FUNCTIONALITY VERIFICATION OF DATA OBTAINED IN THE GREEN HOUSE ON AN ARTIFICIAL POLLUTED SOIL WITH LEAD

VERIFICAREA FUNCŢIONALITĂŢII DATELOR OBŢINUTE ÎN HALA MODELE SOL PE UN SOL POLUAT ARTIFICIAL CU PLUMB

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Abstract. *Phytoextraction is a technique to remove the heavy metals from soil by direct absorption in plant tissues. The implementation of a phytoextraction plans supose one or more plants cultivation as contaminant hyperaccumulators. Specific conditions for the application of the phytoextraction plan in a polluted area reports to improvements, vegetation period, pollution degree etc. This paper presents the effects of ethylenediaminetetraacetic acid (EDTA) application as a potential improvement in an artificial polluted soil with lead (Pb) to increase the translocation capacity in vegetal part of maize in two vegetation cycles.*

Keywords: pollution, heavy metals, EDTA

***Rezumat**. Fitoextracţia este o tehnică de îndepărtare a metalelor grele din sol prin absorbţie directă în ţesuturile plantei. Implementarea unui program de fitoextracţie presupune cultivarea uneia sau mai multor specii de plante care sunt hiperacumulatori de contaminanţi. Condiţii specifice pentru aplicarea programului de fitoextracţie pentru un anumit sit poluat se referă la amendamente, perioada de vegetaţie, gradul de poluare, etc. Lucrarea prezintă efectele aplicării acidului etilen diamin tetraacetic (EDTA) ca potenţial amendament pe un sol contaminat artificial cu Pb în scopul creşterii capacităţii de translocare în partea vegetală a porumbului pe doua cicluri de vegetatie.*

Cuvinte cheie: poluare, metale grele, EDTA

INTRODUCTION

Large areas of agricultural lands from Romania are contaminated with heavy metals provided, especially, by industrial emissions.

Studying the available specialty literature, it is obviously that phytoremediation could restore the balance in the stressed environment, with carefully proceeding in its application as remediation technique of heavy metal polluted soil.

In case of some pollutant metals as lead, phytoextraction could be improved by using chemical compounds with chelating properties in the presence of these metals.

Data from literature shows that ethylenediaminetetraacetic acid (EDTA) and nitrilotriacetic acid (NTA) are the most studied chelating agents.

MATERIAL AND METHODS

The present study is about the evaluation of efficiency of lead transfer from polluted soil in plant by verifying the functionality of the obtained data in laboratory experiment achieved in Green House, on two crop cycles.

The soil used in the experiment was sampled from the contaminated area Neferal – Acumulatorul.

To set up the experiment, the soil sampled from surface (0-20 cm) was homogenized and dried at air temperature.

The plant used in the experiment was maize.

The treatment with EDTA was: 0-2,7 mmol EDTA kg^{-1} soil and was applied before seedling, in the beginning of the experiment (first cycle).

The experiment period of time was eight weeks for each cycle (first cycle, second cycle).

The values of chemical characteristics of soil were determined by analyzing three repetitions (n=3).

In table 1 and 2 are presented chemical and physical characteristics.

The experimental variants are:

- ✓ V2 – control (untreated soil);
- ✓ V3 – soil treated with 0.1 mmol EDTA$\cdot kg^{-1}$;
- ✓ V4 – soil treated with 0.54 mmol EDTA$\cdot kg^{-1}$;
- ✓ V5 – soil treated with mmol EDTA$\cdot kg^{-1}$;
- ✓ V6 – soil treated with 1.08 mmol EDTA$\cdot kg^{-1}$;
- ✓ V7 – soil treated with 1.35 mmol EDTA$\cdot kg^{-1}$;
- ✓ V8 – soil treated with 2.7 mmol EDTA$\cdot kg^{-1}$.

Table 2

Physical characteristics of soil (n=3)

Soil texture	Mean
Coarse sand (2,0 – 0,2 mm) (%g/g)	0,8
Fine sand (0,2 – 0,02 mm) (%g/g)	33,7
Dust (0,02 – 0,002 mm) (%g/g)	33,5
Clay (<0,002 mm) (%g/g)	32,0

Each treatment was applied in three repetitions. Experimental variant CONTROL was soil without EDTA treatment.

After each cycle of vegetation was sampled vegetal plant, weighted and chemically analyzed to determine the accumulation of lead.

Table 1

Chemical characteristics of soil (n=3)

	pH (H_2O)	**C,%**	**H %**	**Nt, %**	**Pb mg kg^{-1}**	**SB me/100g soil**	**Ah me/100g soil**	**T SB+Ah ml/100 g soil**	**V %**
$\bar{x}$	5,70	1,24	2,13	0,158	573	18,53	5,03	23,57	78,6
SD	0,018	0,0081	0,0129	0,002	9,62	0,3935	0,0898	0,4592	0,7483
CV %	0,315	0,653	0,605	1,51	1,67	2,12	1,78	1,94	0,95
S_E	0,0104	0,0046	0,0074	0,0013	5,56	0,2274	0,0519	0,2654	0,4325

$\bar{x}$ – Media; SD – Standard deviation; CV – Coefficient of variation; S_E –Standard error.

RESULTS AND DISCUSSIONS

From lead content point of view, the soil used in experiment was very polluted with lead – 573 mg kg^{-1} (maximum allowable limit – Kloke, 1980).

According to the Order no. 756/1997 concerning soil pollution, lead exceeds Alert threshold for all using types (50 mg·kg^{-1}, 250 mg·kg^{-1}) and Intervention threshold for the sensitive using (100 mg·kg^{-1}).

First cycle represents the direct effect of EDTA treatment, and the second cycle represents the remanent effect of the treatment considering that in the second cycle, the seedling was effectuated after a period of time to reach a chemical equilibrium in soil.

Figure 1 shows the EDTA effect on biomass of maize leaves (first and second harvest – remanent effect). From statistical interpretation (Student test) of the obtained data resulted that the biomass had a significant decrease in both cycles dependent on treatment.

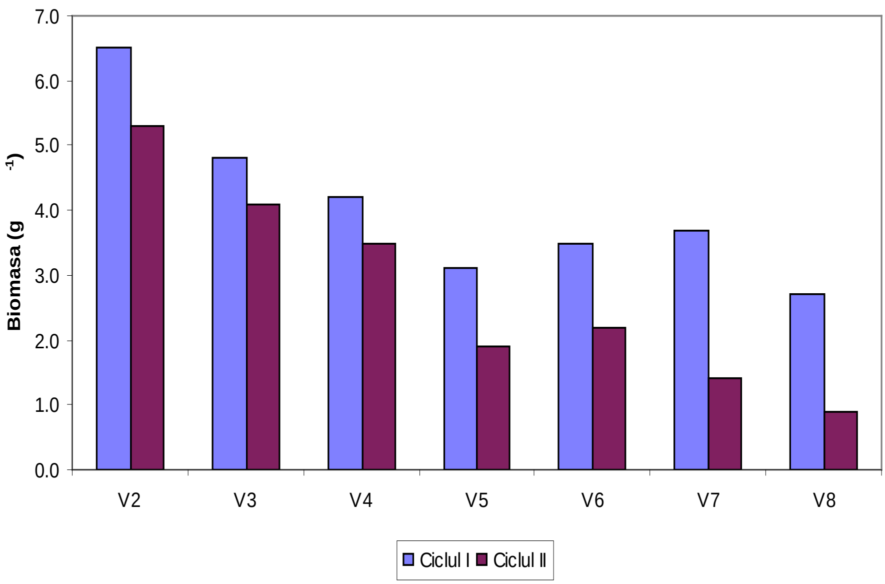

Fig. 1. The effect of EDTA application on biomass (maize) – First and Second Cycle (remanent effect)

Considering the concentration of lead in maize leaves (Fig. 2), were registered normal contents. From statistical interpretation (Student test) of the obtained data resulted that the values had a significant increase proportionally with EDTA content.

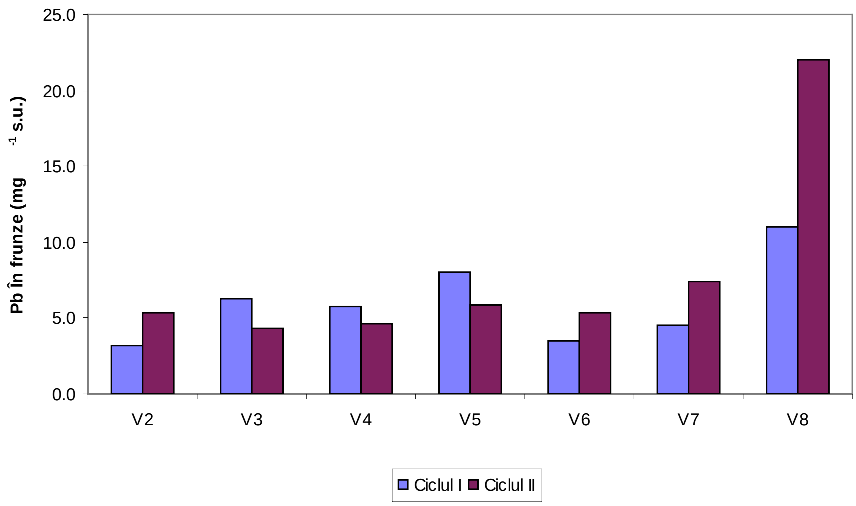

Fig. 2. The effect of EDTA application on Pb concentration in maize leaves – First and Second Cycle (remanent effect)

Regarding remanent effect (Second cycle) of lead content and EDTA treatment on soil reaction, this is presented in Table 3.

Table 3

The effect of EDTA application on soil reaction – Second cycle

Treatment	**pH_{H2O}**	**Significance**
V2 – Soil* + 0 mmol EDTA·kg^{-1}	5,47	
V3 – Soil* + 0.1 mmol EDTA·kg^{-1}	5,41	0
V4 – Soil* + 0.54 mmol EDTA·kg^{-1}	5,42	0
V5 – Soil* + 0.81 mmol EDTA·kg^{-1}	5,39	00
V6 – Soil* + 1.08 mmol EDTA·kg^{-1}	5,38	000
V7 – Soil* + 1.35 mmol EDTA·kg^{-1}	5,35	000
V8 – Soil* + 2.7 mmol EDTA·kg^{-1}	5,32	000
LD 5%	0,048	
LD 1%	0,067	
LD 0.1%	0,093	

* remanent effect
LD – Limit Difference

Comparing with control V2, the pH value had a significant decrease for the first two variants (V3 and V4), a distinct significant decrease for the experimental variant V5 with the treatment 0.81 mmol EDTA kg^{-1} and a strong significant decrease starting with variant V6 (polluted soil (remanent effect) + 1.08 mmol EDTA kg^{-1}).

By EDTA application (remanent effect), can be observed the acidification tendency of soil explainable considering that EDTA is an acid.

Statistical data were calculated by comparison with experimental variant V2, as CONTROL (Student test).

CONCLUSIONS

– Statistical data shows significant differences between experimental variants regarding the biomass of maize and lead accumulation in vegetal part according to the applied treatment.

– High EDTA concentrations have negative effects on maize plants and determine changes in soil acidity. To accomplish the conditions of high biomass and high translocation of lead in plants, are not allowed doses higher than 0,54 mmol EDTA kg^{-1} at different rate.

– The ratio between soil and chelating agent depends on contamination degree of soil. A higher pollution of soil with heavy metals requires a higher quantity of EDTA to mobilize the lead.

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