Molecular Physiology of Abiotic Stresses in Plant Productivity

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PREFACE

The book on **Molecular Physiology of Abiotic Stresses in Plant Productivity** is the outcome of global dedication for researches at physiological and molecular levels that substantially deals with challenges of ongoing international concern over the abiotic stress research, which as the major environmental factors affects plant growth-development. On the other hand, this book also highlights focused researches of significance on image-based plant phenotyping; phenomics and its application in physiological breeding; trace elements; plant functions; physiological basis of yield variation; medicinal and aromatic plants and so on.

In this book over fourteen major chapters emphasize Abiotic stresses and plant productivity followed by seven more chapters in toto in different sections on plant trace elements in plant physiology; physiological basis of yield; medicinal & aromatic plant wealth and so on. The first chapter of this elucidates the molecular physiology of dehydration stress. This stress causes tremendous effect on plant antioxidant defense system that conveys for understanding mechanisms that trigger off physiological responses to dehydration stress and rehydration conditions. In second chapter, exercising of different promoters in ABA mediated pathways in crops species draws attention to a basic construct for a model system to satisfy the hypothesis for developing dehydration stress resistance in crop plants. Subsequently, with the aim to develop strategies for drought mitigation and management, a vibrant team of scientists portrays drought, agricultural practices and private sector lending for sustainability in India, as drought is a serious problem that inhibits nutrient acquisition through roots and limits both quantity and quality of crop productions in *Chapter 3*. Subsequently, in *Chapter 4*, the plant small heat shock proteins are particularly diverse and are a crucial component of the plant heat shock response. Authors consolidate considerable progress made in recent years revealing the structure, function, and evolution of the sHSPs. The *Chapter 5* authors explain physiological adaptations and dynamics for plant productivity under low light intensity highlighting shade tolerance as the maximization of light harvesting and efficient use of captured light in photosynthesis with decreased respiration costs for maintenance according to carbon gain hypothesis. Therefore, how low light intensity affects the morphology, anatomy, physiology and biochemistry of metabolism and the molecular changes in the plant has been thoroughly reviewed**.** Nevertheless, in *Chapter 6* authors have substantially focused on abiotic determinants of tree seedling growth in tropical dry forests, since information on the interactive effects of light,

water and nitrogen on dry tropical tree seedlings is critical to formulating management practices to optimize the species and functional group specific resource availability. This is important for establishing the scientific basis of plantation and restoration programs in the dry tropical environment. Next to this in *Chapter 7,* the TNAU scientists have inclusively compiled major physiological adaptive traits of rice to anaerobic stress conditions caused by flooding during germination and early growth and its implications in crop improvement. This article further discusses the prospects of using knowledge gained in plant adaptation to anaerobic conditions for application in crop improvement programmes. **Of all non-essential heavy metals, cadmium (Cd) due to its potential toxicity to humans, and also its relative mobility in the soil–plant system** requires research for a better understanding of interactions between Cd and plant nutrients in soil-plant system. This has been nicely detailed by two experienced workers in *Chapter 8* as cadmium enrichment in soil: plant physiological manifestation. The *Chapter 9* reviews legume symbiosis under abiotic stresses, since legume–rhizobia association is critical for plant productivity in the view that soil nitrogen often limits plant growth. This symbiosis is affected by environmental stresses.

This book is novel beyond doubt by introducing phenomics and its application in physiological breeding in *Chapter 10* especially enriched through judicious compilation of vital importance in the present scenario by the brilliant team of researchers. This segment covers from simple to complex, focusing upon and discussing the genotyping and phenotyping; concept of a genotype–phenotype map; phenotyping system; plant phenotyping to phenomics; forward and reverse phenomics; phenomic tools; application of plant phenomics to trait-based physiological breeding; plant phenotyping platforms and phenomic projects; plant phenomics and data analysis; as well as plant phenomics in closing the 'gene to genotype' loop, which could be of outstanding interest to readers. The plant breeders have obtained valuable insights regarding heritability of traits, breeding value of the parents, influence of environment and selection approaches for genetically superior offspring using conventional tools like replication and sophisticated experimental designs. After this, in *Chapter 11,* another eminent team of scientists from NBPGR have devotedly endeavoured for contributing on image-based plant phenotyping, the latest consequential developments elucidating a candidate germplasm, which carries genes for targeted traits requires precise and accurate phenotyping of the germplasm. Authors draw attention that efforts are being made to develop new high throughput phenotyping techniques by using imaging, spectroscopy, robotics and high-performance computing. Further in *Chapter 12,* a brief insight into signal transduction pathways of some of the phytohormones based on plant physiological research done till now has been luminously compiled by vibrant workers of undersigned's department for providing enough insight into signal transduction

pathways, which is of course an emerging challenge in plant physiological research.

Besides the above chapters, the last chapter of the first section presents an overview of various metal pollutants and their effects on key metabolic processes in plants, focusing mainly on uptake of metals, induction of oxidative stress, role of different components of enzymic and non enzymic antioxidants under metal toxicity conditions. Phytoremediation process as a measure to decontaminate metal polluted soils has also been commendably discussed by eminent scientists of Plant Biochemistry and out of two of them, illustrious Prof. R. S. Dubey is the Vice-Chancellor of two universities at present.

The ***Section II: Plant Trace Elements in Plant Physiology*** consists of two chapters. Notwithstanding, the importance of nickel depending enzymes in Archea, bacteria, plants and primitive eukaryotes is now very well documented so the scientist from Argentina reviewed the impact of nickel biochemistry and its role in plant physiology, as soluble and insoluble nickel compounds are also found in soils and in waters in *Chapter 15* correlating its impact on human health, hence significant an article in several respects. This chapter follows to *Chapter 16,* which gives an overview on iodine as a unique element in context with soil-plant-air system, since the distribution of iodine deficiency disorders (IDD) generally reflects the soil geochemistry of iodine, with areas remote from marine influence, such as central continental and rain shadow areas of high mountain ranges, being seriously affected. Therefore, producing iodine- enhanced vegetables is an attractive way to control IDD, as focused scientifically by devoted workers.

Besides the above, two fundamental chapters are contained in ***Section III: Plant Functions Research in Agricultural Progression.*** Author from Argentina, briefly presented in *Chapter 17* the most important aspects related to the structure and mechanism of action of alkaline phosphatases followed by discussion on purple acid phosphatases found in many organisms from bacteria to man. This is followed by an ideal article on plant lectins, agricultural advancements and mammalian toxicity in *Chapter 18* that scientifically describes plant lectins, the versatile proteins possessing cytotoxic, fungitoxic, anti-nematode and other properties and also promising candidates against many insect pests coupled with their capacity towards agricultural development. Subsequently, the *Chapter 19* of the ***Section IV: Physiological Basis of Yield*** provides precise information by a team of ICAR scientists about potential yield of a crop and the practical limitations to its realization in the field. This is essential for economically feasible meaningful research that ensures food security along with understanding of factors affecting yield are pivotal for agricultural research.

Eventually, the ***Section V*** on ***Nutraceuticals, Medicinal & Aromatic Plant Wealth,*** out of its two integral segments, in *Chapter 20* while illustrating plant wealth, focuses upon the general composition of

identified and established microalgae as sources of nutraceuticals and pharmaceuticals of value based on pigments, protein and several bioactive compounds essential for human health and nutrition along with elucidating some side effects. This section finally concludes with a comprehensive review on medicinal and aromatic plants, the wealth of India at high and low altitudes where the single author portrays global biodiversity hotspots of Himalayas highlighting ecological, phyto-geographical and evolutionary factors that favour high species diversity amply understood significance of medicinal and aromatic plants. The author extensively and comprehensively depicts the subject by making emphasis upon quality assurance, industrial applications and biotechnological interventions with plant tissue culture approaches in splendid *Chapter 21* of this unique compilation.

Last but not the least, I am beholden to my family members for their blessings and good wishes for inception of this exclusive edited book on **Molecular Physiology of Abiotic Stresses in Plant Productivity.** Besides these, I am extremely thankful to the excellent and talented personnel of the Scientific Publishers, Jodhpur, India, for their authentic competence in the perfect printing of international standard and worldwide circulation.

A. Hemantaranjan
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CONTENTS

Section IV:
Physiological Basis of Yield

Section V:
Nutraceuticals, Medicinal & Aromatic Plant Wealth

Comprehensive Review

Section - I

Abiotic Stresses & Plant Productivity: Physiological & Molecular Perspectives