Date Palm Biotechnology

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Preface

Date palm (*Phoenix dactylifera* L.) is a dioecious fruit tree native to the hot arid regions of the world, mainly grown in the Middle East, and North Africa. Through germplasm exchange, date palm agriculture has expanded to Australia, Southern Africa, South America, Mexico and the United States of America. Since ancient time this majestic plant has been recognized as the "tree of life" because of its integration in human settlement, wellbeing, and food security in hot and barren parts of the world, where only a few plant species can flourish. Date palm trees continue to provide the most sustainable agro-ecosystems in harsh dry environments providing raw materials for housing, furnishings, and many handcrafts in addition to supplying nutritious delicious fruits that can be consumed fresh, dried, or processed, providing a nutritious source of sugars, minerals, and vitamins. Economically, date palm provides a major source of income for local farmers and associated industries in communities where it is grown.

Expansion of date palm agriculture is faced with challenges stemming from propagation and genetic improvement limitations. The heterozygous nature of this dioecious species hampers the use of seeds which produce off type seedlings, and normally are not used to propagate known elite cultivars. The limited availability of offshoots and the difficulties of establishing propogules from offshoots render this traditional propagation method inadequate, particularly for large-scale propagation. Based on recent advances in plant tissue culture, micropropagation technique has been developed for the rapid mass propagation of date palm. Some limitations associated with genetic improvement have been circumvented by taking advantage of tissue culture applications and molecular methodologies.

Overall, this book discusses the major developments in date palm biotechnology during the last few decades highlighting genetics and germplasm, tissue culture methodologies and applications, genetic engineering, genomics, and molecular techniques. The book contains an introductory chapter: Date palm biotechnology from theory to practice that gives a plausible background for the 33 review chapters which highlight current research status relevant to various aspects of date palm biotechnology. The book is divided in five parts. Part I discusses the research development, methodology,

and commercial application of micropropagation in seven chapters: Potential of date palm micropropagation for improving small farming systems; Date palm tissue culture: a pathway to rural development; Date palm micropropagation via somatic embryogenesis; Date palm micropropagation via organogenesis; Micropropagation of date palm using inflorescence explants; Bioreactors and automation in date palm micropropagation; Commercial date palm tissue culture procedures and facility establishment.

Somaclonal variation is quite common in micropropagated plants occurring spontaneously in many plant species, but can be controlled by in vitro culture practices. However, it can be extremely useful to select somaclones exhibiting desirable traits like enhanced tolerance to biotic or abiotic stress agents. In fact, scientists often resort to mutagens to induce mutations to gain a broader genetic pool for more efficient in vitro selection. The maintenance of genetic fidelity of in vitro plantlets is highly desirable and that can be achieved by phenotypic characterizations, which is quite slow; however, molecular techniques are reliable to identify somaclones rapidly. In this book, Part II deals with the research development and applications of somaclonal variation and mutation in date palm, covered in seven chapters: Somaclonal variation in date palm; Growth abnormalities associated with micropropagation of date palm; Molecular detection of somaclonal variation in date palm; In vitro selection for abiotic stress in date palm; *Fusarium oxysporum* f. sp. *albedinis* toxins characterization and use for selection of resistant date palm to Bayoud disease; Radiation induced mutations for date palm improvement; Magnetic field induced biochemical and growth changes in date palm seedlings.

Genetic diversity of date palm is threatened by human development and reduction of suitable arable lands, in addition to ecosystem changes, monoculture, and biotic invasions. Successful utilization of date palm genetic resources requires characterization and preservation of date palm germplasm biodiversity using various conservation methods based on in situ and ex situ collections. Date palm field gene banks are difficult to maintain and the storage of offshoots under biocontrolled environment is impracticable. Seed conservation is not viable due to genetic heterozygosity. To augment traditional conservation methods, in vitro technologies have been applied in date palm. Molecular techniques to characterize date palm germplasm biodiversity are modern tools that have proved useful. The status of date palm germplasm and current techniques employed in conservation and molecular characterization are described in seven chapters in Part III of this book: Date palm germplasm; In vitro conservation of date palm germplasm; Molecular markers in date palm; Biodiversity in date palm: molecular markers as indicators; Polymorphism and genetic relationship in date palm using molecular markers; Date palm genome project at the kingdom of Saudi Arabia; Potential of arbuscular mycorrhizal technology in date palm production.

Plant tissue culture techniques offer several tools to plant breeders based on an understanding of genetic principles. For instants, embryo rescue, in vitro fertilization, in vitro flowering, somatic hybridization. An obstacle of date palm breeding is sex identification of offsprings since first flowering requires at least 3 years. Molecular technologies can effectively identify sex at early growth stages

and produce molecular markers which can drastically reduce breeding cycles. Genetic improvement is necessary to enhance the resistance to numerous date palm diseases and insects, improve yield and fruit quality, and increase tolerance to abiotic stresses. However, traditional breeding methods are inapplicable due to inherently slow growth nature and the long generation time of the date palm. Genetic engineering has proved invaluable to genetically improve many plant species. Although in its infancy, date palm genetic transformation and genomic studies to identify genes coding for useful traits are witnessing great interests. Part IV of this book contains eight chapters addressing research progress made in these areas: Date palm genetics and breeding; Development of new Moroccan selected date palm varieties resistant to Bayoud and of good fruit quality; Molecular markers for genetic diversity and Bayoud disease resistance in date palm; Towards sex determination of date palm; Interspecific hybridization and embryo rescue in date palm; In vitro flowering of date palm; Date palm cell and protoplast culture; Transgenic date palm.

The potential of producing secondary metabolites, enhancing date utilization and the possibility of producing biofuels from date palm-associated microorganisms paves the way to industrial biotechnological applications. Part V of this book describes up-to-date related progress made in three chapters: Secondary metabolites of date palm; Industrial biotechnology: date palm fruit applications; Date palm as a source of bioethanol producing microorganisms.

It is evident that biotechnology has significantly influenced date palm agriculture. Although research in date palm biotechnology is relatively limited, achievements accumulated thus far have inspired us to collect this valuable information under one cover to provide an updated source for beginners in the field of date palm biotechnology as well as a reliable reference for specialists. This book is beneficial to students, researchers, scientists, commercial producers, consultants, and policy makers interested in agriculture or plant science particularly in date palm biotechnology. It is highly recommended for plant biotechnology courses especially in date palm biotechnology graduate courses and training.

The chapters in this book were authored and reviewed by prominent specialists demonstrating distinct research contributions to date palm biotechnology, invited from industry, universities, and research institutes. Their contribution to the quality of this book is gratefully acknowledged.

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