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HEAVY METAL POLLUTION IS A THREAT TO SOIL HEALTH

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ABSTRACT

Heavy metal pollution is of major concern to both soil and plant ecosystems as it is ubiquitous in the environment and a serious threat to humans and soil ecosystems. Various natural and anthropogenic activities cause the toxicity of heavy metals in soil. In the agriculture sector, the pollution of soil and water due to the excessive use of chemicals, pesticides and fertilizers etc., by this deposition of heavy metals in soils poses a severe threat to soil health. Adoption of appropriate location-specific remedial techniques, such as physical, chemical and biological methods, are used to immobilize heavy metals from the soil to address the heavy metal toxicity and maintain the soil fertility and productivity

INTRODUCTION

Heavy metals are defined as metallic elements with high density compared to water (Fergusson, 1990). Heavy metals such as arsenic, lead, cadmium, chromium, and mercury can induce toxicity at low levels of exposure (Duffus, 2002). In addition, essential nutrients such as copper, cobalt, iron, magnesium, manganese, nickel, zinc, and selenium are required for various physiological and biological functions of plants at lower concentrations. However, at their higher levels, they can also cause serious threats to plant and soil health. In recent years, increasing ecological and global public health has been a serious concern caused by heavy metal contamination in the environment. Various reasons for contamination include industrial, agricultural, and domestic applications. Although heavy metals are naturally occurring materials present abundantly in the earth crust exposed to the environment by volcanic eruption, earthquakes are minimal in contamination of heavy metals. The majority of pollution is caused by anthropogenic activities such as industrialization, urbanization, warfare spills, metal tailings, sewage and sludge, excessive use of agrochemicals etc (Khan, et al., 2008; Zhang et. al., 2010).

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SOURCES OF SOIL POLLUTION

Various natural and anthropogenic activities cause heavy metal pollution in soil. The following are the two significant sources of soil pollution:

1. NATURALLY OCCURRING SOIL POLLUTANTS

Many soil parent materials are the natural sources of heavy metals, and other metalloids, such as radionuclides, pose a serious threat to the environment and human health at elevated proportions. High natural radioactivity is common in acidic igneous rocks, mainly in feldspars and illite-rich soils (Blume et al., 2016). Gregoric et al. (2013) found higher radon emissions from soil containing carbonates.

2. ANTHROPOGENIC ACTIVITIES

The main anthropogenic sources of soil pollution produced as byproducts of industrial activities or disposal of wastes, i.e. sewage and sludge, agrochemicals, and petroleum-derived products, are the main sources of heavy metal accumulation in the soil. These chemicals are released into the environment accidentally or intentionally, e.g. oil spills or leaching from landfills, using fertilizers and pesticides, etc.

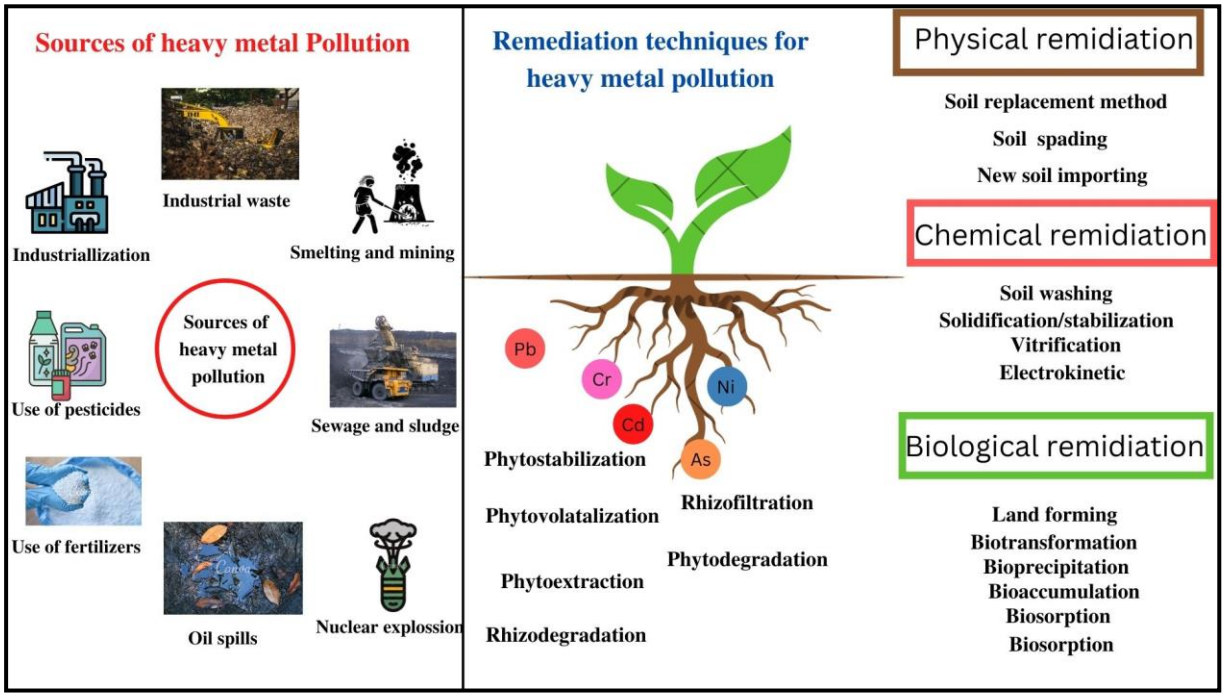

Fig.1: Sources and remediation techniques of heavy metals

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EFFECT OF HEAVY METAL POLLUTION ON SOIL HEALTH

1. **Effect on biological properties and microbial activity of soil.** Heavy metals cause a progressive decline in microbial and enzymatic activity. The impact of various metals on soil varies. Low levels of heavy metals in the soil indicate high levels of microbial activity and growth, which leads to high levels of microbial biomass. Again, high levels of heavy metals in the soil indicate very low levels of microbial growth, which leads to low levels of microbial biomass. The enzymes are crucial in nutrient cycling and the breakdown of organic materials. Therefore, the soil's enzymatic activity decreases due to excess heavy metal concentration, resulting in decreased quality of the soil. The soil becomes entirely deteriorated and loses its fertility. As a result, the damaged soil turned into barren land.
2. **Effect on physio-chemical properties of soil:** Heavy metalloids pollution of soil is caused by various metals, especially Cu, Ni, Cd, Zn, Cr, Pb and Hg. The adverse effects of heavy metals on soil biochemical properties are well-documented properties such as organic matter, clay content, and pH have a pivotal role in physio-chemical properties. Increasing heavy metals' effect on soil microorganisms is not always identical since it depends on soil's physical and chemical characteristics (quantity of pollutants, soil temperature, soil type, soil pH, soil minerals and organic matter and water content). Heavy metal inhibits enzymatic activity such as dehydrogenase, aryl sulphatase, and urease activity with an increase in the extent of concentration because heavy metals limit the enzymatic reactions by bonding themselves to the substrate and creating complexes with the substrate, blocking reactive functional groups of enzymes (Mikanova, 2006). These metalloids will interfere in the uptake of key elements such as Ca, Mn, and Cu in plants (DalCorso 2008). Cd competes with other elements for absorption sites, causing changes in element concentration (Di Toppi and Gabbrielli, 1999).

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REMEDIATION TECHNIQUES

Techniques	Working method
1. Physical remediation:	
Soil replacement	Excavating contaminated soil and replacing it with non-contaminated soil
Soil isolation	Isolating the contaminated soil from non-contaminated soil using a special type of barriers
Vitrification	Reduction in metal bioavailability by forming vitreous material using high temperature
Electrokinetic remediation	Removal of heavy metals from the soil via electrophoresis by applying DC voltage
2. Chemical remediation:	
Immobilization	Reduction in metal mobility and bioavailability by applying immobilizing amendments and forming stable and immobile complexes via adsorption
Soil washing	Removal of heavy metals from the soil by extractants (organic and inorganic) and forming stable and immobile complexes
3. Biological remediation:	
Phytovolatalization	Heavy metal uptake by plants from soil and release in vapour forms to the atmosphere
Phytostabilizaion	Use of plants to decrease metal bioavailability and mobility in soils via sequestration in plant roots
Phytoextraction	Use of hyperaccumulator plants to uptake, translocate and concentrate heavy metal from soil to aerial parts of the plant
Chelated assisted phytoextraction	Use of organic and inorganic ligands to enhance the phytoextraction capacity of plants
Microbial assisted phytoextraction	Use of microorganisms to enhance the phytoextraction capacity of plants

CONCLUSION

Heavy metal toxicity in the soil is a severe issue for human health by the accumulation of heavy metals in plant tissues. In recent years humongous pollution of heavy metals by anthropogenic activities has occurred. So, it is necessary to maintain soil health regarding fertility, microbial activity and physio-chemical properties of soil. In order to address the heavy metal toxicity, the appropriate remedial technologies can adopt to reduce the problem of heavy metal toxicity.

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