ARYAVART SHODH VIKAS PATRIKA
RNI TITLED NO. UPBIL04292
RNI REG. NO. UPBIL/2014/66218 **PP. No.- 244-247**

I S S N NO. - 2347 – 2944 (Print)
e-I S S N NO.- 2582 – 2454 (Online)
Vol.-19, No.-II, Issues-36, YEAR-April-June. 2025

PHYTOREMEDIATION – A TECHNIQUE FOR WASTE WATER TREATMENT

DR. Nidhi Gupta

Assistant Professor - Department of Botany, Dayanand Girls Post Graduate College, Kanpur (U.P.) India

Received-16.06.2025 **Revised-22.06.2025** **Accepted-29.06.2025** **Email : nidhi.dgc@gmail.com**

Abstract: ***Water is scarce if not sustained properly. Recently, the quantity of polluted water has been increasing gradually and is affected by the term waste water. To bring up waste water as utility Water in humankind, nowadays phytoremediation has become a modern eco-friendly technology . Phytoremediation uses plants to clean up contaminated environments. Plants can help clean up many types of contaminants including metals, pesticides, explosives, and oil. However, they work best where contaminant levels are low because high concentrations may limit plant growth and take too long to clean up. Plants also help prevent wind, rain, and groundwater flow from carrying contaminants away from the site to surrounding areas or deeper underground. It is a green technology where both terrestrial and aquatic plant species are chosen conveniently to treat waste water to be remediated from various contaminants. The use of hydrophytes (aquatic macrophytes) as phytoremediators to treat waste water has been pronounced well in the research and commercial field. Here a short approach has been taken to enhance the awareness of phytoremediation in waste water treatment. Water being the source of life has become a scarce resource in this millennium. Since the limited resource availability, reuse of the available supply is more suggestible. For the said goal, many technologies prevail addressing the task, among which is the technique Phytoremediation. Lots of waste waters get generated from industrial, commercial and domestic origins and are discarded. Phytoremediation converts this wastewater into usable water with the help of plants. This is a very eco-friendly technique which decontaminates the wastewater in a very economical way.This study emphasis on treatment of wastewater using different plants such as Duckweed, water hyacinth etc.***

Key words: Polluted water, human kind, phytoremediation, eco-friendly, Green technology, hydrophytes.

Introduction - Environmental pollution affects the quality of Hydrosphere, Atmosphere, Lithosphere and Biosphere. Heavy metals, industrial pollutants, in contrast with organic materials cannot be degraded and therefore accumulate in water soil, bottom sediments and living organisms. The use of Plants to remove heavy metal, known as " Phytoremediation " offers economic and environmental advantages and is a promising technique. Phytoremediation is the use of plants to partially or substantially remediate selected contaminants in contaminated water and soil. It utilises a variety of plant biological processes and the the physical characteristics of plants to and in site remediation.

Water resources are one of the most critical factors contributing to the Principal life – supporting system. Nearly 76% of the earth 's surface is covered with water, hence, this planet is also known as 'watery earth' Out of 76%of the world's water, 96.5% is in the oceans as salty water 3.5% is usable water for municipal, agricultural and industrial purposes of which 1.71% comes from streams, ponds, lakes and groundwater and the remaining 1.79% is trapped in glaciers, permafrost, saline lakes, swamps, atmosphere and living biomass.(Pandey et.al. 2010)

REVIEW OF LITERATURE - Excessive metal concentration in soil and water pose significant hazard to human, animal, plant health and to the environment in general. Contamination of soils with toxic metals has often resulted from human activities, especially those related to mining, industrial emissions, disposal and leakage of industrial wastes, application of sewage sludge to agricultural soils, manure, fertiliser and pesticide use. Due to the potential toxicity and high persistence of metals, soil and water polluted with these elements are in environmental problem that requires an effective and affordable solution. Although a number of techniques have been developed to remove metals from contaminated soils, many sites remain contaminated because economic and environmental costs to clean up those sites with the available technologies are too high (Clistenes Williams AraujodoNascimento and Baoshan Xing, 2006). Therefore, heavy metal pollution poses a great potential threat to the environment and human health. Phytoremediation is a set of processes that uses plants to remove, transfer, stabilize, and destroy organic/inorganic contamination in ground water, surface water, and soil (Kumar and Pal, 2011).

Phytoremediation Technology is simple, cost-effective, sustainable, compatible, eco-friendly and constitutes one of the main components of green technology. Plants have the natural ability to degrade these heavy metals by means of various processes such as bioaccumulation, translocation and pollutant storage/degradation. Phytoremediation is about 10 fold cheaper than classical engineering approaches since

Corresponding Author / Joint Authors

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it is performed in situ, is solar driven, and can function with minimal maintenance oce establnished. (Bilal et. al., 2015, Nascimento and Xing, 2006)

DISCUSSION - The word Phytoremediation comes from the Greek word phyto means plant, and Latin "remedium" means restoring balance or remediation. Phytoremediation consists in mitigating pollutant concentrations in contaminated soils and water with plants able to contain, degrade or eliminate metals, pesticides, solvents explosives crude oil and its derivatives, and various other contaminants from the media that contain them.

Phytoremediation uses plants to cleanup contaminated soil and groundwater, taking advantage of plants' natural abilities to take up, accumulate, and/or degrade constituents of their soil and water environments. Results of research and development into phytoremediation processes and techniques report it to be applicable to a broad range of contaminants including numerous metals and radionuclides, various organic compounds (such as chlorinated solvents, BTEX, PCBs, PAHs, pesticides/insecticides, explosives, nutrients, and surfactants. According to information reviewed, general site conditions best suited for potential use of phytoremediation include large areas of low to moderate surface soil (0 to 3 feet) contamination or large volumes of water with low-level contamination subject to low (stringent) treatment standards. Depth to groundwater for in situ treatment is limited to about 10 feet, but ex situ treatment in constructed troughs or wetlands has also been investigated. There are five basic types of phytoremediation techniques: 1) rhizofiltration, a water remediation technique involving the uptake of contaminants by plant roots; 2) phytoextraction, a soil technique involving uptake from soil, 3) phytotransformation, applicable to both soil and water, involving the degradation of contaminants through plant metabolism, 4) phyto-stimulation or plant-assisted bioremediation, also used for both soil and water, which involves the stimulation of microbial biodegradation through the activities of plants in the root zone, and 5) phytostabilization, using plants to reduce the mobility and migration potential of contaminants in soil. Major advantages reported for phytoremediation as compared to traditional remediation technologies include the possibility of generating less secondary wastes, minimal associated environmental disturbance, and the ability to leave soils in place and in a usable condition following treatment. Cited disadvantages include the long lengths of time required (usually several growing seasons), depth limitations (3 feet for soil and 10 feet for groundwater), and the possibility of contaminant entrance into the food chain through animal consumption of plant material.

METHODS OF PHYTOREMEDIATION - The use of green plants to remove pollutants from the environment or render them harmless is defined as Phytoremediation (Cunningham and Berti, 1993) . Phytoextraction, phytostabilization and phytofiltration are three processes involved in Phytoremediation (Salt et al.,1998); processes which can help reduce metal content of for instance storm water.

METHODOLOGY PROCESSES OF PHYTOREMEDIATION - Phytoremediation is based on certain natural processes carried out by plants including:

• Uptake of metals and certain organic compounds (i.e., moderately water soluble, log Kow=0.5 to 3, such as BTEX) from soil and water;

• Accumulation or processing of these chemicals via lignification, volatilisation, metabolisation, mineralization (transformation into CO2 and water);

• Use of enzymes to breakdown complex organic molecules into simpler molecules (ultimately CO2 and water);

• Increasing the carbon and oxygen content of soil around roots (and so promoting microbial/fungal activity) through release of chemicals (exudates) and decay of root tissue;

• Capture of groundwater (even contaminated groundwater) and utilisation for plant processes

TYPES OF PHYTOREMEDIATION - Several classification schemes were found relating to the types of phytoremediation, the most common of which is presented below.

• Rhizofiltration, the absorption, concentration, and precipitation of heavy metals by plant roots;

• Phytoextraction, the extraction and accumulation of contaminants in harvestable plant tissues including roots and surface shoots;

• Phytotransformation, the degradation of complex organic molecules to simple molecules and the incorporation of these molecules into plant tissues;

• Phytostimulation or plant-assisted bioremediation, the stimulation of microbial and fungal degradation by release of exudates/enzymes into the root zone (rhizosphere);

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• Phytostabilization, involving absorption and precipitation of contaminants, principally metals, by plants, reducing their mobility and preventing their migration to groundwater (leaching) or air (wind transport), or entry into the food chain (4, 16, 19).

In addition, groundwater migration can be affected through the use of deep-rooted trees such as poplars to capture groundwater and retard contaminant migration. The trees utilise the water and then transpire it, potentially depressing the local water table.

Rhizofiltration or Phytofiltration - Phytofiltration is similar in concept to phytoextraction but is concerned with the remediation of contaminated groundwater rather than the remediation of polluted soils. The contaminants are either adsorbed onto the root surface or are absorbed by the plant roots. Plants used for phytofiltration are not planted directly in situ but are acclimated to the pollutant first. Plants are hydroponically grown in clean water rather than soil, until a large root community on sites that have been denuded due to the high levels of metal Contamination. Once a community of tolerant species has been established the potential for wind Erosion is reduced and leaching of the soil contaminants is also reduced (Mendez and Maier, 2008)

Surface water rhizofiltration may be conducted in situ, with plants being grown directly in the contaminated water body. If groundwater is located within the rhizosphere (root zone), rhizofiltration of groundwater can also be in situ. Alternately, rhizofiltration may involve the pumping of contaminated groundwater into troughs filled with the large root systems of appropriate plant species. The large surface areas provided by these root systems allow for efficient absorption of metals from the contaminated groundwater into root tissues.

Phytotransformation - Surface water remediation via phytotransformation can be accomplished in situ in ponds or wetlands. In addition, groundwater can be remediated using phytotransformation in situ if the water table is within the zone tapped by deep-rooted plants such as poplars or ex situ by pumping water to troughs or constructed wetlands containing appropriate plants. In the phytotransformation process, plants take up organic contaminants and degrade them to less toxic or non-toxic compounds.

Phytoextraction or (Phytoaccumulation) - Phytoextraction is the name given in the process where plant roots uptake metal Contaminants from the soil and translocate them to their above soil tissues. Hyper accumulator plant species (species which absorb higher amounts of pollutants than most other species) are used on many sites due to their tolerance of relatively extreme levels of pollution. Phytoextraction is the use of plants to take up contaminants from soil or water, and translocate and accumulate those contaminants in their aboveground biomass (Salt et al., 1995; Jacob et al., 2018). In recent times, Phytoextraction is the most important phytoremediation technique for reclamation of heavy metals and metalloids from the polluted soil (Ali et al.,2013: Sarwar et al., 2017). Phytoextraction is the permanent solution for the removal of heavy metals from polluted soil. Therefore, it is more suitable for commercial application. The process of phytoextraction of heavy metals includes a few steps: (i) mobilisation of heavy metals in rhizosphere, (ii) uptake of heavy metals by plant roots, (iii) translocation of heavy metal ions from roots to aerial parts of plant, (iv) sequestration and compartmentation of heavy metal ions in plant tissues (Ali et al, 2013 and An Yan et al., 2020).Metal compounds that have been successfully phytoextracted include zinc, copper, and nickel, but there is promising research being completed on lead and chromium absorbing plants (Meagher, 2000).

Phytostimulation - Phytostimulation also referred to as enhanced rhizosphere biodegradation, rhizodegradation, or plant-assisted bioremediation/ biodegradation is the breakdown of organic contaminants in the soil via enhanced microbial activity in the plant root zone or rhizosphere. Microbial activity is stimulated in the rhizosphere in several ways: (1) compounds, such as sugars, carbohydrates, amino acids, acetates, and enzymes, exuded by the roots enrich indigenous microbe populations; (2) root systems bring oxygen to the rhizosphere, which ensures aerobic transformations; (3) fine-root biomass increases available organic carbon; (4) mycorrhizae fungi, which grow within the rhizosphere, can degrade organic contaminants that cannot be transformed solely by bacteria because of unique enzymatic pathways; and (5) the habitat for increased microbial populations and activity is enhanced by plants.

Phytostabilisation - 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
Phytostabilization is the use of certain plants to immobilise soil and water contaminants. Contaminant are absorbed and accumulated by roots, absorbed into the roots, or precipitated in the rhizosphere. This reduces or even prevents the mobility of the contaminants preventing migration into the groundwater or air, and also

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reduces the bioavailability of the contaminant thus preventing spread through the food chain.This technique can also be re-establish a plant community on sites that have been due to the high levels of metal Contamination. Once a community of tyrant species has been established the potential for wind erosion is reduced and leaching of the soil contaminants is also reduced (Mendez and Maier 2008). Phytostabilization can occur through precipitation of heavy metals or reduction in metal valence in the rhizosphere, absorption, and sequestration within root issues, or Absorption onto root cell walls (Ginn et al, 2008; Kumpiene et al., 2012; Gerhardt).

Conclusion - The contamination of heavy metal to the environment i.e. , soil, water, plant and air is of great concern due to its potential impact on human and animal health. Cheaper and effective technologies are needed to protect the precious natural resources and biological lives. Phytoremediation has been proven to be a promising technique for revegetation of heavy metal-polluted water and soil with a good public acceptance and shows a variety of advantages compared with other physicochemical techniques.

Plants can help clean up many kinds of pollution including metals, pesticides, explosives and oil. The plants also help prevent wind, rain and groundwater from carrying pollution away from sites to other areas. Phytoremediation is an eco-friendly approach that could be a successful mitigation measure to revegetate heavy metal-polluted water and soil in a cost-effective way.

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