ZINC EXTRACTION FROM POLLUTED SOILS BY USING ZEOLITE AND VICIA SATIVA PLANT

Smaranda Masu1, Benoni Lixandru2, Corneliu Bogatu1

1National R & D Institute for Industrial Ecology – ECOIND, Timisoara,, Romania

2Banat University of Agricultural Sciences and Vetereniray Medicine – USAMVB, Timişoara, Romania

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Introduction

- Uptake of metals by plants from polluted soils is a complex process, which is influenced of different factors, like the comportment of nutritive solutions from soil matrix, tolerance and bioavailability of plants for some metals.

- Assessment studies were realized concerning metals mobility in soils, depending on clay, sand, organic matter content, and the presence of iron and manganese oxyhydroxides

- Some studies showed that bioaccumulation degree of metals from soil in different parts of plants, ranged between tens up to thousands of ppm, and this imply the assessment of risk due to these plants consumption. In the same time, there is need for in-situ remediation possiblitlities of polluted soils by phytoextractive processes, via soil-plant chain.

Introduction

- In the last years, the principal concern was to evaluate the ability of some materials for immobilization of metal species from soil, in order to decrease their bioavailability.

- These materials may include the use of composts, manure, biosolides, different inorganic materials like alkaline agents as are lime and beringite, phosphatic rocks, calys and zeolites. The using of these materials in agricultural management applied to soils polluted with heavy metals, decreases their bioavailability for cultivated plants.

- Because Vicia Sativa plant has the natural property for zinc bioaccumulation, in this paper it was analysed biological answer of this species cultivated on to soils polluted with high zinc content.

Materials and Methods

- Phytoextraction processes were searched taking into account of zinc bioaccumulation in aerial parts of plant, in interrelation with organic (manure) and inorganic (NPK) fertilizers, and also with application of native volcanic tuff containing 70 % clinoptilolite, as soil amendment.

- Investigations were realized onto nine parcels settled in an experimental block, with three modules:

- module M1 with soil parcels as blank samples;
- module M2 containing parcels of soil polluted with zinc;
- module M3 containing parcels of soil polluted with zinc, and treated with volcanic tuff, 4.8 t/ha.

Materials and Methods

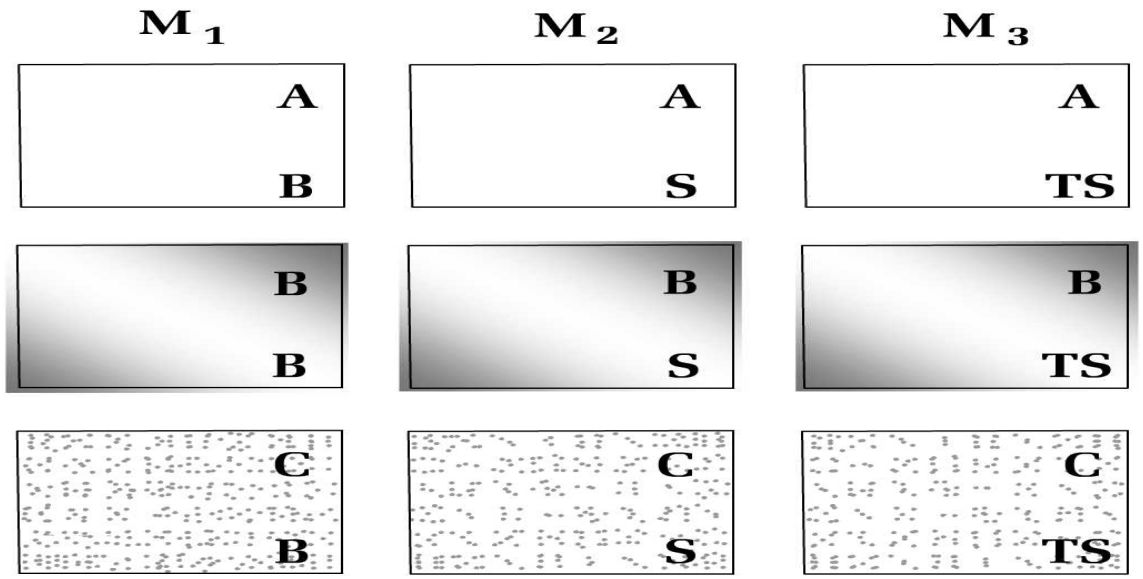
- In every module were three variants:
- A – non-fertilized parcels;
- B - fertilized parcels, with fermented manure (40 t/ha**);**
- C – parcels containing inorganic complex fertilizer, 15N :15P:15K (400 Kg/ha), fig. 1;
- Every experimental parcel had area of 11.2 m2.

- Amendment consisting of volcanic tuff was incorporated into soil up to 20 cm deep. A period of three months was used, for geostabilization of soil.

- Sampling was performed monthly from leaves, during 4 months, and metals concentrations were determined by using of an Atomic Absorption Spectrophotometer, Varian type.

Materials and Methods

Fig. 1. Letters from upper side: A – non-fertilized parcels; B - fertilized parcels with fermented manure (40 t/ha**);** C – parcels containing inorganic complex fertilizer, 15N :15P:15K (400 Kg/ha).



Letters from downside: B – blank samples; S – samples polluted with Zn; TS –samples polluted with Zn, and containing volcanic tuff.

Results and Discussion

The concentrations of chrome, copper, nickel, lead and zinc from parcels of experimental block are presented comparatively with allowable values for non-polluted soils, mg/kg d.s., in brackets, in table 1.

Table 1

Experiment	Cr (30)	Cu (20)	Ni (20)	Pb (20)	Zn (100)
A - M1	4.9	30.1	28.3	23.3	49.5
B - M1	6.3	27.3	25.5	21.9	61.5
C - M1	7.4	28.6	26.2	19.8	62
A - M2	3.8	31.2	28.7	22.0	**795.5**
B - M2	4.8	27.5	25.1	22.0	**721.8**
C - M2	8.0	35.5	28.8	25.0	**802**
A - M3	2.4	32.2	25.5	22.0	**753.1**
B - M3	6.0	30.7	26.3	25.0	**760.2**
C - M3	8.1	30.8	26.3	23	**788.9**

Results and Discussion

- With exception of chrome, for which values from soil are smaller of about 4-12 times then allowable values for non – polluted soils, in case of copper and nickel are recorded greater values, of about 1.3-1.8 times. For lead, soil of experimental parcels presented concentrations closed or somewhat increased, comparatively with allowable values.

- In case of zinc, parcels from module M1 had a content of 49.5 mg/Kg d.s. at variant A, 61.5 mg/Kg d.s variant B, and 62 mg/Kg d.s in variant C.

- Experimental parcels from modules M2 and M3 were polluted with zinc salts, and after three months of geochemical stabilization, mean concentration of zinc from soil was greater then variants of blank module (M1), of about 13.4 times for M2 and 13.3 times for M3.

Results and Discussion

In table 2 is presented monthly bioaccumulation process of zinc in leaves of Vicia sativa, during four months of germination.

Table 2

Experiment	1 month	2 month	3 month	4 month
A - M1	41.16	42.59	69.5	67.0
B - M1	29.14	28.7	37.28	32.18
C - M1	22.15	35.7	64.14	75.38
A - M2	77.5	74.42	113.85	175.25
B - M2	122.4	136.1	127.57	91.03
C - M2	75.64	153.4	212.19	175.9
A - M3	37.29	113.49	97.5	213.78
B - M3	64.47	108.3	70.63	98.5
C - M3	41.6	84.5	126.55	96.6

Results and Discussion

- Phytoextraction process becomes significantly slower in the presence of manure (40 t/h), comparatively with chemical fertilizer as NPK (400 Kg/ha).

- This influence was recorded in the case of all experimental modules, regardless of vegetation period, and is more intense for modules M1 and M2, where soil did not contained volcanic zeolites.

- Zinc bioaccumulation degree is 1.9-2.2 times smaller in variants B, fertilized with manure, then in variants A, for module M1.

Results and Discussion

- When inorganic fertilizer like NPK was used, the phytoextraction process of zinc due to Vicia sativa was not influenced; it was similar with blank variants (75.38 mg/kg d.s., comparatively with 67 mg/kg d.s. at module M1, and 175.9 mg/kg d.s., comparatively with 175.25 mg/kg d.s, at module M2).

- The using of pillared zeolites as amendment, changed zinc bioavailability from polluted soil, by decreasing the absorption efficiency. It appears that between natural zeolites and inoganic fertilizer NPK a synergic effect was produced, that reduce of zinc phytoextraction.

Results and Discussion

- This phenomenon is not evident in the case of variants B, fertilized with manure. It appears that in the case of variants B, decreasing of phytoextraction yields is due to the presence of manure, and in small extent of volcanic tuff.

- Pillared zeolites used in combination with organic and inorganic fertilizers, decreased zinc bioavailability from soil with about 24.1 - 50.7%. This effect is maintained a longer period, in case of inorganic fertilizers.

Results and Discussion

Table 3. The efficiency of Zn phytoextraction due to volcanic zeolites, introduced in polluted soil.

Experiment	1 months	2 months	3 months	4 months
A	51.8	-	14.5	-
B	47.3	24.1	44.6	-
C	42.2	44.9	40.3	50.7

Conclusions

- Vicia sativa species has affinity for zinc ion present naturally in soil. The use of organic fertilizer (manure) decreases efficiency of phytoextraction process with about 50%. Zinc presence into a polluted soil containing about 700-800 mgZn /kg d.s., determines increasing of bioavailability degree in plants, up to 2-3 times.

- Addition of nutrients influences zinc accumulation in plants, increasing somewhat adsorption efficiency. Pillared zeolites used in combination with organic and inorganic fertilizers decrease zinc bioavailability efficiency from soil with about 24.1 - 50.7%, and effect is maintained a longer period, in case of inorganic fertilizers.