrogen fertilizer (ammonium sulfate) increases the production of grain crops and that increasing ammonium sulfate in the aqueous solution from 20 to 40% enhance biomass production by up to 60% compared to nitrate, and that the pollution did not reduce the production of grain crops when adding ammonium sulfate, as ammonium sulfate promotes the growth of the crop.

The researcher [39] confirmed that the increase in the absorption of heavy elements depends on the PH of the soil and that the use of nitrogenous ammonium sulfate fertilizer works to reduce the PH of the soil, because the low pH works on the bioavailability and increase movement of heavy elements, and the reason for this is the conversion of elements from Non-motile forms into more biologically available and interchangeable forms.

As for ammonium nitrate, the researcher [40] confirmed that the use of ammonium nitrate led to a decrease in the rate of heavy elements in the plant, and this is due to the anti-ammonium nitrate effect.

**Table 8. Effect of sources of nitrogen fertilizer and heavy metals (lead, cadmium) mg. L<sup>-1</sup> and their interactions on the weight of 1000 grains (gm).**

Nitrogen source x Heavy metals		Nitrogen source	Nitrogen source x Heavy metals x Heavy metal conc.			Nitrogen source x conc. of heavy metals	Nitrogen source Averages
Pb	Cd		Conc.	Cd	Pb		
			C0	43.97	43.97	43.97	
40.08	39.78	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	C40	38.53	39.10	38.82	39.93
			C80	36.83	37.17	37.00	
			C0	36.23	36.23	36.23	
34.87	34.93	NH <sub>4</sub> NO <sub>3</sub>	C40	34.37	34.37	34.37	34.90
			C80	34.20	34.00	34.10	
			C0	42.70	42.70	42.70	
40.69	39.81	(NH <sub>2</sub> ) <sub>2</sub> CO	C40	38.67	40.03	39.35	40.25
			C80	38.07	39.33	38.70	
			Heavy metal x Heavy metal conc.			Heavy metal conc. Average	
38.54	38.17		C0	40.97	40.97	40.97	
			C40	37.19	37.83	37.51	
			C80	36.37	36.83	36.60	

#### 4. Plant height

Table illustrated that nitrogenous sources possessed significantly effect on plant height, where ammonium sulfate gave highest average of 54.31 cm. whereas, urea had of 51.10 cm. while ammonium nitrate was nonsignificantly differed from ammonium sulfate. This superiority is due to NH<sub>4</sub> be most facilitative and quickly absorbed in plants in comparison on urea and ammonium nitrate. Urea is slowly dissolved which subjected to two types of inversion before it's become available for plant [41]. First, it transferred into NH<sub>4</sub> then NH<sub>3</sub>. Nitrate absorption also is slowly because needs to ATP [43]

Furthermore, table pointed that heavy metals concentrations possessed significant effect on plant height. Control (0.00) had highest plant height of (54.51). The highest concentration (80 mg L<sup>-1</sup>) gave lowest plant height of 51.30 cm. These results is lined with of [43] who indicated that stem length was decreased with increase the Cd concentration. They are also paralleled with of [44] who revealed that leafy crops treated with Cd possessed least stem length due to toxicity of heavy metals on plasma membrane led to decrease water content. Moreover, heavy metals inhibited growth reflected on plant height which the height reduced with increase of Pb concentration . Consequently, Pb possessed negative effect on plant height as its affect biochemical processes like photosynthesis caused weak growth and

development. In the same direction, [45] showed that heavy metals retarded nutrients absorption and lowering water content.

Moreover, the same table showed that binary interaction between heavy metals and nitrogenous sources. Where interaction control X ammonium sulfate achieved highest height of 57.77 cm. whereas, interaction control X urea gave lowest height of 50.62 cm. these results could be due to plants facilitatively absorb nutrients and heavy metals via reduction of hydrogen potential led to increase the absorption of heavy metals from soil [46]. [47] demonstrated that ammonium ions removed cell membrane polarizing potential resulted in  $\text{NH}_4$  taking into root cellular cytoplasm led to the increase this ion absorption and decrease Cd ions. However, this process maximizes Cd transferred into aboveground and underground parts of plant in sunflower because loss of mechanism of toxicity removing.

**Table9. Effect of sources of nitrogen fertilizer and heavy metals (lead, cadmium)  $\text{mg. L}^{-1}$  and their interactions on the Plant heigh.**

Nitrogen source x Heavy metals		Nitrogen source	Nitrogen source x Heavy metals x Heavy metal conc.			Nitrogen source conc. of heavy metals	Nitrogen source Averages
Pb	Cd		Conc.	Cd	Pb		
			C0	58.10	57.43	57.77	
54.74	53.88	$(\text{NH}_4)_2\text{SO}_4$	C40	53.33	54.03	53.68	54.31
			C80	50.20	52.77	51.48	
			C0	55.13	55.13	55.13	
54.70	53.49	$\text{NH}_4\text{NO}_3$	C40	53.83	57.33	55.58	54.09
			C80	51.50	51.63	51.57	
			C0	50.60	50.63	50.62	
50.99	51.21	$(\text{NH}_2)_2\text{CO}$	C40	52.87	50.80	51.83	51.10
			C80	50.17	51.53	50.85	
			Heavy metal x Heavy metal conc.			Heavy metal conc. Average	
53.48	52.86		C0	54.61	54.40	54.51	
			C40	53.34	54.06	53.70	
			C80	50.62	51.98	51.30	

## CONCLUSIONS

1. There is a significant effect for the cadmium and lead concentrations and nitrogen fertilizer sources and it's interactions on barley containt of lead and cadmium
2. Increasing of lead and cadmium concentrations caused a significant increasing in barley parts containt of lead and cadmium but the maximum effect in the roots, shoot a d grain

3. There is a significant effect for ammonium sulfate fertilizer on all nitrogen fertilizer sources for increasing lead and cadmium in different parts of barley but the maximum amount in roots, shoot and grain respectively.
4. Barley can grow in soil which pollution with high concentration of lead and cadmium.

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