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The Efficiency of The Plants' (*Phragmites Australis L.*) Developing in The Waters of The Tigris River Polluted in its Tissue

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ABSTRACT

This research began in October 2022 and continued until December 2023. During this period, four sites along the Tigris River within Saladin Governorate were selected. It was observed that the lead element accumulated in the roots of the reeds (Phragmites) exceeded the overall green biomass of the plant significantly. Specifically, for the second station in February, the lead concentration reached 1.127 milligrams per liter. Statistical analysis indicates significant differences in monthly averages and station averages across the study sites.

Keywords- Phytoremdiation, *Phragmites australis* L., Lead element.

I. INTRODUCTION

Heavy metals constitute an important group of pollutants known for their toxic effects on living organisms. Recently, there has been increasing concern about their harmful impact on the environment, human health, and living communities within terrestrial and aquatic ecosystems. Heavy metals are present in various chemical forms and in small quantities across all environments. They can exist as ions or accumulate in organic matter. Living organisms are exposed to these metals from natural sources such as rocks, as well as human activities like industrial waste and agricultural practices. Consequently, heavy metal concentrations have risen in ecosystems.

Plants and other living organisms require these essential elements to perform vital functions. However, these metals persist at low concentrations due to their limited biodegradability, leading to their accumulation over time. This accumulation can cause adverse and undesirable effects on the environment and living organisms. Heavy metals are relatively dense metals with well-known toxic properties. Even at low concentrations, they can cause poisoning. Their specific gravity is greater than 5 compared to water (where water's specific gravity is 1 at 4°C). Specific gravity is also an indicator of density, representing a certain amount of solid material compared to the same quantity of water.

The distribution of heavy metals in the environment is influenced by two main factors. First, natural processes resulting from geological activities play a role. Second, human activities significantly impact heavy metal inputs globally. These metals are found in rocks and are released into the environment during geochemical transformations. Concentrations of these metals vary based on rock type, age, and location. Natural factors also include volcanic activity, forest fires, weathering processes, and biological emissions from vegetation and sea spray. Human inputs, including agricultural practices and pesticide use, often surpass natural sources globally. When these metals enter the biogeochemical cycle, they distribute throughout the ecosystem. Notably, lead, zinc, and cadmium are among the heavy metals affected by human activities

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II. MATERIAL AND METHODS

The study area and selected locations are described as follows:

The study period spanned six months, starting from October 2022 until March 2023. The city of Tikrit is situated on the right bank of the Tigris River, approximately 180 kilometers north of Baghdad. It is characterized by a steep slope along the Tigris River, with an elevation ranging from 45 to 50 meters approximately. The Tikrit region is semi-undulating and stands at an altitude of 110 meters above sea level. It is intersected by valleys and ridges, with the natural topography sloping from west to east. The study area extends within the western plateau for varying distances, covering a total of 29 kilometers across five sites. These sites were chosen along the Tigris River due to the presence of pollutants in the area[1].

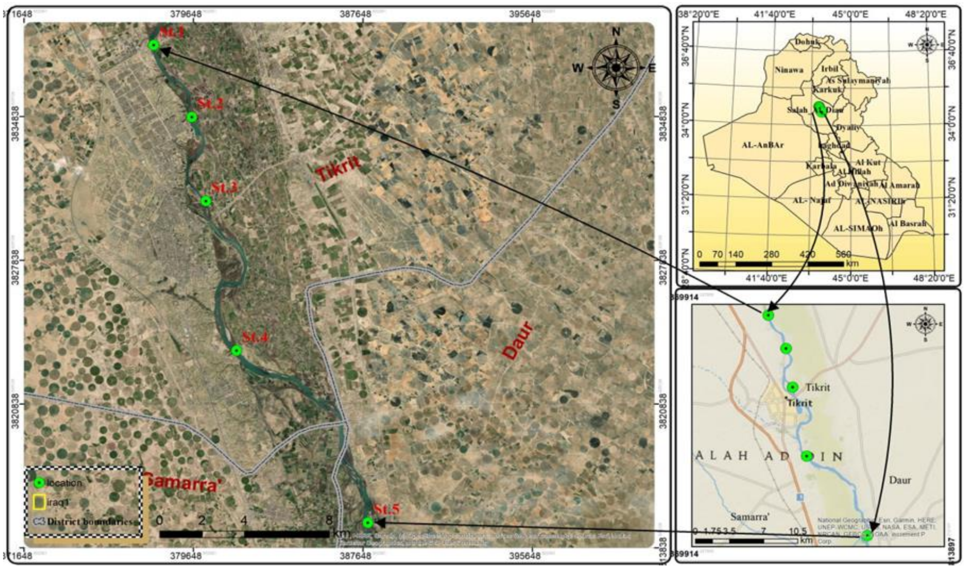

Figure 1: Map of study sites.

Located between Tikrit University and the village of Al-Fandi on the left bank of the river, this site serves as the control point for the study area. It marks the entry point of Tigris River water into the city of Tikrit. Significant amounts of waste and impurities accumulate along the riverbanks, particularly downstream toward the village of Al-Fandi. The area is also considered a recreational spot for families from nearby regions[123].

Figure 1: The first site on the Tigris River.

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Site 2 (st2) is located between the Qadisiyah area and the Dabsah area on the left bank of the Tigris River. It differs from the first site in that it is densely populated with trees on both sides of the riverbanks. This abundance of trees has made it difficult for families to access this site. Additionally, it is farther away from the first site[1].

Figure 2: The second site along the Tigris River.

Site 3 (st3) is situated between the **Presidential Palaces** and the **Al-Kara'at area**, just below the Tikrit Bridge. It serves as a central point connecting Tikrit city with the Al-Ilam district and other neighboring districts. Notably, this location houses water pumps that supply water to tankers. Additionally, residents use this site for swimming and recreation, as it serves as a gathering place for families[[1]][1] [23].

Figure 3: The third site along the Tigris River.

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Site 4 (st4) is situated between the city of **Tikrit** and the **Al-Bu Ajil area**. This location is bordered by mountains from the direction of Tikrit and dense trees from the Al-Bu Ajil area. The abundant vegetation obstructs access for residents, making it challenging to reach this site. Additionally, it is farther away from the third site[1].

Figure 4: The fourth site along the Tigris River.

Site 5 (st5) is located at the **Al-Dawr-Al-Awja crossing** and serves as a scenic promenade for neighboring areas. It features large trees and green spaces, making it a recreational spot for families. Additionally, pollutants discarded by residents accumulate in this area. It is situated farther away from the fourth site[1].

Figure 4: The five site along the Tigris River.

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Sample Collection: The collection of plant samples began in the morning for the five sites. Samples were collected once a month, starting from **October 2022** until the end of **March 2023**. From each site, samples were collected from plants, their roots, and the mud sediments beneath and near aquatic plants. These samples were placed in sterilized polyethylene bags. The same collection point was used for each site, and the process was repeated for each season. Subsequently, the samples were transported to the laboratories of the College of Engineering at Tikrit University. There, tests were conducted to estimate the concentrations of heavy elements, specifically zinc, lead, and cadmium.

Estimation of Heavy Elements: The plant samples were digested to estimate element concentrations. Approximately **0.5 grams** of dry material were taken and placed in a beaker. Digestion was carried out by adding sulfuric acid, nitric acid, and perchloric acid in a ratio of 2:1:1 for a duration ranging from **2 to 4 hours**. The beakers were covered with watch glasses during this process. After digestion, the beakers and watch glasses were washed with deionized water and the samples were filtered. The volume was then adjusted to **50 milliliters** with deionized water. The concentrations of lead were estimated using an atomic absorption spectrophotometer and the standard curve for each element. The results were expressed in milligrams per kilogram of dry weight.

Statistical Analysis: The experimental data were analyzed using the **Genstat** program. The **Least Significant Difference (L.S.D.)** test was applied to compare means between different treatments (water lentil plant and reed plant) using a simple factorial experimental design. Additionally, the **Statistical Analysis System (SAS)** software was utilized for data analysis.

III. RESULTS AND DISCUSSION

The study results, as shown in Table 1, indicate that lead concentrations in the plants range from 0.010 to 0.312 milligrams per liter. The lowest values were recorded in March across all stations, while the highest value occurred in February for station 2. Statistical analysis reveals significant differences in monthly averages and station averages. The monthly means vary between 0.010 and 0.227 milligrams per liter, while the station averages range from 0.076 to 0.126 milligrams per liter.

Additionally, Table 2 highlights that lead levels in plant roots varied between 0.121 and 1.127 milligrams per liter. The highest values were observed in February for station 2, while the lowest values were recorded in March for the same station. Statistical analysis confirms significant differences in both months and stations. The monthly means fall between 0.169 and 1.067 milligrams per liter, while the station averages range from 0.502 to 0.713 milligrams per liter.

These values exceed the Iraqi standards for river and water pollution maintenance (set by Regulation No. 25 of 1967), which stipulates that lead levels in rivers should not exceed 0.1 milligrams per liter. Our current study results are higher than those reported by Mahmood and Saeed (2022), where lead concentration during their study was 0.134 milligrams per liter. However, they are lower than the extreme levels found by TAHER and SAEED (2021) and YONIS and SAEED (2023), where lead concentrations reached 384 milligrams per liter.

Table 1: Lead element concentrations (milligrams per liter) in the green parts of growing plants at the studied stations

Average of monthes	St5	St4	St3	St2	St1	Station / Month
0.047 b	0.020 i	0.020 i	0.093 f	0.056 g	0.046 h	October
0.227 a	0.198 d	0.228 c	0.135 e	0.312 a	0.262 b	November
0.010 c	0.010 j	0.010 j	0.010 j	0.010 j	0.010 j	December
	0.076 e	0.086 c	0.079 d	0.126 a	0.106 b	**Average of Stations**

Table 2: Lead element concentrations (milligrams per liter) in the root parts of growing plants at the studied stations[1].

Average of monthes	St5	St4	St3	St2	St1	Station Month
0.523 b	0.700 f	0.420 g	0.841 e	0.280 i	0.374 h	October
1.067 a	1.070 c	1.073 c	1.096 b	1.127 a	0.969 d	November
0.169 c	0.165 l	0.188 k	0.204 j	0.121 m	0.165 L	December
	0.645 b	0.560 c	0.713 a	0.510 d	0.502 e	**Average of Stations**

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