Reactive Oxygen Species and Oxidative Damage in Plants Under Stress

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Editors

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This book is dedicated in the memory of ***Prof. Emeritus Kozi Asada****, Kyoto University, Japan, for his large contribution in the field of plant ROS, who passed away on 15th December, 2013, and also to* ***Prof. Paul Bolwell****, Royal Holloway, University of London, UK, for his long contribution in plant oxidative burst in response to pathogens who also passed away on 13th of April, 2012.*

Preface

In plants as well as in all aerobic organisms, reactive oxygen species (ROS) are produced commonly as a by-product of aerobic metabolism. It depends on the formation and nature of ROS; some are toxic and easily destroyed/detoxified by several enzymatic and nonenzymatic mechanisms in the plant cells. However, lately, the role of ROS as second messengers participating in signaling processes under normal and certain stress conditions was postulated (Foyer and Noctor 2003). Environmental stresses such as heat, cold, drought, salinity, heavy metal toxicity, ozone, and ultraviolet radiation as well as pathogens/contagion attack lead to enhanced generation of ROS in plants due to disruption of cellular homeostasis. When the increment of ROS in plant cells rapidly increased and the scavenging systems of ROS do not operate properly, a situation of oxidative stress and oxidative injury occurs. The toxicity caused by heavy metals leads to intervention with metabolism and other biological activities through the generation of ROS such as superoxide radicals ($O_2^{\bullet-}$), hydroxyl radicals ($^{\bullet}OH$), and hydrogen peroxide molecule (H_2O_2). Under certain conditions which involve the presence of transition metal ions, basically Cu^{2+} and Fe^{3+}, H_2O_2 may be reduced to $^{\bullet}OH$ radicals by superoxide and generates oxidative damage to the plants. One of the major consequences of heavy metals action in the cell is the enhanced generation of ROS which usually damage the cellular components such as membranes, nucleic acids, chloroplast pigments, and alteration in enzymatic and non-enzymatic antioxidants (Gupta et al. 2013a). Stress-induced increases in ROS level can cause different degree of oxidation of cell components and a gross change in redox status. Thus, an oxidative outburst as a consequence of stress is reflected in the levels of ROS molecules ($O_2^{\bullet-}$, H_2O_2 and $^{\bullet}OH$), which are biochemically connected through metabolic reactions (Halliwell and Gutteridge 2007).

ROS generation is evident in chloroplast, mitochondria, peroxisomes, plasma membrane, and apoplast adjacent to membrane. In green plants, chloroplast is the most important among the organelles in respect of ROS generation as O_2 is continuously provided through the water autolysis and readily available inside the organelle. Several reports showed that ROS induction can take place in response to cadmium stress in pepper (*Capsicum annum* L.) (León et al. 2002) and *Arabidopsis thaliana* (Remans et al. 2010), Pb and As stress in *Zea mays* and in *A. thaliana* (Gupta et al. 2009, 2013b), Cd and Cu stress in pea (*Pisum sativum*) and *A. thaliana* (Palma et al. 1987; Remans et al. 2010), Ni stress in wheat (*Triticum aestivum*) (Hao et al. 2006), and Zn stress in Brassica (Feigl et al. 2014). Since now there is no evidence that cytoplasmic phytochelatins (PCs) have a role in prevention of ROS induction at plasma membrane or associated ROS formation at apoplast. However, it is acceptable that cell-wall-associated peroxidase catalyzes formation of membrane-permeable H_2O_2 in apoplast and then makes it possible to interact with cytosolic PCs and other thiol peptides.

Since last three decades, it's indeed a big boom in the field of ROS and its role/function in plants. The main purpose of the book is to provide detailed and comprehensive knowledge to the academicians and researchers who are interested in the field of oxidative damage caused by stresses in plants with special reference to the metabolism of ROS and site of production of ROS in plant systems. Other key features of this book are ROS signaling, ROS and disease resistance, redox regulation, and antioxidant defense during stresses, heavy metal-induced oxidative stresses, and heavy metal toxicity and detoxification mechanism. Some chapters are also focusing on hormones/polyphenols as antioxidants and the future of transgenic plants in antioxidative defense. The functional interaction between ROS and the reactive nitrogen species (RNS) is also addressed in this volume. In the nutshell, the information compiled in this book will bring very deep knowledge and advancement in the field of ROS and oxidative damages caused by stresses in current years in plant sciences.

Dr. Dharmendra K. Gupta, Prof. José M. Palma, and Dr. Francisco J. Corpas personally thank the authors for contributing their valuable time, knowledge, and enthusiasm to bring this book into the present shape.

Hannover, Germany — Dr. Dharmendra K. Gupta
Granada, Spain — Prof. José M. Palma
Dr. Francisco J. Corpas

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Contents