Extended Abstract Journal of Biotechnology and Phytochemistry 2019

Vol 3:1

Role of Biotechnology in Phytoremediation

Buhari Muhammad L[1]*, Sulaiman Babura R[2], Vyas NL[1], Badaru Sulaiman[1] and Harisu Umar Y[1]

*Corresponding Author: Buhari Muhammad L, Department of Botany, Jodhpur National University, India, Tel: +919001137408, E-mail: buharilawan20@gmail.com

Phytoremediation, the use of plants and their associated microbes to accumulate, detoxify and/or stabilise contaminants, is an environment-friendly and sustainable means of remediating contaminated soil and water. Phytoremediation has been an important aspect of constructed wetlands, which have been used successfully to detoxify large volumes of wastewater with dilute concentrations of contaminants, including petroleum, hydrocarbons, chlorinated solvents, pesticides, explosives, heavy metals and radio nucleids. The most important requirement for Phytoremediation is the use of fast growing high biomass plants that are capable of uptake and accumulation of large amounts of toxic metals in their aboveground harvestable parts. In recent years major scientific progress has been made in understanding the physiological mechanism of metal uptake and transport in these plants. Since most metal hyper accumulators are slow growing and have low biomass, bioengineering of non accumulators having high biomass is essential for effective phytoremediation. Plants adopted for phytoremediation are usually found to exhibit the specific property due to the presence of the special genes coding for it. These plants are usually seen in area where metal ores exist. The genes responsible for this resistance by such plants are isolated and expressed in wide variety of transgenic plants so that they can be made resistant as well. This increases the number of plant species that can be used for such purpose. It is also possible with the help of biotechnology to increase the gene expression for maximum resistance. Certain plants are seen to show increased resistance under the presence of certain microbes. Biotechnology makes it possible to isolate such microbes and enrich the soil so as to enhance the phytoremediation by respective plants. This paper reviews the biotechnological approaches to improve plants' ability to tolerate different pollutants and phytoremediation efficiency and highlights future challenges.

Soil contamination has become an important environmental problem worldwide because of its detrimental effects on human and ecosystem health, soil productivity, and socioeconomic well-being . An increasingly industrialized global economy has led to dramatically elevated releases of anthropogenic chemicals into the environment over the last century and resulted in contamination of many areas on Earth. In 1994, there were an estimated 22 million ha of contaminated soils worldwide. The European Environment Agency has estimated the total costs for the cleanup of contaminated sites in Europe to be between EUR 59 and 109 billion. Also the tsunami that stroke Japan in 2011 not only caused extensive damage to the country's infrastructure, but also poisoned the environment when it caused the Fukushima nuclear power plant to leak radiation into the surrounding area. The cleanup of Japan's radioactive water and land is expected to take decades and will require a variety of corrective methods. One potential method for removing the poisonous material from the environment is through phytoremediation.

Phytoremediation is special application of bioremediation. It is a natural biological process of degradation of xenobiotic and recalcitrant compounds responsible for environmental pollution. In this process specially selected or genetically engineered plants are used which are capable of direct uptake of pollutants from the environment. Phytoremediation can be applied to both inorganic and organic pollutants present in solid and liquid substrate. The word phyto stands for 'plant' hence the remediation mediated by plant system. Phytoremediation involves many processes which are carried out by plant during their growth on contaminated site. A contaminant is treated by plants using all or some of these reactions like phytoextraction, phytostabilization, phytotransformation, phytostimulation and phytovolatization.

As may be clear from the active plant processes involved, plant species differ in their ability to remediate different pollutants, depending on their abundance of transporters and enzymes, their microbial partners, and their transpiration rate. In addition, some general properties of a good phytoremediator species are fast growth and high biomass, hardiness, and tolerance to pollutants. It is an added bonus if a plant species has economic value. All of these biological properties important for phytoremediation may potentially be ameliorated using genetic engineering. Biotechnology offers the opportunity to transfer hyper accumulator phenotypes into fast growing, high biomass plants that could be highly effective in Phytoremediation. Different pollutants have different fates in plant-substrate systems, so they have different rate-limiting factors for phytoremediation that may be targeted using genetic engineering. For instance, remediation of hydrophobic organics may be limited by their release from soil particles, which may be improved by enhanced production of biosurfactants by roots or root-associated microbes. Similarly, certain metals may be made more bioavailable by root excretion of metal chelators and protons. In the case of rhizodegradation, the secretion of degrading enzymes from roots may be up regulated, as can the secretion of compounds that stimulate microbial density or activity. Uptake and transport into/inside plants may be limited by the abundance of membrane transporters, particularly for inorganics, which depend on uptake on transporter proteins. Organics, when moderately hydrophobic, can often pass membranes passively and do not need transporters. If it is

known which transporters mediate pollutant uptake and translocation, these may be overproduced in plants. Plant tolerance, in turn, may be limited by the abundance of enzymes that modify, degrade, or chelate pollutants, or general antioxidant enzymes. Depending on the suspected limiting factors, any such enzymes may be over-expressed to enhance phytoremediation capacity. In addition to boosting the expression of existing genes, novel genes may be introduced from other plant species or any organism. In this way, a totally new phytoremediation capacity may be introduced into a suitable plant species for phytoremediation. All of these approaches have been used successfully.