Acta Physiol Plant
DOI 10.1007/s11738-013-1453-0

ORIGINAL PAPER

Response to oxidative stress induced by cadmium and copper in tobacco plants (*Nicotiana tabacum*) engineered with the trehalose-6-phosphate synthase gene (AtTPS1)

Luisa Louro Martins · Miguel Pedro Mourato · Sergio Baptista · Rafaela Reis · Florbela Carvalheiro · André M. Almeida · Pedro Fevereiro · Ann Cuypers

Received: 29 March 2013 / Revised: 2 November 2013 / Accepted: 25 November 2013

Abstract The response of tobacco plants genetically engineered with the AtTPS1 gene to stress induced by excess Cu and Cd was evaluated in hydroponic solution (100 and 400 μM Cu and 50 and 200 μM Cd) after a 48 h exposure. Two transgenic lines, transformed with the AtTPS1 (trehalose-6-phosphate synthase) gene from Arabidopsis, with different levels of trehalose-6-phosphate synthase expression (B5H, higher and B1F, lower), and a wild type (WT) were investigated. Protein content, antioxidative enzymes (CAT, POD, SOD, and APX), glucose, fructose, lipid peroxidation, hydrogen peroxide and Cd and Cu contents were determined in leaves. The two transgenic lines were differently influenced by Cd and Cu exposure as they induced a different antioxidant enzymatic defense response. B1F and B5H plants showed a better acclimation to Cd and excess Cu compared to WT. Furthermore B1F was more tolerant than B5H to Cd and excess Cu. B1F accumulated less Cd and Cu in leaves, probably due to a more efficient exclusion mechanism. Catalase was shown to be the most important enzyme in the antioxidative system of these plants.

Keywords Antioxidative enzymes · Cadmium · Copper · Oxidative stress · Tobacco

Communicated by G. Klobus.

L. L. Martins and M. P. Mourato contributed equally to the performed work.

L. L. Martins · M. P. Mourato (✉) · S. Baptista · R. Reis
UIQA, Instituto Superior de Agronomia, Universidade Técnica de Lisboa, Lisbon, Portugal
e-mail: mmourato@isa.utl.pt

F. Carvalheiro
Unidade de Bioenergia, LNEG-Laboratório Nacional de Energia e Geologia, Lisbon, Portugal

A. M. Almeida
IICT-Instituto de Investigação Científica Tropical, Lisbon, Portugal

A. M. Almeida · P. Fevereiro
Instituto de Tecnologia Química e Biológica, Universidade Nova de Lisboa, Oeiras, Portugal

P. Fevereiro
Departamento de Biologia Vegetal, Faculdade de Ciências da Universidade de Lisboa, Lisbon, Portugal

A. Cuypers
Environmental Biology, Centre for Environmental Sciences, Hasselt University, Diepenbeek, Belgium

Introduction

Heavy metal pollution is an important cause of abiotic stress in plants that can limit crop productivity worldwide (He et al. 2005). Consequently, to improve plant tolerance to abiotic stresses to maintain productivity and plant production is of paramount importance. However, for successful development of new genotypes, it is essential to fully understand the overall mechanisms by which plants respond to a specific stress condition.

Plants exposure to toxic levels of heavy metals induce changes in physiological, biochemical and molecular mechanisms responsible for metal tolerance and acclimation (Apel and Hirt 2004; Clemens 2006; Sharma and Dietz 2009). The antioxidative defense system (both enzymatic and non-enzymatic) responsible for the removal of excess reactive oxygen species (ROS) is a plant physiological response that plays an important role in stress tolerance (Mittler 2002; Gratão et al. 2005; Gill and Tuteja 2010).

Published online: 06 December 2013