

Contents

Introduction	xi
Bernard DUMAS and Claire PRIGENT-COMBARET	
Chapter 1. Regulatory Aspects of Biocontrol	1
Diane ROBIN, Léa MERLET and Patrice MARCHAND	
1.1. Regulatory definition of biocontrol	2
1.1.1. Definitions of biocontrol	2
1.1.2. Applicable regulations	2
1.2. Current issues and limitations	3
1.2.1. The 3 PPP pillars	3
1.2.2. Fourth pillar	4
1.2.3. Limits with crop protection in Organic Agriculture	4
1.2.4. Limits of biocontrol: contentious substances!	5
1.3. A mixed evolution	5
1.3.1. Struggling bases.	7
1.3.2. Achieved progress	7
1.3.3. Regulatory relief for semiochemicals	8
1.3.4. Regulatory relief for microorganisms	11
1.3.5. Regulatory relief for natural substances.	12
1.4. Necessary evolutions	12
1.4.1. At the EU level	12
1.4.2. At the national level (France)	13
1.5. Conclusion	13
1.6. References	14
Chapter 2. Biological Controls in Horticulture.	19
Nicolas GUIBERT, Maïder SAINT JEAN, Claire PRIGENT-COMBARET, Jean-Marc DEOGRATIAS, Cécile CABASSON and Pierre PÉTRIACQ	
2.1. Introduction	19

2.1.1. Horticulture in Europe	19
2.1.2. Biocontrol solutions in horticulture	20
2.1.3. Biostimulants, complementary to biocontrol	22
2.1.4. A biocontrol example: TRIANUM® P and G approval in France	23
2.2. Biological controls in horticulture	24
2.3. Physiological trade-offs for growth and immunity	26
2.4. Eco-innovations and economic trade-offs	28
2.4.1. Determinants of eco-innovation and trade-offs at the farmer level	28
2.4.2. Influence of sectoral innovation patterns	31
2.5. Challenges and perspectives	36
2.6. Concluding remarks	38
2.7. References	39
Chapter 3. Development of Omics Tools for the Assessments of the Environmental Fate and Impact of Biocontrol Agents	47
Hikmat GHOSSE, Marie-Virginie SALVIA and Cédric BERTRAND	
3.1. Introduction: emergence of biocontrol agents and their risks	48
3.2. Evaluation methodologies: an overview	49
3.3. Limitations of classic methodologies	50
3.4. Omics: potential tools for risks assessment?	52
3.4.1. Genomics for (bio)pesticides and BCAs risks assessment	53
3.4.2. Metabolomics for (bio)pesticides and BCAs risks assessment	57
3.5. Perspectives	62
3.6. List of abbreviations.	63
3.7. Acknowledgments	64
3.8. References	65
Chapter 4. Plant Secondary Metabolites Mode of Action in the Control of Root-Knot Nematodes	75
Nikoletta NTALLI and Pierluigi CABONI	
4.1. Introduction	76
4.2. Recent research on the use of plant secondary metabolites to control <i>Meloidogyne</i> spp.	77
4.2.1. Small-scale experiments reporting in vitro efficacy	77
4.2.2. Large-scale experiments reporting in vivo efficacy	79
4.2.3. Mechanism of action	81
4.3. Conclusion	83
4.4. References	83

Chapter 5. Agro-industrial By-products and Waste as Sources of Biopesticides	91
Maria Fe ANDRES and Azucena GONZÁLEZ COLOMA	
5.1. Introduction	91
5.2. Biopesticidal properties of pyrolysis products from agro-industrial waste . . .	93
5.3. Biopesticidal properties of hydrolates: by-products of essential oil distillation	99
5.4. Biopesticidal properties of olive oil mill waste	103
5.5. Conclusion and future directives	105
5.6. Acknowledgments	107
5.7. References	107
Chapter 6. Antimicrobial and Defense Elicitor Peptides as Biopesticides for Plant Disease Control	121
Emilio MONTESINOS, Esther BADOSA, Maria PLA, Laura MONTESINOS and Anna BONATERRA	
6.1. Introduction	122
6.2. Peptides of microbial origin	124
6.2.1. Bacteriocins	126
6.2.2. Cyclic lipopeptides	126
6.2.3. Peptaibols	128
6.2.4. Other types of peptides produced by microorganisms	129
6.3. Peptides from plants	130
6.3.1. Antimicrobial peptides from plants (AMPs)	131
6.3.2. Damage-associated molecular patterns (DAMPs)	133
6.4. Peptides from animals	134
6.4.1. Antimicrobial peptides in animals	134
6.4.2. Peptides from animal origin active against plant pathogens and diseases .	135
6.5. Synthetic peptides	138
6.5.1. Development of synthetic peptides	138
6.5.2. Synthetic peptides against plant pathogens and diseases	139
6.6. Biotechnological production of peptides	142
6.6.1. Microbial systems	143
6.6.2. Microalgae systems	144
6.6.3. Plant systems	144
6.7. References	145
Chapter 7. Biocontrol of Plant Pathogens via Quorum Quenching	159
Denis FAURE and Xavier LATOUR	
7.1. Quorum quenching to counteract quorum sensing	159
7.2. Quorum sensing inhibitors	160
7.3. Quorum quenching enzymes	161

7.4. Quorum quenching biocontrol agents	162
7.5. Monitoring of quorum quenching biocontrol agents and activities	163
7.6. Biostimulation of quorum quenching	164
7.7. Management of quorum quenching treatments	165
7.8. Quorum quenching in biocontrol: perspectives	166
7.9. Acknowledgments	166
7.10. References	167
Chapter 8. Phage-mediated Biocontrol Against Plant Pathogenic Bacteria	173
Fernando CLAVIJO-COPPENS, Clara TORRES-BARCELO, Mireille ANSALDI, Nicolas TAVEAU and Denis COSTECHAREYRE	
8.1. Introduction	174
8.1.1. A tale of bacteriophages	174
8.1.2. Phage biology, cycle, host range and resistance mechanisms	176
8.1.3. Phage ecology on plant-associated ecosystem	178
8.2. Bacteriophages for plant health.	179
8.2.1. Phage-based biocontrol against plants pathogens	180
8.2.2. Optimizing a phage-based preparation	191
8.2.3. Pros and cons of phage biocontrol on crop protection	196
8.3. Phage-based biocontrol regulations	199
8.4. Conclusions and perspectives.	201
8.5. Acknowledgments	203
8.6. References	203
Chapter 9. Microbiome-assisted Agriculture: Current Knowledge and Future Directions	217
Ke YU, Hongwei LIU, Wei ZHONG and Ioannis A. STRINGLIS	
9.1. Introduction	217
9.1.1. The plant microbiome	218
9.1.2. Composition of the plant microbiome.	220
9.1.3. Contribution of the microbiome to plant fitness	221
9.2. Microbiome-mediated benefits for plants	221
9.2.1. Disease suppressive soils.	222
9.2.2. Induced resistance and soilborne legacy	223
9.2.3. Nutrient stress and microbiome	224
9.2.4. Plant immune system and microbiome	224
9.3. Chemical cues derived from plants and microbes guide microbiome assembly	225
9.3.1. Microbiome assembly mediated by host plants	226
9.3.2. Microbiome assembly mediated by microbe–microbe interactions.	230
9.4. Plant and soil microbiome engineering	232
9.4.1. “Cry for help” strategy for the plant to accumulate beneficial microbes.	232
9.4.2. Microbial strategies for plant and soil microbiome engineering	233

9.4.3. Chemical strategies for plant and soil microbiome engineering	235
9.4.4. Molecular strategies: genetic modification and breeding	237
9.5. Concluding remarks and future perspectives	238
9.6. References	239
List of Authors	255
Index.	259