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Review Article

BIOTERRORISM IS A DANGEROUS TO ENVIRONMENT- A REVIEW

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ABSTRACT

Phytoremediation is a group of technologies that use plants to reduce, remove, degrade, or immobilize environmental toxins, primarily those of anthropogenic origin with the aim of restoring area sites to a condition useable for private or public applications. Phytoremediation efforts have largely focused on the use of plants to accelerate degradation of organic contaminants, usually in concert with root rhizosphere microorganisms, or remove hazardous heavy metals from soils or water. Phyto-remediation of contaminated sites is a relatively inexpensive and aesthetically pleasing to the public compared to alternate remediation strategies involving excavation/removal or chemical in situ stabilization/conversion. Seven aspects of phytoremediation are described in this chapter: phyto-extraction, phyto-degradation, rhizosphere degradation, rhizofiltration, phytostabilization, phytovolatization, and phytorestoration. Combining technologies offer the greatest potential to efficiently phytoremediate contaminated sites (soil and water). The major focus of this study is phytoextraction of arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, and zinc. Scientists should place emphasis on their ethical responsibility for sustainable food production and environmental security since otherwise, bioterrorism could become a major threat to human and environmental security in the near future.

Keywords: Phyto-remediation, Phytoextraction, Phytodegradation, Rhizofiltration, Phytostabilization, Phytovolatization, Phytorestoration, sustainable food production, Eco-friendly environment and Bioterrorism

INTRODUCTION

Rapid population growth in developing countries like India makes difficult to sustain democratic societies and productive economics. Continued population growth is driving global agriculture to high yield production that almost demands large scale, mechanized operations based on chemical and generic technology rather than on natural systems and ecosystems. As a result farmers have been forced to supply increasing does of fertilizers to maintain the crop yield. But, crop yield have failed to show much improvement owing to the acute deterioration in the soil fertility, soil ecosystems are threatened by the progressive loss of organic material (humus) as farmers abandon organic for chemical fertilizers and after the landless fallow or resting time. To make the situation even worse, pest problems have mounted over time requiring increasing application of chemical pesticides, which has further escalated soil and water quantity. This is known as bioterrorism. The food supply is increasing vulnerable to resource constraints. Sound agricultural and population polices implemented today can make the future more secure for food and environment.

INTENSITY OF POLLUTION

The pollutants in the soil and water environment can come from many different sources like chemical industry and the agricultural industry. The chemical industry alone generates over 2500 million pounds of water and the amount of chemicals discharged to surface water, injected underground or released to land totals more than one billion pounds. The agricultural industry also produces tonnes of hazardous chemicals in the form of pesticides, fungicides and herbicides were employed in order to increase crop yields.

The council of environment quality claims that agriculture accounts for 40% of the pollution. These amounts of chemicals being released into the environment represent a potentially serious disposal problem.

HOW TO CONSERVE THE ENVIRONMENT

Disposal of the waste into degradable form itself is the critical first step to conserve the environment. Bioremediation is a multidisciplinary process that uses microorganisms/enzymes from microorganisms to detoxify pollutants in the soil and water environments. The bioremediation process was efficient and accounted for an almost complete removal of contaminants in the soil (Kolwan, 2009).

METHODS OF BIOREMEDIATION

LAND FARMING

Land farming is an on-site treatment method, which is frequently utilized by the petroleum industry (Duncan *et al*., 2003). Nutrient and oxygen are also used to create an optimal environment for microbial activity. Only land with a thick clay layer are used in order to prevent contaminates from leaching into a ground water supply.

COMPOSTING

Farmers have been using composting bioremediation for quite a few years. It includes pilling biodegradable material and using microorganisms to remove natural organic wastes while generating organic matter. This method has recently been very successful in breaking down tri nitro toluene (TNT) to less than 10% of the original level within 75-80 days.

Above ground bio-reactor

Above ground bioreactors uses containment vessels with microorganisms in suspension which are used to incubate contaminated waste in a liquid or slurry form. This form can be very effective because ideal conditions for microbial transformation of the chemical can be created.

In-situ treatment

In-situ bioremediation was microorganisms particularly interesting at the actual site of contamination. This is native to the contaminated site; because of this the organisms are adopted for microbes with transform the compound until one nutrient reaches a limiting concentration. This form of bioremediation was used in soil spills.

ADVANTAGES

- Bioremediation is a naturally method to reduce toxins
- This techniques are generally economically viable than traditional methods
- Bioremediation results in complete degradation of the contaminants
- Pollutants can be treated at the site itself
- Reducing exposure to clean workers.

DISADVANTAGES

- Require careful monitoring
- Determining the ability of microorganisms to adopt the contaminated site is little difficult
- Limited capabilities of the native microbes.

PHYTOREMEDIATION

Phytoremediation is a group of technologies that use plants to reduce, remove, de-grade, or immobilize environmental toxins, primarily those of anthropogenic origin, with the aim of restoring area sites to a condition useable for private or public applications. The generic term Phytoremediation consists of the Greek prefix phyto (plant), attached to the Latin root remedian (to correct or remove an evil). The mechanism of Phytoremediation includes enhanced rhizosphere biodegradation (Ghosh and Singh, 2005). Many plants produce molecules called peptides that bind metals for storage in cell compartments. It is important that the plants, which are selected for Phytoremediation, are suitable for agricultural practices and is able to produce enough biomass with maximum uptake of metallic compounds in order to be effective.

THE PRINCIPLE

- Use plants to "vacuum" heavy metals from the soil through their roots
- Certain species have the ability to extract elements from the soil and concentrate them in the stems, shoots, and leaves
- The unique plants must be able to tolerate and survive high levels of heavy metals in soils-like zinc, cadmium, and nickel.
- These plants possess genes that regulate the amount of metals taken up from the soil by roots and deposited at other locations within the plant.
- Some contaminants also changed into safer gases as plant transpires

METHODS OF PHYTOREMEDIATION

Phytoextraction

The use of plants to remove contaminants from the environment and concentrate them in above ground plant tissue is known as phytoextraction. It is also known as phytoaccumulation, the uptake of contaminants by plant root and the translocation/accumulation of contaminants into the plant shoots and leaves. Research and development efforts focus on two areas of study: (1) remediation of contaminants such as Pb, As, Cr, Hg, and radio nuclides and (2) mining, or recovery, of inorganic compounds, mainly Ni and Cu is having intrinsic economic value. Phyto-extraction can be used in both water and soil environments. Phyto-extraction involves the removal of toxins, especially heavy metals and metalloids, by the roots of the plants with subsequent transport to aerial plant organs. Pollutants accumulated in stems and leaves are harvested with accumulating plants and removed from the site. Phyto-extraction can be divided into two categories: continuous and induced (Anderson *et al*., 1993).

Continuous phytoextraction requires the use of plants that accumulate particularly high levels of the toxic contaminants throughout their life time (hyperaccumulators), while induced phytoextraction approaches enhance toxin accumulation at a single time point by addition of accelerants or chelators to the soil. In the case of heavy metals, chelators like EDTA assist in mobilization and subsequent accumulation of soil contaminants such as lead (Pb), cadmium (Cd), chromium(Cr), copper (Cu), nickel (Ni), and zinc (Zn) in Brassica juncea (Indian mustard) and Helianthus anuus (sunflower) (Prasad, 2011). The ability of other metal chelators such as CDTA, DTPA, EGTA, EDDHA, and NTA to enhance metal accumulation has also been assessed in various plant species (Aksoy *et al*., 2000). However, there may be risks associated with using certain chelators considering the high water solubility of some chelator toxin complexes which could result in movement of the complexes to deeper soil layers (Baker and Brooks, 1989) and potential ground water and estuarian contamination.

PHYTODEGRADATION

Metabolism of contaminants within plant tissues are known as Phytodegradation. Phytodegradation, also called “phyto-transformation,”refers to the uptake of contaminants with the subsequent breakdown, mineralization, or metabolization by the plant itself through various internal enzymatic reactions and metabolic processes. Depending on factors such as the concentration and composition, plant species, and soil conditions, contaminants may be able to pass through the rhizosphere only partially or negligibly impeded by phyto-sequestration and/or rhizodegradation. In this case, the contaminant may then be subject to biological processes occurring within the plant itself, assuming it is dissolved in the transpiration stream and can be phyto-extracted (Prasad, 2011). Plants catalyze several internal reactions by producing enzymes with various activities and functions specifically; oxygenases have been identified in plants that are able to address hydrocarbons such as aliphatic and aromatic compounds. Similarly, nitro-reductases are produced in some plants that can reduce and breakdown energetic compounds such as the explosives trinitrotoluene (TNT), 1, 3, 5 trinitroperhydro -1, 3, 5- triazine (RDX) and 1,3,5,7 tetranitro 1,3,5,7 tetrazocine (HMX High melting explosive) (Anonymous, 2009). Many of the plant enzymes may even be able to metabolize or mineralize several chemicals completely to carbon dioxide and water (McCutcheon and Schnoor, 2003).

Phytostabilization

Production of chemicals compounds by plant, are used to immobilize contaminants at the interface of roots and soil. Phytostabilization involves the establishment of a plant cover on the surface of the contaminated sites with the aim of reducing the mobility of contaminants within the vadose zone through accumulation by roots or immobilization within the rhizosphere, thereby reducing off-site contamination. The process includes transpiration and root growth that immobilizes contaminants by reducing leaching, controlling erosion, creating an aerobic environment in the root zone and adding organic matter to the substrate that binds the contaminant. Microbial activity associated with the plant roots may accelerate the degradation of organic contaminants such as pesticides and hydrocarbons to nontoxic forms. Phytostabilization can be enhanced by using soil amendments that immobilize metals combined with plant species that are tolerant of high levels of contaminants and low-fertility soils or tailings. Soil amendments used to enhance immobilization may need to be periodically reapplied to maintain their effectiveness (Nanthi *et al*., 2011). We critically examine the applicability of this technology to manage metals contaminated soils and identify fertile areas for future research.

Phytovolatilization

Plants can also remove toxic substances, such as organics, from the soil through phyto-volatization. In this process, the soluble contaminants are taken up with water by the roots, transported to the leaves, and volatized into the atmosphere through the stomata. The best example of this is the volatilization of mercury (Hg) by conversion to the elemental form in transgenic Arabidopsis and yellow poplars containing bacterial mercuric reductase. In a study where the movement of volatile organics was monitored by Fourier transform infrared spectrometry in hybrid poplars, Tamarix parviflora, and Medicago sativa (alfalfa) chlorinated hydrocarbons were found to move readily through the plants, but less polar compounds like gasoline constituents did not (Wendy *et al*., 2009). However, amounts of the contaminant transpired are in proportion to water flow and are relatively low, especially in the field. Selenium (Se) is a special case of a metal that is taken up by plants and volatilized. Selenium can also be volatilized following conversion to dimethyl selenide by microbes and algae.

Rhizofiltration

Rhizofiltration removes contaminants from water and aqueous waste streams, such as agricultural runoff, industrial discharges, and nuclear material processing wastes. Absorption and adsorption by plant roots play a key role in this technique, and consequently large root surface areas are usually required. Rhizofiltration was also to be useful in removal of 89% Se from selenite contaminated wastewater released from various oil refineries. The water flowing into the wetland was measured to have 20-30μg L^{-1} selenite, while the outflow from the wetland had less than 5μg L^{-1}selenite.

SUMMARY

There is need for greater vigil against the environment conservation. We don't know the value of our system. We would like to reiterate that bioremediation and Phytoremediation efforts have largely focused on the use of plants to accelerate degradation of organic contaminants, usually in concert with root rhizosphere microorganisms, or remove hazardous heavy metals from soils or water. Phytoremediation of contaminated sites(soil and water) is a relatively inexpensive and aesthetically pleasing to the public compared to alternate remediation strategies involving excavation/removal or chemical in situ stabilization/conversion. Phytoremediation are methods which can almost completely degrade waste with little or no toxic by plant products and also at a fraction of the cost of traditional waste disposal methods. The major focus of this topic is phytoextraction of arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, and zinc. Scientists should place emphasis on their ethical responsibility for sustainable food production and environmental security since otherwise, bioterrorism could become a major threat to human and environmental security in the near future.

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