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ISSN: 2277-9655
[Imam* *et al.*, 6(8): August, 2017] Impact Factor: 4.116
IC™ Value: 3.00 CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

PHYTOREMEDIATION: A GREEN METHOD TO COMBAT ENVIRONMENTAL POLLUTION

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ABSTRACT

Environmental pollution is one of the greatest problems the world is facing today .Environmental pollution consists of five basic types of pollution, namely, air, water, soil, noise and light. The contamination of the environment by toxic metals and other pollutants poses a threat for Human and Biota, it reduces agricultural yield and is also damaging the whole ecosystem. The fast upsurge in concentration of toxic pollutants not only affects natural resources, but also causes major strains on ecosystems. Scientist and scholars worldwide are working on methods to combat this menace. One of the Green methods involves metal tolerant plants, to clean up the pollution. This method is known as Phytoremediation. It is, an emerging low cost green cleanup technology for contaminated soils, groundwater, and wastewater. In present study Catharanthus roseus plant commonly known as Periwinkle was used for phytoremediation lead, from contaminated soil.

KEYWORDS: Contaminants, Plants, Green Technology, Remediation, Lead.

I. INTRODUCTION

Phytoremediation word is derived from greek words phyto means plant and latin word remedium means refurbish balance. It is an in situ method in which various types plants are used to transfer, remove and destroy the contaminants from soil and water. Some plants have ability to grow on metal contaminated soil they accumulate large amounts of heavy metals in their roots and shoot system. This property may be exploited for soil reclamation if an easily cultivated, high biomass crop plant able to accumulate heavy metals is identified. Environmental contaminants such as heavy metals, trace elements, organic compounds, and radioactive compounds in soil or water can be removed by Phytoremediation

There are several types of mechanisms of **Phytoremediation**

1) Phyto stabilization: plant-mediated immobilization or binding of contaminants into the soil medium, thereby reducing their bio availability
2) Phyto stimulation or rhizo degradation: involves use of rhizospheric or symbiotic relations between plants and soil bacteria to degrade pollutants.
3) Phyto volatilization: involves use of a plant's capability to uptake contaminants from the growth medium and later transform and volatilize contaminants into the atmosphere.
4) Phyto extraction: involves the use of plants to take up, translocate and store toxic contaminants from a soil medium into their root and shoot tissue.
5) Phyto degradation: involves the degradation or breakdown of organic contaminants by internal and external metabolic processes taking place in the plant. It involves the use of plants to uptake, accumulate and degrade contaminants inside its tissue.
6) Rhizofiltration: use of roots to uptake also store contaminants from an aqueous growth matrix.

The utilization of phytoremediation as an environmental remediation technology certainly depends on a number of factors including the extent of soil contamination, their uptake into roots (bioavailability), and the ability of the plant to capture, absorb, accumulate, and degrade the contaminants. The chief aim this study is to provide an overview pertaining to the use of plants remediation of contaminated soils and undeep groundwater. It is clear that in spite of a increasing community and commercial interest and the success of several pilot studies and field scale applications more fundamental research still is needed to better exploitation of variety of the plants
All biological, chemical, and physical processes, that plants carry out helps in the uptake, elimination, degradation, and metabolism of contaminants by plants. Phytoremediation has the benefit of the unique and

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selective uptake potential of plant root systems and shoot system, together with the translocation, accumulation, and pollutant storage and degradation abilities of the entire plant body. Plants can be viewed as pumps that work on solar energy to take up pollutants.

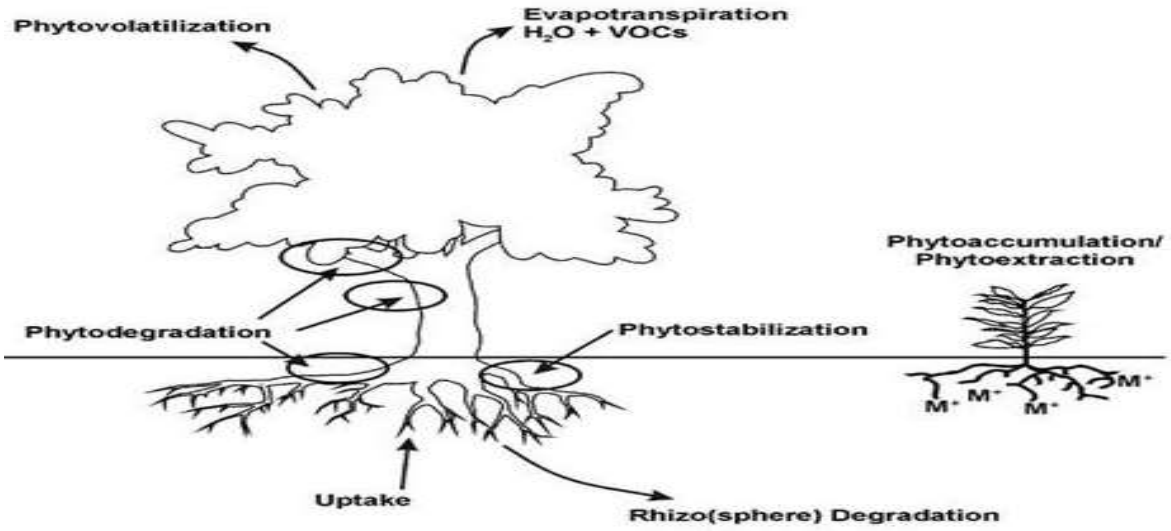

Table 1: Important enzymes linked with bioremediation (Husain** et al **2009)

Enzyme	pollutant
Aromatic dehalogenase	DDT, PCBs
Carboxyl esterases	Xenobiotics
Cytochrome P450	Xenobiotics
Dehalogenase	Chlorinated solvents and Ethylene
Glutathione s-transferase	Xenobiotics
Peroxidases	Xenobiotics
Nitrilase	Herbicides
O-demethylase	Alachlor, metalachor
Peroxdase	Phenols
Phosphatase	Organophosphates

Table 2: Optimum Condition Of Soil For Bioremediation

Environment Factor	Optimum Conditions
pH	5.6 – 8.5
Moisture	25 – 85 %
Temperature	15 – 45^0C
Nutrient	C:N:P = 120:10:1

Advantages Of Phytoremediation

1. Phytoremediation is economic method for the treatment of contaminated water.
2. Phytoremediation is also much less costly than other treatment method.
3. Up to 75% of pollutant present in water could be removed by simply planting trees and letting them grow. (Gordon, 1996)
4. Phytoremediation does not require much of maintenance once initiated.
5. Phytoremediation uses plants, it is aesthetically pleasing.
6. After plants are introduced, wildlife is able to flourish at the once uninhabitable site.
7. Solar energy is used to drive the cleansing activity.

Disadvantages

1. Phytoremediation is limited to sites with lower contaminant concentrations. (USEPA, 1996)

2. Phytoremediation is restricted to sites with contamination as deep as the roots of the plants being used.
3. The food chain could be adversely affected by the degradation of chemicals.
4. The air could be contaminated by the burning of leaves or limbs of plants containing dangerous chemicals.

II. MATERIALS AND METHODS

For the present study Catharanthus roseus (Periwinkle) is chosen. It is a species of Catharanthus genus and Apocynaceae family. The plant is said to be native to the West Indies, it first was described in Madagascar. The periwinkle is a perennial herb with flowers that can bloom throughout the year. Its other popular names are Vinca rosea Ammocallis rosea, and Lochnera rosea. It is also widely cultivated and is naturalized in subtropical and tropical areas of the world. It is noted for its long flowering period, throughout the year in tropical conditions. It is an evergreen herbaceous plant. The flowers are white to dark pink with a darker red centre. The fruit is a pair of follicles 2–4 cm long and 3-4 mm broad.

Soil suitable for plantation was obtained from local nursery. Soil was analyzed to check the parameters like soil moisture, pH, total nitrogen, electrical conductivity etc. The saplings of ***Catharanthus roseus*** (Periwinkle) were taken and potted in pots containing analyzed soil. Care was taken to select healthy saplings of same age height, and uniform size. The reason for choosing Catharanthus roseus is that it is easily available ornamental plant, and is known for its power of endurance in dry and deficient conditions.

Lead ions was selected for the study, the absorption or uptake in root, stem and leaves was determined after every 30 days. The total period of study was 60 days. A set of control plants that is blank experimental pots was also maintained which were watered with normal water. The metal solution was prepared by dissolving suitable salt in distilled water to prepare stock solution of 1000 mg/l for each metal. The calibration curves for each metal were also prepared. Blank reading was taken to include necessary rectification aspect. Dilute solutions having concentration 5mg/L for each metal was prepared from the stock and administer to the plants and care was taken to put back the leached water from the pots. Plant analysis was done after every 30 days , the sample plant is uprooted and washed in running stream of fresh water and final rinse with distill water. Plants were air dried and then dried in hot air oven. Dried plants were powdered and acid digested using aquaregia i.e. HNO_3 and HCl acid in the ratio 3:1. Digestion process is carried out until solution becomes clear. After digestion clear solution is filtered using Whatman filter paper No.42 filtrate was analyzed for the metal contents using Varian Model Spectra AA-250 plus Atomic Absorption Spectrophotometer.

III. RESULTS AND DISCUSSION

During present study it was found that Catharanthus roseus is quite useful in uptake of Lead as shown in the following table.

Table 3: Total accumulation of Lead mg/kg by Catharanthus roseus

		Experimental Plant		
Plant parts	**Control plant**	**30 days**	**60 days**	**Total amount of lead absorbed (Exp 60 days- Control)**
Root	22.02±0.42	82.21±0.12	89.48±0.12	67.46
Stem	64.23±0.23	69.31±0.16	72.49±0.17	08.26
Leaves	22.28±0.37	24.53±0.15	24.95±0.08	02.67
Total plant	108.53	176.05	186.92	78.39

The ability of Catharanthus roseus to take up Lead from the soil has been recognized by screening the plants and studying the phytoremediation of Pb at various concentrations by phytoremediation which is an eco-friendly, solar energy driven in situ remediation technology that employs the intrinsic capability of living plants such as Catharanthus roseus to clean up the environment. Our experimental data demonstrated that C. roseus can well tolerate high amounts of Lead it proves useful in the reclamation and remediation of lead contaminated soil and land.

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ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

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CITE AN ARTICLE

Imam, S. (2017). PHYTOREMEDIATION: A GREEN METHOD TO COMBAT ENVIRONMENTAL POLLUTION. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*, *6*(8), 418-421. Retrieved August 25, 2017.