

Contents

| | |
|--|-----------|
| Contributors | ix |
| Preface | xi |
| 1. Plant Breeding and Biotechnological Advances | 1 |
| <i>Aluizio Borém, Valdir Diola, and Roberto Fritsche-Neto</i> | |
| Introduction | 1 |
| Evolution of Genetics and Plant Breeding | 2 |
| The Impacts of Advances During the Twentieth Century | 3 |
| Advances and Expected Benefits of Biotechnology | 7 |
| Improvement of Tools in the Third Millennium | 7 |
| Combined Classic Breeding and Biotechnology | 12 |
| Perspectives | 13 |
| References | 16 |
| 2. Molecular Markers | 19 |
| <i>Eveline Teixeira Caixeta, Luis Felipe Ventorim Ferrão, Eunize Maciel-Zambolim, and Laércio Zambolim</i> | |
| Introduction | 19 |
| PCR-Based Markers | 19 |
| Hybridization-Based Markers | 30 |
| Markers Based on Sequencing | 33 |
| Choice of Molecular Marker | 41 |
| References | 43 |
| 3. Biometrics Applied to Molecular Analysis in Genetic Diversity | 47 |
| <i>Cosme Damião Cruz, Caio César Salgado, and Leonardo Lopes Bhering</i> | |
| Introduction | 47 |
| Genetic Diversity Between Accesses or Within Populations | 49 |
| Diversity and Population Structure | 74 |
| Statistic Tests of the Variance Components and Statistics Φ | 80 |
| References | 80 |

| | |
|---|------------|
| 4. Genome-Wide Association Studies (GWAS) | 83 |
| <i>Marcos Deon Vilela de Resende, Fabyano Fonseca e Silva, Márcio Fernando R. Resende Júnior, and Camila Ferreira Azevedo</i> | |
| Introduction | 83 |
| QTL Analysis and Genomic Selection: Concepts | 83 |
| Genome-Wide Association Studies (GWAS) | 88 |
| Genome-Wide Mapping via Single Marker Regression | 94 |
| Statistical Power and Significance of Association for QTL Detection | 95 |
| Genome-Wide Mapping with Haplotype Mixed Models | 98 |
| GWAS in Humans | 99 |
| Capturing h^2 in Humans with Imperfect LD Between SNPs and Causal Variants | 101 |
| References | 102 |
| 5. Genome-Wide Selection (GWS) | 105 |
| <i>Marcos Deon Vilela de Resende, Fabyano Fonseca e Silva, Márcio Fernando R. Resende Júnior, and Camila Ferreira Azevedo</i> | |
| Introduction | 105 |
| Genome-Wide Selection (GWS) | 105 |
| Accuracy of GWS | 108 |
| Estimation, Validation, and Selection Populations | 110 |
| Relationship Between Genetic Variance and Marker Variance | 123 |
| Increase in the Efficiency of Selection for Plant Breeding | 129 |
| References | 131 |
| 6. Genes Prospection | 135 |
| <i>Valdir Diola and Roberto Fritsche-Neto</i> | |
| Introduction | 135 |
| Principles of Genetic Mapping | 136 |
| Isolation of Genes by Using Techniques for Structural Genome | 143 |
| Relationship Between Genetic and Physical Maps | 148 |
| Physical Mapping and Isolation of Loci of Interest | 148 |
| The Isolation of Genes From the Functional Genome | 150 |
| Choosing a Technique for Functional Gene Cloning | 150 |
| The Cloning of Genes Using Bioinformatics Resources | 152 |
| Validation of Candidate Genes | 154 |
| Prospects for the Isolation of Genes of Interest | 155 |
| References | 156 |
| 7. Tissue Culture Applications for the Genetic Improvement of Plants | 157 |
| <i>Moacir Pasqual, Joyce Dória Rodrigues Soares, and Filipe Almendagna Rodrigues</i> | |
| Introduction | 157 |
| Somaclonal Variation | 157 |
| Mutagenesis | 162 |

| | |
|---|------------|
| Protoplast Fusion | 163 |
| Embryo Rescue | 166 |
| Production of Double Haploid Lines | 168 |
| Synthetic Seed Production | 170 |
| <i>In Vitro</i> Selection | 172 |
| Germplasm Conservation and Exchange | 173 |
| References | 176 |
| 8. Transgenic Plants | 179 |
| <i>Francisco Murilo Zerbini, Fábio Nascimento da Silva, Gloria Patricia Castillo Urquiza, and Marcos Fernando Basso</i> | |
| Introduction | 179 |
| Organization and Gene Expression in Eukaryotes | 180 |
| Manipulation of Nucleic Acids | 181 |
| Methodologies for the Development of Transgenic Plants | 184 |
| Laboratory Steps for the Development of Transgenic Plants | 190 |
| Identification of Transgenic Plants | 192 |
| Use, Effects, and Management of Transgenic Cultivars | 193 |
| References | 199 |
| 9. Double Haploids | 201 |
| <i>Roberto Fritsche-Neto, Deoclecio Domingos Garbuglio, and Aluizio Borém</i> | |
| Haploid Production | 203 |
| Ploid Identification and Chromosome Counting | 211 |
| Double-Haploid Production | 215 |
| Double Haploids in Breeding | 217 |
| Advantages and Disadvantages in the Use of Double Haploids | 220 |
| Application on the Genomic Statistics | 220 |
| Economical Aspects | 222 |
| References | 222 |
| 10. Tools for the Future Breeder | 225 |
| <i>Valdir Diola, Aluizio Borém, and Natália Arruda Sanglard</i> | |
| Introduction | 225 |
| Genomic Tools | 226 |
| Techniques Applied to Structural Genome | 226 |
| Techniques Applied to Functional Genome | 231 |
| Average- and Large-Scale Attainment of Markers | 235 |
| Bioinformatics Tools | 242 |
| Biotechnology in Plant Breeding | 246 |
| Perspectives of Genome-Assisted Plant Breeding | 247 |
| References | 247 |