



# Genomics-Assisted Crop Improvement

*Volume 2*  
*Genomics Applications in Crops*

Rajeev K. Varshney  
Roberto Tuberosa  
*Editors*



Springer

# Genomics Assisted Crop Improvement Vol 2 Genomics Applications In Crops

**Rajeev K. Varshney, Roberto Tuberosa**



## **Genomics Assisted Crop Improvement Vol 2 Genomics Applications In Crops:**

*Genomics-Assisted Crop Improvement* R.K. Varshney, Roberto Tuberosa, 2007-12-12 Genomics research has great potential to revolutionize the discipline of plant breeding This two volume set provides a critical assessment of genomics tools and approaches for crop breeding Volume 1 entitled *Genomics Approaches and Platforms* illustrates state of the art genomics approaches and platforms presently available for crop improvement Volume 2 entitled *Genomics Applications in Crops* compiles crop specific studies that summarize both the achievements and limitations of genomics research for crop improvement We hope that these two volumes while providing new ideas and opportunities to those working in crop breeding will help graduate students and teachers to develop a better understanding of the applications of crop genomics to plant research and breeding

**Genomics-Assisted Crop Improvement** Rajeev K. Varshney, Roberto Tuberosa, 2007-12-13 This superb volume provides a critical assessment of genomics tools and approaches for crop breeding Volume 1 presents the status and availability of genomic resources and platforms and also devises strategies and approaches for effectively exploiting genomics research Volume 2 goes into detail on a number of case studies of several important crop and plant species that summarize both the achievements and limitations of genomics research for crop improvement

**Genomics-Assisted Crop Improvement** Rajeev K. Varshney, Roberto Tuberosa, 2007-12-20 This superb volume provides a critical assessment of genomics tools and approaches for crop breeding Volume 1 presents the status and availability of genomic resources and platforms and also devises strategies and approaches for effectively exploiting genomics research Volume 2 goes into detail on a number of case studies of several important crop and plant species that summarize both the achievements and limitations of genomics research for crop improvement

**Cereal Genomics II** Pushpendra K. Gupta, Rajeev Varshney, 2013-05-29 *Cereal Genomics* published in 2004 served the purpose of collecting all information on cereal genomics at one place and was well received by the cereal workers through out the world The last eight years have witnessed significant advancement in the field of cereal genomics For instance high density genetic maps physical maps QTL maps and even draft genome sequence have become available for several cereal species Furthermore the next generation sequencing NGS technologies have revolutionized genomics research so that it is possible now to sequence genomes of hundreds or thousands of accessions of an individual cereal crop Significant amounts of data generated using these NGS technologies created a demand for computational tools to analyse this massive data In view of these developments the Editors realised that there was a need to have an updated volume on the present status and future prospects of cereal genomics These developments related to technology and the tools have been documented in this volume thus supplementing our earlier edited volume *Cereal Genomics* *Cereal Genomics II* discusses advances in cereal genomics research made during the last eight years and presents state of art cereal genomics and its utilization involving both basic research such as comparative genomics and functional genomics and applied research like QTL mapping and molecular breeding

Genomics Assisted Breeding of Crops for Abiotic Stress Tolerance, Vol. II Vijay Rani Rajpal, Deepmala Sehgal, Avinash Kumar, S.N. Raina, 2019-07-01 The abiotic stresses like drought temperature cold salinity heavy metals etc affect a great deal on the yield performance of the agricultural crops To cope up with these challenges plant breeding programs world wide are focussing on the development of stress tolerant varieties in all crop species Significant genomic advances have been made for abiotic stress tolerance in various crop species in terms of availability of molecular markers QTL mapping genome wide association studies GWAS genomic selection GS strategies and transcriptome profiling The broad range of articles involving genomics and breeding approaches deepens our existing knowledge about complex traits The chapters are written by authorities in their respective fields This book provides comprehensive and consolidated account on the applications of the most recent findings and the progress made in genomics assisted breeding for tolerance to abiotic stresses in many important major crop species with a focus on applications of modern strategies for sustainable agriculture The book is especially intended for students molecular breeders and scientists working on the genomics assisted genetic improvement of crop species for abiotic stress tolerance     *Translational Genomics for Crop Breeding, Volume 2* Rajeev Varshney, Roberto Tuberosa, 2013-09-13 Genomic Applications for Crop Breeding Abiotic Stress Quality and Yield Improvement is the second of two volumes looking at the latest advances in genomic applications to crop breeding This volume focuses on advances improving crop resistance to abiotic stresses such as extreme heat drought flooding as well as advances made in quality and yield improvement Chapters examine advances in such key crops as rice maize and sugarcane among others Genomic Applications for Crop Breeding Abiotic Stress Quality and Yield Improvement complements the earlier volume on biotic stressors and will be an essential purchase for those interested in crop science and food production     Translational Genomics for Crop Breeding, Volume 1 Rajeev Varshney, Roberto Tuberosa, 2013-12-31 Genomic Applications for Crop Breeding Biotic Stress is the first of two volumes looking at the latest advances in genomic applications to crop breeding This volume focuses on genomic assisted advances for improving economically important crops against biotic stressors such as viruses fungi nematodes and bacteria Looking at key advances in crops such as rice barley wheat and potato amongst others Genomic Applications for Crop Breeding Biotic Stress will be an essential reference for crop scientists geneticists breeders industry personnel and advanced students in the field     *Genetics and Genomics of the Triticeae* Catherine Feuillet, Gary J. Muehlbauer, 2009-06-10 Sequencing of the model plant genomes such as those of *A. thaliana* and rice has revolutionized our understanding of plant biology but it has yet to translate into the improvement of major crop species such as maize wheat or barley Moreover the comparative genomic studies in cereals that have been performed in the past decade have revealed the limits of conservation between rice and the other cereal genomes This has necessitated the development of genomic resources and programs for maize sorghum wheat and barley to serve as the foundation for future genome sequencing and the acceleration of genomic based improvement of these critically important crops Cereals constitute over 50% of total crop

production worldwide <http://www.fao.org> and cereal seeds are one of the most important renewable resources for food feed and industrial raw materials Crop species of the Triticeae tribe that comprise wheat barley and rye are essential components of human and domestic animal nutrition With 17% of all crop area wheat is the staple food for 40% of the world's population while barley ranks fifth in the world production Their domestication in the Fertile Crescent 10 000 years ago ushered in the beginning of agriculture and signified an important breakthrough in the advancement of civilization Rye is second after wheat among grains most commonly used in the production of bread and is also very important for mixed animal feeds It can be cultivated in poor soils and climates that are generally not suitable for other cereals Extensive genetics and cytogenetics studies performed in the Triticeae species over the last 50 years have led to the characterization of their chromosomal composition and origins and have supported intensive work to create new genetic resources Cytogenetic studies in wheat have allowed the identification and characterization of the different homoeologous genomes and have demonstrated the utility of studying wheat genome evolution as a model for the analysis of polyploidization a major force in the evolution of the eukaryotic genomes Barley with its diploid genome shows high collinearity with the other Triticeae genomes and therefore serves as a good template for supporting genomic analyses in the wheat and rye genomes The knowledge gained from genetic studies in the Triticeae has also been used to produce Triticale the first human made hybrid crop that results from a cross between wheat and rye and combines the nutrition quality and productivity of wheat with the ruggedness of rye Despite the economic importance of the Triticeae species and the need for accelerated crop improvement based on genomics studies the size 1.7 Gb for the bread wheat genome i.e. 5x the human genome and 40 times the rice genome high repeat content 80% and complexity polyploidy in wheat of their genomes often have been considered too challenging for efficient molecular analysis and genetic improvement in these species Consequently Triticeae genomics has lagged behind the genomic advances of other cereal crops for many years Recently however the situation has changed dramatically and robust genomic programs can be established in the Triticeae as a result of the convergence of several technology developments that have led to new more efficient scientific capabilities and resources such as whole genome and chromosome specific BAC libraries extensive EST collections transformation systems wild germplasm and mutant collections as well as DNA chips Currently the Triticeae genomics toolbox is comprised of 9 publicly available BAC libraries from diploid 5 tetraploid 1 and hexaploid 3 wheat 3 publicly available BAC libraries from barley and one BAC library from rye 3 wheat chromosome specific BAC libraries DNA chips including commercially available first generation chips from AFFYMETRIX containing 55 000 wheat and 22 000 barley genes A large number of wheat and barley genetic maps that are saturated by a significant number of markers The largest plant EST collection with 870 000 wheat ESTs 440 000 barley ESTs and about 10 000 rye ESTs Established protocols for stable transformation by biolistic and agrobacterium as well as a transient expression system using VIGS in wheat and barley and Large collections of well characterized cultivated and wild genetic resources International

consortia such as the International Triticeae Mapping Initiative ITMI have advanced synergies in the Triticeae genetics community in the development of additional mapping populations and markers that have led to a dramatic improvement in the resolution of the genetic maps and the amount of molecular markers in the three species resulting in the accelerated utilization of molecular markers in selection programs Together with the development of the genomic resources the isolation of the first genes of agronomic interest by map based cloning has been enabled and has proven the feasibility of forging the link between genotype and phenotype in the Triticeae species Moreover the first analyses of BAC sequences from wheat and barley have allowed preliminary characterizations of their genome organization and composition as well as the first inter and intra specific comparative genomic studies These later have revealed important evolutionary mechanisms e g unequal crossing over illegitimate recombination that have shaped the wheat and barley genomes during their evolution These breakthroughs have demonstrated the feasibility of developing efficient genomic studies in the Triticeae and have led to the recent establishment of the International Wheat Genome Sequencing Consortium IWGSC <http://www.wheatgenome.org> and the International Barley Sequencing Consortium [www.isbc.org](http://www.isbc.org) that aim to sequence respectively the hexaploid wheat and barley genomes to accelerate gene discovery and crop improvement in the next decade Large projects aiming at the establishment of the physical maps as well as a better characterization of their composition and organization through large scale random sequencing projects have been initiated already Concurrently a number of projects have been launched to develop high throughput functional genomics in wheat and barley Transcriptomics proteomics and metabolomics analyses of traits of agronomic importance such as quality disease resistance drought and salt tolerance are underway in both species Combined with the development of physical maps efficient gene isolation will be enabled and improved sequencing technologies and reduced sequencing costs will permit ultimately genome sequencing and access to the entire wheat and barley gene regulatory elements repertoire Because rye is closely related to wheat and barley in Triticeae evolution the latest developments in wheat and barley genomics will be of great use for developing rye genomics and for providing tools for rye improvement Finally a new model for temperate grasses has emerged in the past year with the development of the genetics and genomics including a 8x whole genome shotgun sequencing project of *Brachypodium* a member of the Poaceae family that is more closely related to the Triticeae than rice and can provide valuable information for supporting Triticeae genomics in the near future These recent breakthroughs have yet to be reviewed in a single source of literature and current handbooks on wheat barley or rye are dedicated mainly to progress in genetics In *Genetics and Genomics of the Triticeae* we will aim to comprehensively review the recent progress in the development of structural and functional genomics tools in the Triticeae species and review the understanding of wheat barley and rye biology that has resulted from these new resources as well as to illuminate how this new found knowledge can be applied for the improvement of these essential species The book will be the seventh volume in the ambitious series of books *Plant Genetics and Genomics* Richard A Jorgensen series editor that will

attempt to bring the field up to date on the genetics and genomics of important crop plants and genetic models It is our hope that the publication will be a useful and timely tool for researchers and students alike working with the Triticeae

*Genomics and Proteomics* Devarajan Thangadurai, Jeyabalan Sangeetha, 2015-06-09 The book provides scope and knowledge on advanced techniques and its applications into the modern fields of biotechnology genomics and proteomics In this book different genomics and proteomics technologies and principles are examined The fundamental knowledge presented in this book opens up an entirely new way of approaching DNA chip technology Molecular Breeding for Sustainable Crop Improvement Vijay Rani Rajpal, S. Rama Rao, S.N. Raina, 2016-02-02 The world population is estimated to reach to more than 10 billion by the year 2050 These projections pose a challenging situation for the agricultural scientists to increase crops productivity to meet the growing food demands The unavailability and or inaccessibility to appropriate gene pools with desired traits required to carry out genetic improvement of various crop species make this task formidable for the plant breeders Incidentally most of the desired genes reside in the wild genetic relatives of the crop species Therefore exploration and characterization of wild genetic resources of important crop species is vital for the efficient utilization of these gene pools for sustainable genetic improvements to assure food security Further understanding the myriad complexities of genic and genomic interactions among species more particularly of wild relatives of crop species and or phylogenetically distant germplasm can provide the necessary inputs to increase the effectiveness of genetic improvement through traditional and or genetic engineering methods This book provides comprehensive and latest insights on the evolutionary genesis of diversity access and its utilization in the evolution of various crop species A comprehensive account of various crops origin exploitation of the primary secondary and tertiary gene pools through breeding biosystematical cytogenetical and molecular phylogenetical relationships and genetic enhancement through biotechnological interventions among others have been provided as the necessary underpinnings to consolidate information on the effective and sustainable utilization of the related genetic resources The book stresses upon the importance of wild germplasm exploration characterization and exploitation in the assimilation of important crop species The book is especially intended for students and scientists working on the genetic improvement of crop species Plant Breeders Geneticists Taxonomists Molecular Biologists and Plant Biotechnologists working on crop species are going to find this book very useful **Plant Breeding Reviews** Jules Janick, 2011-02-02 Plant Breeding Reviews presents state of the art reviews on plant breeding and genetics covering horticultural agronomic and forestry crops incorporating both traditional and molecular methods The contributions are authored by world authorities anonymously reviewed and edited by Professor Jules Janick of Purdue University USA The series is an indispensable resource for crop breeders plant scientists and teachers involved in crop improvement and genetic resources **Plant Breeding Technology** Zeba Khan, 2024-12-26 This book highlights the latest and most exciting technological tools for plant breeding that are becoming the staple of all crop improvement programs Using case studies and

an evidence based approach to examine the current status of each technique the book discusses the challenges so far uncovered and future trends The book presents a systematic guide to various genomics approaches deployed for trait discovery and improvement in crop species The chapters comprehensively cover each application its advantages and disadvantages and its potential for improvement supported by illustrative examples *Advances in Plant Breeding Strategies: Legumes* Jameel M. Al-Khayri, Shri Mohan Jain, Dennis V. Johnson, 2019-10-08 This book examines the development of innovative modern methodologies towards augmenting conventional plant breeding in individual crops for the production of new crop varieties under the increasingly limiting environmental and cultivation factors to achieve sustainable agricultural production enhanced food security in addition to providing raw materials for innovative industrial products and pharmaceuticals This is Vol 7 subtitled Legumes focuses on advances in breeding strategies using both traditional and modern approaches for the improvement of individual legume crops Included in this volume are Adzuki bean Black gram Chickpea Cluster bean Common bean Cowpea Faba bean Hyacinth bean Lentil Mung bean Pigeonpea and Soybean This volume is contributed by 57 internationally reputable scientists from 9 countries Each chapter comprehensively reviews the modern literature on the subject and reflects the authors own experience *Genomics and Society* Dhavendra Kumar, Ruth Chadwick, 2015-10-29 Genomics and Society Ethical Legal Cultural and Socioeconomic Implications is the first book to address the vast and thorny web of ELSI topics identified as core priorities of the NHGRI in 2011 The work addresses fundamental issues of biosociety and bioeconomy as the revolution in biology moves from research lab to healthcare system Of particular interest to healthcare practitioners bioethicists and health economists and of tangential interest to the gamut of applied social scientists investigating the societal impact of new medical paradigms the work describes a myriad of issues around consent confidentiality rights patenting regulation and legality in the new era of genomic medicine Addresses the vast and thorny web of ELSI topics identified as core priorities of the NHGRI in 2011 Presents the core fundamental issues of biosociety and bioeconomy as the revolution in biology moves from research lab to healthcare system Describes a myriad of issues around consent including confidentiality rights patenting regulation and more **Plant Breeding Reviews, Volume 41** Irwin Goldman, 2018-01-17 Plant Breeding Reviews presents state of the art reviews on plant genetics and the breeding of all types of crops by both traditional means and molecular methods Many of the crops widely grown today stem from a very narrow genetic base understanding and preserving crop genetic resources is vital to the security of food systems worldwide The emphasis of the series is on methodology a fundamental understanding of crop genetics and applications to major crops Handbook on Agriculture, Biotechnology and Development Stuart J. Smyth, Peter W.B. Phillips, David Castle, 2014-03-28 This book is a compendium of knowledge experience and insight on agriculture biotechnology and development Beginning with an account of GM crop adoptions and attitudes towards them the book assesses numerous crucial processes concluding with detail **Biotechnological Approaches to Barley Improvement** Jochen Kumlehn, Nils Stein, 2014-11-20 This volume



offers an up to date overview of biotechnologically oriented barley research It is structured into two major sections the first focusing on current agricultural challenges and approaches to barley improvement and the second providing insights into recent advances in methodology Leading scientists highlight topics such as the global importance of barley genetic diversity and genebanks domestication shoot and inflorescence architecture reproductive development mineral nutrition photosynthesis and leaf senescence grain development drought tolerance viral and fungal pathogens phytophagous arthropods molecular farming sequence resources induced genetic variation and TILLING meiotic recombination *Hordeum bulbosum* genome wide association scans genomic selection haploid technology genetic engineering and whole plant phenomics Providing comprehensive information on topics ranging from fundamental aspects to specific applications this book offers a useful resource for scientists plant breeders teachers and advanced students in the fields of molecular and plant cell biology plant biotechnology and agronomy

**Genetics, Genomics, and Breeding of Tomato** Barbara E. Liedl, Joanne A. Labate, John R. Stommel, Ann Slade, Chittaranjan Kole, 2013-01-17 This volume covers the advances in the study of tomato diversity and taxonomy It examines the mapping of simple and complex traits classical genetics and breeding association studies molecular breeding positional cloning and structural and comparative genomics The contributors also discuss transcriptomics proteomics metabolomics and bioinformatics

**Achieving sustainable cultivation of coffee** Dr Philippe Lashermes, 2018-01-09 Covers recent research on coffee genetics physiology and genetic diversity Reviews the latest developments in breeding new varieties Assesses advances in measuring and understanding the chemical composition and nutraceutical properties of coffee

**Plant Tolerance to Individual and Concurrent Stresses** Muthappa Senthil-Kumar, 2017-01-21 This book focuses on multiple plant stresses and the molecular basis of adaptation addressing the molecular mechanism and adaptation for both abiotic and biotic stresses Ensuring the yield of crop plants grown under multiple individual and or combined stresses is essential to sustaining productivity In this regard the development of broad spectrum stress tolerant plants is important However to date information has largely been compiled only on the individual stress tolerance mechanisms and the mechanisms behind plants tolerance to two or more individual or simultaneous stresses are not fully understood Especially combinatorial stress a new stress altogether has only recently been made the object of systematic study Now several research groups around the world have begun exploring the concurrent stress tolerance mechanisms under both biotic and abiotic stress combinations This book presents contributions from various experts highlighting the findings of their multiple individual and concurrent stress tolerance dissection studies

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