Contents

Prefac	e	vii
1.1 1.2 1.3	ter 1: Plant Growth and Elements in Plant Nutrition Factors Affecting Plant Growth 2 Elements in Plant Nutrition 7 Beneficial Elements 10 Tracer Elements 11 Study Questions 11 Suggested Reading 11	 1
Chap	ter 2: Soil Physical Environment	 12
2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8	Soil Texture 12 Specific Surface Area 13 Soil Structure 14 Bulk Density and Porosity 15 Soil Compaction 17 Soil Water 17 Soil Air 21 Soil Temperature 23 Soil Physical Condition and Nutrient Availability 25 Study Questions 27	
Chan	Suggested Reading 27	28
3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9	Soil Colloids 29 Origin of Charges on Soil Colloids 35 Electric Double Layer 38 Ion Exchange in Soil 38 Buffering Capacity 41 Ion Exchange Equations 43 Root Cation Exchange Capacity 48 Nutrient Movement from Soil to Roots 48 Nutrient Absorption by Plants 51 Nutrient Assimilation 58	 20
	Study Questions 64	
	Suggested Reading 64	
Chapter 4: Soil Organic Matter and Manures		 65
4.2	Carbon Cycle 65 Decomposition of Organic Matter 66 Influence of C/N Ratio on Decomposition 70	

x	Soil Fertility and Plant Nutrition	
4.5	C/N Ratio in Soils 71 Humus 71 Role of Organic Matter on Soil Productivity 74	
	Soil Carbon Sequestration 76	
	Management of Soil Organic Matter 77	
	Manures 78	
4.10	Current Approach to Maintenance of Organic Matter in Soil 83	
	Study Questions 86	
	Suggested Reading 86	
Chap	ter 5: Soil Acidity, Salinity and Alkalinity	 87
5.1	Sources of H ⁺ /OH ⁻ Ions in Soil 88	
5.2	Genesis of Acid Soils 90	
5.3	Occurrence of Acid Soils in the World and India 90	
	Different Pools of Soil Acidity 90	
	Buffering of pH in Soil 92	
	Soil Reaction and Plant Growth 94	
	Liming Materials 94	
	Lime Requirement 95	
	Management of Acid Soils 98 Occurrence of Salt-affected Soils 99	
	Development of Alkaline Soils 100	
	Characterization of Salt-affected Soils 101	
	Classification of Salt-affected Soils 102	
	Growth of Plants on Salt-affected Soils 104	
5.15	Reclamation of Salt-affected Soils 105	
5.16	Management of Salt-affected Soils 112	
5.17	Quality of Irrigation Water 113	
5.18	Use of Brackish Water for Irrigation 118	
	Study Questions 119	
	Suggested Reading 120	
Chapter 6: Nitrogen		 121
6.1	The Nitrogen Cycle 121	
6.2	Functions of Nitrogen in Plants 121	
6.3	Biological N ₂ -fixation 123	
	Forms of Soil Nitrogen 127	
	Nitrogen Transformation in Soil 128	
	Losses of Nitrogen from the Soil 133	
	Addition of Nitrogen by Rain Water and Snow 134	
6.8	Addition through Manures and Fertilizers 134 Study Questions 142	
	Study Questions 142 Suggested Reading 142	
Ole -		7.40
Cnap	ter 7: Phosphorus	 143

7.1 The Phosphorus Cycle 143

7.2 Functions of Phosphorus in Plants 144

Contents

7.3	Forms of Phosphorus in Soil 145	
	Phosphorus Transformation in Soil 147	
7.5	Losses of Phosphorus from Soils 153	
7.6	Phosphorus Sources 153	
	Study Questions 160	
	Suggested Reading 160	
Chap	ter 8: Potassium	 161
	The Potassium Cycle 161	
	Functions of Potassium in Plants 162	
	Forms of Potassium in Soils 163	
	Factors Affecting Potassium Availability 165	
	Quantity–Intensity Relationship of Potassium 166	
	Potassium Fixation/Release 167	
	Losses of Soil Potassium 169	
8.8	Potassic Fertilizers 169	
	Study Questions 171	
	Suggested Reading 171	
Chap	ter 9: Calcium, Magnesium and Sulphur	 172
	Calcium (Ca) 172	
	Sources and Forms of Calcium in Soil 173	
9.3	Losses of Calcium 174	
9.4	Availability of Calcium in Soils 174	
	Calcium Sources 175	
9.6	Magnesium (Mg) 175	
9.7	Sources and Forms of Magnesium in Soil 176	
9.8	Losses of Magnesium 176	
9.9	Availability of Magnesium in Soils 177	
9.10	Magnesium Sources 177	
	Sulphur (S) 177	
9.12	Functions in Plants 179	
	Sources and Forms of Sulphur in Soil 180	
	Losses of Sulphur 181	
9.15	Sulphur Sources 182	
	Study Questions 182	
	Suggested Reading 182	
Chap	ter 10: Micronutrients	 183
10.1	Iron (Fe) 184	
	Zinc (Zn) 189	
	Copper (Cu) 194	
	Manganese (Mn) 198	
	Molybdenum (Mo) 202	
	Boron (B) 206	
	Chlorine (Cl) 211	
10.8	Cobalt (Co) 214	

xii	Soil Fertility and Plant Nutrition		
	Nickel (Ni) 215 Beneficial Elements 216 Study Questions 220 Suggested Reading 220		
Chap	ter 11: Submerged Rice Soils		221
11.2 11.3 11.4	Types of Submerged Soils 221 Characteristics of Submerged Soils 222 Electrochemical Changes 226 Chemical Transformation of Nutrients 229 Management of Rice Soils 235 Study Questions 236 Suggested Reading 236		
Chap	ter 12: Soil Fertility Evaluation		237
12.2 12.3 12.4 12.5 12.6 12.7 12.8	Soil Fertility Concepts 237 Diagnostic Techniques for Soil Fertility Evaluation 238 Nutrient-deficiency Symptoms of Plants 238 Plant Analysis 239 Biological Tests 251 Soil Testing 254 Fertilizer Recommendation 263 Soil Fertility Mapping 265 Specific Problems in Soil Fertility Evaluation 265 Study Questions 266 Suggested Reading 266		
Chap	ter 13: Principles of Nutrient Management		267
13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.9	Nutrient Use Efficiency (NUE) 267 Factors Affecting Fertilizer Use Efficiency 268 Balanced Fertilization 279 Integrated Nutrient Management 280 Nutrient Management of Cropping System 282 Site-specific Nutrient Management 286 Specific Nutrient Consideration 289 Economics of Fertilizer Use 292 Nutrient Management Planning 294 Nutrient Budget 295 Study Questions 299 Suggested Reading 299		
Chapter 14: Nutrient Management and Crop Water Productivity 30			300
14.2 14.3	Crop Water Productivity/Water Use Efficiency 300 Key Principles for Improving Water Productivity 301 Fertilization and Water Extraction by Roots 302 Soil Moisture Level and Nutrient Absorption 303		

Contents	xiii
Contents	xiii

14.5 Precision Agriculture and Water Use Efficiency 311 Study Questions 313 Suggested Reading 313		
Chapter 15: Land Degradation and Environmental Quality		
15.1 Land Degradation 314		
15.2 Soil Pollution 321		
15.3 Soil Degradation and Agricultural Productivity 324		
15.4 Soil Quality/Soil Health 327		
15.5 Environmental Quality 354		
Study Questions 362		
Suggested Reading 362		
Bibliography		363
Appendices		367
Index		373