

Parvaiz Ahmad
Mohd. Rafiq Wani *Editors*

Physiological Mechanisms and Adaptation Strategies in Plants Under Changing Environment

Volume 2

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Preface

Environmental stresses such as salinity, drought, flooding, extreme temperatures, nutrient deficiency, or toxicity in addition to deteriorating soil conditions pose major intimidation to agriculture and food security worldwide. The productivity loss is elicited by a series of morphological, physiological, biochemical, and molecular stress-induced changes. Such an adverse situation is in contrast with the mounting global food demand and becomes even more testing in developing countries where they cause severe food insecurity and ruthless poverty for large populations predominantly in rural areas. Global population is escalating at a distressing rate and is anticipated to reach beyond nine billion by the end of 2050. While plant productivity is being seriously constrained by a range of abiotic stresses, feeding the world population under such horrid environment is a major disquiet for all nations. Water stress, on one hand, affects in excess of 70 million hectares of rice-growing land globally, whereas salt and nutrient stresses render more than one hundred million hectares of agricultural land uncultivable, thereby resulting in low outputs, poor human nutrition, and abridged educational and employment avenues. Knowledge and technology in biological science is expanding leaps and bounds, thus it becomes imperative to keep ourselves updated with the advances in plant abiotic stresses to meet the current scientific challenges, particularly the growing food demand for world population. In this scenario, it is urged that such strategies should be adopted which may be used to get maximum crop stand and economic returns from stressful environments. By employing contemporary tools and techniques, strenuous attempts are being made worldwide to understand how plants respond to these stresses. In this context, the book “*Physiological Mechanisms and Adaptation Strategies in Plants under Changing Environment*” Volume 2 will prove an indispensable source for scientists, students, and others seeking advancements in this area of research.

The present volume comprises of 13 chapters and each chapter has different research scope from the other. Chapter 1 throws light on biochemical and molecular approaches for drought tolerance in plants. Here, the authors scrupulously review the effects of drought stress on biochemical parameters especially proline metabolism in plants besides recounting the mechanism of drought resistance on physiological, molecular, and enzymatic basis. Chapter 2 addresses the heavy-metal

attack on freshwater side: physiological defense strategies of macrophytes and ecotoxicological ops, wherein the authors have comprehensively put in their efforts in elaborating the role of Cd and Cu pollution for inducing heavy-metal stress at all organization levels. The authors reveal that physiological responses remain very sensitive to the xenobiotic levels and constitute the first step towards the development of histological protection against the free radicals. Chapter 3 is about the secondary metabolites and environmental stress in plants: biosynthesis, regulation, and function. In this chapter, recent developments on structural and regulatory genes involved in the biosynthesis of secondary metabolites are explicitly discussed.

Chapter 4 is about the major phytohormones under abiotic stress, where the authors uncover the pivotal role of phytohormones in plants for adapting to changing environments by mediating growth, development, nutrient allocation, and source/sink transitions. Furthermore, the chapter summarizes the recent progress concerning the essential role of phytohormones in plant responses to abiotic stress, which has brought change in transcriptomics, metabolomics, and proteomics. Chapter 5 is regarding the nitric oxide and its role in plants under abiotic stress. In this chapter, the author presents the comprehensive synthesis of nitric oxide and its role in many physiological and developmental processes in addition to signaling molecule interactions with plant hormones and defense gene regulations under environmental stresses. Chapter 6 describes brassinosteroids: improving crop productivity and abiotic stress tolerance. The chapter focuses on the exogenous application of effective doses of brassinosteroids (BRs) in stress-affected plants, which play crucial roles in wide spectrum of biochemical, physiological, growth and developmental processes, besides defending them from adversaries of environmental stresses.

Chapter 7 deals with ethylene and its role in plants under environmental stress. In this chapter, it is highlighted that ethylene acts via complex signaling pathway leading to the activation of *Ethylene Response Factor (ETR)* genes which represent one of the largest transcription factor families in the plant kingdom. Chapter 8 describes the scenario of climate changes in the context of agriculture. Here, the authors painstakingly discuss the contributing factors to global warming in addition to global distribution of synthetic organic compounds, alteration in biochemistry of elemental cycle, and impact of climatic changes on the productivity of plants. Chapter 9 is concerned with the role of protective compounds in stress tolerance. This chapter highlights how protective compounds alleviate the effects of environmental stresses, especially drought and salt and function as metabolic signals for broader influence on physiological responses and metabolic adjustments vis-à-vis stressful conditions.

Chapter 10 deals with the growth patterns of tomato plants subjected to two non-conventional abiotic stresses: UV-C irradiations and electric fields. This chapter covers the effects of the exposition of tomato to UV-C radiation and DC-electric field in bringing the significant alterations in plant growth. The protection of tomato plants against UV-C, combined with growth-promoting effects of electro-culture, could allow farmers to grow better crops in less time and at lower cost. Chapter 11 is about rhizobacteria and the restoration of heavy-metal contaminated soils. In this chapter, the authors enumerate the panoply of mechanisms used by microorganisms to cope

up with metal stress and mobilize their plant growth promotion traits in association with their host plants with special emphasis to actinobacteria in metal contaminated lands. Chapter 12 deals with potassium and sodium transport channels under NaCl stress, where the authors have discussed in detail the pathways for Na⁺ and K⁺ transport across the plasma membrane, tissue distribution of these ions, and their intracellular compartmentalization. Chapter 13 is about *Jatropha curcas*: an overview. The chapter encompasses different aspects of *Jatropha* plantation and its uses including in soil conservation under stressful conditions. In addition, the chapter also includes the information about phytochemical constituents of *Jatropha* and its possible allelopathic effects.

Chapters contributed in this book have been published keeping intact author's justifications; however, suitable editorial changes were made, wherever considered necessary. In spite of our best efforts, there is a chance of some errors still creeping in the book, for which we seek reader's feedback. We wish to express our appreciation to the well-versed contributors, who readily accepted our invitation to write the chapters. Moreover, we would like to thank Springer Science+Business Media, LLC, New York, particularly Eric Stannard (Editor Botany), Flora Kim (Developmental Editor), Andy Kwan (Assistant Editor), and all the other staff members of Springer, who were directly or indirectly associated with us in the current project for their constant support and efforts in bringing out the timely publication of this volume.

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About the Editors



Dr. Parvaiz Ahmad (Editor) Dr. Parvaiz Ahmad is Assistant Professor in Botany at S. P. College, Srinagar, Jammu and Kashmir, India. He has completed his post-graduation in Botany in 2000 from Jamia Hamdard, New Delhi, India. After receiving Doctorate degree from Indian Institute of Technology (IIT) Delhi, India, he joined 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 30 research papers in peer-reviewed journals and 19 book chapters. He is also an editor of 6 volumes (5 with Springer NY USA and 1 with Studium Press Pvt. India Ltd., New Delhi, India). He is the recipient of Junior Research Fellowship and Senior Research Fellowship by CSIR, New Delhi, India. Dr. Parvaiz has been awarded Young Scientist Award under Fast Track scheme in 2007 by Department of Science and Technology (DST), Govt. of India. Dr. Parvaiz is actively engaged in studying the molecular and physio-biochemical responses of different agricultural and horticultural plants under environmental stress.



Dr. Mohd Rafiq Wani (Co-editor) Dr. Mohd Rafiq Wani is currently Assistant Professor in Botany at Government Degree College (Boys), Anantnag, University of Kashmir, India. Dr. Wani did his Masters in Botany in 2003 with specialization in “Genetics and Plant Breeding” from Aligarh Muslim University (AMU), Aligarh, UP, India. After obtaining the Degree of Doctorate in 2008 for his research work on “Chemical Mutagenesis in Mungbean” from the same University, he joined Department of Higher Education, Government of Jammu and Kashmir in 2009. He teaches a

range of bioscience-related subjects at undergraduate/post-graduate levels. At present, his research interests are mainly focused on the improvement of pulses through induced mutations and exploring the physiological and biochemical responses of crop plants to a range of biotic and abiotic stresses. As a part of his research endeavour, Dr. Wani has extensively researched and written on the issues of induced chemo-mutagenesis among the food crops, with special reference to pulses. He has around twenty eight (28) research publications to his credit, published in various international and national journals of repute. Moreover, he has also submitted several book chapters to various research-oriented volumes. Dr. Wani, while constantly working for his academic and research interests, is currently in the process of editing many volumes of books on the subjects of plant stress physiology and induced plant mutagenesis with reputed international publishers. In addition, he is an editorial member and reviewer of few online journals pertaining to plant sciences, besides being the life member of various scientific societies like Indian Society of Pulses Research and Development (ISPRD) and Indian Society of Genetics and Plant Breeding (ISGPB).

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