BOOK REVIEWS


Abiotic or environmental stress has been an active area of research for the past several decades, not only because of its importance in agricultural productivity but also because of the insights that this research provides on basic physiological mechanisms in plants. The contributed chapters in this book review the many facets of temperature stress and collectively describe the diverse research strategies in physiology, biochemistry, and, more recently, molecular biology that have been used over the past decades. Low temperatures affect annual crops through alterations in homeostasis when temperatures drop below optimal. In winter-annual and perennial plants, water actually freezes in plant tissues during winter and the cytoplasm desiccates. On the opposite end of the spectrum, high temperatures can be equally detrimental to metabolism and water relations. These diverse physiological processes are examined in eight contributed chapters in this book, including three chapters related to chilling, two related to freezing, and three to heat stress.

In the first two chapters on chilling stress, from their different perspectives, Tottempudi Prasad and Mark Hodges examine the experimental evidence linking chilling stress and activated oxygen. In his chapter, Prasad reviews his own pioneering biochemical and physiological work on chilling injury in maize seedlings that implicates hydrogen peroxide as a key signaling molecule. He concludes with a review of the genetic engineering approaches that have been used to modify antioxidant scavenging systems in plants and the consequences for chilling tolerance. In the second chapter, Hodges gives a general overview of oxidative stress and the multitude of scavenging systems that are present in the plant. One of the conclusions from Hodges’ review is that apparently different plants are injured by chilling temperatures in different ways. Although this might seem obvious, this relatively simple conclusion has very dramatic ramifications to the biotechnological approaches used to improve chilling tolerance in crops. In the third chapter, Pamela Sanders and Albert Markhart III review the literature from the perspective of low temperature injury to root systems and clearly illustrate the consequences on root functions including nutrient and water uptake. Membranes and membrane lipid composition seem to be as equally important in chilling tolerance in roots as they are in photosynthetic tissues.

Chapters 4 and 5 discuss freezing temperatures. Techniques in molecular biology have been used extensively in the past decade to explore gene expression during the acclimation response and the scientific impact has been tremendous. Jean-Marc Ferullo and Marilyn Griffith have admirably summarized many of the key discoveries in their review of the mechanisms of cold acclimation. They discuss the freezing process in plants and consequent cellular dehydration, carbohydrate and amino acid metabolism, the critical dual roles of sugars, as well as the complex changes in gene expression. In Chapter 5, Sirpa Nuoto, Pekka Heino, and Tapio Palva review in more detail the various signal transduction systems that are operative in plants during the acclimation process. They briefly review the experimental evidence indicating that there are multiple pathways leading to the activation of cold responsive genes, including those mediated directly by low temperature, dehydration and abscisic acid. The importance of calcium and protein phosphorylation cascades is emphasized. The authors end with a short, incomplete section on the application of genetic engineering for freezing tolerance.

The final three chapters focus on heat stress. In Chapter 6, Natalya Klueva, Elena Maestri, Nelson Marmiroli, and Henry Nguyen provide an excellent overview by first discussing the physiology of high temperature stress and the phenomenon of acquired thermotolerance. Heat stress has been studied extensively at the molecular level and induces expression of specific heat shock proteins, antioxidants and membrane-associated proteins. Modifications in membrane structure, antioxidant capacity and stability of protein and mRNA are common mechanisms of thermotolerance. The chapter ends with an endorsement of transformation and quantitative trait loci (QTL) mapping strategies as means to achieve genetic improvement in crops. The next chapter focuses on the molecular biology of the heat shock response. Daniel Galle reviews the control of the heat shock response in crop plants with emphasis on translational control. Finally, Peter Stone provides a comprehensive review of the effects of heat stress on cereal yield and quality that emphasizes the traditional physiological and agronomic view. The effects of heat on the duration of grain filling, the rate of grain filling, light interception, and development have dramatic implications on both yield and quality of cereals.

The editor introduces this volume as one that gives “...a comprehensive account of what is currently known about adaptive responses and presents innovative approaches for optimizing yield potential and stabilizing production... particularly by employing powerful molecular technologies... in combination with conventional plant breeding.” Collectively, the chapters in this book provide a comprehensive and current review of selected topics in abiotic stress, and each contains a listing of extensive citations that guide the reader to the primary literature. I recommend this book to researchers and graduate students in molecular biology, physiology, and agronomy who wish to learn about recent developments in environmental stress responses.

Bryan D. McKersie
BASF Plant Science LLC,
26 Davis Dr.,
Research Triangle Park, NC 27709-3528
(mckersb@basf.com)

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