Biotechnologies towards Sustainable Development in Malaysia

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IIUM PRESS
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

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Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Zarina Zainuddin
Biotechnologies towards Sustainable Development in Malaysia
Zarina Zainuddin
Include index
Bibliography: p. 149

ISBN: 978-967-418-200-7

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM
(Malaysian Scholarly Publishing Council)

Printed by :
IIUM PRINTING SDN. BHD.
No. 1, Jalan Industri Batu Caves 1/3
Taman Perindustrian Batu Caves
Batu Caves Centre Point
68100 Batu Caves
Selangor Darul Ehsan

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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 convertion 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