

Contents

Preface	III
-------------------	-----

CHAPTER 1

Monitoring Electrical Activity and Physiological Processes in Plants	1
--	---

1.1	Electrical Signals and Characteristics in Plants	2
1.1.1	Electrical Signals in Plants	3
1.1.2	Electrical Parameters of Plants	5
1.2	Development of Plant Electrophysiology	7
1.2.1	Development of Plant Electrophysiology Abroad	7
1.2.2	Development of Plant Electrophysiology in China	12
1.2.3	Developmental Dilemmas and Challenges of Plant Electrophysiology	15
1.3	Determination of Real-Time Electrophysiology Information in Plants .	17
1.3.1	Determination of the Real-Time Electrical Signal in Plants . . .	17
1.3.2	Example of Determining Real-Time Electrical Signals – Assessing Cell Transport Capacity in Plant Leaves	21
1.4	Determination of Intrinsic Electrophysiology Information in Plants . . .	28
1.4.1	Intrinsic Electrophysiological Information in Plants: Types and Significance	28
1.4.2	Determination and Characterization of Intrinsic Electrophysiological Information in Plants	32
1.4.3	Examples of Applications for Plants' Intrinsic Electrophysiology Information	42
References		66

CHAPTER 2

Plant Electrophysiology and Assessment of Plant Drought Resistance	75
--	----

2.1	Plant Response to Drought Stress	76
2.1.1	Plant Water Metabolism	76
2.1.2	The Response of Plant Morphological and Anatomical Characteristics to Drought Stress	81

2.1.3	The Responses of Plant Physiological Characteristics to Drought Stress	84
2.1.4	Molecular Responses of Plant Biological Characteristics to Drought Stress	88
2.1.5	Detection of Plant Drought Resistance Using Biological Characteristics	90
2.2	Plants' Electrophysiological Responses to Water Stresses	91
2.2.1	Characterizing the Relationship Between Plant Electrophysiology and Water Stress Conditions	91
2.2.2	Response Characteristics of Plant Electrophysiology to Water Conditions	92
2.3	Principles and Techniques for Characterizing Plant Water Status Based on Leaf Tensity	97
2.3.1	Concept and Determination of Leaf Tensity	98
2.3.2	Relationship Between Leaf Tensity and Water Content	101
2.3.3	Relationship Between Leaf Tensity and Photosynthesis	114
2.3.4	Online Monitoring of Variable Irrigation Based on Leaf Tensity	124
2.4	Principles and Techniques for Characterizing Water Status Using Plants' Intrinsic Electrophysiology	132
2.4.1	Characterizing Plant Water Status by Initial Leaf Tensity	134
2.4.2	Determining Intracellular Water-Use Efficiency and Relative Water-Holding Time in Plants	141
2.5	Characterizing Plant Drought Resistance Using Leaf Electrophysiological-Mechanical Coupling Traits	152
2.5.1	Characterizing Plant Drought Resistance Using Mechanical Characteristics	153
2.5.2	Characterizing Plant Drought Resistance Using Leaf Electrophysiological-Mechanical Coupling Traits	159
	References	166

CHAPTER 3

	Plant Electrophysiological Information in the Detection of Low-Nutrient Tolerance and Nutrient Use Efficiency	175
3.1	Plant Response to Low Nutrients	176
3.1.1	Inorganic Nutrient Uptake and Utilization in Plants	176
3.1.2	Plant Response to Low Nutrient	183
3.1.3	Diagnosis and Detection of Nutrient Deficiencies in Plants	184
3.2	Low Nutrient Tolerance and Nutrient Use Efficiency in Plants	186
3.2.1	Determination of Low Nutrient Tolerance and Nutrient Use Efficiency in Plants	188
3.2.2	Low Nutrient Tolerance and Nutrient Use Efficiency of <i>B. papyrifera</i> in Two Habitats	191
3.2.3	Low Nutrient Tolerance and Nutrient Use Efficiency in Potato and Pepper	194

3.3	Nutrient Transport (Metabolic) Capacity of Plants	196
3.3.1	Methods for Determining Plant Nutrient Transport (Metabolic) Capacity	197
3.3.2	Electrophysiological and Nutrient Translocation Information for <i>B. papyrifera</i> in Two Habitats	199
3.3.3	Information on Electrophysiology and Nutrient Transport in Herbaceous and Woody Plants	203
3.3.4	Information on Electrophysiology and Nutrient Translocation in Potato and Pepper	203
3.3.5	Diversity in Plant Nutrient Transport	203
3.4	Detection of Plant Nutrient-Plundering Capacity	207
3.4.1	Methods for Determining the Nutrient Uptake Capacity of Plants	209
3.4.2	Parameters of the Fitted Equations for <i>B. napus</i> and <i>O. violaceus</i>	210
3.4.3	Electrophysiological Information and Nutrient-Scavenging Capacity of <i>B. napus</i> and <i>O. violaceus</i>	210
3.4.4	Correlation of Electrophysiological Information with Nutrient Transport Capacity	212
3.4.5	Plant Nutrient Plunder Capacity and Environmental Adaptation	214
References		217

CHAPTER 4

Plant Electrophysiology and Assessment of Plant Salt Resistance		221
4.1	Plant Response to Salt Stress	221
4.1.1	Salt Transport and Plant Resistance	222
4.1.2	Response of Plant's Morphological and Anatomic Characteristics to Salt Stress	225
4.1.3	Response of Plant's Physiological Characteristics to Salt Stress	230
4.1.4	Response of the Plant's Molecular Biological Characteristics to Salt Stress	232
4.1.5	Assessment of Plant Salt Tolerance Using Biological Characteristics	234
4.2	Assessment of Plant Salt Resistance Utilizing Plant Electrophysiology	235
4.2.1	Rapid Characterization of Plant Salt Resistance Using Physiological Capacitance and Leaf Tensity	236
4.2.2	Rapid Characterization of Plant Salt Resistance Using Intrinsic Plant Electrophysiology	239
4.2.3	Assessment of Salt Adaptability of Mangrove Plants Under Simulated Tides	252
4.2.4	Characterization of Salt Excretion, Dilution, Ultrafiltration, and Total Salt Resistance of Mangrove Plants	269

4.3	Application of Plant Electrophysiology in Saline Irrigation Practices . .	299
4.3.1	Characterization of Plant Salt Stress Levels by Plant Electrophysiology	299
4.3.2	Characterization of Instantaneous Growth Rate by Plant Electrophysiology	302
4.3.3	Characterization of Irrigation Time Points by Plant Electrophysiology	308
References		314

CHAPTER 5

Electrophysiological Information and Disease Monitoring in Plants		323
5.1	Diagnosis and Resistance to Plant Diseases	324
5.1.1	Types of Plant Diseases and the Process of Susceptibility to Disease	324
5.1.2	Mechanisms of Plant Disease Resistance	326
5.1.3	Detection and Diagnosis of Plant Diseases	328
5.2	Response of Plant Electrophysiological Information to Diseases: An Example of Mycobacteriosis	330
5.2.1	Measurement of the Electrophysiological Information of the Plant in Response to Disease	332
5.2.2	Effect of <i>S. sclerotiorum</i> Infestation on Electrophysiological Information, Intracellular Water Metabolism, and Nutrient Translocation in <i>B. napus</i> Seedlings	336
5.2.3	Effect of <i>S. sclerotiorum</i> Infestation on Electrophysiological Information, Intracellular Water Metabolism, and Nutrient Transport in Flowering <i>B. napus</i>	343
5.2.4	Effect of <i>S. sclerotiorum</i> Infestation on Electrophysiological Information, Intracellular Water Metabolism, and Nutrient Transport in Flowering <i>O. violaceus</i>	350
5.2.5	Electrophysiological Response of <i>B. napus</i> and <i>O. violaceus</i> Under Infestation by <i>S. sclerotiorum</i>	356
5.2.6	Response of Intracellular Water Metabolism and Nutrient Transport in <i>B. napus</i> and <i>O. violaceus</i> Infested with <i>S. sclerotiorum</i>	358
5.2.7	Electrophysiology, Intracellular Water Metabolism, and Nutrient Translocation Response of <i>B. napus</i> and <i>O. violaceus</i> Under Complex Infestation with <i>S. sclerotiorum</i> and Oxalic Acid.	359
5.2.8	Development of a Method for the Early Detection of <i>S. sclerotiorum</i> in <i>B. napus</i> and <i>O. violaceus</i> on the Basis of Electrophysiological Information.	360
5.3	Establishing Plant Health Indices and Disease Incidence Indices: An Example of Mycosis Fungoides	361
5.3.1	Determination of Plant Health Indices and Disease Incidence Indices	362

5.3.2	Metabolic Flow and Rate in <i>B. napus</i> and <i>O. violaceus</i> Infested with <i>S. sclerotiorum</i>	363
5.3.3	Health Index and Disease Index of Mycosis in <i>B. napus</i> and <i>O. violaceus</i> Under Infestation of <i>S. sclerotiorum</i>	366
References		371

CHAPTER 6

Plant Electrophysiology and Assessment of Plant Resistance to Acid and Alkali Stresses		375
6.1	Plant Responses to pH Variations	376
6.1.1	Response of Plant Morphological Traits to pH Variations	376
6.1.2	Response of Plant Nutrient Uptake to pH Variations	377
6.1.3	Physiological and Biochemical Responses of Plants to pH Variations	380
6.1.4	Response of Plant Biological Traits to pH Variations	383
6.2	Assessment of Plant Responses to Environmental Stimuli	384
6.2.1	Traditional Methods for Assessing Plant Responses to Environmental Stimuli	385
6.2.2	Electrophysiology and Cellular Metabolism Energy for Assessing Plant Responses to Environmental Stimuli	386
6.3	Determination of Growth and Physiological Parameters of <i>Iris</i> <i>pseudacorus</i> L. and <i>Iris lactea</i> Pall. Var. <i>chinensis</i> (Fisch.) Koidz Under the Interaction of pH and NaHSO ₃	389
6.3.1	Growth and Sulfur Absorption of <i>Iris pseudacorus</i> L. and <i>Iris</i> <i>lactea</i> Pall. Var. <i>Chinensis</i> (Fisch.) Koidz	390
6.3.2	Determination of Photosynthetic Characteristics and Chlorophyll Contents	393
6.3.3	Determination of Cellular Metabolic Energy	394
6.3.4	Calculation of Energy Allocation Characteristics	394
6.4	Interaction Effect of pH and NaHSO ₃ on Plant Growth and Sulfur Uptake	395
6.4.1	Growth of <i>I. pseudocorus</i> at Various Concentrations of NaHSO ₃	395
6.4.2	Growth of <i>I. pseudocorus</i> and <i>I. lactea</i> Under the Interaction of pH and NaHSO ₃	397
6.4.3	Sulfur Uptake by <i>I. pseudocorus</i> and <i>I. lactea</i> Under the Interaction of pH and NaHSO ₃	403
6.5	Light Energy Use Characteristics of <i>I. pseudacorus</i> and <i>I. lactea</i> Under the Interaction of pH and NaHSO ₃	413
6.5.1	Effect of pH and NaHSO ₃ on Photosynthesis	413
6.5.2	Photosynthetic Characteristics of <i>I. pseudocorus</i> Under NaHSO ₃ Treatments	414
6.5.3	Photosynthetic Characteristics of <i>I. pseudocorus</i> and <i>I. lactea</i> Under the Interaction of pH and NaHSO ₃	416

6.5.4	Chlorophyll Contents of <i>I. pseudocorus</i> and <i>I. lactea</i> Under the Interaction of pH and NaHSO ₃	418
6.5.5	Chlorophyll Fluorescence of <i>I. pseudocorus</i> and <i>I. lactea</i> Under the Interaction of pH and NaHSO ₃	419
6.6	Cellular Metabolic Energy of <i>I. pseudocorus</i> and <i>I. lactea</i> Under the Interaction of pH and NaHSO ₃	421
6.6.1	Electrophysiology-Based Metabolic Energy	421
6.6.2	Cellular Metabolic Energy of <i>I. pseudocorus</i> Under the NaHSO ₃ Treatments	424
6.6.3	Cellular Metabolic Energy of <i>I. pseudocorus</i> and <i>I. lactea</i> Under the Interaction of pH and NaHSO ₃	426
6.7	Energy Distribution Characteristics of <i>Iris pseudacorus</i> and <i>Iris lactea</i> Under the Interaction of pH and NaHSO ₃	429
6.7.1	Normalization of Growth, Photosynthesis, and Cellular Metabolic Energy in <i>I. pseudocorus</i> Under NaHSO ₃ Treatments	429
6.7.2	Normalization of Growth, Photosynthesis, and Cellular Metabolic Energy in <i>I. pseudocorus</i> and <i>I. lactea</i> Under the Interaction of pH and NaHSO ₃	430
6.7.3	Energy Allocation in Resisting Adversity Under the Interaction of pH and NaHSO ₃	439
6.8	Brief Summary	441
	References	443

CHAPTER 7

	Plant Electrophysiological Information and Detection of Plant Health and Adaptation	449
7.1	Evaluation of Plant Health and Adaptability	450
7.1.1	Health Effects of Drought Stress on Plants and Their Adaptive Responses	451
7.1.2	Health Effects of Salt Stress on Plants and Their Adaptive Responses	452
7.1.3	Health Effects of High and Low Temperature Stress on Plants and Their Adaptive Responses	453
7.1.4	Health Effects of Heavy Metal Stress on Plants and Their Adaptive Responses	454
7.1.5	Evaluation of Plant Health and Adaptation	454
7.2	Characterisation of Plant Cell Metabolic Energy Based on Electrophysiological Information	456
7.2.1	Measurement of Metabolic Energy in Plant Cells	457
7.2.2	Variation of the Physiological Capacity, the Resistance, and the Impedance with the Clamping Force in Different Leaves of the <i>B. papyrifera</i> and <i>M. alba</i>	459
7.2.3	Specific Effective Thickness and Cellular Metabolic Energy of Different Leaves	460

7.3	Application of Plant Electrophysiological Information in Plant Health Assessment	463
7.3.1	Methods for Detecting Healthy Plant Vigour	464
7.3.2	Diurnal Variation of Electrophysiological Signals in Four Plant Species Under Different Weather Conditions	468
7.3.3	Construction of Circadian Rhythm Models for Four Plant Species Based on Electrophysiological Signals	471
7.3.4	Comparison of Four Circadian Rhythm Characteristics Based on Physiological Resistance	471
7.3.5	Comparison of Four Circadian Characteristics Based on Physiological Capacitance	475
7.3.6	Comparison of Four Circadian Characteristics Based on Physiological Impedance	477
7.3.7	Comparison of Health Vigour of Four Plant Species Based on Physiological Resistance and Physiological Capacitance	478
7.3.8	Plant Electrophysiological Information and Healthy Plant Vigour	479
7.4	Circadian Rhythms of Plant Electrophysiological Signalling in Response to Simulated Drought Stress	484
7.4.1	Monitoring the Circadian Rhythm of Plant Electrophysiological Signals in Response to Simulated Drought Stress	484
7.4.2	Modelling the Effects of Drought Stress on the Circadian Rhythms of Electrophysiological Signals in <i>B. papyrifera</i> and <i>M. alba</i>	485
7.4.3	Modelling the Effects of Drought Stress on the Circadian Rhythms of Electrophysiological Signals in <i>O. violaceus</i> and <i>B. napus</i>	491
7.4.4	Modelling the Circadian Rhythm of Plant Electrophysiological Signals in Response to Drought Stress	494
7.5	Using Plant Electrophysiological Information to Detect Plant Adaptation (Resistance)	499
7.5.1	Detection of Plant Adaptability (Stress Resistance)	501
7.5.2	Evaluation of Resistance (Adaptation) of Different Potato Varieties	503
7.5.3	Evaluation of Stress Tolerance (Adaptation) of Different Pepper Variety Resources	503
7.5.4	Selection of Stress-Resistant Crop Varieties on the Basis of Electrophysiological Characteristics	509
References		511

CHAPTER 8

Research Significance and Prospects	513
---	-----

8.1	Significance of Determination on Plant Electrophysiological Information	513
-----	--	-----

- 8.1.1 Scientific Significance 513
 - 8.1.2 Application Value 514
 - 8.1.3 Role in Discipline Development 517
- 8.2 Prospect 518