



# PLANT PATHOLOGY

PD Sharma



Alpha  
Science

# Contents

---

*Preface*

*v*

## **PART ONE: PRINCIPLES OF PLANT PATHOLOGY**

- 1. Introduction** **1.3–1.49**  
What is Disease?, 1.5; Components of Disease (Disease Pyramid), 1.6; Causes of Disease, 1.7; Classification of Diseases, 1.8; History of Plant Pathology, 1.13; Plant Pathology in India, 1.25; Significance of Plant Diseases, 1.27; Basic Procedures in Diagnosis of Plant Diseases, 1.34; Stages in the Development of Disease (Disease Cycle), 1.36; General Symptoms of Plant Diseases, 1.43
- 2. Effects of Pathogens on Physiology of Plants** **2.1–2.6**  
Translocation of Water and Nutrients, 2.2; Transpiration, 2.3; Translocation of Organic Nutrients, 2.4; Photosynthesis, 2.4; Plant Respiration, 2.4; Permeability of Cell Membranes, 2.5; Transcription and Translation, 2.5; Plant Growth, 2.6
- 3. Genetic Basis of Host-Pathogen Interactions** **3.1–3.28**  
Genes and Disease, 3.2; Plant Resistance, 3.4; Genetics of Virulence in Pathogen and Resistance in Host Plant, 3.8; Breeding for Disease Resistance, 3.25
- 4. The Attacking Pathogen** **4.1–4.20**  
Pathogenesis or Disease Development, 4.2; Plant-Parasite Relationship, 4.9; Weapons of Attack, 4.9; Enzymes in Plant Disease, 4.10; Microbial Toxins in Plant Disease, 4.14; Growth Regulators in Plant Disease, 4.19; Polysaccharides, 4.20; Suppressors of Plant Disease, 4.20
- 5. The Defending Host** **5.1–5.19**  
Preexisting Structural Defense, 5.3; Preexisting Chemical Defense, 5.3; Defense Through Lack of Essential Factors, 5.4; Induced Structural and

Biochemical Defense, 5.5; Induced Structural Defense, 5.7; Induced Biochemical Defense, 5.9; Induced Biochemical Defense in Hypersensitive Response (Monogenic/R gene Resistance), 5.10; Detoxification of Pathogen Toxins, 5.16; Systemic Acquired Resistance by Inoculation with Microbes and Chemicals, 5.17; Plantibodies (Immunization of Plants), 5.18; Genetically-Engineered Disease-Resistant Plants, 5.18	
<b>6. Effect of Environment on Disease Development</b>	<b>6.1–6.10</b>
Temperature, 6.2; Moisture, 6.4; Wind, 6.5; Light, 6.6; Oxygen and Carbon Dioxide Concentration, 6.6; Soil pH, 6.6; Host-Plant Nutrition, 6.7; Herbicides, 6.10	
<b>7. Epidemiology, Assessment and Forecasting of Plant Diseases</b>	<b>7.1–7.20</b>
Slow and Rapid Epiphytotics, 7.3; Elements of an Epidemic, 7.3; Factors Affecting the Development of Epidemic, 7.4; Assessment of Plant Disease and Yield Loss, 7.9; Measurement of Disease Intensity, 7.9; Measurement of Loss, 7.12; Patterns of Epidemics, 7.13; Development of Epidemics, 7.14; Modelling and Computer Simulation of Epidemics, 7.16; New Tools in Epidemiology, 7.17; Forecasting of Plant Disease Epidemics, 7.17; Disease-Warning and Expert Systems, 7.19	
<b>8. Methods of Control of Plant Diseases</b>	<b>8.1–8.40</b>
Methods of Control, 8.2; Agents of Control, 8.3; Regulatory Methods, 8.4; Cultural Methods, 8.6; Physical Methods, 8.8; Chemical Methods, 8.9; Biological Methods, 8.21; Tactics of Biological Control, 8.22; Commercial Biocides in Market, 8.29; Disease Control by Immunisation or Improvement of the Host Resistance, 8.30; Control Versus Management, 8.38; Integrated Disease or Pest Management, 8.39	
<b>9. Biological Control of Insects, Nematodes and Weeds-Biocides in Crop Protection</b>	<b>9.1–9.35</b>
What is Biocide?, 9.2; Why Biocides?, 9.2; Sources of Biocides, 9.3; Biocontrol of Insect Pests-Bioinsecticides, 9.3; Viral Insecticides, 9.6; Bacterial Insecticides, 9.10; R-DNA Technology for Inserting <i>Bt</i> Genes into Other Organisms, 9.13; Policy of India and Other Developing Countries on Genetically Modified (GM) Crops, 9.19; Fungal Insecticides, 9.21; Protozoa in Insect Control, 9.24; Nematodes in Insect Control, 9.25; Biological Control of Nematodes-Bionematicides, 9.25; Biological Control of Weeds-Bioherbicides, 9.31	
<b>10. Mechanisms of Biological Control</b>	<b>10.1–10.22</b>
Competition, 10.2; Antibiosis, 10.7; Hyperparasitism, 10.14; Hypovirulence, 10.18; Induced Resistance, 10.19; Predation, 10.19; Parasitism, 10.20	
<b>PART TWO: MAJOR CROP PLANT DISEASES</b>	
<b>11. Non-Parasitic Diseases Caused by Environmental Factors</b>	<b>11.3–11.15</b>
Temperature, 11.4; Soil Moisture and Relative Humidity, 11.6; Poor Oxygen, 11.7; Poor Light, 11.8; Air Pollutants, 11.8; Mineral Deficiencies, 11.10;	

Mineral Toxicity, 11.11; Herbicide Injury, 11.11; Tip Burn of Paddy/Pansukh of Rice, 11.11; Black Tip or Mango Necrosis, 11.12; Blackheart of Potato, 11.12; Khaira of Rice, 11.13; Whiptail of Brassicas, 11.14

## **12. Diseases Caused by Bacteria and Mollicutes**

**12.1–12.57**

Characteristic Features of Plant Pathogenic Bacteria, 12.2; General Symptoms of Bacterial Diseases, 12.4; Survival and Spread of Bacterial Plant Pathogens, 12.5; Control of Bacterial Diseases, 12.6; Black Rot/Bacterial Wilt of Crucifers, 12.6; Cassava Bacterial Blight, 12.9; Citrus Canker, 12.10; Bacterial Blight/Angular Leaf Spot/Black Arm of Cotton, 12.12; Bacterial Leaf Blight of Rice, 12.14; Bacterial Leaf Streak of Rice, 12.18; Common Bacterial Blight of Bean, 12.20; Leaf Scald of Sugarcane, 12.22; Bacterial Leaf Spot, Blight and Canker of Mango, 12.24; Red Stripe of Sugarcane, 12.26; Bacterial Wilt of Potato, 12.26; Moko Disease/Bacterial Wilt of Banana, 12.28; Bacterial Stalk Rot of Maize, 12.31; Bacterial Soft Rot of Potato, 12.32; Bacterial Blight of Soybean, 12.34; Fire Blight of Apple and Pear, 12.35; Bacterial Rot/Yellow Ear/Tundu of Wheat, 12.36; Common Scab of Potato, 12.37; Diseases Caused by Fastidious Vascular Bacteria, 12.39; Ratoon Stunting of Sugarcane, 12.41; Citrus Greening, 12.43; Citrus Variegated Chlorosis, 12.45; Yellow Vein Disease of Cucurbits, 12.45; Bunchy Top of Papaya, 12.45; Some Other Important Bacterial Diseases, 12.46; Diseases Caused by Mollicutes: Phytoplasmas and Spiroplasmas, 12.48; Grassy Shoot of Sugarcane, 12.50; Sandal Spike, 12.51; Little Leaf of Eggplant, 12.53; Purple Top Roll, Marginal Flavescence and Witche's Broom of Potato, 12.54; Root (Wilt) Disease of Coconut, 12.55

## **13. Major Groups of Plant Pathogenic Fungi**

**13.1–13.10**

Somatic Structure, 13.2; Reproduction: Asexual and Sexual Spores, 13.2; Survival, Dissemination and Spread, 13.3; General Symptoms, 13.4; Classification: Major Groups, 13.8; Control of Fungal Diseases, 13.10

## **14. Diseases Caused by Fungal-Like Organisms**

**14.1–14.50**

Plasmodiophoromycetes, 14.2; Club Root of Crucifers, 14.2; Oomycetes, 14.6; Damping-off of Seedlings, Seed Rot, Root Rot, Soft Rot, 14.6; Fruit Rot of Cucurbits, 14.9; Stem/Foot Rot of Papaya, 14.10; Rhizome Rot of Ginger, 14.11; Rhizome and Root Rot of Turmeric, 14.12; Late Blight of Potato, 14.13; Leaf Blight of Colocasia, 14.17; Phytophthora Blight of Pigeon Pea, 14.19; Bud Rot of Palms, 14.21; Kolaroga/Mahali Disease of Areca Palms, 14.23; Gummosis, Foot Rot, Root and Fibrous Root Rot of Citrus, 14.24; Green Ear of Pearl Millet (Bajra), 14.26; Downy Mildew of Jowar, 14.29; Downy Mildew of Maize, 14.31; Downy Mildew of Crucifers, 14.35; Downy Mildew of Pea, 14.37; Downy Mildew of Cucurbits, 14.38; Downy Mildew of Grapes, 14.40; Downy Mildew of Sunflower, 14.44; White Rust/White Blisters of Crucifers, 14.47

- 15. Diseases Caused by True Fungi** **15.1–15.8**  
 Diseases Caused by Chytridiomycota, 15.2; Wart/Black Wart of Potato, 15.2; Diseases Caused by Zygomycota, 15.5; Rhizopus Soft Rot of Fruits and Vegetables, 15.6
- 16. Diseases Caused by Ascomycota** **16.1–16.50**  
 Stem Gall of Coriander, 16.2; Leaf Curl of Peach, 16.4; Leaf Blotch of Turmeric, 16.6; Powdery Mildew of Rose, 16.9; Powdery Mildew of Cereals, 16.10; Powdery Mildew of Peas, 16.13; Powdery Mildew of Rapeseed and Mustard, 16.14; Powdery Mildew of Cucurbits, 16.16; Powdery Mildew of Grapevine, 16.20; Powdery Mildew of Apple, 16.22; Ring Spot of Sugarcane, 16.24; Stem Rot of Paddy, 16.25; Ergot of Cereals and Grasses, 16.26; Ergot of Pearl Millet (Bajra), 16.29; False Smut of Rice, 16.32; Apple Scab, 16.34; Sclerotinia Rot and Wilt of Vegetable and Oilseed Crops, 16.38; Banana Leaf Spot/Shigatoka Disease, 16.41; Blackleg of Crucifers, 16.43; Chestnut Blight, 16.46; Nectria Canker, 16.48; Black Rot of Grape, 16.48; Dutch Elm Disease, 16.49; Ceratocystis Wilts, 16.50
- 17. Diseases Caused by Fungi Imperfecti** **17.1–17.76**  
 Early Blight of Potato, 17.2; Leaf Blight of Wheat, 17.4; Alternaria Leaf and Pod Spot of Crucifers, 17.5; Leaf Spot/Tikka of Groundnut, 17.8; Cercospora Leaf Spot of Sugar Beet, 17.11; Stripe Disease of Barley, 17.12; Brown Spot/Leaf Spot of Rice, 17.14; Blast of Rice, 17.17; Grey Mold of Gram, 17.21; Colletotrichum Anthracnose: A Menace to Tropical Crops, 17.23; Coffee Berry Anthracnose, 17.24; Red Rot of Sugarcane, 17.26; Ripe Fruit Rot and Die-Back of Chillies, 17.30; Colletotrichum Leaf Spot of Turmeric, 17.32; Anthracnose of Sorghum, 17.33; Anthracnose of Bean, 17.35; Anthracnose of Mango, 17.38; Wilt of Pigeon Pea (Arhar), 17.39; Fusarium Wilt of Cotton, 17.43; Wilt of Linseed, 17.44; Fusarium Wilt/Panama Disease of Banana, 17.45; Wilt of Sugarcane, 17.48; Wilt of Gram, 17.49; Root and Stem Rot Diseases Caused by “Sterile Fungi” (*Rhizoctonia* and *Sclerotium*), 17.50; Sheath Blight of Rice, 17.52; Stem Canker and Black Scurf of Potato, 17.55; Charcoal Rot of Soybean, 17.56; Rhizoctonia Root Rot of Cotton, 17.58; Root and Stem Rot of Jute, 17.58; Ascochyta Blight of Gram, 17.59; Phomopsis Blight and Fruit Rot of Eggplant, 17.61; Leaf and Glume Blotch of Wheat and Other Cereals, 17.63; Mango Malformation, 17.64; Postharvest Diseases of Plant Products, 17.68; Notes on Some Other Important Plant Diseases Caused by Fungi Imperfecti, 17.74
- 18. Diseases Caused by Basidiomycota** **18.1–18.73**  
 Rusts, 18.2; Spores States of Rust Fungi, 18.2; Life Cycle Patterns in Rust Fungi, 18.3; Host-Rust Relationship, 18.4; Rusts of Wheat, 18.4; Black/Stem Rust of Wheat, 18.6; Yellow/Stripe Rust, 18.10; Brown/Orange/Leaf Rust, 18.11; Rust of Groundnut, 18.18; Rust of Sunflower, 18.21; Rust of Pearl Millet (Bajra), 18.25; Cedar-Apple Rust, 18.26; Rust of Beans, 18.28; Rust of Pea and Lentil, 18.30; Rust of Gram, 18.31; Leaf Rust of Coffee, 18.32; Rust

of Linseed (Flax), 18.35; White Pine Blister Rust, 18.37; Soybean Rust, 18.40; Smuts, 18.40; Plant Parts Attacked by Smuts, 18.41; Modes of Survival and Routes of Infection of Smut Fungi, 18.41; Loose Smut of Wheat, 18.43; Loose Smut of Barley, 18.46; Covered Smut of Barley, 18.47; Loose Smut of Oat, 18.48; Covered Smut of Oat, 18.50; Smut of Sugarcane, 18.52; Grain/Kernel Smut of Jowar, 18.55; Head Smut of Jowar and Maize, 18.57; Loose Smut of Jowar, 18.58; Long Smut of Jowar, 18.59; Smut of Pearl Millet (Bajra), 18.60; Covered Smut/Bunt of Wheat, 18.62; Karnal Bunt of Wheat, 18.65; Bunt of Rice, 18.69; Flag Smut of Wheat, 18.70; Leaf Smut of Rice, 18.73

## **19. Diseases Caused by Viruses and Viroids**

**19.1–19.54**

General Characteristics of Plant Viruses, 19.2; Virus Infection and Virus Synthesis, 19.4; Translocation and Distribution of Viruses in Plants, 19.5; Symptoms Caused by Plant Viruses, 19.6; Transmission of Plant Viruses, 19.9; Purification, Detection and Identification of Plant Viruses, 19.12; Control of Plant Viruses, 19.16; Nomenclature and Classification of Plant Viruses, 19.17; Tobacco Mosaic, 19.20; Potato Mosaics, 19.22; Potato Leafroll, 19.25; Yellow Leaf Curl of Tomato, 19.27; Tomato Mottle, 19.29; Yellow Vein Mosaic of Bhindi, 19.30; Common and Yellow Mosaics of Beans, 19.31; Leaf Mosaic of Cucurbits, 19.33; Rice Tungro, 19.34; Sugarcane Mosaic, 19.37; Sterility Mosaic of Pigeon Pea, 19.38; Leaf Curl of Papaya, 19.41; Papaya Ringspot, 19.42; Bunchy Top of Banana, 19.44; Curly Top of Sugar Beet, 19.46; Pea Seedborne Mosaic Virus, 19.47; Barley Yellow Dwarf, 19.48; Maize Streak, 19.49; Viroids, 19.50; Potato Spindle Tuber, 19.51; Coconut Cadang-Cadang, 19.52

## **20. Diseases Caused by Nematodes**

**20.1–20.18**

Root Knot of Vegetables, 20.5; Molya Disease of Wheat and Barley, 20.9; Ear Cockle of Wheat, 20.12; Soybean Cyst Nematode, 20.14; Potato Cyst Nematode, 20.16; White Tip of Rice, 20.17; Beet Cyst Nematode, 20.18

## **21. Diseases Caused by Flowering Plants and Green Algae**

**21.1–21.9**

Dodder (Amarbel, Love-vine), 21.2; Giant/True/Leaf Mistletoes (Banda), 21.3; Broomrapes, 21.5; Witchweed, 21.6; Parasitic Green Algae, 21.8

## **Glossary**

**G.1–G.10**

## **Recommended Readings**

**R.1–R.3**

## **Index**

**I.1–I.9**