METALS EXTRACTION FROM POLLUTED SOILS BY USING OF PILLARED ZEOLITE AND VICIA SATIVA

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ABSTRACT

In phytoremediation process of soils polluted with heavy metals, the use of amendment with different types of fertilizers and biosolids, will increase process efficiency. Using of fertilizers assure nutrients for plants, and increases the access of metals to their aerial parts, and bioaccumulation above allowable limits.
Amendement consisting of native volcanic tuff, with high clinoptilolit content, modified by supporting with Al_{13} polimers, decreased zinc bioavailability about 1.4 – 2.1 times and that of cadmium 1.4-3.8 times, in aerial parts of Vicia sativa plant, in first weeks of vegetation. Using of pillared zeolite produced advanced decreasing of cadmium access in Vicia sativa roots, and as a consequence a decreasing in aerial parts of plant during advanced vegetation period.

INTRODUCTION

Phytoextraction of heavy metals from polluted soils can be applied by the properly use of agricultural services, soil fertilizers and amendments.
Remediation involving the use of hyperaccumulation plants for contaminated soils is a process that can be considered as a part of natural remediation, and play an important part in the restoration of the physical, chemical and biological properties of soils [1,2]

Pollutants with moderate and low solubilities, such as heavy metals usually require the presence of "scavenger" materials for the control of bioavailability. The efficiency of bioavailability decreasing, depends mainly of soil and metal characteristics (e.g. species, solubility, etc), soil chemistry and processing conditions [3-6]. Long time monitoring is a necessity, since there must be no risk for human, animals and environment health. The parameters of remediation process must be monitored and the frequency and location of data collection established, in order to evaluate plants using as natural accumulators.

MATERIALS and METHODS

In this paper hyperaccumulation of metals from polluted soils into Vicia sativa plant, was analysed. Phytoextraction processes were studied taking in account of Zn and Cd accumulation in shoots and roots of *Vicia sativa* in interaction with biosolid fertilizers and with amendment of pillared zeolite, consisting of volcanic tuff and polimer species of Al_{13}. Investigations were realized on two experimental modules: A - nonfertilized parcels, and B - fertilized parcels with biosolids. Every module had three parcels (table 1): 1N - nonpolluted soil, 2P - polluted soil with Cd, Zn, 3P+T - polluted and amended soil with 4.8 t/ha. Tuff-Al_{13} was incorporated into soil up to 20 cm deep. Parcels had the same area, 11 m^2. Experimental parcels 3P+T were polluted with zinc and cadmium salts, and after three months were amended with pillared zeolite. The module A was considered as blank sample, and module B was fertilized with biosolids, 40 t/ha d.s. Zinc and camium chloride solutions were used to prepare polluted parcels.

Sampling was performed and metals concentration determinated by using an atomic absorption spectrofotometer, Varian type.

RESULTS

In table 1, are presented metal concentrations in the two modules, for every parcels, during experiments undertaken. In case of zinc were recorded greater concentrations then allowable values for non-polluted soils, of about 25-28 times and for cadmium of about 5-10 times.

Tabel 1 Metals concentration from soils experimental parcels

Experimental modules and variants		Metal concentrations mg/kg d.s.			
Module	Parcels	Cadmium	Manganese	Lead	Zinc
A Blank module	1N	-	445.9	19.8	62.0
	2P	7.8	477.0	23.0	2826
	3P+T	6.9	456.4	22.0	2535
B Module fertilized with biosolid	1N	0.05	438.2	21.0	75.3
	2P	9.1	445.8	22.0	2850
	3P+T	6.26	458.1	25.0	2800

In the beginning, cadmium was absent from soil, but after its introduction in soil were determined 7.8 mg/kg d.s. Quantity of cadmium accumulated from soil in plants shoots reached 2.47 mg/kg d.s.

In table 2 is presented bioaccumulation process of Zn and Cd in aerial parts of *Vicia Sativa*. Plants cultivated on polluted and non-fertilized parcels, accumulated about 6.5 times zinc from soil, then content from plants cultivated on non-polluted parcels.

Adding of fertilizer, determined an increase of zinc concentration from plant tissues, up to 650 mg/kg d.s. comparatively with 73.0 mg/kg d.s. in case of non-polluted but fertilized parcel. The increasing of zinc concentration accumulated in tissues, took place by competition with other ions from soil matrix, whose availability will be restrictive, as is the case of cadmium. Accumulation of cadmium form polluted soil in aerial parts of plants decreased of about 2.6 times, after fertilizer adding.

Amendment adding, produced a decrease of zinc and cadmium bioaccumulation from polluted parcels, up to 1.4-1.5 times, module A. In case of amendment of fertilized

polluted parcels, bioavailability of zinc and cadmium decreased of 2.7 times and 3.7 times, respectively.

Table 2 Metals concentration in shoots and roots of *Vicia sativa* plant.

Experiments		Part of *Vicia sativa* plant	Metal concentration mg/kg d.s.		Observations
Modules	Parcels		Cd	Zn	
A Blank module	1N	Shoots	-	69.5	Normal accumulation
	2P		2.47	447.3	Hyperacumulation
	3P+T		1.76	297.5	Reduced hyperaccumulation
B Module fertilized with biosolid	1N	Shoots	-	73.0	Normal accumulation
	2P		0.93	650.0	Hyperacumulation
	3P+T		0.25	307.0	Reduced hyperaccumulation
B Module fertilized with biosolid	1N	Roots	-	85.7	Normal accumulation
	2P		1.25	230.1	Hyperacumulation
	3P+T		0.05	196.5	Reduced hyperaccumulation

Quantity of metals from roots at the moment of analysis, was smaller then in aerial parts; roots are transport way of metals to aerial parts of plants, where accumulation took place in a greater extent.

CONCLUSIONS

Adding of amendment to polluted and non-fertilized soil, decreased zinc and cadmium concentrations in aerial parts of plants up to 1.4-1.5 times.
The bioaccumulation degree of metals was greater in aerial parts of plants cultivated on polluted and fertilized soil, comparatively with accumulation in plants from polluted and non-fertilized soil. Amendament using, decreased zinc and cadmium accumulation about 2.7-3.7 times in aerial parts of plants, cultivated on soils polluted and fertilized with biosolids. Soil fertilization with biosolids increased zinc transport process, which is competitive with cadmium. Metals concentrations accumulated in roots were smaller then in aerial parts of plants.

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