Hazards Assessment of Heavy Metals Build-up in Soil and Plants of Durgapur Industrial Belt Irrigated with Mixed Industrial Effluents

Ganesh Chandra Kisku[*1] and Satish Kumar Singh*[1]

[*1] Senior Principal Scientist, Environmental Monitoring Division, CSIR-Indian Institute of Toxicology Research, M. G. Marg, Lucknow, UP, India

[1] Project Fellow, Environmental Monitoring Division, CSIR-Indian Institute of Toxicology Research, M. G. Marg, Lucknow, UP, India

Abstract

To anticipate a possible health hazard through food chain resulting from the uptake and bioaccumulation of heavy metals in crops from contaminated soils; it is useful to study whether crops exist that are able to mobilize a given metal in the soil to a larger proportion than in an uncontaminated soil. A field survey was conducted to determine the extent of bioaccumulation of heavy metals (iron, manganese and copper) in 11 cultivated crops and 3 weeds grown in Kalipur area of Durgapur industrial belt irrigated with mixed industrial effluent. The Fe, Mn and Cu concentrations of Kalipur varied from 305-339, 180-204, 84.8-149.1 µg g^{-1} soil with average enrichment factors of soil 1.51, 1.43, 7.0 while 189-233, 112-155, 13.2-21.8 µg g^{-1} soil in case of Madhabpur. The Fe, Mn and Cu concentrations in cultivated plants and weeds of Kalipur ranged from 211-337, 99-174, 38.3-80.1 µg g^{-1} dry wt. with average enrichment factors in plants 1.72, 1.97, 8.91 and 108-218, 36-102, 1.7-10.3 µg g^{-1} dry wt. in case of Madhabpur. Results revealed that copper concentration in plants of Kalipur area has already exceeded their limit of phytotoxicity. Due to biomagnifications, toxicity of manganese and iron may also manifest in course of time. The local population should make aware about bioaccumulation of the heavy metals in crop plants particularly in the accumulator species. Consumption of plants, showing high accumulation of the toxic metals, is likely to contribute to the body burden values of these elements, posing a threat to human health.

Key words: *Heavy metal, soil and crops, industrial effluent, bioaccumulation, Durgapur industrial belt*

1. Introduction

More than 500 industries including steel, cement, coal based thermal power plant, sponge iron, chemical, fertilizer, coal washeries as well as a cluster of medium and small scale ancillary industries of Durgapur industrial belt (DIB), India are discharging their wastewaters enriched with heavy metals (density >5 g cm^{-3}) into the Tamala Nala leading to metals pollution of water-soil system and biota of the DIB area. Tamala Nala wastewater has been used for cultivation of cereals, vegetables and others economically important crop plants by farmers since they are ignorant about the hidden toxicity of the pollutants discharged and their subsequent negative impacts such as loss of soil fertility, crop yield, accumulation of heavy metals in edible parts of the plants. Continuous discharge of industrial effluents, sewage and sludge into the agricultural lands is a matter of concern because of persistence of these heavy metals in soils. Although some of the metals (Fe, Mn, Zn and Cu) are essential trace elements to plant life while others (Pb, Ni, Cr, Cd) are toxic even at very low concentrations. However, all these metals are toxic beyond a certain threshold value that may vary with nature and species of element and plant. Uptake-mobilization and accumulation-biomagnifications processes by crops are the key components of human exposure to metals through food chain. Such metallic elements are not biodegradable and build up in soil system (Khan et al., 2008). The subsequent uptake and distribution of these metals in edible and fodder plants increase the health risk through food chain contamination (Sridhar Chary et al., 2008). The extent of these potentially toxic metals (PTM) and the adverse impact thereof on human beings varies from one situation to another. It has become imperative to undertake comprehensive studies on evaluation of the heavy metal pollution of water, soil and plants; uptake and accumulation of potentially toxic metals in soils and plants of DIB.