Effect of Addition cadmium and lead to the Soil on some vegetative traits and seed content of protien of mung bean plant Vigna radiate L.

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Abstract

This study aimed to investigate the impact of cadmium and lead soil contamination on the vegetative growth and protein content of Vigna radiate seeds. The experiment was conducted at the gardens of the College of Education for Women - University of Tikrit during the season 2023. Results indicated that the studied traits were significantly negatively affected by the presence of both elements in the soil, with the highest reduction observed in the treatment with a mixture of 6 mg.kg-1 soil cadmium and 600 mg.kg-1 soil lead. This treatment had the lowest values for vegetative growth characteristics (plant height, number of branches, number of leaves, leaf area, leaf area index, and leaf chlorophyll content) and also had the lowest protein content in the seeds (6.57%). These findings suggest that cadmium and lead contamination in soil can significantly impact the growth and protein content of Vigna radiate plants, with potential implications for crop production and food security.

Keywords: *cadmium, lead, Vigna radiata, vegetative growth, protein content, soil contamination.*

INTRODUCTION

Heavy metal pollution is one of the most concerning inorganic pollutants resulting from industrialization, as it is non-biodegradable and can therefore persist for a considerable amount of time (Pu and Zhang 2011; Ma and Bondada 2003;). A.L. Shahet, Some heavy metals produce insoluble organic-mineral complexes with organic substances (Christensen and Haung., 1999). There are also heavy elements that can substitute for essential plant nutrients in the soil as the plants absorb them. growth and development, as well as other crucial plant processes (Hiroyuki et al., 2002). Different plant tissues accumulate the heavy element because of its significance in enzyme production (Chao et al., 2008).

Heavy metals like cadmium and lead can have far-reaching effects on an ecosystem when they bioaccumulate in the soil. High levels of metals have been shown to inhibit seed germination, growth, and yield due to physiological reasons (Sahu et al., 2004).

Heavy metal accumulation in plants hinders their ability to absorb and transport vital nutrients, leading to a metabolic imbalance that ultimately stunts the plant's growth and reproduction (XUQ, Shi, 2000).

Heavy metal concentrations are often measured in consumable plant components and used as a gauge to estimate the breadth of food pollution concerns in the crops that are grown. Toxic levels of heavy metals in legumes were estimated to be between 5 and 30 micrograms per kilogram for cadmium, 30 and 300 micrograms per kilogram for lead, and 50 micrograms per kilogram for nickel (Chaney et al., 1978).

The element cadmium, denoted by the chemical symbol Cd, can be found in the water cycle in both its metallic and ionic forms (Bochardt, 1985). It has been shown to have negative impacts on soil fertility, plant metabolism, biological activity, animal health, and human health, making it one of the most environmentally dangerous heavy metals (Kabata-Pendias, 2007). Cadmium is particularly harmful to both aquatic and terrestrial creatures (Olateju et al., 2016), and it is typically obtained from human activities (mine, waste burning, pesticide use). Reduced photosynthesis, water uptake, and nutrient uptake can result from an increase in cadmium concentrations in plants. Growth suppression, root drying, and ultimately plant mortality have all been linked to exposure to high cadmium levels in the soil (Dinu et al., 2020; Huang et al., 2017).

Toxic levels of lead in plants were found to be around 1000 ppm in the dry matter of spinach, however this value varied widely depending on the plant species, cultivar, and anatomical region employed for testing. It was also shown that radish grown in soil sourced from animal pastures had a greater lead concentration in its roots and leaves compared to radish grown in regular soil (Allwawy and Davis, 1971). Most of the lead is washed away during the washing process because it is only found on the outer surfaces of the seeds, leaves, and stems.

The summer crop Vigna radiata L. is a member of the Fabacear Paoilionaceae, a family of leguminous plants that attract butterflies (Pandey.,2009). Most Asian households produce and eat this vital edible leguminous crop, which is farmed on more than 6 million hectares (approximately 8.5% of the total global pulse area). Mung bean is widely cultivated in several Asian nations (mostly concentrated in China, India, Bangladesh, Pakistan, and certain East Asian countries) due to its qualities as a reasonably drought-tolerant, low-input crop and short growing cycle (70 days or less). Its seeds are used as a low-cost protein source, and its seed content is anywhere between 19 and 29 percent. Lysine is abundant in protein, which also boasts a high concentration of carbohydrates (62–65%), lipids (1–5%), vitamins (including B vitamins), iron, zinc, calcium, and its antioxidant Isoflavoindes, and vitamin C (through its sporuts). The reduction of anemia by 66% in Asia is another benefit of mash. The flour ground from its seeds has numerous culinary applications. Animals can be fed plant wastes, and the nitrogen they fix in the soil is utilized as a fertilizer. Numerous studies, including those by (Chadha., 2010), (Abdullah Riyad Muhammad et al., 2009), (Al-Younis, Abdul-Hamid Ahmed 1993), and (Kaisher et al., 2010), have shown that it yields positive economic results.

Materials and methods:

Using plastic water bottles, this research was carried out between July 20 and October 1, 2022, in a canopy in the gardens of the College of Education for Girls' scientific departments. Soil was collected from the Tigris River basin and sieved through a (2) mm mesh after air drying. The 15 kg of earth was then packed in 40 cm tall by 30 cm wide plastic bottles.

Experience Design: The experiment used a CRD (completely randomized design) with three replicates and two factors. First, cadmium was added to the bottles at different amounts of 0, 3, and 6 milligrams per kilogram of soil. The second factor is lead, which can be found in soil at concentrations of 0, 400, and 600 mg.kg-1. With nine treatments and three replicates, the total number of experimental units is twenty-seven (27), chosen at random.

On 20/7/2022, 5 Khadrawi mash seeds were planted in each vial after being obtained from sanctioned agricultural authorities. From the day the seedlings were planted until harvest time, they received consistent irrigation. The plants were grown for two weeks before being thinned out to a single plant in each flask. Fertilizer in the amount of (40) kg N.h-1 (17.66 g) was applied to the plants. A bottle of 75 kilograms (33.11) of phosphorus fertilizer. (Al-Tamimi, 2017) flask Laboratory soil from the University of Tikrit's College of Agriculture and College of Engineering was analyzed.

Studied characterictics:

* Plant height (cm):It was measured from the base of the plant to the end of its apex at the stage of maturity. That is, measuring it to the end of the longest branch of three replicates and taking the average.

*Number of branches.plant-1:It included counting the number of branches emerging on the main stem of each plant in each replicator and taking their average.

*Number of leaves.plant-1:The number of leaves per plant in each replicate was counted and the average was taken.

The paper area per sheet (cm2. Sheet-1): Using the (gravimetric method) (Munger and Wallace 1965), where a sample consists of a known number of leaves taken from plants, the leaf area was measured at the end of the experiment by taking a sample of (6 leaves) representing full-grown leaves from each experimental unit. The paper's area is determined by first weighing a sample on a sensitive scale (three ranks after zero), then recording the weight of the yoke, piercing the papers with a special drill (whose diameter is known to be 1 cm) and counting the total number of papers (whose known number is 6 leaves), and finally weighing the discs. After a section is cut out and recorded, the following law is used to calculate the paper's surface area.

$$\text{Paper Area} = \frac{\text{Full paper weight}}{\text{disc weight}} \times \text{disk area}$$

Paper area guide:It was measured according to the following equation:

LAI=LA/A

LAI = paper area index

A = the area occupied by the plant on the ground

LA = leaf area

Leaves relative chlorophyll content (SPAD UNIT): The Minolta Chlorophell meter SPAD-502 was used to determine relative chlorophyll content. Multiple measurements were taken for each leaf, as well as for three leaves from various outer-branch locations and throughout all experimental units (Karhu et al., 2006).

Seed Protein Percentage (%):The (Microkhejldal) instrument was used to assess the nitrogen content of the seeds; this value was then multiplied by the coefficient (6.25), yielding the protein content. Samples were digested according to the method of (Schuffelen et al., 1961): dried seeds were ground, and 4.0 gm of grain powder was taken from each experimental unit and placed in special bottles; 10 ml of concentrated sulfuric acid was added, and the bottles were left at room temperature for 24 hours; after that, the bottles were heated with the aid of hydrogen peroxide until the color of the solution became clear white.

Protein percentage = nitrogen percentage x 6.25 (Rastovski and Vanesetal 1987).

statistical analysis:The data were analyzed for the design used according to Dunkin's multiple range test at the probability level (0.05).

Results:

Table (1) shows that treating the soil with a mixture of cadmium and lead at a concentration of (6 and 600) mg, respectively, led to a significant decrease in the height of the mung bean plant, which amounted to (36.0) cm, with a decrease rate of (28%) compared to soil plants that were not contaminated with the two elements. Its plants reached a height of (50.0) cm.

Table (1): Effect of Different Concentration of Cadmium and Lead(mg.kg-1.soil) on plant high(cm).

Pb \ Cd	0	3	6	Pb Mean
0	50.00a	47.50b	40.50f	46.00a
400	47.66b	46.00c	37.66g	43.77ab
600	45.00d	42.50e	36.00h	41.16c
Cd Mean	47.55a	45.33b	38.05c	

*There are no significant differences between the numbers that have the same or similar letters in the same column, according to Dunkin's multiple range test at the level of probability of 5%.

The use of a mixture of cadmium and lead resulted in a significant decrease in the number of branches of a single plant, giving the lowest number of branches of (9.00) when using concentration (6 and 600) mg of cadmium and lead, respectively, with a decrease rate of (43.75%) compared to non-plants. A treatment that gave the highest value amounted to (16) branch.plant-1 Table (2).

Table (2): Effect of Different Concentration of Cadmium and Lead(mg.kg-1.soil) on number of branchs.plant-1.

Pb \ Cd	0	3	6	Pb Mean
0	16.00a	14.00b	11.00e	13.66a
400	13.00c	13.00c	10.00f	12.00b
600	10.00f	12.00d	9.00g	10.33c
Cd Mean	13.00a	13.00a	10.00b	

*There are no significant differences between the numbers that have the same or similar letters in the same column, according to Dunkin's multiple range test at the level of probability of 5%.

The use of a mixture of cadmium and lead resulted in a significant decrease in the number of leaves per plant, as it reached the lowest number (21.67) leaves. plant-1 at concentrations (6 and 600) mg, respectively, with a decrease rate of (32.28%) compared to untreated plants, which It gave (32.0) leaves. Table (3) plants.

Table (3): Effect of Different Concentration of Cadmium and Lead(mg.kg-1.soil) on number of leaves .plant-1.

Pb \ Cd	0	3	6	Pb Mean
0	32.00a	31.00b	27.00f	30.00a
400	30.00c	29.00d	25.00g	28.00a
600	28.00e	28.00e	21.67h	25.89b
Cd Mean	30.00a	29.33a	24.55b	

*There are no significant differences between the numbers that have the same or similar letters in the same column, according to Dunkin's multiple range test at the level of probability of 5%.

The use of a mixture of cadmium and lead resulted in a significant decrease in the leaf area of (216.89) cm 2 at two concentrations (6 and 600) of cadmium and lead, respectively, with a decrease rate of (32.23%) compared to untreated plants whose plant area reached (320.08). cm2.table(4).

Table (4): Effect of Different Concentration of Cadmium and Lead(mg.kg-1.soil) on leaf (cm2).

Pb \ Cd	0	3	6	Pb Mean
0	320.08a	296.79bc	270.25e	295.71a
400	300.31b	290.01c	250.00f	280.10b
600	280.12d	280.10d	216.89g	25.89b
Cd Mean	300.17a	288.96b	245.71c	

*There are no significant differences between the numbers that have the same or similar letters in the same column, according to Dunkin's multiple range test at the level of probability of 5%.

The use of a mixture of different concentrations of the two elements cadmium and lead showed a significant effect in reducing the leaf area index, giving the lowest value of (0.28) and a decrease of (37.77) compared to plants that were not treated with the two elements, whose leaf area index reached the highest value (0.40).

Table (5): Effect of Different Concentration of Cadmium and Lead(mg.kg-1.soil) on leaf area index.

Pb \ Cd	0	3	6	Pb Mean
0	0.40a	0.41bc	0.38e	0.41a
400	0.42b	0.41c	0.34f	0.39ab
600	0.39d	0.39d	0.28g	0.35b
Cd Mean	40.33a	4.33a	0.33b	

*There are no significant differences between the numbers that have the same or similar letters in the same column, according to Dunkin's multiple range test at the level of probability of 5%.

The use of a mixture of different concentrations of the two elements cadmium and lead caused a significant difference in the content of the chlorophyll pigment in the mung bean plant, as the two concentrations (6 and 600) mg reduced the content of chlorophyll to (54.33) sebum, with a decrease rate of (19.03%) compared to uncontaminated soil plants. Its chlorophyll content reached (67.10) SPAD. table (6).

Table (6): Effect of Different Concentration of Cadmium and Lead(mg.kg-1.soil) on Chlorophyl Content SPAD.

Pb \ Cd	0	3	6	Pb Mean
0	67.10a	63.76c	57.23e	62.70a
400	65.53b	62.50c	56.26c	61.43a
600	63.07c	59.70d	54.33f	59.03b
Cd Mean	65.70a	61.98b	55.94c	

*There are no significant differences between the numbers that have the same or similar letters in the same column, according to Dunkin's multiple range test at the level of probability of 5%.

Soil treatment with a mixture of cadmium and lead, concentration 6 and 600 (mg.kg-1 soil), showed a significant decrease in the protein content of seeds, giving 6.57 (%), with a decrease rate of (42.01%) compared to untreated plants, whose protein content reached the highest percentage, which was 11.33 (11.33). %).table (7).

Table (7): Effect of Different Concentration of Cadmium and Lead(mg.kg-1.soil) on seeds conten from protein(%).

Pb \ Cd	0	3	6	Pb Mean
0	11.33a	11.01b	10.70c	11.01a
400	8.89d	8.05f	7.04h	7.99b
600	8.85e	7.73g	6.57i	
Cd Mean	9.60a	8.93ab	8.10b	

*There are no significant differences between the numbers that have the same or similar letters in the same column, according to Dunkin's multiple range test at the level of probability of 5%.

Discussion:

It was observed that there was a significant negative effect on the growth characteristics of the vigna radiata plant treated with cadmium and lead (Tables 5-12). Chlorophyll pigment because heavy elements cause a change in the characteristics of the selective permeability of the cell membrane or because of the effect on the water enzymatic activity responsible for providing food for the seedlings (Shafiq et al., 2008). Other physiological and biochemical mechanisms (SIDDIQUI et al., 2011 and Intisar and Eman, 2022).

The decrease in the concentration of chlorophyll (a and b) may be due to the presence of these elements inhibiting the biosynthesis of chlorophyll before the protochlorophyllide stage due to its interference with the enzyme protochlorophyllide reductase (Li et al., 2011), or the decrease in the concentration of chlorophyll may be due to an internal replacement in tissues The plant contains a magnesium atom located in the center of the chlorophyll molecule in the heavy element atoms, which is an important breakdown mechanism in plants with effective substitution (Kupper et al., 1996), and these results are consistent with what was reached by (Saeed, 2011) when treating celery.

The toxic effects of heavy metals on the metabolic processes of building protein negatively affected all parts of the plant. And that some heavy elements are ready to oxidize the thiol bonds within the protein structure, and this changes the structure of the secondary protein (Docic and Polle, 2005), and these results are consistent with what was stated by (Khodaverdiloo et al. 2011 and Saleh 2012) that the addition of cadmium and lead to the soil leads to a significant decrease in protein concentration The presence of heavy elements in high concentrations causes a decrease in the number of protein bundles due to a decrease in nitrates (Singh et al., 2011), and may be due to the ability of the elements to bind to the sulfur group which are found in proteins and thus a defect in the synthesis of proteins (John et al., 2009) and to the dissolution of proteins as a reaction and defense response of the plant or may be due to increased activation of the activity of the enzyme protease or lipid peroxidation or due to the breakdown of proteins (Mihailvoc, 2011) or may work to reduce the absorption of elements Important minerals such as iron and magnesium, which are involved in protein synthesis (Khodaverdiloo et al. 2011).

Reference

ZHANG, M. & PU, J. Mineral materials as feasible amendments to stabilize heavy metals in polluted urban soils . Journal of Environmental Science, 23(4), 2011, 607-615.

176.,

Abdulazeez, M. I., Hamdi, A. Q., Mohammed, H. Y., & Ahmed, M. (2020). Dental trauma of permanent incisor teeth in children/Kirkuk city. studies, 22, 23.

Ali, A. H., Ahmed, H. S., Jawad, A. S., & Mustafa, M. A. (2021). Endorphin: function and mechanism of action. Sci Arch, 2, 9-13.

Ali, S. H., Armeet, H. S., Mustafa, M. A., & Ahmed, M. T. (2022, November). Complete blood count for COVID-19 patients based on age and gender. In AIP Conference Proceedings (Vol. 2394, No. 1, p. 020044). AIP Publishing LLC.

Alloway, B. J. and Jackson, A. P. (1991).The Sci. Total Environ., 100: 151-

Al-Younis, Abdel-Hamid Ahmed, 1993. Understanding the production of field crops, Part One, Crops of grains and legumes.

Badi, S., Hamed, A., Abualama, M., Mustafa, M., Abdulraheem, M., & Yousef, B. (2021). Knowledge, attitude, and practice of sudanese pharmacists toward COVID-19 in Khartoum State, Sudan: An online-based cross-sectional study. Libyan International Medical University Journal, 6(01), 19-26.

Borchardt T, 1985. Relation ship between carbon and cadmium uptake in Mytilus edulis." Mar. Biol 85: 233-244.

Chadha , M. L. (2010). Short duration Mung bean a new success in south Asia . Asia-Pacific Ass. Agric. Res. , 1-45.

Christensen, T.H. and Haung ,P.M.(1999). Kluwer Academicpublishers,Dodrechal.pp.1-9.

Dino C.,Vasite G.G.,Buleandra M.,Popa D.E.,Gheorgheb S.,Unguranu E.M. 2020.Transocation and L-plants grown in amining-contaminated soil .J.soils sediments.20:2141-2154.

Ducic, T. ; Polle, A. (2005). Transport and detoxification of manganese and copper in

Govindarajan, S., Mustafa, M. A., Kiyosov, S., Duong, N. D., Raju, M. N., & Gola, K. K. (2023). An optimization based feature extraction and machine learning techniques for named entity identification. Optik, 272, 170348.

growth and antioxidant enzymes activities of mustara (Sinapis arvensis L.). ARPN .

Heidari, M. ; Sarani, S. (2011). Effect of lead and cadmium on seed germination, seedling

Hung D.,Gong X.,Liu Y.,Zeng G.,Lai C.,Bashir H.,Zhou L.,Wang D.,Xu P.,Cheng M.(2017).Effects of Calicum at toxic concentrations of cadmium in plants .Plants.245:863-873. J. Agricu. and Biolo. Sci., 6 (1), 44-47.

Kabata-Pendias A et Pendias H.(2001).Trace elements in soils and plants. 3rd CRC Press, Boca Raton, London, New-York, Washington D.C

Kadham, S. M., Mustafa, M. A., Abbass, N. K., & Karupusamy, S. (2022). IoT and artificial intelligence–based fuzzy-integral N-transform for sustainable groundwater management. Applied Geomatics, 1-8.

Kaisher , M. S. ; Rahman , M. A. ; Amin , M. H. A. ; Amanullah , A. S. M. and Ahsanullah , A. S. M. (2010) . Effect of sulphur and boron on the seed yield and protein content of Mung bean . Bangladesh Res. Pup. J. , 3(4):1181-1186.

Karupusamy, S., Mustafa, M. A., Jos, B. M., Dahiya, P., Bhardwaj, R., Kanani, P., & Kumar, A. (2023). Torque control-based induction motor speed control using Anticipating Power Impulse Technique. The International Journal of Advanced Manufacturing Technology, 1-9.

Khodaverdillo, H.; Ghorbani Dashtaki , Sh. ; Rezapour, S. (2011). Lead and cadmium accumulation potential and toxicity threshold determined for land cress (Barbarea verna) and Spinach (Spinacia oleracea L.) , Inter. J. Plant Prod. 5(3).

Mahdi, E. M., & Mustafa, M. A. (2022). Effect of different concentrations of extract of Urtica dioica and Cladosporium cladosporiodes on Tribolium castaneum or: Coleoptera after 24-48 hours of exposure in Samarra City/Iraq. HIV Nursing, 22(2), 3207-3210.

Mihailovc, N. (2010). Growth and ion uptake in maize plants exposed to Pb , Cd and Ni depend on NO3-/NH4+ Ratio. J. Botan. Serbi. 34(1), 15-20.

Mustafa, M. A., Kadham, S. M., Abbass, N. K., Karupusamy, S., Jasim, H. Y., Alreda, B. A., ... & Ahmed, M. T. (2023). A novel fuzzy M-transform technique for sustainable ground water level prediction. Applied Geomatics, 1-7.

Oiateijou D.A.,Olatekan J.K.,Kayode S.A., Oluwatosin G.A.(2016).Lead and cadmium contents in amedical plants/spice grown an urban city of Nigeria. Cogent food agric.2.

Pandey , P. (2009) . A text book of botany angiosperms . S.Chand and Company , Ramangar , New Delhi : 329 P.

plant . Braz. J. Plant Physiol . 17(1), 103-112.

Rastovski,A.; Vanesetal (1987) .Stronge of potatoes .post-harvest behavior store design practice ,handling pudoc .Wageningen.

Sahu SK, Pradhan KC, Sarangi, September 2004, Soil Pollution in Orissa. Orissa Review.

Saleh, Farah Sobhi (2012). Effect of soil contamination with different concentrations of cadmium and lead on the concentration of carbohydrates, proteins and some mineral elements in the sunflower plant Helianthus annus L.. Journal of Al-Rafidain Sciences, (23) 4:41-55.

Schuffelen , A. C. ; Euller and J.G. Vanschouenburg (1961). Quick tests for soil and plant analysis used by small laboratories .Netherland J. Agic .Sci.9:2-16.

Singh, D.P. and Singh, B.B. (2011). Breeding for tolerance to a biotic stresses in mungbean. J. of Food Legumes, 24(2):83-90.

Sudha, I., Mustafa, M. A., Suguna, R., Karupusamy, S., Ammisetty, V., Shavkatovich, S. N., ... & Kanani, P. (2023). Pulse jamming attack detection using swarm intelligence in wireless sensor networks. Optik, 272, 170251.

XU Q ; Shi G, 2000, The toxic effect of single Cd and interaction of Cd with Zn on some physiological index of [Oenantbe javanica (Blume) DC]. J Nanjing Normal University (Natural Science), Vol. 23. (4): 97.100 (In Chinese with English abstract).