

# Absorption Capacity of Copper and Lead in the Case of *Phragmites Australis* Plant Species

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*The main objective of the current research is to determine the absorption capacity of heavy metals (copper and lead) in the case of Phragmites Australis plant species (root, stalk, leaf, flower). The plant samples were taken from the Moldova and Siret Rivers, belonging to the Siret hydrographic basin, respectively upstream of Roman city, Romania-Siret River; downstream Roman city-Moldova River; downstream confluence Moldova/Siret-Siret River and Dragesti-Siret River. A high absorption capacity of copper was recorded, in the case of Phragmites Australis plant species (especially in the root of the plant for all points analysed). A very higher absorption capacity of lead was recorded, in the flower, in the case of Phragmites Australis plant species (1.45÷39.56 mg/kg dry matter) for all points analysed.*

**Keywords:** copper, lead, absorption capacity, *Phragmites Australis*

The pollution of the environment with heavy metals is caused by the industrial activity, transports or by various other human activities. Pollutants analyzed in this paper belong to the category of persistent pollutants (they cannot be removed or destroyed from the matrices they contaminate), which leads to their bioaccumulation in the organism of plants and animals, creating risks for public health [1-19].

Some risk assessment procedures are based on calculations involving the distribution, transport and behavior of contaminants in the soil-plant system, including physico-chemical characteristics of the soil, to predict the bioavailability of contaminants for the cultivated plants [8, 9, 20-25].

The absorption of heavy metals at the root level is of two types [8, 9, 26-33]:

- passive - through the diffusion of ions from the soil solution into the root endoderm;
- active - it is realized at the expense of energy, against the concentration gradient.

Some authors argue that the absorption of chemical elements is controlled by processes inside the root, at a certain concentration generally distributed in soil solution. The main factors that influence the absorption process of the metals are represented by the activity of the ions in the solution and by the presence of some constituents of the soil, such as microorganisms, which by association with the roots produce organic compounds that facilitate the release of chemical elements in the soil [34-42].

This paper describes the absorption capacity of heavy metals (copper and lead) in the case of *Phragmites Australis* plant species (root, stalk, leaf, flower).

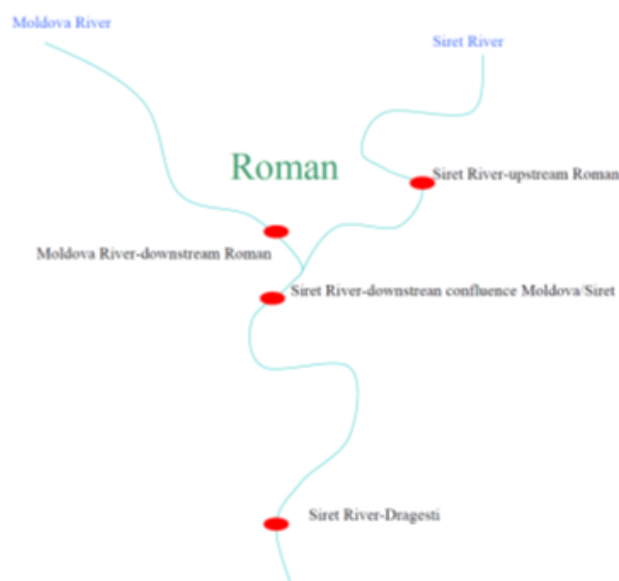


Fig. 1. Sections taken into consideration for taking samples of soil and plants along the Moldova and Siret Rivers [3]

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## Experimental part

Sections taken into consideration for taking samples of plants are presented in Figure 1. The sampling of vegetation was took from four locations/areas along the Moldova and Siret Rivers, belonging to the Siret hydrographic basin (upstream of Roman city, Romania-Siret River, downstream Roman city - Moldova River, downstream confluence Moldova/Siret- Siret River and Dragesti-Siret River) from the banks of the tributaries [3].

*Phragmites Australis* (common reed, Figure 2) is a perennial herbaceous plant from the Gramineae family (Poaceae), having a rigid stalk of about 1-4 m, green-bluish lanceolate leaves and flowers laid out in tassels and is a good accumulator of heavy metals and hydrocarbons [3].



Fig. 2. *Phragmites Australis* [3]

Plants samples were taken for three levels [3]:

- minimum level: soil-water interface level of 0 cm;
- medium level: soil-water interface level of 50 cm, on the river bank;
- maximum level: soil-water interface level of 100 cm, on the river bank.

The copper and lead content in the case of *Phragmites australis* plant species has been determined by using the atomic absorption spectrometer (AAS), ZEENIT AAS version (Figure 3) [3, 43].



Fig. 3. Atomic absorption spectrometer (AAS), Zeenit 700 version [3, 38]

## Results and discussions

Figure 4 represents graphically the absorption capacity of copper from the soil in the case of *Phragmites Australis*

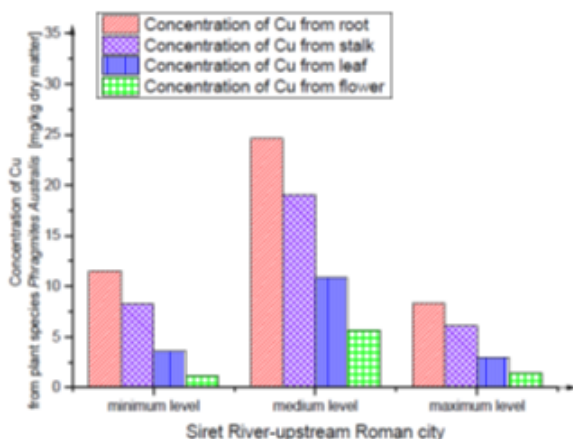


Fig. 4. The absorption capacity of copper from the soil in the case of *Phragmites Australis* plant species (root, stalk, leaf, flower) in the sampling point Siret River - upstream of Roman city

plant species (root, stalk, leaf, flower) in the sampling point Siret River - upstream of Roman city.

The highest absorption capacity of copper in the sampling point Siret River - upstream of Roman city, was detected in the root of *Phragmites Australis* plant species, and the lowest absorption capacity of copper was observed in the flower.

The percentage values of the copper concentration determined in the stem, leaf and flower compared with the root of the *Phragmites Australis* plant species for the sampling point Siret River - upstream of Roman city, was:

a - *stem* (for the minimum level of soil-water interface, it was 28.33 % lower than in the root of plant; for the medium level of soil-water interface, it was 22.75 % lower than in the root of plant and for the maximum level of soil-water interface, it was 26.73 % lower than in the root of plant);

b - *leaf* (for the minimum level of soil-water interface, it was 68.89 % lower than in the root of plant; for the medium level of soil-water interface, it was 55.86 % lower than in the root of plant and for the maximum level of soil-water interface, it was 64.74 % lower than in the root of plant);

c - *flower* (for the minimum level of soil-water interface, it was 89.77 % lower than in the root of plant; for the medium level of soil-water interface, it was 76.83 % lower than in the root of plant and for the maximum level of soil-water interface, it was 82.61 % lower than in the root of plant).

Figure 5 represents graphically the absorption capacity of lead from the soil in the case of *Phragmites Australis* plant species (root, stalk, leaf, flower) in the sampling point Siret River - upstream of Roman city.

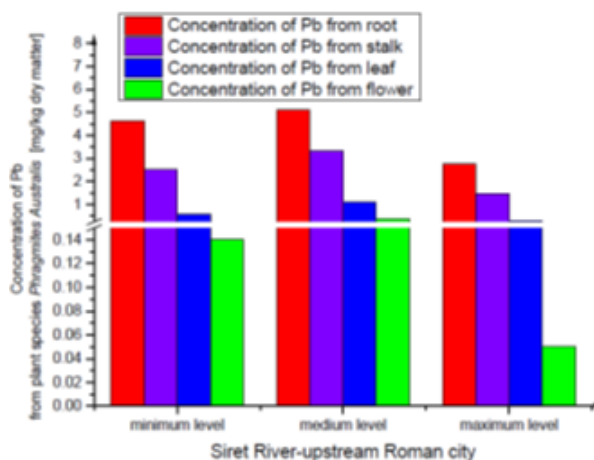


Fig. 5. The absorption capacity of lead from the soil in the case of *Phragmites Australis* plant species (root, stalk, leaf, flower) in the sampling point Siret River - upstream of Roman city

The percentage values of the lead concentration determined in the stem, leaf and flower compared with the root of the *Phragmites Australis* plant species for the sampling point Siret River - upstream of Roman city, was:

a - *stem* (for the minimum level of soil-water interface, it was 54.19 % of concentration from the root of plant; for the medium level of soil-water interface, it was 65.36 % of concentration from the root of plant and for the maximum level of soil-water interface, it was 52.72 % of concentration from the root of plant);

b - *leaf* (for the minimum level of soil-water interface, it was 12.68 % of concentration from the root of plant; for the medium level of soil-water interface, it was 21.91 % of concentration from the root of plant and for the maximum level of soil-water interface, it was 10.18 % of concentration from the root of plant);

**Table 1**  
THE EXPERIMENTAL VALUES DETERMINED FOR ABSORPTION CAPACITY OF COPPER AND LEAD FROM THE SOIL IN THE CASE OF *PHRAGMITES AUSTRALIS* PLANT SPECIES (ROOT, STALK, LEAF, FLOWER) IN THE SAMPLING POINT DOWNSTREAM MOLDOVA RIVER- ROMAN CITY

Location	Level	Cu [mg/kg dry matter]				Pb [mg/kg dry matter]			
		Root	Stalk	Leaf	Flower	Root	Stalk	Leaf	Flower
downstream Moldova River- Roman city	minimum level of soil-water interface (0 cm)	20.93	15.17	8.99	5.87	30.16	22.41	5.9	4.56
	medium level of soil-water interface (50 cm)	23.4	18.53	11.25	7.64	14.21	9.25	5.27	3.14
	maximum level of soil-water interface (100 cm)	25.29	21.49	14.34	8.25	22.45	13.84	8.19	6.41

c -flower (for the minimum level of soil-water interface, it was 3.01 % of concentration from the root of plant; for the medium level of soil-water interface, it was 7.43 % of concentration from the root of plant and for the maximum level of soil-water interface, it was 1.81 % of concentration from the root of plant).

Table 1 present the experimental values determined for absorption capacity of copper and lead from the soil in the case of *Phragmites Australis* plant species (root, stalk, leaf, flower) in the sampling point downstream Moldova River-Roman city.

The highest absorption capacity of copper from the soil, in downstream Moldova River- Roman city, was detected in the root of *Phragmites Australis* plant species (for the minimum level of soil-water interface, it was 356.55 % higher than in the flower of plant), whereas the lowest absorption capacity levels of copper were observed in its leaf and flower.

The highest absorption capacity of lead from the soil, in downstream Moldova River- Roman city, was detected in the root of *Phragmites Australis* plant species (for the minimum level of soil-water interface, it was 456 % higher than in the flower of plant), whereas the lowest absorption capacity levels of lead were observed in its leaf and flower.

Figure 6 represents graphically the absorption capacity of copper from the soil in the case of *Phragmites Australis* plant species (root, stalk, leaf, flower) in the sampling point Siret River - downstream confluence Moldova/Siret.

The percentage values of the copper concentration determined in the stem, leaf and flower compared with the root of the *Phragmites Australis* plant species for the sampling point Siret River - downstream confluence Moldova/Siret, was:

a - steam (for the minimum level of soil-water interface, it was 24.87 % lower than in the root of plant; for the medium level of soil-water interface, it was 35.63 % lower than in the root of plant and for the maximum level of soil-

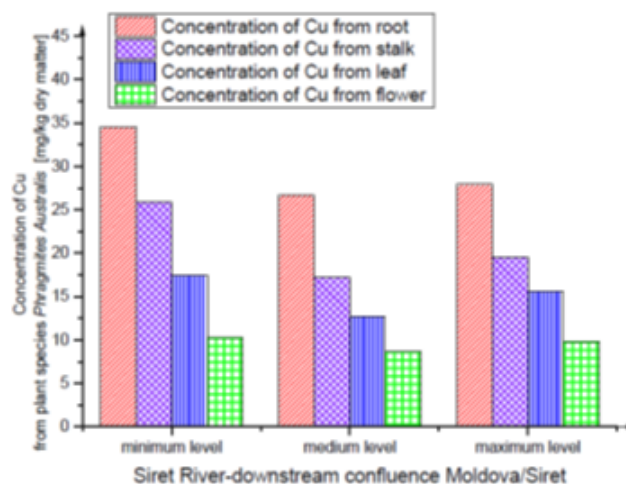


Fig. 6. The absorption capacity of copper from the soil in the case of *Phragmites Australis* plant species (root, stalk, leaf, flower) in the sampling point Siret River - downstream confluence Moldova/Siret

water interface, it was 30.05 % lower than in the root of plant);

b -leaf (for the minimum level of soil-water interface, it was 49.37 % lower than in the root of plant; for the medium level of soil-water interface, it was 52.58 % lower than in the root of plant and for the maximum level of soil-water interface, it was 44.23 % lower than in the root of plant);

c -flower (for the minimum level of soil-water interface, it was 70.19 % lower than in the root of plant; for the medium level of soil-water interface, it was 67.42 % lower than in the root of plant and for the maximum level of soil-water interface, it was 64.68 % lower than in the root of plant).

The percentage values of the lead concentration determined in the stem, leaf and flower compared with the root of the *Phragmites Australis* plant species for the

**Table 2**  
THE EXPERIMENTAL VALUES DETERMINED FOR ABSORPTION CAPACITY OF COPPER AND LEAD FROM THE SOIL IN THE CASE OF *PHRAGMITES AUSTRALIS* PLANT SPECIES (ROOT, STALK, LEAF, FLOWER) IN THE SAMPLING POINT SIRET RIVER DRAGESTI

Location	Level	Cu [mg/kg dry matter]				Pb [mg/kg dry matter]			
		Root	Stalk	Leaf	Flower	Root	Stalk	Leaf	Flower
downstream Moldova River- Roman city	minimum level of soil-water interface (0 cm)	19.23	15.32	8.95	2.7	7.49	2.91	1.09	0.25
	medium level of soil-water interface (50 cm)	22.46	18.69	10.36	3.29	6.24	2.13	0.82	0.11
	maximum level of soil-water interface (100 cm)	21.95	18.25	9.45	3.12	5.57	1.95	0.46	0.09



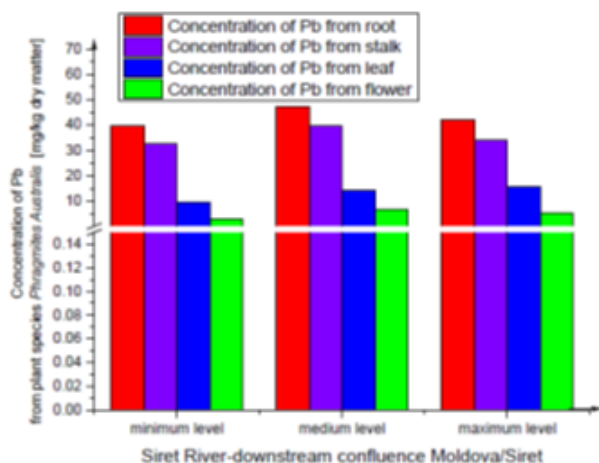


Fig. 7. The absorption capacity of lead from the soil in the case of *Phragmites Australis* plant species (root, stalk, leaf, flower) in the sampling point Siret River - downstream confluence Moldova/Siret

sampling point Siret River - downstream confluence Moldova/Siret, was (Figure 7):

a - *stem* (for the minimum level of soil-water interface, it was 82.64 % of concentration from the root of plant; for the medium level of soil-water interface, it was 83.72 % of concentration from the root of plant and for the maximum level of soil-water interface, it was 80.57 % of concentration from the root of plant);

b - *leaf* (for the minimum level of soil-water interface, it was 24.26 % of concentration from the root of plant; for the medium level of soil-water interface, it was 30.34 % of concentration from the root of plant and for the maximum level of soil-water interface, it was 37.14 % of concentration from the root of plant);

c - *flower* (for the minimum level of soil-water interface, it was 8.13 % of concentration from the root of plant; for the medium level of soil-water interface, it was 14.49 % of concentration from the root of plant and for the maximum level of soil-water interface, it was 12.64 % of concentration from the root of plant).

Table 2 present the experimental values determined for absorption capacity of copper and lead from the soil in the case of *Phragmites Australis* plant species (root, stalk, leaf, flower) in the sampling point Siret River Dragesti.

The highest absorption capacity of copper from the soil, in downstream Siret River - Dragesti, was detected in the root of *Phragmites Australis* plant species (for the minimum level of soil-water interface, it was 712.22 % higher than in the flower of plant), whereas the lowest absorption capacity levels of copper were observed in its leaf and flower.

The highest absorption capacity of lead from the soil, in downstream Siret River - Dragesti, was detected in the root of *Phragmites Australis* plant species (for the maximum level of soil-water interface, it was 6188.88 % higher than in the flower of plant), whereas the lowest absorption capacity levels of lead were observed in its leaf and flower.

## Conclusions

The highest absorption capacity of copper from the soil, in all points analyzed, was detected in the root of *Phragmites Australis* plant species (8.34 ÷ 34.53 mg/kg dry matter), whereas the lowest absorption capacity levels of copper were observed in its leaf and flower.

In case of lead the highest absorption capacity from the soil, in all points analyzed, was detected in the root of *Phragmites Australis* plant species (2.75 ÷ 47.25 mg/kg dry matter).

Comparing the absorption capacity of metals from the soil in the case of *Phragmites Australis* plant species it was observed that it is a very good accumulator of copper and lead in the root of the plant.

*Phragmites Australis* plant species proved to be a very good accumulators of metals, especially in their roots, a fact which shows that they can be used in soil phyto-remediation processes, particularly in continuous phyto-extraction and induced phyto-extraction processes for the removal of heavy metals from contaminated soils.

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