

Biotechnologies towards Sustainable Development in Malaysia

Zarina Zainuddin

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Chapter 9

Mechanisms of heavy metal tolerance in plants (I) – Tolerance mechanisms

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Introduction

Various mechanisms have been suggested to account for abiotic stress and tolerance in plants. At high metal concentrations, primary barriers (e.g. plasma membrane) are broken down and lose their function. Inadequate avoidance mechanisms cause the concentration of metal ions increases in the plant body, closely followed by production of free radicals that imposes oxidative stress. Plants need to undergo biochemical changes to defend against metal-induced oxidative stress. The tolerance mechanisms must be able to limit the activity of potentially harmful metal species in the cytosol. Therefore, heavy metal ions that enter the cytoplasm are inactivated by chelation, by conversion into a less toxic form, or by compartmentalization (Hall, 2002; Yang *et al.*, 2005). The degree of heavy metal-generated cell damage relies on: (1) the rate of free radical and reactive oxygen species formation, and (2) the efficiency of detoxification and repair mechanisms (Dietz *et al.*, 1999).

Vacuolar compartmentalization

Excess metal ions must be removed from the cytoplasm. This can be achieved by efflux of ions or compartmentalization into the vacuole. Earlier studies on Zn and Cd have shown that the vacuole is the main storage site of these toxic metals. It has often been postulated that this