

Contents

1	The Concept and Research Progress of Quantitative Traits	1
1.1	History of Molecular Quantitative Genetics	1
1.2	Concept and Genetic Characters of Quantitative Traits	2
1.3	Tools for Quantitative Trait Studies	3
1.3.1	Types of Molecular Markers	4
1.3.2	Applications of Molecular Markers	4
1.4	Progress and Prospect of QTL Mapping	6
1.4.1	Methods of QTL Mapping	6
1.4.2	QTL Mapping Progress	6
1.4.3	Application Prospects of QTL Mapping	9
	References	11
2	Genetic Analysis Methods of Quantitative Traits in Wheat.	13
2.1	The Types and Quality of Genetic Populations	13
2.1.1	The Types of Genetic Populations	13
2.1.2	Genetic Population Construction and Some Key Notes to Consider	19
2.1.3	Quality of Genetic Populations	24
2.2	Types and Applications of Genetic Markers.	26
2.2.1	Morphological Markers.	26
2.2.2	Cytological Markers.	26
2.2.3	Biochemical Markers	27
2.2.4	DNA Molecular Markers	27
2.3	Statistical and Mapping Method of Quantitative Traits	31
2.3.1	The Principle of QTL Mapping	31
2.3.2	Methods of QTL Mapping	32
2.4	New Methods of QTL Mapping.	35
2.4.1	Conditional QTL	35
2.4.2	eQTL Mapping Method	36

2.4.3	QTL Mapping Methods of New Gene Mining Germplasm	37
	References	38
3	Construction of Molecular Genetic Map of Wheat	41
3.1	Genetic Map and Construction Methods	43
3.1.1	Concept of Genetic Map	43
3.1.2	Construction Methods of Genetic Map	43
3.2	Genetics Map Construction	44
3.2.1	Genetic Map Construction Using DH Population Derived from Huapei 3 × Yumai 57	44
3.2.2	Genetic Map Constructed Using RIL Population Derived from Nuomai 1 × Gaocheng 8901	52
3.2.3	Genetic Map Constructed Using RIL Population Derived from Shannong 01-35 × Gaocheng 9411	59
3.2.4	High-Density Genetic Linkage Map Constructed Using SNP Markers and Others Markers	66
3.2.5	High-Density Genetic Linkage Map Constructed Using SNP Markers in Natural Population	70
3.2.6	Genetics Map Constructed Using a Wheat Backbone Parent “Aimengniu” and Derived Lines	77
3.3	Research Progress of Genetic Map Construction	86
3.3.1	Comparsion of the Genetic Map with that of Previous Studies	86
3.3.2	Summary of Wheat Genetics Maps	87
	References	91
4	Genetic Detection of Main Yield Traits in Wheat	95
4.1	Experimental Populations and Methods	95
4.1.1	Experimental Populations and Field Experimental Design	95
4.1.2	Traits Evaluation and Statistical Analysis	97
4.2	QTL Mapping for Main Yield Traits Using Different Populations	98
4.2.1	QTL Mapping for Spike-Related Traits	98
4.2.2	QTL Mapping for Grain-Related Traits	117
4.2.3	The Summary and Comparison of QTL Mapping Results for Main Yield Traits Among Three Populations	123
4.3	QTL Mapping for Wheat Tiller Number in Different Period Using a DH population and an Immortalized F ₂ Population	123
4.3.1	Research Materials and Methods of Wheat Tiller Character	126
4.3.2	QTL Mapping for Wheat Tiller Character in Different Period	127

4.3.3	Research Progress of Wheat Tiller Character QTL Mapping and Comparison of the Results with Previous Studies	131
4.4	QTL Mapping for Biomass Yield, Grain Yield, and Straw Yield Using a DH Population	132
4.4.1	Materials and Methods	133
4.4.2	QTL Mapping for Biomass Yield, Grain Yield, and Straw Yield.	134
4.4.3	Research Progress of QTL Mapping for BY, GY, SY in Wheat and Comparison of the Results with Previous Studies	139
4.5	QTL Analysis of Heterosis for Number of Grains and Grain Weight Per Spike Using a DH population and an Immortalized F ₂ Population	141
4.5.1	QTL-Based Analysis of Heterosis for Grain Number Per Spike	141
4.5.2	QTL-Based Analysis of Heterosis for Grain Weight Per Spike	147
4.6	QTL Analysis for Thousand-Grain Weight Using the High-Density Genetic Map	152
4.6.1	QTL Mapping for Thousand-Grain Weight	152
4.6.2	Research Progress of QTL Mapping for Thousand-Grain Weight and Comparison of the Results with Previous Studies	154
4.7	Association Mapping for Spike-Related Traits Using Wheat Backbone Parent “Aimengniu” Population.	156
4.7.1	Correlation Analysis for Spike-Related Phenotypic Traits	156
4.7.2	Association Mapping for Spike-Related Traits	158
4.8	Research Progress of QTL Mapping for Wheat Grain Yield Trait and Comparison of the Results with Previous Studies	163
4.8.1	Overview of QTL Mapping for Wheat Yield-Related Traits	163
4.8.2	Comparison of the Results with Previous Studies	173
	References	173
5	Genetic Detection of Main Quality Traits in Wheat	177
5.1	QTL Mapping of Wheat Kernel Quality Traits.	178
5.1.1	QTL Mapping of Wheat Grain Quality Traits	178
5.1.2	Research Progress of Wheat Grain Quality QTL Mapping and Comparison with Previous Studies	186
5.2	QTL Mapping of Wheat Nutritional Quality Traits.	187
5.2.1	QTL Mapping for the Protein Content of Wheat Grain and Flour.	188
5.2.2	QTL Mapping for Beneficial Mineral Elements	204

5.2.3	QTL Mapping of Amino Acid Content and Components in Wheat Grain	213
5.2.4	QTL Mapping of Carotenoid Pigments and Other Pigments	222
5.3	QTL Mapping for Flour Quality Traits	228
5.3.1	QTL Mapping of Gluten Content and Gluten Index	229
5.3.2	QTL Mapping of Flour Whiteness, Color, and PPO Activity	234
5.3.3	QTL Mapping of Sedimentation Volume	245
5.3.4	QTL Mapping of Paste Viscosity Characteristics	254
5.3.5	QTL Mapping of Falling Number	275
5.3.6	QTL Mapping of Starch Content and Components	278
5.4	QTL Mapping of Wheat Dough Rheological Characteristics	281
5.4.1	QTL Mapping for Farinograph Traits	282
5.4.2	QTL Mapping of Mixograph Traits	291
5.4.3	QTL Mapping of Alveograph Traits	300
5.5	QTL Mapping of Wheat Processing Quality Traits	306
5.5.1	QTL Mapping for Noodle Cooking Quality Traits	306
5.5.2	QTL Mapping of Noodle Texture Property Analyzer (TPA) Parameters	311
5.5.3	QTL Mapping of Steamed Bread's Texture Property Analyzer (TPA) Parameters	319
5.5.4	QTL Mapping of Steamed Bread Specific Volume	329
5.5.5	QTL Mapping of Steamed Bread Color	333
	References	344
6	Genetic Analysis of Main Physiological and Morphological Traits	351
6.1	QTL Mapping of Photosynthetic Characters in Wheat	352
6.1.1	QTL Mapping of Photosynthesis Characters of Wheat in Field	353
6.1.2	QTL Mapping of Photosynthesis of Wheat Seedlings in Phytotron	363
6.1.3	QTL Mapping of Dry Matter Production (DMA) and Fv/Fm at Jointing and Anthesis Stage in Field	368
6.1.4	Research Progress of Photosynthetic Characters QTL Mapping and Comparison of the Results with Previous Studies	376
6.2	QTL Conferring Microdissection Characteristics of Wheat Stem	382
6.2.1	QTL Mapping for Anatomical Traits of Second Basal Internode	382
6.2.2	QTL Mapping for Anatomical Traits of the Uppermost Internode	387

6.2.3	Research Progress of Anatomical Traits of Culm QTL Mapping and Comparison of the Results with Previous Studies	396
6.3	QTL Mapping and Effect Analysis of Heading Date.	397
6.3.1	QTL Analysis of Heading Date Based on a DH Population Derived from the Cross of Huapei 3 × Yumai 57	398
6.3.2	QTL Analysis of Heading Date Based on a RIL Population Derived from the Cross of Nuomai 1 × Gaocheng 8901	399
6.3.3	QTL Analysis of Heading Date Based on a RIL Population Derived from the Cross of Shannong 01-35 × Gaocheng 9411	404
6.3.4	Research Progress of Growth Period QTL Mapping and Comparison of the Results with Previous Studies	406
6.4	QTL Mapping of Cell Membrane Permeability of Wheat Leaf Treated by Low Temperature	408
6.4.1	QTL Mapping for Cell Membrane Permeability of Wheat Leaf	408
6.4.2	Research Progress of Cell Membrane Permeability QTL Mapping and Comparison of the Results with Previous Studies	411
6.5	QTL Mapping of Root Traits in Wheat.	413
6.5.1	QTL Mapping and Effects' Analysis of Root Traits	414
6.5.2	Research Progress of Root Traits' QTL Mapping and Comparison of the Results with Previous Studies.	420
6.6	QTL Mapping Conferring Leaf-Related Traits in Wheat	425
6.6.1	QTL Mapping for Leaf Morphology of Wheat Based on a DH Population	425
6.6.2	Association Analysis for Leaf Morphology Based on a Natural Population Derived from the Founder Parent Aimengniu and Its Progenies	431
6.6.3	Research Progress of Leaf Morphology QTL Mapping and Comparison of the Results with Previous Studies	434
	References	439
7	Genetic Dissection of Stress-Tolerance Traits in Wheat	445
7.1	QTL Mapping and Effect Analysis of Drought Resistance.	446
7.1.1	QTL Mapping of Drought Resistance Traits	447
7.1.2	Research Progress of Drought Resistance QTL Mapping in Wheat and Comparison of the Results with the Previous Studies.	452

7.2	QTL Mapping and Effect Analysis of Heavy Metals Resistance . . .	453
7.2.1	QTL Mapping for Seedling and Root Traits Under Cadmium Stress.	454
7.2.2	QTL Mapping for Seedling and Root Traits of Wheat Under Chromium Stress	463
7.2.3	Research Progress of Heavy Metals Resistance QTL Mapping and Comparison of the Results with the Previous Studies	470
7.3	QTL Mapping and Effect Analysis for Wheat Preharvest Sprouting Resistance	472
7.3.1	QTL Mapping for Wheat Preharvest Sprouting Resistance.	472
7.3.2	Research Progress of Preharvest Sprouting Resistance QTL Mapping and Comparison of the Results with the Previous Studies.	476
7.4	QTL Mapping and Effect Analysis of Disease Resistance	481
7.4.1	QTL Mapping for Adult-Plant Resistance to Powdery Mildew.	481
7.4.2	QTL Mapping for Resistance to Fusarium Head Blight. . .	482
7.4.3	Research Progress of Wheat Disease-Resistant QTL Mapping and Comparison of the Results with the Previous Studies	486
7.5	QTL Mapping and Effect Analysis of Salt Resistance.	494
7.5.1	QTL Mapping of Salt-Resistance Traits	495
7.5.2	Research Progress of Salt-Tolerance Traits QTL Mapping and the Comparative Analysis with this Study	505
7.6	QTLs Mapping of Potassium-Deficiency Tolerance at the Seedling Stage in Wheat.	507
7.6.1	QTL Mapping of Potassium-Deficiency Tolerance	508
7.6.2	Research Progress of Potassium-Deficiency Tolerance QTL Mapping and the Comparative Analysis with this Study.	519
	References	520
	Afterword	527

Genetic Analyses of Wheat and Molecular
Marker-Assisted Breeding, Volume 1
Genetics Map and QTL Mapping

Tian, J.; DENG, Z.; Zhang, K.; Yu, H.; Jiang, X.; Li, C.
2015, XXV, 528 p., Hardcover
ISBN: 978-94-017-7388-1