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PHYTOREMEDIATION FOR SOIL POLLUTION MANAGEMENT

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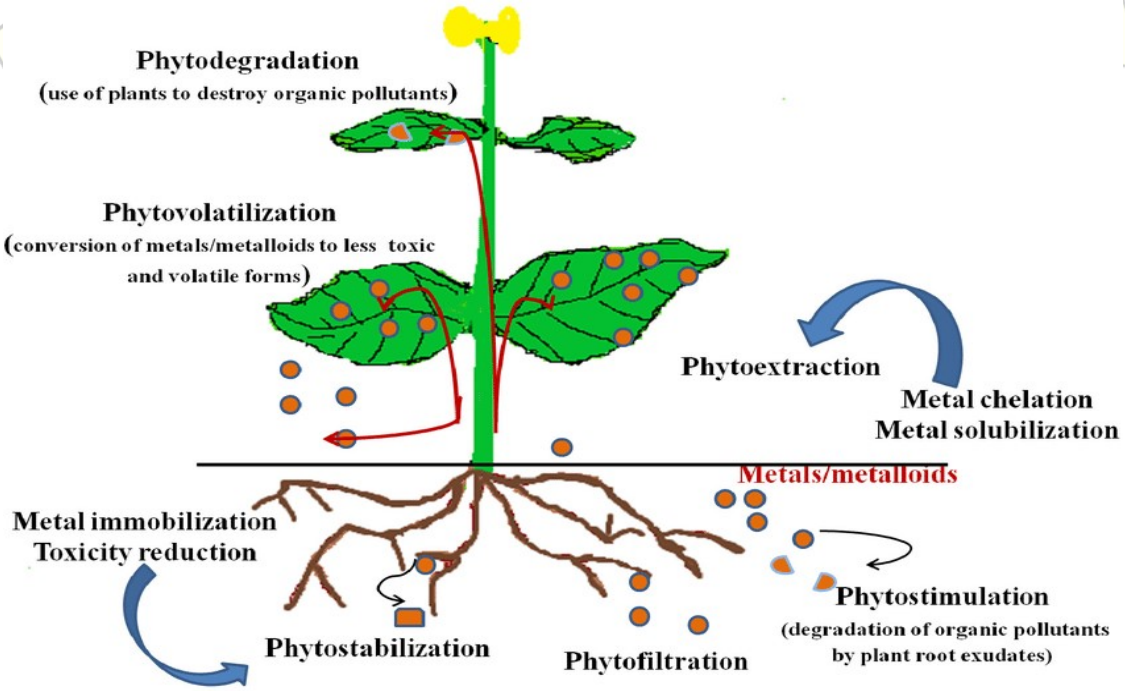
Phytoremediation is a bioremediation process that uses various types of plants to remove, transfer, stabilize, and/or destroy contaminants in the soil and groundwater.

It is used for the remediation of metals, radionuclides, pesticides, explosives, fuels, volatile organic compounds and semi-volatile organic compounds. It is defined as the use of green plants and the associated microorganisms, along with proper soil amendments and agronomic techniques to either contain, remove or render toxic environmental contaminants.

It may be used to clean-up contaminants found in soil and groundwater. For radioactive substances, chelating agents are sometimes used to make the contaminants amenable to plant uptake. Although attractive for its cost, phytoremediation has not been demonstrated to redress any significant environmental challenge to the extent that contaminated space has been reclaimed.

DESCRIPTION ON PHYTOREMEDIATION AS A METHOD OF SOIL POLLUTION MANAGEMENT.

Phytoremediation is proposed as a cost-effective plant-based approach of environmental remediation that takes advantage of the ability of plants to concentrate elements and compounds from the environment and to detoxify various compounds. The concentrating effect results from the ability of certain plants called hyperaccumulators to bioaccumulate chemicals. The remediation effect is quite



different. Toxic heavy metals cannot be degraded, but organic pollutants can be and are generally the major targets for phytoremediation. Several field trials confirmed the feasibility of using plants for environmental clean-up.

Phytoremediation may be applied to polluted soil or static water environment. This technology has been increasingly investigated and employed at sites with soils contaminated heavy metals like with cadmium, lead, aluminium, arsenic and antimony. These metal can cause oxidative stress in plants, destroy cell membrane integrity, interfere with nutrient uptake, inhibit photosynthesis and decrease plant chlorophyll.
Phytoremediation has been used successfully include the restoration of abandoned metal mine workings, and sites where polychlorinated biphenyls have been dumped during manufacture and mitigation of ongoing coal mine discharges reducing the impact of contaminants in soils, water, or air. Contaminants such as metals, pesticides, solvents, explosives, and crude oil and its derivatives, have been mitigated in phytoremediation projects worldwide. Many plants such as mustard plants, alpine pennycress, hemp, and pigweed have proven to be successful at hyperaccumulating contaminants at toxic waste sites.

There are several different types of phytoremediation mechanisms. These are:

1. **Rhizosphere biodegradation** (Phyto-stimulation) In this process, the plant releases natural substances through its roots, supplying nutrients to microorganisms in the soil. The microorganisms enhance biological degradation.

2. **Phyto-stabilization** in this process, chemical compounds produced by the plant immobilize contaminants, rather than degrade them.

3. **Phyto-accumulation** (also called phytoextraction). In this process, plant roots absorb the contaminants along with other nutrients and water. The contaminant mass is not destroyed but ends up in the plant shoots and leaves. This method is used primarily for wastes containing metals.

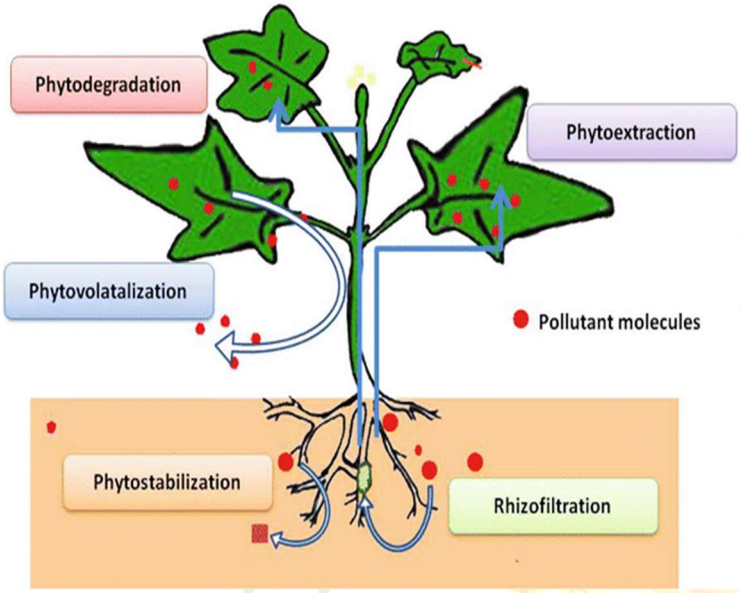
4. **Rhizofiltration** is similar to phytoaccumulation, but the plants used for clean-up are raised in greenhouses with their roots in water. This system can be used for ex-situ groundwater treatment. That is, groundwater is pumped to the surface to irrigate these plants. *Sunflowers, using rhizofiltration, were used successfully to remove radioactive contaminants from pond water in a test at Chernobyl, Ukraine.*

5. **Phyto-volatilization** In this process, plants take up water containing organic contaminants and release the contaminants into the air through their leaves.

6. **Phyto-degradation** in this process, plants actually metabolize and destroy contaminants within plant tissues.

7. **Biological hydraulic containment** occurs when some plants, like poplars, draw water upwards through the soil into the roots and out through the plant, which decreases the movement of soluble contaminants downwards, deeper into the site and into the groundwater.

8. **Phyto-desalination** uses halophytes (plants adapted to saline soil) to extract salt from the soil to improve its fertility.



Examples

1. Submersed and floating-leafed species (coontail and pondweed, and arrowhead, respectively) decreased trinitrotoluene (TNT) to 5% of original concentration.

2. Submersed plants were able to decrease Royal Demolition Explosive (RDX) levels by 40%, and when microbial degradation was added, RDX decreased by 80%.

3. Mercury, selenium and organic pollutants such as polychlorinated biphenyls (PCBs) have been removed from soils by transgenic plants containing genes for bacterial enzymes.

4. Salt-tolerant (moderately halophytic) barley and/or su gar beets are commonly used for the extraction of sodium chloride (common salt) to reclaim fields that were previously flooded by sea water.

5. Chromium is toxic to most plants. Tomato (Solanum lycopersicum) however shows some promise.

ADVANTAGES:

1. The cost of the phytoremediation is lower than that of traditional processes both in situ and ex situ.
2. The possibility of the recovery and re-use of valuable metals (by companies specializing in "Phyto mining").
3. It preserves the topsoil, maintaining the fertility of the soil.
4. Increase soil health, yield, and plant phytochemicals.
5. The use of plants also reduces erosion and metal leaching in the soil.

LIMITATIONS AND CONCERNS

1. The toxicity and bioavailability of biodegradation products is not always known.

2. Degradation by-products may be mobilized in groundwater or bio-accumulated in animals. Additional research is needed to determine the fate of various compounds in the plant metabolic cycle to ensure that plant droppings and products do not contribute toxic or harmful chemicals into the food chain.

3. Scientists need to establish whether contaminants that collect in the leaves and wood of trees are released when the leaves fall in the autumn or when firewood or mulch from the trees is used.

4. Disposal of harvested plants can be a problem if they contain high levels of heavy metals.

5. The depth of the contaminant's limits treatment. The treatment zone is

determined by plant root depth. In most cases, it is limited to shallow soils, streams, and groundwater. Pumping the water out of the ground and using it to irrigate plantations of trees may treat contaminated groundwater that is too deep to be reached by plant roots. Where practical, deep tilling, to bring heavy metals that may have moved downward in the soil closer to the roots, may be necessary.

6. Generally, the use of phytoremediation is limited to sites with lower contaminant concentrations and contamination in shallow soils, streams, and groundwater. However, researchers are finding that the use of trees (rather than smaller plants) allows them to treat deeper contamination because tree roots penetrate more deeply into the ground.

7. The success of phytoremediation may be seasonal, depending on location. Other climatic factors will also influence its effectiveness.

8. The success of remediation depends in establishing a selected plant community. Introducing new plant species can have widespread ecological ramifications. It should be studied beforehand and monitored.

9. If contaminant concentrations are too high, plants may die. Some phytoremediation transfers contamination across media, (e.g., from soil to air).

10. Phytoremediation requires a large surface area of land for remediation.

As we know that a sustainable soil management is very important for the continuation of living organisms, but due to excess population and human wants and technologies the soil is getting deteriorated day by day. So, phytoremediation with its many different forms will suit different kinds of soil problems and soils with various contaminants, prevent the soil from degradation and maintain the fertility and soil life.