AGRIBLOSSOM
ISSN-2582-8258
A monthly peer reviewed e-magazine for Agriculture & allied Sciences

Heavy Metal Contamination in agricultural soils and their Management

V. Sai Surya Gowthami*, P. Anjibabu ** and V.S.L. Raj Rushi. K ***

* Ph.D. Scholar, Department of Agronomy, Agricultural College, Bapatla-522101

** Ph.D. Scholar, Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla-522101

*** Ph.D. Scholar, Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla-522101

Introduction

Soil pollution comprises the pollution of soils with materials, mostly chemicals that are out of place or are present at concentrations higher than normal which may have adverse effects on humans or other organisms. It is difficult to define soil pollution exactly because different opinions exist on how to characterize a pollutant; while some consider the use of pesticides acceptable if their effect does not exceed the intended result, others do not consider any use of pesticides or even chemical fertilizers acceptable. However, soil pollution is also caused by means other than the direct addition of xenobiotic (man-made) chemicals such as agricultural runoff waters, industrial waste materials, acidic precipitates, and radioactive fallout. Both organic (those that contain carbon) and inorganic (those that don't) contaminants are important in soil. The most prominent chemical groups of organic contaminants are fuel hydrocarbons, polynuclear aromatic hydrocarbons (**PAHs)**, polychlorinated biphenyls (PCBs), chlorinated aromatic compounds, detergents, and pesticides. Inorganic species include nitrates, phosphates, and heavy metals such as cadmium, chromium and lead; inorganic acids; and **radionuclides** (radioactive substances). Among the sources of these contaminants are agricultural runoffs, acidic precipitates, industrial waste materials, and radioactive fallout.

In general, heavy metal toxicity can cause chronic, degenerative conditions. General symptoms include: headache, short-term memory loss, mental confusion, sense of unreality, distorted perception, pain in muscles and joints, and gastro-intestinal upsets, food intolerances, allergies, vision problems, chronic fatigue, fungal infections etc. Sometimes the symptoms are vague and difficult to diagnose.

Management of Contaminated Soil

Soil and crop management methods can help prevent uptake of pollutants by plants, leaving them in the soil. The soil becomes the sink, breaking the soil-plant animal or human cycle through which, the toxin exerts its toxic effects. The following management practices will not remove the heavy metal contaminants, but will help to immobilize them in the soil and reduce the potential for adverse effects from the metals

1. Increasing the soil pH to 6.5 or higher

Cationic metals are more soluble at lower pH levels, so increasing the pH make them less available to plants and therefore less likely to be incorporated in their tissues and ingested by humans. Raising pH has the opposite effect on anionic elements.

2. Draining wet soils

Drainage improves soil aeration and will allow metals to oxidize, making them less soluble. Therefore, when aerated, these metals are less available. The opposite is true for chromium, which is more available in oxidized forms. Active organic matter is effective in reducing the availability of chromium.

3. Applying phosphate

Heavy phosphate applications reduce the availability of cationic metals, but have the opposite effect on anionic compounds like arsenic. Care should be taken with phosphorus applications because high levels of phosphorus in the soil can result in water pollution.

4. Carefully selecting plants for use on metal-contaminated soils

Plants translocate larger quantities of metals to their leaves than to their fruits or seeds. The greatest risk of food chain contamination is in leafy vegetables like greens. Another hazard is forage eaten by livestock.

4.1 Plants for Environmental Cleanup

Phytoremediation is a general term for using plants to remove, degrade, or contain soil pollutants such as heavy metals, pesticides, solvents, crude oil, polyaromatic hydrocarbons, and landfill leacheates. For example, grasses can stimulate breakdown of petroleum products. Wildflowers were recently used to degrade hydrocarbons from an oil spill in Kuwait.

4.2 Plants for Treating Metal Contaminated Soils

Plants have been used to stabilize or remove metals from soil and water. The three mechanisms used are *phytoextraction*, *rhizofiltration*, and *phytostabilization*. Rhizofiltration is the adsorption onto plant roots or absorption into plant roots of contaminants that are in solution surrounding the root zone (rhizosphere).

Rhizofiltration is used to decontaminate groundwater. Plants are grown in greenhouses in water instead of soil. The plants are then planted on the site of contaminated ground water where the roots take up the water and contaminants. Once the roots are saturated with the contaminant, the plants are harvested including the roots. In Chernobyl, Ukraine, sunflowers were used in this way to remove radioactive contaminants from groundwater.

Phytostabilization is the use of perennial, non-harvested plants to stabilize or immobilize contaminants in the soil and groundwater. Metals are absorbed and accumulated by roots, adsorbed onto roots, or precipitated within the rhizosphere. Metal-tolerant plants can be used to restore vegetation where natural vegetation is lacking, thus reducing the risk of water and wind erosion and leaching. Phytostabilization reduces the mobility of the contaminant and prevents further movement of the contaminant into groundwater or the air and reduces the bioavailability for entry into the food chain.

5. Glomalin-related soil protein

The identification of glomalin, a glycoprotein produced by arbuscular mycorrhizal fungi, has led to a reevaluation of fungal contributions to SOM and aggregate stability. GSRP presents a strong cementing ability inducing the formation of aggregates with an increased structural stability (Wu et al., 2013). Besides the GSRP could act in soil remediation, sequestering toxic elements as copper. GRSP and hyphae would be decomposed rapidly by soil microoganisms in the absence of available host plants; and GRSP is a potentially important metal-binding fraction of the SOM.

References

Chibuike, G. U. and Obiora, S. C. 2014. Heavy metal polluted soils: Effect on plants and bioremediation methods. *Applied and Environmental Soil Science.* 243–254.

Liu, L. W., Li, W., Song, W. P., and Guo, M. X. 2018. Remediation techniques for heavy metal–Contaminated soils: Principles and applicability. *Science* of the *Total Environment.* 633, 206–219.

Lombi, E., Zhao, F.J., Dunham, S.J. and McGrath, S.P., 2001. Phytoremediation of heavy metal–contaminated soils: Natural hyperaccumulation versus chemically enhanced phytoextraction. *Journal of Environmental Quality*, *30*(6), pp.1919-1926.

Mishra, J., Singh, R. and Arora, N.K., 2017. Alleviation of heavy metal stress in plants and remediation of soil by rhizosphere microorganisms. *Frontiers in microbiology*, *8*, p.1706.

Wu, Z., McGrouther, K., Huang, J., Wu, P., Wu, W., & Wang, H. (2014). Decomposition and the contribution of glomalin-related soil protein (GRSP) in heavy metal sequestration: field experiment. *Soil Biology and Biochemistry*, *68*, 283-290.