Chapter 6
Role of Plant Growth Promoting Rhizosphere (PGPR) on Molecular Mechanisms Transporters Under Heavy Metal Stress

ABSTRACT

In this chapter, the authors discuss the molecular mechanisms transporters used for the removal of heavy metals contaminants from soil and water. The bioremediation method used for soil remediation render the land useless as a medium for plant growth as they also remove other contaminants that harm microbes and maintaining soil fertility with the help generating heat shok protein and metallothiones and also molecular transporters.

INTRODUCTION

Bacteria have ability to tolerance of metals using different mechanism which maintain metal homeostasis with keeping concentration of essential metals (Nies, 2003). Microorganisms involve both actively and passively for metal uptake, remaining or sequestering. Effects of different bacteria on metal uptake, depends on the basis of chromosomally or extrachromosomally which controlled detoxification of metals (Ehrlich, 1997). Several type sequestration

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mechanism of metal resistant system including efflux pumps to remove metals from the cell and to bind inside the cell. Metals pump out by using adenosine triphosphates two efflux system and through antiports proton generate protein gradient across the cell membrane (Nies, 2003). Researchers indicated about another mechanism about metals resistance in cyanobacteria is sequestration by metallothioneins signaling. Metallothioneins compounds bind to different metals on receptor of plasmamembrane to sufhydryl group of cysteine residue with phosphate groups and activate the channels for the expression of gene to tolerate under stress. More cadmium (Cd) accumulation and tolerance by Stenotrophomonas maltophilia and also found Cd efflux pump. Some bacteria produce more extracellular polymeric susbstances (EPS) which bind to metal and create environment around the plant root for less toxic.

Hyperaccumulation mechanism in pant described briefly that hyperaccumulation is not only depends on plant but also interaction between microbes and present amount available of metals and non netals in soil. Bacterial communities present in soil with tolerable metals like zinc, lead, coper and nickel. According to Idris et al. (2004) were reported that rhizosphere of hyperaccumulating plants such as *Arabidopsis murale* and *Thlaspigoesingense* has an increased proportion of metal resistant bacteria. Many bacteria have tendency that can alter heavy metal mobility for uptake plant easily (Rajkumar and Freitas, 2006). Isolated Ni mobilizing bacteria from Ni rich soil and check their efficiency to promoting plant growth with the using Brassica species (Abou-Shanab et al., 2003). Soil bacteria produce such compounds biosurfactants, siderphores and organic acids which stimulate metal bioavailability in soil and increase root absorption of various ions like (Mn^{2+}, Fe^{2+} and Cd^{2+}).

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Rhizobium leguminosarum of different strains was showed Cd tolerant and increased the levels of glutathione which indicating about tripeptide allows bacterium to deal under heavy metals stress rather than efflux systems activate (Ma et al., 2013). Metal toxicity occured in cell or plant organs at that condition important glutathione antioxidant generate to protect against stress. Apart from other mechanism plants also dealing with toxic metals which involve polyphosphates and long chains of thiophosphates for metals sequester (Lv et al., 2012). Biofilm formation from E.coli under nickel stress which may serve as as tolerance mechanism and involved in adherence by inducing

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