ARUNIMA *et al*, International Journal of Advances in Agricultural Science and Technology,
Vol.2 Issue.6, June- 2014, pg. 33-38 **ISSN: 2348-1358**

PHYTOREMEDIATION OF SOIL AND WATER CONTAMINATED WITH HEAVY METALS

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ABSTRACT: Modern style of living, exponential growth in different industries, release of effluents and sewage without treatment has contaminated our soil and water bodies. Not only these, food materials are also being polluted with these toxic compounds and finally we are passively taking these chemicals through our food chain. Detoxification of the toxic metabolites is a burning challenge before the researcher and the scientists of the age. Among the different techniques so far being used, it is a confirmed fact that phytoremediation is the best because it is sustainable, cost effective and eco-friendly. More than 400 plant species have been identified to have potential for soil and water remediation. Among them *Thlapsi, Brassica, Sedum alfredii H, Arabidopsis, Helianthus* species have been mostly studied. This paper attempted to provide a brief review on recent progressive in research and practical applications of phytoremediation for soil and water resources.
KEYWORDS: detoxification, phytoremediation, cost effective, eco-friendly, potential.

INTRODUCTION

Heavy metals are regarded as serious pollutants to eco-system because of their environmental persistence, toxicity and ability to be incorporated into food chains. These heavy metals are toxic because they cause DNA damage and their carcinogenic effects in animals and humans are probably caused by their mutagenic ability (Baudouin *et. al.*, 2002). Exposures to heavy meals has been linked to several human diseases such as kidney damage, cancer, abortion, effect on intelligence and behaviour, and even death in some cases of exposure to very high concentrations (Banarjee, 2003 ; Jiries, 2003). Heavy metals that have been identified in the polluted environment include As, Cu, Pb, Cr, Ni & Zn.

Different sources of heavy metals:

HEAVY METALS	SOURCES	REFERENCES
As	Semiconductors, herbicides, Mining and smelting	Nriagu, 1994
Cd	metal smelting and refining, fossil fuel burning, sewagesludge	Alloway ,1995
Cr	electroplating industry, solid waste	Knox *et. al*, 1999
Pb	mining and smelting of metalliferous Ores, burning of leaded gasoline.	Richardson, 1990
Ni	volcanic eruptions, forest fire	Knox *et. al*, 1999

To eradicate pollution containing the above mentioned heavy metals, several measures and experiments are being taken by the government. The remediation technology can be broadly divided into two categories- Conventional and Biological methods. Conventional methods include physiochemical remediation technologies used to clean up the heavy metals contaminated environment are given below- Excavation and landfill, *in situ* vitrification solidificaton & Stabilization, *in situ* Redox manipulation, soil washing, soil flushing and electrokinetic system.

To overcome the shortcomings of conventional methods, bioremediation, typically referring to microbe based cleanup and phytoremediation or plant based cleanup, have generated much interest as effective low cost and environmental friendly technologies for the cleanup of a broad spectrum of hazardous organic and inorganic pollutants.(Pilon-Smits, 2005)

Phytoremediation – Green Technology is being considered as a new highly promising technology for the remediation of polluted sites. It is the process of utilizing green plants to absorb, accumulate, detoxify or remove pollutants from the environment or to render them harmless (Salt *et. al.,* 1994 ; Berti & Cummigham, 2000). In this respect, plants can be compared to solar driven pumps capable of extracting and concentrating certain elements from their environment (Salt *et. al.,* 1995). Plants would be one of the key actors in heavy metal remediation (Cheng *et. al.*, 2004 ; Rajakarina *et. al.*, 2006). The roots of Indian mustard are found to be effective in the removal of Cd, Cr, Zn, Ni, Cu & Pb and sunflower can remove Cs-137, Sr-90, U & Pb from hydroponic solutions (Zaranyika and Ndapwadza, 1995; Wang *et. al.*, 2002a, Prasad and Freitas, 2003). The potential of duck weed was investigated by Zayed *et. al.*, (1998) for the removal of Cd, Cr, Cu, Ni, Pb & Se from nutrient added solution and the results indicate that duck weed is a good accumulator for Cd, Se & Cu, a moderate accumulator for Cr, but a poor accumulator of Ni & Pb. Several aquatic species have been modified and have been identified and tested for the phytoremediation of heavy metals from the polluted water. These include Sharp dock (*Polygonum amphibium* L), duck weed (*Lemna minor* L), water hyacinth(*Eicchornia Crassipes*), water lettuce (*P.Stratiotes*), water dropwort (O*enathe javenica)*, Calamus (*Lepironia articulate*), Rennywort (*Hydrocotyle cembellate* L) (Prasad and Freitas, 2003).
Zhang *et. al.*,(2005) investigated the efficiency of Cu removal from the contaminated water by *Elsholzia argyi* and *Elsholtzi splendens* in hydroponics. The results show that *Elsholtzia argyi* showed better Cu phytofilteration than *Elsholtzi splendens*, which was associated with better ability to higher Cu concentrations and translocation to shoots.
Accumulation of toxic metals (Cd, Cr, Cu, Ni, Pb, & Zn) at two different concentrations (0.05 & 0.25 mm) was studied in *Allium* species grown in hydroponics. The significant hyper accumulation of Cadmium and Lead was followed in chive, garlic, leek and three cultivars of onion. The distribution of toxic metals in different plant tissues was compared, the highest metal content being found in the roots. Transport of heavy metals to bulbs and leaves was rather low (Soudek *et. al.*, 2009).

Plants used in phytoremediation -:

METALS	**PLANT SPECIES**	**REFERENCES**
As	*Pteris viltata* L.	Wang *et. al.*,2002a
Cd	*Brassica juncea*	Kumar *et.al.*,1995a,Huang *et. al.*,1997,Ebbs *et. al.*,1997,Salt *et. al.*,1995
Cr	*Brassica juncea* *Helianthus annuus*	Kumarr *et. al.*1995aMc cutcheon and Schnoor, 2003

Cu	*Brassica juncea*	Ebbs and Kochain, 1997
Pb	*B. Compestris* L.	Begonia *et. al.*,1999
Zn	*Avena sativa*	Ebbs *et. al.*,1999

A study was carry on to investigate the potential of corn (*Zea mays*) for phytoremediation of soil contaminated with Cadmium and Lead. This study indicated that corn is an effective accumulator plant for phytoremediation of Cadmium & Lead pollited soil (Mojiri, 2011). Khan *et. al.*,(2013) studied the potential of *Brassica juncea* plant to remediate atrazine (herbicide) contaminated soil. They found that residues of atrazine were reduced at faster rate in treated soil which was planted with *Brassica juncea* L, was useful for phytoremediation of soil contaminated with atrazine.

CONCLUSIONS AND PERSPECTIVES

The contamination of soil and water with heavy metals is a challenging problem before us. Heavy metals found persisting in the environment lead to bioaccumulation, biotransformation causing toxicity to plants animals and human beings. So, there is an urgent need to reduce or remove these toxicants from soil-water environment. Plant based environmental remediation has been widely pursued by academic and industrial scientists as a favorable low cost clean up technology applicable in both developed and developing nations. (Raskin & Ensley, 2000, Robinson *et. al*., 2003a,b; Jadia and Fulekar, 2009a) This field has generated great excitement because it may offer a reasonable cost effective means to restore the hundreds of thousands of square miles of land & water that have been polluted by human activities (Salt *et. al.,* 1995a, Cunningham *et. al.*,1996 ,Salt *et. al.*,1998).

ACKNOWLEDGEMENT

Authors are obliged to the Head, University Department of Botany, B.R Ambedkar Bihar University, Muzaffarpur for Laboratory and Library facilities and also to the Department of Science & Technology, (DST), Govt. of India, New Delhi for financial support.

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