Emerging Technologies and Management of Crop Stress Tolerance

Volume I Biological Techniques

Edited by
Parvaiz Ahmad
and Saiema Rasool

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Biological Techniques

Volume 1

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Salma Rasool

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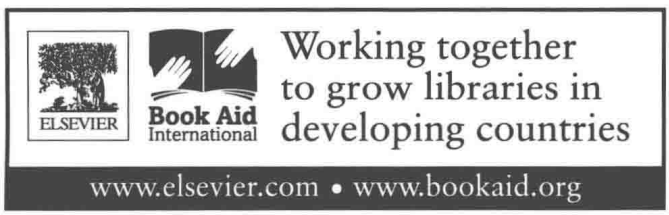
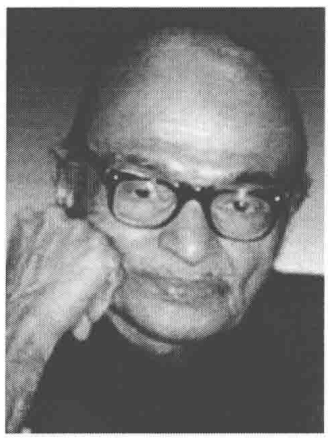


Emerging Technologies and Management of Crop Stress Tolerance

Dedication

This book is dedicated to



Hakim Abdul Hameed
(1908–1999)
Founder of Jamia Hamdard (Hamdard University)
New Delhi, India

Preface

More than 450 million small-scale producers around the world are reliant on agriculture for their way of life. A "right to food" movement has built momentum all over the developing world. "Food Security" has become a buzz word – meaning when people have enough food to feed themselves. Recent articles on the "Global Food Crisis", "Warming Planet Struggles to Feed Itself", and "Cutting Food Waste to Feed the World" reveal that roughly one third of the food produced for human consumption each year is wasted. This amounts to nearly 1.3 billion tonnes of food. The effects of a rapidly changing climate on the availability of food add to this grave situation. Climatic conditions are changing day by day and have an negative impact on the growth and dvelopment of the crops and ultimately reduced the crop yield. Environmental stress is responsible for the huge crop loss worldwide and this loss is increasing in coming years. The adverse impact of climate change in the form of declining rainfall and rising temperatures, and thus, increased severity of drought and flooding, is bound to threaten food security and livelihoods in the economy in many developing countries. To mitigate the effect of the environmental stress, plant biologists are trying to develop plants with higher levels of resistance to these stresses. They are employing new technologies to understand the physiobiochemical responses of the plants. Different approaches like genomics, proteomics, metabolomics, and micromics are being used to study plant metabolism, and up- and downregulation of genes under such stress. Advanced technologies have widened our genetic and molecular understanding of plant responses espacially under environmental stress. *Emerging Technologies and Management of Crop Stress Tolerance: Volume 1 Biological Techniques* will focus on the latest technologies used in plant stress resistance and development.

The book has 21 chapters; all of which deal with the alleviation of environmental stress through a different new technology that can be employed to increase the crop yield. Chapter 1 deals with the genomic approaches in abiotic stress tolerance in plants. Here the authors have clearly mentioned physiological, cellular and biochemical mechanisms of abiotic stress in plants. The authors have also highlighted functional genomic approaches in alleviating abiotic stress. Chapter 2 discusses the role of metabolomics in crop improvement and various techniques involved in metabolomics. Chapter 3 explains the role of transcription factors in mitigating environmental stress in plants. The author also highlights NAC, WRKY and Zinc Finger transcription factors. Chapter 4 describes the impact of cold stress in plants and the role of proteomics, genomics and metabolomics in alleviating the cold stress. Chapter 5 deals with genetic engineering of crop plants for abiotic stress tolerance. Here the overexpression of genes for transcriptional regulation, over expression of genes for osmoprotectants, and engineering of ion transport is meticulously explained.

Chapter 6 deals with Bt crops as a sustainable approach towards biotic stress tolerance. In this chapter the author discusses the transformation of crops with Bt genes, molecular analysis of transgenic plants and biosafety and risk assessment studies. Chapter 7 is about modern tools for enhancing crop adaptation to climate changes. Here the author describes diferent stresses caused by climatic changes. Conventional and molecular breeding methods, genetic engineering and GM crops is also well documented.

Chapter 8 is about interaction of nano-particles (NPs) with plants, an emerging prospective in agriculture industry. In this chapter classification and applications of nano-particles are observed. Modes of nanoparticles internalization by plants, the influence of NPs as growth promoter in plants and the influence of NPs as biological control in plants is discussed. Chapter 9 highlights the role of miRNAs in abiotic and biotic stresses in plants. Discussions in this chapter cover miRNA as a significant player in gene regulation, mechanisms of miRNA biogenesis and function, miRNA-mediated functions in plants, genome-wide miRNA profiling under stresses, and the involvement of miRNAs in plant stresses.

Chapter 10 discusses gene silencing, a novel cellular defense mechanism improving plant productivity under environmental stresses. Here the authors explain the elements of RNAi and RNAi under environmental stresses. Chapter 11 discusses the role of carbohydrates in plant resistance to abiotic stresses. The chapter highlights the importance of carbohydrates in osmotic balance and signaling.

The role of glucosinolates in plant stress tolerance is discussed in Chapter 12. The author talks about glucosinolate structure, isolation and analysis, biosynthesis of GSLs, role of glucosinolates in stress alleviation, and signaling networks. Chapters 13 and 14 deal with the trace elements and their deficiency symptoms and physiological roles is described. Also the alleviation of the different environmental stresses by these trace elements is also discussed in detail.

Chapter 15 discusses nutritional stress in dystrophic savanna soils of the Orinoco Basin, looking at the biological responses to low N and P availabilities. Here the chapter describes the climate in the Orinoco basin, nutritional stress, enhancing nitrogen-fixation and phosphorus acquistion and uptake. Chapter 16 looks at silicon and selenium, two vital trace elements that confer abiotic stress tolerance to plants. Here the author discusses silicon and selenium uptake and transport in plants, the involvement of Si and Se in plant growth, development, and physiology, and the protective roles of Si and Se under abiotic stress.

Chapter 17 highlights the mechanisms of herbicide/pesticide tolerance in plants. Chapter 18 is about the effects of humic materials on plant metabolism and agricultural productivity. Here the authors discuss the characteristics of humic materials and their functions and use of humic materials for sustainable plant production.

Chapter 19 discusses climate change and potential impacts on quality of fruit and vegetable crops. Impacts of climate change on vegetable production systems in Brazil, harvest and postharvest, and the effects of abiotic stress on different aspects of fruit is well explained. Chapter 20 regards the interplay of plant circadian clock and abiotic stress response networks. The chapter looks at the molecular basis of the circadian clock function in plants, the interaction between the clock components and cold response, and crosstalk between the circadian clock and ABA transcriptional networks. Finally, Chapter 21 throws light on the development of water-saving techniques for sugarcane (*Saccharum officinarum* L.) in the arid environment of Punjab in Pakistan.

We fervently believe that this volume comprises a wealth of knowledge, especially for plant biologists, environmentalists, agriculturists and students of different science colleges and universities. We have tried our level best to provide this compilation, but there may be some errors creeping in the volume for which we seek readers' indulgence and feedback.

We are very much thankful to our contributors who have devoted their valuable time in preparing their chapters and bearing the editors' corrections and suggestions as well. We owe our gratidude to Patricia Osborn (Acquisitions Editor, Elsevier), Carrie Bolger (Editorial Project Manager, Life Sciences, Elsevier), Melissa Read (Freelance Project Manager, Elsevier) and all the other staff members of Elsevier who were directly or indirectly associated with the project, for their constant help, valuable suggestions and timely publication of this volume.

Parvaiz Ahmad
Saiema Rasool

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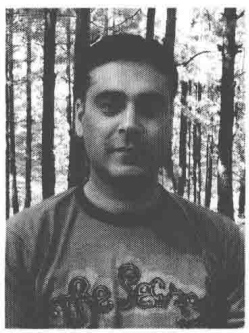
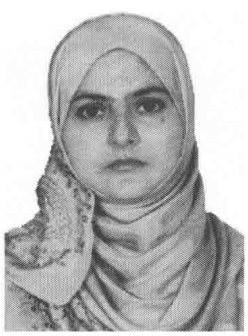
About the Editors



Dr. Parvaiz Ahmad is Senior Assistant Professor in the Department of Botany at Sri Pratap College, Srinagar, Jammu and Kashmir, India. He has completed his postgraduated study in Botany in 2000 at Jamia Hamdard, New Delhi, India. After receiving a Doctorate degree from the Indian Institute of Technology, Delhi, India, he joined the International Centre for Genetic Engineering and Biotechnology, New Delhi, in 2007. His main research area is Stress Physiology and Molecular Biology. He has published more than 35 research papers in peer-reviewed journals and 29 book chapters. He is also an editor of 12 volumes (1 with Studium Press Pvt. India Ltd., New Delhi, India, 8 with Springer USA and 3 with Elsevier USA). He is a recipient of the Junior Research Fellowship and Senior Research Fellowship by CSIR, New Delhi, India. Dr. Ahmad has been awarded the Young Scientist Award under the Fast Track scheme in 2007 by the Department of Science and Technology, Government of India. Dr. Ahmad is actively engaged in studying the molecular and physio-biochemical responses of different agricultural and horticultural plants under environmental stress.



Dr. Saiema Rasool is currently teaching plant science in the Education department, Government of Jammu and Kashmir India. Dr. Rasool completed her Masters in Botany at Jamia Hamdard New Delhi, India in 2007, specializing in plant stress physiology. She has eight research publications to her credit, published in various international and national journals of repute. She has also published 7 book chapters in international published volumes from publishers such as Springer, Elsevier and Wiley. At present, her research interests are mainly focused on the development of abiotic stress tolerant plants and the physiological and biochemical responses of crop plants to a range of biotic and abiotic stresses.

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