EVALUATION OF ECOTOXIC EFFECTS OF TRACE ELEMENT CONTAMINATION IN SOILS

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Capsule: heavy-metal contaminated soil samples were collected to perform standard chemical soil analyses and ecotoxicological tests. The results were compared to the physiological parameters of plants grown on the same media under laboratory conditions.

1. Introduction

Symptoms of the toxicity and the stress caused by heavy metals on plants can be measured by several methods. Estimations can also be made on the possible effects of the contaminated soil on other organisms of the ecosystem by using ecotoxicological methods. This latter is gaining an increasing importance as there is a growing number of reports suggesting that the effects of contaminants are much more complicated than a dose–response relationship and that they might be predicted by using ecotoxicological and plant phytotoxicity tests. The comparison of these two methods can offer a comprehensive investigation on the toxic effects of trace metals in soils.

2. Sampling area

Heavy-metal contaminated soil samples were collected from Gyöngyösoroszi (*Figure 1)* to perform standard ecotoxicological tests that were compared to the physiological parameters of cucumber (*Cucumis sativus*) and wheat (*Triticum aestivum*).

Figure 1. The severe heavy metal contamination in Gyöngyösoroszi is caused by the abandoned ore mine situated upstream that was closed down without proper remediation measures. Soil samples were collected from an area regularly flooded by the Toka-creek (flowing next to the line of trees).

3. Results

3.1. Soil sampling and analyses

Element (mg/kg soil)	Sample 1			Sample 2			Sample 3		
	total	bioav.	dist. water	total	bioav.	dist. water	total	bioav.	dist. water
Pb	409	160,0	n.d.	652	220,0	n.d.	590	232,0	n.d.
Cu	203	53,3	n.d.	133	42,9	n.d.	183	59,7	n.d.
Zn	1520	351,0	0,065	2740	555,0	0,455	2320	536,0	0,195
Cd	7,4	4,9	n.d.	10,6	4,8	n.d.	10,2	6,1	n.d.
As	80	0,6	n.d.	119	0,5	n.d.	122	0,5	n.d.
Al	30300	86,7	n.d.	25500	97,4	n.d.	29400	95,3	n.d.

Table 1. – In this table only those elements are shown that are above the guidelines for total element content (total) (Dutch list version "C", 1992). For bioavailable faction (bioav.) there are no standardised guidelines. The distilled water (dist. water) extract was used for the ecotoxicological tests. Comparison between the samples was possible as pH, humus ad clay contents etc. were similar.

3.3. Ecotoxicological tests

Growth inhibition tests were performed using white mustard (*Sinapis alba*) seeds. Microbiological tests were carried out using *Azotobacter agile* and *Pseudomonas fluorescence* and measuring the dehydrogenase activity. All tests were performed using the distilled water extract and were carried out following the instruction of the current Hungarian Standards.

The extract of soil samples did not cause inhibition of growth of white mustard sprouts in contrast, enhancement was apparent inn several cases. The extract did not inhibit bacterial growth in either of the microbiological tests. Therefore, according to these test alone, the used soil samples could be considered as non-toxic.

3.2. Plants grown in soil

Figure 2. – Cucumber plants were grown in the collected soil samples under standard laboratory conditions. Control plants are in pot No.4.

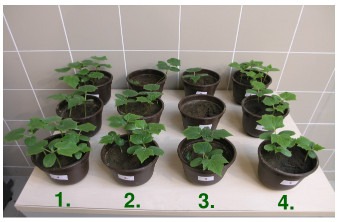
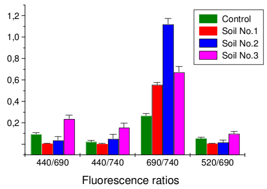


Figure 3. The results of the fluorescence imaging of cucumber leaves shows that the red/far red fluorescence ratio (F690/740), increased significantly in all cases inversely indicating a lowered chlorophyll-a content.



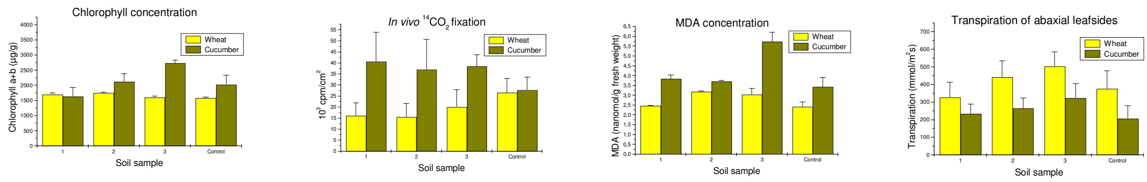


Figure 4. – Physiological parameters of wheat and cucumber plants. Oxydative stress is apparent by a higher level of malon-dialdehyd (MDA) in certain groups. Elevated transpiration can be caused by metals. Higher level of CO_2 fixation in cucumber as compared to control needs to be re-investigated.

4. Conclusions

- Based on the results of the ecotoxicological tests we have found the predicted ecological risk lower than expected on the basis of the plant physiological parameters. This might be explained by the different concentration that species encounter in the extract and in the soil itself.

- Physiological tests conducted on plants have shown to be more sensitive than ecotoxicological ones as measurements have indicated stress symptoms in the case of certain groups (Sample No. 3 of MDA for cucumber and No 2 and 3 for wheat; all treatments on wheat for CO_2 fixation; all groups by fluorescence imaging, etc.)

- Enzymatic measurements (such as MDA) and fluorescence imaging can offer a simple and easily comparable method in the forthcoming experiments.

- The findings of this research can be refined further by testing other species (tests on pigweed (*Amaranthus retroflexus*) are currently carried out) and other parameters for plants (e.g. enzymatic responses) and other ecotoxicological methods (e.g. Microtox) that could allow a comprehensive statistical analyses as well.

- The investigations on the effective metal concentration of plants (in progress) can also add important information.