

Phytoremediation: An Ultimate Hope for the Planet

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The destruction of environment has taken place very rapidly, over the last few decades. Human activities have lead to the degradation of air and soil, decline of biodiversity, scarcity of water, increasing hazardous waste, and so on. All these problems ultimately lead to Global Warming and Climate change that could have serious consequences. Recently, world becomes increasingly toxic due to huge amount of industrial waste. The composition, quantity and disposal of waste determine the environmental and health problem it creates. The enormous dumping of industrial waste in soil causes soil pollution. Industrial regions in Bhopal city is one of the most important source of hazardous waste production. These regions contain many industries with some of residential area also and thus, there is a big risk of environmental pollution which is very hazardous to our health. Such sites in Bhopal require remediation. Phytoremediation of pollutants is a multidisciplinary treatment technique with the central thrust on plant physiology. Thus, knowledge of the natural habitat of the degrading plant population is essential before a less costly, ecological and environment friendly bioremediation plan can be submitted. A particular industry must follow the phytoremediation plan according to the type of pollutants emitted by the industry. Phytoremediation workout should be major criteria for grading the industry.

“We're losing biodiversity globally at an alarming rate, and we need a cornucopia of different plants and animals, for the planet's health and our own”

Diane Ackerman

Introduction

At present we live in an increasingly toxic world due to huge amount of waste we produce and the resultant pollution. This toxicity is affecting our health. Waste has always been the part of earth's ecosystem. The composition, quantity and disposal of waste determine the environmental problems it creates. Environmental pollution takes place when nature cannot process and neutralize the hazardous waste generated from human activities.



Figure 1. Phytoremediation – Hope for the Planet.

Environmental pollution is a problem of global concern, which affects the entire planet directly or indirectly. Due to rapid increase in human population and industrialization, the demand for natural raw materials and source of energy are increasing day by day in all the countries. Industrial wastes are disposed in one way or another into natural resources, without proper pretreatment, thus generating a serious menace to the ecosystem [6].

Bhopal city and nearby regions are one of the most important industrial hub in the country. These regions contain many industries which are engaged in producing electrical products, cotton and jute. Generation of power is also very important to this city. The industry related to the production of electrical goods is also located in Bhopal. Therefore there is a big risk of environmental pollution which is very hazardous to our health. Due to this, almost every major city and Industrial Township of the state like Indore, Bhopal, Ujjain, Dewas, Peethampur, Nagda, Mandideep and Ratlam is situating on the top of highly toxic wastes underground. In Mandideep and Govindpura many industries are disposing effluents through drains that join Betwa River. Thus in Bhopal Industrial activities are major sources of soil, water and air pollution [4]. Pollution is a slow, gradual process. At many hazardous waste sites in industrial area in Bhopal requiring remedy of the contaminated land and groundwater. Wastewater effluents from industries contain a mixture of various contaminant types- salts, organics, trace elements, heavy metals etc.

Heavy metals are hazardous pollutants in natural environments due to their toxicity, long time retention and accumulation problems. High concentration of heavy metals in the environment has become a concern due to the health risks to humans and animals [2]. The problem is not restricted to soils with high metal levels, such as mining areas, but also includes those with moderate to low contamination of metals. These toxic elements, such as Cr, Cd, Cu, Pb and Zn, are present at increased levels mainly through human activities, as smelting, refining of nonferrous metals, electroplating, and agricultural practices.

But fact is that industries are required for the economy modernization and development of the city like Bhopal. Therefore environmental pollution with toxic chemicals, metals and xenobiotics is a global problem. There are some preventive or controlling measures for it but most of the conventional remedial technologies are expensive and inhibit the soil fertility; this subsequently causes negative impacts on the ecosystem [9]. There must be an effective solution to fight against such a big problem and the solution to this problem comes from the concept of phytoremediation. Phytoremediation is an environmental friendly, cost effective, and aesthetically pleasing method most suitable for developing countries & city like Bhopal [3].

Main Body

Phytoremediation is the engineered use of green plants to remove or accumulate environmental contaminants such as trace elements, organic compounds and heavy metals in water or soil. Biodiversity prospecting would lead to the discovery of wild plants that could clean polluted environments of the world. Plants can help clean up many kinds of pollution including heavy metals, fertilizers, explosives, and oil. These plants also help to prevent soil erosion by wind, rain, and groundwater and reduce the possibility of carrying pollution away from one site to another site. Phytoremediation is the most powerful tool against the industrial pollution because it takes advantage of natural plant process. In phytoremediation technology plants act as bioreactors and clean up the pollutants from the soil.

Mechanism of Phytoremediation

Phytoremediation consists of four different plant-based technologies each having a different mechanism of action for the remediation of soil polluted with heavy metals or water. These technology comprise: rhizofiltration, involving the use of plants to remediate aquatic environments; phytostabilization, involving stabilization of polluted soil by using plants; phytovolatilization, involving the use of plants to extract some metals from soil and then releasing them into the atmosphere by volatilization; and phytoextraction, involving the use of plants to absorb metals among the soil and their translocation in the harvestable shoots [7].

The main physiological steps in phytoremediation include:

- a. Stimulation of microorganism-based transformation by plant exudates
- b. Slowing of contaminant transport from the vegetated zone due to adsorption and increased evapo-transpiration
- c. Plant uptake, followed by metabolism or accumulation

Phytoremediation is an interdisciplinary technology that can benefit from many different approaches [10]. Results already obtained have indicated that some plants can be effective in toxic metal remediation. The processes that affect metal uptake, availability, translocation, degradation, chelation, and volatilization need to be investigated in detail [8].

The importance of biodiversity (below and above ground) is increasingly considered for the cleanup of the metal contaminated

ecosystems. This area is evolving as a revolutionary area of research gaining commercial significance in the contemporary field of environmental biotechnology.

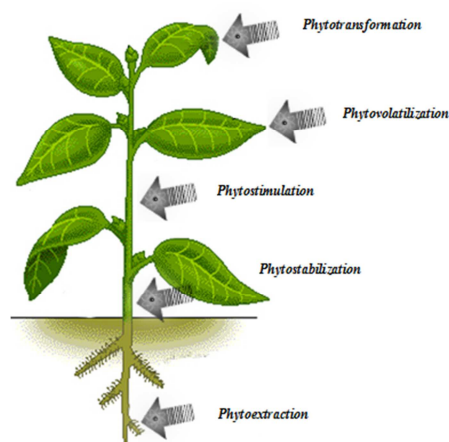


Figure 2. Mechanism of Phytoremediation.

Plant tissue culture is a convenient laboratory tool for phytoremediation studies [5]. Once established, these in vitro cultures can be propagated indefinitely and are available on demand. In contrast, whole plants grown either in soil or hydroponic systems have a limited lifespan and each individual plant needs to be replaced and reestablished after each experiment. Therefore, the time required to carry out experimental investigations may be substantially reduced using plant tissue cultures rather than whole plants.

Advantages of Tissue Cultured Plantlets

Locally adapted tissue cultured plants could be used for seed increase or transplantation onto contaminated site. Plants produced through tissue culture have several advantages:

- Plants are genetically similar having same characteristics, e.g. heavy metal tolerance
- More number of plants generated in very short time
- Maturation rate of plants will be higher
- Small space will be required for culturing many plants

No commercial plant nurseries or tissue culture labs provide any heavy metal tolerant locally adapted tissue cultured plants. Plant tissue cultures also offer important technical advantages compared with whole plants. Because in vitro plant cultures are grown and maintained free from microbial contamination.

Tissue cultures offer more than just experimental convenience and speed compared with whole plant systems. By eliminating the effects of micro flora and translocation barriers, a closer approximation to the intrinsic capacity of plant cells for detoxification of pollutants can be obtained.

Conclusion

Plant tissue cultures are a powerful tool in phytoremediation research as model systems to identify the biochemical responses of plant cells to environmental contaminants, the metabolic capabilities of plant tissues, and the reaction products formed. Plant tissue culture offers the opportunity to examine the genetic endowment or intrinsic enzymatic capacity of particular plant species or cultivars removed from the effects of microbial activity. Much further work is needed in this area to enhance our understanding of the complex biotransformation mechanisms and pathways employed by plants to detoxify organic pollutants [1].

Efforts should be made for dense vegetation of heavy metal bioaccumulation plants at the industrially contaminated sites. So that they reduce pollution and also give eco friendly aesthetic sense to enhance the beauty of the Bhopal city. Growing and, in some cases, harvesting plants on a contaminated site must be compulsory condition to setup or run a specific industry because

this remediation method is an aesthetic, driven by solar-energy, that can be used to clean up sites with shallow, or low to moderate levels of contamination. Government and industry must be committed to phytoremediation program. It must be a primary requirement to setup or run the industry. A particular industry must follow the phytoremediation plan according to the type of pollutants emitted by the industry. Phytoremediation workout should be major criteria for grading the industry [4].

We are truly living in extraordinary time on earth. Our today's activities will have negative impact on the planet for decades, it will also harmful to our future generations. Thus now there time to understand the need for clean up technologies for environmental pollution like phytoremediation which ultimately proved to be hope for the green and clean planet.

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