Current World Enviroment Vol. **2**(2), 183-186 (2007)

Removal of Zn, Pb and Cd ions from soil using cereals

R.N. JADHAV, S.H. RAJPUT, S.M. NHALADE, V.A. KHATIK and S.R. THORAT

School of Environmental and Earth Sciences North Maharashtra University, Jalgaon (India).

(Received: June 06, 2007; Accepted: September 13, 2007)

ABSTRACT

Seeds of Vigna *radiate, Phaseolus aconitifolius and Doliphous Biflorus* were treated with growth regulator and planted on soil contaminated with salt of Zn, Pb, Cd, and some salt mixtures. It was shown that during 15 days of germination quantity of zinc in primary leaves of 1) Increased from to 243.75%in compression to control experiment's and decreased in soil: 95.74 and 85.07 in upper layer 95.83 to 82.04, lower layer 85.72 to 72.74 mkg/kg correspondingly approximately the same was shown for Zn and other metals absorption of heavy metal by a plant was shown to be depended from growth stimulator pretreatment procedure and is connected with exudative activity of roots of a plant. Specify of the process of phytoextraction for each metal and for the type of plant are speculated thus, it was shown that stimulation of root exudative activity by pretreatment with a growth regulative may be successful in cleaning of soil.

Key words: *Phytoremediation, Vigna radiate, Phaseolus aconitifolius, Doliphous Biflorus,* Zn, Pb and Cd.

INTRODUCTION

Soil frequently receive a wide range of contaminants from industrial activities, sewage sludge , disposal , metal processing and energy production and many cases remediations both expensive and intrusive to the ecosystem, phytoremediation is the use of plant's and plant processes to remove degrade or render harmless hazardous materials present in the soil or groundwater. This emerging technology may offer a cost-effective, non-intrusive, and safe alternative to conventional soil cleanup techniques by using the ability of certain tree; shrub and grass species to remove degrade or immobilize harmful chemicals from the soil.

A plant management remediation strategy for Se was developed base upon research from Banuelos and Meek (1990*)* and other earlier research that showed that certain exotic plants*, e.g., Astragalus, stanteya*, accumulate high concentration's of Se when grown on seleneferous soils (Rosenfeld and Beath'1964). In this regard, California researchers developed and demonstrated the phytoremediation of Se under a variety of condition 's (Banuelos *et al*., 2002b; Zayed *et al*., 2000; Wu *et al*., 2000; Franken Berger and Karlsn, 1995; Lin *et al*., 2002).

MATERIAL AND METHODS

Soil experiment's: seeds of *Vigna radiate, Phaseolus aconitifolius, Doliphous Biflorus w*ere treated with strong water solution of FeSuc before planting in soil of black earth type and in the same soil, which was previously treated with solution of ZnSo4 (650 mg/kg of soil). Control experiment with and without Feso4 and salt of metals were done in the same condition. Zn, Pb and Cd in plant's and in soil were measured by ICP-AES method of spectrophotometer AAS-30 (Germany). Sterile experiments: Seeds of inbred lands. (Hybrid of 1) *(Vigna radiate, 2) (Phaseolus aconitifolius, 3) Doliphous biflorus* were germinated in vessels with sterile sand during 15 days with following collection

of root exudates on digestion with Nitric acid. Amino acids of primary leaves exudates was performed on automatic amino acid analyzer AAA-339, CZECH.

RESULTS AND DISCUSSION

Optimum concentrations, conditions of pretreatment of seeds by solution FeSuc was experimentally selected and lead to increase an ability to germinate (energy of germination of treated seed was higher). It is very important fact in the case of highly contaminated soils were remediants may not germinate at all is possible to demonstrate the process of plant uptake of metal ions enhanced by application of the growth regulator in soil experiments shown in Table 1.

During growth of seeds of wild grasses in condition of soil experiments described about quantity of amino acid in primary leaves increased in the most of amino acid in primary leaves increased in the most of experiments under influence of FeSuc and metal ions, that depended from a species. It is impossible to study real exudation of amino acid in that experiments due to complexity of a natural soil (presence of microorganisms) that's why only results were calculated as a quantity of ionized group in the molecule of each amino acids, multiplied on its quantity in percent in mixture, obtained in sterile experiments shown in Table 2.

Table 1: Quantity of metal ions in primary leaves of 1, 2, 3 during growing on contaminated with metal salt with application of FeSuc in % control.

S. No.	Plant species	Quantity of metal ions in % to category Zn	Pb	Cd
1.	*Vigna radiate,*	121.46 ± 10.63	141.85 ± 13.34	122.53 ± 10.99
2.	*Phaseolus aconitifolius,*	243.75 ± 19.35	134.78 ± 12.41	160.53 ± 15.03
3.	*Doliphous Biflorus*	111.41 ± 8.31	108.68 ± 7.01	139.01 ± 12.98
4	Control	104.32 ± 13.30	102.62 ± 5.00	108.08 ± 10.38

Application of the growth regulator was very effective in the process of absorption of metal ions; especially significant in the uptake of Zn was increased (Table 1). It is well known fact that wild cereals may accumulate Zn in quantities that exceeds the quantity of the metal in soil, i.e. biological coefficient of absorption (BCA) for Zn by some type of wild cereal plants was greater than 1 and reaches in some cases 1,8, - 1,9 (Cabata - Pendias, 1986 and Kostishin, 1995, Kulkarni *et. al,* 2006). On highly contaminated with Zn salts soil under influence FeSuc uptake of Zn by plant in our experiment N_2 increased in 2,5 times. Cd is the second and Pb is the third metal in ability to accumulate in plants. But their BCA is only 0, 66 and 0, 47 maximum and is highly dependant from type of soil, its pH and quantity of humic acids. Application of the growth regulator changes these value very much and made uptake of Cd more preferentially and Pb nearer to that of Zn. Even more, in this experiments absorption of Cd is more than Zn. Thus influence of FeSuc lead not only to increase of metal ions but also develop a mechanism that is not a same that is natural condition of the growth. It is impossible to explain these data only by activity of metalothioneins, but it seems to occur due to

Table 2: Total density (TD) of amino acid in root excludes of cereals

S. No.	Types of cereal species	Total density (TD)
1	*Vigna radiate,*	243.09 ± 9.2
2	*Phaseolus aconitifolius,*	274.8 ± 3.6
3	*Doliphous biflorus*	245.71 ± 6.1
4	Control	238.42 ± 6.7

better ability of Cd and Pb to format complexes with amino acids.

Amino acids have fictional group that can act as sides of interaction with heavy metal ions in soil. Wild cereals had more polyfuctional amino acids in the exudates a larger value of TD. During growing on sterile sand application of FeSuc lead to increase of total quantities of exudates amino acids in 1.5-2 times (Shtemenko, 2000). We guess that similar effect occurs in natural condition too. Over exudation of amino acids that is very important fact which, could explain altering of rhizospore by conditions of FeSuc application. As polyfuctional substances are exudates, as more intensive is the process of modification of rhizosphere by enhancing mobility and by bioavailability of metals (Salt, 1995).

The origin of amino acids in coming to soil from seeds during germination Is not almost clear even physiological role of this process is an object of discussion. One point view is that root exudation has an allelopathic role and that physiological function of a releasing pool is to have a place in ecological low (Grodzinsky, 1975) It is very interesting to note that, we found species of cereals, that differs so much in this process and are so active in the exudation of amino acids under influence of growth regulation.

CONCLUSION

Stimulation of growth by pre- treatment of cereal seeds with a synthetic substances lead to increase of amino acids exudation, changed mechanism of uptake of metal ions and clean the soil. Thus, phytoremediation hold greater potential specially, promising with elaboration of growth regulator application.

ACKNOWLEDGEMENTS

Authors are thankful to Head of Department, School of Environmental and Earth Sciences, North Maharashtra University**,** Jalgaon for providing necessity facility for this research work.

REFERENCES

1. Banuelos, G.S., Meek, D.W.,"Accumulation of selenium in plants grown on selenium-treated soil". J. Environ.Qual. **19**: 772-777 (1990).
2. Banuelos,G. S., Lin. Z. Q., Wu,L., Terry, N, "Phytoremediation of selenium contaminated soil and waters: fundamentals and future prospects." *Rev. Environ. Health.,* **17**: 291-306 (2002 b).
3. Cabata A., Pendias, "*Microelements in soil and plant*", Mir, Moscow, USSR,(1986)
4. Grodzinsky A., Basic of chemical interaction between plants. *Nukova dymka*, Kiev, (1975).
5. Irankenberger Jr., W.T., Karlson, U., "Volatilization of selenium from watered Serineferous sediment: a field study". *J.Ind. Microbiology.,* **14**: 226-237. (1995).
6. Kulkarni M.N., Karpate H.S., Sayed Aafreen., Chavan A.V., Narkhede S.A., and Thorat S.R., Impact of chromium on seed germination seedling vigour some legume" *Bull. Bio. Sci.,* **4**(2): 133-136. (2006).
7. Lin, Z.Q., Cervinka, V., Pickering, I.J., Zayed, A Terry. N., "Managing selenium contaminated agricultural drainage water by the integrated on farm drainage management system: role of selenium volatilization. *Water Res.* **36**: 3150-3160. (2002).
8. Rosenfeld,I,Beath,O.A."Selenium, Geobotany, Biochemistry, Toxic its and nutrition" Academic press, New york, NY(1964).
9. S.Kostishin, Agropyron Perens L. as a model for metal absorption by plants, *physiology and biochemistry of cultural plants.,* **27**(1): 65 (1995).
10. Salt D., phytoremediation: A novel strategy

for the removal of toxic metals from the environment using plants, *biotechnology*, **13**: 408 (1995).

11. Shtemenko, N. 1270, "Free amino acids in root exudates of cereals during the Process of growth stimulation and phytoremediation", seventh international Fzk / TNO conference on contaminated soil, Lpzig, Germany, (2000).
12. Wu, L., Banuelos G.S., X., changes of soil and plant tissues selenium status in an upland contaminated by selenium-reach agricultural drainage sediment after ten years transformed from a wetland habitat *Ecotoxicol. Environ. Saftey* **47**: 201-209 (2000).
13. Zayed, A., Pilon- Smiths, E., de souza, M., Lin, Z.Q., Terry.N., "Remidiation of selenium polluted soils and waters by phytovolatilisation. In: Terry, N. Benuelos, G.S.(Eds.), *Phytoremediation of contaminated soil and Water.* CRC Press LLC, Boca Raton, FL, 61-83 (2000).