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Bio remediation
(Phyto remediation)

A Promising Environmental Technology for the pollution Clean up

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Abstract

Bioremediation is "the use of living organisms for removal of a pollutant from the biosphere" It relies on biological process to minimize an unwanted environmental impact of the pollutants. The microorganisms in particular have the abilities to degrade, detoxify and even accumulate the harmful organic as well as inorganic compounds. Besides them, Higher plants have also been reported to remove such pollutants primarily through their ability to accumulate these in their tissues Bioremediation has emerged during resent past as the most ideal alternative, environment friendly and ecologically sound technology for removing pollutants from the environment, restoring contaminated sites and preventing further pollution. This technology has the potential to be more socially acceptable when compared to physical or chemical process and is therefore expanding the range of organisms to be used for pollution cleaner. Bioremediation in fact forms a vital component of the so called green movement of maintaining the natures overall ecological balance, an issue of top priority of environmental awareness and public policy.

The objective of this abstract is to focus on how do plants remediate contaminated sites. Phytoremediation is an attractive remediation technology for removing hazardous substances from soil sediments, surface or ground waters contaminated with municipal or industrial wastes etc. This use of plants for environmental desperation is an emerging cost effective clean up technology suitable for broad range of contaminants including metals, radio nuclides and organics. Green plants are not only the lungs of nature with an ability of purifying impure air by photosynthesis but some species have also be unique ability to uptake, tolerate and even hyper accumulate heavy metals and other toxics substances from soil and water through their roots and concentrate them in roots, stems and leaves. These include some aquatic weeds such as species of salvinia, Lemna, Azolla and Eichhornia, sedges like Typha latifolia and some herbaceous as well as woody flowering plants. The author wanted to discuss in detail about the phytoremediation process. Phytoremediation relies the plant ability to act as a solar driven pump and filtering system and enhances or stimulates the natural tendency of eco system to restore itself.

Keywords: Phytoremediation, Green Plants, Soil sediments, Heavy metals, Green Technology

Introduction

Around the world, there is an increasing trend in areas of lands. Surface waters and groundwater affected by contamination from industrial, military and agricultural activities either due to ignorance, lack of vision, or carelessness. The build-up of toxic pollutants (Metals, radionuclides and organic contaminants in soil, surface water and ground water not only affects natural resources but also causes a major strain on ecosystems. Remediation of contaminated sites using conventional practices, such as 'pump-and-treat' and dig-and-dump' techniques, is often expensive, has limited potential, and is usually only applicable to small areas. Additionally, these conventional approaches to remediation often make the soil infertile and unsuitable for agriculture and other uses by destroying the microenvironment. Hence there is the need to develop and apply alternative, environmentally sound technologies (ESTs), taking into account the probable end use of the site once it has been remediated.

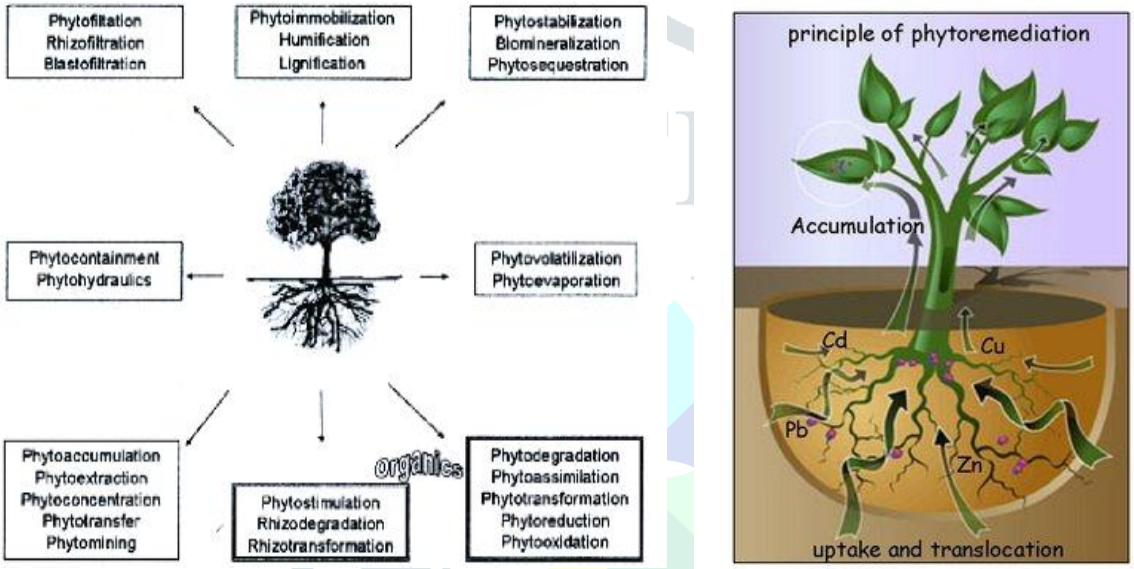
Phytoremediation is the direct use of living green plants for insitu, or in place, removal, degradation or containment of contaminants in soils, sludges, sediments, surface water and ground water, Phytoremediation is

- A low cost, solar energy driven cleanup technique
- Most useful at sites with shallow, low levels of contamination

- Useful for treating a wide variety of environmental contaminants
- Effective with, or in some cases, in place of mechanical cleanup methods

Phyto means plant remediation means to correct. It can be defined as the efficient use of plants to remove, detoxify or immobilize environmental contaminants in a growth matrix. (Soil, water of sediments) through the natural biological, chemical or physical activities and process of the plants. Plants are unique organisms equipped with remarkable metabolic and absorption capabilities as well as transport systems that can take up nutrients or contaminants selectively from the growth matrix. Soil or water, Phytoremediation involves growing plants in a contaminated matrix, or facilitate immobilization or degradation of the pollutants.

Various Processes in Phytoremediation:-



1. **Enhances Rhizosphere degradation:** This is also referred to as plant assisted bioremediation and Phytostimulation. It involves the stimulation of the microbial community associated with the rhizosphere by the plant through the release of exudates. It is the bacterial and fungal communities that are primarily responsible for degrading the contaminant rather than the plant itself. The interactions between plant and rhizosphere act as nutrient sources for microorganisms. Exudates may be organic or inorganic and can result from active exudation, passive leaking production of mucilage or dead or sloughing of plant cells. There is wide variety of exudates (simple sugars, amino acids, organic acids, fatty acids, sterols, growth factors, and enzyme. Some exudates are structurally analogs to xenobiotics so the rhizosphere community may already be enriched to degrade certain environmental contaminants.

   There possible mechanisms have been reported for the ways which plants could enhance the degradation of soil contaminants.

   1. The plants non- specifically enhance the microbial community i.e., increases R/S ration.
   2. Enhancements of microbial activity that protects the plant from the contaminant.
   3. The development of microbial activity communities that specifically degrade the contaminant.

In the first case plants provide a niche that can support a wide diversity of microorganisms. Often it is not a single strain responsible for the complete degradation of a contaminant, but rather the concerted effort of a community of microorganisms each responsible for a subsequent step in the degradation. The plant increases the probability of completing each step in the degradation process.

The second mechanism of plants role in phytoremediation is to enhance microbial community that protect the plant. Plants exposed to contaminants alter their exudation patterns, there by sending signals to micro – organisms to detoxify the contaminant.

The third possible role of plants is that, they enrich a degrading community. Plant have been shown to enhance degradation rates in variety of environmental conditions of a wide range of organic contaminants such a total petroleum hydrocarbons, PAH, PCBS, Pesticides organic solvents and surfactants. In presence of exudates the rhizosphere microbes enhance and degrade contaminants. This is called rhizodegradation. Microbes typically adapt to a contaminant by selective enrichment of those capable of tolerating or degrading the contaminant. The plant provides further selection pressure, stimulates co metabolism, provides a niche for long term survival degradative plasmids and also an environment conducive to gene transfer.

2. Phytoextraction: This is the process of up taking of the contaminants through plant roots and accumulating them in the above ground plant tissue this is therefore, the use of pollutant-accumulating plants to remove metals or organics from soil or water by concentrating them in the harvestable plant parts. Plants suitable for this process must be able to tolerate the high – level of contaminants, and with a higher biomass, those plants may be able to accumulate larger volumes of the pollutants.

Although several plants species have neem shown to accumulate heavy metals some proved relatively very promising for the purpose. Typha latifolia could remove Cd, Fe, pd and zn. Azolla remove 98.8 pb, Eichhornia, Hydrocotyl and lemna showed a high purification capacity.

Eucalyptus bark could remove up to 99 percent of chromium from the waste water of an automobile plant near Delhi.

Indian mustard, Ragweed and Hemp which sequester lead in their Biomass. Sunflower and fern plants are hyperaccumulators stores Arsenic in their leaves.

Salt tolerant barley and sugar beets are commonly used for the extraction of sodium chloride to reclaims to reclaims fields that were previously flooded by seawater.

Mercury, Selenium and organic pollutants such as pcbs have been removed form soils by transgenic plants containing genes for bacterial enzymes.

3. Rhizofilration: This the process of uptake of inorganic pollutants dissolved in water & accumulating them in plant roots. This is the use of plant roots to absorb & adsorb pollutants, mainly metals from water & aqueous waste streams. The efficient plants for this process should have rapidly growing roots with higher root biomass.

4. Phytotransformation: This is the process of degradation of a compound by plant itself through its metabolism or through the release of enzymes by the plant. Some algae, stone-wort, hybrid poplars, cattails and rice have been reported to posses such characteristics of degradation of environmental contaminants.

5. Phytovolatilization This is the process of transporting organic contaminants to the leaves that transpire, evaporate or volatize the contaminants in to the atmosphere.

6. Phytostabilization: This is the process of reducing or eliminating the bio-availability of pollutants to the environment by the plant. Barren lands are more susceptible to erosion and leaching. This spreads the pollutants to the environment. Revegetation of such soils with tolerant plant species will help stabilize such lands. Trees are ideal for phytostablisation with extensive root system spreading over wide areas.

Advantages:

1. The cost of the phytoremediation is lower than that of traditional process both insitu and existu.
2. The plant can be easily monitored.
3. The possibility of the recovery and re use of valuable metals.
4. It is potentially the least harmful method because of uses naturally occurring organisms and preserves the environment in a more natural state.

Limitations:

1. Phytoremediation is limited to the surface area and depth occupied by the roots.
2. Slow growth and low biomass require a long term commitment.
3. The survival of the plants is affected by the toxicity of the contaminated land and the General condition of the soil.
4. Bio-accumulation of contaminants, especially metals, into the plants which then pass into the foodchain, from, primary level consumers upwards or requires the safe disposal of the affected plant material.

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