

Preface

Plants due to their sessile nature are exposed to different environmental stresses. These environmental stresses (biotic and abiotic) have been reported to decrease plant growth and development and massive crop loss worldwide. Environmental stress imposes ionic, osmotic stress and in severe cases causes oxidative stress in plants. Oxidative stress is generated by the production of reactive oxygen species (ROSs). These ROSs are highly reactive and can attack biomolecules and change their structural and functional utility. However, plants are equipped with defense mechanisms like osmolytes, osmoprotectants and antioxidants that enable them to withstand the negative effects of osmotic and oxidative stress. Genes and proteins related to defence mechanisms are up and down-regulated and leads to plant tolerance against the particular stress.

Plant growth and development is regulated by different physio-biochemical and molecular processes which are dependent on photosynthesis. All environmental stresses, irrespective of their targets and nature of perception in plants, algae, and cyanobacteria bring perturbation in the cellular energy homeostasis. The stress-adaptive mechanisms developed by these photosynthetic organisms are primarily based on reestablishment of cellular energy balance. In this background photosynthesis, the energy-producing process, plays a central role in modulating energy signaling and balance, which have significant implications for energy homeostasis of the whole organism.

Therefore, this book is compiled to acquaint readers with the latest update and future goals of photosynthetic research and also some of the scientific challenges that still exist in photosynthesis and living organism's interactions. The book is a compilation of 14 chapters.

The volume entitled "Photosynthesis, Productivity, and Environmental Stress" has a wide variety of chapters with updated information related to the relevant topics. This book has been planned to fulfill the gap of knowledge in relation to photosynthesis, crop productivity, and environmental stress. Chapter 1 of this book describes the effects of organic pollutants (OPs) on photosynthesis. The authors have worked very hard and have provided information on the characteristics of the OPs, sources of OPs, uptake and accumulation of OPs by plants, and effects of OPs on plant growth. Chapter 2 demonstrates the photosynthetic processes under cold stress and the authors have discussed the aspects of primary targets of cold stress in plants, cold stress infiltration of the chloroplast membrane integrity, damage to photosynthetic apparatus, effects on carbon dioxide (CO₂) fixation, and strategies to ameliorate cold stress and improve photosynthesis. Chapter 3 deals with high-temperature stress and photosynthesis under the pathological impact with the main focus on high-temperature stress

on crop plants, photosynthesis mechanisms, the impact of pathogens on photosynthesis mechanisms under temperature stress, and genomic, biochemical, and physiological approaches for crop plants under temperature and pathogenic stresses. Chapter 4 describes differential photosynthetic responses to light intensity with the thrust on characteristics of light, light absorption, and pigments, light absorption by leaves, light and photosynthetic responses. Chapter 5 deals with a case study of the effect of mineral mobilizing bacteria on photosynthesis and other physiological attributes under salinity stress. Chapter 6 narrates the regulation of photosynthesis under metal stress and the authors explain the ill effects of metals on photosynthesis and the mechanisms of photosynthesis regulation under metal stress. Heavy metals and photosynthesis: recent developments is the subject of Chapter 7. The authors take the opportunity to explain the heavy metals and hyperaccumulation, characteristics of hyperaccumulator plants, hyperaccumulation and photosynthesis, and the effect of heavy metals on chloroplast structure, gas-exchange, photosynthetic pigments, photosystems (PSI and PSII), key photosynthetic enzymes, and antioxidant defence mechanism from the photosynthetic systems. Chapter 8 deals with the regulation of photosynthesis under abiotic stresses. Different abiotic stresses like, drought, salinity, cold, and heat stress have been considered with a focus on photosynthesis. Overexpression of photosynthesis related genes and transcription factors have also been explained very well. Chapter 9 describes the regulatory roles of miRNAs for enhancing photosynthesis in plants under environmental stresses. miRNAs involved in photosynthesis and other downstream biological processes, effect of abiotic stresses on photosynthesis and plant productivity, genome wide miRNA profiling under abiotic stresses, functional characterization of miRNAs associated with photosynthesis and the role of MiRNAs in shoot/tiller development, root development, controlling stomatal density, hormone signaling, and controlling nodule development in leguminous crops are the thrust area of this chapter. Chapter 10 explains mineral mobilizing bacteria (MMB) mediated regulation of secondary metabolites for proper photosynthesis in maize under stress. The main focus of the chapter is on MMB mediated regulation of nutrients, chlorophyll content, carbon/sugar metabolite, nitrogen metabolite, and gene expression for secondary metabolites production and photosynthesis. MMB mediated regulation of secondary metabolites production and photosynthesis under biotic and abiotic stresses is also explained. Chapter 11 discusses the improvement of photosynthesis with phytohormones. The authors explain phytohormones: watchdogs of plant growth and development, the role of phytohormones in photosynthesis and abiotic stress tolerance. Chapter 12 deals with thermal and chlorophyll fluorescence imaging with respect to drought, salt, light, herbicides, pathogens, herbivory, and air pollutant stresses. Chapter 13 is about the biotechnological approach of introgression of C_4 pathway gene(s) in C_3 plants to improve photosynthetic carbon assimilation for crop improvement. The authors explain CO_2 assimilation in C_3 and C_4 plants, evolution of C_4 metabolism in higher plants, the effect of elevated CO_2 on C_3 and C_4 plants, and ectopic expression of C_4 photosynthesis genes in C_3 plants. Chapter 14 describes a case study regarding the interaction of photosynthesis, productivity, and the environment. Here the authors explain the effect of drought stress on some physiological traits, yield, and yield components of durum (*Triticum durum* Desf.) and bread (*Triticum aestivum* L.) wheat genotypes, subcellular localization of the NADP-ME and NAD-ME activity in the leaves of the wheat genotypes under soil drought conditions

physico-chemical parameters of NADP-ME and NAD-ME in the leaves of the Barakatli 95 and Garagylchyg 2 genotypes under soil drought conditions.

Although we have tried our best to gather the information and recent updated discoveries related to photosynthesis, crop productivity, and environmental stress in this volume. We believe however, that there still must be some scope for expansion; therefore, valuable suggestions from the readers and researchers are welcome, which we would include in our future editions and volumes. Last but not the least, we are very much thankful to the contributors and the entire publication team of Wiley who helped in every possible way to make this project possible and valuable for publication.

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