EDITORIAL

Phytoremediation to reduce soil and water pollutions

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Phytoremediation is a method of bioremediation that utilizes different kinds of plants in the soil and groundwater to eliminate, stabilize, and kill pollutants. This uses various types of plants like Solanum nigrum, Arabidopsis halleri. Phytoremediation is proposed as a cost-effective plant-based environmental remediation solution that takes advantage of the ability of plants to concentrate and detoxify different substances from the atmosphere.

In this era not only in industrial areas, but even cultivated lands are contaminated by heavy metals, creating threats to human health. Brassicaceae species are very helpful in accumulating certain metals while generating high volumes of biomass in the process, and the star of this category is Indian mustard [1].

Poplar trees are the plants most utilized and studied. These plants have been used by the US Air Force to contain trichloroethylene (TCE) in groundwater. EPA showed in Iowa that poplar trees were natural pumps to keep harmful herbicides, pesticides and fertilizers out of the streams and groundwater. To kill explosive substances in the soil and groundwater, the US Army Corps of Engineers has experimented with wetland plants. Trinitrotoluene (TNT) decreased to 5 percent of the original concentration in submerged and floating-leafed plants. Submersed plants were able to reduce levels of Royal Demolition Explosive (RDX) by 40 percent and RDX decreased by 80 percent when microbial degradation was applied. Phytoremediation has the benefits of using:

- It will reduce the exposure of contaminants to the atmosphere and the ecosystem, both environmentally and eco- friendly.
- It can be extended to a large-scale area and can be quickly disposed.
- It avoids corrosion and leaching of metals by stabilizing heavy metals, reducing the chance of pollutants spreading.
- Economically feasible-phytoremediation is a solar-powered autotrophic device, thus easy to operate, and installation and maintenance costs are minimal.
- By releasing various organic matters into the soil, it can also enhance soil fertility.

In soil, heavy metal occurs mostly as an insoluble form that is not bioavailable to plants. By releasing a variety of root exudates, plants can increase their bioavailability, which can alter rhizosphere pH and increase heavy metal solubility. At the root surface, the bioavailable metal is sorbed and passes through the root cells across the cell membrane. The absorption of heavy metals into roots occurs predominantly through two pathways, the apoplastic pathway and the symplastic. An energy-dependent process mediated by metal ion carriers or complexing agents is the common uptake of heavy metals through symplastic pathways. Heavy metal ions can form complexes with various chelators, such as organic acids, after entering into root cells. These complexes are then immobilized in extracellular space (apoplastic cell walls) or intracellular spaces, including carbonate, sulfate, and phosphate precipitate (symplastic compartments, such as vacuoles). The metal ions sequestered inside the vacuoles can be passed into the stele through the root symplasm and enter the xylem stream and are then transferred to the shoots through xylem vessels.

They are transported and transmitted by apoplast or symplast in leaves where ions are sequestered in extracellular compartments (cell walls) or in plant vacuoles, thereby preventing the accumulation of free metal ions in cytosol ions [2].

Detoxification of heavy metals is a crucial condition for phytoremediation. There are usually two protective mechanisms adopted by plants to cope with heavy metal toxicity: avoidance and tolerance. Plants tend to keep the cellular concentrations of heavy metals below the toxicity threshold thresholds by these two mechanisms.

Continuous attempts have been made to develop technologies that are easy to use, safe and economically viable in order to preserve good soil quality and keep it free of pollution. Physicochemical approaches, especially on a small scale, have been widely used for remedying contaminated soil. However, due to high costs and side effects, they are more complicated for a wide scale of remediation. Since the last decade, the use of plant species for cleaning contaminated soils, called phytoremediation, has gained growing popularity as an emerging cheaper technology. In the last two decades, several studies have been conducted in this area. Many plant species have been described and checked for their characteristics in the processing and accumulation of various heavy metals. Progress has been made in the mechanical and functional implementation of phytoremediation elements. As, Cu, Cd, Pb, Cr, Ni, Hg and Zn contain heavy metals that have been found in the contaminated climate. For volatile metals, conventional disposal approaches such as burning and ashing are not applicable; thus, research is required to develop new methods for successful metal recovery from hyperaccumulative plant biomass.

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