

Chapter 13

Risk Implications of Heavy Metal Contamination in Agricultural Soil and Crop Productivity

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ABSTRACT

Heavy metals especially lead, nickel, cadmium, copper, cobalt, chromium and mercury are more toxic and chief contaminants of the environment. Agricultural soils in many parts of the world are slightly to moderately polluted with heavy metals due to increase in geologic and anthropogenic activities (use of phosphate fertilizers, sewage sludge application, dust from smelters, industrial waste). Plants growing on these contaminated soils showed toxicity symptoms that results in reduce growth and activity which declined the productivity and posing threats to agro-ecosystems. They put plants under stress and affect their physiology. In this chapter, we have summarized the effects of heavy metals on plants including both symptoms and productivity.

INTRODUCTION

Heavy metals are mostly metalloids and cannot be degraded, thus accumulated in soils and water system. Heavy metal pollution exerts an unpropitious effect on agricultural soil and hence become a serious concern. Continuous use of fertilizers, application of sewage sludge, dust from smelters, industrial effluents and wrong irrigation process may lead to the accumulation of heavy metals in agricultural land (Bell et al., 2001; Schwartz et al., 2001; Passariello et al., 2002). Though heavy metal plays a significant role in physiological process of plants in trace amounts but higher concentration of heavy metal than permissible level slow down their growth and biomass yield which further decline the crop productivity.

Plants uptake heavy metals from contaminated soil and accumulate them throughout the food chain. It is a potential threat to animal and human health (Jordao et al., 2006; Sprynskyy et al., 2007; Oves, 2016).

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The heavy metals can cause some adverse effect in the body, such as depletion of some vital nutritional minerals from their original place, cancer development, kidney and liver diseases, damage of lung, neurological abnormalities, depletion of immunological defense, malnutrition etc. (Khan et al., 2008).

Heavy metals also affect soil fertility by modifying micro-organism through their toxic effects. The microbial population and their activity in soil influences the fertility of soil (Ashraf and Ali, 2007; Rathnayake et al., 2013). Agricultural runoff containing heavy metals enter in aquatic environment and caused toxicity to plants and animals inhabiting the habitat. Heavy metal contamination of sewage sludge, municipal solid waste and pig manure affects the process of composting by inhibiting bacterial growth. Heavy metals affect the life cycle of Earth-worm in vermicomposting. These impacts of heavy metals adversely affect the bio-community and thus the productivity (Figure 1)

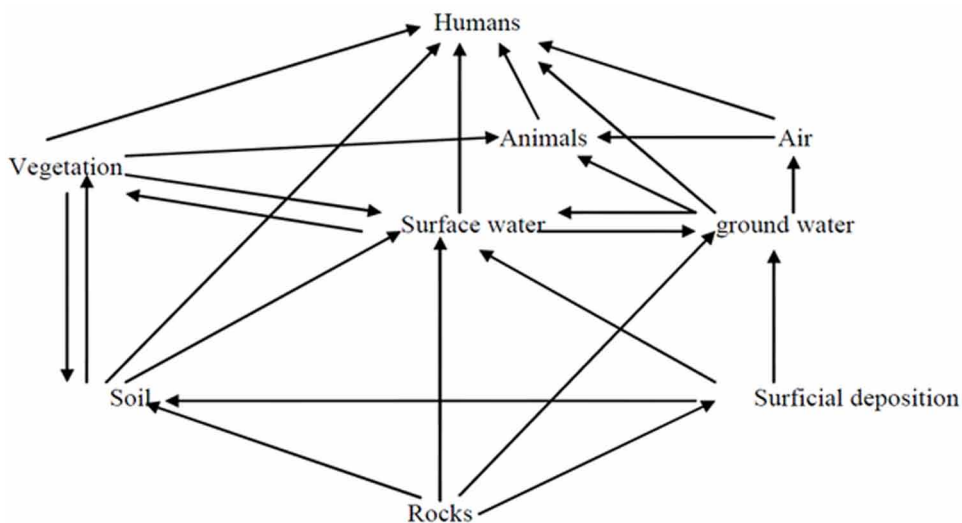
In these respects, heavy metal contamination of agricultural soils has always been considered a critical challenge. Heavy metals are normally present at low levels in agricultural soil but due to their cumulative behavior and toxicity, they have a potential harmful effect, not only on crop plants but also on human health. Therefore, this chapter has been focused on the impact of the heavy metals to determine the loss of agricultural productivity and their possible management.

BACKGROUND

Heavy Metals

Heavy metals exhibit metallic properties and belong to the group of loosely-defined subset of elements. Most of the heavy metals are transition elements having incomplete filled d-orbitals. These d-orbitals provide heavy metal cations that have ability to form complex compounds which may or may not be redox active (Nies, 1999). It mainly comprises the transition metals, some metalloids, lanthanides, and

Figure 1. Pathways for heavy metals in soil, plants, animals and humans



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