

Contents

Contributors	xi
Preface	xiii
Chapter 1 Biological control of weeds with fungal plant pathogens	1
<i>D.O. TeBeest</i>	
1.1 Introduction	1
1.2 Strategies for controlling weeds with plant pathogens	2
1.3 Examples of the classical strategy	2
1.4 Examples of the mycoherbicide strategy	4
1.5 Pathogens under evaluation for biological weed control	7
1.6 The effectiveness of fungal plant pathogens as weed control agents	10
1.7 Summary	12
Chapter 2 The use of <i>Bacillus thuringiensis</i> as an insecticide	19
<i>D.R. Dent</i>	
2.1 Introduction	19
2.2 Mode of action and specificity	20
2.3 Selection, manipulation and evaluation of strains	24
2.4 Fermentation, formulation and field application	26
2.5 Commercialization of <i>Bt</i> as a microbial insecticide	30
2.6 IPM and the future of <i>Bt</i>	32
Chapter 3 Aspects of biocontrol of fungal plant pathogens	45
<i>J.M. Whipps and M.P. McQuilken</i>	
3.1 Introduction	45
3.2 Direct application of antagonists	46
3.3 Commercial biocontrol agents of fungal pathogens	64
3.4 Future prospects	68

Chapter 4	The use of microbial agents for the biological control of plant parasitic nematodes	81
	<i>B. Kerry</i>	
4.1	Introduction	81
4.2	Historical background	82
4.3	Potential biological control agents	83
4.4	Ecological considerations	86
4.5	Selection of potential agents	93
4.6	Biological control strategies	98
4.7	Research needs and prospects	100
Chapter 5	Insect viruses as biocontrol agents	
	<i>D. Winstanley and L. Rovesti</i>	105
5.1	Introduction	105
5.2	Insect viruses	106
5.3	Baculoviruses	106
5.4	Variations in virus susceptibility in insects	113
5.5	Current status of insect viruses for pest control	114
5.6	Strategies of use for insect viruses	115
5.7	Specific examples for pest control	120
5.8	Production and formulation	124
5.9	Application of viral insecticides	126
5.10	Genetic improvement of viral insecticides	129
5.11	Conclusions	130
Chapter 6	Cyanobacteria and <i>Azolla</i>	
	<i>B.A. Whitton</i>	137
6.1	Introduction	137
6.2	Features of cyanobacteria	138
6.3	Free-living cyanobacteria in rice-fields	145
6.4	<i>Anabaena-Azolla</i> symbiosis	154
6.5	Attempts to develop new symbiotic associations	156
6.6	Discussion and conclusions	156
Chapter 7	Mycorrhizal associations	
	<i>D.T. Mitchell</i>	169
7.1	Introduction	169
7.2	Types of mycorrhizal association	171
7.3	Role of mycorrhizas in agriculture, forestry and horticulture	177
7.4	Selection and production of ectomycorrhizal fungi for tree inoculation	181
7.5	Selection and production of vesicular-arbuscular mycorrhizal (VAM) inoculum	185

7.6	Selection and production of ericoid endomycorrhizal inoculum	187
7.7	Conclusions and future developments	188
Chapter 8	<i>Rhizobium</i> inoculation of crop plants	197
	<i>D. Gareth Jones and D.M. Lewis</i>	
8.1	Introduction and historical background	197
8.2	The nature of rhizobial inoculants	201
8.3	The extent and success of <i>Rhizobium</i> inoculation	209
8.4	Future prospects	211
Chapter 9	The use of microorganisms in plant breeding	225
	<i>G.M. Evans</i>	
9.1	Introduction	225
9.2	<i>Agrobacterium</i> -mediated gene transfer	227
9.3	Viral genomes as transformation vectors	233
9.4	Application to plant breeding	235
9.5	Future prospects	242
9.6	Conclusions	245
Chapter 10	The mushroom industry	249
	<i>J.F. Smith</i>	
10.1	History of mushroom culture	249
10.2	The role of microorganisms in composting	255
10.3	Microorganisms and fruitbody initiation	263
10.4	Future trends	265
Chapter 11	The exploitation of microorganisms in the processing of dairy products	273
	<i>A.H. Varnam</i>	
11.1	Introduction	273
11.2	Starter microorganisms in manufacture of cheese and fermented milk	274
11.3	Starter technology in manufacture of yoghurt and other fermented milks	281
11.4	Starter technology in production of soft cheese	284
11.5	Starter technology in manufacture of hard, semi-hard and semi-soft cheese	287
Chapter 12	The exploitation of microorganisms in the manufacture of alcoholic beverages	297
	<i>A.H. Varnam</i>	
12.1	Introduction	297
12.2	The key role of <i>Saccharomyces</i>	297

12.3	Microorganisms in the brewing of beer	302
12.4	Microorganisms in wine-making	311
12.5	Manufacture of other non-distilled alcoholic beverages	315
12.6	Manufacture of distilled alcoholic beverages	316
Chapter 13	The exploitation of moulds in fermented foods	321
	<i>R.A. Samson</i>	
13.1	Introduction	321
13.2	Fungal flora involved in fermentation of food	322
13.3	Growth characteristics of food-fermenting moulds	325
13.4	Two examples of traditional food-fermenting products	329
13.5	Starter cultures	332
13.6	Safety	332
13.7	Alternative substrates of food-fermenting fungi	334
13.8	Conclusions	335
Chapter 14	The exploitation of microorganisms in the developing countries of the tropics	343
	<i>K.A. Jones, A. Westby, P.J.A. Reilly and M.J. Jeger</i>	
14.1	Introduction	343
14.2	Use of microbes for pest control	344
14.3	Fermentation – a low-cost, appropriate technology for lesser developed countries	354
Chapter 15	Microorganisms and detoxification of industrial waste	371
	<i>M.T. Balba</i>	
15.1	Introduction	371
15.2	Factors affecting biodegradation	371
15.3	Strategems used by microorganisms for the degradation of xenobiotics	379
15.4	Biodegradation of major groups of environmental pollutants	380
15.5	The prospects of microbial application to toxic waste treatment	389
15.6	General conclusions	406
Chapter 16	Formulation of biological control agents	411
	<i>D.J. Rhodes</i>	
16.1	Introduction	411
16.2	Principles of formulation	412
16.3	Properties of biological control agents	413

Contents

ix

16.4	Requirements for formulation, distribution and application	418
16.5	Available technology	420
16.6	Application to the foliar surface	423
16.7	Application to soil	429
16.8	Postharvest and non-agricultural applications	433
16.9	Conclusions	434

Chapter 17	The commercial exploitation of microorganisms in agriculture	441
	<i>K.A. Powell</i>	
17.1	Introduction	441
17.2	Microbial control agents	441
17.3	Mycorrhizal inoculants	449
17.4	<i>Rhizobium</i> inoculants	449
17.5	Historical aspects	450
17.6	Future prospects	451
17.7	Developmental influences for biological control agents	451
17.8	Conclusion	457
Index		461