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Phytoremediation: As A Degradation of Heavy Metals

Aparna Bharti

Abstract— Phytoremediation is a process which is having a major role for the naturally removal of excessive metals, non metals and metalloids by the help of phytoremediating plants. Various plants species uptakes the fatal impurities and release up in the atmosphere, which as a result prepares the land for various agricultural practices. Various methods are included in this process which shows extremely good results and helps in sustainable development of human and environment.

***Index Terms*— Phytoremediation, phytodegradation, phytostimulation, phytovolatization, phytoextraction, phytostabalization, rhizofiltration, rhizosphere.**

I. INTRODUCTION

Phytoremediation is an natural plant process which carry capability of remove or stabilize organic and inorganic pollutants from soil and water sediments with low to moderate level of contamination. It uses different plant species for the removal of contaminants which includes certain heavy metals, pesticides, explosives, crude oils e.t.c. It is a sub category of phytotechnology, which uses plant to absorve pollutants and help for solving lots of environmental problem such as land fillings, bio fuels reforestation e.t.c. heavy metals which acts as pollutant is considered as any metals that may create environmental problem and cannot be further degrade such as cu, zn, pb[1]. *Dr. Ray Hinchman*, botanist and plant physiologist, Argonne National Laboratory says that, phytoremediation is an in-suit approach, not reliant on the transport of contaminated substances to other sites. In many cases pollutants are completely destroyed rather than simply immobilized or restore[2].

The vital use of phytoremediation is to detoxify the contaminant through physical, chemical and biological activity of plants. There are lots of plant species which act as phytoremediating plant and helps for making pollution free environment, like as *Hydaenges and Melastoma (blue tongue)* are popular ornamental plants which removes alumina from soil. *Water Hyssop* (*Bacopa monneiri*) removes not only lead but also mercury and cadmium. An aquatic plant *Water Hyasinth* naturally absorve pollutant from warerwhich includes cadmium, mercury, lead, zinc, cesium, strontium-90, uranium and pesticides[3]. By using these phytoremediation plants, effective removal of contaminants occurs which cleansup the environment

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Aparna Bharti, Intrim Trainee, at EMG, CSIR-CIMFR Dhanbad, Jharkhand (Nov 2013- May 2014), from: College Of Commerce, Magadh University, Patna, Bihar, India, Mobile- +91-9473426728

II. DIFFERENT PHYTOREMEDIATION PROCESSES

Depending upon the types of contaminants, phytoremediation can be broadly classified as[4] :

1. Phytodegradation
2. Phytostimulation or Rhizodegradation
3. Phytovolatization
4. Phytoextraction
5. Rhizofiltration
6. Phytostabilization

A. PHYTODEGRADATION

It is also known as phytotransformation which breaks the contaminants taken up by plants through metabolic process within the plants or the breakdown of contaminants surrounding the plant through effects of enzymes produced by the plants, because these enzymes are capable to catalyse and accelerate degradation[5].

B. PHYTOSTIMULATION

The process is also known as rhizosphere degradation. It is enhancement of soil microbial activity for the degradation of contaminants typically by organisms that associates with roots. Cynobacteria are commonly use for phytostimulation of crops due to their nitrogen fixing ability. Cynobacteria has the ability to release phytoharmone in the rhizosphere from where plant root may absorve these hormones and help in phytostimulation[6].

C. PHYTOVOLATIZATION

It refers to the uptake and transpiration of contaminants, primary organic compounds by plants. Phytovolatization has been primarily used for the removal of mercury (*Henry-2000).* it has been successful in tritium (3H), a radioactive isotope of hydrogen [7]. The process occurs as growing plants absorve water and organic contaminants. As water travels from root to leaves along with the vascular system of plants, it is changed and modified along the way. Then some of the contaminants like mercury moves through the plants to the leaves and evaporates into atmosphere[8]. Result of one study confirmed that popular trees volatize 90% of trichloroethylene (TCE) they extracted from the ground[9].

Table 1. Performance data of phytoremediation on field investigation[11]:

1. Site/ Media	Refinery waste and agricultural soil.
2. Contaminants	Selenium
3. Plants	Brassica species

4. Performance	Selenium partially taken up and volatized; Soil decontamination difficult
5. Location	San- Francisco, CA

D. PHYTOEXTRACTION

Phytoextraction is the use of plants to take up metal contaminants from soil through the absorption by plant roots. After the plants are allowed to absorve the contaminants for some time, they are harvested to either be dispose by incineration or be composted to recycle metals. The plant take up the contaminants through the system of roots and store them in roots and transport them up into the stems and leaves, and plants will carry on absorbing. Contaminants until it is being harvested as such, this growth and harvested cycle is usually repeated for a no. of times to achieve a considerable cleanup [12a, 12b].

E. RHIZOFILTRATION

Rhizofiltration is the adsorption or precipitation of toxic metals from ground water in which we use both terrestrial and aquatic plants. Rhizofiltration can partially treat industrial discharge, acid mine drainage or agricultural runoff, which can be used for lead, cadmium, cu, ni, zn & cr, which are primarily retained within the roots[13a, 13b]. Recently two bacterial strains, Bacillus mycoides and stenotrophomonas maltophilia have shown potential to detoxify Se and a modal system for Se rhizofiltration based on Astragalus bisulcatus rhizobacteria interaction has also been proposed

F. PHOTOSTABALIZATION

Photostabalization is a process of stabilizing soil contaminants through leaching, runoff and erosion by plant roots or root exudates which may cause metals to precipitate, converting them to less bio available form[14]. Phytostabalization also known as phytorestoration which is plant based remediating technique that stablises waste and prevent exposure pathways via wind and water erosion; provides hydraulic control, which suppresses the vertical migration of contaminants by root absorption and by chemical fixation with various soil amendments[15].

III. ROLE OF PHYTOREMEDIATION TOWARDS ENVIRONMENT

Phytoremediation is an environmental friendly process which acts against environmental constraints. As we know that heavy metals which are one of the most important contaminant and which are non degradable i.e. cannot change its nuclear structure but they can transform from one state to another state. Remediation of these contaminants are very much difficult due to its cost effectiveness. But phytoremediation is very acceptable process and very much beneficial to detoxify contamination using accumulation, volatization, absorption of compounds. It also enhance rhizosphere activity of soil. phytoremediation takes advantage of the unique, selective uptake capabilities of plant root system together with the translocation, bioaccumulation and pollutant storage of the entire plant bodies. Phytoremediation is one of the best ecological ways for treating pollutant sewage water. Using the high efficiently nutrient absorbing plant like water hyacinth for reducing the harmful toxic chemical contents from sewage and playing as a substratum, providing microbial growth. This plant has ability to grow & reproduce fastly. Primarily reproduce by the way of stolen eventually forming daughter cells, and also via seeds. It can effectively absorve more than 8 heavy metals from the sewage such as Ag, Cd, Cr, Cu, Hg, Ni, Pb, Zn[16].

IV. CONSTRAINT

Phytoremediation is easily applicable and cost effective it has some inherent technical constraints. The contaminating material should be present within the root zone to be accessible to the roots. The phytoremediation site should large enough to grow plants. It is a slower process[17]. Phytoremediation is limited to sites with lower contaminant concentration (USEPA, 1996). Phytoremediation is restricted to sites with contamination as deep as the roots of the plants being used. The food chains could be adversely affected by the degradation of chemicals. The air could be contaminated by the burning of leaves or limbs of plants containing dangerous chemicals[18].

V. CONCLUSION

Phytoremediation is a fast developing field, since last ten years lot of field application were initiated all over the world, it includes Phytoremediation of Organic, Inorganic. A sustainable and inexpensive process, fastly emerging as a viable alternative to conventional remediation methods, and will be most suitable for a developing country like India. It removes heavy metals by the help of plants which is a ecofriendly and sustainable development practice.

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