Biotic and Abiotic Stress Tolerance in Plants

Sharad Vats
Editor

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Foreword

Throughout evolution, plants have faced extreme variations in environment. Yet, they have survived and adapted themselves in different ecological niches. However, it is foreseen that in the ensuing period of present day global climatic changes, the impact on the domesticated crops, which feed the humanity, will result in negative growth and productivity. Scientists will have to develop new varieties, either through classical breeding tools or using new genomic approaches like molecular assisted breeding or developing biotech crops using transgenic or genome editing technologies. To achieve success in this direction it is essential to understand, at the biochemical and molecular level, the mechanisms of plant perception to abiotic and biotic stresses, the signaling pathways, and the identification of genes that respond to confer stress tolerance. The present book is an attempt to line up different chapters to illustrate the knowledge that has accumulated in some of the domains in the area of biotic and abiotic stress tolerance in plants.

One of the chapters broadly cover plant responses to drought in particular, to illustrate how the stress affects the physiology and biochemistry of the plants. How plants can be made to survive short drought conditions is an important aspect of future plant biotechnology studies. Using either phenomics or genomics based approaches one should get plants which can produce more per drop of water, which is going to be more scare for agriculture with increasing population and urbanization. More specifically, one of the chapters deals with impact of abiotic stresses on photosynthesis, which is the fundamental process that needs to be protected in order for the plants to survive and grow. It has been seen that senescence and chlorophyll breakdown ensues following stress conditions, which lowers photosynthesis and hence yield. A few chapters deal with the role of signaling molecules like nitric oxide, reactive oxygen species, and salicylic acid in modulating and adapting to stress environment and also in inducing cell death. These signals are produced in addition to changes in abscisic acid and calcium, etc., whose role has been well studied in stress physiology. One of the important molecule that also plays

a very significant role is glutathione. Modulation of GSH and GSSG seems to be one of the key parameters that senses and transduces stress signals. In view of this, the role of glutathione transferases and phosphite in adaptation is also discussed in two chapters.

Air, water, and soil pollution influence plant growth and development. Two chapters are devoted to pollution as a stress for plants where effect of insecticides and also biomonitoring have been presented. Among other changes that occur in plants following stress perception, role of bioactive compounds has been presented in a separate chapter. In order to assess the overall molecular changes under stress environment, a chapter deals with changes in miRNA and another on the availability of bioinformatic resources. One chapter on breeding for stress has been included using *Capsicum* as a test case.

Overall, the editor has effectively used his experience and knowledge to incorporate experts from various parts of the globe to write chapters covering important aspects of plant stress biology. The information compiled in this volume will be useful to students and researchers of molecular plant physiology in general and to those working in stress physiology in particular.

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Preface

Plants, being sedentary, are highly exposed to environmental stress (biotic and abiotic). However, they have developed several mechanisms to tolerate adverse conditions, which are rather complex to decipher. Global climatic changes, pollution, ever-increasing population, resistant pests, and other related factors have even worsened the current environmental situation, having a direct negative impact on the world's crop production. Thus, understanding the effects and various tolerance mechanisms of plants under stress is of prime importance to the scientific fraternity. The present work is an attempt to incorporate some of the biochemical, physiological, and molecular aspects of plant stress with latest updates.

The book is organized into 14 chapters written by eminent experts from different parts of the globe. The first chapter focuses on the physiological, biochemical, and molecular response of the plants under drought stress, which is one of the most predominant abiotic stresses. The second chapter highlights the effect of abiotic stress on the photosynthetic apparatus of the plants. The strategies involved to safeguard this apparatus have been discussed, which could help in the development of plants with effective photosynthetic machinery under stress. This is followed by a chapter which emphasizes on the ecotoxicological effects of insecticides on plants with special reference to germination and other phytotoxicity tools. The Chaps. 4 and 5 explore the variations of plant bioactive compounds and the role of salicylic acid in modulating salinity stress. Chapters 6, 7, 8 and 9 bring to light the involvement of beneficial elements, glutathione-S-transferase, phosphite, and nitric oxide, respectively, in the adaptive response of plants under stress and as a stimulator of better plant performance. Stress induced programmed cell death (PCD) in plants as a survival strategy and the role and cross-talk of reactive species of oxygen and nitrogen in activating PCD in plants have been efficiently described in the chapter "Involvement of Reactive Species of Oxygen and Nitrogen in Triggering Programmed Cell Death in Plants." In the Chap. 11, the research progress toward *Capsicum*, a commercially important plant, against stress tolerance has been compiled from classical breeding to the recent use of large-scale transcriptome and genome sequencing technologies. This is followed by a chapter, which underlines

the role of small RNAs in the plant development and stress mitigation. Apart from knowing the adaptive mechanisms of the plants it is also very important to identify some biological agents that monitor the level of environmental stress. Viewing the same, Chap. 13 has been included, which specifies the significance of the liliputians of the plant kingdom (Bryophytes) as biomonitors/bioindicators. The last chapter focuses on various general and specialized bioinformatics resources useful for people working in the field of plant stress biology. Overall, the book includes the latest developments in the field of plant stress biology supplemented with related figures and tables, which can be useful for students and research scholars.

I am extremely grateful to the publisher (Springer), contributors, and reviewers for their support and meticulous assessment of the book chapters. I would like to state that the encouragement and unconditional support of my parents, my wife, and my beloved daughter (Vaibhavi) were the guiding factors behind the effective completion of this work. I am also thankful to Prof. S. K. Sopory for providing his guidance and consent to write the foreword of this book.

Rajasthan, India Sharad Vats

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