Chapter 10
Heavy Metal Stress Mechanism by Signaling Cascades in Plants

ABSTRACT

This chapter highlights the role of cascade for remediation of heavy metals, their mechanism of action, and their applications approach of hyperaccumulation. Further, it also highlights the role of uptake and detoxification of metals by cellular mechanisms that facilitate the bioremediation of heavy metals from contaminated areas.

INTRODUCTION

Heavy metal is a big problem in most parts of the world; but it also responsible for the loss of agricultural productivity and loss of farmers. Under physiological conditions based on their solubility, 17 heavy metals may be available for living cells and are important for organisms and ecosystem in the environment (Schutzendubel and Polle, 2002; Hameed et al., 2016). Heavy metals such as Mn, Mo, and Fe are important as micronutrients, whereas Vu, Ni, Zn, Co, W, V, and Cr are trace elements but present at higher amount so they are toxic to other metals like Ag, Hg, As, Sb, Cd, U and Pd have no function and seems to be toxic to the plants, animals and microorganisms (Nazar et al., 2012; Hammed et al., 2016). Heavy metal pollutants are basically derived from industries in the form of waste, chemical reagents and agriculture practices

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such as pesticides, chemical fertilizers and most important herbicides. Chemicals have adverse effects on the “human beings, plants and, soil, microflora, including beneficial microbes. These contaminants accumulate in the agricultural soils where they are released and therefore reach to the food chain, creating a high risk to the living organisms and ultimately giving rise to the food scarcity. They reach plants by the process of absorption by roots from soil and disturb the balance of the food chain in the form of particulate contaminants because of their regular presence (Tak et al., 2013)

Many different industries and agricultural activities contribute to heavy metal contamination in urban areas. Heavy metals can directly influence growth, senescence and energy synthesis processes because of their high reactivity. They adversely affect the absorption and transport of the essential elements, thereby distributing the metabolism and having an impact on the growth of plants and reproduction (Xu et al., 2008; Hameed et al., 2016). More than 30 mg of lead Pb leads to a reduction of plants growth and decline in the chlorophyll synthesis in leaf reduction in growth as well as crop production, yellowing of young leaves, reduction in the absorption of essential elements such as Fe and decline in rate of photosynthesis. When plants are subjected to heavy metal stress production of reactive oxygen species (ROS) were found imbalanced in plants and disturb the metabolic activity (Hameed et al., 2016). The toxicity and tolerance to heavy metals differ from arrangement to the plants in the environment, and a number of efforts to their tolerance mechanism at molecular level have not been fully understood yet (Thapa et al., 2012).

EFFECT ON PLANT GROWTH UNDER STRESS

Heavy metals can affect on the growth of plants in a number of points and toxic effect at different levels of cell structure and function of the plants. Inhibition of the germination and root extension can be result of the interference with the cell division or with the cell elongation. It has been observed that the main pressure of heavy metals such as Zn, Cu, Co, Cd, Hg and Pb is the inhibition of the germination rate, root elongation and shoot and leaf growth (Munzurog and Geckil, 2002; Rascio et al., 2008; Hameed et al., 2016). The inhibition of root elongation in many instances is the most sensitive parameter of heavy metal toxicity (Schutzendubel et al., 2001; Hameed at al., 2015). In crop production Al toxicity is one of the major growth-limiting factors in acidic mineral soils (Panda et al., 2009). The root systems become stubby

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