Contents

Contributors ix

1 The Physiology and Molecular Biology of Stress-Induced Senescence

MD. MAHADI HASAN, IFFAT-ARA SHARMEEN, KHALID REHMAN HAKEEM, HESHAM F. ALHARBY, ABDULRAHAMAN S. HAJAR

- 1 Introduction 1
- 2 Senescence-Associated Genes and Abiotic Stress 3
- 3 Salt Stress and Leaf Senescence 6
- 4 Extreme Temperature and Leaf Senescence 6
- 5 Low Temperature and Leaf Senescence 7
- 6 Heavy Metal and Leaf Senescence 7
- 7 Ultraviolet Radiation and Leaf Senescence 8
- 8 Ozone and Leaf Senescence 8
- 9 Conclusions and Future Research 9
- References 10

2 Abiotic Stress and Plant Senescence

SAIEMA RASOOL, BILAL AHMAD MIR, MUNEEB U REHMAN, INSHA AMIN, MANZOOR UR RAHMAN MIR, SHEIKH BILAL AHMAD

- 1 Introduction 15
- 2 Senescence in Plant Cells (Programmed Cell Death) 16
- 3 ROS and Senescence 16
- 4 Abiotic Stress–Induced Chloroplast Degradation During Senescence 19
- 5 UV Radiation–Induced Stress 19
- 6 Drought Stress—Soil Water Scarcity 20
- 7 Strategies to Control Abiotic Stress–Induced Plant Senescence 22
- 8 Conclusion 23
- References 23

3 Plant Leaf Senescence: Integrating Multiple Environmental and Internal Cues SAMIR SHARMA, SUDHIR K. AGARWAL

- 1 Introduction 29
- 2 Characteristics of Leaf Senescence 30
- 3 Changes in Canopy Structure Induces an Inclination to Senesce: The Nitrogen Connection 31
- 4 Light Deprivation: The Central Regulator of Leaf Senescence 32
- 5 Reactive Oxygen in Leaf Senescence: The Mitochondrial Conundrum 35
- 6 Conclusion 37
- References 38

4 Signal Transduction in Leaf Senescence: An Overview

ISHFAQ MAJID, NAZIA ABBAS

- 1 Introduction 41
- 2 Environmental Factors Regulating Leaf Senescence 42
- 3 Hormonal Regulation of Leaf Senescence 43
- 4 Transcriptional Regulation of Leaf Senescence 49
- 5 Conclusion and Perspectives 52
- Acknowledgments 53
- References 53
- Further Reading 59

5 Regulation of Leaf Senescence by Macromolecule Degradation and Hormones

SHABNAM AKHTAR, ALTAF AHMAD, SHIPRA R. JHA, JAVED AHMAD

1 Introduction 61

- 2 Beginning of Leaf Senescence 62
- 3 Genetic Expression During Leaf Senescence 63
- 4 Regulation of Leaf Senescence 70

vi CONTENTS

- 5 Genes Involved in Other Degradative Physiological Processes 87
- 6 Conclusion and Future

Perspectives 87

References 88 Further Reading 97

6 The Role of Growth Regulators in Senescence

IMRAN HAIDER SHAMSI, TICHAONA SAGONDA, XIN ZHANG, GERALD ZVOBGO, HEREN ISSAKA JOAN

Introduction 99
 Plant Growth Regulators 100
 PGRs in Senescence 100
 PGR Cross-Talk 106
 Conclusion 108
 Acknowledgments 108
 References 108
 Further Reading 110

7 Jasmonic Acid (JA)-Mediated Signaling in Leaf Senescence ABID ULLAH, ADNAN AKBAR, XIYAN YANG

- 1 Introduction 111
- 2 Signal Regulation in Leaf Senescence 112
- 3 JA-Induced Leaf Senescence 116
- 4 Conclusion 120

References 120

Further Reading 123

8 Polyamine as Signaling Molecules and Leaf Senescence

AUTAR K. MATTOO, EWA SOBIESZCZUK-NOWICKA

- 1 Introduction 125
- 2 Polyamines and Senescence 126
- Perspectives: Nitrous Oxide (NO), Polyamines (PAs), and Hydrogen Peroxide (H₂O₂)—A Signaling Triad That Regulates Leaf Senescence? 132
 References 134

9 Oxidative Stress and Leaf Senescence: Important Insights

VINAY KUMAR, TUSHAR KHARE, AMRITA SRIVASTAV, CHALLA SUREKHA, VARSHA SHRIRAM, SHABIR H. WANI

- 1 Leaf Senescence: An Important Developmental Process in Plants 139
- 2 Progression and Regulation of Leaf Senescence 140
- 3 Correlation Between Oxidative Stress and Leaf Senescence 147
- 4 Expression Levels of Senescence-Related Genes in the Oxidative Environment 150
- 5 Targeting Leaf Senescence as a Potent Strategy for Crop Improvement Against Abiotic Oxidative Stress 153
- 6 Conclusion 154
- Acknowledgments 155 References 155

Further Reading 162

10 Proteolytic Processes During Leaf Senescence

SHAISTA QADIR, IRAM AYUB, MARYAM SARWAT, RIFFAT JOHN

- 1 Introduction 165
- 2 Experimental Material for the Study of Leaf Senescence 167
- 3 Conclusion and Future Aspects 177 References 178 Further Reading 185

11 Role of Histones During Leaf Senescence

BHUBANESWAR PRADHAN, KRISHNA KUMAR JANGID, MARYAM SARWAT, SUJIT KUMAR BISHI

- 1 Introduction 187
- 2 Physiological and Biochemical Events During Leaf Senescence 188
- 3 Molecular Genetics of Leaf Senescence 189
- 4 Role of Histones in Leaf Senescence 190
- 5 Conclusion and Future Prospects 194
- Acknowledgment 194

References 194

12 Receptor-Like Kinases Control the Development, Stress Response, and Senescence in Plants NISHAT PASSRICHA, SHABNAM K. SAIFI, RAKSHITA SINGH, PUSHPA KHARB, NARENDRA TUTEJA

1 Introduction 199

- 2 RLKs in Plant Development 200
- 3 RLKs in Senescence 201
- 4 RLKs in Hormone Signaling 202
- 5 RLKs in Stress Responses 202
- 6 Abiotic Stresses 203
- 7 Biotic Stresses 205
- 8 Concluding Remarks 206

References 207

13 Flower Senescence: Present Status and Future Aspects MARYAM SARWAT, NARENDRA TUTEJA

1 Introduction 211

- 2 Events Associated With Senescence 213
- 3 Interactions Between Ethylene and Other
- Hormones During Flower Senescence 218
- 4 Conclusion and Future Prospects 221

References 221

14 Nutrient Remobilization During Senescence

MUKHTAR AHMAD BHAT, HELAL AHMAD LONE, SYED SANA MEHRAJ

1 Introduction 227

- 2 Macro and Micronutrient Remobilization During Senescence 228
- 3 Senescence and Sugars 229
- 4 Senescence and Sulfur 230
- 5 Senescence and Potassium 230
- 6 Senescence and Nitrogen 230
- 7 Senescence and Phosphorus 231
- 8 Phytohormone and Senescence 232
- 9 Reactive Oxygen Species and Senescence 233
- 10 Conclusion 234
- References 234

Further Reading 237

15 Autophagy and Senescence Wei LAN, YING MIAO

The Mechanism of Autophagy 240
 Autophagy and Senescence 244
 Discussion 249
 Conclusion 250
 References 250

16 Plant Senescence and Organ Abscission 255

MOHD GULFISHAN, AJMAT JAHAN, TARIQ AHMAD BHAT, DANISH SAHAB

1 Introduction 255

- 2 Mechanism of Senescence and Abscission 257
- 3 Role of Hormones in Senescence and Abscission 261
 4 Conclusion 265
 References 266

Further Reading 272

17 Senescence-Associated Markers JYOTI BALA, ANUPAM J. DAS, HOSHANG UNWALLA

Introduction 273
 Characteristics of Senescence 274
 Senescence-Associated Markers in Plants 275
 Summary 278
 Acknowledgments 279
 Conflict of Interest 280
 References 280

18 Plant Senescence and Agriculture

PRANJAL YADAVA, ALLA SINGH, KRISHAN KUMAR, SAPNA, ISHWAR SINGH

- 1 Introduction 283
- 2 Monocarpic Senescence Versus Polycarpic Senescence 283
- 3 Orchestrated Biological Events During Transition to Flowering 284
- 4 Leaf Senescence in Plants 285
- 5 Senescence Triggers 285
- 6 Biological Changes Accompanying Leaf Senescence 286

viii CONTENTS

- 7 Molecular Mechanisms Operating During Senescence 287
- 8 The Impact of Senescence on Source-Sink Relationship and Crop Yield 288
- 9 Utilization of the Stay-Green Trait in Crop Improvement 289
- 10 Senescence and Postharvest Quality of Produce 291
- 11 Plant Genetic Engineering for Manipulation of Senescence 291

12 Conclusion 297 Acknowledgments 297 Conflict of Interest 297 References 298 Further Reading 302

Index 303