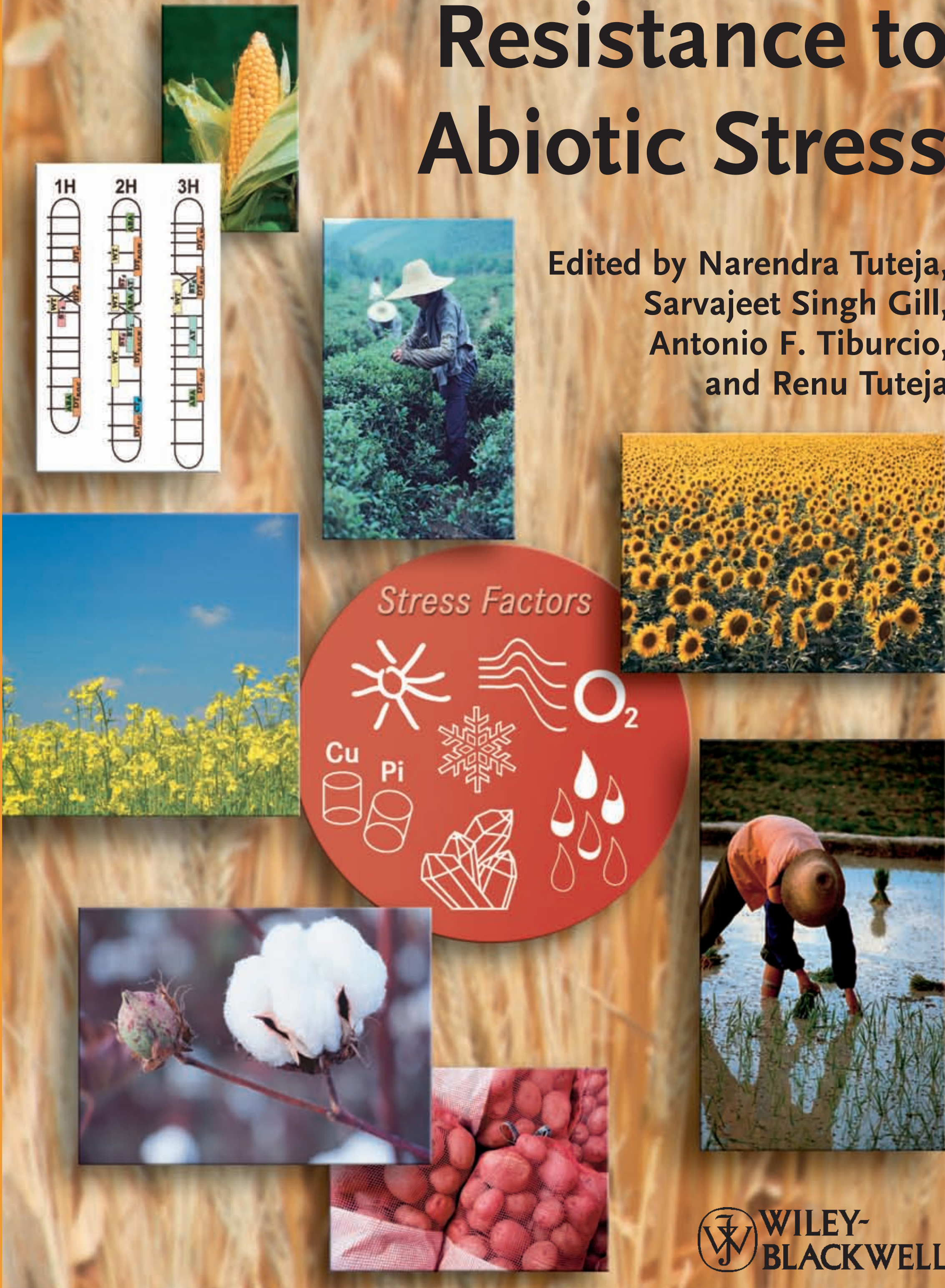
# Improving Crop Resistance to Abiotic Stress

Edited by Narendra Tuteja,
Sarvajeet Singh Gill,
Antonio F. Tiburcio,
and Renu Tuteja

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Abiotic stress tolerance QTLs mapped on the barley genome, excerpt, for further information see Fig 34.1.



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## Foreword I

We are guests of green plants on this planet. Plants are a source of food, fiber, and materials for shelter. Ornamental plants contribute to our esthetic environment. Numerous plants are sources of pharmaceuticals. Our civilization developed progressively after the domestication of plants about 10 000 years ago. Since then plants were constantly improved through conscious and unconscious selection by ancient farmers for more than 9000 years. During the last century, crop improvement became a scientific endeavor after the rediscovery of Mendel's laws of inheritance. The science of genetics provided many additions to plant breeder's tool kit and major advances in food production were made. Green Revolution is a shining example of these advances. It has been possible to feed 6 billion of Earth's inhabitants.

Human population continues to increase unabated. It is estimated that there will be 9 billion people on this planet in 2050 and this will require doubling of food production. To meet this challenge, we must increase the yield potential of our food crops and close the yield gap. The average yield of most crops is about half their potential yield. For example, yield potential of rice is 10 ton ha$^{-1}$, but farmers on average harvest about 5 ton ha$^{-1}$. This yield gap is due to losses caused by biotic and abiotic stresses. Abiotic stresses include drought, submergence, salinity, and unfavorable temperatures.

Very little progress has been made in developing crops with tolerance to abiotic stresses through conventional breeding approaches. Breakthroughs in molecular biology and biotechnology have provided new tools such as molecular marker-aided selection (MAS) and genetic engineering. These technologies have opened new avenues for developing crops with tolerance to abiotic stresses.

Editors of this volume have done an admirable job of assembling a wealth of information on these new approaches for crop improvement. They have sought contributions from knowledgeable authors from all over the world. The number of crops included in the volume is comprehensive. These include grain, oil, fruits, vegetable, and ornamental crops and sugarcane, tea, tobacco, and cassava. Several chapters provide overview of latest advances in molecular biology such as genomics, transcriptomics, proteomics, and metabolomics, collectively called "omics." There is an excellent chapter on the role of plant transporters in abiotic stress tolerance. The chapter on improving crop productivity under changing environment is a welcome addition in view of concerns about the impact of climate change on crop productivity. This comprehensive volume should prove useful for basic researchers, plant scientists, and students interested in crop improvement, as well as teachers.

I would like to congratulate the editors for their labor of love for preparing this valuable scientific resource.

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## Foreword II

Together with other photosynthetic organisms, plants are the primary producers and the foundation of the global biogeochemical cycles that sustain terrestrial life. As such, plants are also the main biological resource for humans by providing food, feed, and various biomaterials such as oils, fibers, and wood. Taking into account population growth, urbanization, climate change, and the limitation of natural resources, global food security has become a strategic challenge just half a century after the "Green Revolution." There is a need for higher stability of yield to ensure global food security and repartitioning and lowering the prices of plant products. Moreover, the need to cut $CO_2$ emissions and the foreseeable end of the oil era makes the transition from conventional fossil fuels to alternative and renewable resources a priority, resulting in a growing demand for plant biomass for alternative energies and green chemistry.

Agriculture is also challenged by increasing urbanization and industrial pollution, resulting in the overexploitation of fossil resources, water, and arable land. Seventy percent of freshwater is used for irrigation, making water one of the most critical parameters in plant production. The predictions in climate change for this century are estimated to further negatively affect water supplies and agricultural productivity leading to the potential amplification of catastrophic incidents. Forty percent of the Earth's land surface is now used for agriculture. However, this area cannot be enlarged and instead, we foresee a reduction in arable land due to urbanization, pollution, and climate change in the next decades. If this was not enough, the world population will reach 9.2 billion by 2050, revealing that food production will have to double and farm productivity to increase by 1.75% each year.

In the face of these challenges, there is an urgent need to develop new crop lines that can perform better but under conditions of less water, less nutrient inputs, and by better withstanding abiotic and biotic stresses. This book, edited by Drs. Narendra Tuteja, Sarvajeet Singh Gill, Antonio F. Tiburcio, and Renu Tuteja, comes at the right time to tackle the problems plants face under abiotic stress conditions and will clearly be of major value for researchers and breeders. The editors have achieved to assemble a number of experts that share their knowledge in a very complementary way. The volume thereby provides both an excellent overview and a detailed account of the field of plant abiotic stress response mechanisms. Importantly, the contributions range from established concepts in model plants to applied questions in specific crops. The book thereby will enlighten readers of various disciplines and at various levels, bridging text book knowledge to application.

Paris *Heribert Hirt*

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