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RESEARCH ARTICLE

PHYTOREMEDIATION OF HEAVY METALS AND ITS EXPLOITATION – REVIEW.

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Abstract

This review represents the condition of phytoremediation technologies with meticulous prominence on phytoextraction of contaminated soil by heavy metals and also focused on the probable usage of trees for the phytoremediation of heavy metal-contaminated soil. Heavy metals, the source of pollution in the environment impart serious crisis since these metals are non biodegradable and can accumulate in living organism. Most of the remedial technologies are abundant and slow up the soil fertility; this consequently causes pessimistic impacts on the ecosystem. Phytoremediation is found to be an advanced treatment process which yields cost-effective and eco-friendly technology. Further, the exploit of plants in metal extraction (phytoremediation) has emerged as a potential option in the amputation of heavy metal surplus from soil and water. Phytoremediation of impure water, is based on the farming of aquatic plants such as *Eichhornia crassipes* and *Azolla filiculoides* Lam., which have verified as high potential to absorb cadmium (Cd), copper (Cu), nickel (Ni) and zinc (Zn) from aqueous solutions. High biomass weeds were preferred to check the way of contaminants into the food chain by choosing non-edible, disease resistant and tolerant plants, which can afford renewable energy. Consequently creating phytoextraction more feasible for current exploitation.

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Introduction:-

A chief environmental anxiety due to distribution of industrial and domestic wastes produced by human actions is the contagion of soil. Contamination of ecosystem by restricted and unrestrained disposal of waste, accidental and process spillage, mining and smelting of metalliferous ores, sewage sludge application to agricultural soils. A extensive variety of inorganic and organic compounds is the source of pollution, these include heavy metals, combustible and putrescible substances, hazardous wastes, explosives and petroleum products (Adriano, 1986, Alloway, 1990). Heavy metals cannot be degraded biologically but altered from individual oxidation state or organic complex to a new form (Garbisu and Alkorta, 2001; Gisbert et al., 2003). Consequently, heavy metal contamination causes a great possible risk to the environment and human health. The numerous regulatory steps have been executed to diminish or control the discharge of pollutants in the soil, they are not enough for scrutiny the contamination. Metal polluted soil can be remediated by physical, chemical and biological methods. These can be classified into two types (M.Ghosh and S.P.Singh, 2005), (Baker A.J.M, Walker P.L., 1990).

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Several variety of plants have the ability to absorb and accumulate the contaminants such as lead, cadmium, chromium, arsenic, and various radionuclides from soils. One of phyto remediation method, phytoextraction, can be used to eradicate the heavy metals from contaminated soil using its ability to uptake metals which are essential for plant growth (Fe, Mn, Zn, Cu, Mg, Mo, and Ni). several metals with unfamiliar biological function (Cd, Cr, Pb, Co, Ag, Se, Hg) can also be accumulated (Cho-Ruk et al., 2006). The damaging characteristics of the heavy metals contaminated soil were condensed cost-effectively and competently by bioremediation process (Priya AK & Nagan S, 2015). Pollution due to heavy Metals has dangerous consequence on biological systems and does not endure biodegradation. Toxic heavy metals such as Pb, Co, Cd can be discriminated from other contaminants, as they cannot be biodegraded however can be accumulated in plants, thus causing different sickness and disorders even in comparatively lesser concentrations (Pehlivan et al., 2009).

The aim of this paper, to confer the feasible of phyto remediation practice on treating the heavy metal-contaminated soil, to offer a brief observation about the heavy metals uptake method by plant and also explain the fate of heavy metals in plant tissue, especially on arsenic (As), lead (Pb), and mercury (Hg).

Mechanisms of Heavy Metal Uptake:-

Heavy metals uptake by plants and its mechanisms have been being investigated by numerous researchers. It might be used to optimize the issues to advance the performance of plant uptake. According to Sinha et al., the plants perform together as “accumulators” and “excluders”. Accumulators endure even with absorbed contaminants in their tissues. They biodegrade or biotransform the contaminants into immobile forms in their tissues. The excluders limit the contaminant uptake into their tissues. The variety of transport mechanisms or particular proteins surrounded in the plant cell plasma membrane concerned in ion uptake and translocation include (1) proton (2) co- and anti transporters and (3) channels. Every transport mechanism is likely to up take a variety of ions. A fundamental trouble is the interface of ionic species through uptake of different heavy metal contaminants. Following the uptake by roots, translocation into shoots is enviable since the reap of root biomass is usually not possible (U. S. Department of Energy, 1994).

Ex-situ method:-

It requires elimination of polluted soil for treatment on or of site and recurring the treated soil to the resorted site. The conventional ex-situ methods applied for remediating the polluted soils relies on excavation, detoxification and/or destruction of contaminant physically or chemically, as a result the contaminant undergo stabilisation, solidification, immobilisation, incineration or destruction.

In-situ method:-

It is remediation without excavation of contaminated site. Reed et al. defined in-situ remediation technologies as destruction or transformation of the contaminant, immobilisation to reduce bioavailability and separation of the contaminant from the bulk soil (Reed et al., 1992). In-situ techniques are favoured over the ex-situ techniques due to their low cost and reduced impact on the ecosystem. Conventionally, the ex-situ technique is to excavate soil contaminated with heavy metal and their burial in landfill site (McNeil and Waring, 1992, Smith, 1993).

Phytoextraction:-

Phytoextraction (also known as phytoaccumulation, phytoabsorption or phytosequestration) is the uptake by plant roots and remove contaminants from soil or water and accumulation in over land biomass i.e., shoots (Sekara et al., 2005; Yoon et al., 2006; Rafati et al., 2011). Heavy metals translocation from root to shoot is a critical mechanism and also the root harvest is not practical (Zacchini et al., 2009; Tangahu et al., 2011).

Rhizofiltration:-

Rhizofiltration also treat wastewater from industry and runoff from fields. It can treat heavy metals from various industries and those metals are arrested in the roots of the plant (Chaudhry et al., 1998, United States Protection Agency Reports 2000). This rhizofiltration can be used as insitu or exsitu methods and also except hyperaccumulators any type of species can be used. Some plant species like tobacco, spinach etc were examined for the efficiency in metal removal from industrial wastewater.

Phytostabilisation:-

It is commonly used for the remediation of soil, sediment and sludges (United States Protection Agency Reports, 2000, Mueller et al 1999) and based on roots ability to clear pollutant mobility and bioavailability in the soil. Phytostabilisation can occur during the sorption, precipitation, complexation, or metal valence diminution.

Exploitation of Phytoremediation by-product:-

Phytoextraction engross frequent cropping of plants in heavy metal tainted soil, until the metal concentration plummet to tolerable level. Metal uptake and biomass production plays an important role in attaining metal concentration less in contaminated soil. Barrier for profitable achievement of phytoextraction has been the disposal of infected plant material. Subsequent to every cropping, the plant is detached from the location; this direct to addition of massive quantity of hazardous biomass. This harmful biomass should be accumulated or disposed suitably so that it does not pretense any hazard to the environment. Biomass is the material having combustible organic matter. Biomass contains carbon, hydrogen and oxygen, it is known as oxygenated hydrocarbons (Iyer et al., 2002). The major components of any biomass material are lignin, hemicellulose, cellulose, mineral matter and ash. It possesses high moisture and volatile matter ingredients, low bulk density and calorific value. The proportion of these constituents differs from species to species. Phytoextraction of lead by dry weight of *Brassica juncea* quantifies to 6 tonnes per hectare with 10,000 to 15,000 mg/kg of metal in dry weight (Blaylock et al., 1997). Managing of massive quantity of this category of waste is a trouble and hence require volume reduction (Blaylock and Huang, 2000). Composting and compaction has been projected as post harvest biomass treatment by several researchers (Kumar et al., 1995, Garbisu and Alkorta, 2001, Raskin et al., 1997). Leaching tests for the composted material proved that the composting procedure created soluble organic compounds that improved metal (Pb) solubility. Hetland et al., illustrates that the composting can considerably compact the volume of collected biomass, conversely metal contaminated plant biomass would still involve treatment former to dumping.

Conclusion:-

phytoremediation technology appear to be successful way to remediate heavy-metals-contaminated environment. Compared to other conventional technologies it have its own benefits. For effective performance of phytoremediation different factors to be considered, mainly appropriate plant species which can be used to uptake the heavy metals. Genetic engineering may come into important role for heavy metal accumulation. The lack of perceptive in metal uptake and mechanisms takes place in plants, enhancement and exterior effects of phytoremediation is delayed its full scale application. Owing to its vast promising as a feasible option to conventional polluted land remediation technique, phytoremediation is at present an stimulating area of energetic research. Since heavy metals in soil and water became severe environmental crisis, consequently successful remediation techniques are essential. Compare to physical and chemical methods for removal of heavy metals from environment, phytoremediation is a enhanced resolution to solve the problem like high cost, irreparable modification in soil properties, devastation of resident soil microflora and formation of byproducts. Phytoremediation have good public recognition and also it is ecofriendly, economically dependable solar-driven technology. Though phytoremediation technique give the impression of the finest option, it also have several restrictions. To reduce this limitations extended research to be performed to implement this technique efficiently. Its study is extremely interdisciplinary in nature and involves background understanding in soil chemistry, plant biology, ecology and soil microbiology as well as environmental engineering. Providentially, interdisciplinary studies and research are cherished and extremely encouraged in scientific society across the world and it is completely trusted that the combination of technical discipline will be greatly successful.

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