Chapter 10
Cadmium- and Lead-Tolerant PGPRs as Proficient Toxicity Alleviators for Agricultural Crops

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ABSTRACT

Agricultural lands are being polluted with different contaminants due to various anthropogenic activities like toxic discharge from Ni-Cd battery industry, tannery industry, alloying of metals like steel, application of agrochemicals, etc. Cadmium and lead contamination in agricultural land are directed towards global food insecurity. Bioremediation, stress alleviation, and phytostimulation by Cd and Pb tolerant PGPR is a promising eco-friendly method to develop sustainable agricultural system. At present, cadmium and lead-tolerant plant growth promoting rhizobacteria (PGPR) can be a sustainable option for heavy metal-contaminated agricultural lands. PGPRs such as Bacillus*,* Bradyrhizobium*,* Enterobacter*,* Klebsiella*,* Micrococcus*,* Pseudomonas*,* Ralstonia*, etc. can survive the metal stress and stimulate the plant growth under Cd and Pb contaminated condition by direct or indirect plant growth promoting ability. So, these PGPRs could be exploited as biofertilizers and bioremediators under Cd or Pb stressed conditions for futuristic agricultural development.*

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INTRODUCTION

Various metals such as lead, zinc, cadmium, nickel, copper and mercury are continuously being added to our soil ecosystem through different agrochemical usage, industrial waste disposal, application of urban sewage sludge, vehicle exhausts, and waste incineration and from many anthropogenic sources (Noumavo et al. 2016). These contaminations in our agricultural soils cause threat to food safety. Plants uptake different metals into their body and retains for a long days. As a result these metals can transferred to the higher tropic level like human and other animals.

Cadmium inhibits plant growth, hampers plant water relationship and ion metabolism, inhibits chlorophyll biosynthesis, inhibits many enzymes like Fructose bis-phosphatase, Fructose 6 phosphate kinase, Phosphoenolpyruvate carboxylase, NADP+ glyceraldehyde-3-phosphate dehydrogenase Ribulose-1,5-bisphosphate carboxylase oxygenase, and Carbonic anhydrase (Krantev, Yordanova, and Popova 2006; Popova et al. 2009). Cd act as a potent nephrotoxin and class-I carcinogen in animals. Lead (Pb) persists in the environment for a long time and causes anemia, reproductive impairment, renal failure, neurodegenerative damage etc. (Eslami et al. 2011). Pb badly affects plants in the seed germination, biomass production, root-shoot growth, chlorophyll content and ion distribution (Trvedi and Erdei 1992; He 1990).

These heavy metals affect a considerable harmful effect on environment, soil ecosystems and human health due to their mobility and solubility (Kabata-Pendias 1992). Frequently, the soil may be contaminated as much as a harmful waste (Berti and Jacob, 1996). In developing countries, heavy metals contamination in soil is a much talkative concern (Yanez *et al*., 2002; Pramanik et al. 2016; Pal and Sengupta, 2019). It is now important to remediate the contaminated soil to develop suitable agricultural land.

Cause of Soil Contamination by Heavy Metals

The heavy metal can be contaminated in the environment by means of various man made or by natural occurrences. Sewage sludge are beneficially used as a common and useful disposal mechanism in agricultural land, but these sewage sludge are normally contaminated with various heavy metals like Cd, Pb, Ni, Cu, Cr etc (Singh *et al*., 2004). These metals commonly leached or channeled with soil particles. Such metals produced some long term deleterious effects on the plants or animals. Though sewage sludge have some advantages as it contained some available nutrients for crop yield but these short term beneficial effects of sewage sludge can be ignored for their long term toxic effects on plant yield and production. Cadmium and lead present in the sewage sludge accumulated in the plant body, transferred into higher tropic level and ultimately into human (Logan and Chaney, 1983). According to Benitez at al. (2001) higher concentration of heavy metals like Cd, Mn and Zn are deposited in agricultural soil after using sewage sludge as land application (Benítez *et al*., 2001).

Heavy metal contamination of soil from atmosphere of many industries like sulfuric acid plants, energy plants, paint industry, metallurgy and production of construction materials etc. In many developing countries disposal of garbage and dumping of waste along the road side is one of the major subjects of concern in aspect of soil pollution. According to Agritas and Kilicel, (1999), many toxic metals coming from human activities are finally gathered and ultimately pollute soil (Agirtas and Kilicel, 1999). These toxic metals can transfer to the plant body that grows in the polluted soil (Ogunsola *et al*., 1993) and finally they transfer into the animal body (Kilice, 1999). Gasoline and lubricating oil contains different heavy metals like Pb, Zn, Cu etc. These heavy metals are deposited in soil and vegetation beyond the considerable limit alongside the highway (Nyangababo and Hamya, 1986). Many studies revealed that