

Contents

Preface — V

List of contributing authors — XI

Ireneo B. Pangga, Arnold R. Salvacion, and Christian Joseph R. Cumagun

- 1 Climate change and plant diseases caused by mycotoxigenic fungi: implications for food security — 1**
 - 1.1 Introduction — 1**
 - 1.1.1 Mycotoxigenic fungi and food security — 2**
 - 1.1.2 Climate change and food security — 3**
 - 1.1.3 Climate change effects on plant diseases and food security — 4**
 - 1.2 Effects of climate change on plant diseases caused by mycotoxigenic fungi — 5**
 - 1.2.1 Epidemiology and resistance — 5**
 - 1.2.2 Pathogen population genetics and evolution — 10**
 - 1.3 Prediction of climate change effects on epidemics — 12**
 - 1.3.1 Bioclimatic niche models — 13**
 - 1.3.2 Climate change scenario models — 16**
 - 1.4 Management of plant diseases caused by mycotoxigenic fungi under climate change — 19**
 - 1.5 Outlook and conclusions — 20**

X. Li and X. B. Yang

- 2 Impact of climate change on genetically engineered plants and mycotoxigenic fungi in the north central region of the US — 29**
 - 2.1 Introduction — 29**
 - 2.2 GMO cropping systems in US agriculture — 33**
 - 2.2.1 The establishment of GMO cropping systems in the US — 33**
 - 2.2.2 Glyphosate-resistant crops and Bt transgenic techniques — 34**
 - 2.2.3 General impact of GM crops on US agriculture — 34**
 - 2.2.4 Impact of GM crops on mycotoxigenic fungi — 35**
 - 2.3 Global climate change and current situation in the US — 36**
 - 2.4 Impacts of climate change on the occurrence of mycotoxigenic fungi — 38**
 - 2.4.1 The impact of climate change in the off-seasons: winter and early spring — 38**
 - 2.4.2 Impact of climate change on planting date and fungi at seedling stages — 39**

- 2.4.3 Impact of climate change on crops and diseases in late spring and summer — 41
- 2.4.4 Increased use of fungicides — 44
- 2.5 Summary and future risks — 44

José-Miguel Barea

- 3 Interactions among plants, arbuscular mycorrhizal and mycotoxigenic fungi related to food crop health in a scenario of climate change — 53**
 - 3.1 Introduction — 53
 - 3.2 Arbuscular mycorrhizal (AM) symbiosis — 55
 - 3.2.1 AM establishment, function, and management — 55
 - 3.2.2 AM and stress alleviation in plants — 57
 - 3.2.3 Effects of agricultural practices on AM symbiosis — 58
 - 3.3 Interactions among plants, AM symbiosis, and mycotoxigenic fungi related to plant health — 59
 - 3.3.1 The effect of AM on plant protection against pathogens and pests — 59
 - 3.3.2 Mycorrhiza-induced resistance and priming of plant defenses — 60
 - 3.3.3 Interactions between AM symbiosis and mycotoxigenic fungi — 62
 - 3.3.4 Impact of climate change on AM fungi and repercussions for the protection of food crops against fungal diseases — 63
 - 3.3.5 Research perspectives and opportunities for exploiting the interactions between mycotoxigenic and AM fungi with regard to plant health as affected by climate change — 64

Angel Medina, Alicia Rodriguez, and Naresh Magan

- 4 Changes in environmental factors driven by climate change: effects on the ecophysiology of mycotoxigenic fungi — 71**
 - 4.1 Background — 71
 - 4.1.1 Environmental change, fungal adaptation, and mycotoxins — 71
 - 4.1.2 Climate change and mycotoxigenic fungi — 72
 - 4.2 Ecophysiological modifications on mycotoxigenic fungi under climate change conditions — 75
 - 4.2.1 Two-way $a_w \times$ temperature interactions — 75
 - 4.2.2 Three-way $a_w \times$ temperature \times CO₂ interactions — 79
 - 4.3 Climate change impact on mycotoxin gene cluster expression and its relationship to growth and toxin production. — 82
 - 4.4 Conclusions — 85

Antonio Moretti and Antonio F. Logrieco

- 5 Climate change effects on the biodiversity of mycotoxigenic fungi and their mycotoxins in preharvest conditions in Europe — 91**
 - 5.1 Introduction — 91

- 5.2 Climate change and the risk of aflatoxin and *Aspergillus* contamination in Europe — 93
- 5.3 Fusarium head blight (FHB) of cereals: impact of climate change on the risk of trichothecenes and *Fusarium* contamination in Europe — 96
 - 5.3.1 Organization of *TRI* loci and trichothecene structural variation — 97
 - 5.3.2 FHB of minor cereals — 98
 - 5.3.3 Impact of climate change on the *Fusarium* species profile associated with FHB — 101

Leif Sundheim and Trond Rafoss

- 6 Fumonisin in maize in relation to climate change — 109
 - 6.1 Introduction — 109
 - 6.2 Fumonisin-producing fungi — 110
 - 6.2.1 Biology of fungi producing fumonisin — 111
 - 6.3 Fumonisin accumulation in developing maize kernels — 113
 - 6.3.1 Fumonisins are not required for pathogenicity — 113
 - 6.3.2 Insect damage increases risk of fumonisin contamination — 114
 - 6.3.3 Small grain cereals contaminated with fumonisins — 115
 - 6.3.4 Other crops and commodities contaminated with fumonisins — 115
 - 6.4 Geographical distribution of fumonisins in maize — 116
 - 6.4.1 Africa — 117
 - 6.4.2 Europe — 118
 - 6.4.3 South America — 119
 - 6.4.4 North America — 119
 - 6.4.5 Asia — 120
 - 6.5 Climate change predicted by IPCC — 121
 - 6.5.1 Climate effects on fungi producing fumonisin in maize — 121
 - 6.5.2 Effects of temperature — 122
 - 6.5.3 Effects of drought — 122
 - 6.5.4 Effects of elevated CO₂ level — 124
 - 6.6 Conclusions on the effect of climate change on fumonisin — 124

Maria Paula Kovalsky Paris, Yin-Jung Liu, Karin Nahrer, and Eva Maria Binder

- 7 Climate change impacts on mycotoxin production — 133
 - 7.1 Introduction — 133
 - 7.2 Impact of temperature, water availability, and CO₂ on mycotoxin production — 134
 - 7.3 Prediction strategies — 135
 - 7.4 Other factors to consider — 136
 - 7.5 Insights into potential mycotoxin production: focus on Europe — 137
 - 7.6 Trends in mycotoxin occurrence — 138
 - 7.7 Conclusion — 149

María J. Sainz, Amparo Alfonso, and Luis M. Botana

8 Considerations about international mycotoxin legislation, food security, and climate change — 153

8.1 Introduction — 153

8.1.1 Main mycotoxins — 154

8.2 Impacts of climate change on agriculture — 155

8.3 Detection methods — 157

8.3.1 Sampling procedures — 157

8.3.2 Extraction procedures — 157

8.3.3 Mycotoxin analysis — 159

8.3.4 Requirements for mycotoxin analysis methods — 161

8.4 International mycotoxin regulations — 162

8.5 Mycotoxin legislation and climate change — 173

Index — 181