

Advances in Plant Breeding Strategies: Cereals

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Dennis V. Johnson
Editors

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Volume 5

 Springer

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ISBN 978-3-030-23107-1 ISBN 978-3-030-23108-8 (eBook)
<https://doi.org/10.1007/978-3-030-23108-8>

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Contemporary plant breeders no longer need to rely solely on traditional methodologies in their work of assuring a sustainable and elastic level of world food production. However, human population is increasing at an alarming rate in developing countries, and food availability could gradually become a serious problem. Agriculture production is severely affected because of environmental pollution, rapid industrialization, water scarcity and quality, erosion of fertile topsoil, limited remaining arable land to expand production area, lack of improvement of local plant types, erosion of genetic diversity, and dependence on only few crop species for food supply worldwide. According to FAO, 70% more food must be produced over the next four decades to feed a projected population of 9 billion people by the year 2050. Currently, only 30 plant species are used to meet 95% of the world's food requirements, which are considered as the *major crops*. The breeding programs of these crops have been very much dependent on the ready availability of genetic variation, either spontaneous or induced. Plant breeders and geneticists are under constant pressure to sustain and increase food production by using innovative breeding strategies and introducing minor crops that are well adapted to marginal lands and can provide source of nutrition through tolerance of abiotic and biotic stresses. In traditional breeding, introgression of one or a few genes into a cultivar is carried out via backcrossing over several plant life cycles.

With the development of new molecular tools, molecular marker-assisted backcrossing has facilitated rapid introgression of a transgene into a plant and reduced linkage drag. Continued development and adaptation of plant biotechnology, molecular markers, and genomics have established ingenious new tools for the creation, analysis, and manipulation of genetic variation for the development of improved cultivars. For example, molecular breeding has great potential to become standard practice in the improvement of several fruit crops. Adopting a multidisciplinary approach comprised of traditional plant breeding, mutation breeding, plant biotechnology, and molecular biology would be strategically ideal for developing new improved crop varieties. This book highlights the recent progress in the development of plant biotechnology, associated molecular tools, and their usage in plant breeding.

The basic concept of this book is to examine the best use of both innovative and traditional methods of plant breeding to develop new crop varieties suited to different environmental conditions to achieve sustainable food production and enhanced food security in a changing global climate, in addition to the development of crops for enhanced production of pharmaceuticals and innovative industrial uses. Three volumes of this book series were published in 2015, 2016, and 2018, respectively: Volume 1, *Breeding, Biotechnology and Molecular Tools*; Volume 2, *Agronomic, Abiotic and Biotic Stress Traits*; and Volume 3, *Fruits*. In 2019, the following four volumes are concurrently being published: Volume 4, *Nut and Beverage Crops*; Volume 5, *Cereals*; Volume 6, *Industrial and Food Crops*; and Volume 7, *Legumes*.

This Volume 5, subtitled *Cereals*, focuses on advances in breeding strategies using both traditional and modern approaches for the improvement of individual crops. This volume addresses important staple food crops including barley, fonio, finger millet, foxtail millet, pearl millet, proso millet, quinoa, rice, rye, tef, triticale, and spelt wheat.

Chapters are written by internationally reputable scientists and subjected to a review process to assure quality presentation and scientific accuracy. Each chapter begins with an introduction covering related backgrounds and provides in-depth discussion of the subject supported with high-quality color photos, illustrations, and relevant data. This volume contains a total of 96 figures and 50 tables to illustrate presented concepts. The chapter concludes with an overview of the current status of breeding and recommendations for future research directions. A comprehensive list of pertinent references is provided to facilitate further reading.

The book is an excellent reference source for plant breeders and geneticists engaged in breeding programs involving biotechnology and molecular tools together with traditional breeding. It is suitable for both advanced undergraduate and post-graduate students specializing in agriculture, biotechnology, and molecular breeding as well as for seed companies and policy makers.

We are greatly appreciative of all chapter authors for their contributions toward the success and quality of this book. We are proud of this diverse collaborative undertaking, especially since this volume represents the efforts of 53 scientists from 14 countries. We are also grateful to Springer for giving us an opportunity to compile this book.

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About the Editors



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Shri Mohan Jain is a Consultant and Plant Biotechnologist, Department of Agricultural Sciences, University of Helsinki, Helsinki, Finland; he received his MPhil in 1973 and PhD in 1978, Jawaharlal Nehru University, New Delhi, India. He was a Postdoctoral Fellow in Israel and the USA and Visiting Scientist/Professor in Japan, Malaysia, Germany, and Italy. He was a Technical Officer, Plant Breeding and Genetics, International Atomic Energy Agency (IAEA), Vienna, Austria, 1999–2005. He is a Member of the International Association of Plant Tissue Culture and Biotechnology and an Editorial Board Member of *Euphytica*, *In Vitro*, *Propagation of Ornamental Plants*, *Emirates Journal of Food and Agriculture*, and a series on *Forest Biotechnology*. His publications are more than 160 in peer-reviewed journals, book chapters, and conference proceedings, and he has edited 55 books and was invited speaker and acted as a Chairperson in several international conferences worldwide. He was awarded Nobel Peace Prize in 2005 in commemoration of the awarding to IAEA of the Nobel Peace Prize for 2005; he is also former consultant to IAEA, the European Union, the Government of Grenada, Iranian Private Company, and the Egyptian Government. Currently his research interests are somatic embryogenesis, organogenesis, haploidy, somatic cell hybridization, somaclonal variation, and mutagenesis mainly in medicinal plants, date palm, and banana genetic improvement, genetic diversity, erosion, conservation, and utilization in the context of climate change and food and nutritional security.



Dennis V. Johnson is a Consultant and former University Professor. He is a graduate of the University of California, Los Angeles, where he completed his BA (1966), MA (1970), and PhD (1972) degrees in Geography, with specialization in Agriculture and Biogeography. He has taught at several colleges and universities, including the University of Houston, and was a Visiting Professor for 2 years at the University of Ceará, Fortaleza, Brazil. Dr. Johnson also has worked extensively with international development agencies providing technical assistance to agriculture and forestry on projects and programs in Africa, Asia, Europe, and Latin America. He has published numerous articles on palm utilization and conservation and has edited or written books for FAO, IUCN, and UNEP. He has also translated into English plant science books from Portuguese and Spanish. A decade ago, Dr. Johnson began to focus his research on date palm, in particular its introduction to nontraditional areas such as Spain, North and South America, and Australia. He co-authored a book on date growing in the USA and has made presentations at five international date palm conferences and co-edited books on date palm, sago palm, and plant breeding.

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