

Preface

The population of the world is estimated to increase from 7.3 to 9.7 billion by the year 2050. To keep up with the pace of population growth, it has recently been estimated that food production will need to be increased by 50% by 2030 and by 70–100% by 2050 for a well-fed world population. This situation will be exacerbated by a decrease in available arable land coupled with reduced crop yields, both of which are predicted to arise from climate change. Global climate change affects crop production not only through altered weather patterns, but also via increased environmental stresses such as soil salinity, drought, flooding, metal/metalloid toxicity, environmental pollution, low and high temperature, and the emergence of new diseases and insect-pests. It is estimated that these stresses will reduce the crop yield of staple food up to 70%. As sessile organisms, plants cannot avoid all these predicted abiotic stresses, but can evolve sophisticated mechanisms to adapt to the changing environment. Therefore, a better understanding of plant responses to abiotic stresses is fundamental in designing biorational strategies to improve crop plants and obtain a sustainable crop production. Over decades, agronomic, physiological, genetics, genomics and other molecular biological studies have generated a large body of knowledge on reactions of plants to various abiotic stresses. Considerable success has also been achieved in the improvement of plant tolerance to abiotic stresses through the utilization of new knowledge generated by research. The application of various omics approaches is shedding light on molecular crosstalks between plants and abiotic stresses; this should promote the development of stress-tolerant crop plants by the application of exogenous and endogenous regulators.

The application of various phytoprotectants has become one of the most effective and plausible approaches in enhancing plant tolerance to abiotic stresses. These phytoprotectants include but are not limited to osmoprotectants (compatible solutes), antioxidants, phytohormones, nitric oxide, polyamines, amino acids, and nutrient elements of plants. A large body of literature is available on how these protective agents exert beneficial effects on plants, helping them tolerate abiotic stresses. However, the actual dose, timing, and methods of practical application of phytoprotectants need to be finely tuned. Several lines of evidence suggest that exogenous osmolytes, phytohormones, signaling molecules and nutrient elements enhance the antioxidant defense system of plants. This, too, augments their tolerance to

abiotic stresses. Additionally, the application of phytoprotectants activates reactive oxygen species (ROS) signaling in plants.

This book outlines the recent updates of our understanding of the effects that various abiotic and biotic agents (commonly known as phytoprotectants) have on plant tolerance to major abiotic stresses. It includes 26 chapters contributed by 127 leading experts, including diverse areas of life sciences such as agronomy, plant physiology, cell biology, environmental sciences, and biotechnology. Chapter 1 describes the morphological and physiological changes undergone by plants under various abiotic stresses. The roles of phytoprotectants on abiotic stress signaling in plants are discussed in Chapter 2. Chapter 3 focuses on the improvement of abiotic stress tolerance in plants brought by seed priming. The enhancement of abiotic stress tolerance in plants through the application of various osmolytes is discussed in Chapter 4. Proline is a small molecule biosynthesized in plants which plays a significant role in their tolerance to salinity and drought. Chapter 5 comprehensively reviews the functions of proline in conferring salinity and drought tolerance to plants. Phytohormones are involved in various physiological processes including plant adaptation to harsh environments. Chapter 6 discusses the role of phytohormones in improving abiotic stress tolerance in plants. The enhancement of drought tolerance in plants through the ROS-scavenging system of phytohormones is illustrated in Chapter 7.

Stigalactones are chemical compounds biosynthesized in roots and are known as branching-inhibition hormones in plants. Their molecules have profound roles in plant–fungi (e.g., mycorrhiza) interactions and signaling systems in plants. Chapter 8 describes the role of strigalactones as mediators of abiotic stress responses and parasitic attraction in plants. The effects of non-enzymatic antioxidants in improving the tolerance of plants to abiotic stresses are presented in Chapter 9. Nitric oxide is a signaling molecule involved in various physiological processes in plants and other organisms. It also plays an important role in plant tolerance to abiotic stresses through antioxidants and ROS responses. Chapter 10 updates the regulatory role of nitric oxides in plant tolerance to abiotic stresses. The improvement of abiotic stress tolerance in plants through exogenous hydrogen peroxide and nitric oxide is covered in Chapter 11. The application of amino acids, calcium, balanced sulfur nutrition, silicon, and selenium in the enhancement

of plants tolerance to abiotic stresses is described in Chapters 12, 13, 14, 15, and 16, respectively. The role of bioorganic fertilizers and biochar in the improvement of soil health and mitigation of stress-induced damages in plants is discussed in Chapters 17 and 18, respectively.

Plant-associated beneficial microorganisms (such as plant probiotic bacteria) play important roles in promoting abiotic stress tolerance in plants. Chapters 19–22 focus on the effects of various beneficial microorganisms in protecting plants from abiotic stresses and increasing the yield of crops. The long road to the development of novel priming products to increase crop yield under stressful environments is covered by Chapter 24. Finally, the alleviation of the adverse effects of abiotic stresses to plants through plant-derived smoke and magnetopriming is illustrated in Chapters 25 and 26, respectively.

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